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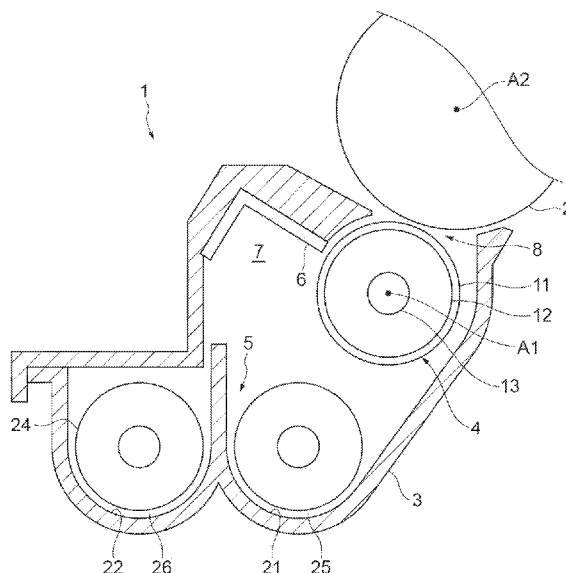
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Fig.1



(57) Abstract: A developer conveying device includes a housing forming a channel extending inside the housing in a longitudinal direction, and a stirring and conveying member extending within the channel to convey a developer through a conveyance path formed between a wall of the channel and the stirring and conveying member. The conveyance path includes a main portion extending along a substantial portion of the conveyance path, and a narrowed portion formed outside the main portion. A first cross-sectional area of the conveyance path taken in the narrowed portion is less than a second cross-sectional area of the conveyance path taken in the main portion.

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DEVELOPER CONVEYING DEVICE WITH NARROWED PORTION

BACKGROUND

[0001] Some image forming devices include a developing device that uses a developer containing a toner and a carrier to develop an electrostatic latent image of an image carrier. Such developing devices are provided with a developer conveying device including a channel and a stirring and conveying member extending inside the channel to convey and stir the developer through the channel.

BRIEF DESCRIPTION OF DRAWINGS

[0002] FIG. 1 is a schematic cross-sectional view of an example developing device.

FIG. 2 is a schematic cross-sectional view of an example developer conveying device.

FIG. 3 is a partial enlarged view of the schematic cross-sectional view illustrated in FIG. 2.

FIG. 4 is a schematic cross-sectional view of the example developer conveying device illustrated in FIG. 3, taken along line IV-IV.

FIG. 5 is a schematic cross-sectional view of the example developer conveying device illustrated in FIG. 3, taken along line V-V.

FIG. 6 is a schematic cross-sectional view of a developer conveying device of another example.

FIG. 7 is a graph of a charge distribution amount in a Test Example for

a drive time of 10 seconds.

FIG. 8 is a graph of a charge distribution amount in a Test Example 1 for a drive time of 15 seconds.

FIG. 9 is a graph of a charge distribution amount in the Test Example 1 for a drive time of 20 seconds.

FIG. 10 is a graph of a charge distribution amount in the Test Example 1 for a drive time of 30 seconds.

FIG. 11 is a graph of a charge distribution amount in a Comparative Test Example 1 for a drive time of 10 seconds.

FIG. 12 is a graph showing a charge distribution amount in the Comparative Test Example 1 for a drive time of 15 seconds.

FIG. 13 is a graph showing a charge distribution amount in the Comparative Test Example 1 for a drive time of 20 seconds.

FIG. 14 is a graph showing a charge distribution amount in the Comparative Example 1 for a drive time of 30 seconds.

FIG. 15 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

FIG. 16 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

FIG. 17 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

FIG. 18 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

FIG. 19 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

FIG. 20 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

FIG. 21 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

FIG. 22 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

FIG. 23 is a schematic cross-sectional view illustrating a portion of a developer conveying device according to another example.

DETAILED DESCRIPTION

[0003] A developing device of an image forming device is provided to develop an electrostatic latent image formed on an image carrier. The developing device is provided with a developer conveying device in which a magnetic carrier and a non-magnetic toner are stirred and mixed so that the carrier and the toner are triboelectrically charged. When the toner density of a developer decreases, a replenishing toner is replenished and the replenishing toner and the developer are stirred and mixed so that the replenishing toner and the developer are triboelectrically charged. Here, when the developing device is reduced in size or when amount of the developer is decreased, the amount of the developer to be stirred and triboelectrically charged with the replenishing toner is reduced, which may in turn cause an image defect (stain) due to soft blocking the toner contained in the replenishing toner supplied onto a developing roller without collapsing, an image defect (fog) due to the replenishing toner supplied onto the developing roller without being sufficiently triboelectrically charged with the developer, and toner scattering due to weak electrostatic adhesion between the carrier and the toner as a result of insufficient triboelectric charging of the developer.

[0004] According to examples, a conveyance path formed between a channel of a housing and a stirring and conveying member to convey a developer, includes a main portion extending along most of the conveyance path and a

narrowed portion formed outside the main portion. A first cross-sectional area of the conveyance path in the narrowed portion is less (e.g., smaller area) than a second cross-sectional area of the conveyance path in the main portion. Accordingly, the developer is stirred and conveyed along the conveyance path such that the developer is temporarily accumulated on the upstream side of the narrowed portion and is fed (or pushed or squeezed) into the narrowed portion, so as to promote the stirring and mixing and triboelectrically charging of the developer in the narrowed portion are promoted. Consequently, it is possible to suppress an increase in image defects or toner scattering even when the amount of the developer that is stirred and mixed with the replenishing toner is relatively low due to a reduced size of the developing device or due to a reduced amount of the developer in the developer conveying device.

[0005] Hereinafter, an example of a developer conveying device will be described with reference to the drawings. In the following description, with reference to the drawings, the same reference numbers are assigned to the same components or to similar components having the same function, and overlapping description is omitted.

[0006] FIG. 1 is a schematic cross-sectional view of an example of a developing device provided with an example of a developer conveying device. A developing device 1 illustrated in FIG. 1 develops an electrostatic latent image to be formed on a surface (a peripheral surface) of an image carrier 2 of an image forming device, so as to form a toner image. The developing device 1 includes a housing 3, a developing roller 4, a developer conveying device 5, and a layer thickness regulation member 6. The developing device 1 may use a two-component developer containing a toner and a carrier as a developer to form the toner image. Namely, in the developing device 1, the toner and the carrier are adjusted to a desired stirring ratio and are further stirred to disperse

the toner so that the developer is adjusted to have an optimal charge amount.

[0007] The housing 3 includes a developing chamber 7 therein. The developing chamber 7 in the housing 3 stores a developer containing a toner and a carrier. Additionally, the developing chamber 7 of the housing 3 accommodates a developing roller 4 and a layer thickness regulation member 6. The housing 3 includes an opening adjacent to the developing roller 4 and the developer inside the developing chamber 7 is supplied through the opening to the image carrier 2.

[0008] The developing roller 4 is disposed to face the image carrier 2 so that a gap is formed between the image carrier 2 and the developing roller. The developing roller 4 rotates while carrying the developer stored in the housing 3 on the surface thereof. Namely, the developing roller 4 rotates in a predetermined direction to transport the developer. The developing roller 4 is formed in, for example, a substantially cylindrical shape. The developing roller 4 is disposed so that a rotation axis A1 of the developing roller 4 is parallel to a rotation axis A2 of the image carrier 2. The developing roller 4 carries the developer stored in the developing chamber 7 of the housing 3 on the surface thereof. The developing roller 4 develops the electrostatic latent image of the image carrier 2 by conveying the stored developer to a developing area 8. The developing area 8 is an area located between the developing roller 4 and the image carrier 2 and is an area in which the developing roller 4 faces the image carrier 2.

[0009] The developing roller 4 includes a developing sleeve 11 which forms a surface layer of the developing roller 4 and a magnet 12 which is disposed inside the developing sleeve 11. The developing sleeve 11 is a cylindrical member that is formed of non-magnetic metal. The developing sleeve 11 is rotatable around the rotation axis A1. The magnet 12 is fixed to, for example,

a shaft 13 extending along the rotation axis A1 fixed to the housing 3 and includes a plurality of magnetic poles. The developing sleeve 11 is rotatably supported by, for example, the shaft 13 and is rotationally driven by a drive source such as a motor. The developer is carried on the surface of the developing sleeve 11 due to the magnetic force of the magnet 12. The developing roller 4 conveys the developer in the rotation direction of the developing sleeve 11 by rotating the developing sleeve 11. In the present example, the rotation of the developing roller 4 refers to the rotation of the developing sleeve 11 and the rotation direction of the developing roller 4 refers to the rotation direction of the developing sleeve 11.

[0010] A magnetic brush formation of the developer is formed on the developing sleeve 11 due to a magnetic force of the magnetic poles of the magnet 12. The magnetic brush formation of developer may also be referred to as the spike of the developer. The developing roller 4 allows the magnetic brush formation of the developer formed by the magnetic pole to contact or approach the electrostatic latent image of the image carrier 2 in the developing area 8. Accordingly, the toner of the developer carried on the developing roller 4 is transferred to the electrostatic latent image formed on the peripheral surface of the image carrier 2 so that the electrostatic latent image is developed.

[0011] The layer thickness regulation member 6 regulates (or limits) the thickness of the developer (or developer layer) carried on the developing roller 4. Namely, the layer thickness regulation member 6 limits the conveying amount of the developer conveyed by the developing roller 4. The layer thickness regulation member 6 is disposed in the vicinity of the developing area 8 on the upstream side of the developing area 8 in the rotation direction of the developing roller 4. The layer thickness regulation member 6 is spaced apart

from the developing roller 4, so as to form a predetermined gap between the developing roller 4 and the layer thickness regulation member. Thus, the layer thickness regulation member 6 regulates the layer thickness of the developer carried on the peripheral surface of the developing roller 4 when the developing roller 4 rotates. By adjusting the gap between the layer thickness regulation member 6 and the developing roller 4, the conveying amount of the developer conveyed to the developing area 8 by the developing roller 4 can be adjusted.

[0012] The developer conveying device 5 conveys the developer stored in the developing chamber 7 of the housing 3 while stirring the developer. Namely, the developer conveying device 5 stirs a magnetic carrier and a non-magnetic toner constituting a developer so that the carrier and the toner are triboelectrically charged. Additionally, the developer conveying device 5 conveys the developer while stirring the developer.

[0013] FIG. 2 is a schematic cross-sectional view of an example of the developer conveying device. FIG. 3 is a partially enlarged view of the schematic cross-sectional view illustrated in FIG. 2. With reference to FIGS. 1 to 3, the developer conveying device 5 includes a first channel 21 which is disposed below the developing roller 4 and extends inside the housing 3 in the longitudinal direction D, a second channel 22 which is disposed adjacent to the first channel 21 and extends inside the housing 3 in the longitudinal direction, a first stirring and conveying member 23 which extends inside the first channel 21, and a second stirring and conveying member 24 which extends inside the second channel 22. A first conveying path (or first conveyance path) 25 along which the developer is conveyed is formed between the first channel 21 and the first stirring and conveying member 23. A second conveying path (or second conveyance path) 26 along which the developer is conveyed is formed

between the second channel 22 and the second stirring and conveying member 24. A first through-hole 27 which connects the first conveying path 25 and the second conveying path 26 is formed in a first end portion of the first channel 21 and the second channel 22, adjacent a first longitudinal end of the developer conveying device. A second through-hole 28 which connects the first conveying path 25 and the second conveying path 26 is formed in a second end portion of the first channel 21 and the second channel 22, adjacent a second longitudinal end of the developer conveying device. Namely, the first conveying path 25 and the second conveying path 26 communicate with each other through the first through-hole 27 and the second through-hole 28. Additionally, the second conveying path 26 is provided with a replenishing port 29 to which a replenishing toner is replenished. The replenishing port 29 is located adjacent second longitudinal end of the developer conveying device, so as to be disposed opposite to the first through-hole 27 in relation to the second through-hole 28.

[0014] The first stirring and conveying member 23 and the second stirring and conveying member 24 stir a magnetic carrier and a non-magnetic toner constituting the developer so that the carrier and the toner are triboelectrically charged. The first stirring and conveying member 23 extends inside the first channel 21 and conveys the developer through the first conveying path 25. In the example of FIG. 2, a conveying direction D1 of the developer of the first conveying path 25 is a rightward direction (pointing to the right in the view). The second stirring and conveying member 24 extends inside the second channel 22 and conveys the developer through the second conveying path 26. In the example of FIG. 2, a conveying direction D2 of the developer of the second conveying path 26 is a leftward direction (pointing to the left in the view).

[0015] The first stirring and conveying member 23 is a supply auger which stirs the developer and supplies the developer to the developing roller 4. The first stirring and conveying member 23 includes a rotation shaft 31 which extends along a rotation axis A3 and a spiral blade 32 which protrudes from the rotation shaft 31 in the radial direction of the rotation shaft 31. The rotation shaft 31 is rotationally driven around the rotation axis A3 by a drive source such as a motor. The spiral blade 32 extends in a spiral shape around the rotation shaft 31 so as to convey the developer in the conveying direction D1 when the rotation shaft 31 rotates. The developer of the first conveying path 25 conveyed in the conveying direction D1 by the first stirring and conveying member 23 is supplied to the developing roller 4 and is supplied to the second conveying path 26 through the second through-hole 28.

[0016] The second stirring and conveying member 24 is an admix auger which stirs the developer and circulates the developer between the first conveying path 25 and the second conveying path 26. The second stirring and conveying member 24 includes a rotation shaft 33 which extends along a rotation axis A4 and a spiral blade 34 which extends from the rotation shaft 33 in the radial direction of the rotation shaft 33. The rotation shaft 33 is rotationally driven around the rotation axis A4 by a drive source such as a motor. The spiral blade 34 extends in a spiral shape around the rotation shaft 33 so as to convey the developer in the conveying direction D2 when the rotation shaft 33 rotates. The developer of the second conveying path 26 conveyed in the conveying direction D2 by the second stirring and conveying member 24 is supplied to the first conveying path 25 through the first through-hole 27.

[0017] The second conveying path 26 includes a main portion 26A which extends along most of the second conveying path 26, and a narrowed portion

26B which is formed outside the main portion 26A. Namely, the main portion 26A extends along a substantial portion of the second conveying path 26. A first cross-sectional area of the second conveying path 26 taken in the narrowed portion 26B is less (e.g., a smaller area) than a second cross-sectional area of the second conveying path 26 taken in the main portion 26A. The first cross-sectional area and the second cross-sectional area are cross-sectional areas formed along a plane orthogonal to the conveying direction D2 of the developer in the second conveying path 26. The first cross-sectional area of the second conveying path 26 in the narrowed portion 26B may be, for example, 80% or less, 70% or less, or 60% or less of the second cross-sectional area of the second conveying path 26 in the main portion 26A, depending on examples. Additionally, the first cross-sectional area of the second conveying path 26 in the narrowed portion 26B may be, for example, 50% or more, 60% or more, or 70% or more of the second cross-sectional area of the second conveying path 26 in the main portion 26A.

[0018] The second channel 22 includes a protrusion portion 30 which protrudes toward the second stirring and conveying member 24 to form the narrowed portion 26B. Namely, the protrusion portion 30 reduces the cross-sectional area of the second conveying path 26, so that the first cross-sectional area taken in the narrowed portion 26B is smaller than the second cross-sectional area taken in the main portion 26A. The protrusion portion 30 may be formed by the housing 3 that defines the second channel 22 according to some examples, or may be formed by attaching a separate member to the housing 3 that forms the second channel 22 according to other examples. The protrusion portion 30 includes, for example, a linear portion 30A which has an inner surface parallel to the rotation axis A4, a first taper portion 30B which is located on the upstream side of the linear portion 30A in

the conveying direction D2 and which is oriented to gradually extend closer to the rotation axis A4 in the conveying direction D2, and a second taper portion 30C which is located on the downstream side of the linear portion 30A in the conveying direction D2 and which is oriented to gradually extend away from the rotation axis A4 in the conveying direction D2.

[0019] FIG. 4 illustrates a cross-section of the example developer conveying device illustrated in FIG. 3, taken along line IV-IV. FIG. 5 illustrates a cross-section of the example developer conveying device, taken along line V-V in FIG. 3. With reference to FIGS. 3 to 5, the second channel 22 includes a gutter-shaped wall 22A which is open upwardly. The upward opening indicates that a space above the second stirring and conveying member 24 is greater than a gap formed between the second stirring and conveying member 24 and the wall of the second channel 22 below the second stirring and conveying member 24. Accordingly, a component may be located above the second channel 22, in some examples. In a cross-section that is taken along a plane orthogonal to the conveying direction D2 of the second conveying path 26, the wall 22A may have a U-shape opening upwardly, for example.

[0020] The second channel 22 includes a roof portion 22B which extends to a high flow portion 26C of the second conveying path 26, so as to form a tunnel in the high flow portion 26C. The roof portion 22B narrows a space formed above the second stirring and conveying member 24 compared to a portion not provided with the roof portion 22B. The roof portion 22B forms, for example, a gap which has substantially the same size as the gap between the lower end of the second stirring and conveying member 24 and the second channel 22 around the second stirring and conveying member 24. In a cross-section taken along a plane orthogonal to the conveying direction D2 of the second conveying path 26 in the roof portion 22B may have an arc shape, for example,

which has the same diameter as that of the lower end portion of the second channel 22.

[0021] As illustrated in FIGS. 1 to 3, the second stirring and conveying member 24 includes a first portion 24A which is adjacent to the upstream side of the narrowed portion 26B of the second conveying path 26 in the conveying direction D2 and a second portion 24B which extends along the narrowed portion 26B of the second conveying path 26.

[0022] The first portion 24A is provided with the spiral blade 34 and forms the high flow portion 26C which is formed in the main portion 26A of the second conveying path 26 so as to promote the movement of the developer. The high flow portion 26C is a portion which is adjacent to the upstream side of the narrowed portion 26B in the conveying direction D2 in the second conveying path 26. According to examples, the first portion 24A may be provided with an additional spiral blade 35 in addition to the spiral blade 34 in order to promote the movement of the developer. The additional spiral blade 35 protrudes from the rotation shaft 33 in the radial direction of the rotation shaft 33 separately from the spiral blade 34. Additionally, the additional spiral blade 35 may extend in a spiral shape around the rotation shaft 33 so as to convey the developer in the conveying direction D2 when the rotation shaft 33 rotates similarly to the spiral blade 34. The additional spiral blade 35 may be selectively extend within the first portion 24A exclusively.

[0023] According to examples, second portion 24B is not provided with the spiral blade 34. The second portion 24B may include a protrusion portion 36 which protrudes toward the second channel 22 to form the narrowed portion 26B. Namely, the protrusion portion 36 is a portion for allowing the first cross-sectional area of the second conveying path 26 in the narrowed portion 26B to be smaller than the second cross-sectional area of the second

conveying path 26 in the main portion 26A. The protrusion portion 36 is a portion in which the rotation shaft 33 is enlarged (e.g., to have an increased diameter). The protrusion portion 36 may be formed by the rotation shaft 33 itself or may be formed by attaching a separate member to the rotation shaft 33. The protrusion portion 36 includes, for example, a linear portion 36A which has an outer peripheral surface parallel to the rotation axis A4 and a taper portion 36B which is located on the upstream side of the linear portion 36A in the conveying direction D2 and is oriented to gradually extend away from the rotation axis A in the conveying direction D2. The outer peripheral surface of the linear portion 36A is provided with a spiral groove 37. The spiral groove 37 extends in a spiral shape on the outer peripheral surface of the linear portion 36A so as to convey the developer in the conveying direction D2 when the rotation shaft 33 rotates.

[0024] In the developer conveying device 5 with such a configuration, when the rotation shaft 31 of the first stirring and conveying member 23 is rotationally driven by a drive device, the developer is conveyed in the conveying direction D1 while being stirred by the spiral blade 32 which rotates together with the rotation shaft 31. The developer is supplied to the developing roller 4 and is supplied from the first conveying path 25 to the second conveying path 26 through the second through-hole 28.

[0025] Additionally, when the rotation shaft 33 of the second stirring and conveying member 24 is rotationally driven by a drive device, the developer is stirred and mixed by the spiral blade 34 rotating together with the rotation shaft 33 and is conveyed in the conveying direction D2, so as to triboelectrically charge the developer. Additionally, when a replenishing toner is supplied from the replenishing port 29 due to a decrease in the toner density of the developer, the replenishing toner is stirred and mixed with the developer and is

conveyed in the conveying direction D2 while being triboelectrically charged with the developer.

[0026] In the above described examples, the second conveying path 26 is narrowed by the protrusion portion 30 of the second channel 22 and the protrusion portion 36 of the second stirring and conveying member 24 in the narrowed portion 26B, to form a developer pool in which the developer is temporarily accumulated in the high flow portion 26C adjacent the narrowed portion 26B on the upstream side in the conveying direction D2. The developer that is temporarily accumulated in the high flow portion 26C is fed (or pushed) into the narrowed portion 26B by the spiral blade 34 and the additional spiral blade 35 formed in the second portion 24B of the second stirring and conveying member 24. At this time, since a tunnel is formed in the high flow portion 26C by the roof portion 22B of the second channel 22, the developer that is temporarily accumulated in the high flow portion 26C is efficiently pushed into the narrowed portion 26B.

[0027] The developer which is fed into the narrowed portion 26B is sufficiently stirred and mixed so as to be triboelectrically charged between the protrusion portion 30 of the second channel 22 and the protrusion portion 36 of the second stirring and conveying member 24, and is subsequently discharged from the narrowed portion 26B. Additionally, the developer which is fed into the narrowed portion 26B may enter the spiral groove 37 formed in the protrusion portion 36 of the second stirring and conveying member 24, so as to increase friction charge due to the increased contact area with the second stirring and conveying member 24, and so as to further promote the conveying in the conveying direction D2. The developer discharged from the narrowed portion 26B is supplied from the second conveying path 26 to the first conveying path 25 through the first through-hole 27 while being sufficiently

stirred and mixed and triboelectrically charged. Accordingly, the developer circulates through the first conveying path 25 and the second conveying path 26 in the developer conveying device 5.

[0028] Here, the charge distribution amount of the developer was measured by using the developing devices of Example 1 and Comparative Example 1. The Example 1 corresponds to the developing device 1 including the developer conveying device 5 illustrated in FIG. 2. Comparative Example 1 corresponds to a developing device including a developer conveying device 100 illustrated in FIG. 6. The developer conveying device 100 illustrated in FIG. 6 is different from the developer conveying device 5 illustrated in FIG. 2 in that developer conveying device 100 does not include the narrowed portion 26B in the second conveying path 26, nor the protrusion portion 30 in the second channel 22, nor the additional spiral blade 35 and the protrusion portion 36 in the second stirring and conveying member 24. In the measurement of the charge distribution amount of the developer over time, a relatively small amount of an additional toner was replenished to the developing device, the developing device was stopped after being driven for a predetermined time, the developer on the developing roller was sampled, and the charge distribution amount of the sampled developer was measured. The drive time of the developing device was set to 10 seconds, 15 seconds, 20 seconds, and 30 seconds, for respective tests. An E-SPART analyzer manufactured by HOSOKAWA MICRON CORPORATION was used to measure the charge distribution amount.

[0029] FIGS. 7, 8, 9 and 10 illustrate respective graphs showing a charge distribution amount using the developing device according to Example 1 for drive times of 10 seconds, 15 seconds, 20 seconds and 30 seconds, respectively. FIG. 11, 12, 13 and 14 illustrate respective graphs showing a

charge distribution amount using the developing device according to Comparative Example 1 for drive times of 10 seconds, 15 seconds, 20 seconds and 30 seconds, respectively. In FIGS. 7 to 14, a horizontal axis indicates a charge amount distribution (q/d) and a vertical axis indicates the number of the developers of the sample.

[0030] With reference to FIGS. 11 to 14, in Comparative Example 1, when 15 seconds elapsed after the additional toner was replenished (cf. FIG. 12), the charge amount distribution spread widely and the charge amount distribution returned to an original state over time. It is considered that this is because the charge amount distribution spreads widely since the additional toner is not sufficiently stirred and mixed and triboelectrically charged for a while after the replenished additional toner is supplied to the developing roller (cf. FIG. 12) although the charge amount distribution is stable until the replenished additional toner is supplied to the developing roller (cf. FIG. 11). Accordingly, it is considered that the charge amount distribution is stabilized since the additional toner is sufficiently stirred and mixed and triboelectrically charged with the developer over time (cf. FIGS. 13 and 14).

[0031] In contrast, as shown in FIGS. 7 to 10, in Example 1, the charge amount distribution was stabilized regardless of whether the time elapsed after the additional toner was replenished. It is considered that this is because the spread of the charge amount distribution as in Comparative Example 1 was suppressed since the replenished additional toner was immediately stirred and mixed and triboelectrically charged.

[0032] As described above, in the developer conveying device 5, the developer is stirred and conveyed along the second conveying path 26. However, the developer is temporarily accumulated in the high flow portion 26C adjacent to the upstream side of the narrowed portion 26B and is pushed or

squeezed into the narrowed portion 26B, which promotes the stirring and mixing and triboelectrically charging of the developer in the narrowed portion 26B. Consequently, it is possible to suppress or inhibit an increase in image defects and toner scattering even when the amount of the developer that is stirred and mixed with the replenishing toner is relatively low due to a reduced size of the developing device 1 or due to a reduced amount of the developer. Namely, the developer is sufficiently triboelectrically charged, so as to suppress or inhibit occurrences, such as an image defect (stain) caused by soft blocking toner contained in the replenishing toner supplied onto the developing roller without collapsing, an image defect (fog) caused by the replenishing toner supplied onto the developing roller without being sufficiently triboelectrically charged with the developer, and/or toner scattering caused by weak electrostatic adhesion between the carrier and the toner, for example.

[0033] Although various examples have been described and shown herein, it should be understood that other examples can be modified in their arrangement and details. [0034] For example, with reference to an example illustrated in FIG. 15, the second stirring and conveying member 24 may include a plurality of additional spiral blades 35A in the high flow portion 26C of the second conveying path 26 (in the first portion 24A of the second stirring and conveying member 24), so as to further promote the stirring and mixing and triboelectrically charging of the developer. In this case, in order to further promote the stirring and mixing and triboelectrically charging of the developer, the blade thickness of the additional spiral blade 35A may be thinner than the blade thickness of the spiral blade 34.

[0035] Additionally, with reference to an example illustrated in FIG. 16, when the portion of the spiral blade 34 in the high flow portion 26C of the second conveying path 26 is formed as the high flow spiral blade 34A, the spiral blade

34 may be formed so that the pitch of the high flow spiral blade 34A is lower (e.g., narrower pitch) than the pitch of the spiral blade 34 in a portion other than the high flow spiral blade 34A, so as to further promote the stirring and mixing and triboelectrically charging of the developer. In this case, in order to increase the conveying capacity of the developer, the blade thickness of the high flow spiral blade 34A may be thinner than the blade thickness of the spiral blade 34 in the portion other than the high flow spiral blade 34A. Additionally, the additional spiral blade 35 may or may not be provided depending on examples.

[0036] Additionally, a textured protrusion 30a may be formed on the surface of the protrusion portion 30 in some examples, as illustrated in FIG. 17. In other examples, a groove 30b which is orthogonal to the conveying direction D2 may be formed on the surface of the protrusion portion 30 as illustrated in FIG. 18. In yet other examples, a groove 30c which is parallel to the conveying direction D2 may be formed on the surface of the protrusion portion 30 as illustrated in FIG. 19. Accordingly, it is possible to increase the frictional force between the developer and the protrusion portion 30 of the second channel 22 in the narrowed portion 26B.

[0037] Additionally, with reference to an example illustrated in FIG. 20, unevenness 36a may be formed on the protrusion portion 36 of the second stirring and conveying member 24, so as to increase the frictional force between the developer and the protrusion portion 36 of the second stirring and conveying member 24 in the narrowed portion 26B. The size, number, orientation, and the like of the unevenness 36a can be appropriately set.

[0038] Additionally, with reference to an example illustrated in FIG. 21, when the first cross-sectional area of the second conveying path 26 in the narrowed portion 26B is less (e.g., a smaller area) than the second cross-sectional area

of the second conveying path 26 in the main portion 26A, the second stirring and conveying member 24 may not include the protrusion portion 36. Additionally, with reference to an example illustrated in FIG. 22, the second channel 22 may not include the protrusion portion 36. Additionally, in the case illustrated in FIG. 21, in order to further increase the conveying performance, the stirring and mixing performance, and the triboelectrical charging performance of the developer in the narrowed portion 26B, the protrusion amount of the protrusion portion 30 toward the second stirring and conveying member 24 may be increased and the first cross-sectional area of the second conveying path 26 in the narrowed portion 26B may be decreased. Similarly, in the case illustrated in FIG. 22, in order to further increase the conveying performance, the stirring and mixing performance, and the triboelectrical charging performance of the developer in the narrowed portion 26B, the protrusion amount of the protrusion portion 36 toward the second channel 22 may be increased and the first cross-sectional area of the second conveying path 26 in the narrowed portion 26B may be decreased.

[0039] Additionally, with reference to an example illustrated in FIG. 23, the protrusion portion 36 of the second stirring and conveying member 24 may not be provided with the spiral groove 37, according to some examples.

[0040] Additionally, in the above-described example, a case has been described in which two conveying paths of the first conveying path 25 and the second conveying path 26 are provided as the conveying path of the developer, but a single conveying path or three or more conveying paths may be provided as the conveying path of the developer, depending on examples. When a plurality of conveying paths are provided as the conveying path of the developer, any suitable conveying path may provide the narrowed portion so that the first cross-sectional area of the conveying path in the narrowed portion

is smaller than the second cross-sectional area of the conveying path in the main portion or a plurality among the conveying paths may provide respective narrowed portions in which the first cross-sectional area of the conveying path in each narrowed portion is smaller than the second cross-sectional area of the conveying path in the main portion.

[0041] It is to be understood that not all aspects, advantages and features described herein may necessarily be achieved by, or included in, any one particular example. Indeed, having described and illustrated various examples herein, it should be apparent that other examples may be modified in arrangement and detail is omitted.

CLAIMS

1. A developer conveying device comprising:
 - a housing forming a channel that extends inside the housing in a longitudinal direction; and
 - a stirring and conveying member extending within the channel to convey a developer through a conveyance path formed between a wall of the channel and the stirring and conveying member,wherein the conveyance path includes a main portion extending in the longitudinal direction along a substantial portion of the conveyance path, and a narrowed portion located outside the main portion, and
 - wherein a first cross-sectional area of the conveyance path taken in the narrowed portion is less than a second cross-sectional area of the conveyance path taken in the main portion.
2. The developer conveying device according to claim 1,
 - wherein the channel includes a protrusion portion protruding toward the stirring and conveying member to form the narrowed portion.
3. The developer conveying device according to claim 1,
 - wherein the stirring and conveying member includes a protrusion portion protruding toward the channel to form the narrowed portion.
4. The developer conveying device according to claim 1,
 - wherein the stirring and conveying member includes a rotation shaft extending along a rotation axis and a spiral blade protruding from the rotation shaft in a radial direction to convey the developer in a conveying direction,

wherein a first portion of the stirring and conveying member located on an upstream side of the narrowed portion of the conveyance path in the conveying direction of the developer, includes the spiral blade, and

wherein a second portion of the stirring and conveying member located in the narrowed portion of the conveyance path includes a spiral groove, without being provided with the spiral blade.

5. The developer conveying device according to claim 1,

wherein the stirring and conveying member includes a rotation shaft extending along the rotation axis and a spiral blade protruding from the rotation shaft in a radial direction to convey the developer in a conveying direction, and

wherein the conveyance path includes a high flow portion adjacent the narrowed portion of the conveyance path, on an upstream side of the narrowed portion in a conveying direction of the developer.

6. The developer conveying device according to claim 5,

wherein the stirring and conveying member includes one or more additional spiral blades formed around the rotation shaft in the high flow portion of the conveyance path.

7. The developer conveying device according to claim 5,

wherein the spiral blade has a variable pitch so that a first pitch of the spiral blade taken at the high flow portion of the conveyance path is lower than a second pitch of the spiral blade taken outside the high flow portion of the conveyance path.

8. The developer conveying device according to claim 5,

wherein the stirring and conveying member does not include the spiral blade in the narrowed portion of the conveyance path.

9. The developer conveying device according to claim 5,
wherein the rotation shaft of the stirring and conveying member includes a spiral groove in the narrowed portion.

10. The developer conveying device according to claim 9,
wherein the rotation shaft of the stirring and conveying member includes a protrusion portion forming the narrowed portion, and
wherein the protrusion portion includes the spiral groove.

11. The developer conveying device according to claim 5,
wherein a blade thickness of the spiral blade is formed so that the high flow portion of the conveyance path is thinner than the main portion of the conveyance path.

12. The developer conveying device according to claim 5,
wherein the channel includes a gutter-shaped wall opening upward,
and
wherein the channel includes a roof portion extending to the high flow portion of the conveyance path and forming a tunnel in the high flow portion.

13. The developer conveying device according to claim 1,
wherein the first cross-sectional area and the second cross-sectional area are taken along a plane that is orthogonal to a conveying direction of the developer.

14. The developer conveying device according to claim 1,
wherein the first cross-sectional area of the conveyance path is 80% or less of the second cross-sectional area of the conveyance path.
15. An image forming device comprising:
a housing forming a channel that extends in a longitudinal direction inside the housing; and
a stirring and conveying member extending inside the channel to convey a developer through a conveyance path formed between a wall of the channel and the stirring and conveying member,
wherein a narrowed portion is formed along the conveyance path, and
wherein a first cross-sectional area of the conveyance path taken in the narrowed portion is less than a second cross-sectional area of the conveyance path taken on the downstream side of the narrowed portion, in a conveying direction of the developer.

Fig. 1

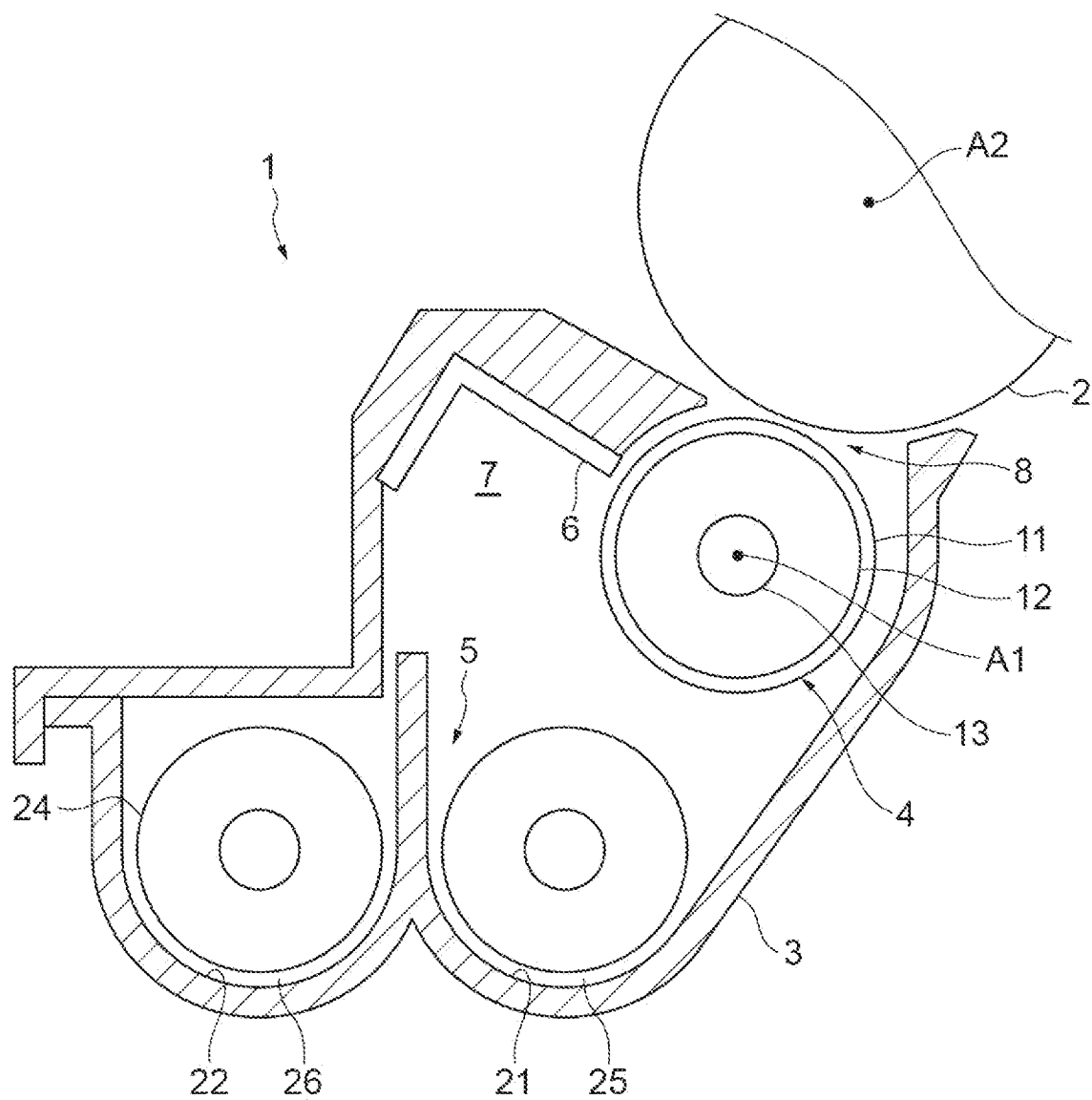


Fig.2

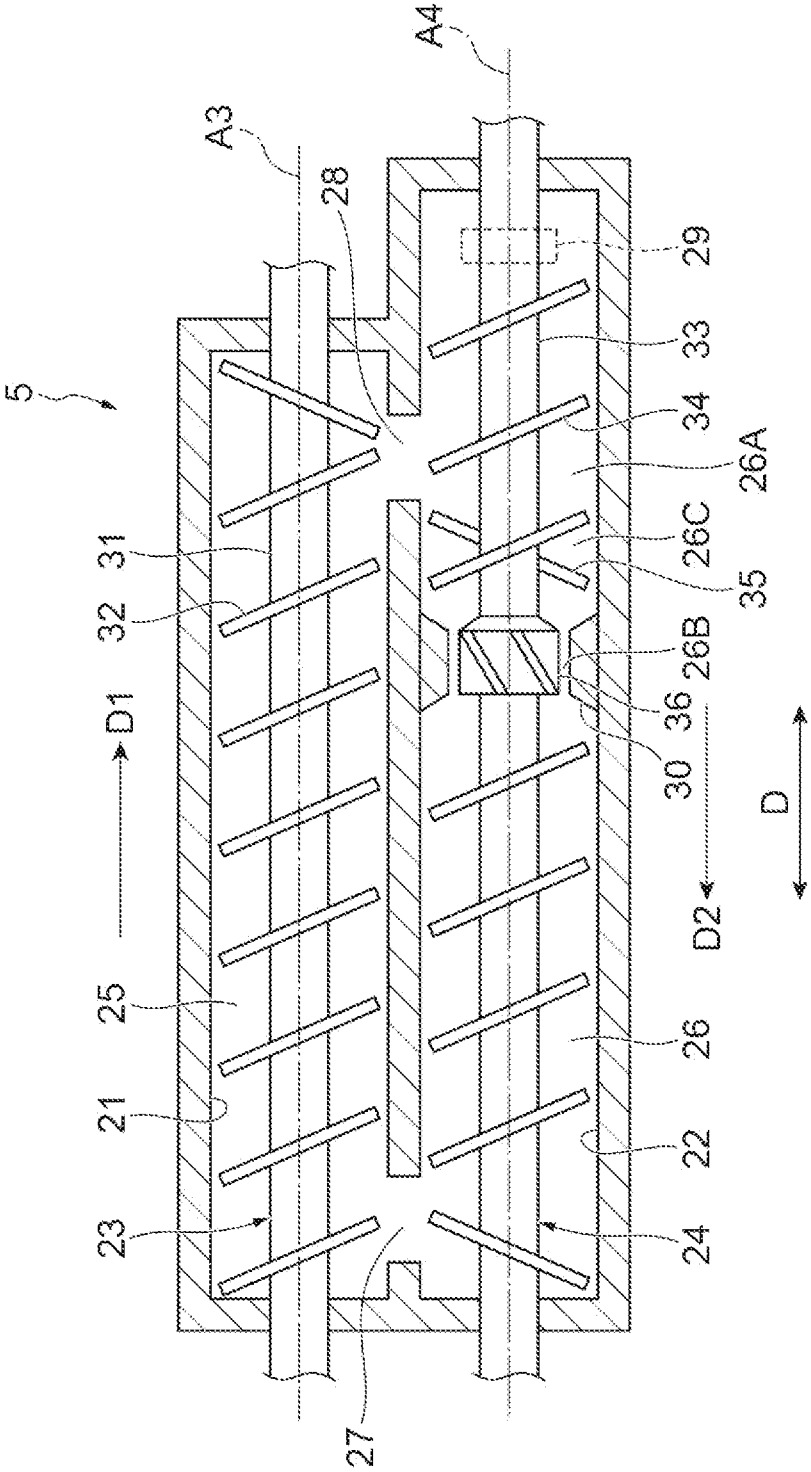


Fig. 3

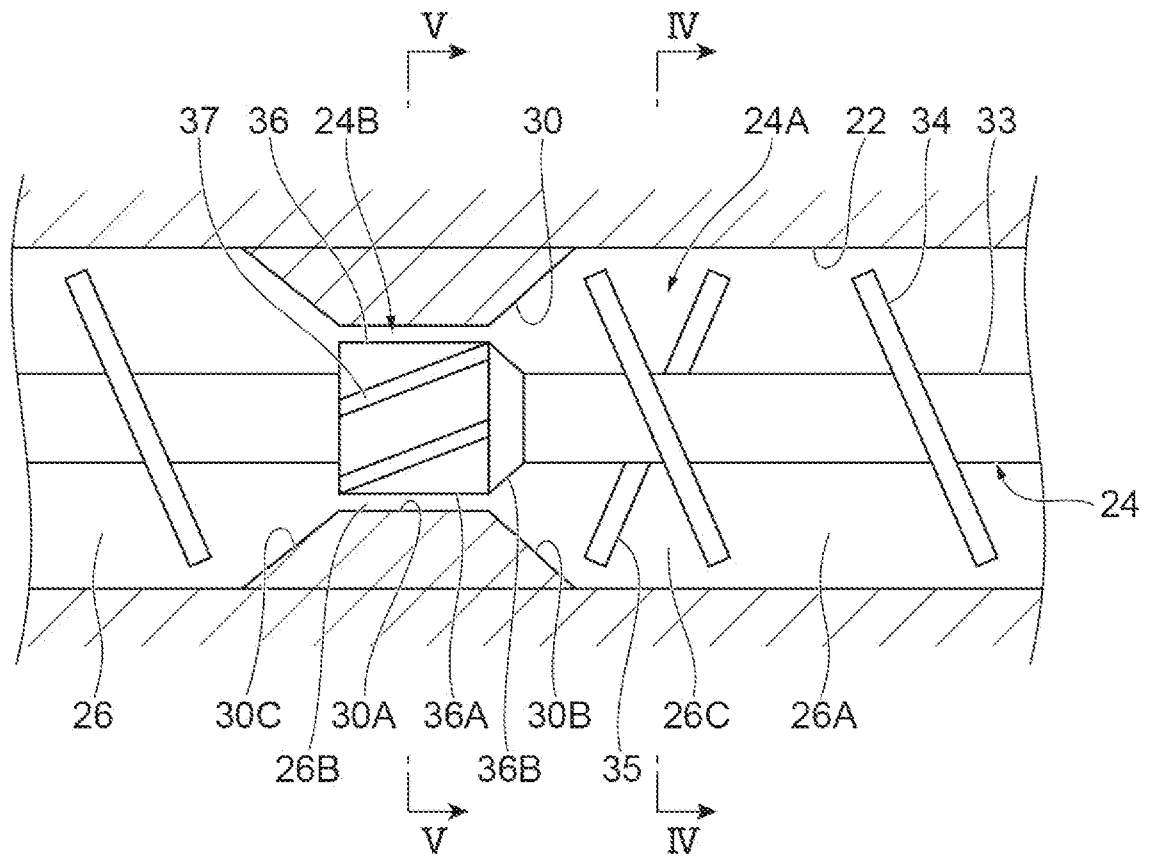


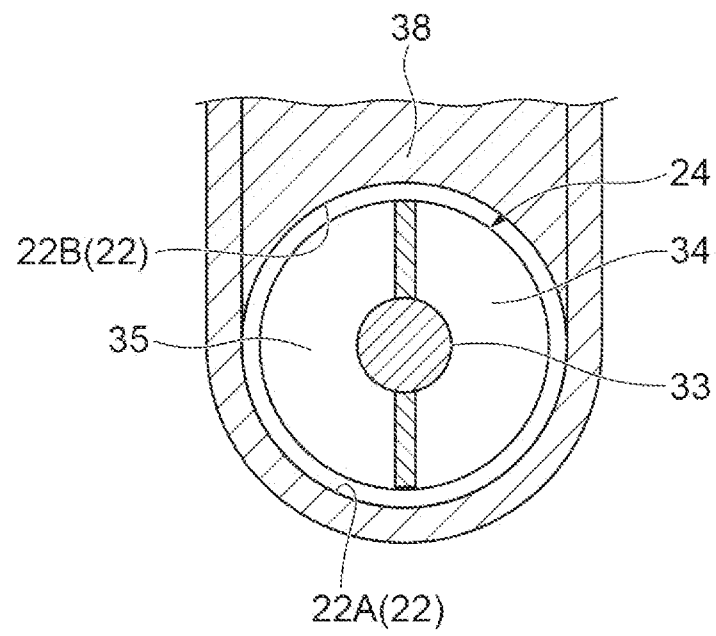
Fig.4

Fig.5

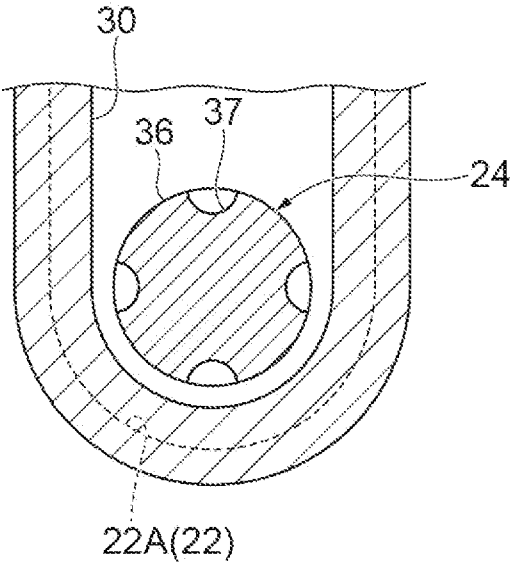
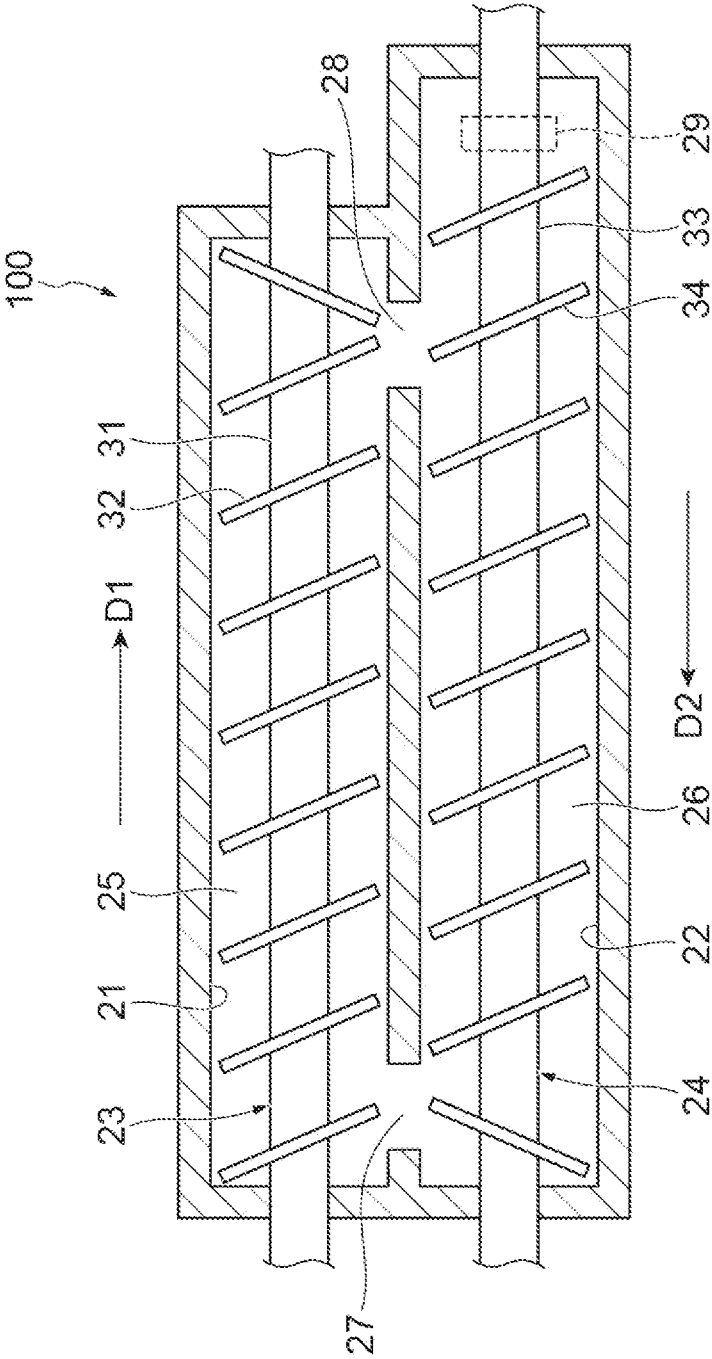
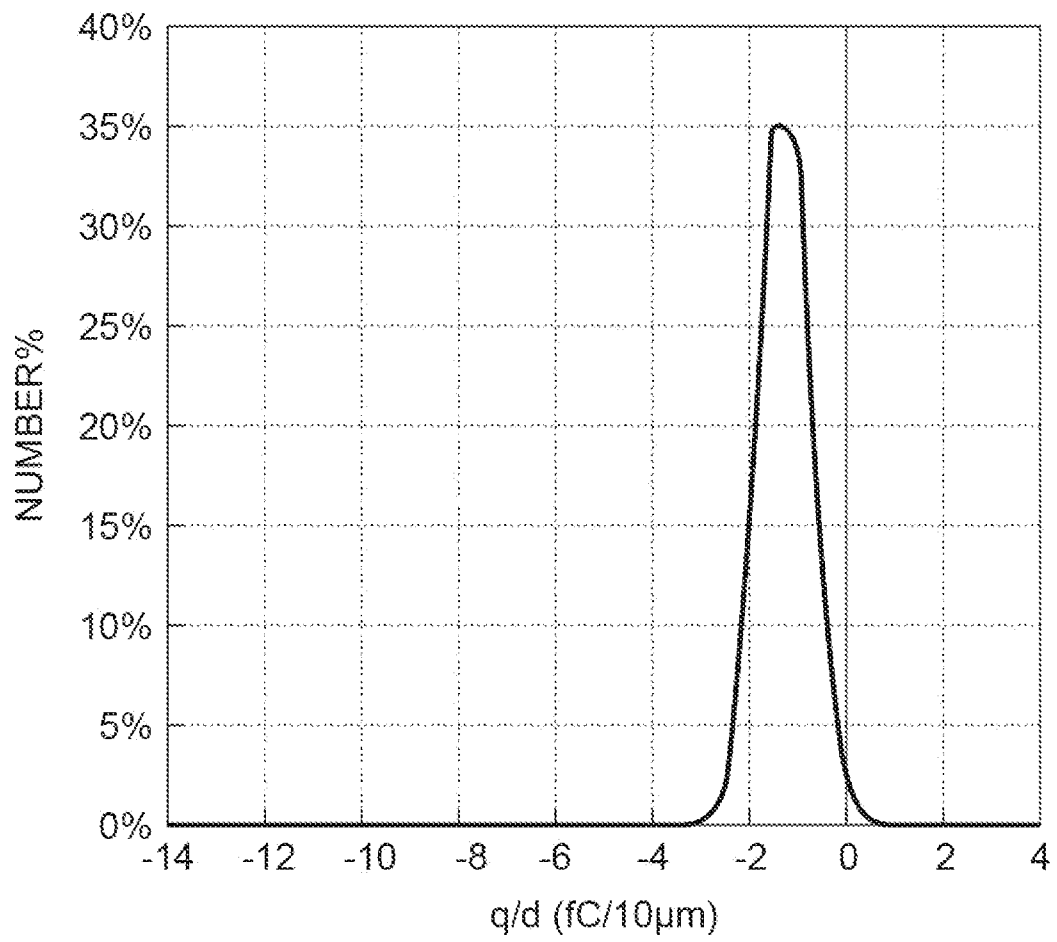


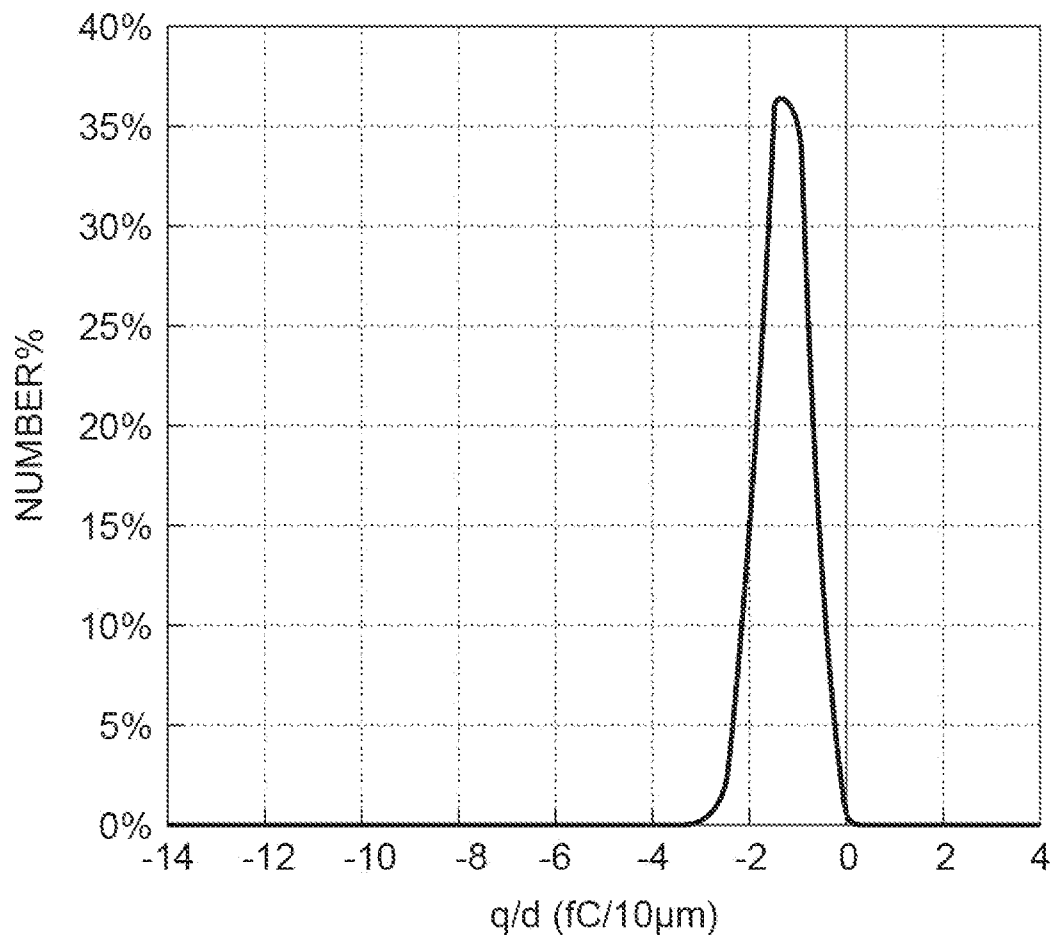
Fig.6



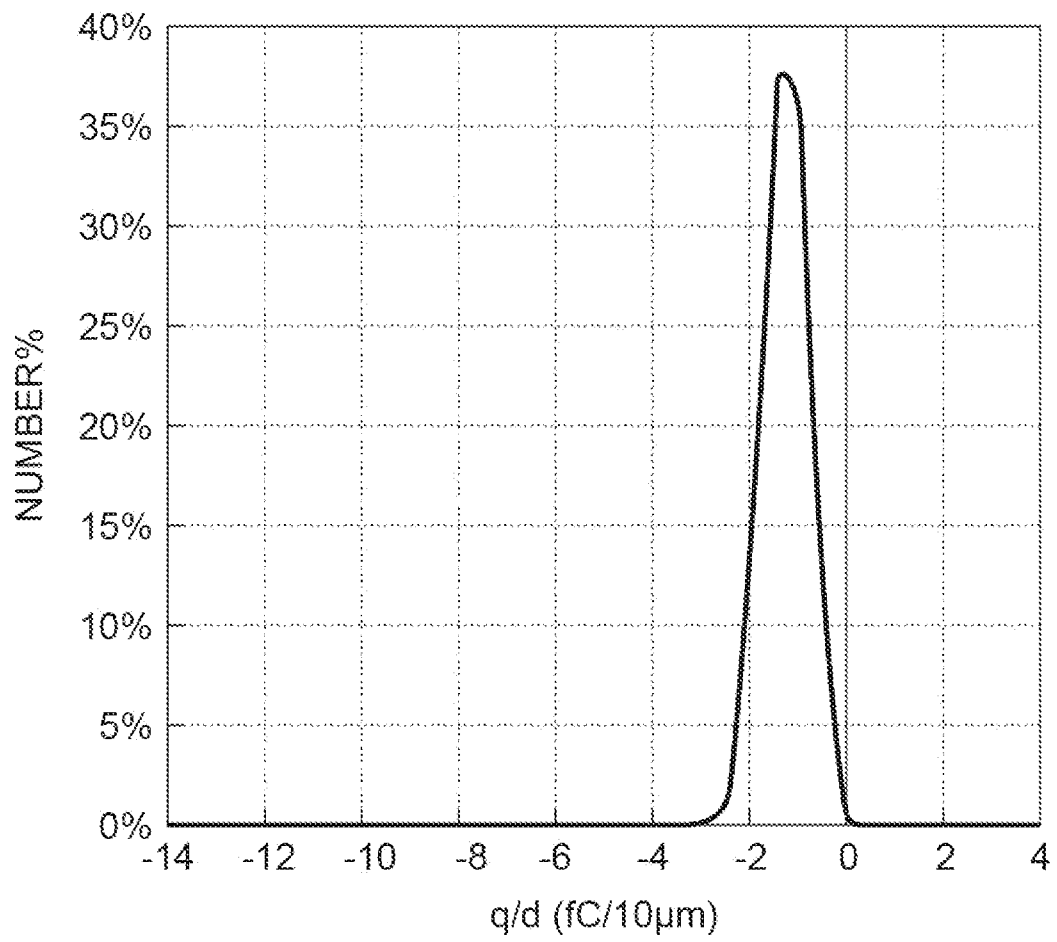
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Fig.7

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Fig. 8

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Fig.9

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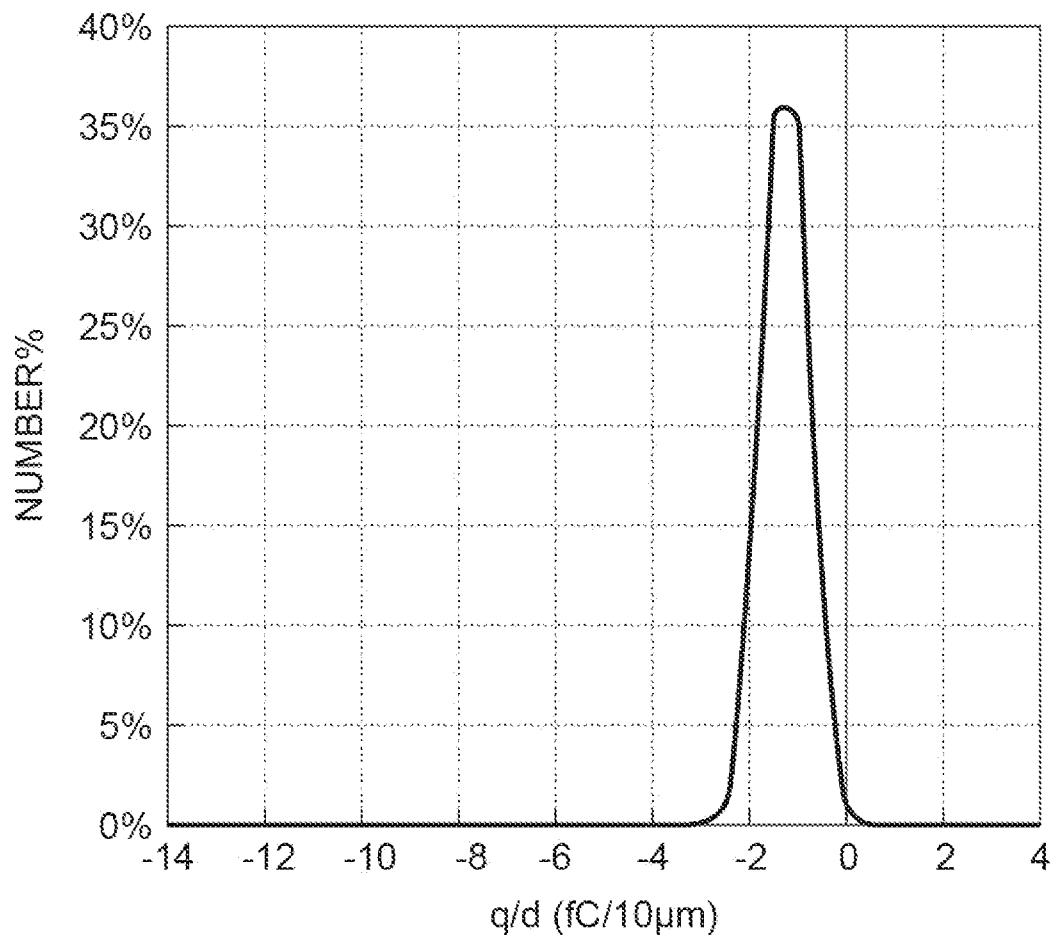
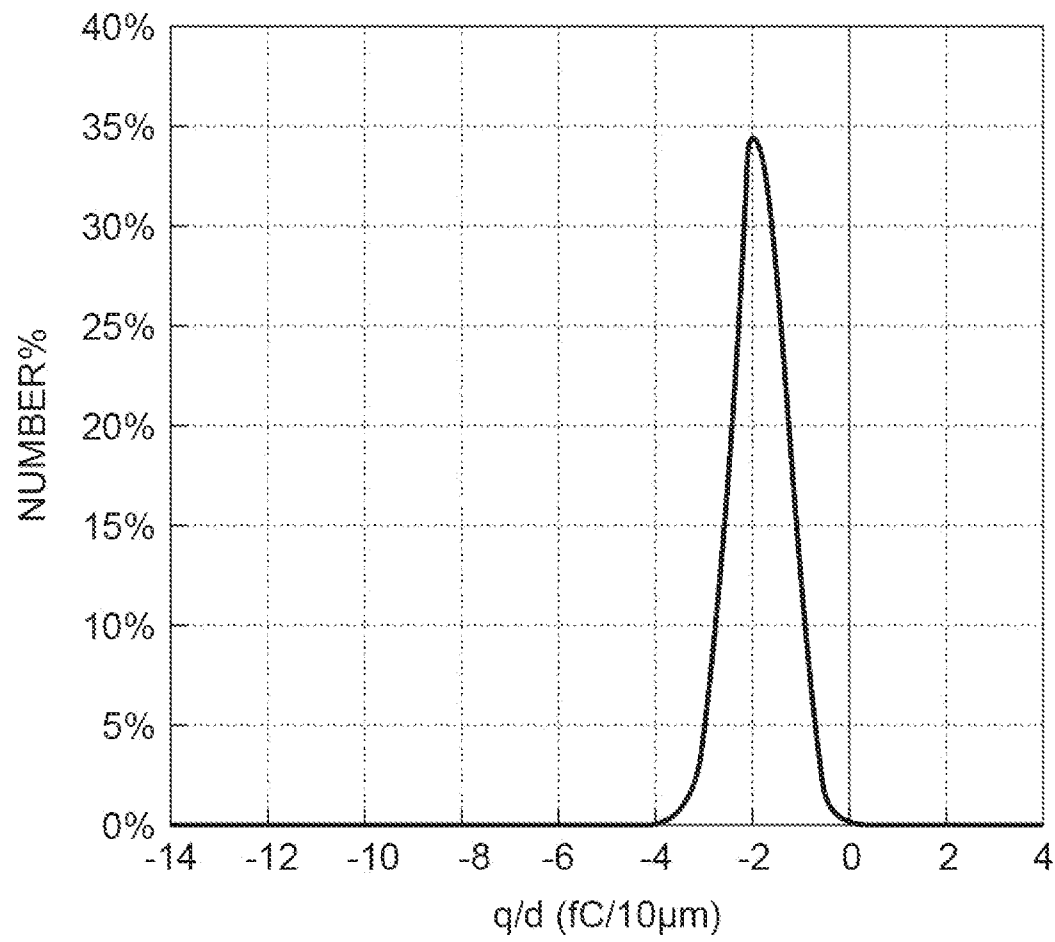
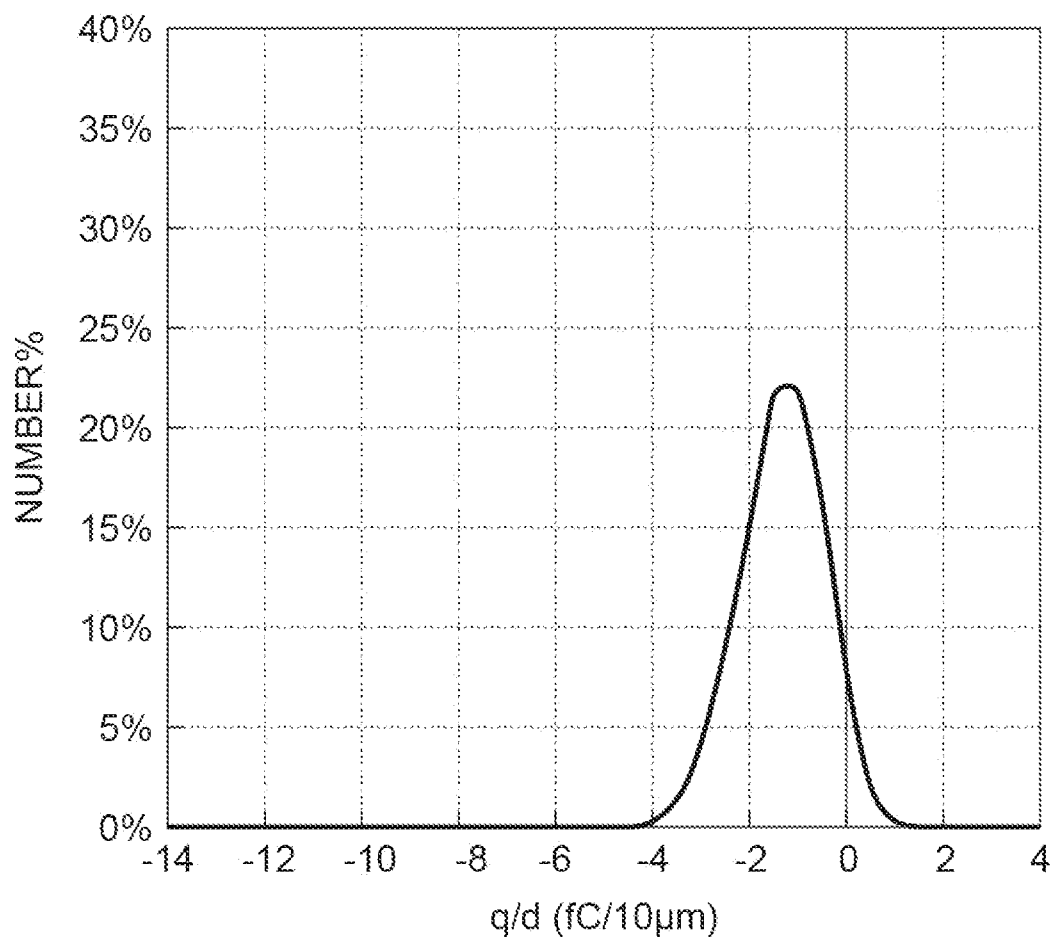
Fig. 10

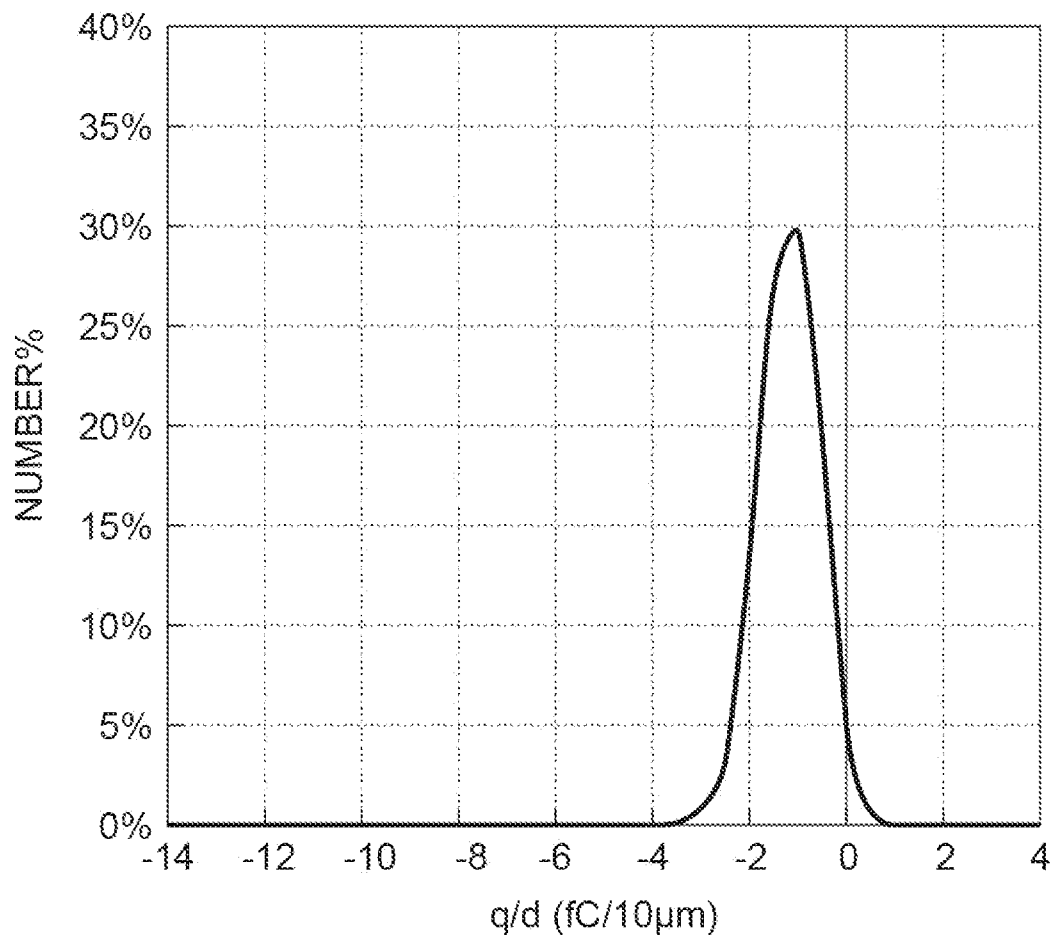
Fig.11



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Fig. 12

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Fig. 13

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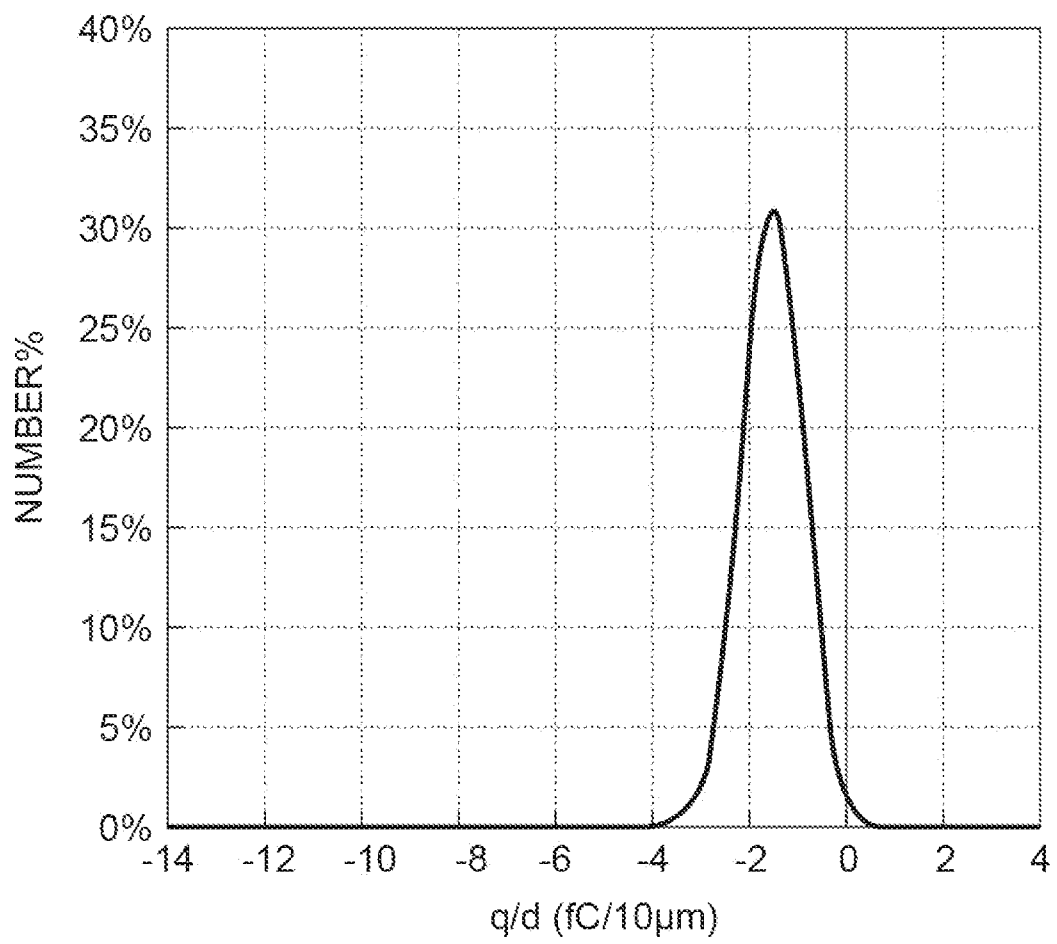
Fig. 14

Fig.15

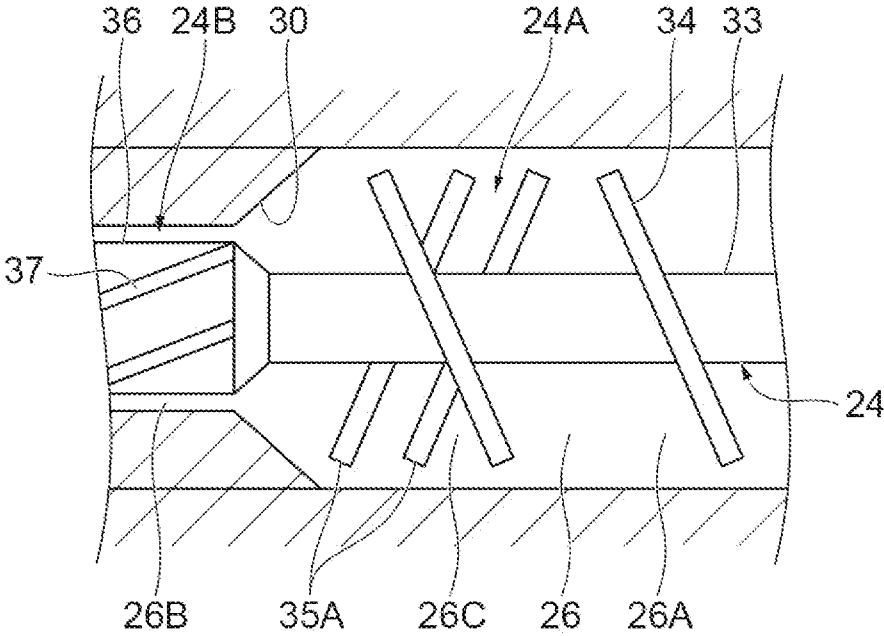
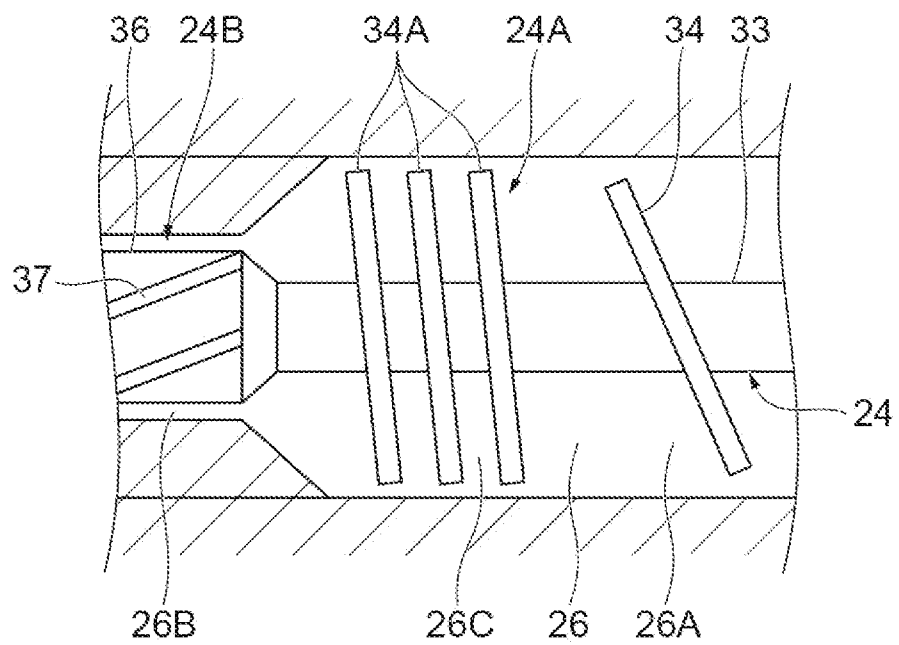


Fig.16



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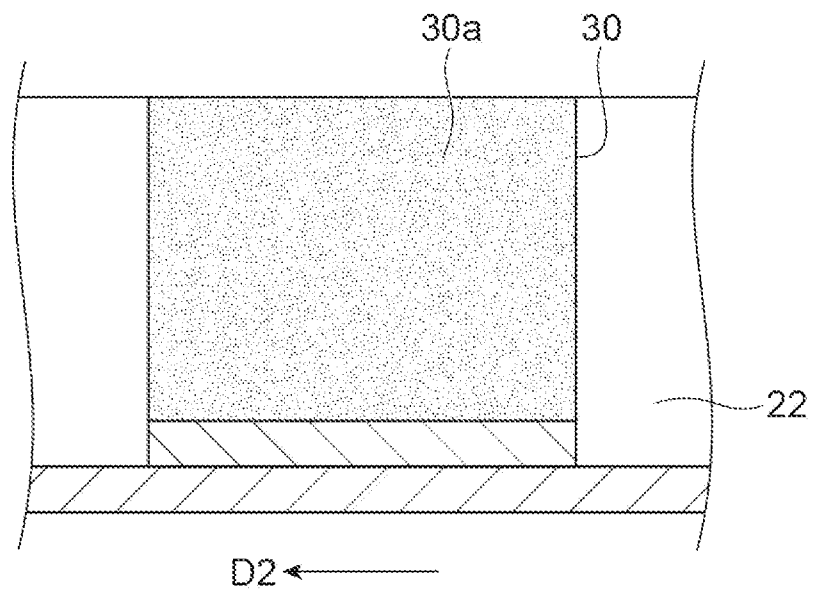
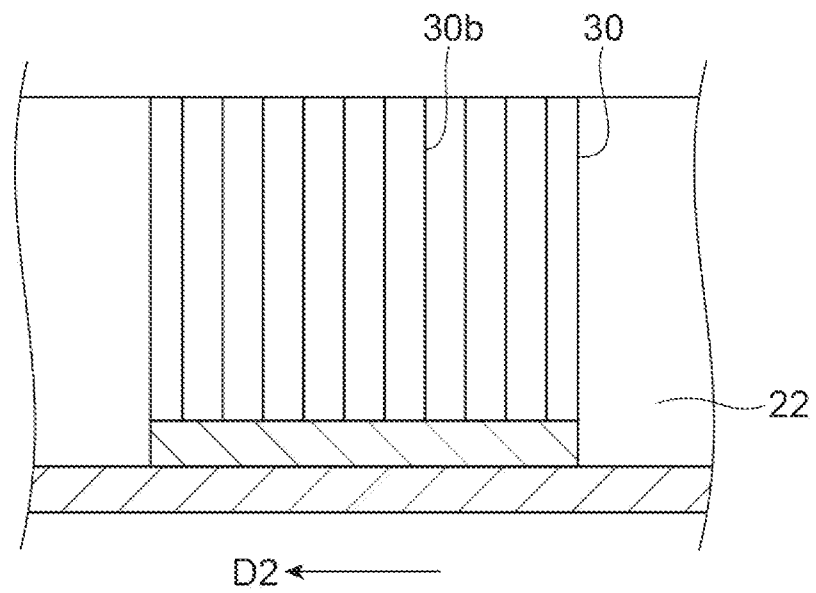
Fig.17

Fig.18

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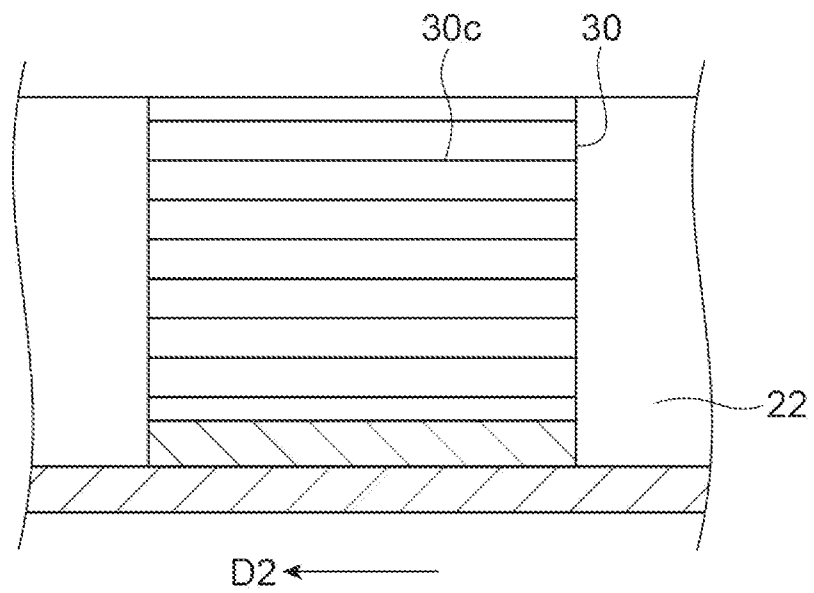
Fig.19

Fig.20

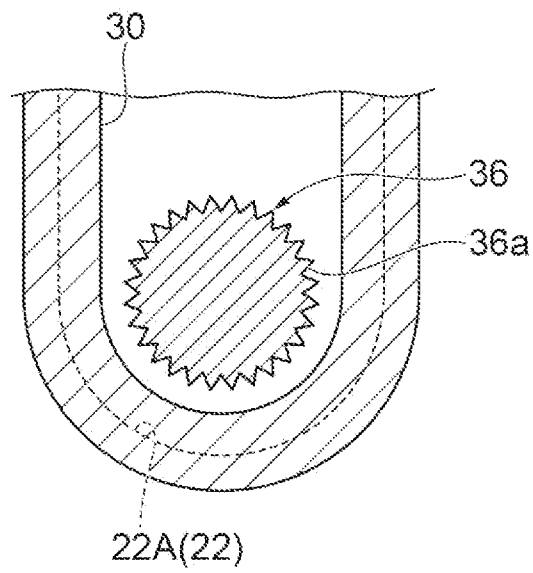


Fig.21

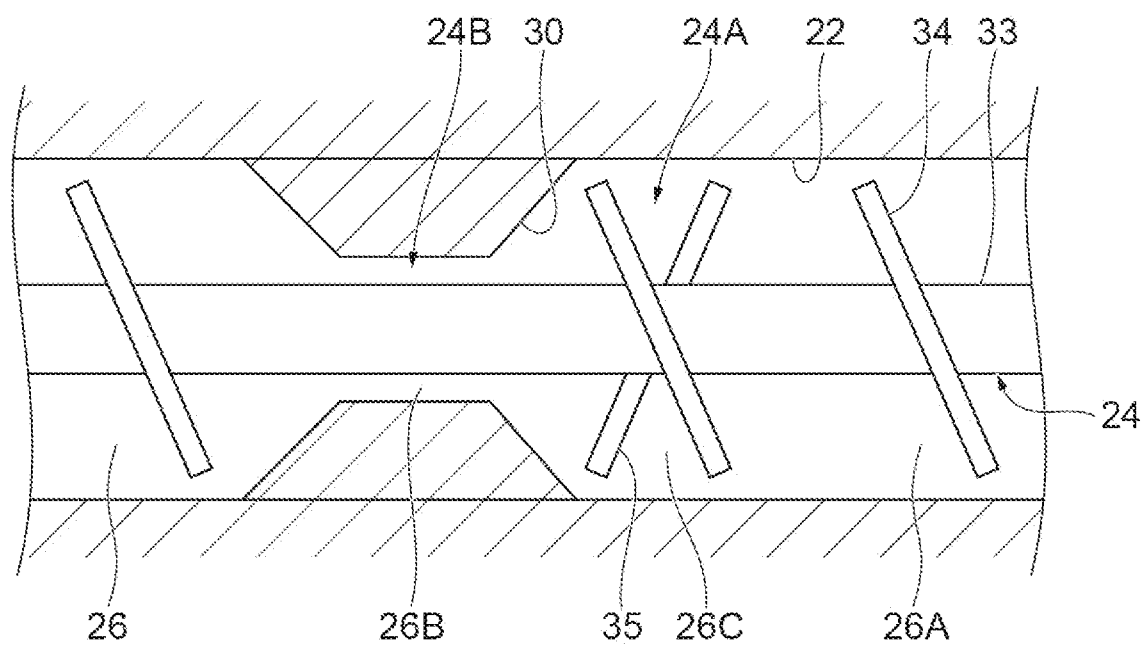


Fig.22

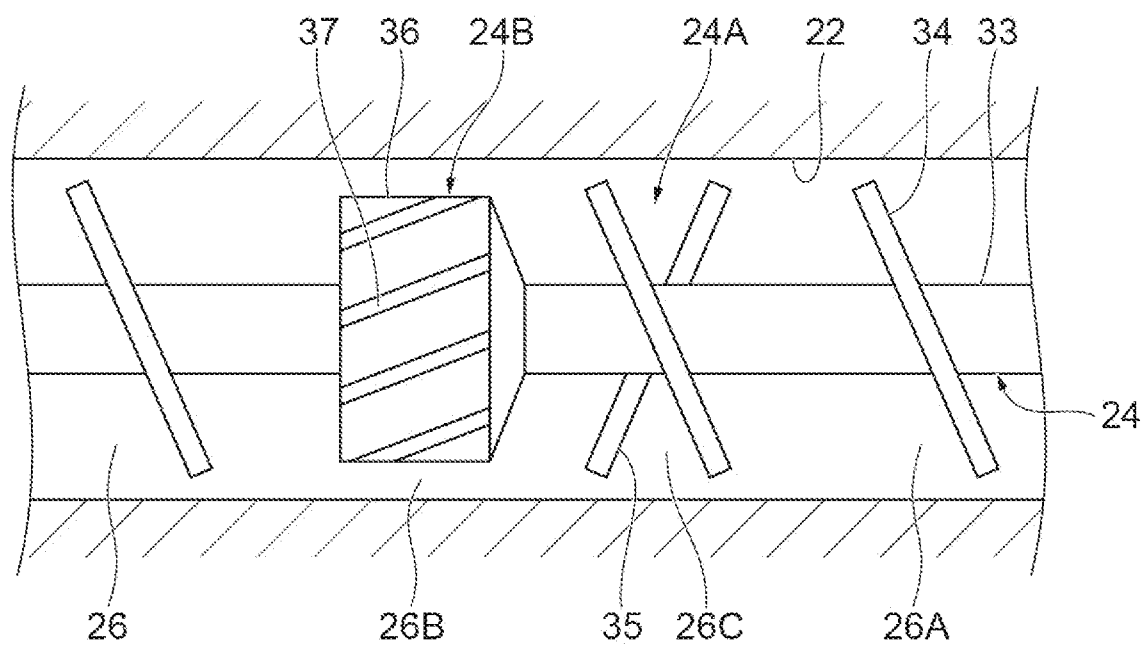
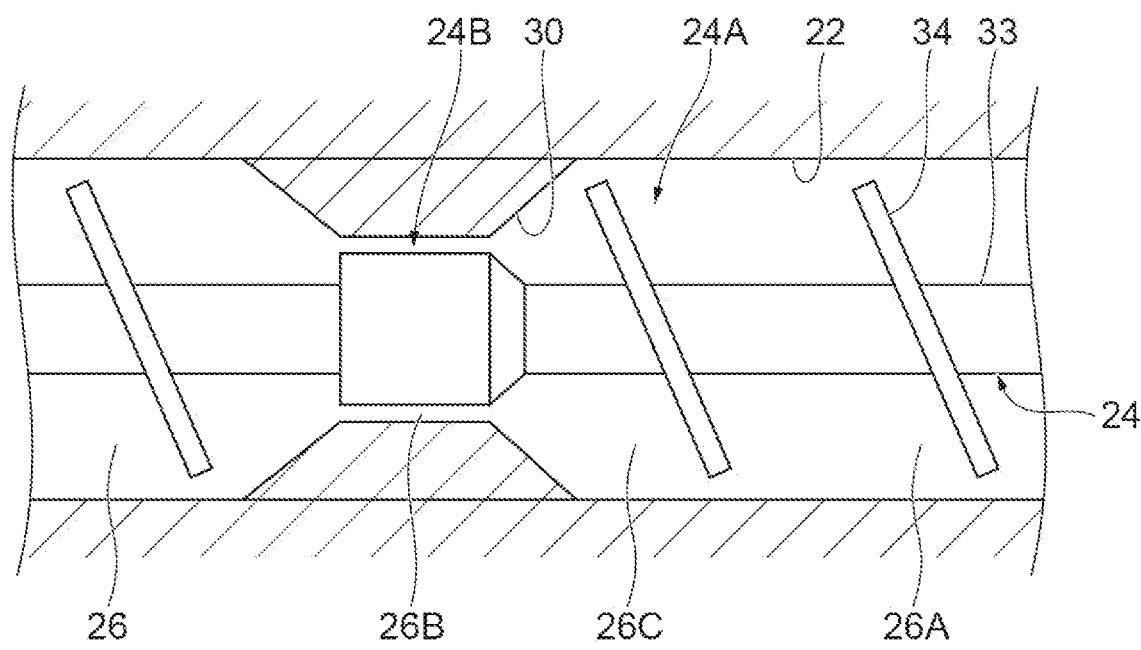


Fig.23



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2021/034860

A. CLASSIFICATION OF SUBJECT MATTER <i>B65G 53/08 (2006.01)</i> <i>G03G 15/08 (2006.01)</i> According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) G03G 15/00, 15/06, 15/08, 21/00, B65G 53/00, 53/08 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatSearch (RUPTO internal), USPTO, PAJ, K-PION, Esp@cenet, Information Retrieval System of FIPS		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/0248868 A1 (S-PRINTING SOLUTION CO LTD) 31.08.2017, abstract, [0005]-[0010], [0050]-[0055], [0085]-[0086], [0091]-[0097], [0100], [0104]-[0120], fig. 1-4, 8-9	1, 2, 4-8, 13-15
A		3, 9-12
A	US 2007/0183813 A1 (NAOYA IWATA et al.) 09.08.2007	1-15
A	US 2015/0331360 A1 (SHARP KABUSHIKI KAISHA) 19.11.2015	1-15
A	US 2017/0219958 A1 (KYOCERA DOCUMENT SOLUTIONS INC) 03.08.2017	1-15
A	US 2009/0214266 A1 (KONICA MINOLTA BUSINESS TECHNOLOGIES, INC.) 27.08.2009	1-15
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “D” document cited by the applicant in the international application “E” earlier document but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family	
Date of the actual completion of the international search 18 August 2021 (18.08.2021)	Date of mailing of the international search report 26 August 2021 (26.08.2021)	
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	Authorized officer A. Semenova Telephone No. 499-240-60-15	