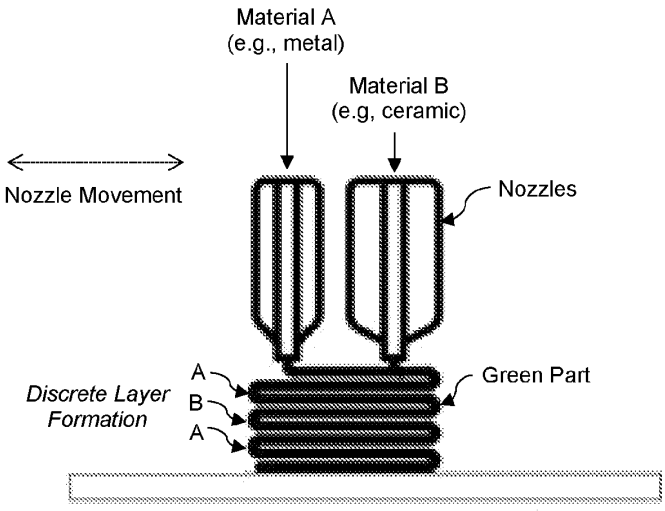


FIGURE 1

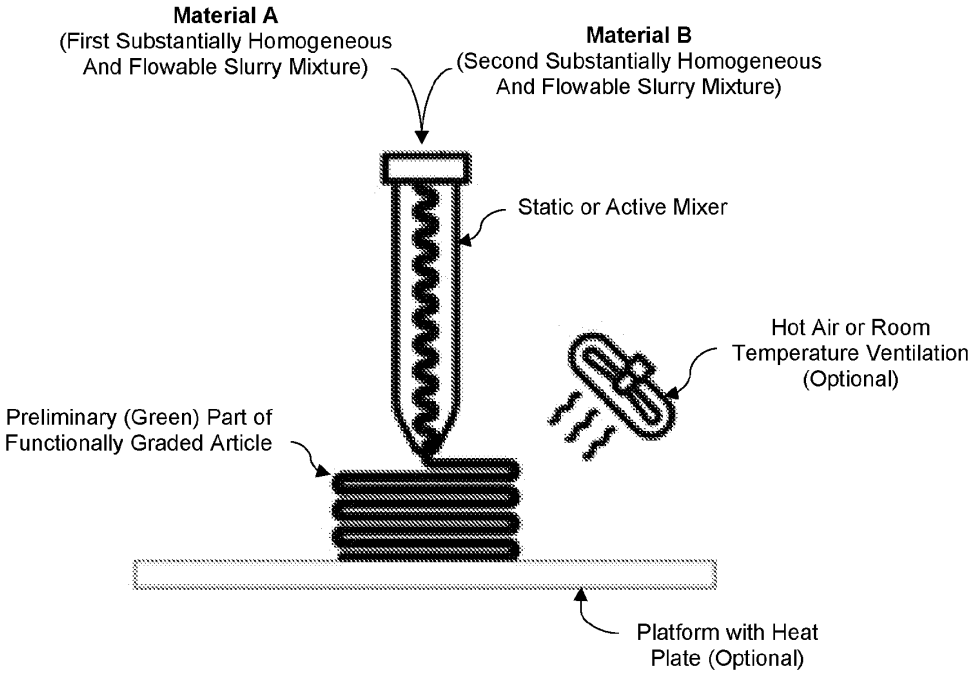


FIGURE 2

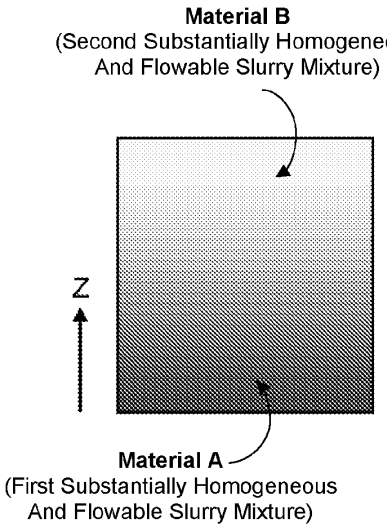


FIGURE 3a

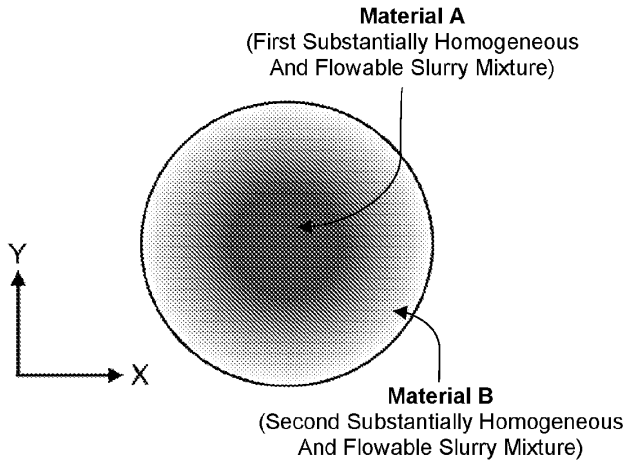


FIGURE 3b

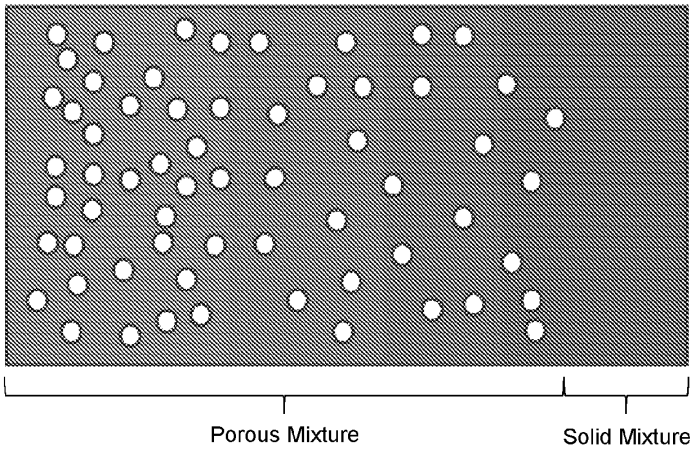


FIGURE 4

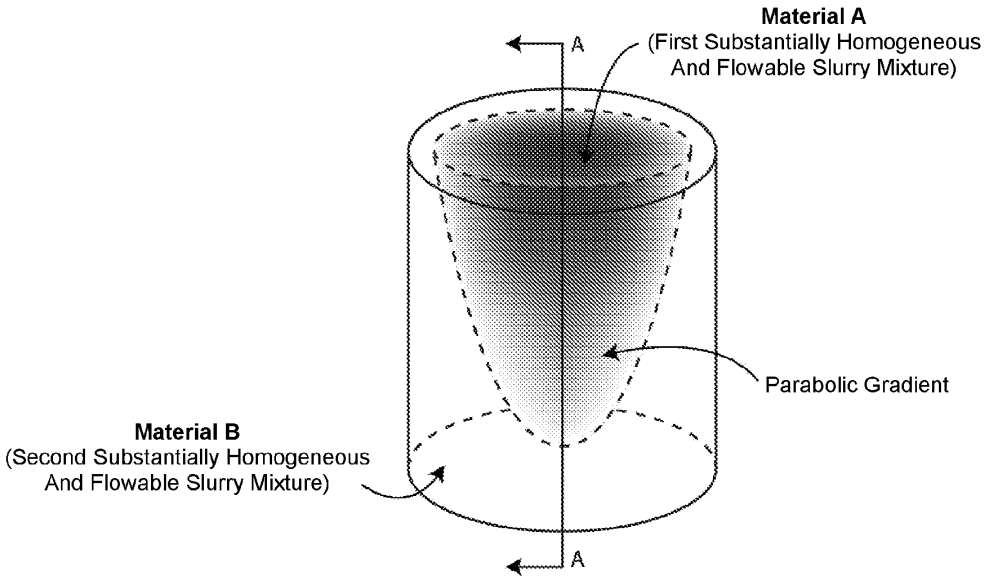


FIGURE 5a

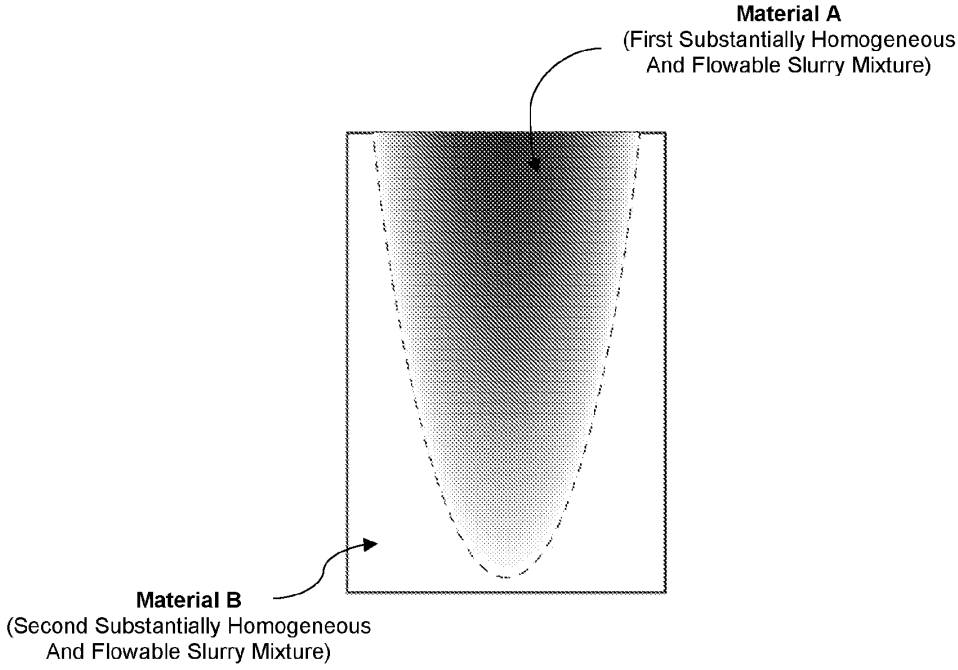


FIGURE 5b

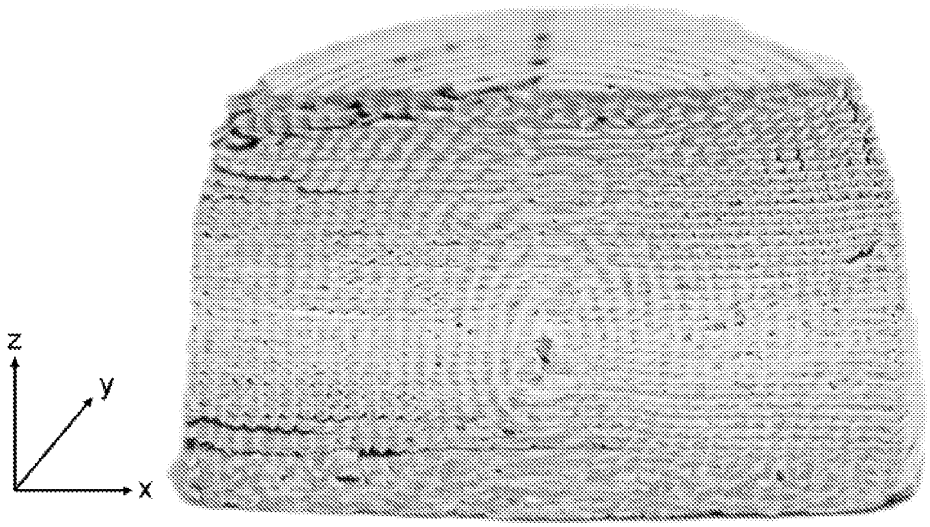


FIGURE 6a

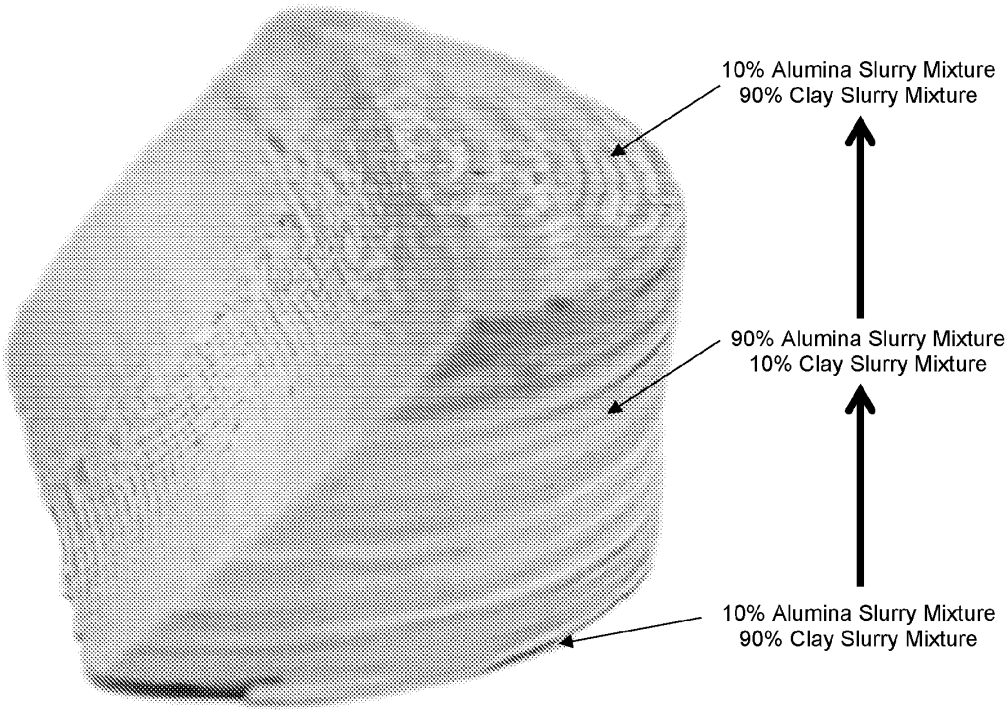


FIGURE 6b

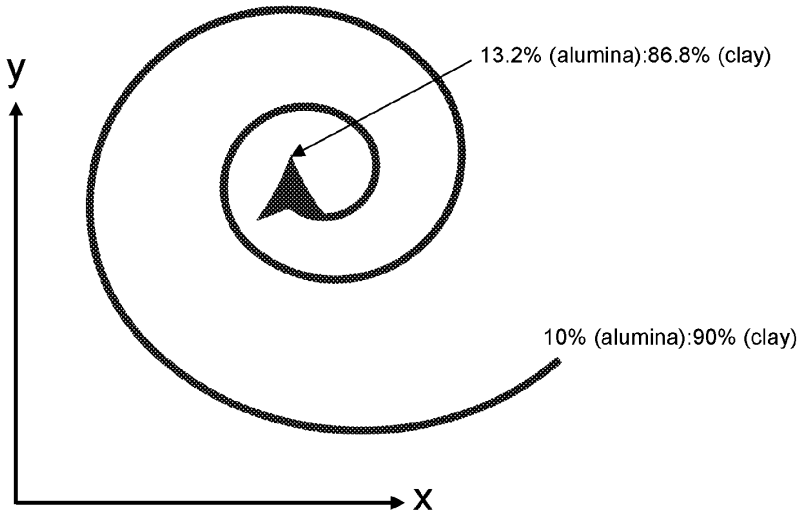


FIGURE 6c

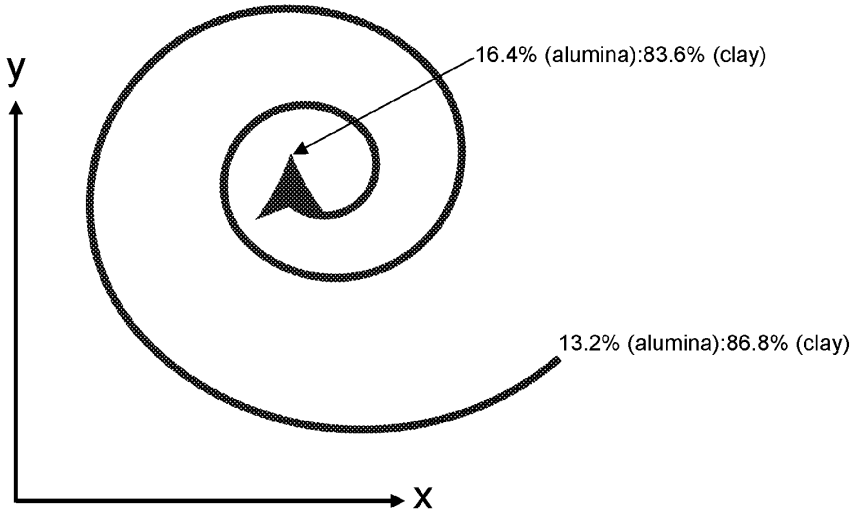


FIGURE 6d

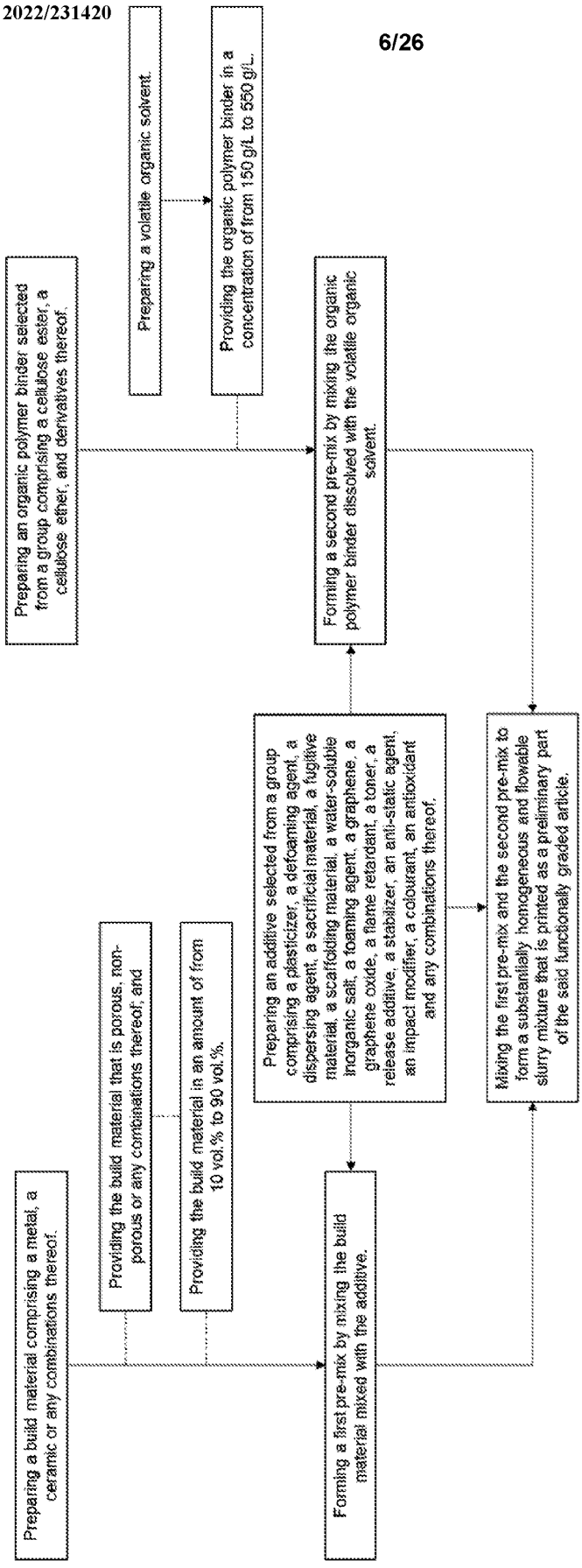

Preparing a build material comprising a metal, a ceramic or any combinations thereof.
Providing the build material that is porous, non-porous or any combinations thereof; and
Providing the build material in an amount of from 10 vol.% to 90 vol.%.
Forming a first pre-mix by mixing the build material mixed with the additive.
Preparing an additive selected from a group comprising a plasticizer, a defoaming agent, a dispersing agent, a sacrificial material, a fugitive material, a scaffolding material, a water-soluble inorganic salt, a foaming agent, a graphene, a graphene oxide, a flame retardant, a toner, a release additive, a stabilizer, an anti-static agent, an impact modifier, a colourant, an antioxidant and any combinations thereof.
Preparing an organic polymer binder selected from a group comprising a cellulose ester, a cellulose ether, and derivatives thereof.
Preparing a volatile organic solvent.
Providing the organic polymer binder in a concentration of from 150 g/L to 550 g/L.
Forming a second pre-mix by mixing the organic polymer binder dissolved with the volatile organic solvent.
Mixing the first pre-mix and the second pre-mix to form a substantially homogeneous and flowable slurry mixture that is printed as a preliminary part of the said functionally graded article.

FIGURE 7

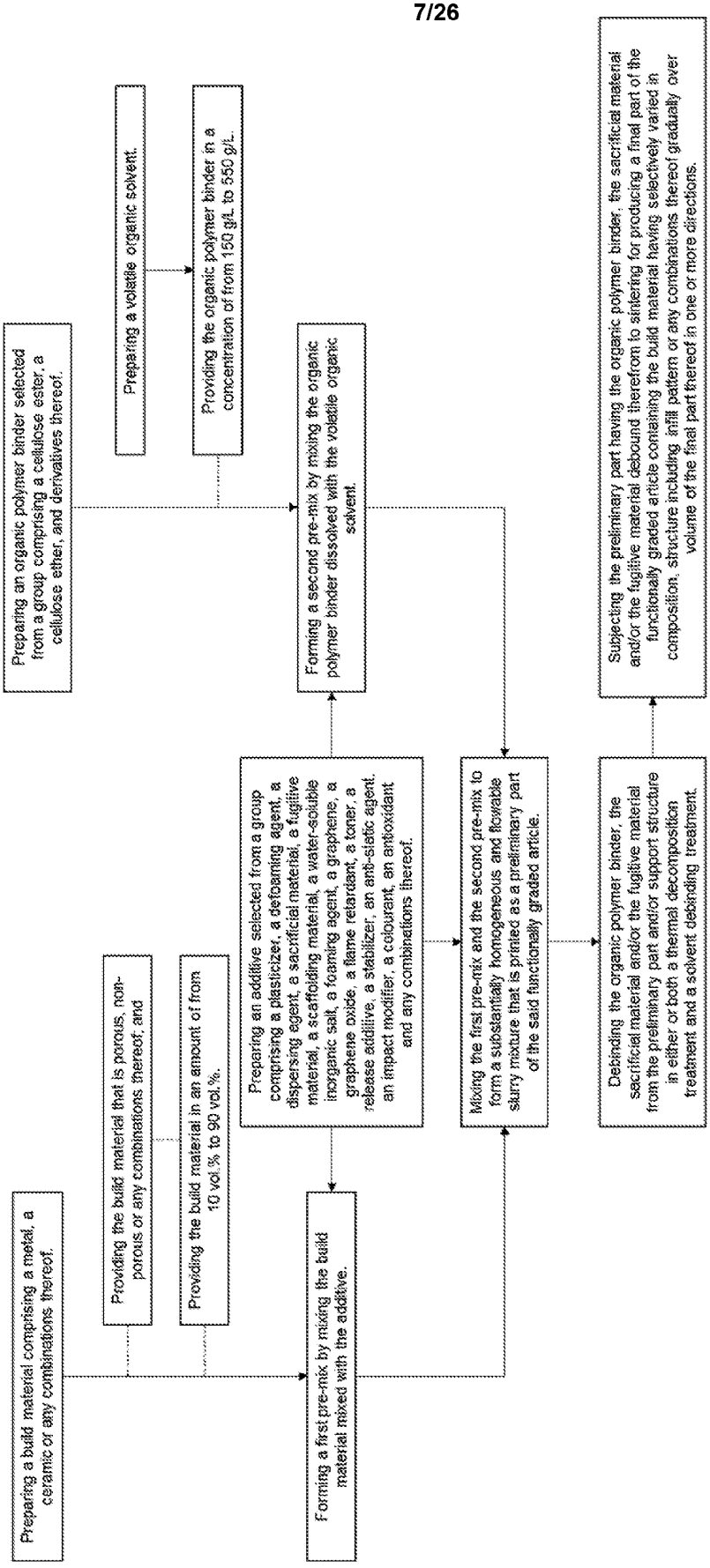

Preparing a build material comprising a metal, a ceramic or any combinations thereof.
Providing the build material that is porous, non-porous or any combinations thereof, and
Providing the build material in an amount of from 10 vol.% to 90 vol.%.
Forming a first pre-mix by mixing the build material mixed with the additive.
Preparing an organic polymer binder selected from a group comprising a cellulose ester, a cellulose ether, and derivatives thereof.
Preparing a volatile organic solvent.
Providing the organic polymer binder in a concentration of from 150 g/L to 550 g/L.
Forming a second pre-mix by mixing the organic polymer binder dissolved with the volatile organic solvent.
Preparing an additive selected from a group comprising a plasticizer, a defoaming agent, a dispersing agent, a sacrificial material, a fugitive material, a scaffolding material, a water-soluble inorganic salt, a foaming agent, a graphene, a graphene oxide, a flame retardant, a toner, a release additive, a stabilizer, an anti-static agent, an impact modifier, a colourant, an antioxidant and any combinations thereof.
Mixing the first pre-mix and the second pre-mix to form a substantially homogeneous and flowable slurry mixture that is printed as a preliminary part of the said functionally graded article.
Debinding the organic polymer binder, the sacrificial material and/or the fugitive material from the preliminary part and/or support structure in either or both a thermal decomposition treatment and a solvent debinding treatment.
Subjecting the preliminary part having the organic polymer binder, the sacrificial material and/or the fugitive material debound therefrom to sintering for producing a final part of the functionally graded article containing the build material having selectively varied in composition, structure including infill pattern or any combinations thereof gradually over volume of the final part thereof in one or more directions.

FIGURE 8

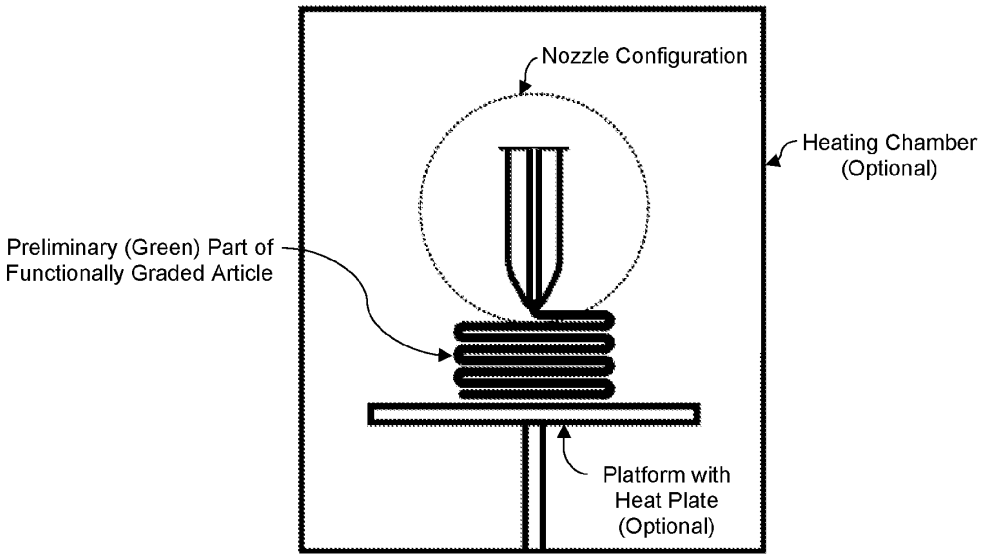


FIGURE 9a

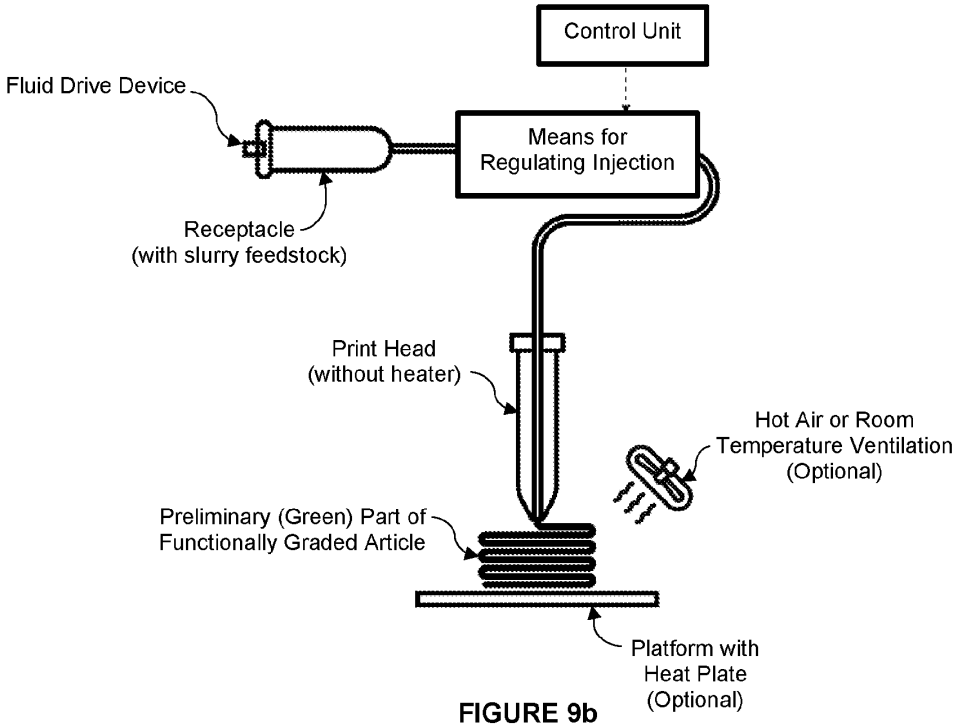


FIGURE 9b

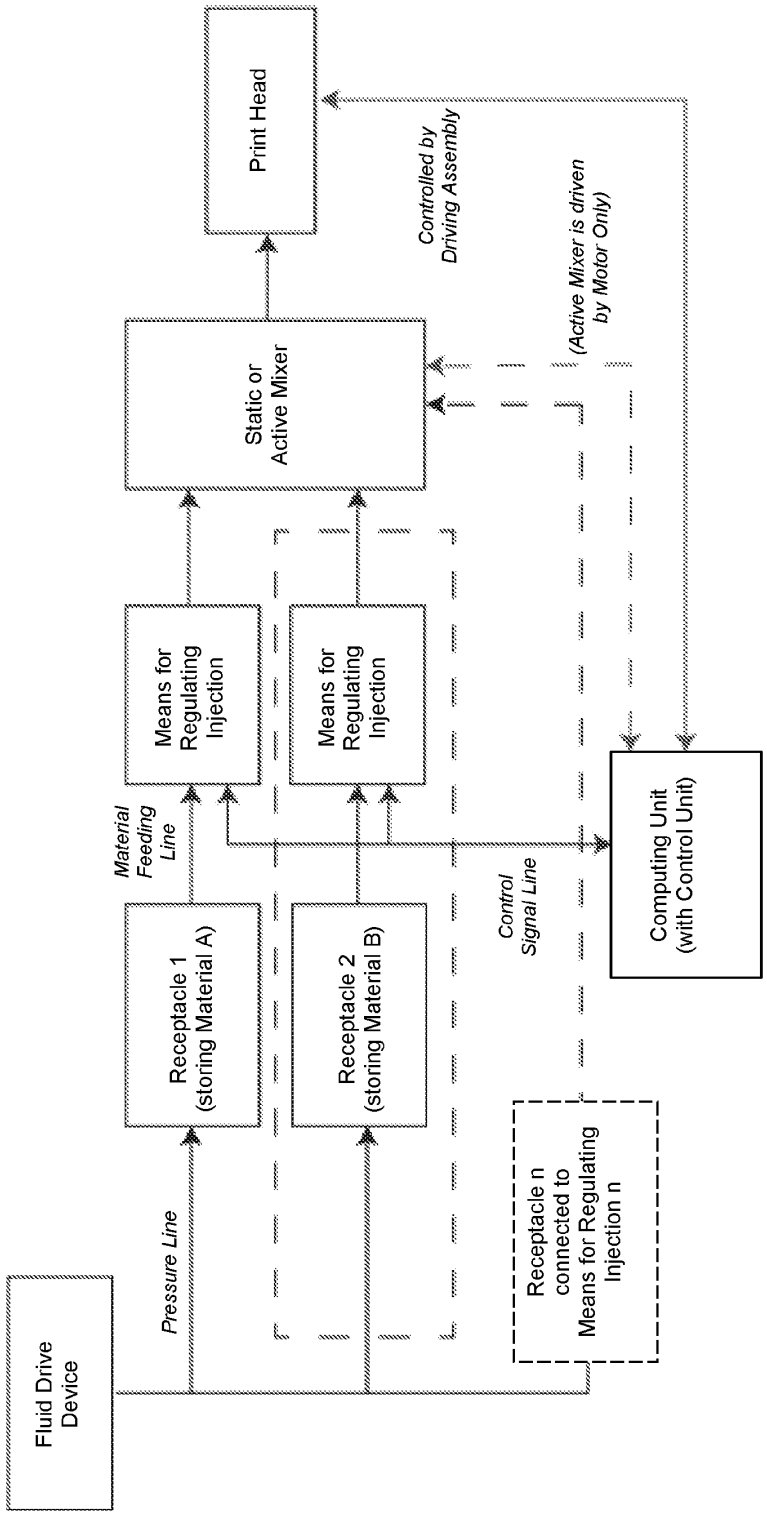

Print Head
Controlled by Driving Assembly
(Active Mixer is driven by Motor Only)
Static or Active Mixer
Means for Regulating Injection
Means for Regulating Injection
Material Feeding Line
Receptacle 1 (storing Material A)
Receptacle 2 (storing Material B)
Control Signal Line
Computing Unit (with Control Unit)
Pressure Line
Receptacle n connected to Means for Regulating Injection n
Fluid Drive Device

FIGURE 10

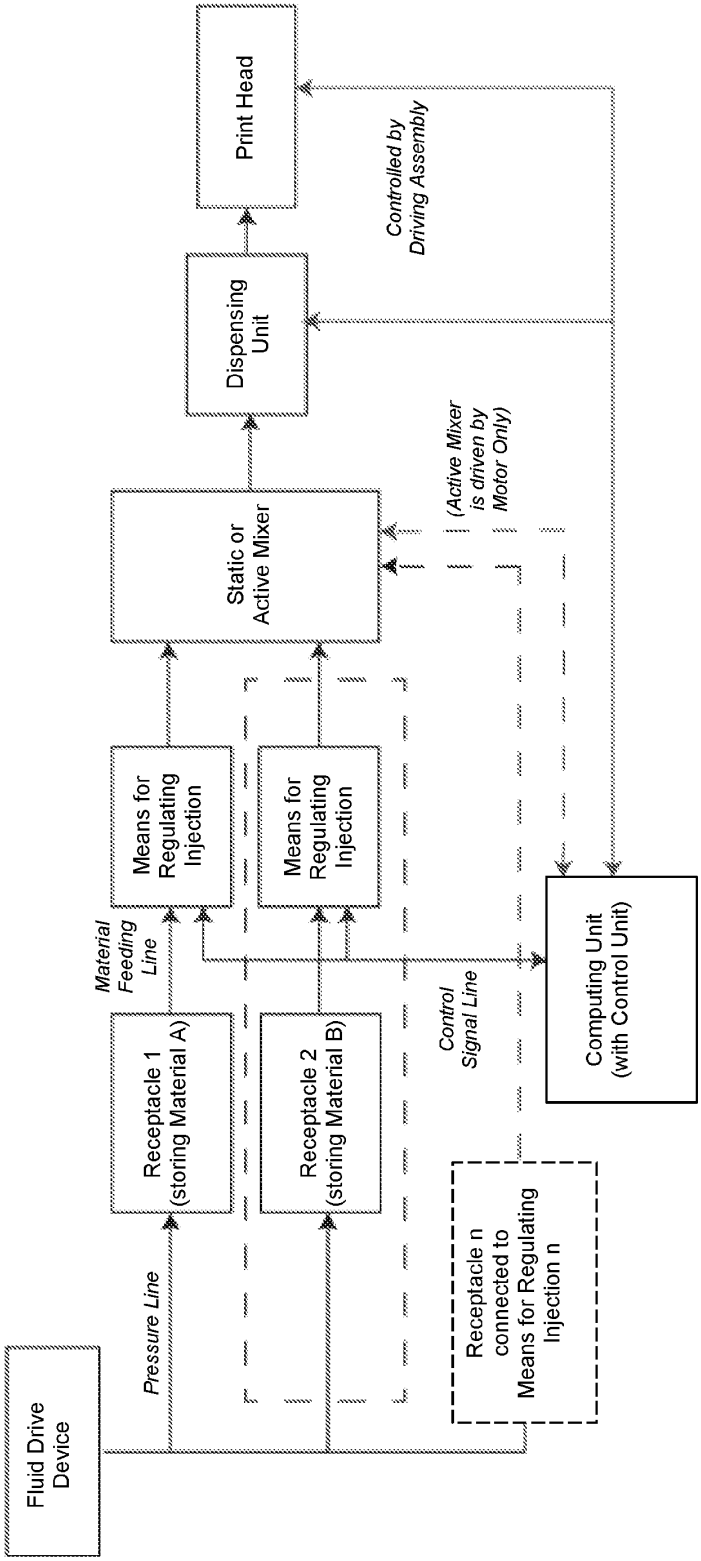

Print Head
Controlled by Driving Assembly
Dispensing Unit
(Active Mixer is driven by Motor Only)
Static or Active Mixer
Means for Regulating Injection
Means for Regulating Injection
Material Feeding Line
Receptacle 1 (storing Material A)
Receptacle 2 (storing Material B)
Control Signal Line
Computing Unit (with Control Unit)
Receptacle n connected to Means for Regulating Injection n
Pressure Line
Fluid Drive Device

FIGURE 11

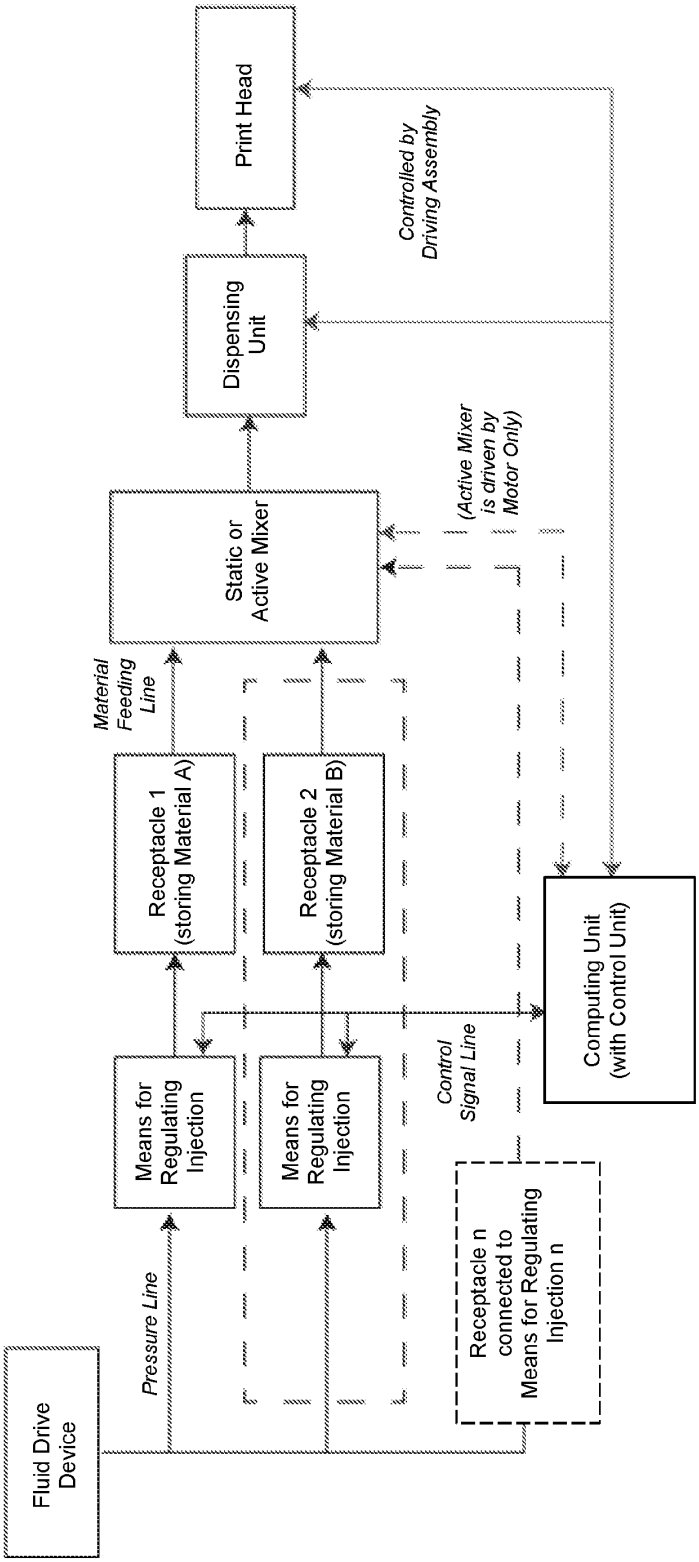

Print Head
Controlled by Driving Assembly
Dispensing Unit
(Active Mixer is driven by Motor Only)
Static or Active Mixer
Material Feeding Line
Receptacle 1 (storing Material A)
Receptacle 2 (storing Material B)
Means for Regulating Injection
Means for Regulating Injection
Control Signal Line
Computing Unit (with Control Unit)
Pressure Line
Receptacle n connected to Means for Regulating Injection n
Fluid Drive Device

FIGURE 12

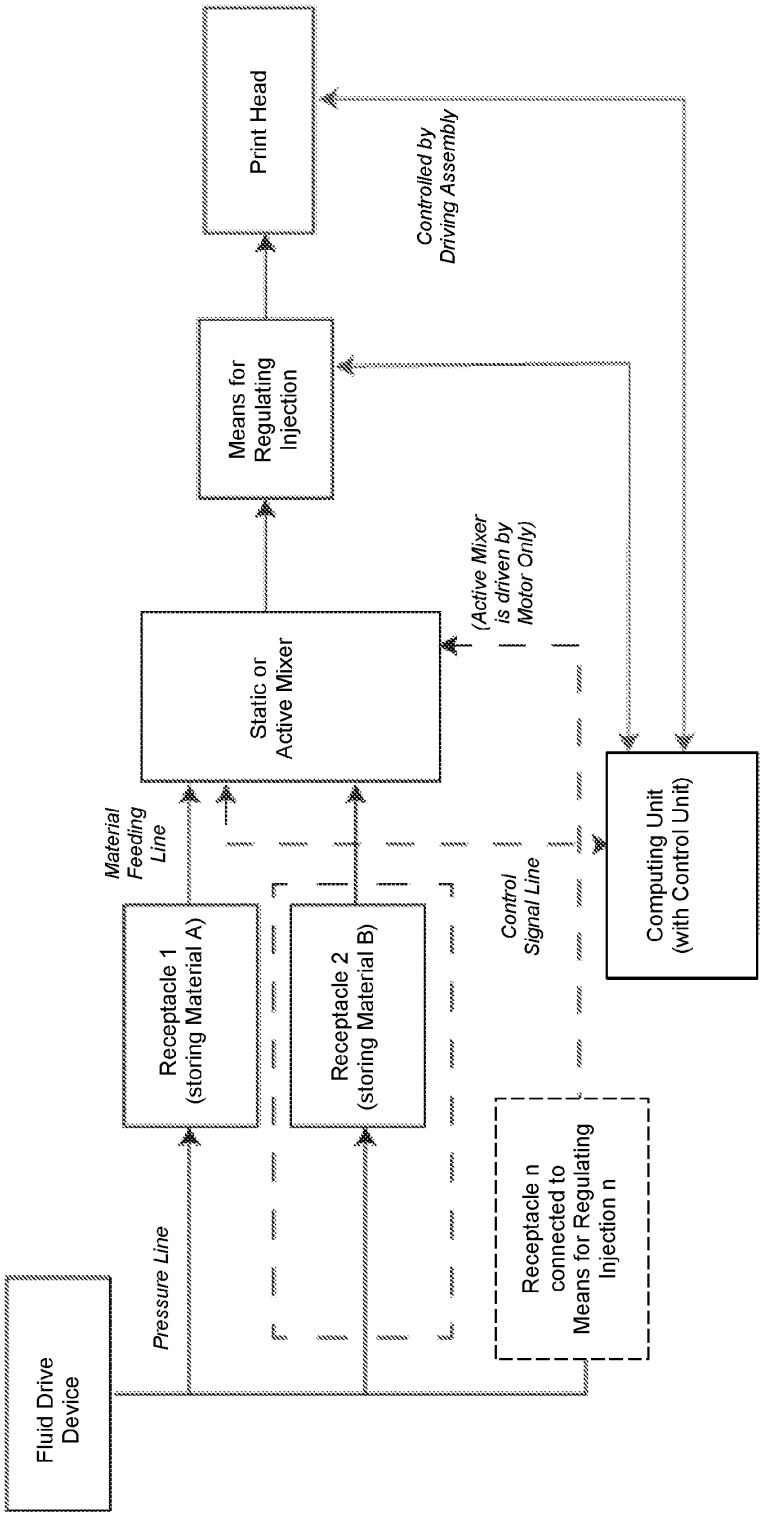

Print Head
Controlled by Driving Assembly
Means for Regulating Injection
(Active Mixer is driven by Motor Only)
Static or Active Mixer
Material Feeding Line
Receptacle 1 (storing Material A)
Receptacle 2 (storing Material B)
Control Signal Line
Computing Unit (with Control Unit)
Receptacle n connected to Means for Regulating Injection n
Pressure Line
Fluid Drive Device

FIGURE 13

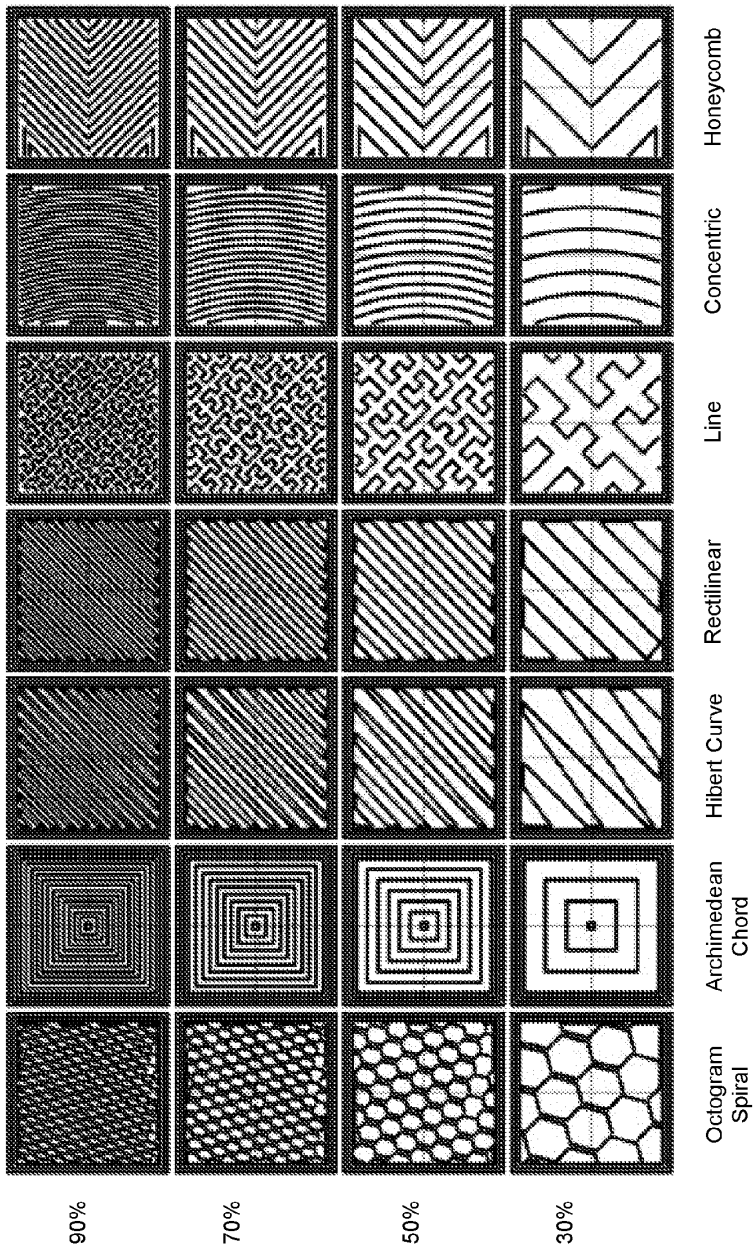

Octogram Spiral
Archimedean Chord
Hilbert Curve
Rectilinear
Line
Concentric
Honeycomb
90%
70%
50%
30%

FIGURE 14

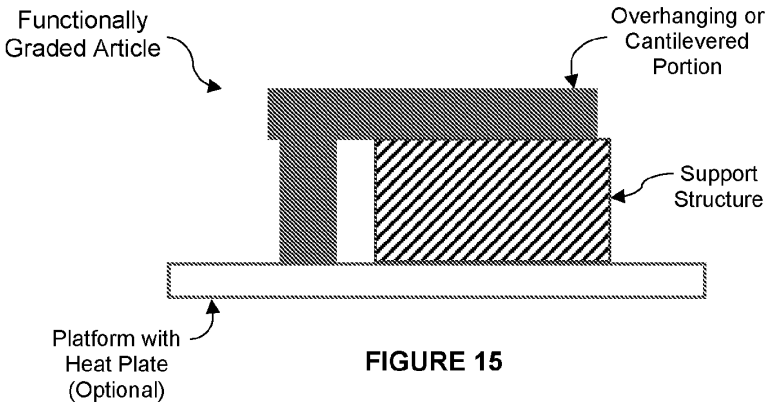


FIGURE 15

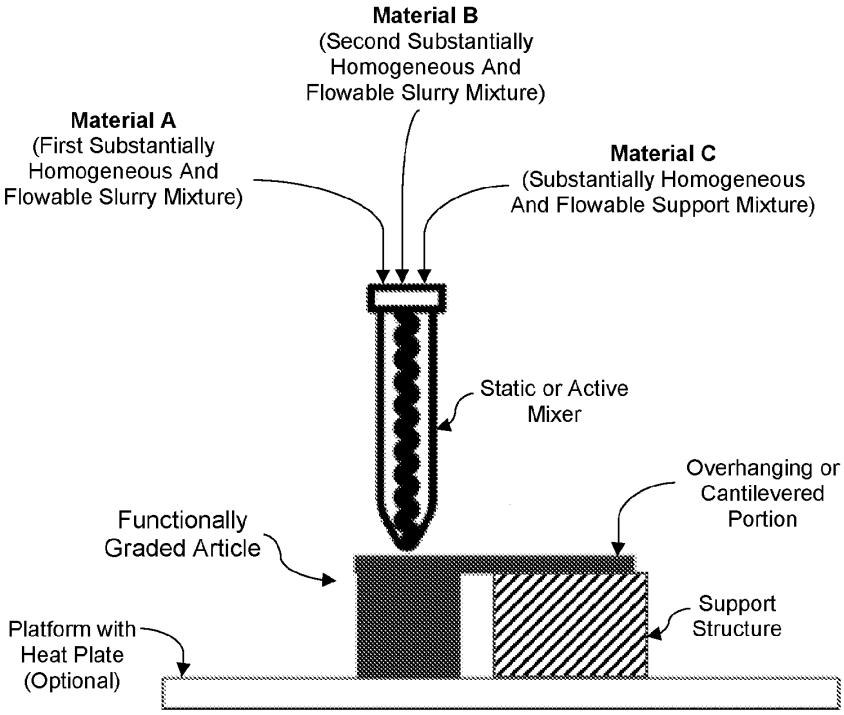


FIGURE 16

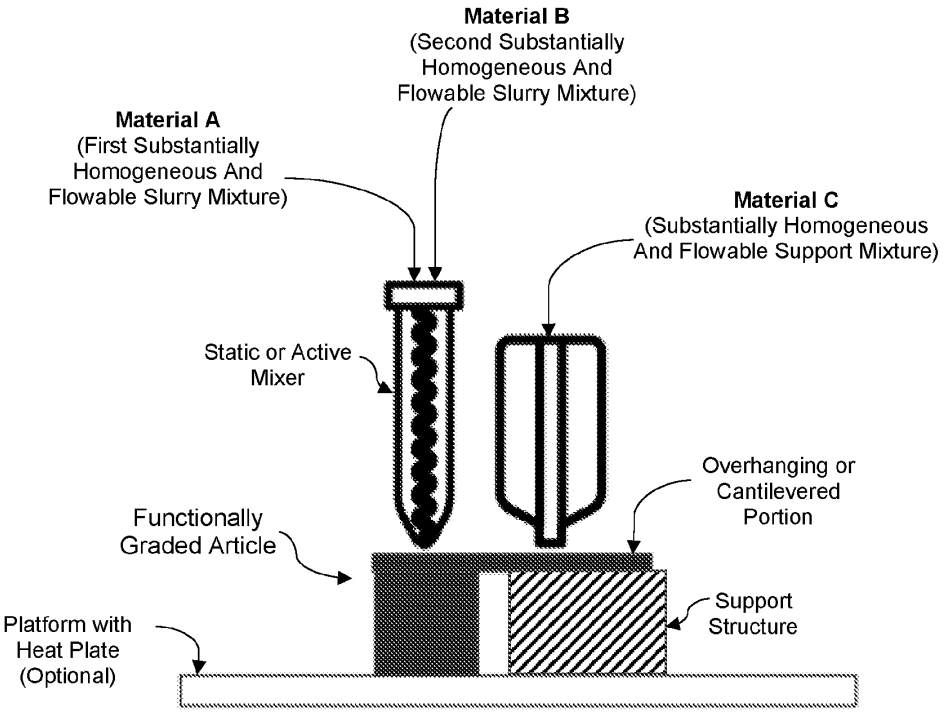

Material B
(Second Substantially
Homogeneous And
Flowable Slurry Mixture)
Material A
(First Substantially
Homogeneous And
Flowable Slurry Mixture)
Material C
(Substantially Homogeneous
And Flowable Support Mixture)
Static or Active
Mixer
Overhanging or
Cantilevered
Portion
Functionally
Graded Article
Support
Structure
Platform with
Heat Plate
(Optional)

FIGURE 17

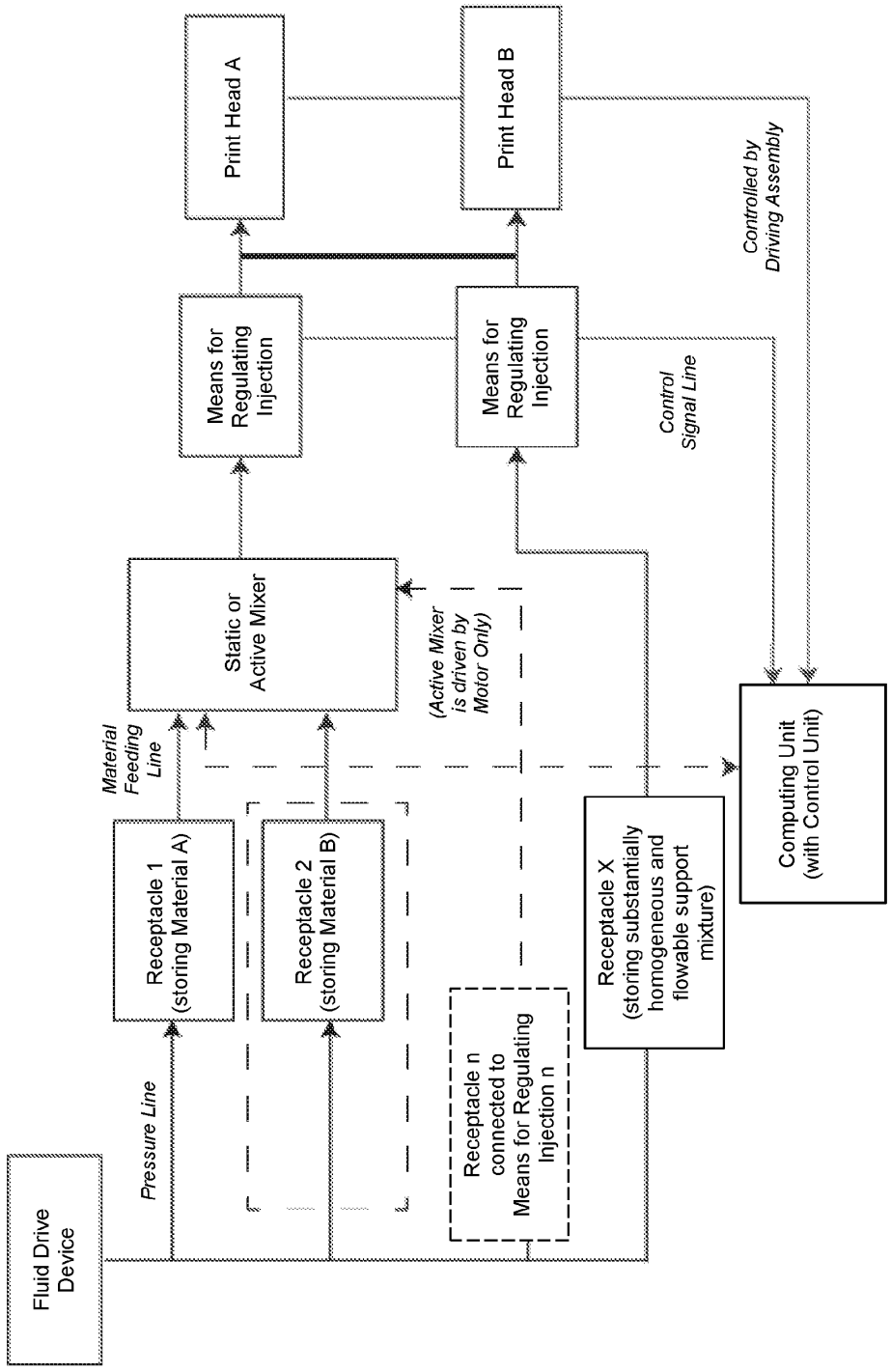

Print Head A
Print Head B
Controlled by Driving Assembly
Means for Regulating Injection
Means for Regulating Injection
Control Signal Line
Static or Active Mixer
(Active Mixer is driven by Motor Only)
Material Feeding Line
Receptacle 1 (storing Material A)
Receptacle 2 (storing Material B)
Receptacle n connected to Means for Regulating Injection n
Receptacle X (storing substantially homogeneous and flowable support mixture)
Computing Unit (with Control Unit)
Pressure Line
Fluid Drive Device

FIGURE 18

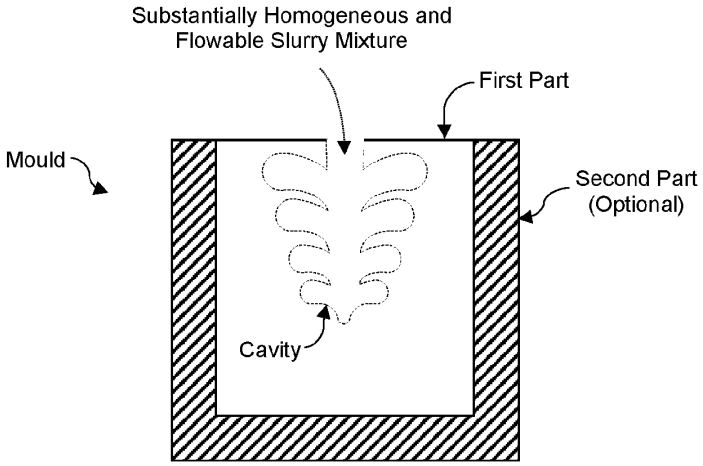


FIGURE 19

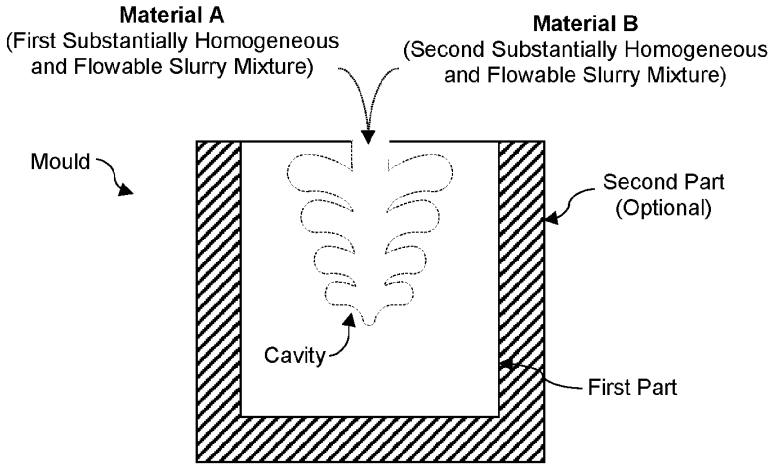


FIGURE 20

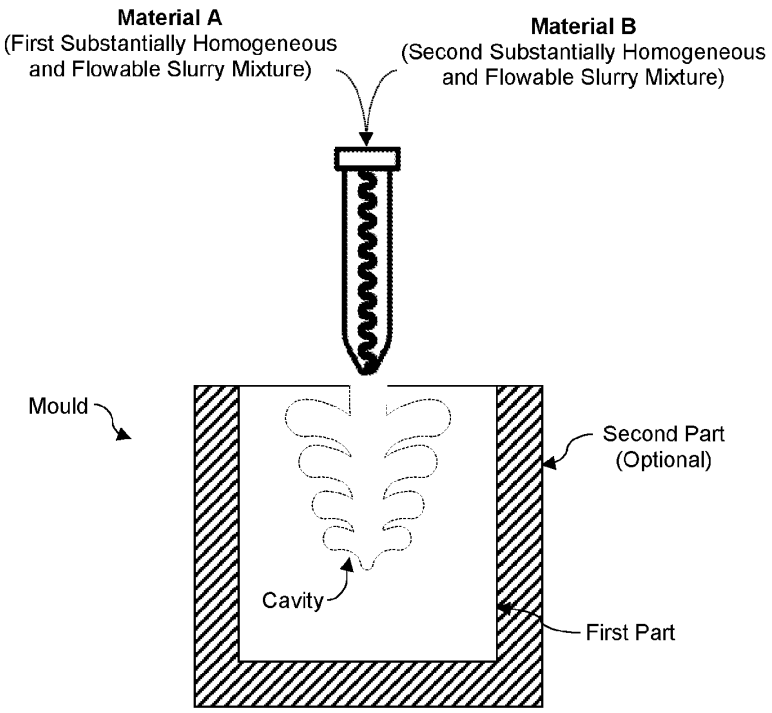

Material A
(First Substantially Homogeneous and Flowable Slurry Mixture)
Material B
(Second Substantially Homogeneous and Flowable Slurry Mixture)
Mould
Second Part (Optional)
Cavity
First Part

FIGURE 21

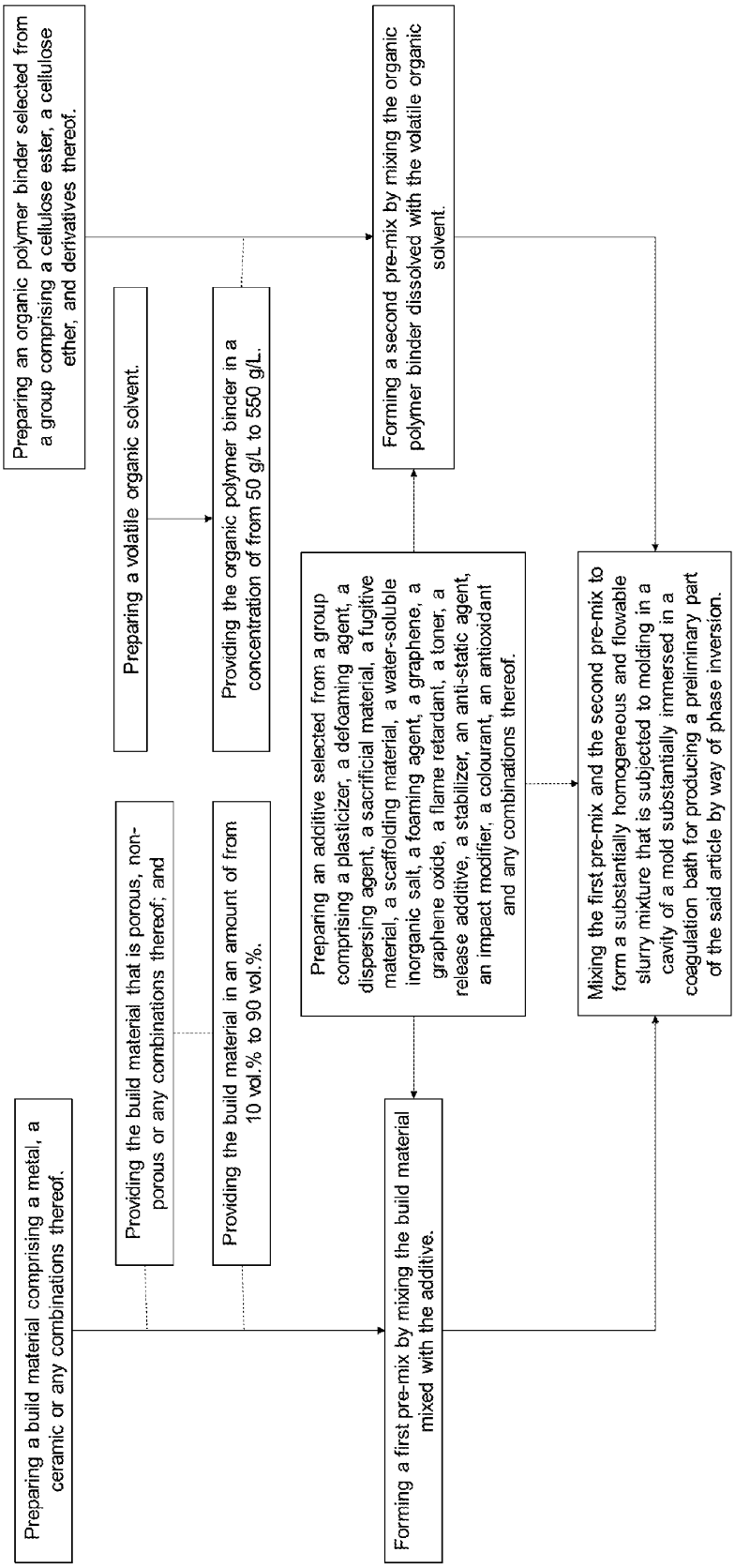

Preparing an organic polymer binder selected from a group comprising a cellulose ester, a cellulose ether, and derivatives thereof.
Preparing a volatile organic solvent.
Providing the organic polymer binder in a concentration of from 50 g/L to 550 g/L.
Forming a second pre-mix by mixing the organic polymer binder dissolved with the volatile organic solvent.
Preparing a build material comprising a metal, a ceramic or any combinations thereof.
Providing the build material that is porous, non-porous or any combinations thereof; and
Providing the build material in an amount of from 10 vol.% to 90 vol.%.
Preparing an additive selected from a group comprising a plasticizer, a defoaming agent, a dispersing agent, a sacrificial material, a fugitive material, a scaffolding material, a water-soluble inorganic salt, a foaming agent, a graphene, a graphene oxide, a flame retardant, a toner, a release additive, a stabilizer, an anti-static agent, an impact modifier, a colourant, an antioxidant and any combinations thereof.
Forming a first pre-mix by mixing the build material mixed with the additive.
Mixing the first pre-mix and the second pre-mix to form a substantially homogeneous and flowable slurry mixture that is subjected to molding in a cavity of a mold substantially immersed in a coagulation bath for producing a preliminary part of the said article by way of phase inversion.

FIGURE 22

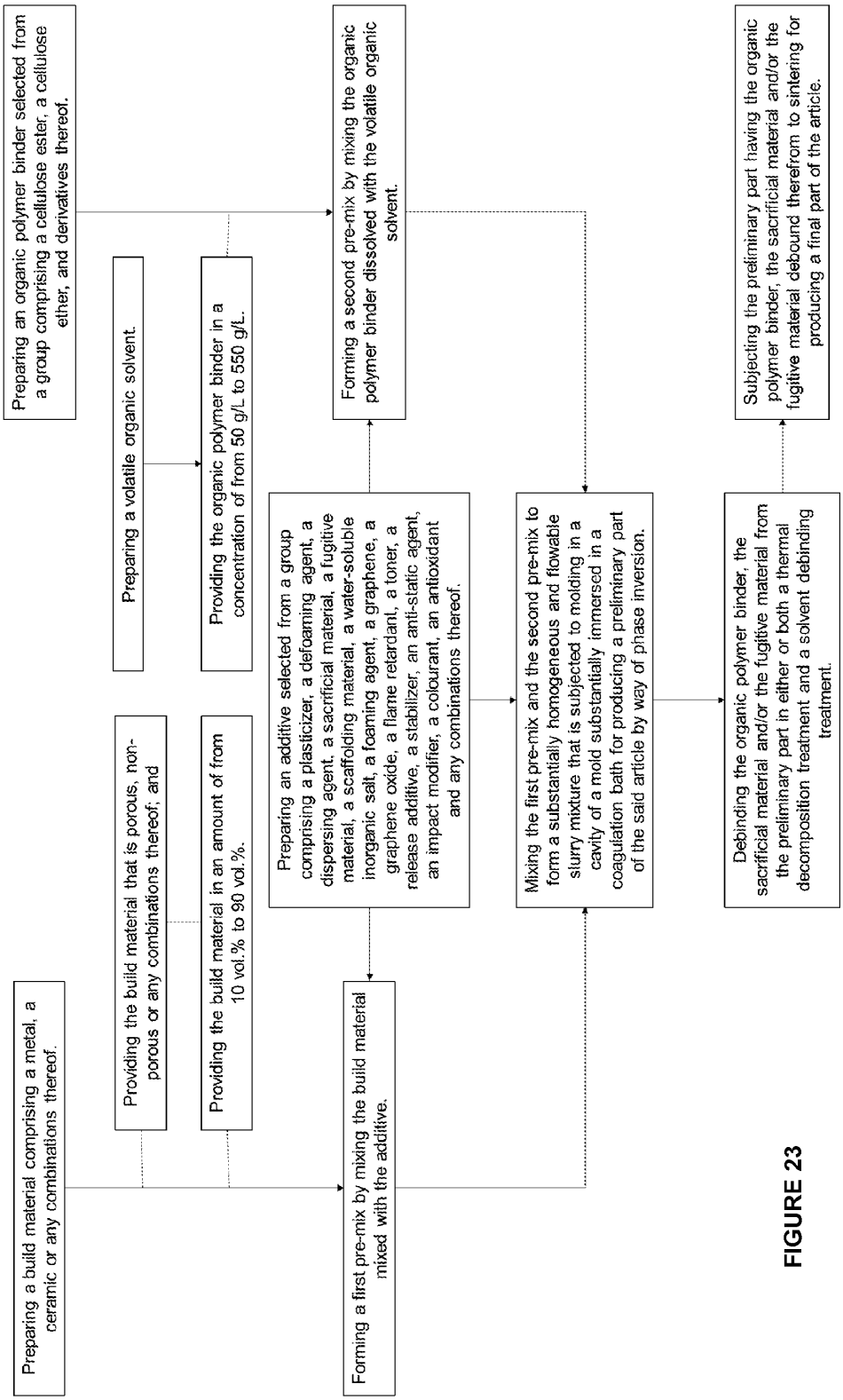

Preparing a build material comprising a metal, a ceramic or any combinations thereof.
Providing the build material that is porous, non-porous or any combinations thereof; and
Providing the build material in an amount of from 10 vol.% to 90 vol.%.
Forming a first pre-mix by mixing the build material mixed with the additive.
Preparing an organic polymer binder selected from a group comprising a cellulose ester, a cellulose ether, and derivatives thereof.
Preparing a volatile organic solvent.
Providing the organic polymer binder in a concentration of from 50 g/L to 550 g/L.
Forming a second pre-mix by mixing the organic polymer binder dissolved with the volatile organic solvent.
Preparing an additive selected from a group comprising a plasticizer, a defoaming agent, a dispersing agent, a sacrificial material, a fugitive material, a scaffolding material, a water-soluble inorganic salt, a foaming agent, a graphene, a graphene oxide, a flame retardant, a toner, a release additive, a stabilizer, an anti-static agent, an impact modifier, a colourant, an antioxidant and any combinations thereof.
Mixing the first pre-mix and the second pre-mix to form a substantially homogeneous and flowable slurry mixture that is subjected to molding in a cavity of a mold substantially immersed in a coagulation bath for producing a preliminary part of the said article by way of phase inversion.
Debinding the organic polymer binder, the sacrificial material and/or the fugitive material from the preliminary part in either or both a thermal decomposition treatment and a solvent debinding treatment.
Subjecting the preliminary part having the organic polymer binder, the sacrificial material and/or the fugitive material debound therefrom to sintering for producing a final part of the article.

FIGURE 23

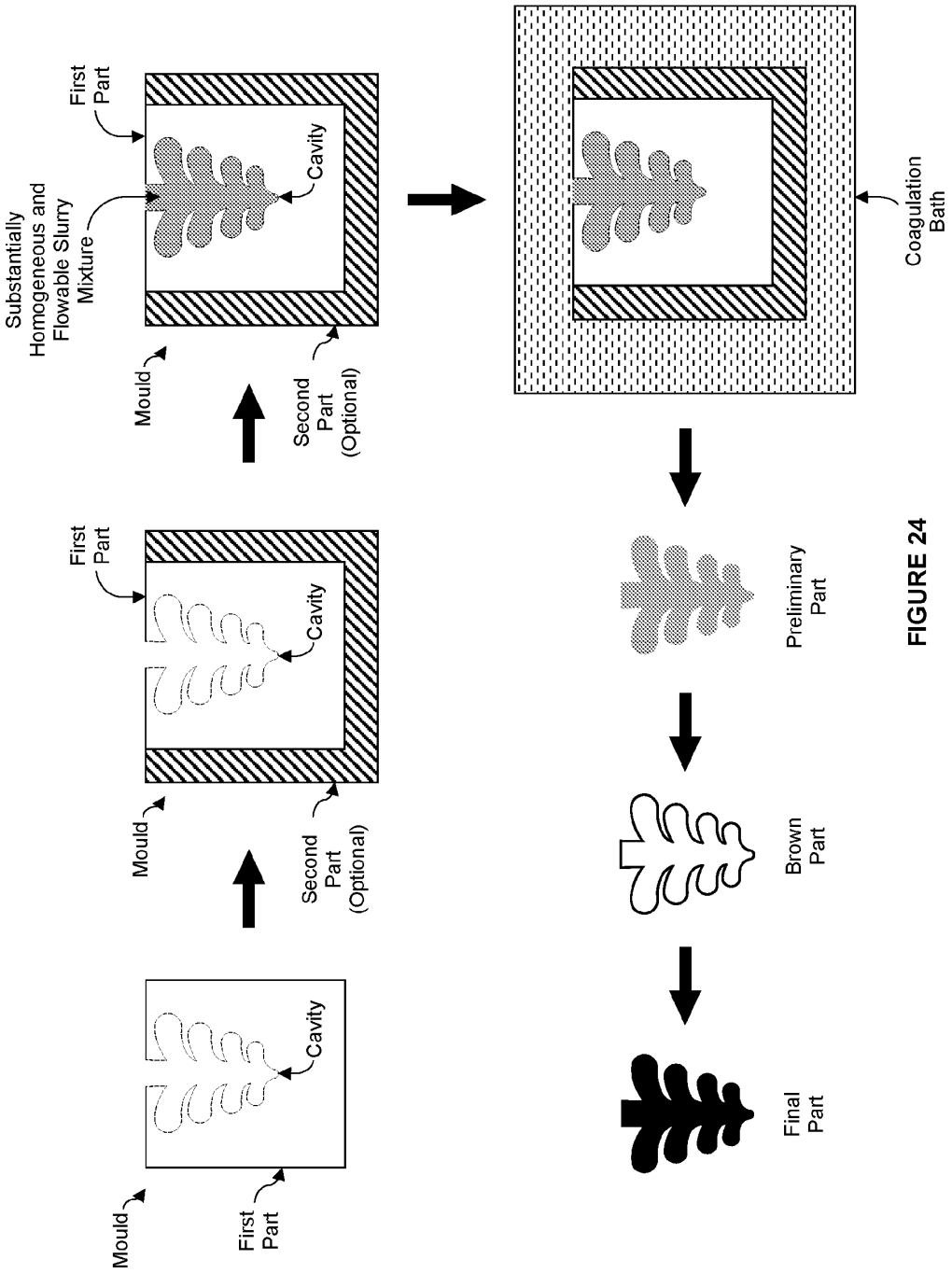

Mould
First Part
Cavity
Second Part (Optional)
Substantially Homogeneous and Flowable Slurry Mixture
Coagulation Bath
Preliminary Part
Brown Part
Final Part

FIGURE 24

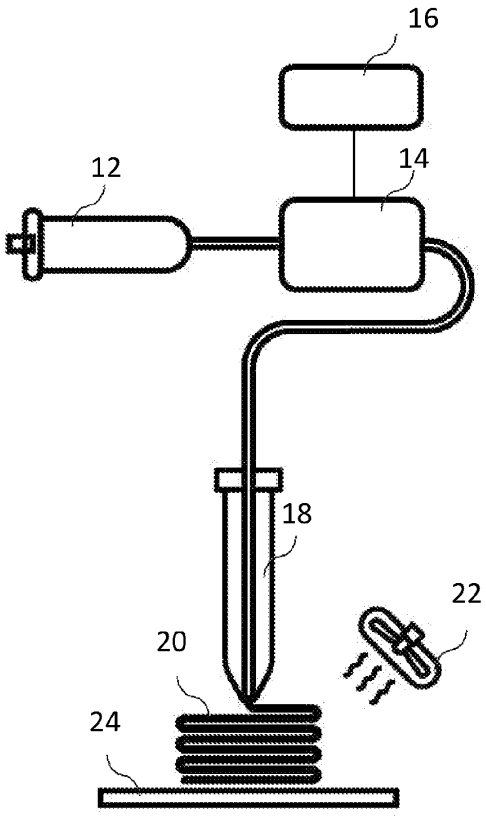


FIGURE 25

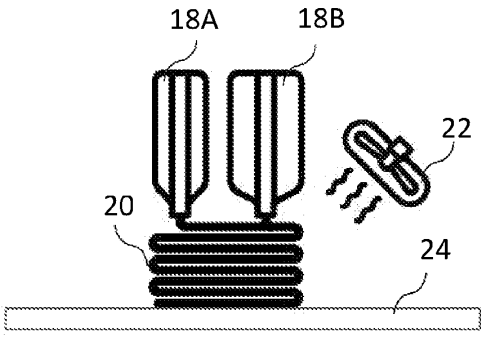


FIGURE 26

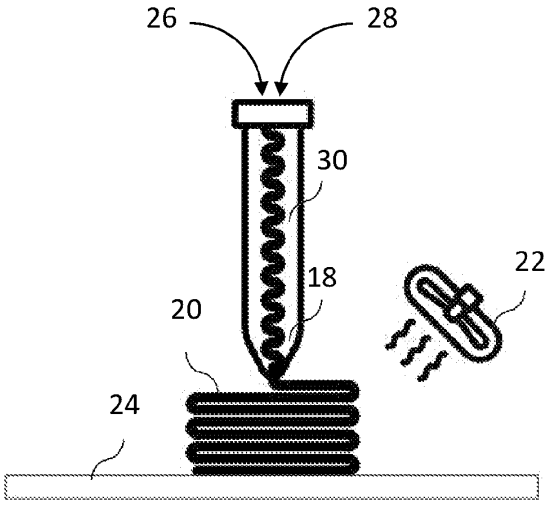


FIGURE 27

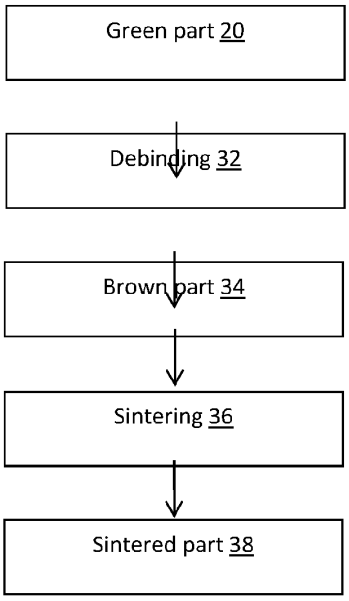


FIGURE 28

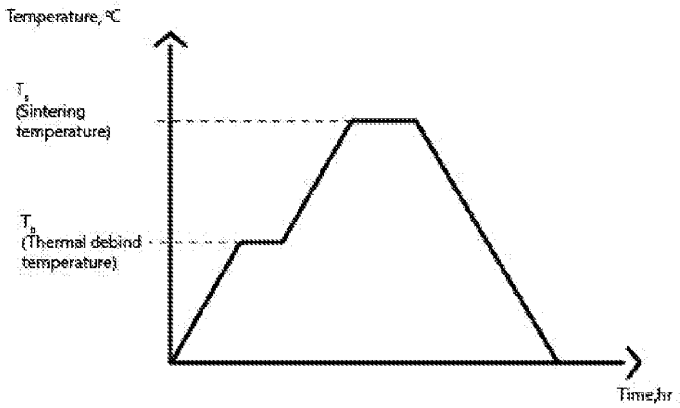


FIGURE 29

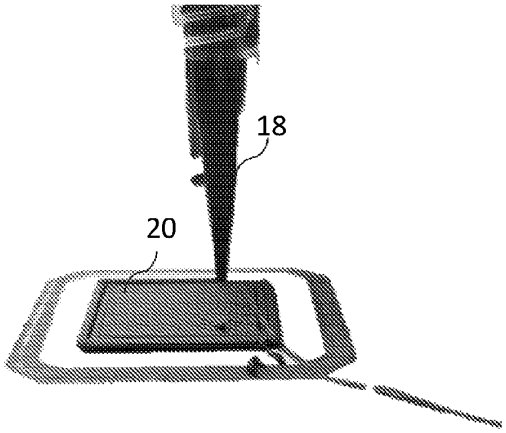


FIGURE 30

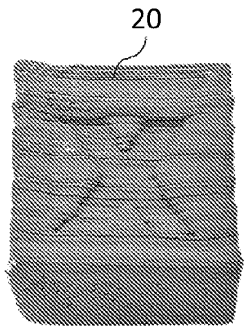


FIGURE 31

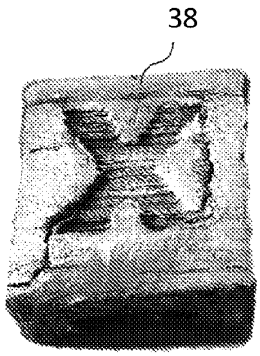


FIGURE 32

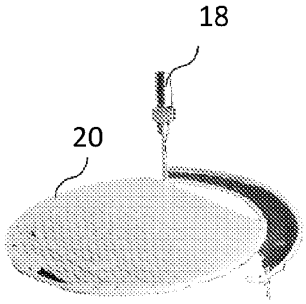


FIGURE 33

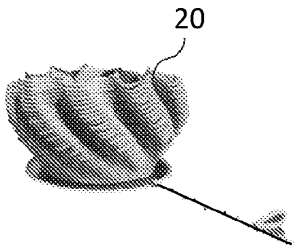


FIGURE 34

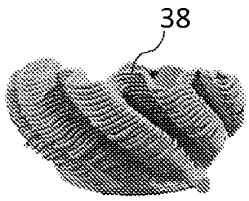


FIGURE 35