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**Clark et al.**

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(54) **DEFORMABLE PAD FOR PAD PRINTING**

(76) Inventors: **Lloyd Douglas Clark**, 15 Conrad St., San Francisco, CA (US) 94131-2924; **Brian A Brown**, 325 Lake St., San Francisco, CA (US) 94118

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(21) Appl. No.: **11/464,203**

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(51) **Int. Cl.**
*B41F 17/34* (2006.01)

(52) **U.S. Cl.** ..... **101/41**; 101/35

(58) **Field of Classification Search** ..... 101/33, 101/35, 401, 483, 41
See application file for complete search history.

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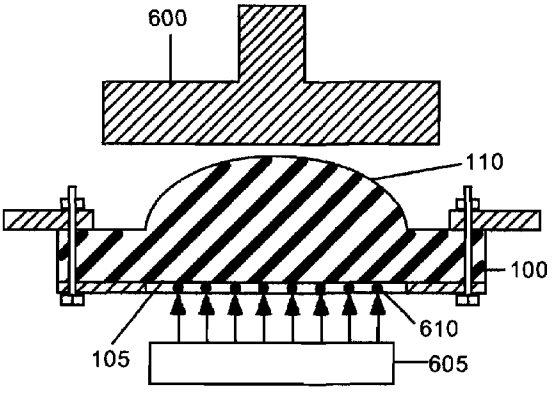
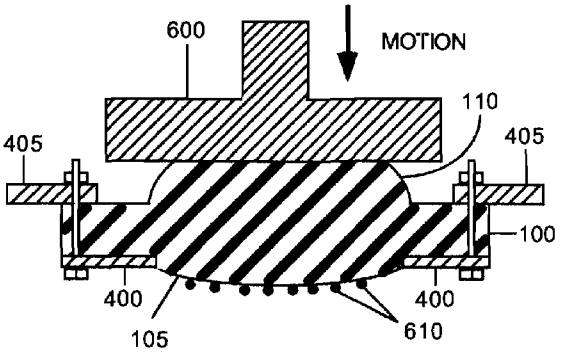
*Primary Examiner*—Daniel J Colilla

(57) **ABSTRACT**

A deformable pad (**100**) for pad printing has an initially flat side (**105**) and an opposite bulged side (**110**). An ink image (**610**) is applied to the flat side of the pad using an inkjet head (**605**) or other ink image source. The pad is then distorted using a ram (**600**) or hydrostatic or pneumatic source applied to a chamber (**1300**) so that the initially bulged side is flattened and the initially flat side bulges. After distortion, the now bulged side with the ink image is pressed against a receiving surface for transfer of the ink image to the surface. An alternative embodiment starts by deforming a pad to produce a flat surface, inking the surface with an image, then allowing the pad to relax, rendering the previously flat, image-bearing surface newly bulged. The newly-bulged surface is then temporarily urged against a receiving surface for transfer of the ink image.

**15 Claims, 6 Drawing Sheets**



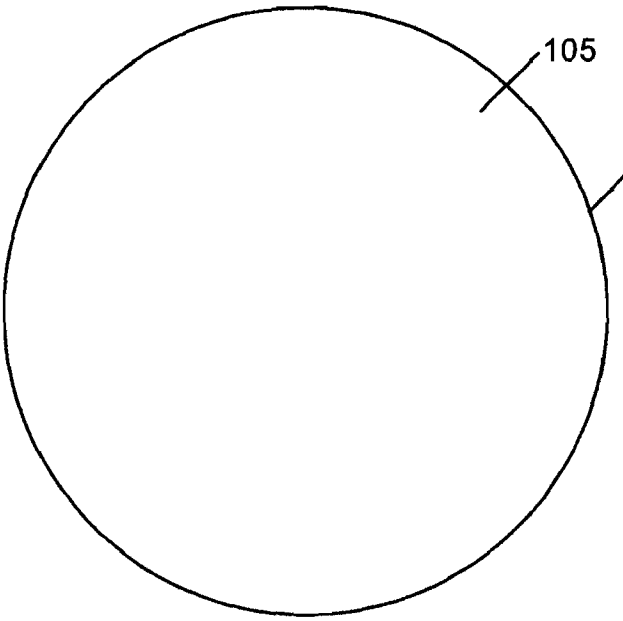



Fig. 1

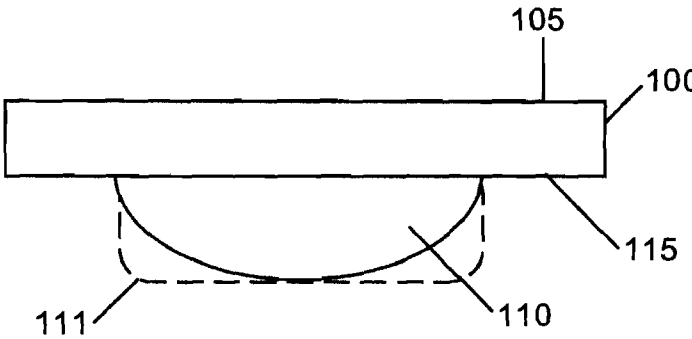



Fig. 2

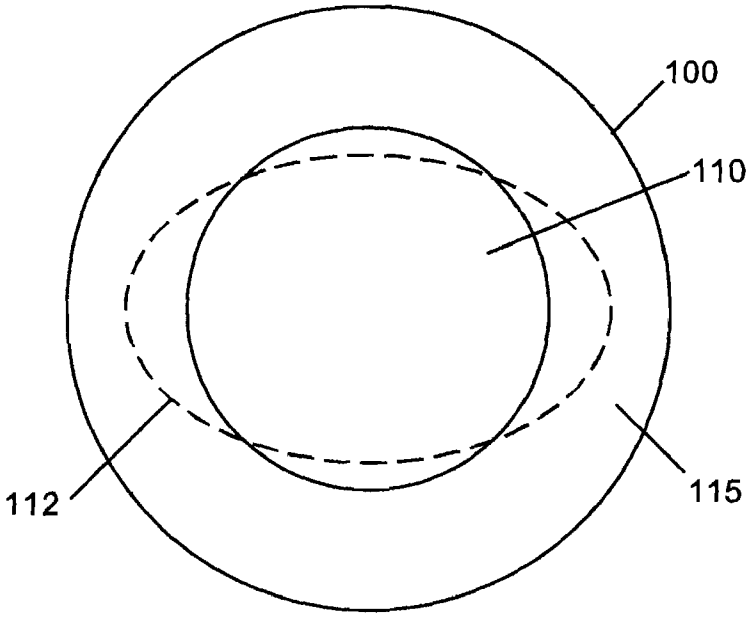



Fig. 3

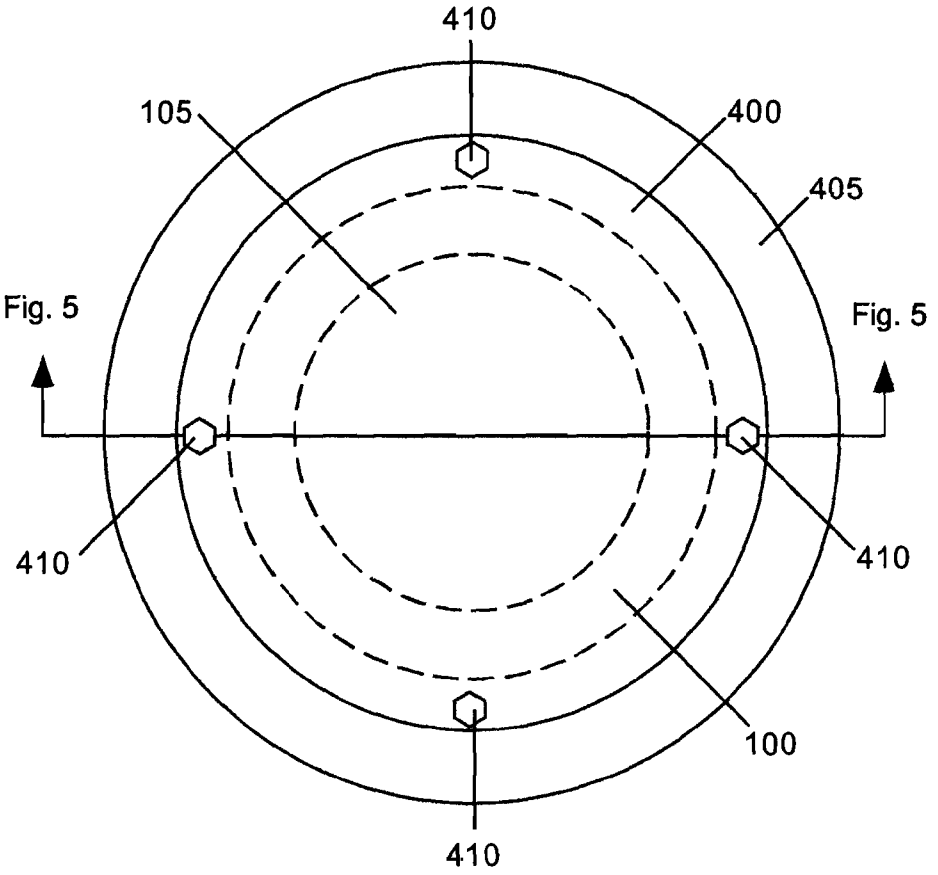

410
105
400
405
Fig. 5
Fig. 5
410
410
100
410

Fig. 4

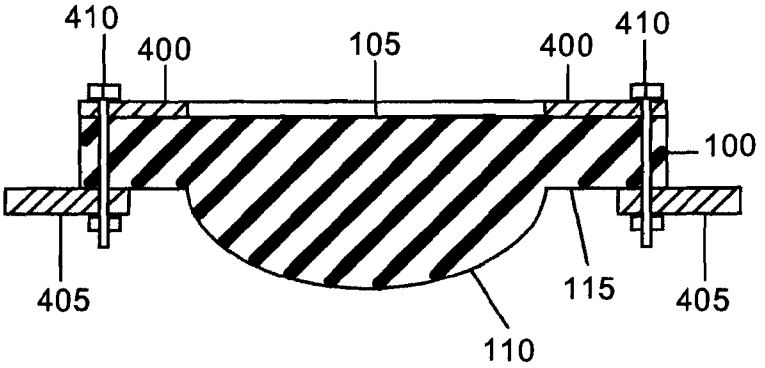

410
400
105
400
410
100
405
115
405
110

Fig. 5

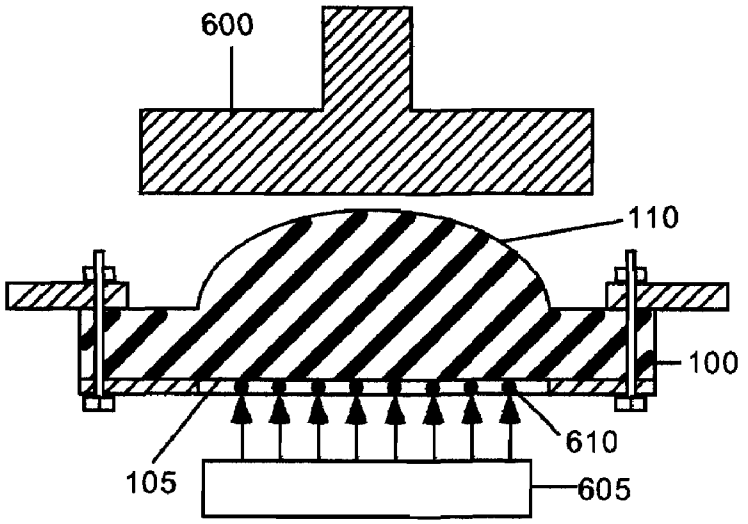



Fig. 6

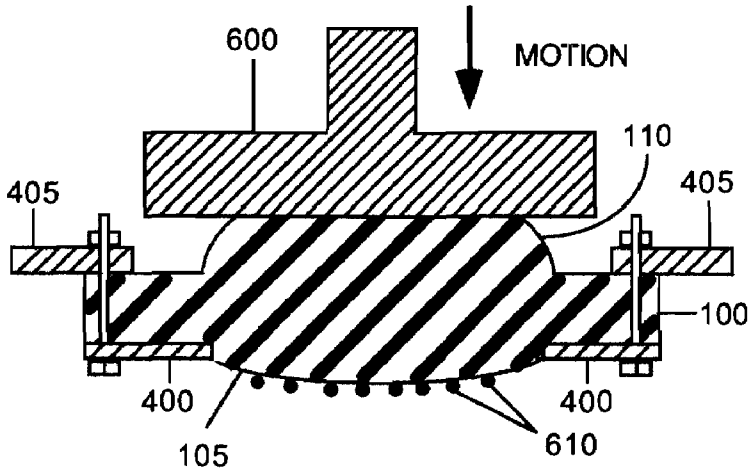



Fig. 7

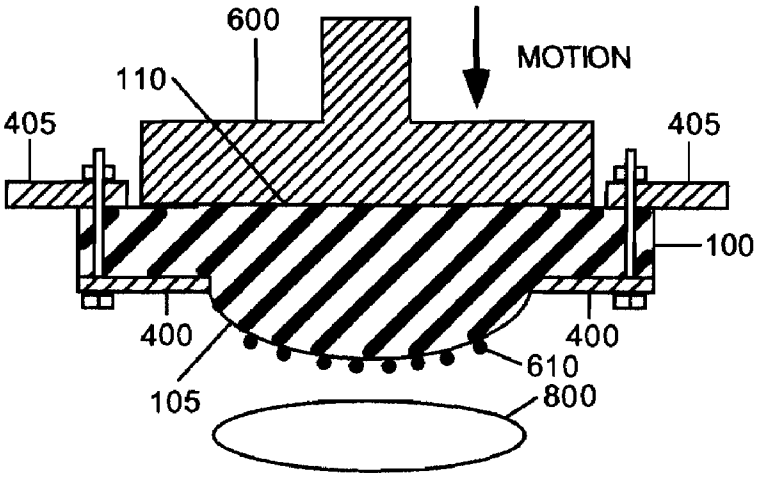



Fig. 8

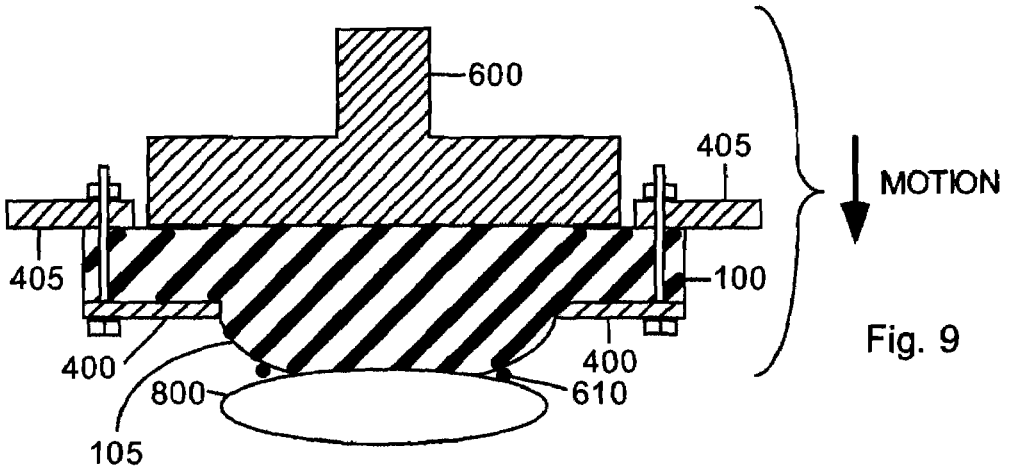

600
405
405
100
MOTION
400
400
800
610
105

Fig. 9

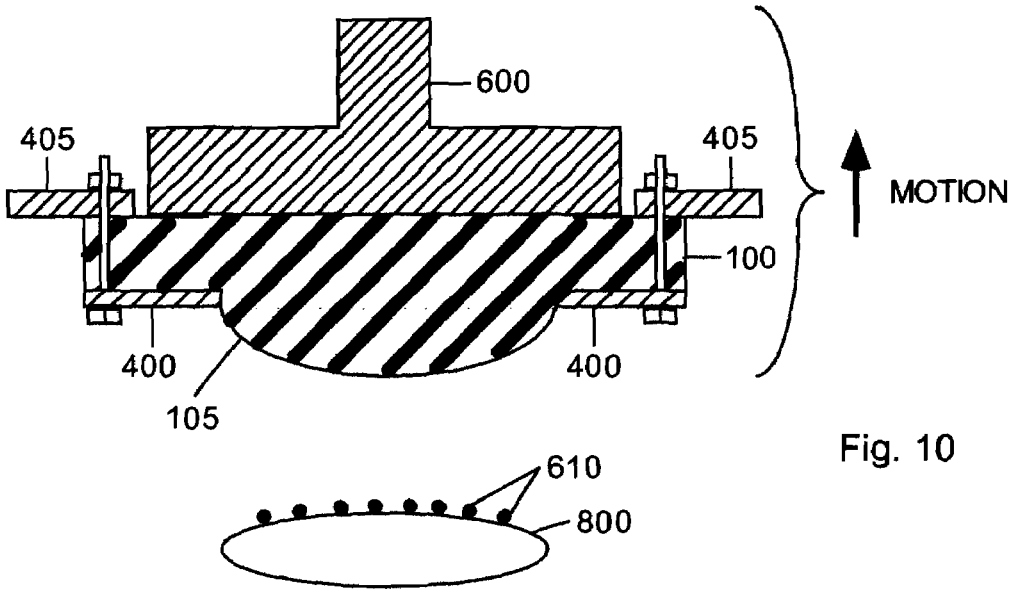

600
405
405
100
MOTION
400
400
105
610
800

Fig. 10

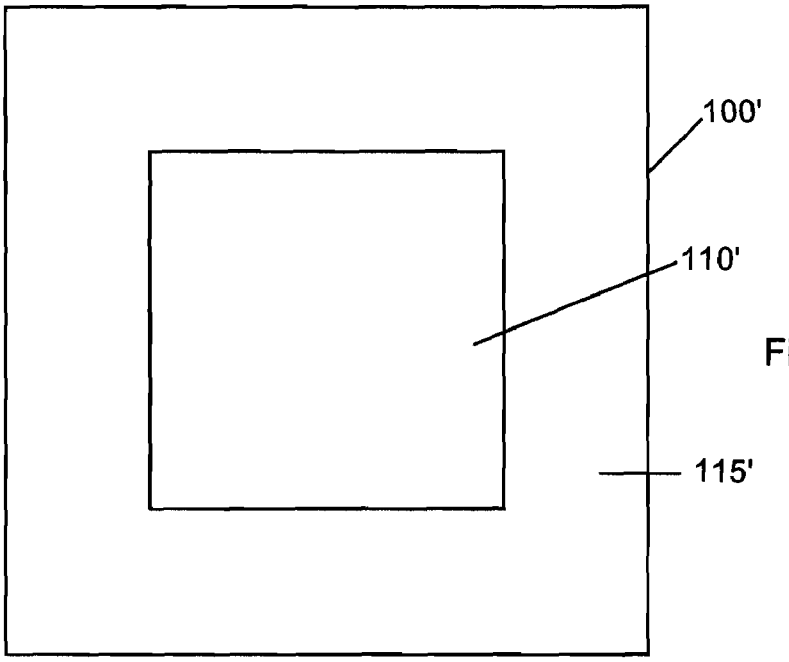



Fig. 11

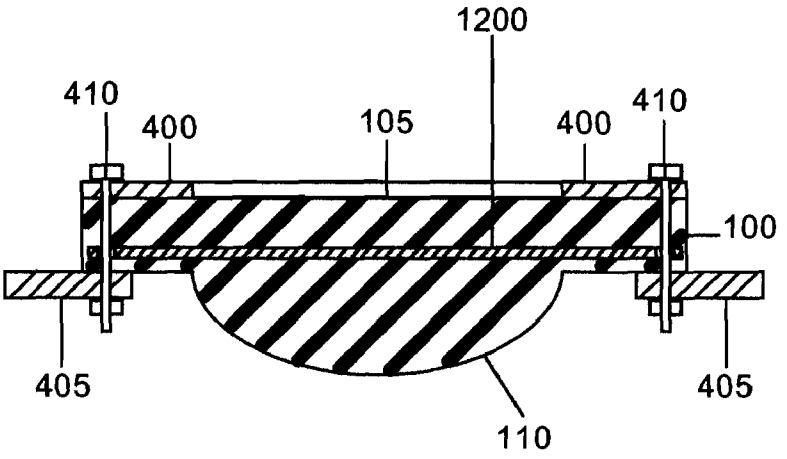



Fig. 12

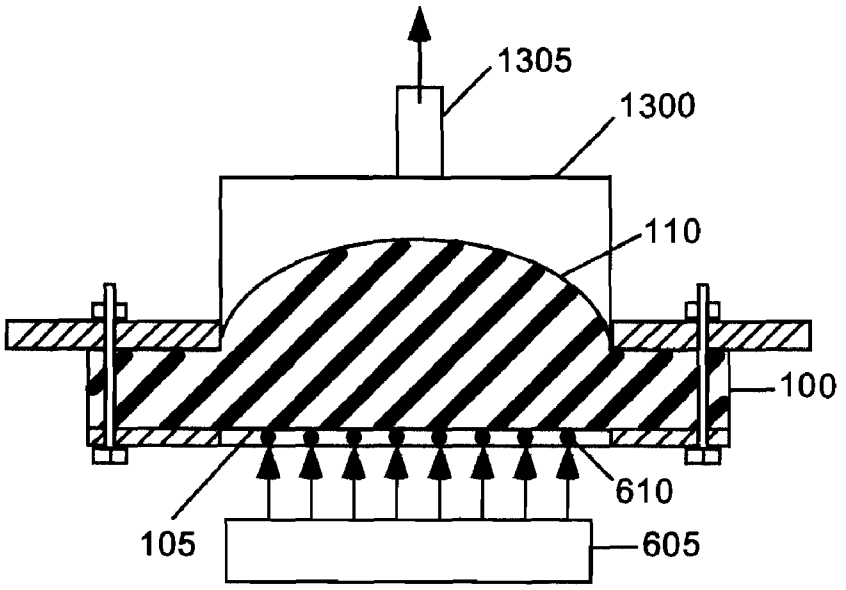

1305
1300
110
100
610
105
605

Fig. 13

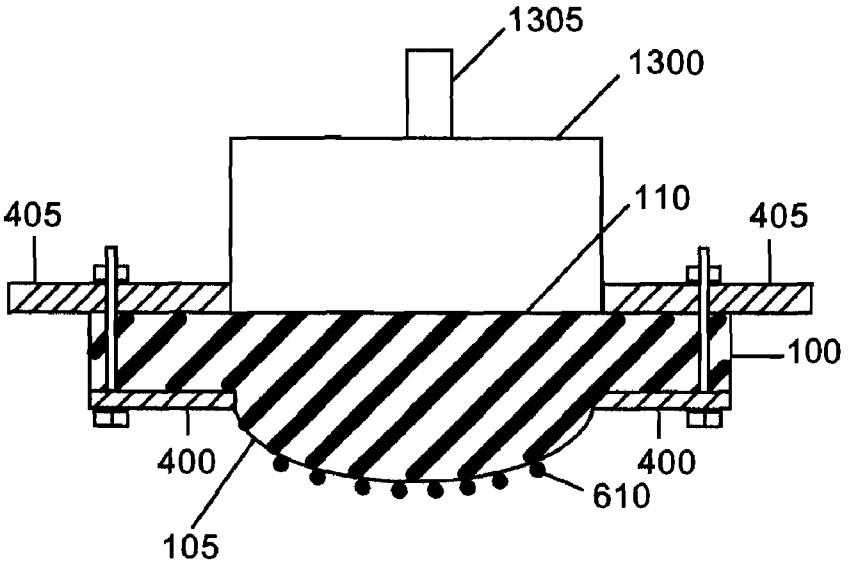

1305
1300
110
405
405
100
400
400
610
105

Fig. 14

# DEFORMABLE PAD FOR PAD PRINTING

## CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority of our provisional patent application, Serial Number US60/709,216, filed Aug. 18, 2005.

## BACKGROUND

1. Field of Invention

This invention relates to printing, and in particular to printing with a deformable pad.

2. Prior Art

Pad printing has long been used to apply images to surfaces. This printing technology is especially useful for applying images to uneven, non-flat surfaces of virtually any size. These include products ranging from bottles to cellular telephones to home and industrial appliance panels.

The concept of a deformable pad for printing is taught in our U.S. Pat. No. 6,840,167 (2005). The pad comprises a flat sheet of flexible pad material, such as silicone rubber. It is preferably square, 10 cm on a side, and 1.5 cm thick. The pad can be smaller or larger. The size of the pad is determined by the area and shape of the final receiving surface.

The pad is initially flat and its edges are restrained by a holding bracket. An inkjet head deposits an image on the flat front pad surface. The pad is then forcibly deformed by a ram applied to the opposite side of the pad. The ram preferably has a curved frontal shape. Since the edges of the pad are restrained, the ram forces the pad into a bulged shape. The bulged pad is then brought into contact with the final receiving surface. The previously-applied inkjet image transfers from the pad to the receiving surface. A printed or decorated receiving surface results. The principal advantage of this system is the ability to transfer multi-color images in a single step. This system has been shown to work well, however operation of its pad can be improved for use in certain machine configurations.

## SUMMARY

An alternative pad design comprises, in one embodiment, a bulged pad. A flat ram is used to deform the pad, but a shaped ram can still be used.

## DRAWING FIGURES

FIGS. **1-3** show top, side, and bottom views of an ellipsoidal or circular aspect of a first embodiment.

FIGS. **4** and **5** show top and sectional views of a pad with mechanical restraining apparatus, according to the first embodiment.

FIG. **6** shows the pad in its undeformed condition receiving an inkjet image.

FIG. **7** shows the pad being deformed by a ram.

FIG. **8** shows the pad fully-deformed, ready to transfer the inkjet image to a receiving surface.

FIG. **9** shows the pad being urged into contact with the final receiving surface, thereby transferring the inkjet image from the pad to the surface.

FIG. **10** shows the pad and the receiving surface after the two are separated.

FIG. **11** shows a parallelepiped-shaped pad.

FIG. **12** shows a pad with a spring-metal insert.



FIGS. **13** and **14** show a bulged pad with a vacuum or pressure chamber for changing the shape of the pad.

## DRAWING FIGURE REFERENCE NUMERALS

| DRAWING FIGURE REFERENCE NUMERALS | |
|---|---|
| 100 | Pad |
| 105 | Surface |
| 110 | Bulge |
| 111 | Shape |
| 112 | Shape |
| 115 | Region |
| 400 | Ring |
| 405 | Ring |
| 410 | Fastener |
| 600 | Ram |
| 605 | Head |
| 610 | Droplet |
| 800 | Surface |
| 1200 | Spring |
| 1300 | Chamber |
| 1305 | Connection |

## DESCRIPTION

### First Embodiment—FIGS. **1-3**

A pad **100** (FIG. **1**) according to one aspect of a first embodiment is preferably cast or molded in silicone rubber of Shore (also known as durometer) hardness between 5 and 85, although other hardness values can be used. The required hardness of the rubber is determined by a number of factors, including the size of the object to be decorated (printed), the thickness of the pad, the ink used, and so forth. Alternatively, pads can be made from gelatin and other elastomers. When at rest, pad **100** has a normally flat surface **105** on its active or front side, and a bulge **110** (FIG. **2**) on the back side, surrounded by a flat surface region **115**. Flat surface **105** is typically treated in such a way that it will fully release ink onto a receiving surface (not shown) when the two are brought into contact. In this embodiment, pad **100** is 10 cm in diameter, although smaller and larger sizes can be used, depending on the size of the area to be printed. Pad **100** is 1 cm thick at its edges, and 2.5 cm thick at its center. The diameter of bulge **110** (FIG. **3**) at its outer edge is preferably between 5 and 8 cm, In this embodiment, bulge **110** has an axially symmetric domed shape (FIG. **2**), although other shapes such as a cylinder, shown in dashed lines **111**, can be used. The cross-sectional shape of bulge **110** can be circular as shown, or another shape such as elliptical as shown by dashed lines **112** (FIG. **3**). It can also be a parallelepiped (FIG. **11**) or another shape. Different thicknesses can also be used. A flat region **115** surrounds bulge **10**. The intersection between surface **115** and bulge **110** can be sharp or gradual, depending on user preference and the printing job at hand.

### Operation—FIGS. **4** through **10**

In preparation for use, pad **100** is restrained by two concentrically disposed annular rings, **400** and **405** (FIGS. **4** and **5**). Ring **400** is placed in contact with flat surface **105** on the front side and ring **405** is placed in contact with flat region **115** on the rear side. Mechanical fasteners such as bolts **410** are used to secure pad **100** between rings **400** and **405** together. More or fewer bolts **410** can be used, depending on the stresses encountered during the deformation of pad **100**, as described below.

In FIGS. **6** through **10**, the assembly of FIG. **5** is inverted so that front surface **105** faces downwardly. A mechanical ram **600** is positioned above bulge **110** of pad **100**. No external force is applied to pad **100** and it is said to be in a resting condition. An inkjet head **605** or other ink source including, but not limited to electrographic, spray, and other marking technologies emits fine droplets **610** onto flat surface **110**. These droplets form an image to be printed in well-known fashion.

In FIG. **7**, inkjet head **605** has been removed. Ink droplets rest on pad **100** in the shape of the image to be printed. Pad **100** is deformed as ram **600** moves downward against it. Pad **100** and rings **400** and **405** are restrained from moving relative to ram **600** by an external restraining mechanism (not shown) which is attached to the same datum as the driving force for ram **600**. Formerly flat surface **105** begins to bulge outward opposite ram **600**.

In FIG. **8**, ram **600** has pushed the back or top surface **110** of pad **100** down to the level of the bottom of ring **405** so that formerly flat side **105** of pad **100** is fully-bulged. Bulge **110** is flattened by ram **600** and formerly flat side **105** of pad **100** now bulges outward. A receiving surface **800**, such as a cellular telephone case, is shown in place below pad **100** prior to transfer of ink droplets **610**.

In FIG. **9**, ram **600**, pad **100**, and rings **400** and **405** move downward as a unit toward the top surface of an object **800**. Side **105** of pad **100** is deformably pressed against the top surface of object **800**, applying ink droplets **610** to the top surface of object **800**.

In FIG. **10**, all of droplets **610** have been transferred to object **800** and ram **600**, pad **100**, and rings **400** and **405** have moved upward as a unit away from the top surface of object **800**. The printing operation is complete.

Ram **600** now moves upward (not shown), away from pad **100**, returning pad **100** to its resting condition. Bulge **110** resumes its original shape, shown in FIG. **6**, and the printing operation can be repeated. The same or a different image can be applied to surface **105** of pad **100** for a subsequent transfer.

The flat side of pad **100** is made to bulge during transfer in order to prevent the entrapment of air between pad **100** and the receiving surface of object **800**. As pad **100** is urged against object **800**, the bulged surface of pad **100** executes a rolling motion. This motion prevents formation of air pockets which can otherwise abruptly release air, causing ink droplets **600** to be ejected in a direction parallel to the surface of object **800**, thereby ruining the image.

If the receiving surface of object **800** is flat, bulging pad **100** prior to transfer does not distort the image since pad **100** is again flattened by the surface of object **800** during transfer; an image is applied to a first flat surface and then transferred to a second flat surface. However, if the surface of object **800** is irregular, steps must be taken to properly pre-distort the image to be transferred. This pre-distortion step is well-known to those skilled in the art of pad printing. It is normally done in imaging software (not shown) prior to applying droplets **610** to pad **100**.

## Alternative Embodiments—FIGS. **11** through **14**

The embodiment of FIGS. **1-3** has, when seen from below, a circular or ellipsoidal bulge **110** (FIG. **3**). The embodiment of FIGS. **11** to **14** has, when seen from below, a square or rectangular parallelepiped bulge **110'** as best seen in FIG. **11**. Pad **100** includes a border region **115'** between bulge **110** and the outer edges to provide for an appropriately (in this case square) shaped restraining ring **400** and mounting ring **405**. Similarly, ram **600** has the same shape as dome or bulge **110**.

In another aspect, shown in FIG. **12**, an internal metal spring **1200** can be inserted or cast into pad **100**. Spring **1200** aids in maintaining the flatness of surface **105** after pad **100** has been deformed and then released to return to its original shape.

Instead of steel, an elastomeric material such as a thermoplastic rubber can be used for spring **1200**. In this case, elastomeric spring **1200** extends to near the edges of pad **100** and be anchored by bolts **410**.

In yet another aspect, FIGS. **13** and **14** show a pad which is normally "bulged" in its resting condition. Pad **100** normally has the shape shown in FIG. **14**. A chamber **1300** with a tubular connection **1305** to a source of pressure or vacuum (not shown) is sealed against the top side of pad **100**. When it is desired to apply an ink image to pad **100**, as shown in FIG. **13**, a vacuum is drawn through connection **1305** until the bottom side of pad **100** is flat. The ink image, represented by droplets **610**, is then applied to surface **105** by inkjet head **605** while pad **100** is in its deformed condition. When it is desired to transfer ink droplets **610** to a receiving surface (not shown), the vacuum in chamber **1300** is released and replaced by atmospheric or even positive pressure in order to restore the resting shape (bulged) of pad **100**. Pad **100** is then brought into contact with the receiving surface and transfer of the ink image, represented by droplets **610**, is complete. The cycle can then be repeated.

In still another aspect, FIGS. **13** and **14** show a pad which is normally "flat" in its resting condition. It is forced to bulge by either hydrostatic or pneumatic pressure. Pad **100** normally has the shape shown in FIG. **13**. When it is desired to apply an ink image to pad **100**, as shown in FIG. **13**, no gauge pressure is applied through connection **1305**. The ink image, represented by droplets **610**, is then applied to surface **105** by inkjet head **605** while pad **100** is in its resting condition. When it is desired to transfer ink droplets **610** to a receiving surface (not shown), chamber **1300** is pressurized and forced into a bulged condition (FIG. **14**). Pad **100** is then brought into contact with the receiving surface and transfer of the ink image, represented by droplets **610**, is complete. As in the previous aspect, the cycle can then be repeated.

The various alternative embodiments provide additional ways to use the basic concept of the first embodiment. One embodiment may be selected over another when it is desired to print either a small or a large number of parts, for example. Alternatively, one embodiment may be selected over another when printing machine cost, size, or complexity is a consideration.

## SUMMARY, RAMIFICATIONS, AND SCOPE

Thus it is seen that we have provided an improved deformable pad for pad printing. Instead of deforming a flat shape with a domed ram, a flat ram is used to deform a domed pad. Alternatively, a domed ram can still be used. Instead of a mechanical ram, the shape of the pad can be controlled by application of pressure or a vacuum to the back side of the pad. In some applications, this pad provides an advantage in that a simpler ram, i.e. one with a flat face, can be used. In the case of a flat-face ram, the same ram can be used with pads of different sizes and there is no critical requirement to center the ram on the bulge of the pad.

While the above description contains many specificities, it will be apparent that the inventive system is not limited to these and can be practiced with the use of additional hardware and combinations of the various components described. For example, a variety of shapes of ram, pad, and restraining members can be used, including rectangular, oval, star-

shaped, pentagonal, hexagonal, octagonal, and the like. The size of the pad can vary from very small to very large, depending on the size of the surface to be printed. A wide variety of materials can be used for the components.

Accordingly the full scope of the invention should be determined by the appended claims and their legal equivalents, rather than the examples given. Also, while the present system employs elements that are well-known to those skilled in the art of pad printing, it combines these elements in a novel way which produces a new result not heretofore discovered.

The invention claimed is:

**1**. A pad for pad printing, said pad comprising an elastic material and having opposing sides, with one of said sides being initially flat while said pad is in a resting condition and the opposite side including a central bulge while said pad is in said resting condition, said flat side being arranged to receive an ink image while said pad is in said resting condition, said pad being thin enough so that when the edges of said pad are restrained and said bulge is flattened by an axial force applied thereto, said initially flat side will bulge, whereby said ink image on said pad can then be applied to a receiving surface.

**2**. The pad of claim **1** wherein the cross-sectional shape of said bulge is selected from the group consisting of ellipsoidal, circular, and parallelepiped.

**3**. The pad of claim **1** wherein the axial shape of said bulge is selected from the group consisting of cylindrical and domed.

**4**. The pad of claim **1** wherein said pad comprises a material selected from the group consisting of silicone rubber and gelatin.

**5**. The pad of claim **1** wherein said pad will return to said resting condition when said axial force is removed.

**6**. The pad of claim **1**, further including an internal spring within said pad which is arranged to flatten said pad when said axial force is removed.

**7**. The pad of claim **6** wherein said spring is selected from the group consisting of metal and elastomeric materials.

**8**. A method for pad printing, comprising:

providing an elastic pad having restrainable edges and first and second opposing sides with said first side being initially flat while said pad is a resting condition and said second side being initially bulged while said pad is in said resting condition,

providing restraining means for restraining said edges of said pad,

providing a source of ink capable of emitting an image comprising droplets of said ink onto said first surface while said first surface is flat,

providing a flat ram arranged to apply an axial flattening force to said second side of said pad,

providing a receiving surface selected from the group consisting of flat and non-flat surfaces,

applying said image to said first side of said pad while said pad is in said resting condition,

restraining said edges of said pad,

applying said flattening force to said second side of said pad using said ram, thereby causing said first side of said pad to bulge, and

urging said first side of said pad against said receiving surface,

whereby said image is applied to said receiving surface.

**9**. The method of claim **8** wherein the cross-sectional shape of said bulge is selected from the group consisting of ellipsoidal, circular, and parallelepiped.

**10**. The method of claim **8** wherein the axial shape of said bulge is selected from the group consisting of cylindrical and domed.

**11**. The method of claim **8** wherein said pad comprises a material selected from the group consisting of silicone rubber and gelatin.

**12**. The method of claim **8** wherein said pad will return to said resting condition when said flattening force is removed.

**13**. The method of claim **8** further including an internal spring within said pad which is arranged to flatten said first side of said pad when said flattening force is removed.

**14**. The method of claim **8** wherein said restraining means comprises two concentrically disposed annular rings.

**15**. The method of claim **8** wherein said source of said ink is selected from the group consisting of inkjet, electrographic, and spray marking technologies.

* * * * *