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B. L. KLINE ET AL

2,294,149

METHOD OF AND MEANS FOR RECORDING SIGNALS

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FIG. 1

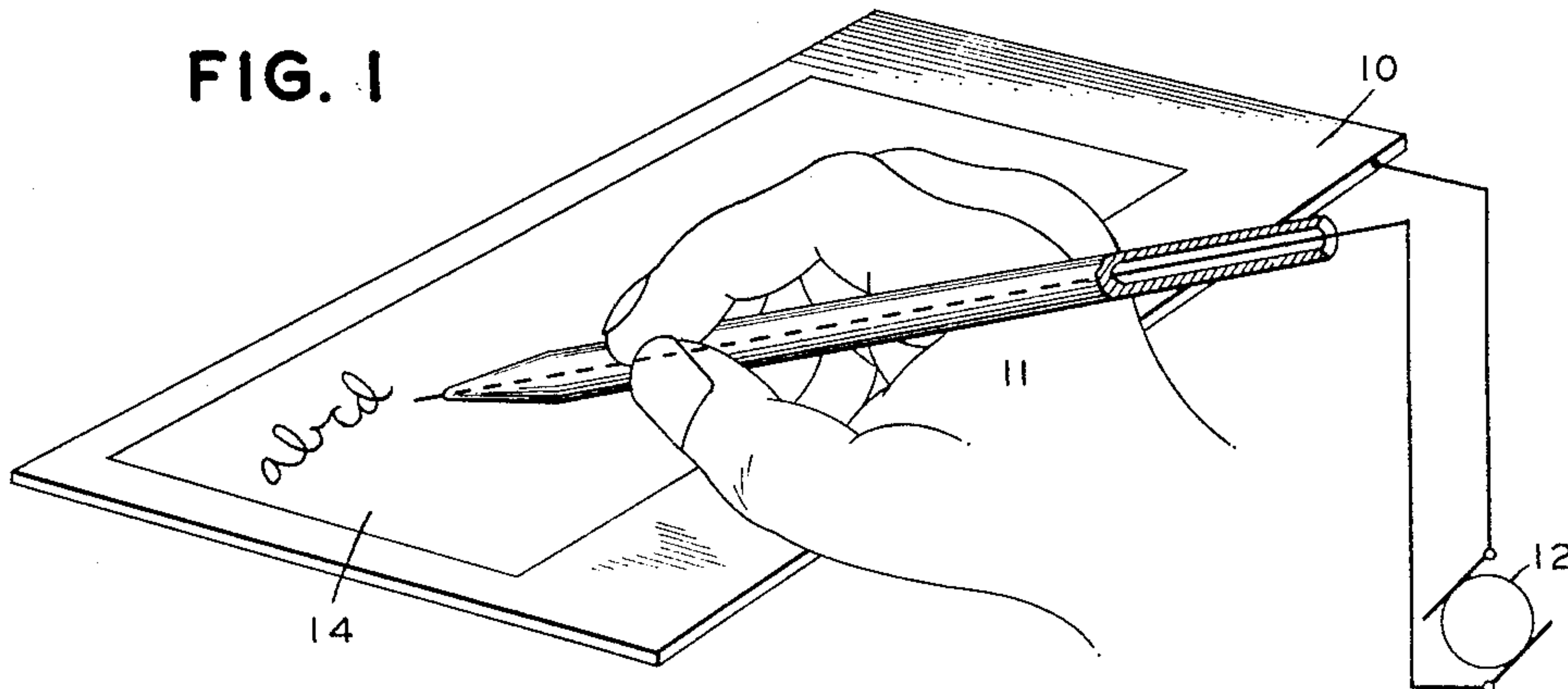


FIG. 2

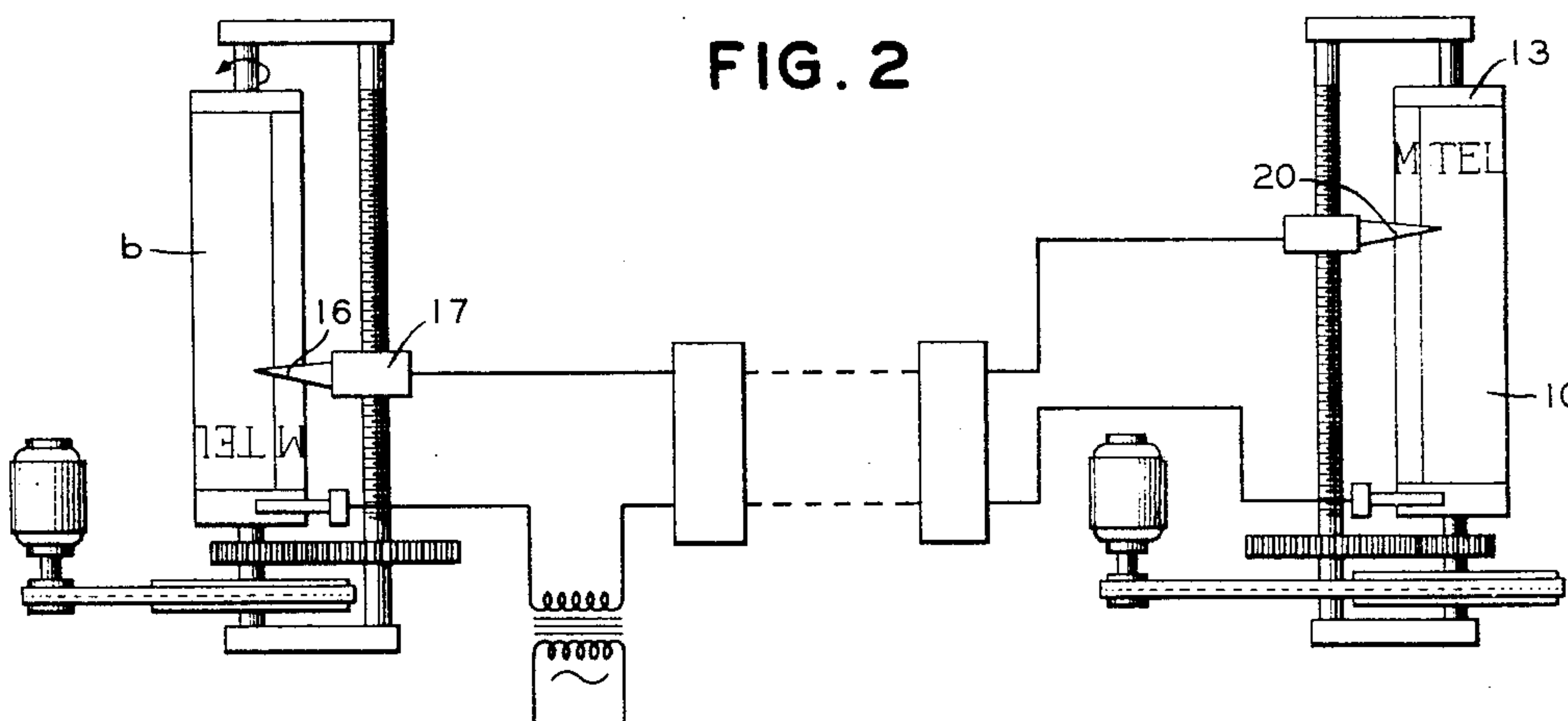
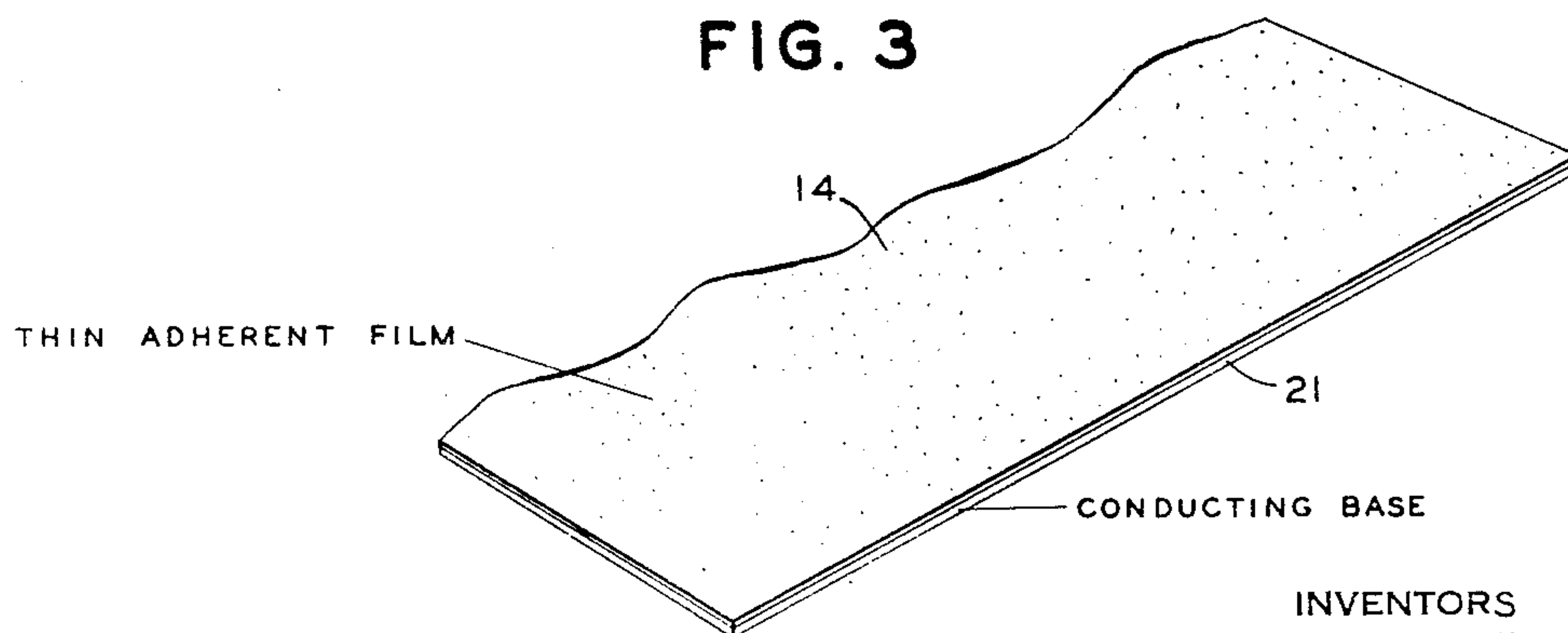


FIG. 3



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METHOD OF AND MEANS FOR RECORDING SIGNALS

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Original application August 31, 1940, Serial No. 354,940. Divided and this application June 7, 1941, Serial No. 396,998. In Great Britain May 3, 1940

8 Claims. (Cl. 178—5)

This invention relates generally to an electro-sensitive recording blank, and more particularly to an electrosensitive blank adapted to record various kinds of subject matter by means of telegraph facsimile or other types of electrical signals which are applied to selected elemental areas of the recording blank by means of an electrode that scans the surface of the recording blank for applying the signals to selected areas thereof.

This application is a division of our application, Serial No. 354,940, filed August 31, 1940, which latter application is in part a continuation of our application, Serial No. 54,484, filed December 14, 1935.

Various methods of recording in facsimile by means of electrical signals and various types of recording mediums have heretofore been proposed, but in general the methods and recording blanks employed required special handling or treatment prior to their use, as in the case where wet recording papers were employed, or required heaters or other mechanisms controlled by signals which in turn operated to mark the message sheet, or required special handling or development treatment after recording, and none of the devices or recording mediums heretofore proposed have enabled satisfactory recording to proceed at a sufficiently fast rate with relatively small amounts of energy whereby they are adapted for use with the currents and voltages ordinarily employed in telegraph recording systems, and none of the prior art methods and recording mediums has produced the sharp definition desired in facsimile recording consistent with producing records which may be scanned at a high rate of speed and with small values of currents and voltages.

For example, it is old to have paper tape impregnated with suitable electrically conducting solutions, said solutions being adapted to be decomposed by signal impulses so that a permanent record of the signal is made. Such recordings, however, are only suitable for relatively coarse work where no fine gradations of tonal values are necessary. This is true in the reception of telegraphic signals in general and recording of various types of curves in connection with the performance of instruments. In the transmission of matter, particularly of pictures and the like, where half-tones are encountered, the range of tonal values extends from what might be termed pure white to pure black.

Prior art methods of recording have suffered

from the serious drawback of diffusion of the record area. Thus, for example, with the wet paper method previously discussed, the capillary action of the paper often results in a spreading of the record element so that satisfactory definition for precise work becomes an impossibility under normal high speed operation.

This invention provides a recording blank which is remarkably free from the above objections. Thus, high speed of recording is a prime requisite due to the customary diversion of a telegraph or other signal transmitting means in connection therewith. The need of high speed operation is further enhanced by requirements for sharp definition, and in picture transmission, increasing the number of lines to the inch by itself increases the length of time required for the making of a record and, therefore, places a slow speed system at a further disadvantage. A further and desirable property of the record is the fact that the recording blanks may be stored under normal conditions for long periods of time without any substantial deterioration and are ready for use at all times. No supplementary treatment of the blanks is necessary apart from the reception of the signal impulses and the transformation of such signal impulses to record elements during the normal process of recording.

The invention in general makes use of the phenomenon of chemical disintegration by electric potentials and currents, the disintegration being generally accompanied by the absorption of electric energy. The substance to be disintegrated is preferably disposed as a thin adherent coating over a base material which for practical purposes may be considered as permanent and uninfluenced by the electric current. This base coating functions as one electrode surface for the entire record coating and also functions to provide a uniform color background which may be exposed to view over selective areas and to predetermined degrees to make up record elements. The material to be disintegrated preferably is of a color to contrast with the base material, which contrast may be as great or as small as the requirements dictate. It is evident that for bold outlines and where considerable picture contrast is required, the contrast between the disintegratable material and base material should be substantial. However, the tonal range of the record may be controlled by controlling the degree of contrast between the base and disintegratable material.

An object of the invention is a recording blank

in which the foregoing disadvantages of the prior art methods are obviated, and which produces sharp definition of the recorded image with a relatively small expenditure of energy and at a high rate of speed, and in which the energy is confined to sharply defined areas beneath a recording stylus or its equivalent at any given instant during the scanning operation.

Another object is an improved recording blank having a coating or surface layer primarily composed of an opaque compound of contrasting color with respect to a conducting base sheet of the blank, and in which partial or substantially complete removal of the coating may easily be effected in the selected elemental areas by the marking currents applied thereto.

A further object of the invention is a recording blank of the character described which is dry and records in the absence of moisture, and is substantially unaffected by humidity, and in which complete recording may be effected with the blank in the same dry state as when the blank was made.

The invention further resides in the features of combination, construction and arrangement hereinafter described and claimed.

We have discovered that certain substances when firmly bound to the surface of a base of suitable conducting material may be removed therefrom by electrical energy applied locally, for example, by a recording stylus to expose the base in varying degrees to delineate a record. We have further discovered that the ease with which these substances can be disintegrated and dissipated and hence removed to expose the surface of the base of the recording blank is substantially inversely proportional to their heats of formation. These substances, especially when embodied in the coating, should be opaque and have a contrasting color with respect to the base of the recording blank so that when they are removed therefrom, the surface of the recording blank will be visible to a greater or less degree.

As an example of such substances suitable for this purpose are metal compounds such as lead thiocyanate, mercuric sulphide, cadmium sulphide, zinc oxide, lead thiosulphate, and titanium dioxide, which in the order named have increasing heats of formation, halogen salts of metals and particularly the iodides of mercury, lead and copper, and opaque organic materials, such as the nickel salt of dimethyl-glyoxime and the complex hansa yellow. That the phenomenon just stated does not necessarily depend upon a chemical change or a change of state of the particular substance appears from the fact that substances such as cadmium sulphide, zinc oxide and titanium dioxide cannot produce a black mark or record by chemical change but must be disintegrated and dissipated and thereby removed from a black or other contrasting color record surface to produce a contrastingly colored mark upon application of energy in accordance with the invention. Again, others of the named substances which are capable of undergoing chemical change to produce a mark by the resulting color change upon application of energy do so when energy is applied in substantially less amounts than that contemplated in practicing the present invention. For example, lead thiocyanate, lead thiosulphate and mercuric sulphide will produce marks by a color change. Lead thiosulphate and lead thiocyanate are converted to colored chemical compounds which remain in the immediate neighbor-

hood of the stylus upon application of electrical energy by the stylus. The mercuric sulphide undergoes an allotropic change upon application of electrical energy, as disclosed in the copending application Ser. No. 23,928, filed May 28, 1935, and in which the present applicants are coinventors. In some instances the change in color may be effected by a change in the content of water of crystallization. The conducting surface may be the surface of a piece of paper or other suitable base material made conducting in the manner described in the copending application of one of the applicants, Ser. No. 38,825, filed August 31, 1935, now Patent No. 2,251,742, issued August 5, 1941, or it may be paper or material of any kind which is made conductive during manufacture, as for example, black carbon bearing paper.

Referring to the drawing:

Fig. 1 is a perspective view of the recording medium and a simplified marking means illustrating the principle of the invention;

Fig. 2 illustrates diagrammatically a facsimile system embodying transmitting and recording means, the said system being of the type employing a receiver in which a telegraphic blank embodying the present invention is adapted to be used; and

Fig. 3 is a perspective view of a telegraphic blank embodying the invention.

Referring for the present to Fig. 1 of the drawing, reference character 10 designates a sheet or block of relatively good conductive material, preferably presenting a black surface. A pencil of stylus 11 is assumed to be movable in contact with the recording medium so that it may be placed at any point where a mark is desired. The platen and the stylus 11 are connected to a source 12 of electrical energy having sufficient power to accomplish marking in the manner contemplated by the invention. The recording medium 14 is applied as a thin adherent film to the sheet 10, which film may be removed in minute, sharply defined areas when the stylus is touched to the surface of the platen with the source 12 in operation. The sheet 10 is preferably of a flexible nature so that it may be rolled, as shown in Fig. 2, for application to the surface of the cylinder 13, of the reproducing device.

In the facsimile apparatus illustrated in Fig. 2, which may be of a conventional type, the scanning electrode or stylus 16, whose point bears on the surface of the blank *b* bearing conductive characters, is supported by a traveling carriage 17 adapted for longitudinal movement. The stylus 16 is caused to traverse the cylinder in a longitudinal manner by any suitable means and therefore the stylus point will describe a helical path as it moves over the surface of the transmitting blank and thus produce a scanning action. A transmitter of this nature is shown in application of R. J. Wise, Ser. No. 23,926, filed May 20, 1935, now Patent No. 2,153,858, issued April 11, 1939. Likewise in the receiving device shown at the right hand side of Fig. 2 of the drawing, the cylinder 13 is rotated and the receiving stylus 20 is advanced axially so that it traverses the blank with a helical movement covering all parts of the blank by a series of parallel lines. It will be understood that any suitable receiver or recording device may be employed and that axial movement may be imparted to the receiving blank as is done in graphic measuring devices.

Referring to Fig. 3, the body 21 of the recording blank which corresponds to the sheet 10 of Fig. 1, may, as previously stated, comprise a sheet of paper or other suitable material made conducting by being impregnated with sodium nitrate dissolved in an alcohol of low volatility as disclosed in the copending application Ser. No. 38,825 referred to above and 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 it may consist of a black carbon bearing paper. The sheet of conducting paper 21 forming the body of the recording blank is preferably of such color that it will contrast with the recording substance which is to be applied to its surface in a manner later to be described.

If the paper layer 21 of the blank is of a kind which is not inherently conductive, it may be necessary to first apply the recording medium to its surface and thereafter to impregnate the back of the paper. By having the electrically conducting material, such as the sodium nitrate solution or carbon embodied in the recording blank adjacent to the recording surface layer, the recording may be accomplished by a small expenditure of energy, which is closely confined to the small area immediately beneath the recording stylus or its equivalent at any instant, and sharp definition of the recorded subject matter is obtained. The coating itself is of a character which readily is disintegrated and dissipated by the passage therethrough of a small marking current, the low heat of formation appearing to promote this ready disintegration and dissipation by small currents. The conductive base immediately beneath the coating provides a relatively good conducting path directly through the recording blank from the point of the stylus to the recording cylinder beneath the blank, and prevents dispersion of substantial amounts of marking current in and around the area of the blank beneath the stylus at any given instant, and thus spraying effects or other undesirable effects in the coating or recording blank at this point are eliminated, and blurring of the mark is obviated.

Inasmuch as the coating to be disintegrated represents the load of the electric current, it is clear that the resistance of the record material should be concentrated in that region. In order to provide a permanent record, the material to be disintegrated may be formed in part from some suitable binder, such as lacquer, gelatin, starch, casein, cellulose derivatives, synthetic resins, and the like. The filler, such as above referred to, is preferably uniformly distributed in finely divided form throughout the binder. The resistance characteristics of the entire mixture may be adjusted by either controlling the resistance characteristics of the binder itself or the filler. In practice the resistance characteristics of the binder are not easily controlled, since such binders are good insulators when dry. Many of the fillers do not have a high degree of conductivity but generally have a lower resistance than the binder itself. By controlling the fineness of the grains of the filler and the dispersion of this material throughout the binder, it is possible to control the electrical breakdown characteristics of the entire coating within reasonable limits. This coating is applied as a surface covering to the base material and for all practical purposes forms a unitary record blank. Inasmuch as the disintegrating properties of the entire coating are

to be maintained at a uniform value with the variations in disintegration being controlled by the intensity of current or potential, the thickness of the coating should be maintained at a substantially constant value throughout the useful area of the record. While the base material itself should have an electric resistance low in comparison with the resistance of the coating, which inherently is high, the resistance of the base material may have a substantial value.

The nature of the coating to be disintegrated may vary within wide limits so long as the coating has a suitable degree of contrast with respect to the base material and is capable of quick disintegration with currents of moderate intensity. For convenience in storing it is preferred to use compounds which are relatively stable with respect to time and are also substantially unaffected by light, moderate changes of heat and moisture such as are present in the atmosphere and which are not unduly expensive.

The recording medium may conveniently be applied to the surface of the blank as an ink which is formed by powdering the material and grinding this powder with a linseed oil to a suitable consistency for application to the surface of the blank by a printing operation, or by grinding in a lacquer or other binder vehicle. It is within the scope of the invention to mix a plurality of selected materials from the preferred group in formulating the ink or other coating mixture. In some circumstances of use it may be desirable to incorporate a trace of drier to aid in oxidation of the oil when in ink form. The powdered substance is not affected in any way by including the drier. Resinates, linoleates of lead, cobalt, manganese, etc., are standard driers and may be used when a drier is considered desirable or necessary.

The recording mediums of the present invention, as stated above, have low heats of formation, lying in the range of from -28,670 calories for lead thiocyanate to 217,400 calories for titanium dioxide. For purposes of producing the mark with the amount of electrical energy available for practical use, best results are obtained when materials are used, the heats of formation of which do not exceed 150,000 calories as an upper limit.

These chemical compounds when ground to a powder in a suitable vehicle may be disintegrated and removed from a conducting surface upon application of electrical energy, as shown by tests which involved weighing pieces of paper bearing a coating of the ink so formed before and after subjecting the ink to the application of electrical energy by a stylus similar to the stylus 11.

The substances having lower heats of formation respond more quickly and are more easily removed by the application of electrical energy impressed by the stylus 11. In all cases it is necessary to use more energy than is required to produce the allotropic change in mercuric sulphide as disclosed in the copending application Ser. No. 23,928 referred to above.

To improve the covering power of the coating mixture, any suitable opaque material may be added. Zinc oxide or titanium dioxide are preferred for this purpose. The zinc oxide is more suitable as it has a heat of formation of 84,350 calories and gives better definition in the received record even though it has a lower covering power than titanium dioxide. The heat of formation of titanium dioxide is given as 217,400 calories. Titanium dioxide when used in small

amounts is suitable, but if too much of this opaque material is used, definition of the record may be impaired and an increase in the applied electrical energy is necessary.

In recording upon a blank embodying the present invention, the coating is removed immediately under the stylus, as current is passed therethrough, to expose the surface of the record blank beneath. The binders named above surround each particle of the filler and prevent the filler from acting in the same manner as it would if exposed to air. It is possible that exposure to air would permit some oxidation resulting in the formation of other chemical compounds which may be colored and which may interfere with disintegration of the film in the manner contemplated.

Combinations of the materials which are comprised within the desired group have been proved to give a sharply defined record of a distinctive color contrast. As an example, a telegraphic blank having a greenish yellow background is produced by mixing two parts of lead thiosulphate, two parts of cadmium sulphide and one part of titanium dioxide ground in a linseed oil to a suitable consistency for application by a printing operation to the surface of a black conductive base.

Variations in the color and opacity of the background and sharpness of the record may also be obtained by superimposing a plurality of films, each film containing the same material from the desired group or different materials selected from the group.

From the foregoing disclosure of the invention it will be seen that there is provided a series of recording materials or substances adapted for the formation of ink films or other films and that record blanks covered by such films provide ready means for recording electrical signals. The blanks both before and after use in a recording apparatus may be handled without special precautions as they are not sensitive to ordinary variations of light and/or heat.

The thickness of the coating should be just sufficient to mask the base material and will vary with the opacity. The potential impressed across the coating should be just below the breakdown value so that superposed signal potentials will provide the differential necessary for effective operation. The character of potential appears to be immaterial and recording may be effected with either direct current or alternating current of frequencies ranging into the carrier spectrum.

What is claimed is:

1. A blank for the making of a visual record by electrical currents, said blank comprising as the active portions thereof a base material having a substantially uniform color and functioning as a selectively exposable background, said base material having a substantially good electrical conductivity, a superficial substantially opaque coating directly disposed over said base material as a thin adherent film, said coating having a contrasting color and having a substantial electrical resistance in comparison to the base material but susceptible to break-down under suitable electrical marking potential applied to selected local areas of said coating by a metallic stylus, said coating being adapted to break down under potential difference between said base material and said stylus point and to be disintegrated and dissipated in accordance with the intensity of the potential, to form a sharply defined break-down area whereby upon scan-

ning movement of said stylus over said record, variations in intensity of said break-down of said coating result in variations of exposure of said base material.

2. The blank of claim 1 wherein said coating includes as a substantial ingredient thereof a substance in finely divided form and uniformly distributed therethrough, said substance having a heat of formation of between about 200,000 calories and about -28,000 calories.

3. The blank of claim 1 wherein the coating consists of a binder such as linseed oil, for example, having dispersed therein a substance in finely divided form having a heat of formation lying in the range of between about 200,000 calories and about -28,000 calories.

4. The blank of claim 1 wherein said coating comprises a finely divided suspension of one or more substances having heats of formation of between about 200,000 calories and about -28,000 calories in a binder, said coating being just sufficiently thick to be substantially opaque.

5. A blank for visual recording comprising a base material of uniform color and having substantially good electrical conductivity, a superficial substantially opaque coating as a thin adherent film directly over said blank, said coating having an electrical resistance substantially higher than that of the base material and being susceptible to local disintegration and dispersion from said base by electrical marking currents applied to selected local areas thereof by an inert metallic stylus, said coating having a contrasting color to the base material and including as a substantial ingredient thereof a metallic compound having a heat of formation between about -28,000 calories and about +217,000 calories and the characteristic of being susceptible to ready disintegration by electric currents passing between the stylus and base material.

6. A blank for visual recording comprising a base material of uniform color and having substantially good electrical conductivity, a superficial substantially opaque coating as a thin adherent film over said blank, said coating having an electrical resistance substantially higher than that of the base material and being susceptible to local disintegration and dispersion from said base by electrical marking currents applied to selected local areas thereof by a metallic stylus, said coating having a contrasting color to the base material and including as a substantial ingredient thereof a metallic compound having a heat of formation of the order of 150,000 calories or less and the characteristic of being susceptible to ready disintegration by electric currents passing between the stylus and base material.

7. A blank for visual recording comprising a base material of uniform color and having substantially good electrical conductivity, a superficial substantially opaque coating as a thin adherent film over said blank, said coating being susceptible to local disintegration and dispersion from said base by electrical marking currents applied to selected local areas thereof by a metallic stylus, said coating having a contrasting color to the base material and including as a substantial ingredient thereof at least one compound of a group consisting of lead thiocyanate, cadmium sulphide and zinc oxide and having a heat of formation lying in the range of about -28,000 calories to about +84,000 calories and the characteristic of being susceptible to ready disintegration by electric currents passing between the stylus and base material.

8. A blank for visual recording comprising a base material of uniform color and having substantially good electrical conductivity, a superficial substantially opaque coating as a thin adherent film over said blank, said coating being susceptible to local disintegration and dispersion from said base by electrical marking currents applied to selected local areas thereof by a metallic stylus, said coating having a contrasting color to the base material and including as a substantial ingredient thereof at least one compound

of a group consisting of lead thiocyanate, cadmium sulphide, zinc oxide and halogen compounds of lead, mercury, cadmium, titanium, copper, nickel and zinc and having a heat of formation lying in the range of about -28,000 calories to about +217,000 calories and the characteristic of being susceptible to ready disintegration by electric currents passing between the stylus and base material.

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