CLAIMS

1. A printing apparatus for producing on a substrate an optical effect layer (OEL) comprising a radiation cured coating composition comprising non-spherical oblate magnetic or magnetizable pigment particles, said non-spherical oblate magnetic or magnetizable pigment particles being oriented according to an orientation pattern, wherein the orientation pattern is circularly symmetric around a center of rotation, wherein the non-spherical oblate magnetic or magnetizable pigment particles at at least two, preferably four, distinct locations x_i along any selected diameter of the OEL have an average zenithal deflection angle φ' at location x_i and an average azimuth angle θ with respect to the selected diameter at the same location x_i that satisfy the condition $|\varphi' \sin(\theta)| \geq 10°$, preferably $|\varphi' \sin(\theta)| \geq 15°$, and said optical effect layer providing an optical impression of at least one circularly moving spot or at least one comet-shaped spot rotating around said center of rotation upon tilting said OEL,

wherein the non-spherical oblate magnetic or magnetizable pigment particles are oriented with the magnetic field from at least one spinning magnetic assembly (x00) comprised in the apparatus, the spinning magnetic assembly (x00) having an axis of spinning, wherein the surface of the substrate provided with the OEL is substantially perpendicular to the axis of spinning of the magnet assembly (x00) and comprising a magnetic-field generating device (x30) comprising:

a disc-shaped dipole magnet (x31) having its North-South magnetic axis substantially perpendicular to the axis of spinning, or

a loop-shaped, preferably a ring-shaped, dipole magnet (x31) having its North-South magnetic axis substantially perpendicular to the axis of spinning, or

a bar dipole magnet (x31) having its North-South magnetic axis substantially perpendicular to the axis of spinning and arranged on the axis of spinning

wherein the disc-shaped dipole magnet (x31), the loop-shaped, preferably the ring-shaped, dipole magnet (x31) or the bar dipole magnet (x31) of the magnetic-field generating device (x30) comprises at least one pair of indentations (I) and/or at least one pair of voids (V) and/or at least one pair of protrusions (P), wherein the indentations (I) of the at least one pair, the voids (V) of the at least one pair and/or the protrusions (P) of the at least one pair are located:

symmetrically about the axis of spinning,

and asymmetrically with respect to a mirror plane of the disc-shaped dipole magnet (x31), the loop-shaped, preferably the ring-shaped, dipole magnet (x31) or the bar dipole magnet (x31), which is perpendicular to the North-South magnetic axis of the disc-shaped dipole magnet (x31), the loop-shaped, preferably the ring-shaped, dipole magnet (x31) or the bar dipole magnet (x31) of the magnetic-field generating device (x30) and which contains the axis of spinning.

2. The apparatus according to claim 1, wherein the magnetic-field generating device (x30) comprises the disc-shaped dipole magnet (x31) having its North-South magnetic axis substantially perpendicular to the axis of spinning or the loop-shaped, preferably the ring-shaped, (x31) having its North-South magnetic axis substantially perpendicular to the axis of spinning.

3. The apparatus according to any one of claims 1 or 2, wherein the indentations (I) and/or voids (V) and/or protrusions (P) of the at least one pair are arranged in a symmetric configuration about the

axis of spinning along a line (α), and

wherein the projection of the magnetization axis (β) of the magnetic-field generating device (x30) and the projection of the line (α) where the indentations (I) and/or the voids (V) and/or the protrusions (P) are arranged along the axis of spinning onto a plane perpendicular to the axis of spinning form an angle (Ω) either in the range from 5° to 175° or in the range from -5° to -175°, preferably in the range from 15° to 165° or in the range from -15° to -165°.

4. The apparatus according to any one of claims 1 to 3, wherein the magnetic-field generating device (x30) comprises at least one pair of indentations (I) and/or at least one pair of voids (V).

5. The apparatus according to any one of claims 1 to 4, further comprising a rotating magnetic cylinder or a flatbed printing unit, wherein the at least one spinning magnetic assembly (x00) is comprised in the rotating magnetic cylinder or the flatbed printing unit.

6. A process for producing an optical effect layer (OEL) (x10) on a substrate (x20), said optical effect layer (OEL) comprising a radiation cured coating composition comprising non-spherical oblate magnetic or magnetizable pigment particles, said non-spherical oblate magnetic or magnetizable pigment particles being oriented according to an orientation pattern, wherein the orientation pattern is circularly symmetric around a center of rotation, wherein the non-spherical oblate magnetic or magnetizable pigment particles at at least two, preferably four, distinct locations x_i along any selected diameter of the OEL have an average zenithal deflection angle φ' at location x_i and an average azimuth angle θ with respect to the selected diameter at the same location x_i that satisfy the condition $|\varphi' \sin(\theta)| \geq 10°$, preferably $|\varphi' \sin(\theta)| \geq 15°$, and said optical effect layer providing an optical impression of at least one circularly moving spot or at least one comet-shaped spot rotating around said center of rotation upon tilting said OEL,

wherein said process comprises the steps of:

i) applying on a substrate (x20) surface a radiation curable coating composition comprising non-spherical oblate magnetic or magnetizable pigment particles, said radiation curable coating composition being in a first state;

ii) exposing the radiation curable coating composition to a magnetic field of the printing apparatus recited in any one of claims 7-11 so as to orient at least one part of the non-spherical oblate magnetic or magnetizable pigment particles; and

iii) at least partially curing the radiation curable coating composition of step ii) to a second state so as to fix the non-spherical oblate magnetic or magnetizable pigment particles in their adopted positions and orientations.

7. The process according to claim 6, wherein step iii) is carried out by UV-Vis light radiation curing and wherein step iii) is carried out partially simultaneously with the step ii).

8. The process according to claim 6 or 7, wherein at least one part of the plurality of non-spherical oblate magnetic or magnetizable particles is constituted by non-spherical oblate optically variable magnetic or magnetizable pigment particles.

9. The process according to any one of claims 6 to 8, wherein the optically variable magnetic or magnetizable pigments are selected from the group consisting of magnetic thin-film interference pigments, magnetic cholesteric liquid crystal pigments and mixtures thereof.

10. The process according to any one of claims 6 to 8, wherein the radiation cured coating composition is a UV-Vis radiation cured coating composition.