United States Patent [19]
Taylor
[11] 3,714,928
[45] Feb. 6, 1973

[54] MULTIPLE JET CHANNEL

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[22] Filed: **Nov. 17, 1970**
[21] Appl. No.: **90,363**

[52] **U.S. Cl.** **118/624,** 117/93.4, 117/93.44, 118/621, 118/627, 239/15
[51] **Int. Cl.** **B05c 5/02**
[58] **Field of Search**......118/621, 624, 627, 629, 630, 118/637 LX; 117/93.4, 93.41, 93.42, 93.44; 239/3, 15; 346/75

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[57] **ABSTRACT**

In a noncontacting printing system in which drops of coating material are projected toward a receiving member and their trajectories controlled to provide a desired coating pattern, as in printing, the drops formed are much smaller in diameter than usual and are arranged in discrete packets of drops with each packet forming a single dot when it impinges on the receiving member.

8 Claims, 5 Drawing Figures

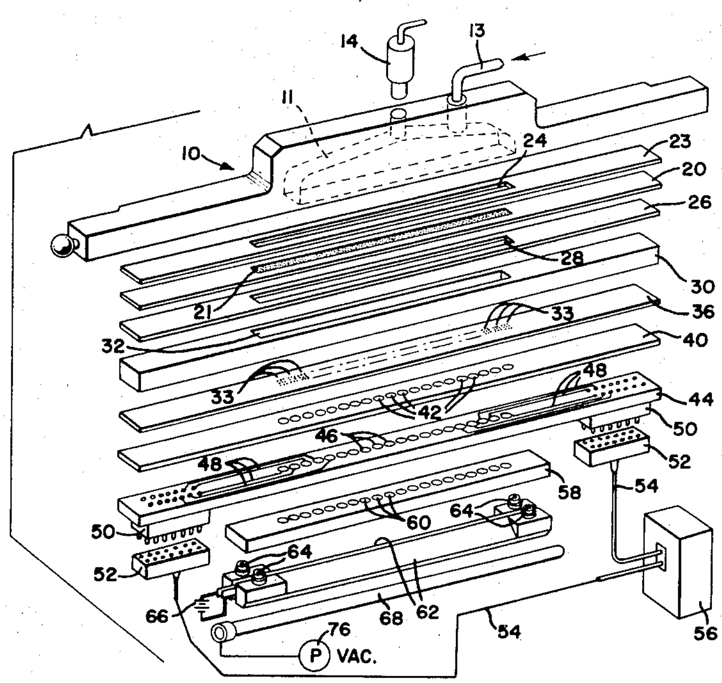


FIG-1

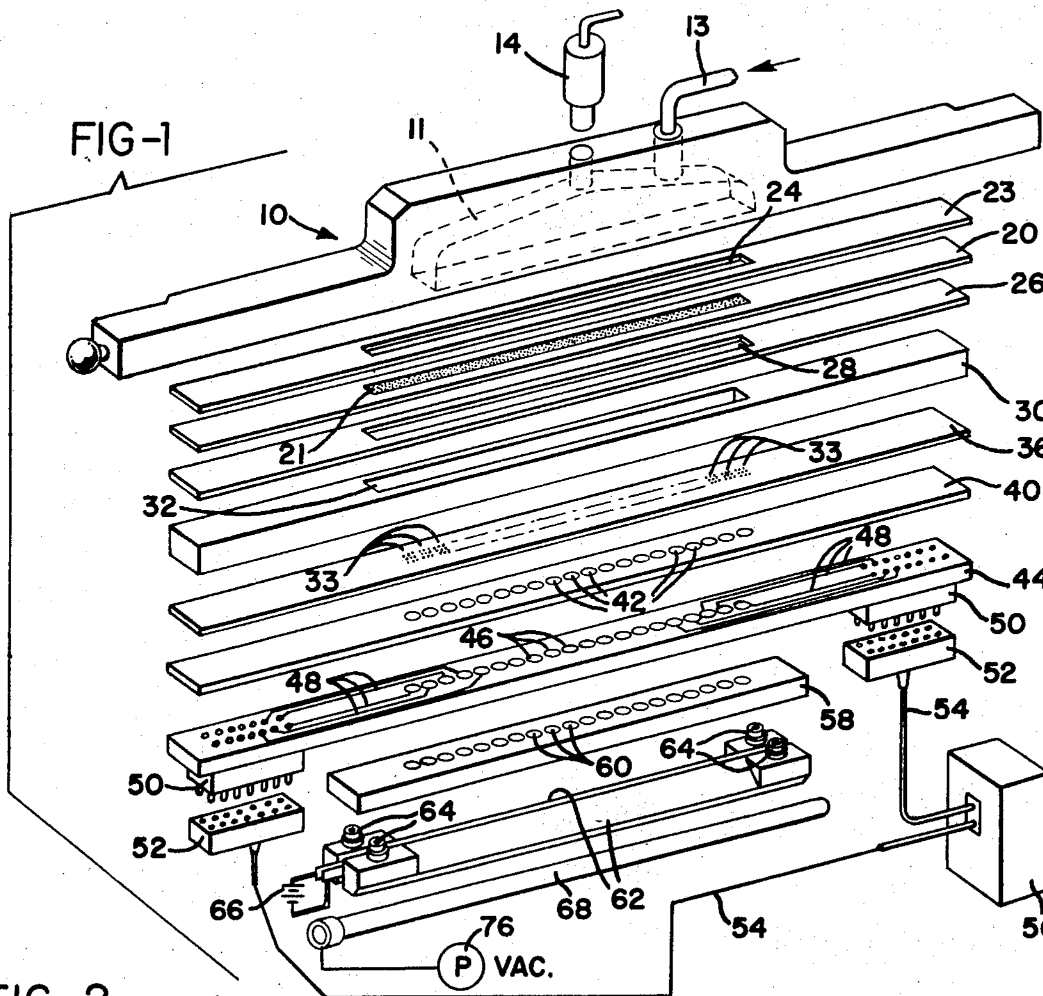


FIG-2

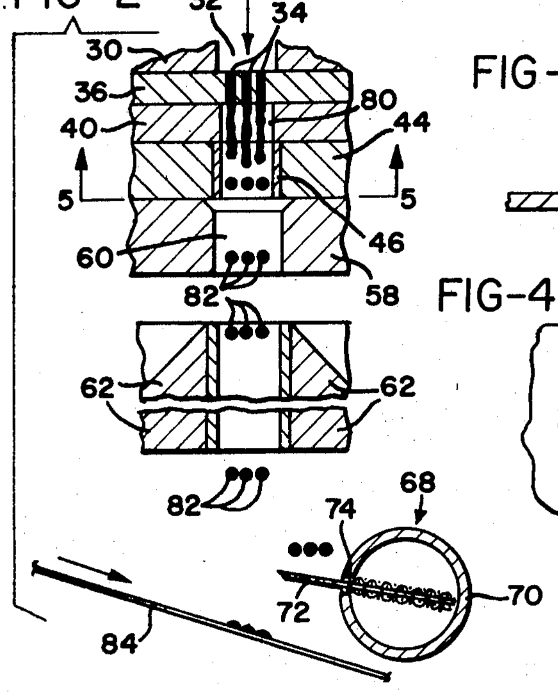


FIG-3

FIG-4

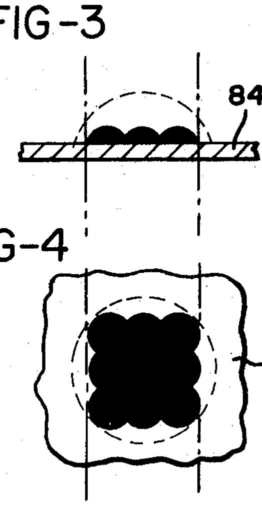
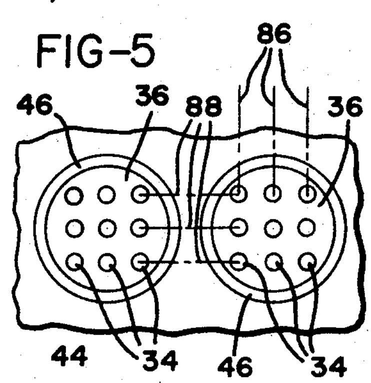


FIG-5



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MULTIPLE JET CHANNEL

CROSS REFERENCES TO RELATED APPLICATIONS

Image Construction System Using Multiple Arrays of Drop Generators, Ser. No. 768,790, filed Oct. 18, 1968, now U.S. Pat. No. 3,560,641, and Laminated Coating Head, Ser. No. 877,250 filed Nov. 17, 1969, now Pat. No. 3,586,907.

BACKGROUND OF THE INVENTION

The above noted, related applications disclose non-contacting systems in which drops of coating material are projected toward a receiving member and their trajectories electrostatically altered to provide patterned coating, as in printing. This is accomplished in the systems described in these applications by projecting the coating material through a series of orifices to form fine filaments of coating material. The filaments of coating material have a natural tendency to break down into drops and this natural drop generation is stabilized by applying a constant frequency oscillation to the system. As each drop travels toward the receiving member it passes through a charge ring and as it does, a charge is either applied or not applied to that particular drop. Thereafter, each of the drops passes through an electrostatic deflecting field formed by opposing electrodes, resulting in charged drops being deflected from their trajectories and allowing uncharged drops to pass straight through. In this way a desired pattern of coating may be applied to the receiving member.

In similar systems, instead of the charge rings operating in a binary mode, the drops receive a charge of varying intensity as they pass through the charge rings, thereby causing them to be deflected different amounts as they pass through the electrostatic deflecting field. In still another system of this general type means are provided for charging all drops to a common level and drop placement control is achieved by modulating the intensity of the deflection field. All the systems described above have several features in common, including the fact that each of the drops from each of the orifices is treated separately and thus, individually controlled.

It will be appreciated that coating systems of the type herein involved require that there be some overlap of drop deposits on the receiving member. It follows that any decrease in the size of the drops requires an increase in the number of drops deposited. If the drops are to be individually controlled, then the mentioned decrease in drop size results in an increase in the information transfer rate. Thus it can be seen that the above described prior art systems have a lower limit on drop size which is set by the upper limit on system information transfer rate. Such a situation is acceptable if small drops are to be employed for the purpose of improving system resolution. It is not acceptable in many cases wherein usage of small drops may be prompted by other reasons.

SUMMARY OF THE INVENTION

The present invention resides broadly in a non-contacting coating system which generates a packet of coating drops from a cluster of orifices and employs common charging and deflection means for the packet of drops so that all the drops in the packet are deflected substantially simultaneously. Thus, the coating system of the present invention utilizes orifices that are much smaller than those usually found in systems of this general type and arranged in one or more clusters so that the drops from a cluster of orifices may be treated as a group rather than separately. This allows a higher electrostatic charge/mass ratio for each drop because of the greater surface/volume ratio and consequently lower charge and/or deflection voltage.

In this regard, although the term voltage is used, it will be apparent that the deflecting field may be either electric or magnetic in nature. Additionally, as noted above in the discussion of the background of the invention, the deflection field may be either static or time variant.

By forming the cluster of orifices in a regular pattern, such as a matrix, specially shaped marks can be imprinted on the receiving member rather than only round dots. For example, using a matrix having an even number of columns and rows of orifices, a substantially square dot may be printed on the receiving member, giving a much sharper edged print. It will also be seen that the volume of coating material needed to mark a given receiving area is less when a large number of smaller drops are used. This not only results in a saving in printing material but also permits increased drying rates and, when utilizing a material such as paper as the receiving member, decreased problems of cockling.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view showing the principal components of a coating system incorporating the present invention;

FIG. **2** is an enlarged cross sectional view through a portion of a coating head formed in accordance with the present invention;

FIG. **3** is an enlarged elevational view comparing the amount of printing materials used in a system according to the present invention and a system in which each drop is individually controlled;

FIG. **4** is another comparison view but in plan; and

FIG. **5** is view taken on line **5—5** of FIG. **2**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference initially to FIG. **1** of the drawings, it will be seen that a non-contacting coating system may include a manifold bar **10** having a coating chamber **11** supplied with coating material under pressure through a conduit **13** and having a constant frequency oscillator, as at **14**, attached thereto for a purpose to be prsently explained. A filter plate **20** having a central portion **21** formed with a series of extremely small diameter openings therethrough is attached to the lower surface of the manifold bar **10** with a gasket **23**, having a slotted central portion **24**, interposed therebetween. A second gasket member **26**, also having a slotted central portion, as at **28**, extends between the lower surface of the filter plate **20** and an inlet plate **30**.

Inlet plate **30** has a slotted central portion **32** in registration with the slotted portions of the members thereabove and overlying a seris of discrete groups **33** of orifices **34** (see also FIG. **2**) formed in an orifice plate **36**. A spacer plate **40** is mounted beneath the orifice plate **36** and is provided with a series of openings **42** therein surrounding the orifices in each of the groups **33**. A charge ring plate **44** is positioned beneath the spacer plate **40** and is provided with a series of charge rings **46**, each of which is connected through a line **48** to a plug **50** engaging a socket **52** which, through a line **54**, places each of charge rings in circuit with and controlled by intelligence signals from control unit **56**. A clamp bar **58**, having a series of openings **60** formed therein concentrically with the charge rings **46**, is positioned beneath the charge ring plate. The clamp bar, in conjunction with a plurality of bolts, not shown, passing through the clamp bar and the other components of the system and threaded into the manifold bar **10**, serves to clamp the assembly together.

Electrodes **62** are mounted on a lower surface of the assembly of components just described by means of plugs **64** engaging in sockets (not shown) on the bottom of the assembly, and the electrodes are provided with energy from a source indicated somewhat schematically at **66**. A catcher **68**, consisting of a tubular member **70** having a blade **72** projecting from a slot **74** formed therein, is positioned beneath the electrodes **62** and fastened thereto by any suitable means and the interior of the tubular member **70** is preferably connected to a source of vacuum, indicated schematically at **76**.

With reference to FIGS. **1** and **2**, it will be seen that coating material is pumped under pressure through the conduit **13** to the chamber **11** and the manifold **10** and thus passes down through the filter plate **20** and inlet plate **30** to provide coating material under pressure to the orifices **34** in the orifice plate. The coating material is ejected from the orifices **34** in a series of fine filaments **80**, each of which has a natural tendency to break down into a stream of discrete drops. The rate of generation, however, will not ordinarily be uniform and the oscillator **14** is provided to impose a constant frequency vibration on the system to cause the filaments to break down into drops of a uniform size at a uniform rate. Thus, streams of drops are formed with the drops in each stream synchronized with the drops in each of the other streams. It is preferable that the charge ring be located at the point where the filaments begin to break down into drops. The spacer plate **40** is, therefore, provided to insure that the charge ring plate **44** with its associated charge rings **46** is properly positioned in this regard.

As seen in FIG. **2** each charge ring **46** controls the charge distribution at the tips of all fluid filaments issuing from an associated cluster of orifices. Thus a similar charge treatment may be accorded all drops within one synchronously generated drop packet. As explained above, this treatment may be either binary or a sampled value of a filament tip charge of varying intensity. Subsequently, when the packets of drops pass between the electrodes **62** or other means establishing the deflection field, each of the drops in a packet is treated substantially simultaneously. That is, they are all either deflected or not deflected and either caught, or imprinted on the receiving member. While the drops are necessarily slightly separated as they pass downwardly through the various components of the coating system, when they impinge upon the receiving member **84** they spread out somewhat to overlap and form a composite dot of coating material.

While the orifices in a particular cluster of orifices may be arranged in any desired pattern, it will often be preferable to arrange the orifices, as best seen in FIG. **5**, in a regular matrix having an even number of columns **86** and rows **88**. This permits the imprinting of dots of coating material of substantially square outline, as seen in FIG. **4**, to minimize unnecessary overlap of dots while still obtaining sharp resolution.

It will also be noted from FIGS. **3** and **4** that the volume of coating material necessary to imprint a dot of comparable size is much smaller when the dot is formed from a plurality of small drops rather than from a single large drop. This not only results in a saving of coating material but permits faster drying times and lessens problems of cockling when utilizing a receiving member of paper or the like.

In the above description a binary system has been described wherein each of the drops in each packet of drops is either charged or not charged as the drops pass through the charge rings **46**. Thereafter, the drops in each packet are either deflected or not deflected, depending upon whether or not they have been charged, as they pass between the deflecting electrodes **62**. It will be apparent, however, that the principles of the present invention may also be incorporated in a system in which the packets of drops are treated in a somewhat different manner. For example, the charge imposed on the drops in one packet may be different from the charge on the drops in another packet so that the mean trajectories of the packets will be deflected different amounts as they pass through the deflecting field established by the deflecting electrodes **62**.

It will also be seen that the present invention finds utility in a system in which the charges imposed on the drops by the charging rings or electrodes **46** are constant and a separate set of deflecting electrodes is provided for each cluster of orifices, with the strength of the deflecting field established by each set of deflecting electrodes varied to obtain variable deflection of the drops of each group as they pass therebetween. Further it may be appreciated that drops generated in packets in accordance with this invention could be controlled by coding a physical characteristic other than electrical charge. For instance, packets of magnetically polarized drops could be deflected by the action of an appropriate magnetic field. Regardless of the specific manner in which the drops are treated, however, it will be apparent that the same advantageous results accrue.

While the methods and forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and forms of apparatus, and that changes may be made therein without departing from the scope of the invention.

What is claimed is:

1. A noncontacting coating system comprising: means defining a cluster of orifices, means for supplying coating material under pressure to said orifices to form streams of synchronized drops of coating material from said orifices with synchronized drops from each of said streams forming packets of drops, charge means positioned downstream of said orifices and defining means for substantially simultaneously and uniformly treating each drop in each packet of drops, deflection field generating means positioned downstream of said charge means for substantially simultaneously and uniformly controlling the trajectory of the drops in each packet, and means for catching packets of drops traversing some predetermined trajectory from said deflection field generating means.

2. The apparatus of claim 1 wherein: said orifices are arranged in a matrix pattern.

3. The apparatus of claim 2 wherein: said orifices are arranged in columns having an equal number of rows and rows having an equal number of columns.

4. A noncontacting coating system comprising: means defining a plurality of discrete clusters of orifices, means for supplying coating material under pressure to each of said cluster of orifices to form streams of drops of coating material from each of said discrete clusters with the drops from each of said streams forming packets of drops, charge means positioned downstream of said clusters of orifices and defining one electrode for each cluster of orifices and for substantially simultaneously and uniformly treating each drop in a particular packet of drops, deflection field generating means positioned downstream of said charge means for substantially simultaneously and uniformly controlling the trajectory of all of the drops in each particular packet of drops, and means for catching packets of drops traversing some predetermined trajectory from said deflection field generating means.

5. The apparatus of claim 4 wherein said orifices in each of said clusters of orifices are arranged in a matrix pattern.

6. The apparatus of claim 5 wherein said orifices in each of said clusters of orifice are arranged in columns having an equal number of rows and rows having an equal number of columns.

7. A noncontacting coating system comprising: an elongated orifice plate, means defining a series of regularly spaced clusters of orifices through said orifice plate, means for supplying a liquid coating material under pressure to each of said orifices in said clusters of orifices, a charge ring plate extending coextensively with said orifice plate, a series of charge rings mounted in and extending through said charge ring plate, each of said charge rings being concentrically positioned with respect to one of said clusters of orifices whereby all of the streams of drops of coating material ejected from the orifices of a cluster will pass through a corresponding charge ring positioned concentrically thereto, control means associated with said charge rings for selectively applying an electric charge to predetermined packets of drops of coating material as they pass through said charge rings, means establishing a constant potential electrostatic deflection field positioned downstream of said charge rings in the trajectory of coating drops passing through said charge rings to cause packets of drops charged by said charge rings as they pass therethrough to be deflected by said deflection field, and means for catching said packets of drops deflected by said deflection field.

8. A noncontacting coating system comprising: means defining a cluster of orifices, a common fluid supply reservoir and means for maintaining said reservoir under stream forming pressure for generating a stream of drops of coating material at the exit of each orifice in said cluster, an oscillating transducer in communication with said reservoir for causing the drops in said streams to be generated in synchronized packets, a charging electrode for coding a physical characteristic of all drops in a particular packet in accordance with the level of an input intelligence signal at a selected instant of time, static electrical field generating means for selective lateral deflection of all drops in a particular packet of drops in accordance with its coded physical characteristic, and means for catching all drops following a trajectory through a predetermined catching region.

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