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ELECTROSTATIC DUPLICATOR FOR REPRODUCING AN IMAGE FROM ELECTRICAL CHARGE RETAINING INK PARTICLES FIXED IN PLACE

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FIG. 1

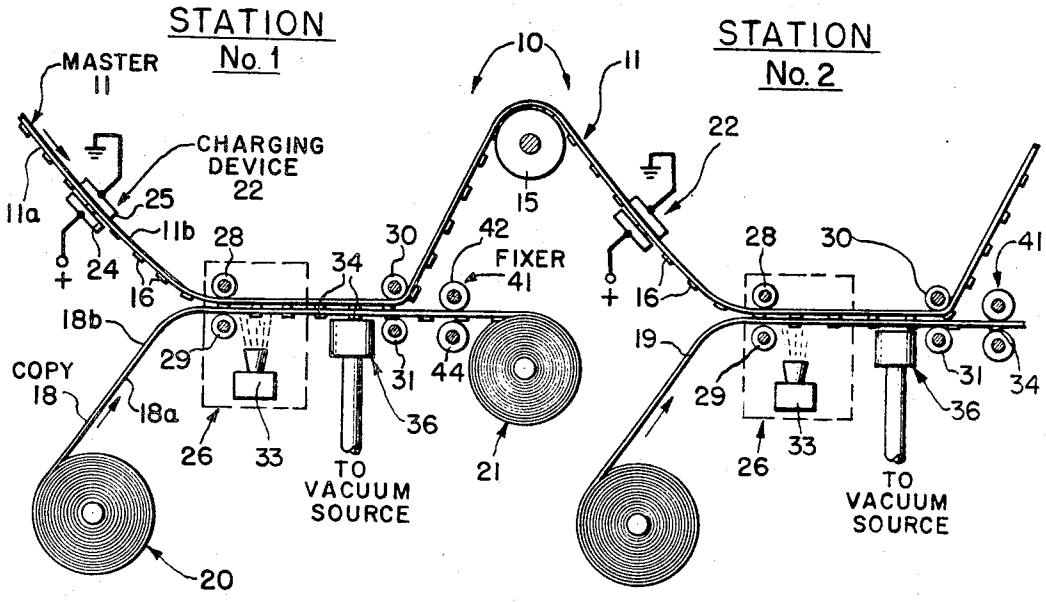


FIG. 2

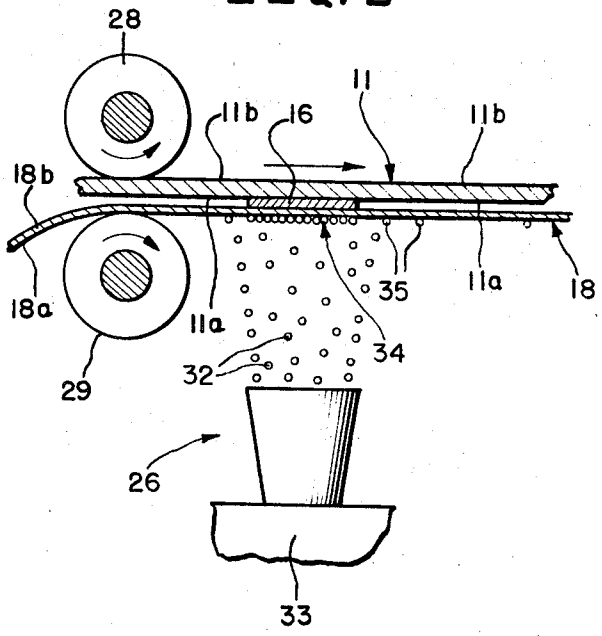
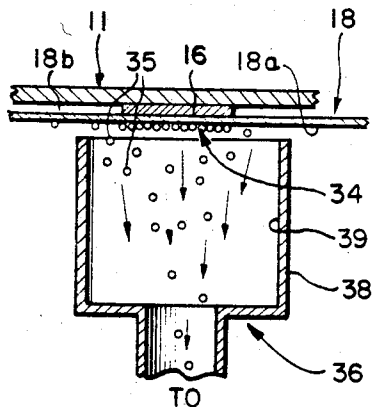


FIG. 3



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ELECTROSTATIC DUPLICATOR FOR REPRODUCING AN IMAGE FROM ELECTRICAL CHARGE RETAINING INK PARTICLES FIXED IN PLACE

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The present invention relates to a duplicating system and more particularly to an improved electrostatc copier system.

One of the problems in providing copies from an original is that several seconds are required by the machines to print corresponding characters or images on a copy sheet from the master. Thus, the units are not capable of handling copying in installations processing data at high speeds, as for example from outputs of computers or the like. It is accordingly desirable to provide a reliable and simple method and apparatus for producing copies at high speeds. At the same time the image on the original must remain intact and not be destroyed or affected by the duplicating process. One approach for simplifying the copying process is to provide a system which does not require intermediate steps or equipment for converting a mirror image, as where a copy is made by "taking-a-picture" of the image as it appears on the printed side of an original, and instead print corresponding images on the copy sheet directly from the original, accomplishing the latter end, however, without affecting the original.

Accordingly, it is an object of the present invention to provide an improved procedure and an apparatus for accomplishing electrostatic duplication in which copies are produced directly from a master, with the images on the copy corresponding to those on the original and the latter is not affected, thereby retaining the integrity of the original.

It is a more detailed object of the present invention to provide a procedure and apparatus of the above type which can print copies from a master on various forms of dielectric material, i.e., a continuous roll, a fan-fold or individual sheets of material, without requiring the material to have a sensitized surface.

It is an over-all object of the present invention to provide an improved duplicating system of the above type capable of making clear copies and which is economical to manufacture and easy to use substantially simplifying the duplication procedure.

Further advantages and objects of the invention not at this time enumerated will become readily apparent as the nature of the invention is better understood.

In the accompanying drawings forming a part of this specification:

FIGURE 1 is a schematic of a duplicating system embodying the present invention;

FIGURE 2 is an enlarged view of a print-out station as shown in FIGURE 1; and

FIGURE 3 is an enlarged view of a clean-up station as shown in FIGURE 1.

Turning to the drawings and FIGURE 1 in particular, there is shown a schematic of a duplicating system **10** for practicing the present invention. A master or original sheet **11** having respective opposite surfaces **11***a*, **11***b* and manufactured of suitable dielectric material, for example, paper, is transported through respective duplicating stations "No. 1" and "No. 2," an intermediate support roll **15** being provided to carry the master sheet from one station to the other. Printed on the surface **11***a* of the master sheet **11** are images **16**, these being defined by a collection of ink particles, the images being printed with electrical charge retaining ink for reasons explained subsequently. The carbon black or graphite customarily

included in printing inks for pigmentation purposes provides the necessary electrical properties. In the present instance, a copy of the original images is effected on a copy sheet **18** having respective opposite surfaces **18***a*, **18***b* at Station No. 1, and on a copy sheet **19** at Station No. 2. Because the duplication procedure and structure is the same at each of the respective stations, only the operation at Station No. 1 is described in detail. The copy sheet **18** is shown as a continuous roll of dielectric material, such as paper, paying out from roll **20** and being taken up on roll **21**. Though the preferred embodiment shows the original and copy material in a continuous sheet form, the present invention can be practiced using any combination of forms for the original and copy materials, as for example fan-folded or individual sheet forms. It is but necessary for one skilled in the art to adapt the transporting means for the material to use these forms of material.

In accordance with the present invention an image is effected on the copy sheet corresponding to that on the master **11** by first charging the images **16** on the master, bringing the copy sheet **18** and master sheet **11** into juxtaposed relationship so that the copy sheet is pressed against the image side **11***a* of the master and utilizing the electrical field established on the opposite surface of the copy sheet to attract ink particles and thereby form an image on the copy sheet corresponding to that on the original.

As herein illustrated, for electrically charging the images **12**, the original sheet **11** is transported through charging means **22**. To this end, a set of electrical field establishing plates **24**, **25**, respectively, are disposed adjacent the respective opposite surfaces **11***a*, **11***b* of the original. Plate **24** is juxtaposed surface **11***a* on which are printed images **16**, plate **24** being as a high positive potential, while the plate **25** on the opposite side of the original, i.e., adjacent surface **11***b*, is maintained at ground. The required positive voltage at which the plate **25** must be maintained is determined by several factors such as the dielectric constant of the material forming the substrate of the original, the charge-accepting capability of the ink particles of which the images **16** are formed and the spacing between plates **24**, **25**. Utilizing a master with a conductive backing, in other words surface **11***b* would be conductive, yields a higher charge on images **16** for each volt applied across the master **11**.

After the images **16** have become electrically charged, the original is transported to a print-out station **26**. At the print-out station the master original sheet **11** and the copy sheet **18** are brought into intimate engagement or juxtaposed each other, i.e., surface **11***a* of the master sheet and the surface **18***b* of the copy sheet being gently pressed together. In the present instance this is accomplished by a pair of rollers **28**, **29** at the input end of the print out station and **30**, **31** at the output end of the print-out station.

To print a direct image instead of a mirror image, the electrical field established on an opposite surface **18***a* of the copy sheet is utilized to attract electrically charged ink particles **32** (see FIGURE 2). Of course, the ink may be liquid or in substantially dry powder form. This is accomplished by having the image-carrying surface **11***a* of the original sufficiently close to the copy sheet so that ink particles applied to the opposite copy sheet surface **18***b* are influenced and attracted by the electric field established by the charged image. For directing ink particles into the electrical field, an ink spray device **33** is provided. By maintaining the original and copy sheet in intimate pressing engagement and preventing relative lateral movement, the electrical field appearing at surface **18***a* of the copy sheet **18** attracts ink particles to this surface and holds them so as to define a copy image **34** corresponding substantially to the original image **16**. Because the necessary attraction of the ink particles to form the desired copy

image is effected by the electrical field, the copy sheet surface need not be sensitized. Though the ink spray device **33** is herein shown for applying ink to the copy sheet, other means, such as an ink bath or the like, can be employed for this purpose.

The copy image **34** may be sufficiently sharp as defined by the electric field attracted ink particles which stick to the copy paper, while ink particles sprayed generally in the direction of the copy sheet surface and not attracted by the electric field fall due to gravity. However, it may be that an excess of ink particles appearing on the copy sheet surface **18***a* will detract from the sharpness of the image **34** on the copy sheet. Such excess ink particles are exemplified by reference character **35** in FIGURES 2 and 3. For improving the copy image by cleaning the background, a clean-up means or device **36** is provided (see FIGURE 3). The latter includes a suction means **38** having a suction slot **39** disposed adjacent the surface **18***a* of the copy sheet to remove from the latter surface excess ink particles **35**. Though clean-up of the image may be effected in various ways, the vacuum method reduces the chance of smear, and because the ink particles attracted by the electrical field adhere strongly to the copy surface **18***a* and are further held to the surface by the electrically charged original image **16**, there is a difference in attachment of the respective ink particles—ones defining a desired image on the copy sheet and the others blurring the images—that permits adjustment of the vacuum produced by a source (not shown) to remove only the excess ink particles **35**.

For fixing the images on the copy sheet, in the present instance the ink particles forming image **34** are pressed into the copy sheet at a fixer station **41** including a set of rolls **42**, **44**. Of course other means of fixing images are well known by those skilled in the art, for example heating.

Summarizing the operation of the present device, an original **11** having thereon images **16** is transported by charging means **22** so as to electrically charge the ink particles defining the image **16** on the original. Next the original **11** and the copy sheet **16** are pressed together with the electrically charged image disposed inbetween the two sheets. The ink particles establish an electrical field on the opposite surface **11***a* of the copy sheet. When ink particles in suitable form, for example triboelectrically charged, are brought into the field, they are attracted to the copy sheet surface to form thereon images corresponding to the images on the original. In the area where an electrical field is established, the ink particles are strongly attracted toward the copy sheet so that they adhere to the copy paper surface. There are surrounding areas which will also receive ink particles that will attach to the copy sheet surface **18***a* by simple mechanical attachment. These are subsequently removed at the clean-up station **36**. The fixer station **41** is provided to mechanically press the ink particles defining the copy image **34** into the copy sheet, thereby making the image permanent.

It is clear from the foregoing that the present procedure and apparatus provides a novel means of making copies from an orginial at high speeds. The procedure is simple and permits speedier copying, along with simplifying the mechanism for effecting electrostatic duplication.

While the invention has been described in connection with a preferred embodiment and method, it is understood that I do not intend to limit the invention to such an embodiment and method, but on the contrary, I intend to cover all alternative, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

I claim as my invention:

1. In a method for producing copies from a master having imprinted thereon a first image with electrical charge retaining ink, the steps comprising applying an electrical charge to the image on the master, pressing one surface of a copy sheet of dielectric material into juxtaposed relationship with the master, the image on the original being disposed between the original and copy sheet, and applying ink particles to an opposite surface of said copy sheet, said particles attracted electrically by said charged image on said master and adhering to said copy sheet surface so as to establish a corresponding second image on said copy sheet.

2. In the method of claim **1** adding a step of cleaning excess ink particles blurring said second image so as to leave a sharply defined copy second image corresponding to the original first image.

3. In an electrostatic duplicating system for producing a copy from a master having a first image formed thereon with electrical charge retaining ink, the combination comprising charging means for electrically charging the ink, means for supporting the master and the copy with one surface of the latter in juxtaposed relationship with the surface of the original on which is formed the first image, said electrically charged first image defining an electrical field, and means for depositing ink particles on the copy surface opposite said surface juxtaposed to the original, said ink particles being attracted by said electrical field and adhering to the copy sheet to form a second image on the copy sheet corresponding to the first image on the original.

4. The combination of claim **3** including means for transporting the original and copy in side-by-side relationship through said ink depositing means with the first image disposed between respective surfaces of the original and copy.

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