May 13, 1969 D. SMITH ET AL 3,443,515

APPARATUS FOR FLAT PLATE POWDER GRAVURE PRINTING

Filed Aug. 3, 1966

FIG.1

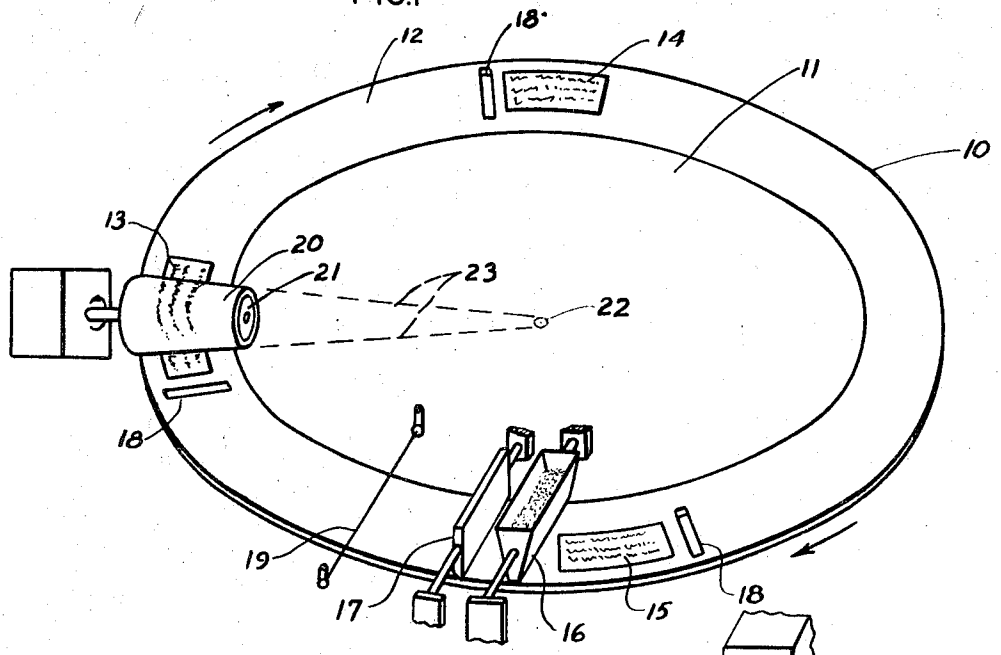
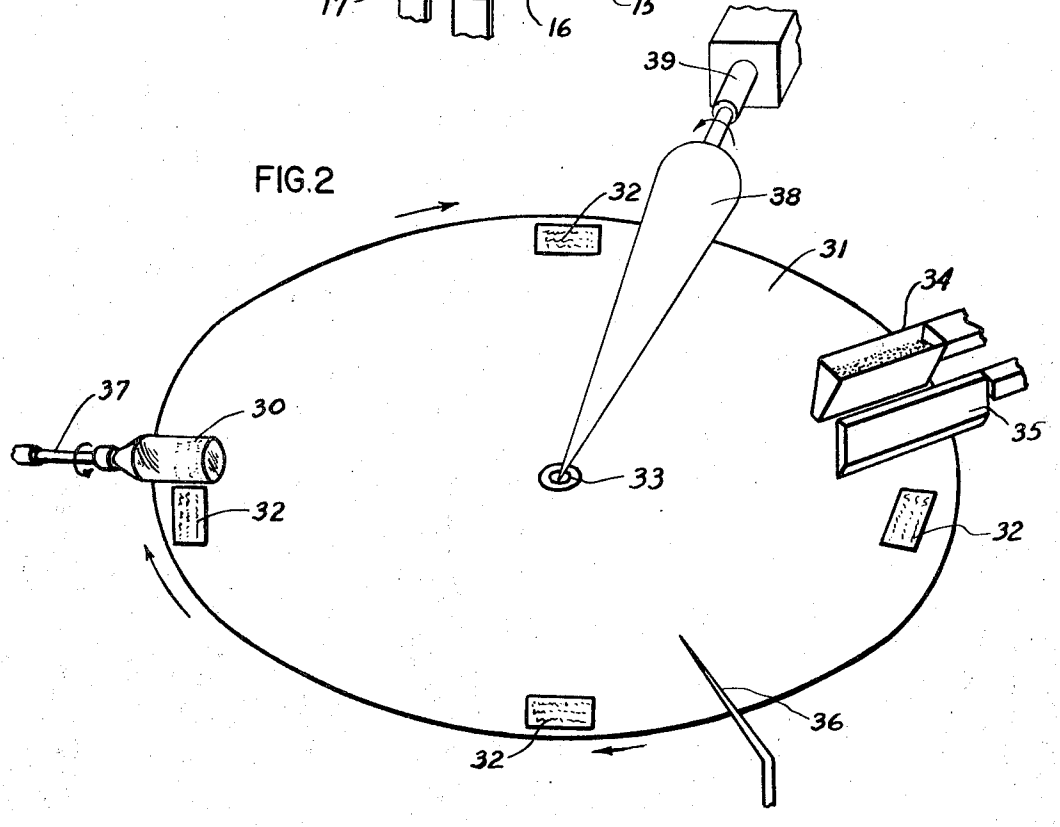



FIG.2



United States Patent Office 3,443,515 Patented May 13, 1969



3,443,515

# APPARATUS FOR FLAT PLATE POWDER GRAVURE PRINTING

Daniel Smith, Riverdale, N.Y., and Norman S. Cassel, Ridgewood, N.J., assignors to Interchemical Corporation, New York, N.Y., a corporation of Ohio

Filed Aug. 3, 1966, Ser. No. 570,004
Int. Cl. B41b 19/00
U.S. Cl. 101—150 12 Claims

## ABSTRACT OF THE DISCLOSURE

An electrostatic powder gravure printing apparatus where the gravure engraving is on a flat circular rotatable plate in operable proximity to a powder supplier, a doctoring device, an electrostatic charging means, and a device for bringing the substrate to be printed on close to the powdered engraving, the device being furnished with means for establishing an electrical field between the charged powder and the substrate. Frustums of cones and also cylinders may be the substrates.

This invention relates to gravure printing with the aid of electrostatic forces using dry powder as printing material. More particularly, it relates to novel apparatus for flat plate powder gravure printing.

Copending application S.N. 372,226, Reif et al., filed June 3, 1964, now Patent 3,296,965 issued Jan. 10, 1967, is a basic application in the field of powder gravure printing and is directed primarily to gravure printing with printing cylinders.

Gravure printing has the advantages of being effective on a wide assortment of substrates and of producing high quality prints. Powder has the advantage over conventional links of eliminating organic solvents with their attendant odors and fire hazards. Powder also permits the use of insoluble resins as well as soluble ones. Employing electrical fields for printing eliminates the need for actual contact between the substrate and the printing plate. Printing can be accomplished even when the printing plate is as much as 0.1 inch from the surface to be printed on. It is also possible to do contact printing electrostatically. By powder gravure, prints may be effectively made on quite irregular surfaces and also on materials where contact would injure the material or the printing plate. For example, prints can be made on wet substrates. The powder gravure process has the advantage over other powder printing processes of a built-in metering system. That is, each cell of the gravure printing element provides the same amount of powder for each print made on the substrate from that cell, thus providing uniformly printed reproductions.

The process is conveniently carried out by depositing a suitable printing powder in the cells of a gravure printing element, the powder being substantially free from electrostatic charges, applying an electrostatic charge of substantial magnitude to the powder in the cells, transferring the charged powder to a substrate in an electric field of appropriate direction, and optionally fixing the powder thus transferred to the substrate. The magnitude of the charges required and means for imparting them are well known to the art, as is the process of fixing resinous powders to substrates. The powders can be charged, for example, by induction if they are sufficiently conductive. On the other hand, if the powders are good insulators they can be charged by ion bombardment from a corona. Electrical fields can be established on conductive surfaces by direct application of potential, and on the surfaces of insulating materials by the deposition of charges.

On certain structures, particularly frustums of cones,



difficulties have been encountered in printing by using a printing cylinder. In order to overcome these difficulties, we have developed novel apparatus for continuous printing by powder gravure using a flat gravure plate.

The novel apparatus of this invention comprises a flat circular gravure plate. The flat surface of this plate has formed therein a gravure type engraving. The plate, or at least the annular portion of the plate containing the engraving, is rotatable about the axes of the plate. As the engraving rotates it moves past the following components which are operatively associated with the plate and are in fixed positions along the path of rotation of the engravings: means for depositing a chargeable dry powder on the engraving including means for removing the excess powder; electrostatic charging means for charging the deposited powder; means for bringing the substrate to be printed upon into close proximity with the engraving and means for establishing an electrical field between the charged powder and the substrate which is brought into proximity with the engraving. The field thus established causes the movement of the powder from the engraving and the deposition of the powder on the substrate in the same pattern as the engraving.

In the most advantageous embodiments of the apparatus of this invention, the means for bringing the substrate into proximity with the engraving are means which will rotate a solid of revolution such as cylinder, cone or frustum thereof so that the curved surface of the solid is in close proximity to, even in contact with, the engraving and is preferably moving substantially in the same direction as the engraving at the point closest to the engraving.

It should be noted that if the surface to be printed upon is made of a relatively dielectric material such as plastic, wood, glass or paper, the substrate is preferably but not necessarily in contact with the engraving. On the other hand, if the surface to be printed upon is a non-dielectric or conductive material such as metal, the surface should be separated from the plate by an air space.

FIG. 1 shows one preferred embodiment of the present invention. Flat circular gravure plate **10** comprises stationary center portion **11** and rotatable annular ring **12** which moves in the direction shown and contains one or more gravure engravings, in this case three engravings **13**, **14** and **15**. As the engravings pass under powder reservoir **16** which is fixed in the position shown—this reservoir is of the same type described in copending application S.N. 372,226—chargeable powder from a discharge outlet in the base of the reservoir is deposited into the gravure engraving. Doctor blade **17** removes the excess powder from the surface of the rotating portion of the plate. One conventional method of accomplishing the removal of powder from the surface involves apertures **18** which trail the moving engravings. Excess powder which is scraped from the surface by doctor blade **17** is swept into an aperture **18** by the blade. The gravure engraving carrying the chargeable powder then passes under the corona discharge produced by corona wire **19** whereby a charge is applied to the particles. The engraving carrying the charged particles then passes under the substrate to be printed upon which in this case is a plastic container in the form of a frustum **20**. The container is mounted on a rotating mandrel **21** of a conductive material. The container **20** rotates in or near tangential contact with the engraving. At or near the point of contact, the container is moving in the same direction as the engraving and is preferably but not necessarily moving at the same speed as the engraving. An electrical field is established between the mandrel **21** and the annular portion of the plate **12** by applying an electrical potential difference between these two elements. The resulting field which passes through dielectric container **20** is of such a nature that the charged particles in the

engraving will tend to move from annular plate **12** to mandrel **21**.

The particles will of course be intercepted by the surface of the intervening container **20** and be deposited on said surface in a pattern corresponding to that of the engraving. The particles deposited on the surface of the container may then be fixed to the surface by conventional means such as heating. The container is then removed from the mandrel by any conventional automatic means. A fresh container is placed on the mandrel and awaits the passage of the next engraving. When the container to be printed on is a frustrum of a cone as shown in FIG. 1, the container is preferably in tangential contact with the plate and so positioned that the apex of the cone from which the frustum is derived coincides with the center of the circular gravure plate. (The outline of the cone is shown in FIG. 1 by dashed lines **23**.) When the container to be printed upon is thus positioned, in order to produce a true representation of the design to be printed on the container, the design in the engraving is situated along polar coordinates the radical lines of which pass through the center of the circular plate.

FIG. 2 represents another embodiment of the present invention which is particularly suitable for printing on cylindrical substrates such as cans or bottle **30**. The elements which are shown diagrammatically may have structures similar to those in FIG. 1. Flat circular gravure plate **31** contains one or more gravure engravings **32** situated circularly about center **33** equally distant from center **33** and from each other. The plate is rotated in the direction shown at intervals which may be determined by dividing 360° by the number of engravings. Since in the present embodiment there are four engravings, the plate is rotated for intervals of 90° each. As the engravings pass under powder reservoir **34** and doctor blade **35** powder is deposited in the engraving in the manner described with respect to FIG. 1. The engravings filled with powder subsequently pass under corona discharge wire **36** whereby a charge is imparted to the powder particles carried in the engraving.

Cylinder bearing mandrel **37** is so positioned with respect to the engravings that after rotation of the plate for an interval which in this case is 90°, the engraving to be printed on the curved surface is aligned parallel to the ends of the cylinder. Mandrel **37** is then so moved that cylinder **30** rolls over engraving **32**, the lateral directions of the roll being parallel to the ends of the cylinder while the rotational element of the roll is conventional as shown in FIG. 2. While the bottle is being rolled over engraving **32** the engraving remains stationary. As in FIG. 1, if container **30** is made of a dielectric material such as glass, the cylinder is preferably in contact with the engraving. On the other hand, if the cylinder is made of conductive material, such as metal then it must be spaced from the engraving as it rolls over it. In any event, a potential difference is applied by the mandrel **37** and engraving **32** to create an electrical field between the mandrel and the engraving of such a nature that the charged particles in the engraving will move towards the mandrel and consequently be deposited on the surface of cylinder **30**. The transferred powder may then be fixed to the cylinder. The cylinder is then removed and a fresh cylinder is deposited while the mandrel is moved back to its starting position. At the same time, the plate may be turned for another 90° interval to place the next engraving in printing position.

The powder application means used in the present invention including the doctoring and brush means are preferably those described in copending application S.N. 372,226. The engraved patterns on the printing plates may represent a variety of structures including various sizes of dots, lines and recessed designs. They may be of course of varying depths.

Although the process of this invention is not limited to the use of any particular powder material, the preferred printing powder in combinations of resinous material with colorants dispersed therein as described in copending application S.N. 372,226 may be used. Examples are "Pliolite VTL" containing 30% carbon black, "Dow PS–2" with 30% carbon black, a mixture of "Dow PS–3" and "Pliolite VTL" in the proportions 3:2 together with "Ultrasil" and colorant.

The resins and colorants were ground in a "Mikro-Atomizer." Finer grinds were obtained by regrinding the material in a fluid-energy "Micronizer." Coarser grinds were obtained by screening a coarse precrush through 200-mesh and 325-mesh sieves 74 and 44 microns. There were thus obtained fractions with mean-mass sizes of 8 and 14 microns with "Pliolite VTL" and mean-mass sizes of 4, 11, 18 and 42 microns with "Dow PS–2." Pigment was milled into the resin before grinding.

Powders with mean-mass size of about 11 to 18 microns are preferred. Finer powder does not fill the printing cells as well and transfers less readily. Powders coarser than about 11 to 18 microns mean-mass size produce somewhat grainy prints.

Suitable resins for the process were numerous. Some performed better than others but it was found that the use of release agents improved the performance of many powders in cases where the transfers were otherwise not as clean as desired. Some of those resins found suitable were ethyl cellulose, "Durez 19591," "Piccolastic D–150," "Pliolite S–5E," "Pliolite VTL," "Saran F–120," "Tylac CZ 210–4," "Vinylite VYHH," "Vinylite VYNS–3," "Dow PS–2," (polystyrene), "Epon 1004," "Lucite 41," "Saran F–220," "Vinylite VYLF," and "Gelvatol 40–10."

"Pliolite VTL" is a vinyl-toluene/butadiene resin.
"Dow PS–2" is polystyrene.
"Ultrasil" is very finely divided silica.
"Piccolastic D–150" is a polystyrene resin.
"Pliolite S–5E" is a copolymer of 1 part by weight of butadiene and 6 parts by weight of styrene.
"Saran F–120" is a copolymer of vinylidene chloride and acrylonitrile.
"Vinylite VYHH" is a copolymer of 87% by weight of vinyl chloride and 13% by weight of vinyl acetate.
"Vinylite VYNS–3" is a copolymer of 90% by weight of vinyl chloride and 10% by weight of vinyl acetate.
"Epon 1004" is an epichlorohydrin/bisphenol A type solid epoxy resin having an epoxide equivalent of about 875–1025 and a melting point of about 95–105° C.
"Lucite 41" is polymethylmethacrylate.
"Saran F–200" is a vinylidene chloride/acrylonitrile copolymer.
"Vinylite VYLF" is a copolymer of 87% by weight of vinyl chloride and 13% by weight of vinyl acetate.
"Gelvatol 40–10" is a polyvinyl alcohol with 37–42% of residual polyvinyl acetate.

The substrates may be paper, wood, glass, cloth, rubber, plastics, ceramics as well as conductive material such as aluminum foil, metal sheets, tin plate.

While there have been described what is at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim:

1. A printing apparatus for gravure printing wherein an image is formed on a substrate with a dry printing powder which comprises (a) a flat circular gravure plate having a flat surface with at least one gravure-type engraving thereon, said plate and the engraving thereon being rotatable about the axis of the plate, and the following components in fixed positions along the path of rotation of said engraving: (b) means for depositing a chargeable dry printing powder on the engraving (c) electrostatic charging means for charging the powder deposited on the engraving (d) means for bringing a substrate into

close proximity with said engraving (e) means for establishing an electric field between the charged powder and the substrate when the latter is brought into close proximity to the engraving to cause the movement of the powder from the engraving to the substrate.

2. The apparatus of claim 1 wherein the means for bringing the substrate into close proximity with the engraving are means for rotating a solid of revolution so that the surface of said solid which is in close proximity to the engraving is moving substantially in the same direction as the engraving.

3. The apparatus of claim 2 wherein the solid of revolution is a cylinder.

4. The apparatus of claim 2 wherein said solid of revolution is a cone.

5. The apparatus of claim 4 wherein the solid of revolution is a frustum of a right circular cone.

6. The apparatus of claim 5 wherein said frustum is made of a dielectric material.

7. The apparatus of claim 6 wherein said frustum is rotated with its curved surface in tangential contact with said engraving and is so positioned that the apex of the cone from which the frustum is derived would pass through the center of the surface of the circular gravure plate.

8. The apparatus of claim 1 wherein said means for depositing a chargeable dry printing powder to the engraving comprise a powder reservoir having a discharge outlet above the plate in combination with doctoring means in contact with the surface of the engraving positioned along the path of rotation of the engraving just subsequent to the reservoir.



9. The apparatus of claim 1 further including means for fixing the transferred powder to the substrate.

10. The apparatus of claim 1 wherein said engraving is on an annular portion of the circular plate, said annular portion being rotatable about said axis.

11. The apparatus of claim 1 wherein the means for bringing the substrate into proximity with the engraving are means for rolling a solid of revolution over the engraving and the engraving is rotatable to a position adjacent to the solid of revolution at which position the engraving remains stationary while the solid is rolled over it.

12. The apparatus of claim 11 wherein the solid of revolution is a cylinder.


**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,787,556 | 4/1957 | Hoas. | |
| 3,241,483 | 3/1966 | Duff | 101—114 |
| 3,245,341 | 4/1966 | Childress et al. | 101—150 |
| 3,253,540 | 5/1966 | Lusher | 101—170 |
| 3,285,168 | 11/1966 | Childress | 101—150 |
| 3,296,965 | 1/1967 | Reif et al. | 101—170 |
| 3,302,579 | 2/1967 | Edwards et al. | 101—114 |
| 3,302,580 | 2/1967 | Edwards et al. | 101—114 |



EDGAR S. BURR, *Primary Examiner.*

U.S. Cl. X.R.

101—170