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METHOD AND APPARATUS FOR PRINTING

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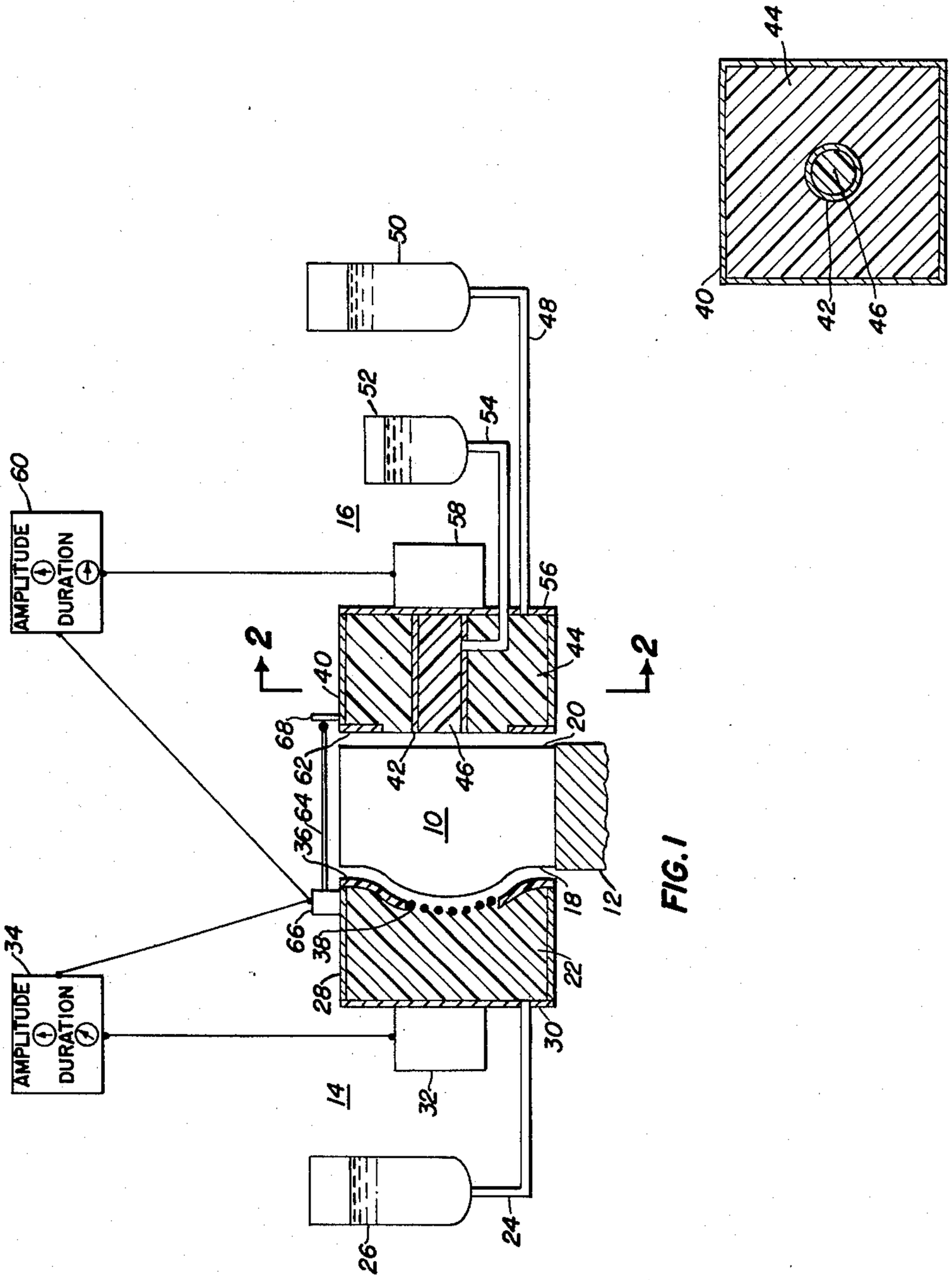


FIG. 1




FIG. 2

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# METHOD AND APPARATUS FOR PRINTING

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This invention relates to an apparatus and method for printing and, more particularly, to a novel printing apparatus and method utilizing a source of impulse energy in combination with a porous material containing a liquid printing medium. This invention is especially useful for prnting on flexible and/or irregular surfaces.

In conventional printing methods, such as letter-press, lithography, and gravure, a plate, or an equivalent element containing the symbol to be printed, comes into physical contact with the material to be printed. It is necessary to support the object being printed in order that the plate, or equivalent element, can apply the requisite pressure to the object being printed. If the object being printed is not rigidly held, the gradual build-up and reduction in pressure may result in smearing. In many instances, it is desirable to print an object without it being rigidly supported. For example, modern packaging techniques often require the printing of objects having pressure-yielding surfaces, such as flexible plastic containers filled with a liquid.

In accordance with this invention, we have devised a novel printing apparatus and method in which the need for rigidly holding the paper or other object being printed by a roller or other means is eliminated. Briefly, this invention is based on the discovery that objects can be printed without being rigidly supported by the application of a pulse of energy to a porous material containing a liquid printing medium which is in juxtaposition to the surface being printed. The pulse of energy causes the liquid printing medium in the porous material to contact the object in juxtaposition thereto. The use of a pulse permits easy adjustment of amplitude to accommodate various situations, and permits precise timing of the pulse in the printing cycle. This invention is useful for printing irregularly shaped surfaces as well as flexible surfaces.

It is an object of this invention to provide an apparatus for printing wherein the application of pressure to the object being printed is eliminated.

Another object of this invention is to provide an apparatus and method for printing wherein any physical contact between the printing apparatus and the object being printed is short and sharp.

A third object of this invention is to provide an apparatus and method for printing wherein the object being printed need not be rigidly held.

A further object of this invention is to provide an apparatus and method for printing flexible and/or irregular surfaces.

A still further object of this invention is to provide an apparatus and method for printing wherein the printing is accomplished by the application of a pulse of energy to a porous material containing a liquid printing medium.

These and further objects of this invention will become apparent as the description proceeds and references made to the accompanying drawings in which:

FIGURE 1 is a view, partly in schematic and partly in cross-section, of the novel printing apparatus of this invention; and

FIGURE 2 is a cross-sectional view taken along the line 2—2 in FIGURE 1.

The printing assembly of our invention includes a porous material containing a liquid printing medium which is placed in juxtaposition to the object to be printed. The



printing surface, the surface of the porous material which is adjacent to the object to be printed, is shaped substantially to conform to the shape of the surface to be printed. For reasons which will be apparent as the description of our invention proceeds, the porous material, with the exception of the printing surface, is preferably contained within a fluid-impermeable housing. The fluid-impermeable housing has at least one rigid surface which is in contact with the porous material contained therein. The shape of the printing surface exposed to the surface to be printed conforms to the wording, symbol, configuration, etc., it is desired to print. The printing is accomplished by the application of a pulse of energy to a rigid plate in contact with the porous material. Depending upon the construction of the printing assembly, the pulse of energy will either cause particles of the liquid printing medium to be projected from the porous material across the space between the printing surface and the surface to be printed, or cause the printing surface to flex and momentarily contact the surface to be printed, thereby depositing particles of the printing medium thereon.

The method of printing used, and therefore the construction of the printing assembly, will be determined by the shape of the object which is to be printed. If the surface to be printed is a regularly shaped surface, viz., flat, semi-cylindrical, etc., either method may be used. For example, if a cylindrical object is to be printed, two printing assemblies having semi-cylindrical printing surfaces can be used to provide the printing form by closing linearly on the object in opposite directions. However, if the surface is an irregularly shaped surface, viz., one having concave and convex portions, it is preferred that the printing assembly be so constructed that the pulse of energy will cause particles of the printing medium to project across the gap between the printing surface of the assembly and the object. It is preferred that printed surfaces of the object are not parallel to the movement of the printing surface of the assembly, since the withdrawal of the printing surface may result in the printing being smeared.

A variety of materials adapted to contain various printing mediums are suitable for use as the porous material which contains the liquid printing medium. It may be comprised, for example, of a plurality of pieces of cloth, or of sponge-like materials having pores of capillary dimensions, such as cellulose or polyurethane sponges. If the printing is to be accomplished by flexing of the porous material to contact momentarily the object to be printed, it is essential that the porous material be relatively flexible. There are several suitable methods of limiting the exposure of the porous material to the adjacent object in order to produce the desired wording, symbols, configurations, etc. In instances where a field of a solid color, or relatively large symbols, configurations, etc., are to be printed, the printing surface can be shaped to conform to the shape of the desired printing. Another method by which the desired printing may be obtained, is to coat the printing surface with a suitable fluid-impermeable material, such as varnish, in the areas in which no printing is desired to prevent the passage of the printing medium. However, it will be evident that the utilization of a stencil will permit the rapid changing of the symbol which is to be printed. If the pulse of energy is to cause the printing surface to flex and momentarily contact the adjacent object, it is preferred that the stencil be movable with the porous material when a pulse of energy is applied thereto. Should the alternative method of printing in accordance with this invention be used, the stencil is preferably relatively rigid, and secured to the housing in which the porous material is located, to limit the movement of the

printing surface when the pulse is applied to the porous material. Where the printing is to be accomplished by projection of the printing medium, the provision of a screen over the exposed printing assembly will serve to counteract the tendency of the porous material to flex upon actuation of the pulse-generating device. It will be evident that a stencil and screen can be formed as one integral unit by providing a screen over the entire surface of the porous material which is adjacent to the object to be printed, and coating the areas of the screen where printing is not desired with a material impermeable to the liquid printing medium.

Although a variety of materials can be used as the stencil, screen, and fluid-impermeable coating for the printing surface, the utilization of materials, or coatings for such materials, which are non-wetting to the printing medium employed would reduce the tendency of the printing medium to drip down the portion of the printing assembly adjacent to the object to be printed and possibly smear the object being printed. The material or coatings used would necessarily be dependent upon the nature of the printing medium. For example, plastics such as fluoroethylenes are suitable when the printing medium is of a water base. In addition, the utilization of a screen non-wetting to the printing medium would serve to prevent flow of the printing medium through the screen before the impulse is applied in instances where the impulse is to cause the printing medium to be projected.

The impulses may be created by an electrical solenoid or other impulse-generating device, such as an ultrasonic transducer or loudspeaker. Although the rigid plate to which the impulse is applied may be in contact with any surface of the porous material, other than the printing surface, it is preferred that the impulse be applied to the surface opposed to the printing surface. The resulting shock wave will pass through the porous printing-medium-containing material and provide sufficient energy to either flex the printing surface or project particles of the printing medium to the object being printed, depending upon the construction of the printing assembly. The required amplitude of the impulse will depend upon variables such as the viscosity of the printing medium, characteristics of the porous material, distance between the printing surface and object being printed, method by which the printing is to be accomplished, and the like. If the impulse is to cause the printing medium to be projected from the printing surface covered by a non-wetting screen, the amplitude of the impulse will have to be sufficient to overcome the existing forces of adhesion.

A variety of liquids adapted to form coatings on materials are suitable for use as the printing medium of this invention. For example, many of the inks and paints utilized in conventional printing and spraying operations may be used. The viscosity of the printing medium must be such to permit its flow through the porous material. The printing medium can be fed to the porous material by gravity or capillary action, or by a constant-pressure pump.

If printing in more than one color is desired, a plurality of printing assemblies can be used. However, in some instances two or more colors can be applied simultaneously by a single printing assembly utilizing a multi-section printing surface with a compartmented porous material. A single impulse can serve to apply all the colors at the same time, since the impulse can be made to travel uniformly through the several portions of the porous printing-medium-containing material.

Our apparatus and method are useful in printing on a wide range of materials. The surface to be printed may be of any metal, fiber, or plastic, such as polystyrene, polypropylene, etc. Since the printing medium may not readily adhere to some surfaces, it may be necessary to treat these surfaces before printing by oxidation, by coating with a printing-medium-receptive material, or by other means.



The printing apparatus of this invention is readily adaptable to use with conveyor systems. When it is desired to print objects traveling on a conveyor, the printing assembly of this invention can be installed at the sides and/or above the conveyor, depending upon the position of the surface to be printed. Since the printing action is substantially instantaneous, it may be possible to print an object without arresting its travel. For example, when the surface to be printed is regularly shaped and parallel to the direction of travel, and the rate of travel is relatively slow, the impulse-generating device can be automatically actuated when the object is positioned in front of the printing surface. However, when the surface to be printed is irregularly shaped and/or not parallel to the direction of travel, it would be necessary to halt the object in front of the printing assembly of this invention and place the printing surface and the surface to be printed in juxtaposition to each other.

Referring to the drawings, object **10** is shown resting on support **12** between printing assemblies **14** and **16**. Object **10** can be manually or mechanically placed on support **12**, or support **12** may be a conveyor on which object **10** is traveling. Printing assemblies **14** and **16** are adjacent to sides **18** and **20** which are to be printed. Since side **18** is irregularly shaped, printing assembly **14** is to operate by projecting a printing medium, such as ink, from the surface of porous material **22** to adjacent side **18**. Porous material **22** is a plastic such as foamed polyurethane having pores of capillary dimensions. The printing medium is supplied to porous material **22** by conduit **24** connected to ink reservoir **26**. Porous material **22** is enclosed within fluid-impermeable housing **28**. Housing **28** includes plate **30**, the inside of which is in contact with porous material **22**, and the outside of which is in contact with impulse-generating device **32**, such as an electrical solenoid. Electrical solenoid **32** is electrically connected and actuated by control **34**, which includes means for regulating the amplitude and duration of the impulse. The desired wording, symbol, etc. is printed on side **18** by providing stencil **36**, which is relatively rigid, on the surface of porous material **22** adjacent to side **18**. The tendency of porous material **22** to flex upon actuation of electrical solenoid **32** is counteracted by securing stencil **36** to housing **28**, and providing rigid screen **38** over the openings in stencil **36**. Stencil **36** and screen **38** are shaped to conform to the shape of side **18**. As hereinbefore described, stencil **36** and screen **38** can be formed as one integral unit, and preferably are non-wetting to the ink contained within porous material **22**.

Printing assembly **16** is to print on side **20** a symbol of one color on a field of a second color. Printing assembly **16** comprises fluid-impermeable housing **40** divided by fluid-impermeable separator **42** into sections containing porous materials **44** and **46**. Porous materials **44** and **46** also have pores of capillary dimensions and are of a plastic such as foamed polyurethane. A printing medium, such as ink, is fed to porous material **44** by conduit **48** connected to ink reservoir **50**, while reservoir **52**, containing ink of a color other than that contained in reservoir **50**, is connected to porous material **46** by conduit **54**. Housing **40** includes rigid plate **56** in contact with porous materials **44** and **46**. The outside of rigid plate **56** is in contact with an impulse-generating device **58**, such as an electrical solenoid. Electrically connected to electrical solenoid **58** is control **60** to operate same. Control **60** includes means for adjusting the amplitude and duration of the impulse created by electrical solenoid **58**. Since side **20** is a regularly shaped surface, i.e., flat, the actuation of electrical solenoid **58** is to cause porous materials **44** and **46** to flex and contact side **20**. Porous

material 44 is coated in the areas in which no printing is desired with fluid-impermeable material 62. A suitable material would be varnish.

In the operation of our invention, the travel of object 10 on conveyor 12 is arrested when object 10 reaches a printing station containing printing assemblies 14 and 16. During the period when object 10 is momentarily stopped, printing assemblies 14 and 16 approach object 10 from both sides. When printing assemblies 14 and 16 reach a predetermined closure distance, arm 64 on switch 66 strikes plate 68 to actuate switch 66. Switch 66 then operates controls 34 and 60 which, in turn, actuate electrical solenoids 32 and 58, respectively. The electrical solenoid 32 causes particles of the ink-contained within porous material 22 to be projected across the gap between porous material 22 and side 18, to print the desired wording. The actuation of electrical solenoid 58 causes porous materials 44 and 46 to flex and contact side 20. When porous materials 44 and 46 contact side 20, particles of the printing mediums contained within porous materials 44 and 46 are deposited on side 20 to produce the desired configuration. After this has occurred, printing assemblies 14 and 16 withdraw from object 10 and conveyor 12 moves object 10 to an oven or other curing station. It will be evident that since printing assemblies 14 and 16 move in this described embodiment, conduits 24, 48, and 54 must be flexible, or conduit 24 and reservoir 26 must be movable with printing assembly 14 and conduits 48 and 54, and reservoirs 50 and 52 must be movable with printing assembly 16.

The embodiments of this invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a method of printing, the improvement which comprises placing in spaced relation a porous material containing a printing medium and a body to be printed, a portion of the surface of said porous material being exposed and adjacent to but separated from an exposed surface of said body, covering with a substantially non-porous member the portion of the outer surface of said porous material from which printing medium is not to be projected onto the surface of the body to be printed, and while maintaining the exposed surface of said porous material separated from the surface of the body to be printed, applying to a rigid member in contact with a surface of said porous material other than said exposed surface a pulse of energy sufficient to project said printing medium across a gap existing between said porous material and said body, said printing medium being deposited upon the surface of said body thereby printing the same without causing contact between said body and said porous material.

2. The method in accordance with claim 1 which includes the step of disposing a stencil between said exposed surface of said porous material and said surface to be printed.

3. The method in accordance with claim 1 in which said pulse is applied to a rigid member in contact with the surface of said porous material opposite said exposed surface.

4. In a printing apparatus, the improvement which comprises a porous material containing a printing medium, a non-porous means for confining the outer surface of said porous material except that portion of the surface from which the printing medium is to be projected, the exposed surface of said porous material being adjacent to but separated from an exposed surface of a body to be printed, means for maintaining the exposed surface of said porous material a predetermined distance away from the surface of said body to be printed, and means for applying a pulse of sufficient amplitude to a rigid member in contact with a surface of said porous material other than said exposed surface to cause said printing medium to be projected from the exposed surface of said porous material across a gap onto the surface of said body so that the surface of said body is printed while it is still separated from the surface of said porous material.



5. An apparatus in accordance with claim 4 including a stencil interposed between said exposed surface of said porous material and said surface to be printed.

6. An apparatus in accordance with claim 4 including means for continuously supplying said porous material with a liquid printing medium.

7. An apparatus in accordance with claim 4 in which said porous material comprises foamed polyurethane containing within the pores of the foam a liquid printing medium.

8. An apparatus in accordance with claim 4 in which said porous material is divided into at least two sections by means comprising at least one liquid-impermeable separator.

9. An apparatus in accordance with claim 4 including a foraminated screen disposed between the exposed surface of said porous material and the surface of said body to be printed.

10. In a printing apparatus, the improvement which comprises a porous material adapted to contain interstitially a liquid printing medium, said porous material being enclosed within a liquid-impermeable housing with a portion of the outer surface of said porous material facing an exposed surface of a body to be printed, a substantially rigid plate forming a stationary portion of said housing in contact with a portion of the outer surface of said porous material not facing said body to be printed, means for supporting said housing so that the exposed surface of the porous material is adjacent to and spaced equidistant from the surface of said body to be printed, electrically-actuated pulse-applying means adapted to apply to said plate a pulse of energy to cause printing medium to be projected from the exposed surface of the printing medium to the surface of the body to be printed, and electrical means for actuating said pulse-applying means while said surfaces of said printing medium and said body to be printed are still equidistantly spaced.

11. Apparatus in accordance with claim 10 in which said rigid plate is in contact with the outer surface of said porous material opposite to said exposed surface.

12. In a printing apparatus, the combination which comprises, a porous material adapted to contain interstitially a liquid printing medium, said porous material being enclosed within a fluid-impermeable housing with a portion of the outer surface of said porous material exposed, said exposed portion of said porous material facing an exposed surface of a body to be printed, a substantially rigid plate forming a stationary portion of said housing in contact with a portion of the outer surface of said porous material not facing said body to be printed, a stencil interposed between said exposed surface of said porous material and said exposed surface of said body to be printed, means for supporting said housing so that the exposed surface of the porous material is adjacent to and separated from the surface of said body to be printed, electrically-actuated pulse-applying means adapted to apply to said plate a pulse of energy to cause particles of said printing medium to be projected from the exposed surface of the printing medium to the exposed surface of the body to be printed, and electrical means including means for actuating and regulating the amplitude and duration of pulse produced by said pulse-applying means so that said particles of said printing medium are projected while said surfaces of said printing medium and said body to be printed are still separated.

13. In a process for printing, the steps which com-

prise, placing a porous material containing a liquid printing medium in spaced relation to a body to be printed such that an exposed surface of said porous material is adjacent to but separated from an exposed surface of said body, interposing a stencil between said exposed surface of said porous material and said exposed surface of said body to be printed, and, while holding a substantially non-porous member in contact with the portions of the outer surfaces of said porous material not adjacent said exposed surface to be printed, applying to said member an electric pulse of energy of sufficient amplitude and duration to cause particles of liquid of said printing medium to be projected from the exposed surface of said porous material to the exposed surface of said body to be printed while the surface of said body is still separated from the surface of said porous material.




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# UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 3,180,256 April 27, 1965

Walter E. Kramer et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 14, for "prnting" read -- printing --; column 3, line 4, after "printing" insert -- surface and secured to the printing --.

Signed and sealed this 21st day of September 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents