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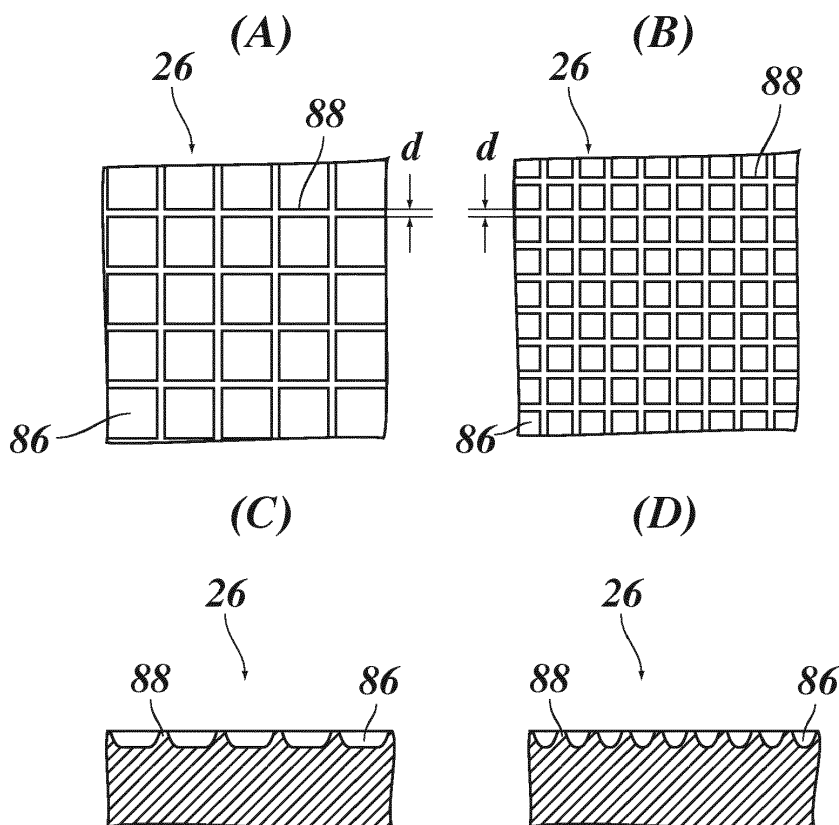
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(54) **Inking roller and inking roller set for colour proofing**

(57) An inking roller for colour proofing, having, on its peripheral surface, a plurality of pit arrays (26) formed by pits (86) that are separated from one another by dam

portions (88), said pit arrays (26) being different from one another in the total volume of the pits per unit area, characterized in that the dam portions (88) of different pit arrays (26) have the same width (d).

**Fig. 6**



## Description

**[0001]** The invention relates to an inking roller for colour proofing, having, on its peripheral surface, a plurality of pit arrays formed by pits that are separated from one another by dam portions, said pit arrays being different from one another in the total volume of the pits per unit area.

**[0002]** The invention also relates to an inking roller set for colour proofing, comprising a plurality of inking rollers each of which has, on its peripheral surface, a pit array formed by pits that are separated from one another by dam portions, said pit arrays being different from one another in the total volume of the pits per unit area.

**[0003]** In the printing industry, it is desired to be able to predict a colour value of a printed product or a certain area of the printed product before a print run is started, so that colour errors may be detected and eliminated, e.g. by adjusting the settings of the printing press, changing the recipe of the inks and/or, in the case of flexographic printing, selecting an engraved roller with a different screen.

**[0004]** It has been known to use a hand-held proofing apparatus having an inking roller for applying an ink film onto a sample of the substrate and then to inspect the colour of the ink film on the substrate.

**[0005]** Other known proofing methods attempt to simulate the entire flexographic print process by using a colour proofing apparatus that is configured as a miniature version of the printing press.

**[0006]** In order to produce ink layers of different thickness, it is possible to use a set of inking rollers which have pit arrays with different ink carrying capacities. It is also known to use an inking roller which has a plurality of different pit arrays on its peripheral surface, so that a number of ink layers with different thicknesses can be produced with a single roller.

**[0007]** Conventionally, the pit arrays are formed by pressing a diamond stamp into the surface layer of the roller, so that the surface material is subject to plastic deformation and a pit is left when the stamp is withdrawn. The volume of the pits and, accordingly, the ink carrying capacity of the inking roller, is controlled by controlling the depth to which the stamp is pressed into the roller surface. The stamp typically has a pyramid shape, so that the footprint of the pit formed in the roller surface increases with increasing depth of the pit. The pit density, i.e. the number of pits per unit area, is typically the same for the different pit arrays, so that the ink carrying capacity, i.e. the total pit volume per unit area, is proportional to the volume of the individual pits, and the width of the dam portions that separate the individual pits from one another increases with decreasing pit volume.

**[0008]** It is an object of the invention to improve the accuracy with which the colour of a printed product to be obtained in a print process, in particular a flexographic print process, can be predicted.

**[0009]** To that end, the invention proposes an inking roller and an inking roller set wherein the dam portions of different pit arrays have the same width.

**[0010]** Since the width of the dam portions is unchanged, the ink carrying capacity of the pit arrays can be varied only by varying the depth of the pits, without changing the footprint thereof, or by varying both the footprint and the density of the pits. In the latter case, an increased pit density has the effect that the dam portions occupy a larger fraction of the total surface of the roller, so that the ink carrying capacity is reduced.

**[0011]** The thickness of the dam portions may be relatively small and is determined by the pit array with the largest ink carrying capacity (and the narrowest dams). As a result, the uniformity of the ink layers is improved, especially for pit arrays with small ink carrying capacity. This permits an improved accuracy and reproducibility in the colour measurements to be performed on the ink films, so that the colour impression can be predicted more reliably.

**[0012]** The pit array of the inking roller that is used for colour proofing does not have to be identical with the pit array of the anilox roller that is actually used for printing. All that is required is that the thickness of the ink layer formed in the actual print process, which ink layer is influenced not only by the screen of the anilox roller but also by the material of the anilox roller, the ink transfer properties of the printing plates, and the like, is equal to the thickness of the ink layer on the proof formed with the inking roller.

**[0013]** More specific optional features of the invention are indicated in the dependent claims.

**[0014]** Subject of the invention is also a colour proofing apparatus having an inking roller with the features described above.

**[0015]** Embodiment examples will now be described in conjunction with the drawings, wherein:

Fig. 1 is a schematic cross-sectional view of a colour proofing apparatus;

Fig. 2 shows essential parts of the apparatus shown in Fig. 1 in a top plan view;

Fig. 3 a schematic view of essential parts of a flexographic printing press;

Fig. 4 is a view of an inking roller according to an embodiment of the invention;

Fig. 5 (A) and (B) show two inking rollers of a set according to another embodiment of the invention;

Fig. 6 (A) - (D) are enlarged plan views and cross-sectional views, respectively, of pit arrays of the inking rollers shown in Fig. 5; and

Fig. 7 (A) and (B) cross-sectional views of pit arrays of two inking rollers of a set according to another embodiment.

**[0016]** As is shown in Fig. 1, a colour proofing apparatus 10 comprises an engraved inking roller 12, a back pressure cylinder 14, and a conveyor 16 arranged to feed a sheet 18 of a print substrate through a nip formed between the inking roller 12 and the back pressure cylinder 14.

**[0017]** An ink fountain 20 is disposed at the periphery of the inking roller 12 for inking the surface of the roller. A metered amount of ink may be filled into the ink fountain 20 with a pipette 22. The ink fountain 20 further includes a probe 24 for measuring the temperature and/or the viscosity of the ink contained therein.

**[0018]** As is generally known in the art, the surface of the inking roller 12 is formed with at least one array of pits which will be filled with ink when they pass through the ink fountain 20.

**[0019]** As is shown in Fig. 2, the peripheral surface of the inking roller 12 carries a plurality of screens or pit arrays 26. The pit arrays 26 extend in axial direction of the inking roller and are equally distributed in circumferential direction. The volume of the pits, and hence the ink carrying capacity of the screens (volume of ink per surface area) differs from array to array.

**[0020]** When the sheet 18 is fed through the nip between the inking roller 12 and the back pressure cylinder 14, each pit array 26 will print an ink layer 28 onto the print substrate, as has been shown in Fig. 2. The colours of these ink layers (numbered as 1-7 in Fig. 2) will differ from one another due to the different ink carrying capacities of the pit arrays 26. A colour sensitive optical sensor 30, e.g. a spectrometer, is mounted in a stationary position above the conveyor 16 so as to successively measure the colour of each ink layer 28 as the sheet 18 passes through. The colours measured by the sensor 30 will be represented by colour values in a suitable colour space such as CIE XYZ or CIE L\*a\*b\*.

**[0021]** As is shown in Fig. 1, the sensor 30 is combined with an illumination system 32 for illuminating the sheet on the conveyor 16. Another light source 34 is mounted below the conveying path of the sheet, so that transparent or translucent sheets may also be illuminated from below. Since the entire colour proofing apparatus 10 is accommodated in a closed casing 36 and the sensor 30 and the light sources 32, 34 are mounted in fixed positions in this casing, it is assured that the ink layers 28 on the sheets 18 will always be measured under the same illumination conditions.

**[0022]** The conveyor 16 has two endless conveyor belts 38 passed around guide rollers 40 and a tensioning roller 42 and spaced apart from one another in axial direction of the inking roller 12.

**[0023]** A stationary part 44 of a lower cutting die (Fig. 2) is mounted in the space between the conveyor belts 38 on an upstream side of the conveyor. The lower cutting die is supplemented by two movable parts 46 each of which is fixed on or integrated in one of the conveyor belts 38. Together, the parts 44 and 46 form a rectangular cutting die for cutting out the rectangular sheet 18 from a larger blank. A corresponding upper cutting die 48 (Fig. 1) is pivotally mounted above the conveyor 16.

**[0024]** The cutting mechanism formed by the lower and upper cutting dies can be accessed by an operator by opening a lid 50 in the top wall of the casing 36. Thus, a blank of a print substrate may be placed on the conveyor belts 38 and the lower cutting die, and a rectangular sheet 18 may be punched out by temporarily closing the upper cutting die 48. Then, the upper cutting die is lifted again and the remaining outer portion of the blank is removed while the cut sheet 18 remains on the parts 44, 46 of the lower cutting die. The movable parts 46 of the lower cutting die are configured as sheet holders for holding the marginal areas on both sides of the sheet 18. For example, each part 46 of the lower cutting die may be formed with a suction blower and suction nozzles (not shown) for attracting the marginal areas of the sheet 18 and thereby fixing the sheet on the conveyor belts 38.

**[0025]** Endless guide belts 52 are disposed above the conveyor belts 38 at each end of the inking roller 12. A lower stretch of each of these guide belts 52 extends horizontally immediately above the conveyor belt 38, so that, when the sheet 18 is fed through, the marginal areas of the sheet are safely held on the conveyor belts by the guide belts 52. This will prevent the sheet from sticking to the inked peripheral surface of the inking roller 12.

**[0026]** A drive motor 54 and a drive gear (shown only schematically in Fig. 1) are provided for driving the inking roller 12 and the guide belts 52 in synchronism. Another drive motor 56 is provided for the conveyor 16. The speeds of the drive motors 54 and 56 are synchronized electronically, so that the speed with which the sheet 18 is conveyed on the conveyor belts 38 exactly equal to the peripheral speed of the inking roller 12.

**[0027]** The back pressure cylinder 14 is also driven by the drive motor 54, and the associated drive train includes a one-way clutch 58 permitting the back pressure cylinder to rotate at a speed that is higher than the speed imposed by the drive motor 54. The axis of the back pressure cylinder 14 is supported in a set mechanism 60 that is mounted on a carriage 62 and adapted to lift and lower the back pressure cylinder 14 relative to the inking roller 12. Although not shown in detail, the set mechanism 60 may comprise pneumatic cylinders, eccentrics and the like arranged to lift the back

pressure 14 into contact with the inking roller 12 and the sheet 18 that is passing through and to bias the back pressure cylinder against the inking roller 12 with a pre-defined force. Since the sheet 18 has been cut to a well-defined width, this force will translate into a well-defined line pressure that will be constant irrespective of the thickness of the sheet. In addition, the back pressure cylinder 14 may have a rubber-elastic surface layer. The body of the back pressure cylinder 14 is preferably formed by a fibre-reinforced carbon, so that the back pressure cylinder 14 has a low weight and a low moment of inertia.

**[0028]** The carriage 62 is movable back and forth in horizontal direction in parallel with the transport direction of the sheet 18, and carries also a cleaning device 64 for the inking roller 12. By moving the carriage 62 towards the right side in Fig. 1, the cleaning device 64 may be moved into the position of the back pressure cylinder 14 and into engagement with the lower vertex of the inking roller 12, so that an automatic cleaning process for cleaning the inking roller may be performed.

**[0029]** The top wall of the casing 36 has another lid 66 or connector giving access to the pipette 22, and yet another lid 68 gives access to the sensor 30, so that the sensor may optionally be replaced by another type of optical sensor, e.g. a colour sensor that will also be used in the flexographic printing press, so that the measurement results may directly be compared to one another.

**[0030]** When all the lids 50, 66 and 68 of the casing 36 are closed, the interior of the casing is sealed air-tightly. A compressor 70 or any other source of compressed air and a vent valve 72 are connected to the casing 36, so that the interior of the casing may be set under pressure and vented.

**[0031]** With the colour proofing apparatus 10 as described above, a colour proofing cycle may be performed as will be described below.

**[0032]** It shall be assumed that the proofing process aims at predicting the colour of a print product that is obtained with a flexographic printing press that has schematically been shown in Fig. 3. The printing press comprises a central impression cylinder 74 and a number of colour decks arranged at the periphery of the central impression cylinder. Only one of the colour decks has been shown in Fig. 3. This colour deck comprises a printing cylinder 76, an anilox roller 78 and a chambered doctor blade 80. A web of a print substrate 82 is passed around the central impression cylinder 74 so as to pass through the nip formed with the printing cylinder 76. The anilox roller 78 has a pattern of minute ink-receiving pits. The pits of the anilox roller 78 are filled with ink from the chambered doctor blade 80. The anilox roller 78 is set against the peripheral surface of the printing cylinder 76 and rotated, so that the ink is transferred onto the printing cylinder 76. The printing cylinder 76 is rotated and pressed against the print substrate 82, so that the elevated printing parts of printing plates mounted on the printing cylinder 76 transfer the ink onto the print substrate 82, and an image is printed.

**[0033]** The colour proofing apparatus 10 is used for predicting the colour of that printed image. The screen of the anilox roller 78 corresponds to one of the pit arrays 26 of the inking roller 12 in the proofing apparatus in the sense that, given the ink transfer properties of the anilox roller 78 and the printing cylinder 76, the screen of the anilox roller 78 results in an ink layer on the substrate 82 which has the same thickness as the ink layer formed on the sheet 18 by means of the pit array 26.

**[0034]** In order to start a proofing cycle, the vent valve 72 is opened, so that any possible elevated pressure in the casing 36 is relieved. An operator opens the lid 50 and places a blank of a web material that is identical with the material of the print substrate 82 onto the conveyor 16 and, more particularly, onto the fixed and movable parts 44, 46 of the lower cutting die. The upper cutting die 48 is pivoted onto the lower cutting die and pressed downward, so that the sheet 18 is cut out of the blank. The upper cutting die 48 is opened again, the remaining parts of the blank are removed, and the lid 50 is closed again.

**[0035]** Using the pipette 22, a sample of ink which has the same composition as the ink to be used in the chambered doctor blade 80 is filled into the ink fountain 20. Then, when the casing 36 is sealed air-tightly, the operator presses a start button of an electronic control unit (not shown) that is connected to the proofing apparatus 10 and controls the further operation thereof as follows:

The vent valve 72 is closed and the compressor 70 is activated for raising the air pressure in the casing 36 to a level at which the evaporation of ink on the inking roller 12 is reduced to an amount that corresponds to the evaporation losses of ink on the anilox roller 78 and the printing cylinder 76 of the printing press (Fig. 3) when the same operates at its normal printing speed which is much higher than the "printing" speed of the proofing apparatus 10.

The suction blowers (not shown) in the moving parts 46 of the lower cutting die are activated to suck the marginal areas of the cut sheet 18 and to hold the sheet on the movable parts 46 and hence on the conveyor belts 38. The drive motors 54 and 56 are started to drive the conveyor 16 and the guide belts 52 as well as the inking roller 12. The conveyor belts 38 with the moving cutting die parts 46 fixed thereon move the sheet 18 towards the inking roller 12. The back pressure cylinder 14 is still held in a lowered position in which it is not in contact with the inking roller nor with the sheet 18. Meanwhile, the pit arrays 26 on the inking roller 12 take up ink from the ink fountain 20 and,

as the inking roller rotates, this ink is conveyed along the periphery of the inking roller. Note that, in this phase, evaporation of ink is suppressed by the increased air pressure. The temperature and viscosity of the ink are measured with the probe 24 and recorded in the control unit.

**[0036]** When the leading edge of the sheet 18 has passed through between the inking roller 12 and the back pressure cylinder 14, the set mechanism 60 is activated to lift the back pressure cylinder 14 and bias the same with the pre-defined line pressure against the web 18. The drive motor 54 drives the back pressure cylinder 14 with a circumferential speed that is slightly lower than that of the inking roller 12. As soon as the back pressure cylinder comes into frictional contact with the sheet 18, the one-way clutch 58 permits the back pressure cylinder to accelerate until the circumferential speed is exactly identical with that of the inking roller 12, so that no slippage will occur between the rollers and the sheet, regardless of the amount of compression of the rubber-elastic layer of the back pressure cylinder. Thanks to the low moment of inertia of the back pressure cylinder 14, this speed adjustment is achieved within a very short time.

**[0037]** Then, the pit arrays 26 which have been inked in the ink fountain 20 will successively reach the nip between the inking roller 12 and the back pressure cylinder 14, and the ink will be transferred onto the sheet 18 to form the ink layers 28 in a well reproducible manner.

**[0038]** Before the trailing edge of the sheet 18 reaches the nip, the back pressure cylinder 14 is lowered again and brought out of contact with the sheet and the inking roller 12, so that the back pressure cylinder is prevented from becoming soiled with ink.

**[0039]** Meanwhile, the guide belts 52 force the sheet 18 to stay on the conveyor belts 38 and prevent the sheet from sticking to the peripheral surface of the inking roller 12.

**[0040]** The vent valve 72 is opened so as to relieve the elevated pressure in the casing 36.

**[0041]** The sheet 18 reaches the position of the sensor 30 and, while the illumination system is activated, the colours of the ink layers 28 are measured and recorded as the sheet passes through below the stationary sensor 30. The measured colour values are transmitted to the control unit for further processing.

**[0042]** Then, the transport direction of the conveyor 16 is reversed, so that the movable parts 46 of the lower cutting line, with the sheet 18 still held thereon, are returned to the position shown in Fig. 1. When the sheet has cleared the gap between the inking roller 12 and the back pressure cylinder 14, the carriage 62 is moved rightwards in Fig. 1, so that the cleaning unit 64 is brought into its operative position, and the peripheral surface of the inking roller 12 is cleaned. It should be noted that the conveyor belts 38 pass outside of the axial ends of the inking roller 12 as is shown in Fig. 2, so that they will not become stained with ink.

**[0043]** Finally, the lid 50 may be opened and the sheet 18 may be taken out, and a new proofing cycle may begin.

**[0044]** If a proof has to be made for reverse side printing on a transparent print substrate, the sheet 18 with the ink layers 28 formed on the top side (which will be the reverse side in the actual print process) may be taken out and reversed manually for measuring the colours of the ink layers with the sensor 30 through the transparent sheet.

**[0045]** While Fig. 2 shows an embodiment where the pit arrays 26 formed on the surface of the inking roller 12 are configured as stripes that extend in axial direction of the roller, Fig. 4 illustrates an example of an inking roller 12' where the pit arrays 26 are configured as bands that extend in circumferential direction of the roller.

**[0046]** Fig. 5 (A) and (B) illustrate two inking rollers 82, 84 that form part of a set of several inking rollers. Each of these inking rollers has only a single pit array 26 that occupies the entire peripheral surface of the roller. The inking rollers 82, 84 may be hand-held rollers or may be configured to successively replace the inking roller 12 shown in Fig. 2. In the latter case, proofs with different ink layer thicknesses can be formed in a plurality of operating cycles of the colour proofing apparatus.

**[0047]** Fig. 6 (A) shows an enlarged plan view of a pit array 26 formed by square pits 86 that are separated from one another by dam portions 88.

**[0048]** Fig. 6 (B) shows, on the same scale as Fig. 6 (A), a plan view of another pit array 26 in which the square pits 86 have a smaller size. However, the width "d" of the dam portions 88 is the same for both pit arrays in Fig. 6 (A) and (B).

**[0049]** It is an important feature of the inking roller 12 shown in Fig. 2 that the dam portions separating the individual pits from one another have the same width for all pit arrays 26. The same applies to the pit arrays 26 of the inking roller 12' shown in Fig. 4 and also to the pit arrays 26 of the inking rollers 82 and 84 shown in Fig. 5 as well as the pit arrays of all other inking rollers that belong to the same set.

**[0050]** Fig. 6 (C) and (D) show cross-sectional views of the pit arrays 26 shown in Fig. 6 (A) and Fig. 6 (B), respectively. It can be seen here that the pits 86 of both pit arrays have the same depth. Nevertheless, the total pit volume per unit area is smaller for the pit array shown in Fig. 6 (D), because the dam portions 88 occupy a larger fraction of the surface of the roller. Consequently, the ink layer formed with the pit array shown in Fig. 6 (B) and (D) will be smaller than the thickness of the ink layer formed with the pit array shown in Figs. 6 (A) and (C).

**[0051]** Figs. 7 (A) and (B) show cross-sectional views of two pit arrays 26 of an inking roller or inking roller set according to a modified embodiment. In this case, the pits 86 of both pit arrays have the same footprint but a different depth. Again, the width of the dam portions 88 is the same for both pit arrays. In this case, the total pit volume per unit area is smaller

in Fig. 7 (B) because the volume of the individual pits 86 is smaller while the number of pits per unit area is the same as in Fig. 7 (A).

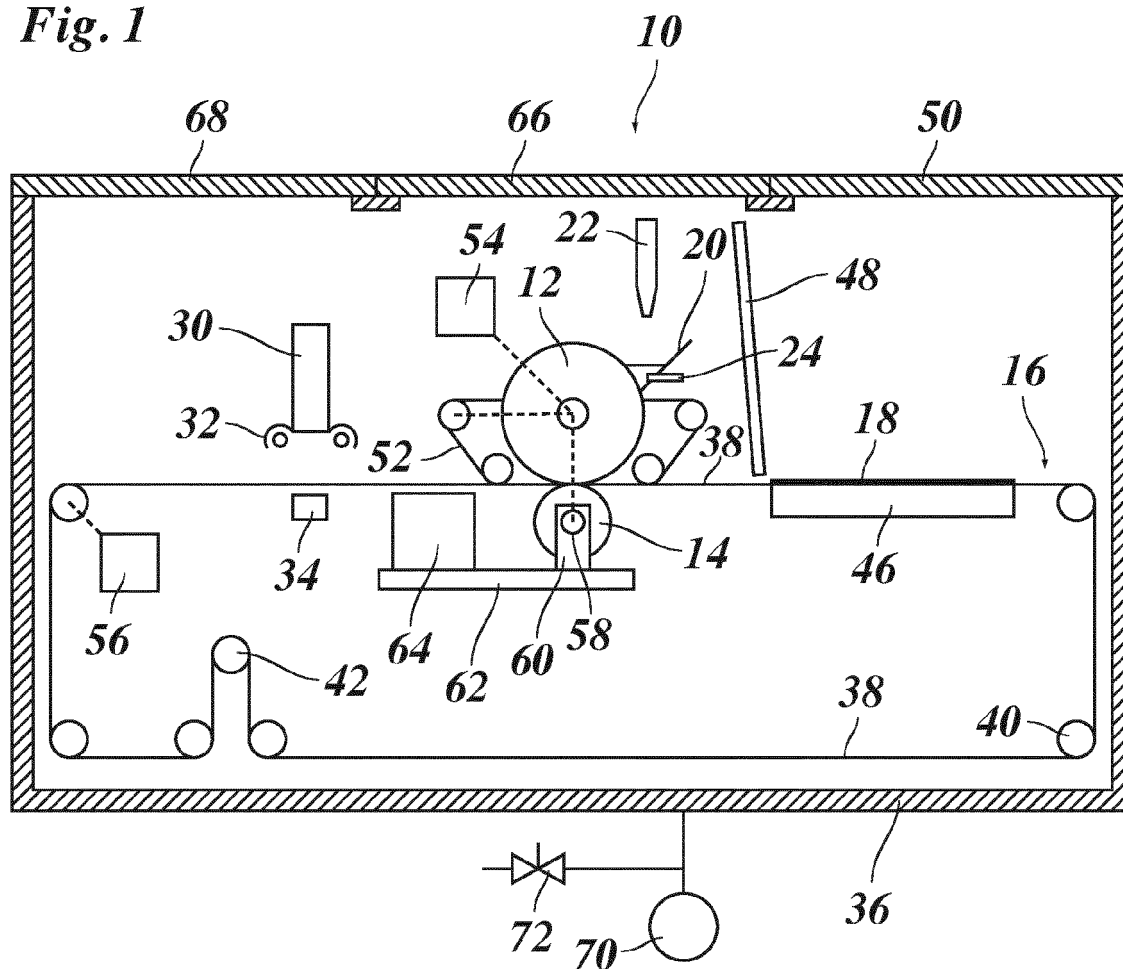
**[0052]** Inking rollers with pit arrays of the type described above may be formed for example by engraving the pits into the surface of the inking roller with a laser. The shape of the footprint of the pits 86 does not have to be a square but may for example also be a rectangle on a regular hexagon. Preferably, the pits of each pit array 26 are arranged in a regular raster. In any case, the density of the pits should be correlated with the size of the footprints of the pits such that the dam portions 88 have the same width "d" for all pit arrays 26 that belong to the same inking roller or inking roller set.

**[0053]** In the pit array 26 which has the largest total pit volume per surface area, the width "d" of the dam portions 88 is selected as small as possible, so that it is just sufficient to reliably separate the individual pits 86 from one another. When this pit array 26 is used to form an ink layer on the substrate, the ink will be evenly distributed over the surface of the substrate, so that the ink layer will have a uniform thickness. When an ink layer is formed with another pit array, for which the total pit volume per unit area is smaller, the uniformity of the ink layer will be just as good because the dam portions 88 have the same width, and only the layer thickness will be smaller because of the reduced pit volume.

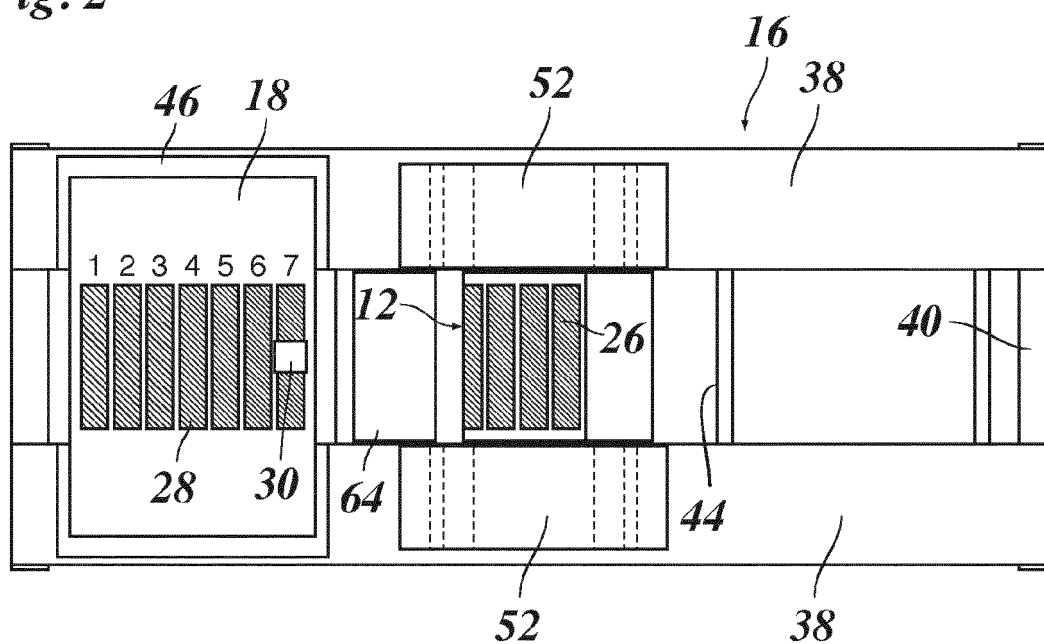
## Claims

1. An inking roller (12; 12') for colour proofing, having, on its peripheral surface, a plurality of pit arrays (26) formed by pits (86) that are separated from one another by dam portions (88), said pit arrays (26) being different from one another in the total volume of the pits per unit area, **characterized in that** the dam portions (88) of different pit arrays (26) have the same width (d).
2. The inking roller (12) according to claim 1, wherein the pit arrays (26) are configured as stripes that extend in axial direction of the inking roller.
3. The inking roller (12') according to claim 1, wherein the pit arrays (26) are configured as bands that extend in circumferential direction of the roller.
4. An inking roller set for colour proofing, comprising a plurality of inking rollers (82, 84) each of which has, on its peripheral surface, a pit array (26) formed by pits (86) that are separated from one another by dam portions (88), said pit arrays (26) being different from one another in the total volume of pits per unit area, **characterized in that** the dam portions (88) of different pit arrays (26) have the same width.
5. A colour proofing apparatus **characterized by** comprising an inking roller (12; 12') according to any of the claims 1 to 3.

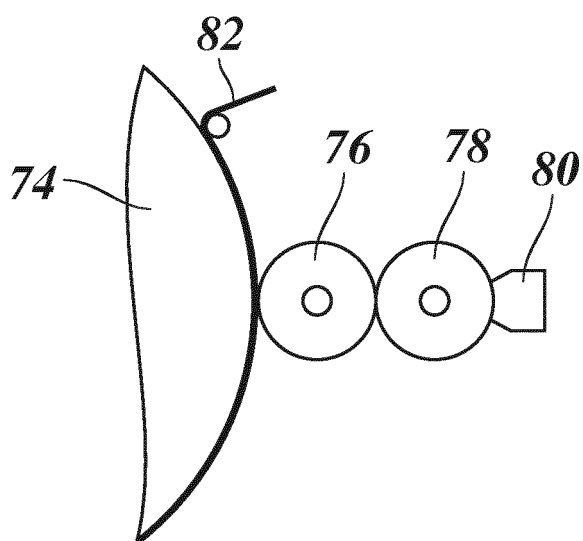
**Fig. 1**



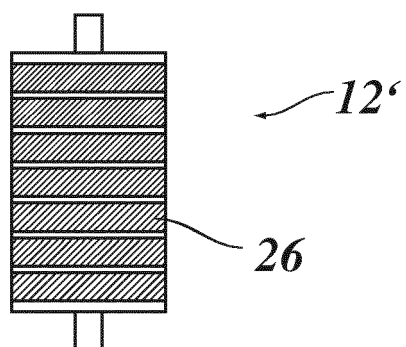
**Fig. 2**



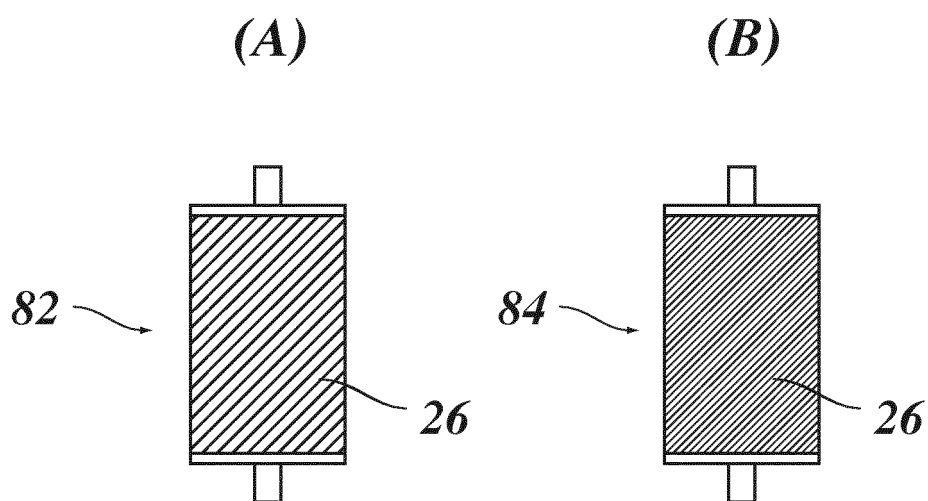
**Fig. 3**



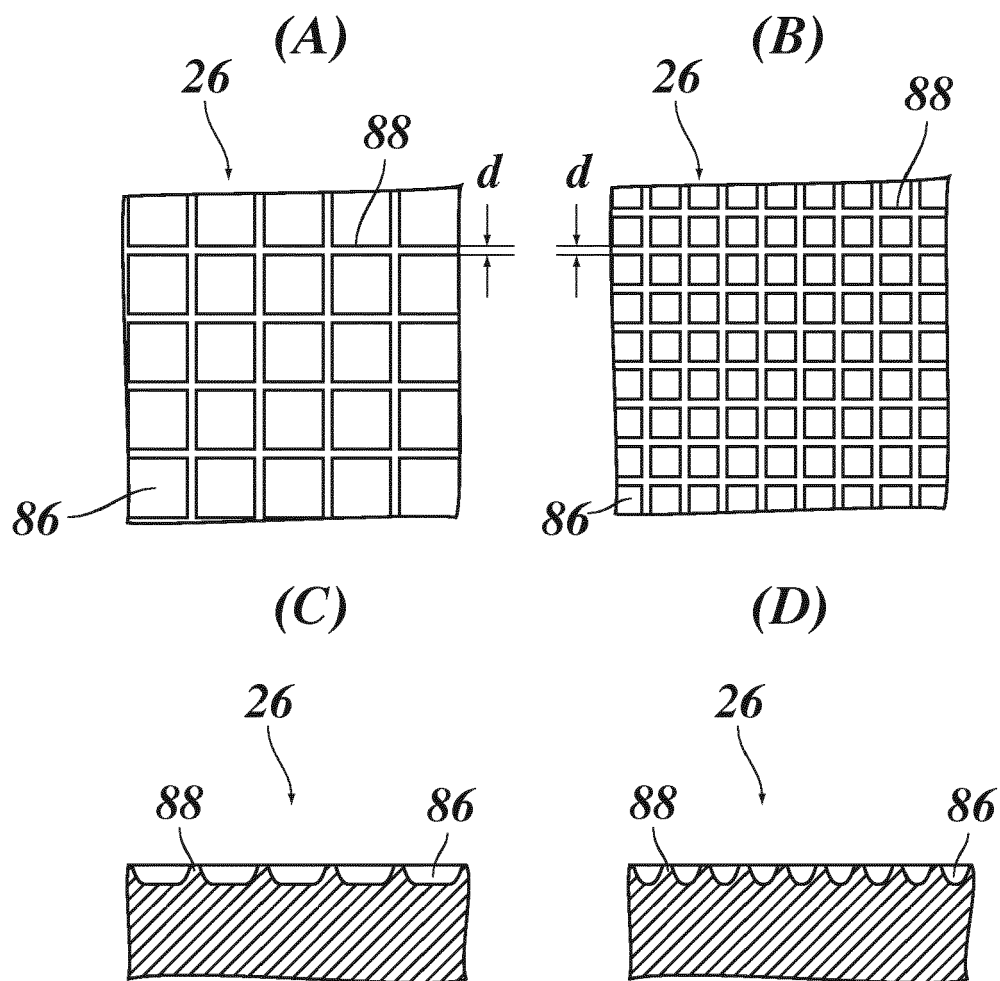
**Fig. 4**



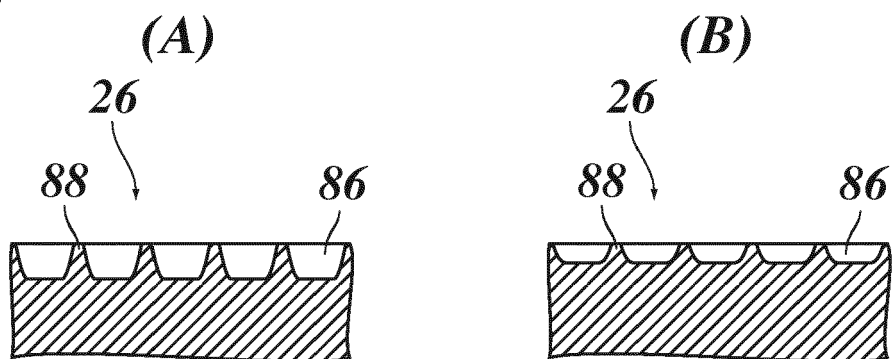
**Fig. 5**



**Fig. 6**



**Fig. 7**





## EUROPEAN SEARCH REPORT

Application Number  
EP 11 18 5341

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                              |                                                   |                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document with indication, where appropriate, of relevant passages                                                                | Relevant to claim                                 | CLASSIFICATION OF THE APPLICATION (IPC) |
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| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                              |                                                   |                                         |

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 18 5341

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