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(54) **TRACING DEVICE**

(57) The present disclosure relates to a system comprising a pin screen comprising a plurality of movable pins comprising a magnet. Further, the system comprises a drawing substrate configured to change color based on a magnetic force. The drawing substrate comprises

a base layer comprising a plurality of pedestals, an intermediate layer comprising ferromagnetic particles and a cover layer, wherein the intermediate layer is disposed between the base layer and the cover layer.

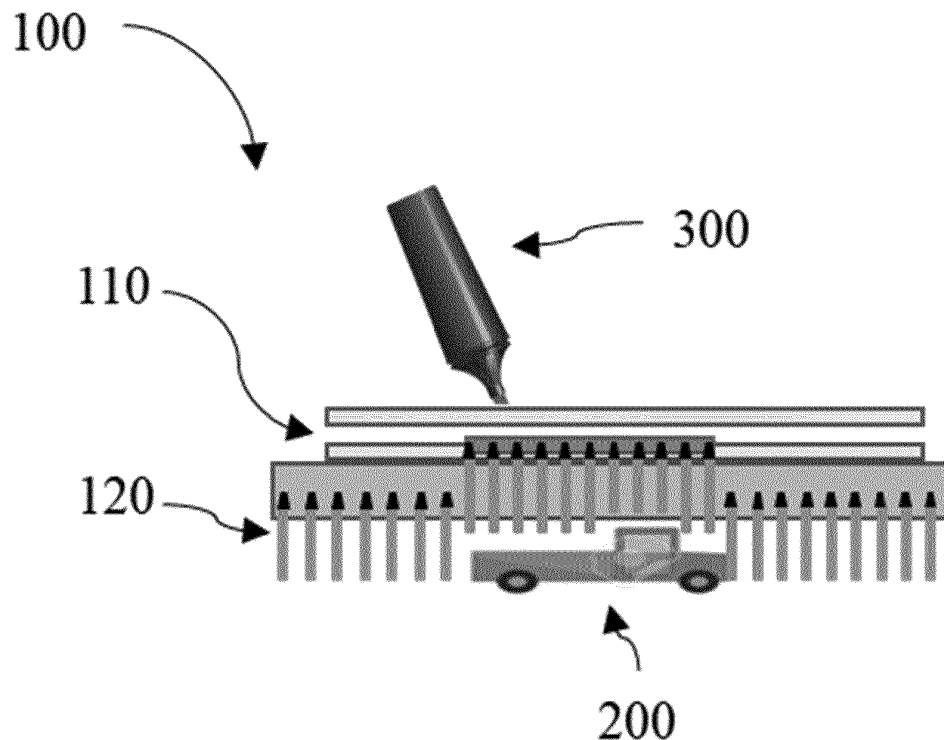


Figure 3

Description

Technical Field

[0001] The present disclosure relates to the field of stenciling system. More specifically, the present disclosure relates to stenciling devices displaying structural colors based on magnetism.

Background

[0002] Tracing is a leisure activity enjoyed by adults and especially children. Tracing may improve the development of motor skills, bilateral coordination and self control in children. Stencils may be used for tracing activities.

[0003] However, at their edges stencils are difficult to trace. Further, stencils may quickly become obsolete, as a user may become uninterested in stenciling the same shape multiple times.

[0004] In nature, structural coloration is observed. For example, the feather of peacocks or the fur of golden moles exhibit structural coloration. Structural coloration occurs when microscopically structured surfaces interfere with visible light. Surfaces may appear in different colors depending on the spatial configuration of the surface without the need for pigments and/or dyes. While the colors of pigments and/or dyes are usually fixed, as their chemical nature would need to be changed to attain a different color, structural colors may change due to changes in physical parameters. For example, in thin films the color of the thin film may be changed by changing the thickness of the thin film or the layers therein.

[0005] The present disclosure aims to provide a novel system allowing tracing with adjustable stenciling shapes with vibrant colors and without edges.

Summary

[0006] In a first aspect, the present disclosure relates to a system 100 comprising a pin screen 120 comprising a plurality of movable pins comprising a magnet. Further, the system 100 comprises a drawing substrate 110 configured to change color based on a magnetic force. The drawing substrate 110 comprises a base layer 210 comprising a plurality of pedestals 220, an intermediate layer 230 comprising magnetic particles and a cover layer 250, wherein the intermediate layer 230 is disposed between the base layer 210 and the cover layer 250.

[0007] In some embodiments, the magnetic particles may be configured to form a plurality of columns 240 upon exposure to a magnetic field, in particular wherein at least one, in particular each, of the plurality of columns 240 protrudes from a pedestal from the plurality of pedestals 220.

[0008] In some embodiments, the intermediate layer 230 may be a fluid, in particular an aqueous solution comprising the magnetic particles.

[0009] In some embodiments, the concentration of the

magnetic particles in the intermediate layer 230 may be between about 0.05 vol.% to about 0.5 vol.%, more specifically between about 0.1 vol.% to about 0.15 vol.%, relative to the total volume of the intermediate layer 230.

[0010] In some embodiments, the base layer 210 may also comprise magnetic particles, in particular between about 10 wt.-% to about 30 wt.-% relative to the weight of the base layer 210.

[0011] In some embodiments, the magnetic particles may be magnetic nanoparticles, in particular wherein the magnetic particles have a diameter between about 5 nm to about 50 nm.

[0012] In some embodiments, the magnetic particles may be iron oxide particles.

[0013] In some embodiments, the base layer 210 may comprise silicone and/or magnetic particles, more specifically polydimethylsiloxane comprising the magnetic particles.

[0014] In some embodiments, the base layer 210 may comprise a polymer, in particular wherein the polymer comprised within the base layer 210 may comprise or consists of or substantially consists of PDMS.

[0015] In some embodiments, the base layer 210's magnetic particles may be embedded in the base layer 210's polymer.

[0016] In some embodiments, a distance (270) between two adjacent pedestals of the plurality of pedestals 220 may be between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm .

[0017] In some embodiments, the diameter of a pedestal of the plurality of pedestals 220 may be between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm .

[0018] In some embodiments, the height of a pedestal of the plurality of pedestals 220 may be between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm .

[0019] In some embodiments, the overall thickness of the base layer 210, intermediate layer 230 and cover layer 250 may be between about 10 μm to about 50 μm , more specifically between about 20 μm to about 40 μm .

[0020] In some embodiments, the distance (260) between the base layer 210 and cover layer 250 may be between about 5 μm to about 50 μm , and in particular between about 15 μm to about 30 μm .

[0021] In some embodiments, each of the columns of the plurality of columns may be configured to tilt by between about 0° to about 45°, more specifically between about 5° to about 30° based on the direction of the applied magnetic field.

[0022] In some embodiments, the drawing substrate 110 may comprise a trace layer.

[0023] In some embodiments, the trace layer may be attached to the cover layer 250, or wherein a gap may be disposed between the trace layer and the cover layer

250, in particular a gap with a width between about 50 μm to about 3000 μm .

[0024] In some embodiments, the trace layer may have a thickness between about 0.5 mm to about 5 mm.

Pins

[0025] In some embodiments, the diameter of the plurality of movable pins may be between about 0.1 mm to about 5 mm.

[0026] In some embodiments, the length of the plurality of movable pins may be between about 0.5 cm to about 10 cm.

[0027] In some embodiments, the plurality of movable pins may comprise between about 50 to about 1000 movable pins.

[0028] In some embodiments, the plurality of movable pins may be connected to a restoring force element configured to exert a restoring force on the pins when the pins may be moved out of a rest position, more specifically wherein the pins may be connected to a spring or an elastomer.

[0029] In some embodiments, the plurality of pins may be of variable length, more specifically wherein the pins may comprise a plurality of segments, wherein the segments are configured to move relative to one another.

[0030] In some embodiments, at least one pin of the plurality of movable pins may comprise at least one permanent magnet, more specifically at least one rare-earth magnet and at least one neodymium magnet.

[0031] In some embodiments, at least one pin of the plurality of movable pins may comprise at least one electromagnet, in particular an electromagnet configured to activate when force may be applied to the movable pin.

[0032] In some embodiments, at least one pin of the plurality of movable pins may comprise part of an electrical circuit, wherein the electrical circuit may be closed when force may be applied to the movable pin, in particular when a force exceeding a threshold pressure may be applied to the movable pin.

[0033] In some embodiments, the magnet of the at least one pin of the plurality of pins may have a diameter between about 50 μm to about 10000 μm , more specifically between about 200 μm to about 5000 μm and in particular between about 500 μm to about 1000 μm .

[0034] In some embodiments, the length of the magnet of the at least one pin of the plurality of pins may be between about 0.1 cm to about 3 cm.

[0035] In some embodiments, the magnet may have a remanence between about 200 mT to about 2 T, more specifically between about 500 mT to about 1.8 T and in particular between about 800 T to about 1.5 T.

System Arrangement and Base Plate

[0036] In some embodiments, the pin screen 120 may be attached to the drawing substrate 110.

[0037] In some embodiments, the system 100 may

comprise a base plate, more specifically a base plate arranged between the plurality of movable pins and the drawing substrate 110, and in particular a stiff base plate arranged between the plurality of movable pins and the drawing substrate 110 configured to prevent direct contact between the movable pins and the drawing substrate 110.

[0038] In some embodiments, the base plate may be attached to the drawing substrate 110 and/or wherein the drawing substrate 110 may be coated on the base plate.

[0039] In some embodiments, the base plate may comprise glass, plastic or metal.

Brief Description of the Drawings

[0040]

Figure 1 shows an angle tilt of columns formed from ferromagnetic particles under magnetic influence and the resulting change in light diffraction (Source: Zhiren Luo et al., Magnetically Actuated Dynamic Iridescence Inspired by the Neon Tetra, ACS Nano 2019, 13, 4657-4666, DOI: 10.1021/acsnano.9b00822).

Figure 2 shows a schematic of a magnetic field extending between two poles of a magnet.

Figure 3 shows the system 100 in use.

Figure 4 shows the structure of the drawing substrate 110 with a plurality of columns 240 formed on a plurality of pedestals 220 due to a magnetic field.

Detailed Description

[0041] Hereinafter, a detailed description will be given of the present disclosure. The terms or words used in the description and the aspects of the present disclosure are not to be construed limitedly as only having common-language or dictionary meanings and should, unless specifically defined otherwise in the following description, be interpreted as having their ordinary technical meaning as established in the relevant technical field. The detailed description will refer to specific embodiments to better illustrate the present disclosure, however, it should be understood that the presented disclosure is not limited to these specific embodiments.

[0042] It has been found that ferromagnetic particles in fluids may form columns when exposed to a magnetic field. Additionally, it has been found that the location of the formation of the columns can be influenced by disposing the fluid between two solid layers, wherein at least one of the layers comprises pedestals. In particular, the columns may preferentially form on top of the pedestals. A length of the columns may substantially extend along a local magnetic field line of the magnetic field. The rel-

ative angle of the formed columns may be altered by changing the angle of the local magnetic field line. It has been found that by tilting the angle of the plurality of columns 240 protruding from one or more pedestal the wavelength of light diffracted by the columns may be altered, hence the color of the diffracted light may be altered, see Figure 1. Without wishing to be bound by theory, it is believed that the diffraction may follow Bragg's law and/or that the plurality of columns may form a diffraction grating.

[0043] In a first aspect, the present disclosure relates to a system 100 comprising a pin screen 120 comprising a plurality of movable pins comprising a magnet. Further, the system 100 comprises a drawing substrate 110 configured to change color based on a magnetic force. The drawing substrate 110 comprises a base layer 210 comprising a plurality of pedestals 220, an intermediate layer 230 comprising magnetic particles and a cover layer 250, wherein the intermediate layer 230 is disposed between the base layer 210 and the cover layer 250.

[0044] The system 100 may be used for tracing with a writing instrument 300. For example, a user may want to trace an object 200, such as a car toy, such as shown in Figure 3. The user may press the pin screen 120 on the car toy, whereby the movable pins move creating a negative of the disc. The user may leave the pin screen 120 on the car toy. Alternatively, the pins may be locked in place or require a threshold force to be overcome to move and the pin screen 120 may be moved to a desired location while still replicating the car toy. Drawing substrate 110 may be placed on or be attached to the pin screen 120. The color of the drawing substrate 110 may change as the magnets comprised in the plurality of pins exert magnetic force on the drawing substrate 110, in particular on the ferrofluid, which may lead to a change in color displayed by the drawing substrate 110. The user may now trace the layer itself along the borders between two colors or place a transparent writing substrate on the drawing substrate 110 and trace on the transparent writing substrate.

[0045] Further, the user may press the pin screen 120 against an object with a complicated geometry, for example multiple stacked cylinders. The direction of magnetic field lines may vary based on the distance from the magnet, see for example Figure 2. As the magnets comprised within the plurality of pins located further away from the drawing substrate 110 exert magnetic force at a different angle on the drawing substrate 110, each ring of the cylinder may be displayed in a different color, allowing tracing along the border of each cylinder.

[0046] In some embodiments, as shown in Figure 4, the magnetic particles may be configured to form a plurality of columns 240 upon exposure to a magnetic field, in particular wherein at least one, in particular each, of the plurality of columns 240 protrudes from a pedestal from the plurality of pedestals 220. Without wishing to be bound by theory, the mechanism of the position control of the column formation may be that magnetic particles

may aggregate to form aligned chains along the field direction, when disposed between two parallel planes and an out-of-plane magnetic field. The combination of multiple chains may result in the formation of each of the columns of the plurality of columns 240. The formation of the columns may require less energy when the distance between the two parallel planes is smaller. As a result, the columns may preferentially form on the pedestals, as shown in Figure 4, as the distance to the cover layer 250 is smaller there. The cover layer 250 and the base layer 210 may be disposed substantially parallel or parallel. Further, still without wishing to be bound by theory, the plurality of columns 240 may repel one another, preventing the formation of columns between the pedestals.

[0047] In some embodiments, the intermediate layer 230 may be a fluid, in particular an aqueous solution comprising the magnetic particles.

[0048] In some embodiments, the concentration of the magnetic particles in the intermediate layer 230 may be between about 0.05 vol.% to about 0.5 vol.%, more specifically between about 0.1 vol.% to about 0.15 vol.%, relative to the total volume of the intermediate layer 230. The magnetic particles may be covered with a surfactant. The surfactant may allow the magnetic particles to interact with the surrounding fluid, or solid when disposed within a solid, and may prevent the magnetic particles from aggregating, as the Van der Waals force of the surfactants is high enough to prevent aggregation of the magnetic particles due to the magnetic field. However, in a fluid with a high concentration of the magnetic particles the Van der Waals forces may prevent the formation of columns, as they may keep the magnetic particles in a regular distribution. If the concentration is very low, the concentration of the magnetic particles may not be high enough to form the plurality of columns 240.

[0049] In some embodiments, the magnetic particles may have a diameter between about 5 nm to about 50 nm. Magnetic particles with a diameter between about 5 nm to about 50 nm may be processed into a colloidal fluid, wherein the magnetic particles do not clump, in particular wherein the magnetic particles do not clump when surfactants are bound to their surface.

[0050] In some embodiments, the base layer 210 may also comprise magnetic particles, in particular between about 10 to about 30 wt.% relative to the weight of the base layer 210. The magnetic particles may increase a local magnetic flux density on a top of the pedestal compared to a local magnetic flux density at a surface of the base layer 210 between two pedestals. As a result, each column of the plurality of columns 240 may preferentially form on top of a pedestal compared to between pedestals.

[0051] In some embodiments, the magnetic particles may be iron oxide particles. Iron oxide particles may be ferro- and/or ferrimagnetic. Further, iron oxide particles may be highly magnetic materials compared to other magnetic materials. The iron oxide particles may com-

prise magnetite and/or maghemite. Iron oxide particles may be non-toxic and cost-efficient. The magnetic particles may comprise cobalt and nickel.

[0052] In some embodiments, the magnetic particles may comprise surfactants, in particular surfactants attached to an outer surface of the particles. The surfactant may allow the magnetic particles to interact with the solid, e.g. the polymer, or the fluid, in particular the aqueous solution, surrounding them. This may increase the effect of magnetism upon the solid and in particular the fluid. Additionally, the surfactants may prevent clumping/aggregation of the magnetic particles.

[0053] In some embodiments, the base layer 210 may comprise silicone and/or magnetic particles, more specifically polydimethylsiloxane comprising magnetic particles. The magnetic particles in the base layer 210 may comprise the same properties as the magnetic particles in the intermediate layer 230. The magnetic particles in the base layer 210 may improve the formation of the plurality of columns 240.

[0054] In some embodiments, the base layer 210 may comprise a polymer, in particular wherein the polymer comprised within the base layer 210 may comprise or consists of or substantially consists of PDMS.

[0055] In some embodiments, the base layer 210's magnetic particles may be embedded in the base layer 210's polymer. The magnetic particles may be present in the base layer 210 and hence within the polymer and in particular the PDMS.

[0056] The PDMS comprising the magnetic particles may be manufactured as described on page 2 of "Magnetically Actuated Dynamic Iridescence Inspired by the Neon Tetra" by Zhiren Luo, Benjamin Aaron Evans, and Chih-Hao Chang in ACS Nano on 2019 13 (4), 4657-4666 DOI: 10.1021/acsnano.9b00822, which is incorporated herein by reference.

[0057] In some embodiments, a distance 270 between two adjacent pedestals of the plurality of pedestals 220 may be between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm . The distance between each of the columns may be adjusted to affect light in the visible spectrum and to achieve a high color intensity.

[0058] In some embodiments, a diameter of a pedestal of the plurality of pedestals 220 may be between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm .

[0059] In some embodiments, the height of a pedestal of the plurality of pedestals 220 may be between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm .

[0060] In some embodiments, the overall thickness of the base layer 210, intermediate layer 230 and cover layer 250 may be between about 10 μm to about 50 μm , more specifically between about 20 μm to about 40 μm .

[0061] In some embodiments, the distance 260 between the base layer 210 and cover layer 250 may be between about 5 μm to about 50 μm , and in particular between about 15 μm to about 30 μm . The aforementioned ranges of distances 260 between the base layer 210 and cover layer 250 may allow the formation of the columns upon exposure of the intermediate layer 230 to a magnetic field. The base layer 210 may comprise a base layer inner surface, wherein the inner surface is oriented towards the cover layer 250. Similarly the cover layer 250 may comprise a cover layer inner surface oriented towards the base layer 210. The distance 260 between the base layer 210 and the cover layer 250 may be the distance 260 between the base layer's 210 inner surface and the cover layer's 250 inner surface.

[0062] In some embodiments, each of the columns of the plurality columns may be configured to tilt by between about 0° to about 45°, more specifically between about 5 to about 30° based on the direction of the applied magnetic field. Beyond a tilt of 30° the columns may be damaged. The tilt of the columns may be measured by microscopy, in particular top-view optical microscopy.

[0063] In some embodiments, the drawing substrate 110 may comprise a trace layer. A user may place their writing substrate, for example a transparent piece of paper, on the trace layer and then perform their tracing. The trace layer may provide a stiff support to the writing substrate. Further, the trace layer may protect the underlying drawing substrate 110 from damage, for example due to the user pressing their writing instrument 300 with excessive force on the writing substrate.

[0064] In some embodiments, the trace layer may be attached to the cover layer 250, or wherein a gap may be disposed between the trace layer and the cover layer 250, in particular a gap with a width between about 50 μm to about 3000 μm . The gap may prevent forces from being transferred from the trace layer to the cover layer 250, which may prevent damage to the cover layer 250.

[0065] In some embodiments, the trace layer may have a thickness between about 0.5 mm to about 5 mm.

Pins

[0066] In some embodiments, wherein a diameter of the plurality of movable pins may be between about 0.10 mm to about 5 mm. Pins of smaller diameter may increase the resolution of the drawing substrate 110. Pins of higher diameters may be resistant to deformation.

[0067] In some embodiments, a length of the plurality of movable pins may be between about 0.5 cm to about 10 cm. Longer pins may allow replicating objects of increased depth. Shorter pins may be more resistant to deformation.

[0068] In some embodiments, the plurality of movable pins may comprise between about 50 to about 1000 movable pins. More pins may allow replicating larger object, given the same diameter of the pins.

[0069] In some embodiments, the plurality of movable

pins may be connected to a restoring force element configured to exert a restoring force on the pins when the pins may be moved out of a rest position, more specifically wherein the pins may be connected to a spring or an elastomer. The restoring force element may move the plurality of movable pins back to their rest position after being pressed against the object 200, allowing reusing the pin screen 120 for another object, without requiring the user to manually move the plurality of movable pins back to the rest position.

[0070] In some embodiments, the plurality of pins may be of variable length, more specifically wherein the pins may comprise a plurality of segments, wherein the segments are configured to move relative to one another. The segments may be arranged as a telescopic tube. Upon being compressed against the object 200 the pin may shorten. The segments may also comprise restoring force element to move back into their rest position after use. The magnet may be comprised within the pins distal end relative to the drawing substrate 110, such that upon compression of the pin the magnet moves closer or proximal towards the drawing substrate 110.

[0071] In some embodiments, at least one of the plurality of movable pins may comprise at least one permanent magnet, more specifically at least one rare-earth magnet and at least one neodymium magnet. Permanent magnets may be easy to use. In particular, permanent magnets may result in the system 100 being independent from a power source. The system 100 being independent from a power source may result in improved portability and/or weight of the system 100. Further, power sources, such as electrical power sources may be hazard, for example when the system 100 or parts thereof are damaged. Rare-earth magnets and in particular neodymium magnets may be permanent magnets providing a strong magnetic field compared to other magnets of similar size. As a result, a rare-earth magnets may allow to more efficiently change the color of the drawing substrate 110.

[0072] In some embodiments, at least one of the plurality of movable pins may comprise at least one electromagnet, in particular an electromagnet configured to activate when force is applied to the movable pin. Electromagnets may allow controlling the magnets comprised in each pin individually, which may improve the contours displayed on the drawing substrate 110. Electromagnets configured to activate when force is applied to the movable pin may for example only activate when pressed against the object 200, whereby force is applied. This may automatically activate the pins required to form the contour.

[0073] In some embodiments, at least one pin of the plurality of movable pins may comprise part of an electrical circuit, wherein the electrical circuit may be closed when force may be applied to the movable pin, in particular when a force exceeding a threshold pressure may be applied to the movable pin.

[0074] In some embodiments, the magnet may have a diameter between about 50 μm to about 10000 μm , more

specifically between about 200 μm to about 5000 μm and in particular between about 500 μm to about 1000 μm .

[0075] In some embodiments, a length of the magnet may be between about 0.1 cm to about 3 cm.

[0076] In some embodiments, the magnet may have a remanence between about 200 mT to about 2 T, more specifically between about 500 mT to about 1.8 T and in particular between about 800 T to about 1.5 T. Stronger magnets may result in a more effective formation of the columns leading to a higher color intensity.

System Arrangement and Base Plate

[0077] In some embodiments, the pin screen 120 may be attached to the drawing substrate 110. As a result, the object 200 the pin screen 120 is or was pressed against is immediately displayed on the drawing substrate 110.

[0078] In some embodiments, the system 100 may comprise a base plate, more specifically a base plate arranged between the plurality of movable pins and the drawing substrate 110, and in particular a stiff base plate arranged between the plurality of movable pins and the drawing substrate 110 configured to prevent direct contact between the movable pins and the drawing substrate 110.

[0079] In some embodiments, the base plate may be attached to the drawing substrate 110 and/or wherein the drawing substrate 110 may be coated on the base plate. The drawing substrate 110 may be damaged by contact with the movable pins, in particular if the movable pins are pressed against the drawing substrate 110 with force. The base plate may prevent damage, while still allowing the magnetic field to largely pass. The drawing substrate 110 may also be coated on the base plate reducing the number of components and assembly time.

[0080] In some embodiments, the base plate may comprise glass, plastic or metal, in particular glass.

[0081] In some embodiments, the base plate may be opaque, in particular black, to increase the contrast of the drawing substrate 110. Additionally or alternatively, the system 100 may comprise one or more light sources configured to illuminate the drawing substrate 110. The one or more light sources may increase the visibility of the patterns formed by the pin screen 120.

[0082] Although the present disclosure is defined in the attached claims, it should be understood that the present disclosure can also (alternatively) be defined in accordance with the following aspects:

1. In a first aspect, the present disclosure relates to a system (100) comprising:

a pin screen (120) comprising a plurality of movable pins comprising a magnet;
a drawing substrate (110) configured to change color based on a magnetic force,

wherein the drawing substrate (110) comprises:

a base layer (210) comprising a plurality of pedestals (220), an intermediate layer (230) comprising magnetic particles; and
a cover layer (250), wherein the intermediate layer (230) is disposed between the base layer (210) and the cover layer (250).

2. The system (100) according to aspect 1, wherein the magnetic particles are configured to form a plurality of columns (240) upon exposure to a magnetic field, in particular wherein at least one, in particular each, of the plurality of columns (240) protrudes from a pedestal from the plurality of pedestals (220).

3. The system (100) according to any preceding aspect, wherein the intermediate layer (230) is a fluid, in particular an aqueous solution comprising the magnetic particles.

4. The system (100) according to any preceding aspect, wherein the concentration of the magnetic particles in the intermediate layer (230) is between about 0.05 vol.% to about 0.5 vol.%, more specifically between about 0.1 vol.% to about 0.15 vol.%, relative to the total volume of the intermediate layer (230).

5. The system (100) according to any preceding aspect, wherein the base layer (210) also comprises magnetic particles, in particular between about 10 wt.-% to about 30 wt.-% relative to the weight of the base layer (210).

6. The system (100) according to any preceding aspect, wherein the magnetic particles are magnetic nanoparticles, in particular wherein the magnetic particles have a diameter between about 5 nm to about 50 nm.

7. The system (100) according to any preceding aspect, wherein the magnetic particles are iron oxide particles.

8. The system (100) according to any preceding aspect, wherein the base layer (210) comprises silicone and/or magnetic particles, more specifically polydimethylsiloxane comprising magnetic particles.

9. The system (100) according to any preceding aspect, wherein the base layer (210) comprises a polymer, in particular wherein the polymer comprised within the base layer (210) comprises or consists of or substantially consists of PDMS.

10. The system (100) according to aspect 9, wherein

the base layer (210)'s magnetic particles are embedded in the base layer's polymer.

11. The system (100) according to any preceding aspect, wherein a distance (270) between two adjacent pedestals of the plurality of pedestals (220) is between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm .

12. The system (100) according to any preceding aspect, wherein the diameter of a pedestal of the plurality of pedestals (220) is between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm .

13. The system (100) according to any preceding aspect, wherein the height of a pedestal of the plurality of pedestals (220) is between about 0.5 μm to about 50 μm , more specifically between about 1 μm to about 5 μm , and in particular between about 1.5 μm to about 3 μm . system (100)

14. The system (100) according to any preceding aspect, wherein the overall thickness of the base layer (210), intermediate layer (230) and cover layer (250) is between about 10 μm to about 50 μm , more specifically between about 20 μm to about 40 μm .

15. The system (100) according to any preceding aspect, wherein the distance (260) between the base layer (210) and cover layer (250) is between about 5 μm to about 50 μm , and in particular between about 15 μm to about 30 μm .

16. The system (100) according to any of aspects 2 to 15, wherein each of the columns of the plurality of columns is configured to tilt by between about 0° to about 45°, more specifically between about 5° to about 30° based on the direction of the applied magnetic field.

17. The system (100) according to any preceding aspect, wherein the drawing substrate (110) comprises a trace layer.

18. The system (100) according to aspect 17, wherein the trace layer is attached to the cover layer (250), or a gap is disposed between the trace layer and the cover layer (250), in particular a gap with a width between about 50 μm to about 3000 μm .

19. The system (100) according to any of aspects 17 or 18, wherein the trace layer has a thickness between about 0.5 mm to about 5 mm.

20. The system (100) according to any preceding

aspect, wherein a diameter of the plurality of movable pins is between about 0.1 mm to about 5 mm.

21. The system (100) according to any preceding aspect, wherein a length of the plurality of movable pins is between about 0.5 cm to about 10 cm. 5

22. The system (100) according to any preceding aspect, wherein the plurality of movable pins comprises between about 50 to about 1000 movable pins. 10

23. The system (100) according to any preceding aspect, wherein the plurality of movable pins are connected to a restoring force element configured to exert a restoring force on the pins when the pins are moved out of a rest position, more specifically wherein the pins are connected to a spring or an elastomer. 15

24. The system (100) according to any preceding aspect, wherein the plurality of pins are of variable length, more specifically wherein the pins comprise a plurality of segments, wherein the segments are configured to move relative to one another. 20

25. The system (100) according to any preceding aspect, wherein at least one pin of the plurality of movable pins comprises at least one permanent magnet, more specifically at least one rare-earth magnet and at least one neodymium magnet. 25 30

26. The system (100) according to any preceding aspect, wherein at least one pin of the plurality of movable pins comprises at least one electromagnet, in particular an electromagnet configured to activate when force is applied to the movable pin. 35

27. The system (100) according to any preceding aspect, wherein at least one pin of plurality of movable pins comprises part of an electrical circuit, wherein the electrical circuit is closed when force is applied to the movable pin, in particular when a force exceeding a threshold pressure is applied to the movable pin. 40 45

28. The system (100) according to any preceding aspect, wherein the magnet has a diameter between about 50 μm to about 10000 μm , more specifically between about 200 μm to about 5000 μm and in particular between about 500 μm to about 1000 μm . 50

29. The system (100) according to any preceding aspect, wherein a length of the magnet is between about 0.1 cm to about 3 cm. 55

30. The system (100) according to any of aspects 25 or 28 and 29 when dependent on aspect 25, wherein the magnet has a remanence between

about 200 mT to about 2 T, more specifically between about 500 mT to about 1.8 T and in particular between about 800 T to about 1.5 T.

31. The system (100) according to any preceding aspect, wherein the pin screen (120) is attached to the drawing substrate (110).

32. The system (100) according to any preceding aspect, wherein the system (100) comprises a base plate, more specifically a base plate arranged between the plurality of movable pins and the drawing substrate (110), and in particular a stiff base plate arranged between the plurality of movable pins and the drawing substrate (110) configured to prevent direct contact between the movable pins and the drawing substrate (110).

33. The system (100) according to aspect 32, wherein the base plate is attached to the drawing substrate (110) and/or wherein the drawing substrate (110) is coated on the base plate.

34. The system (100) according to aspect 32 or 33, wherein the base plate comprises glass, plastic or metal, in particular glass.

Claims

1. A system (100) comprising:

a pin screen (120) comprising a plurality of movable pins comprising a magnet;
a drawing substrate (110) configured to change color based on a magnetic force,
wherein the drawing substrate (110) comprises:

a base layer (210) comprising a plurality of pedestals (220), an intermediate layer (230) comprising magnetic particles; and
a cover layer (250), wherein the intermediate layer (230) is disposed between the base layer (210) and the cover layer (250).

2. The system (100) according to claim 1, wherein the magnetic particles are configured to form a plurality of columns (240) upon exposure to a magnetic field, in particular wherein at least one, in particular each, of the plurality of columns (240) protrudes from a pedestal from the plurality of pedestals (220).

3. The system (100) according to any preceding claim, wherein the intermediate layer (230) is a fluid, in particular an aqueous solution comprising the magnetic particles.

4. The system (100) according to any preceding claim,

wherein the concentration of the magnetic particles in the intermediate layer (230) is between about 0.05 vol.% to about 0.5 vol.%.

5. The system (100) according to any preceding claim, wherein the magnetic particles are iron oxide particles. 5
6. The system (100) according to any preceding claim, wherein a distance (270) between two adjacent pedestals of the plurality of pedestals (220) is between about 0.5 μm to about 50 μm . 10
7. The system (100) according to any preceding claim, wherein the diameter of a pedestal of the plurality of pedestals (220) is between about 0.5 μm to about 50 μm . 15
8. The system (100) according to any preceding claim, wherein the height of a pedestal of the plurality of pedestals (220) is between about 0.5 μm to about 50 μm . 20
9. The system (100) according to any preceding claim, wherein the distance (260) between the base layer (210) and cover layer (250) is between about 5 μm to about 50 μm , and in particular between about 15 μm to about 30 μm . 25
10. The system (100) according to any preceding claim, wherein a diameter of the plurality of movable pins is between about 0.1 mm to about 5 mm and/or wherein a length of the plurality of movable pins is between about 0.5 cm to about 10 cm. 30
11. The system (100) according to any preceding claim, wherein the plurality of movable pins comprises between about 50 to about 1000 movable pins. 35
12. The system (100) according to any preceding claim, wherein the plurality of pins are of variable length, more specifically wherein the pins comprise a plurality of segments, wherein the segments are configured to move relative to one another. 40
13. The system (100) according to any preceding claim, wherein at least one pin of the plurality of movable pins comprises at least one permanent magnet, more specifically at least one rare-earth magnet and at least one neodymium magnet. 45
14. The system (100) according to claim 13, wherein the magnet has a remanence between about 200 mT to about 2 T. 50
15. The system (100) according to any preceding claim, wherein the pin screen (120) is attached to the drawing substrate (110). 55

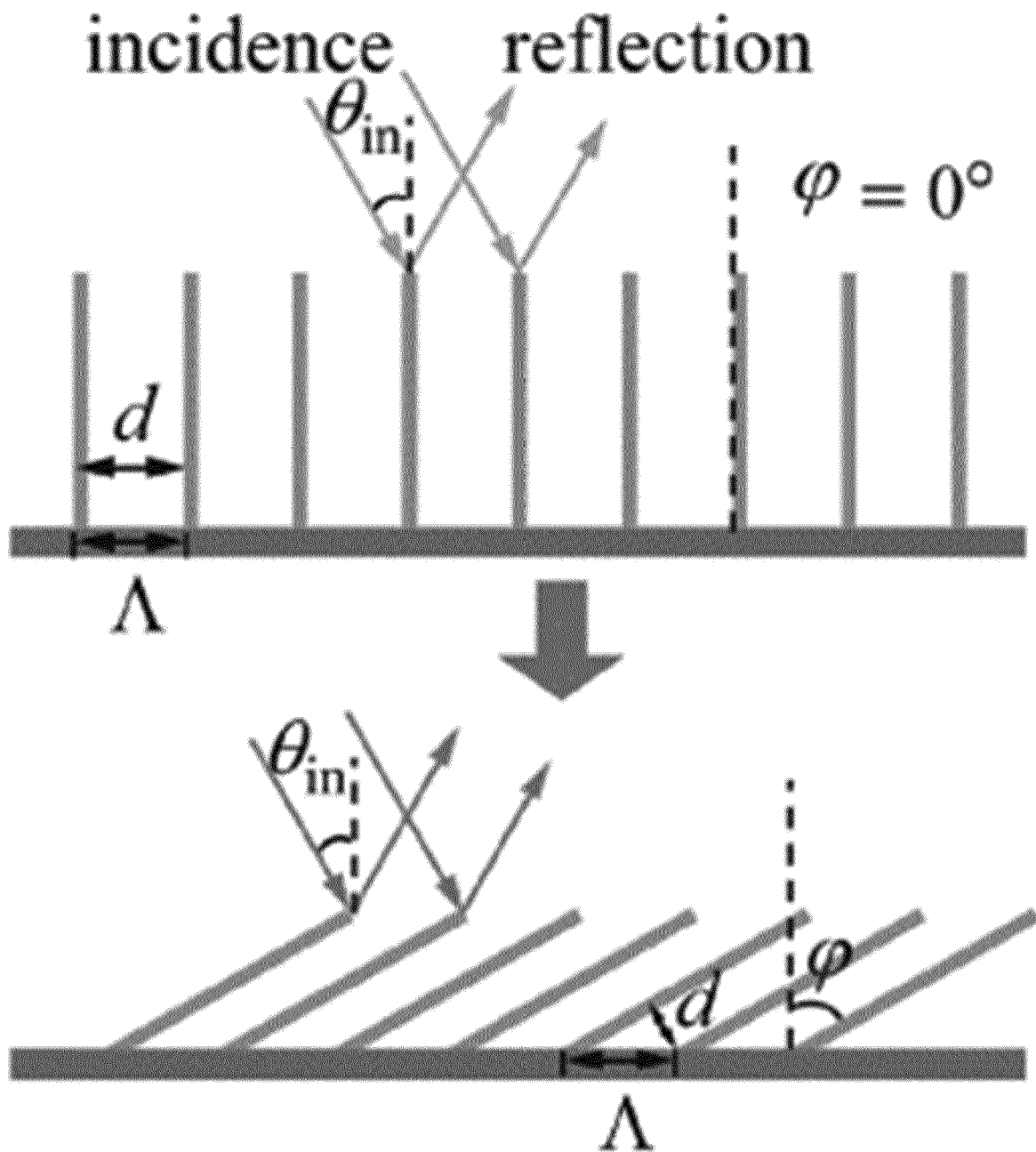


Figure 1

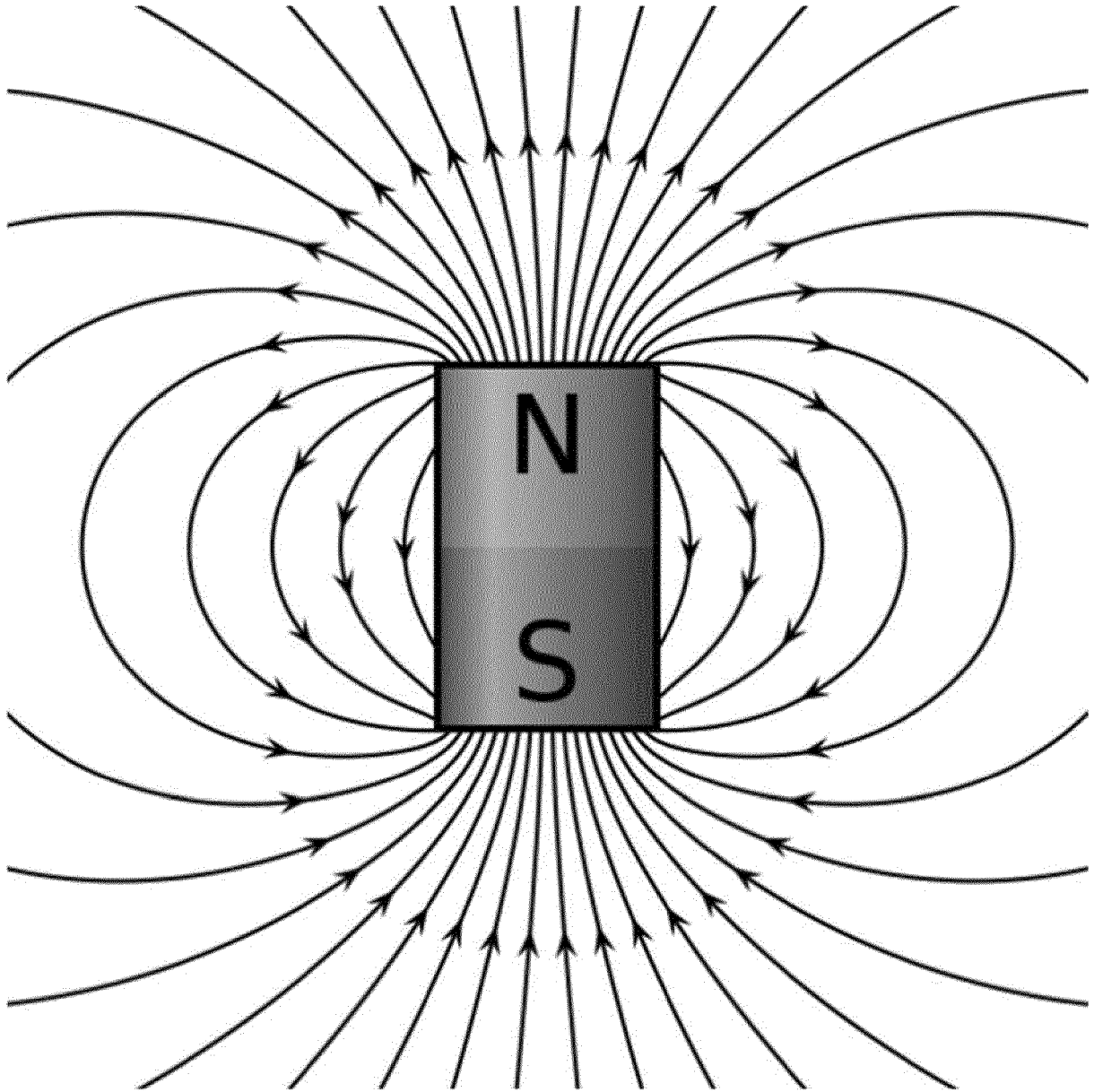


Figure 2

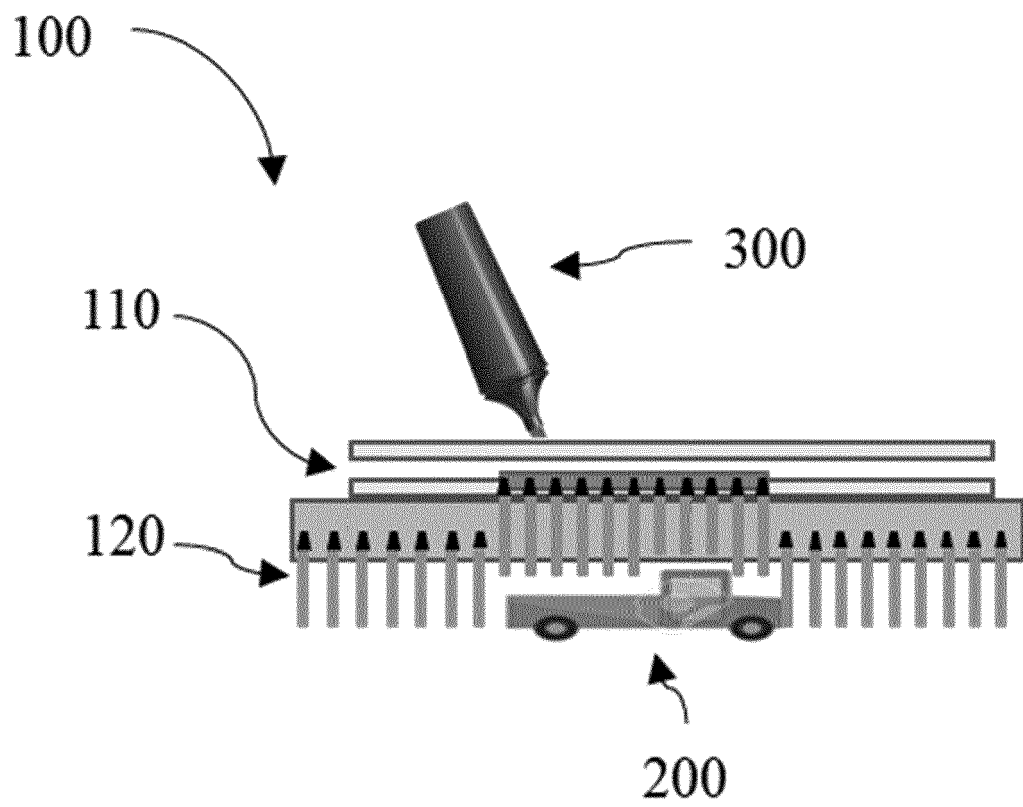


Figure 3

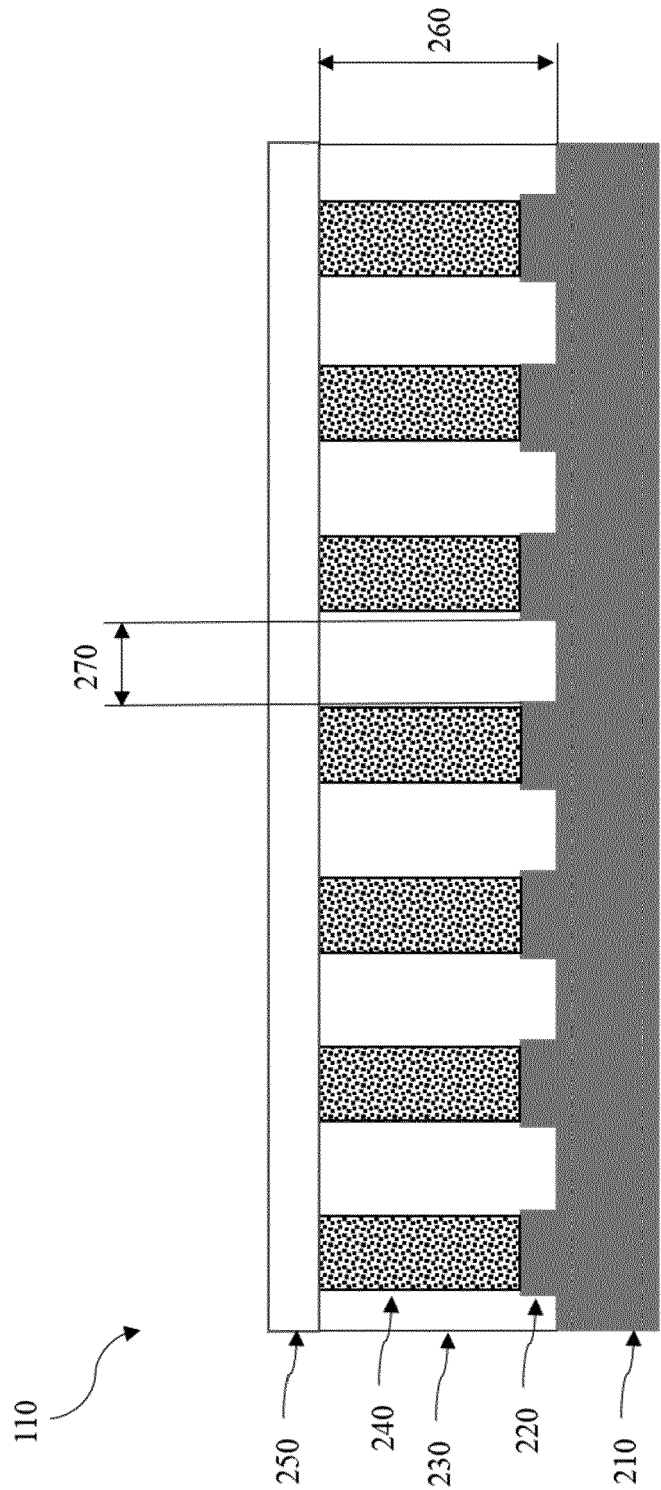


Figure 4



EUROPEAN SEARCH REPORT

Application Number

EP 22 16 6076

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EPO FORM 1503 03.82 (P04C01)

Place of search Munich	Date of completion of the search 18 August 2022	Examiner Kelliher, Cormac
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