Sept. 20, 1960 B. K. GREEN ET AL 2,953,470

METHOD FOR ELECTROSTATIC PRINTING

Filed June 27, 1957

FIG. 1

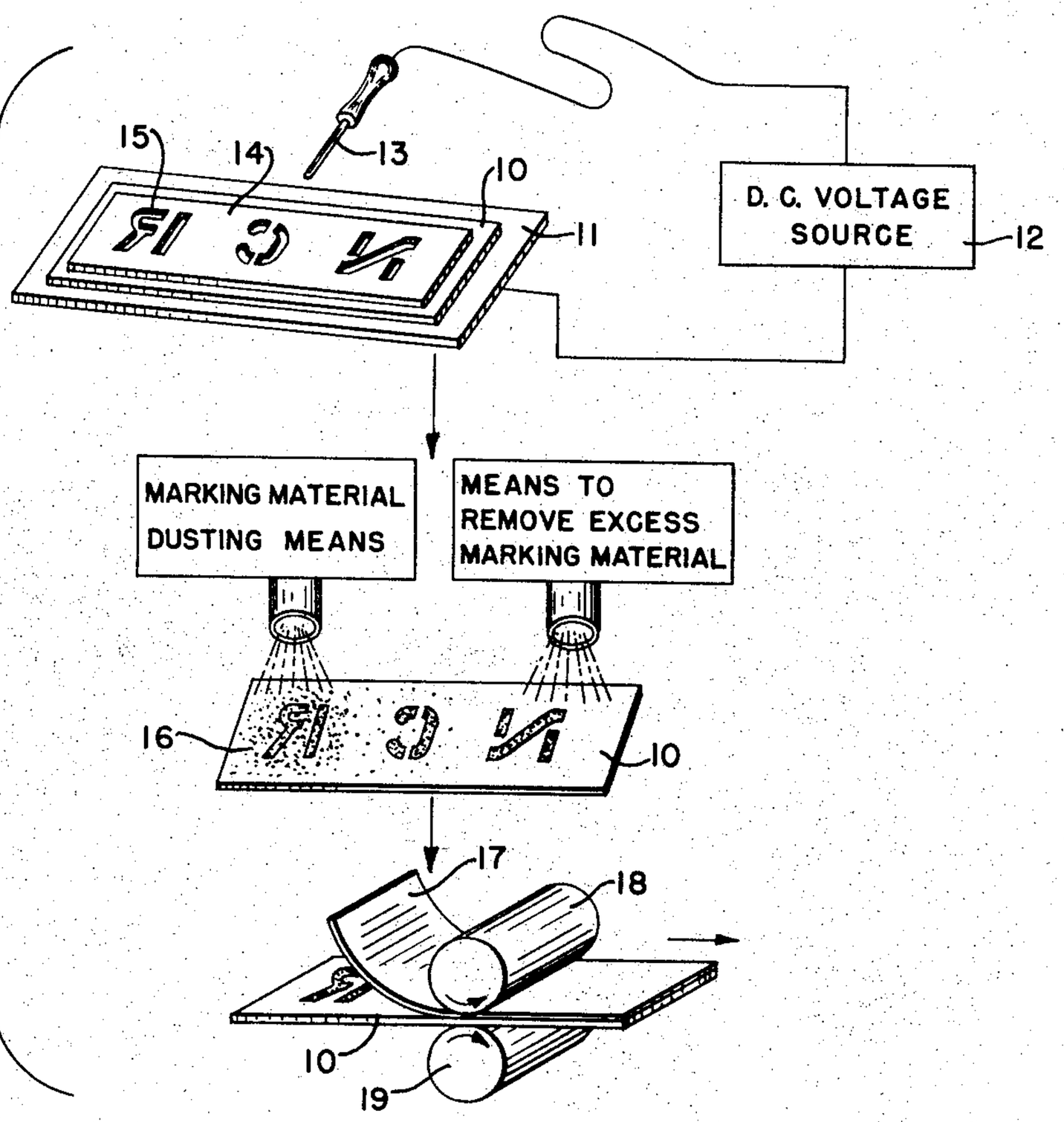


FIG. 2

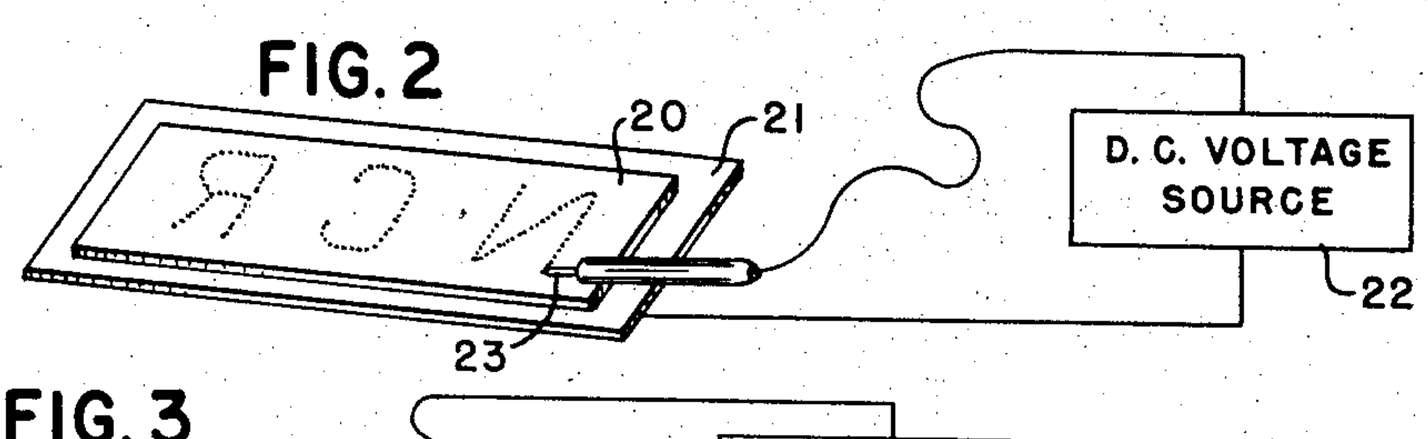


FIG. 3

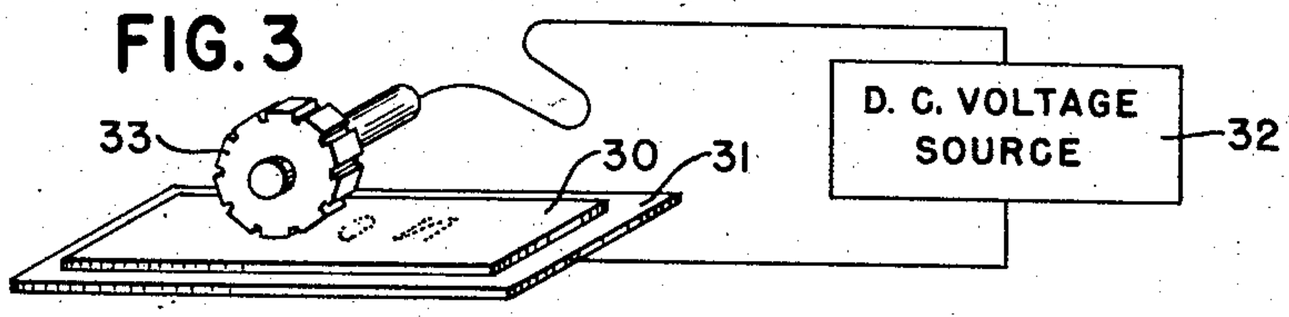
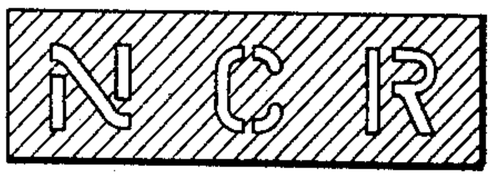


FIG. 4

FIG. 5



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METHOD FOR ELECTROSTATIC PRINTING

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This invention relates to a novel printing method utilizing electrostatic forces.

In the novel method, an electrostatic charge is applied to a charge-receiving member in areas corresponding in shape to the markings desired to be made on a record member. The charge-receiving member is then dusted with marking material which has the appearance and some of the other characteristics of a fine powder, is composed of a great number of microscopic, liquid-containing capsules, and is caused by the electrostatic force to adhere to the charged areas of the charge-receiving member. Excess powder which has fallen on uncharged areas of the charge-receiving member is removed by any suitable means, such as air pressure. The surface of the record member to be printed upon is then placed in engagement with the surface of the charge-receiving member bearing the adhering marking material, and pressure is applied to the capsules of the marking material, as, for example, by placing the assembled charge-receiving member and record member between the rollers of a press, to rupture the capsules and release the marking fluid for printing on the record member in areas corresponding to the charged areas of the charge-receiving member. Printing completed, the record member and the charge-receiving member may be separated, after which the charge-receiving member may be reconditioned for further use.

An important advantage of this invention is that no binder is required to cause the marking material to adhere to the record member, since the released marking material is in a liquid state and directly marks the member. Also, no application of heat or other fixing treatment to create a permanent bond between the marking material and the record member is necessary. Since the liquid marking material is encapsulated, the capsules taking the form of a dry powder, the handling and the application of the marking material are greatly facilitated.

An object of this invention is to provide a novel method of printing.

A further object is to provide a novel method of printing which utilizes electrostatic force.

Another object is to provide a novel method of electrostatic printing in which a charge-receiving medium is provided with an electrostatic charge in selected areas thereof, encapsulated liquid marking material in dry powder form is applied to the charge-receiving medium and adheres to the surface of said medium only in the areas provided with the charge, a record member is placed on the marking-material-bearing surface of the charge-receiving member, and the liquid marking material is then expressed from the individual capsules to mark the record member in a pattern corresponding to the pattern of the charges on the charge-receiving medium.

Another object is to provide a novel method of electrostatic printing in which a charge may be applied to selected areas of a dielectric member, either by direct contact or by use of a stencil and an electrical discharge,

for retaining marking material in position for printing on a record member.

An additional object is to provide a novel method of printing in which encapsulated marking material is caused to adhere to a charge-receiving medium in selective charged areas and is then expressed from the capsules for marking a record member placed in juxtaposition to the charge-receiving medium for printing on the record member in a pattern corresponding to the charges on the charge-receiving medium.

Still another object is to provide a novel method of electrostatic printing in which the record member may be marked with either a positive or a reverse image, using the same apparatus, simply by reversal of the polarity of the charging means.

Still a further object is to provide a novel method of electrostatic printing in which the adhering qualities of the encapsulated marking material may be enhanced by the mixture of a charge-forming medium with said encapsulated marking material.

With these and incidental objects in view, the invention includes the use of novel process steps, some of which are optional or alternative, described with reference to the drawing which accompanies and forms a part of this specification.

In the drawing:

Fig. 1 is a diagram showing in pictorial representation the various steps of the novel process of this invention, and exemplary apparatus which may be used to perform these steps.

Figs. 2 and 3 show alternative means which may be used for placing a charge on selected areas of the dielectric charge-receiving member.

Figs. 4 and 5 show a typical record member bearing printing accomplished by means of the novel process, and show the effect of reversing the polarity of the voltage supply used in applying the charge to the dielectric member.

As the first step in the novel printing process of the present invention, it is necessary to place a charge on certain areas of a dielectric member in accordance with the indicia which it is desired to print. This may be accomplished by the apparatus shown topmost in Fig. 1, though such apparatus forms only one of several available means for achieving this result.

As shown in Fig. 1, a charge-receiving dielectric member **10** is placed on a conducting plate **11**, which may be of steel, copper, or other conducting material. The member **10** may be made from a sheet of polyethylene terephthalate or from other materials possessing suitable dielectric properties. Other materials which have been tested and found suitable for use as dielectrics in the present invention include sheets of vinylidene chloride polymer, sheets of cellulose nitrate or paper coated with such, and sheets of chlorinated rubber or paper coated with such. The naming of these specific dielectric materials is not to be deemed to limit the scope of the invention.

The conducting plate **11** is connected to one terminal of a D.C. high-voltage supply **12**, the other terminal of which is connected to an electrode **13**. Charges may then be placed on selected areas of the dielectric member **10**, in accordance with the indicia which it is desired to print, in the following manner. A stencil **14** is formed with cut-out portions, such as **15**, corresponding to the inverse image of the indicia which it is desired to print. This is placed over and in engagement with the dielectric member **10**, so that the member **10** is covered or shielded by the stencil **14** except in those areas **15** where the stencil has been cut out.

Now, if the high-voltage supply is made operative, a corona or emission will take place between the electrode

13 and the plate 11. As is well known, gas (in this case, the atmosphere) between two electrodes is ionized in a corona discharge when the potential gradient between the electrodes exceeds a certain value but is not sufficient to cause sparking. In this case, the value of D.C. voltage employed is on the order of eight thousand to ten thousand volts, when a dielectric member of polyethylene terephthalate having a thickness of approximately 0.005 inch is used. A charge is thus developed on the dielectric member 10 in those areas which correspond to the cut-out portions 15 of the stencil 14.

After the charges have been applied to the selected areas of the dielectric member 10, the charged member is moved to a dusting station, where encapsulated fluid marking material 16 in a dry, powdery, or granular form is applied thereto. The dusting station may comprise a dusting chamber, as indicated in Fig. 1, or the dusting may be accomplished in some other manner, as, for example, by hand. The encapsulated marking material is dispersed over a substantial area of the dielectric member 10 but will adhere to the charged areas of said member, due to electrostatic attraction exerted by said areas.

For a description of the method of making encapsulated marking material of the type used in the method of the present invention, reference may be had to the United States application for Letters Patent Serial No. 365,105, filed June 30, 1953, by Barrett K. Green and Lowell Schleicher, inventors, now U.S. Patent No. 2,800,457, issued July 23, 1957. As disclosed in that application, marking material of various types may comprise, or be contained in, a fluid in turn contained in microscopic capsules which are spray-dried to assume a dry, granular, powder-like form, suitable for application to the charged dielectric member 10 by dusting techniques or other suitable means of application. The marking material thus provided in the capsules is released by rupture of the microscopic capsules under the required amount of pressure. The marking material may be a conventional oil-base ink or dye which will mark the surface of any record member or other object with which it comes into contact, or it may be a colorless color reactant such as that disclosed and claimed in the U.S. Patent No. 2,730,456, issued January 10, 1956, to Barrett K. Green and Lowell Schleicher, which turns to a colored form only on contact with a record member sensitized by having thereon an acid clay-like material.

It has been found that the particles of encapsulated marking material will also be attracted by the charged areas of the dielectric member 10 if a number of glass beads of a very small diameter are interspersed with said particles. The marking material, in dry, granular form, and the beads are thoroughly mixed, and the resulting mixture is applied to the dielectric member 10 in the dusting chamber. It is believed that the mixing of the beads with the marking material causes a triboelectric effect which produces or increases a negative charge on the particles of marking material and thereby renders them more readily attracted to positively-charged areas on the member 10. Use of the glass beads as described above is therefore desirable, although the novel process may be carried on successfully without their use.

Upon completion of dusting the encapsulated marking material 16 onto the member 10, the excess is removed, as shown in Fig. 1, by air pressure or other suitable means, so that the only marking material remaining on the member 10 is that which is caused to adhere to said member in the charged areas due to electrostatic attraction between the particles of the marking material and said charged areas. If desired, the dusting and removal of the marking material may be accomplished in a single operation by blowing the marking material 16 against the dielectric member 10.

It may be noted that the glass beads which were included in the mixture dusted onto the dielectric member

10 will not adhere to the positively-charged areas on said member.

A record member 17, upon which it is desired to print the indicia set up on the member 10, is now brought into engagement with the member 10, with the surface to be printed upon in contact with the surface of the member 10 bearing the encapsulated marking material 16, so that the marking material is sandwiched between the members 10 and 17.

Pressure is then applied to the assembled record member 17 and dielectric member 10, as illustrated, for example, by the pressure rolls 18 and 19, shown in Fig. 1. This pressure ruptures the individual capsules of the encapsulated marking material and expresses the marking material fluid from said capsules and into contact with the surface of the record member 17 to effect printing thereon corresponding to the pattern cut out of the stencil 14.

Printing having been accomplished on the record member 17, it may be removed from the dielectric member 10. The member 10 may, if desired, be sent through a reprocessing station for removal of any marking material retained thereon, and removal of any remainder of the charges thereon, after which it is ready for reuse in another printing operation. If desired, of course, a new member 10 may be used for each printing operation.

An alternative method of placing charges in selected areas of the dielectric member preparatory to printing on a record member is shown in Fig. 2. Here, a charge-receiving dielectric member 20 is placed on a conducting plate 21. The plate 21 is connected to one terminal of a D.C. voltage supply 22, the other terminal of which is connected to an electrode 23.

Using this arrangement, charges may be placed on selected areas or in selected lines of the dielectric member 20 in accordance with the indicia which it is desired to print, merely by using the electrode 23 as a stylus, holding it in contact with the surface of the dielectric member 20, and writing on said surface to produce a mirror image of the indicia to be printed on the record member.

This method of placing a charge on the dielectric member 20 has the advantage that no stencil is required. In addition, since the electrode 23 is placed in direct contact with the dielectric member, a lower voltage, on the order of five hundred to one thousand volts, is all that is required to provide an adequate charge on the dielectric member 20.

Other contact type means for applying charges to the member 20 may readily be used. For example, as shown in Fig. 3, a type-bearing member, such as a type wheel 33, may be connected to a voltage supply 32 and, when brought into contact with a dielectric member 30, positioned on a conducting plate 31, will cause a charge in the mirror image of the desired character to be applied to said member 30. As is the case with the apparatus of Fig. 2, a lower voltage, on the order of five hundred to one thousand volts, is all that is required to provide an adequate charge on the dielectric member 30, using the apparatus shown in Fig. 3.

In addition, other means may be employed for producing localized charges on charge-receiving members. For example, the well-known Xerographic method may be employed, in which selected areas of a charged photoconductive plate, coated with anthracene, selenium, or some other suitable material, are exposed to light.

If desired, the capsules may be transferred to the record member by reversal of electrostatic fields, as is common in the Xerographic art, and the capsules so transferred can be ruptured to cause printing on the record member without any further fixing of the print, as by heat, solvents, or other methods commonly used for this purpose in the Xerographic process.

Two different printing effects, as illustrated in Figs. 4 and 5, may be obtained using the same stencil 14

shown in Fig. 1, the same contact electrode writing means **23** shown in Fig. 2, or the same type wheel **33** shown in Fig. 3, by reversing the polarity of the voltage supply in any of the above instances. It has been found that, when the electrode of Fig. 1 is negative with respect to the plate **11**, the applied encapsulated marking material will adhere to those areas of the dielectric member **10** which were exposed by the cutouts **15** in the stencil **14**. A record member bearing printing as shown in Fig. 4 will result from this arrangement.

However, when the electrode **13** is positive with respect to plate **11**, the marking material will adhere to the areas of the dielectric member **10** which were shielded by the stencil **14** during the time of the corona discharge between the electrode **13** and the plate **11**. Completion of the printing process using a dielectric member charged thus will produce a record member having the appearance of Fig. 5.

Results similar to those described above are obtained by reversing the polarity of the voltage supply of the apparatus shown in Figs. 2 and 3. When the electrode **23** or the type wheel **33** is negative with respect to the plate **21** or **31**, the record member produced will resemble the showing of Fig. 4, and, when the electrode **23** or the type wheel **33** is positive with respect to the plate **21** or **31**, the record member produced will resemble the showing of Fig. 5.

While the invention, including the preferred materials and the steps of the process, has been fully outlined in the foregoing specification and is admirably adapted to fulfill the objects primarily stated, it is to be understood that it is not intended to confine the invention to the particular materials and steps disclosed herein, for these are susceptible of some modification without departing from the invention.

What is claimed is:

1. A method of printing on a record member comprising the steps of applying charges in the shape of the marks to be printed to a dielectric member; mixing microscopic encapsulated marking material with charge-forming material to produce a triboelectric charge on the marking material opposite in sign to the charges on the dielectric member; depositing the marking material on one surface of the dielectric material, the marking material being attracted to said surface and adhering to the dielectric member in the areas of the applied charges, solely by the electrostatic force between said marking material and said dielectric member; placing the record member to be marked adjacent the marking-material-bearing surface of the dielectric member; and applying pressure to the superimposed record member and dielectric member to cause the marking material to be expressed from the capsules adhering to the dielectric member and transferred to the record member to mark the record member in a pattern corresponding to the pattern of the charges applied to the dielectric member.

2. A method of printing on a record member comprising the steps of applying a charge in the shape of the marks to be printed to a dielectric member; dusting the charged dielectric member with marking material in microscopic encapsulated form, the encapsulated marking material adhering to the dielectric member in the areas of the applied charges; removing the encapsulated marking material from the dielectric member except for that marking material which is caused to adhere to the dielectric member by the applied charges; placing the record member to be marked adjacent the surface of the dielectric member bearing the encapsulated marking material in the charged areas; and applying pressure to the superimposed record member and dielectric member to cause the marking material to be expressed from the capsules adhering to the dielectric member and transferred to the record member to mark the record member in a pattern corresponding to the pattern of the charges applied to the dielectric member.

3. A method of printing on a record member comprising the steps of providing localized electrostatic charges, in accordance with the indicia to be printed, on a charge-receiving medium; depositing microscopic capsules containing liquid marking material on the surface of the charged medium, said microscopic capsules being in the form of a dry powder and adhering to the charge-receiving medium only in the areas of the applied charges; placing the record member on the surface of the charge-receiving medium to which the marking material is adhering; and expressing the liquid marking material from the individual capsules of the dry powder into engagement with the record member to effect the marking of said record member in accordance with the pattern of the localized electrostatic charges on the charge-receiving medium.

4. A method of printing on a record member comprising the steps of providing a charge in the shape of the marks to be printed on a charge-receiving medium; applying marking material in microscopic encapsulated form to the surface of the charge-receiving medium, the marking material adhering to the charge-receiving medium only in the areas of the charges; placing the record member on the surface of the charge-receiving medium to which marking material is adhering; and expressing the marking material from the individual capsules to the record member to mark the record member in a pattern corresponding to the pattern of the charges on the charge-receiving medium.

5. The method of claim 4 in which the charged and non-charged areas of the charge-receiving medium may be selectively reversed by reversing the polarity of the charging means to produce selectively either a positive or a reverse image of the marks to be printed.

6. The method of claim 4 in which the encapsulated marking material is mixed with a charge-forming medium to improve the adhering qualities of the marking material.

7. The method of claim 4 in which the encapsulated marking material comprises an oily ink in fluid form.

8. The method of claim 4 in which the record member is coated with a normally colorless composition and the encapsulated marking material comprises a normally colorless fluid which reacts with the coating of the record member when expressed from the capsules to form visible markings.

9. A method of printing on a record member from an element having localized electrostatic charges thereon in accordance with the indicia to be printed, comprising the steps of applying microscopic capsules containing liquid marking material to the surface of the charged element, said microscopic capsules being in the form of a dry powder and adhering to the element only in the charged areas; placing the record member on that surface of the charged element to which the marking material is adhering; and expressing the liquid marking material from the individual capsules of the dry powder into engagement with the record member to effect the marking of said record member in accordance with the pattern of the localized electrostatic charges on the charged element.

10. The method of claim 9 in which the liquid marking material is an oil-base ink.

11. The method of claim 9 in which the record member is coated with a normally colorless composition and the liquid marking material comprises a normally colorless fluid which reacts with the coating of the record member when expressed from the capsules to form visible markings.

12. The method of claim 9 in which the dry powder containing the marking material is mixed with a charge-forming medium to improve the adhering qualities of the powder.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

1,783,912	Scott	Dec. 16, 1930
1,865,610	Blair	July 5, 1932
2,221,776	Carlson	Nov. 19, 1940
2,551,582	Carlson	May 8, 1951
2,618,384	Hatfield	Nov. 18, 1952
2,647,464	Ebert	Aug. 4, 1953
2,681,473	Carlson	June 22, 1954
2,712,507	Green	July 5, 1955
2,730,456	Green et al.	Jan. 10, 1956
2,735,785	Greig	Feb. 21, 1956
2,761,416	Carlson	Sept. 4, 1956

FOREIGN PATENTS

20,726	Great Britain	1910
734,909	Great Britain	Aug. 10, 1955