US 20210363984A1

(19) United States
(12) Patent Application Publication
(10) Pub. No.: US 2021/0363984 A1
(43) Pub. Date: Nov. 25, 2021
Mou et al.

(54) **FLUID TRANSPORTATION ACTUATOR**

(71) Applicant: **Microjet Technology Co., Ltd.**, Hsinchu (TW)

(72) Inventors: **Hao-Jan Mou**, Hsinchu (TW); **Jyun-Yi Jhang**, Hsinchu (TW); **Chun-Lung Tseng**, Hsinchu (TW); **Shih-Chang Chen**, Hsinchu (TW); **Jia-Yu Liao**, Hsinchu (TW); **Chi-Feng Huang**, Hsinchu (TW); **Yung-Lung Han**, Hsinchu (TW); **Yang Ku**, Hsinchu (TW); **Yi-Ting Lu**, Hsinchu (TW)

(73) Assignee: **Microjet Technology Co., Ltd.**, Hsinchu (TW)

(21) Appl. No.: **17/314,197**

(22) Filed: **May 7, 2021**

(30) **Foreign Application Priority Data**

May 19, 2020 (TW) 109116602

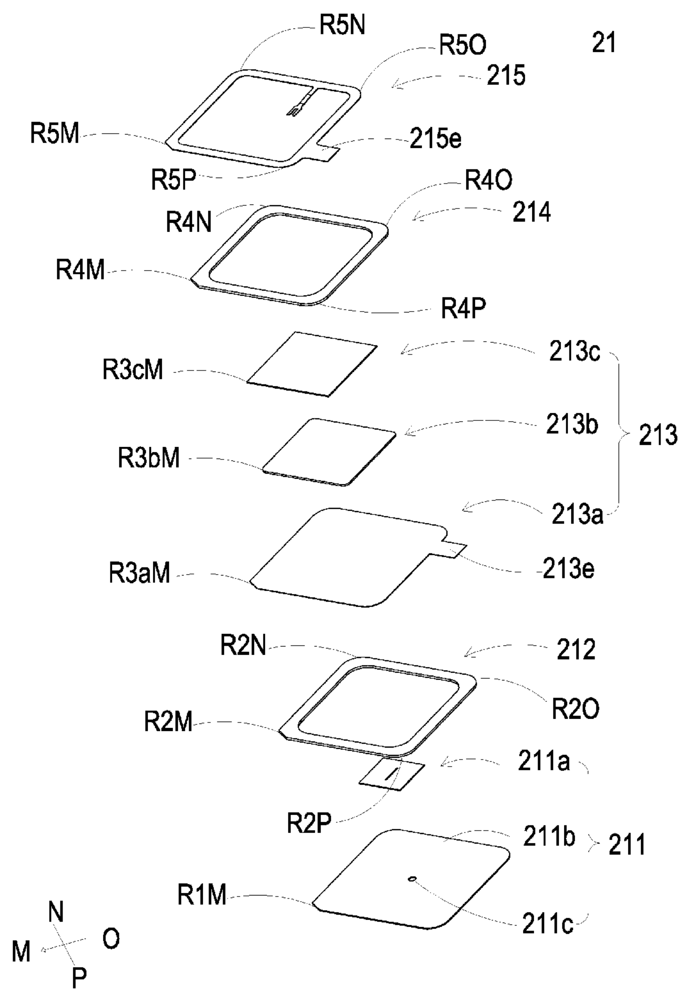
Publication Classification

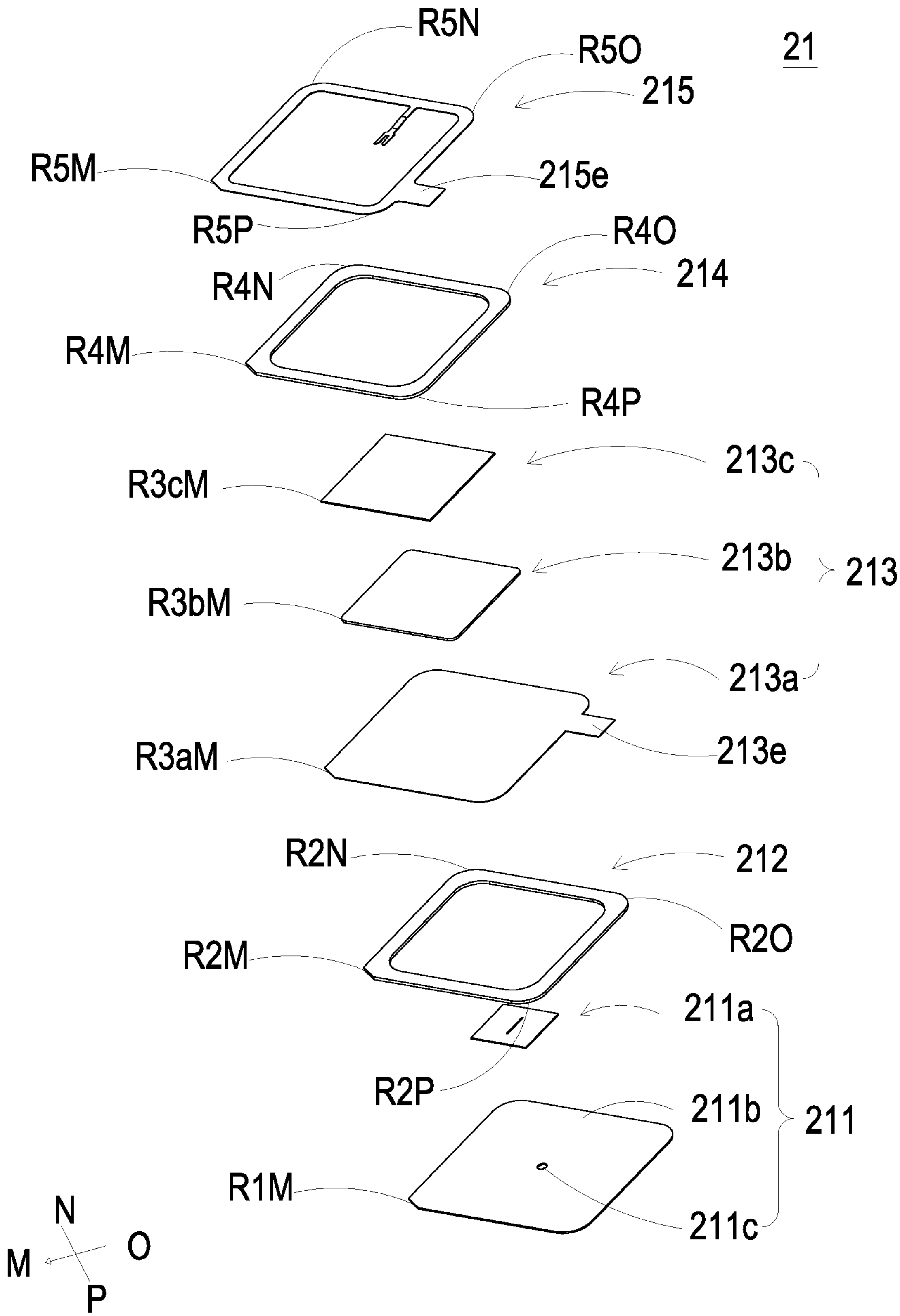
(51) **Int. Cl.**
F04B 43/04 (2006.01)
F15D 1/02 (2006.01)

(52) **U.S. Cl.**
CPC *F04B 43/046* (2013.01); *F15D 1/025* (2013.01)

(57) **ABSTRACT**

A fluid transportation actuator is disclosed and includes a silencing jet orifice plate, a chamber frame, an actuator, an insulation frame and a conductive frame. The silencing jet orifice plate includes a silencing plate, a suspension plate and a central aperture. The suspension plate is permitted to undergo a bending vibration. The central aperture is formed on a center of the suspension plate. The silencing plate is disposed and fixed in the central aperture disposed at the center of the suspension plate. The chamber frame is stacked on the suspension plate. The actuator is stacked on the chamber frame. The actuator generates the bending vibration in a reciprocating manner as a voltage is applied thereto. The actuator includes a piezoelectric-thin-plate pin. The insulation frame is stacked on the actuator. The conductive frame is stacked on the insulation frame and includes a conductive-frame pin.

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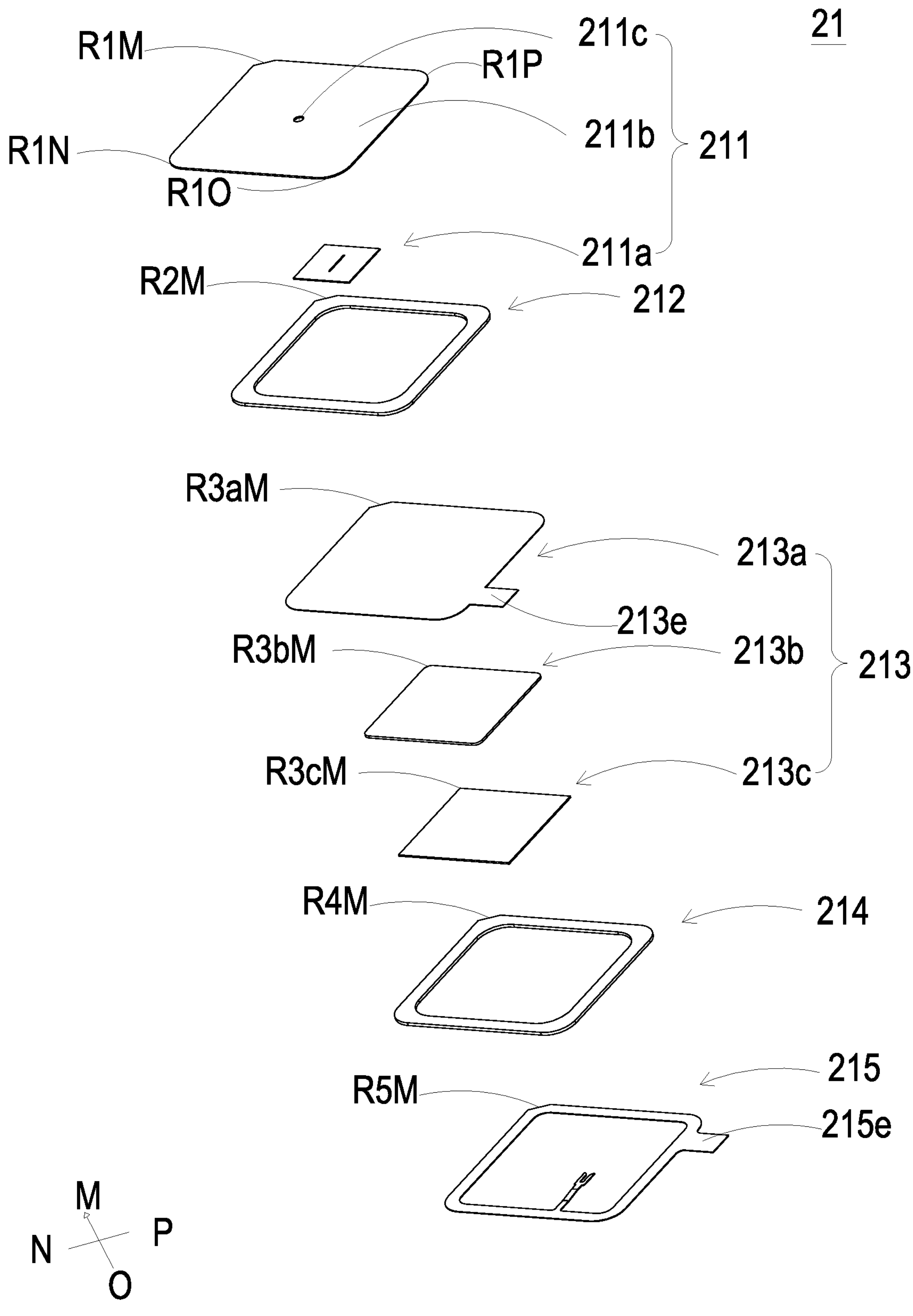
R5O
21
215
R5M
215e
R5P
R4O
214
R4N
R4M
R4P
213c
R3cM
213b
213
R3bM
213a
R3aM
213e
R2N
212
R2O
R2M
211a
R2P
211b
211
R1M
211c
N
M
O
P

FIG. 1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R1M
211c
R1P
211b
211
R1N
R1O
211a
R2M
212
R3aM
213a
213e
R3bM
213b
213
R3cM
213c
R4M
214
215
R5M
215e
M
N
P
O

FIG. 2

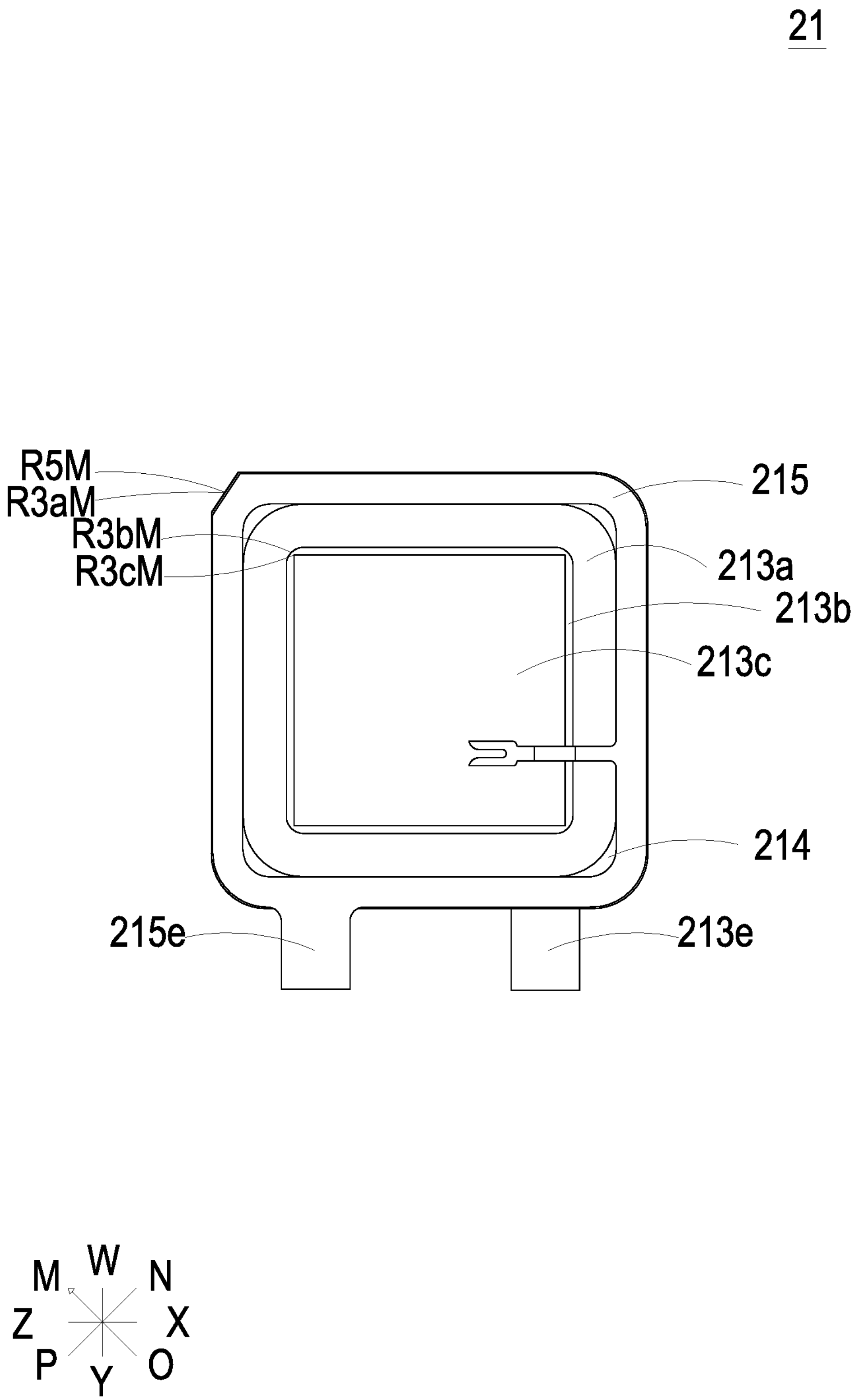
21
R5M
R3aM
R3bM
R3cM
215
213a
213b
213c
214
215e
213e
M
W
N
Z
X
P
Y
O

FIG. 3

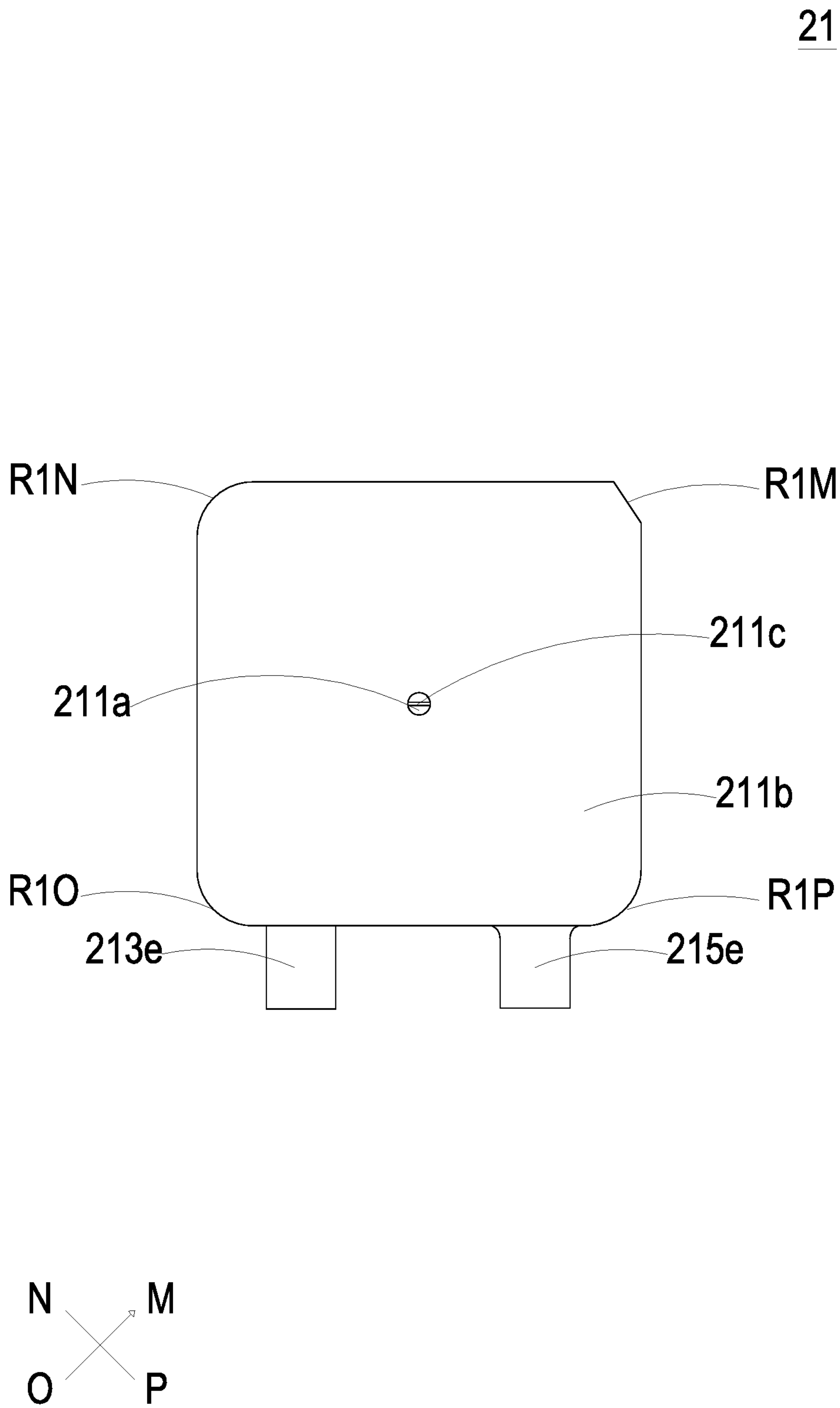

FIG. 4

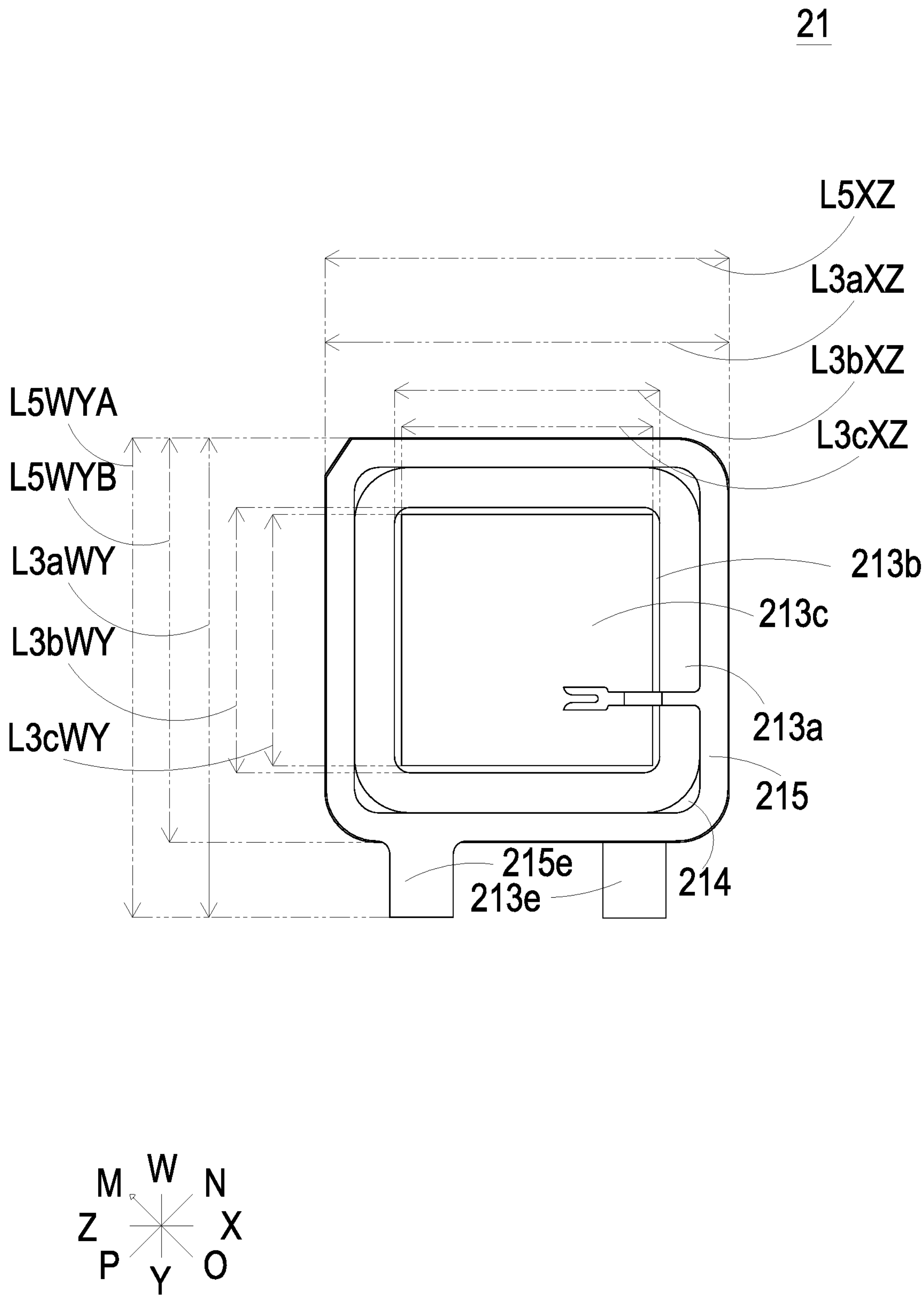
21
L5XZ
L3aXZ
L3bXZ
L3cXZ
L5WYA
L5WYB
L3aWY
L3bWY
L3cWY
213b
213c
213a
215
215e
213e
214
M
W
N
Z
X
P
Y
O

FIG. 5

21

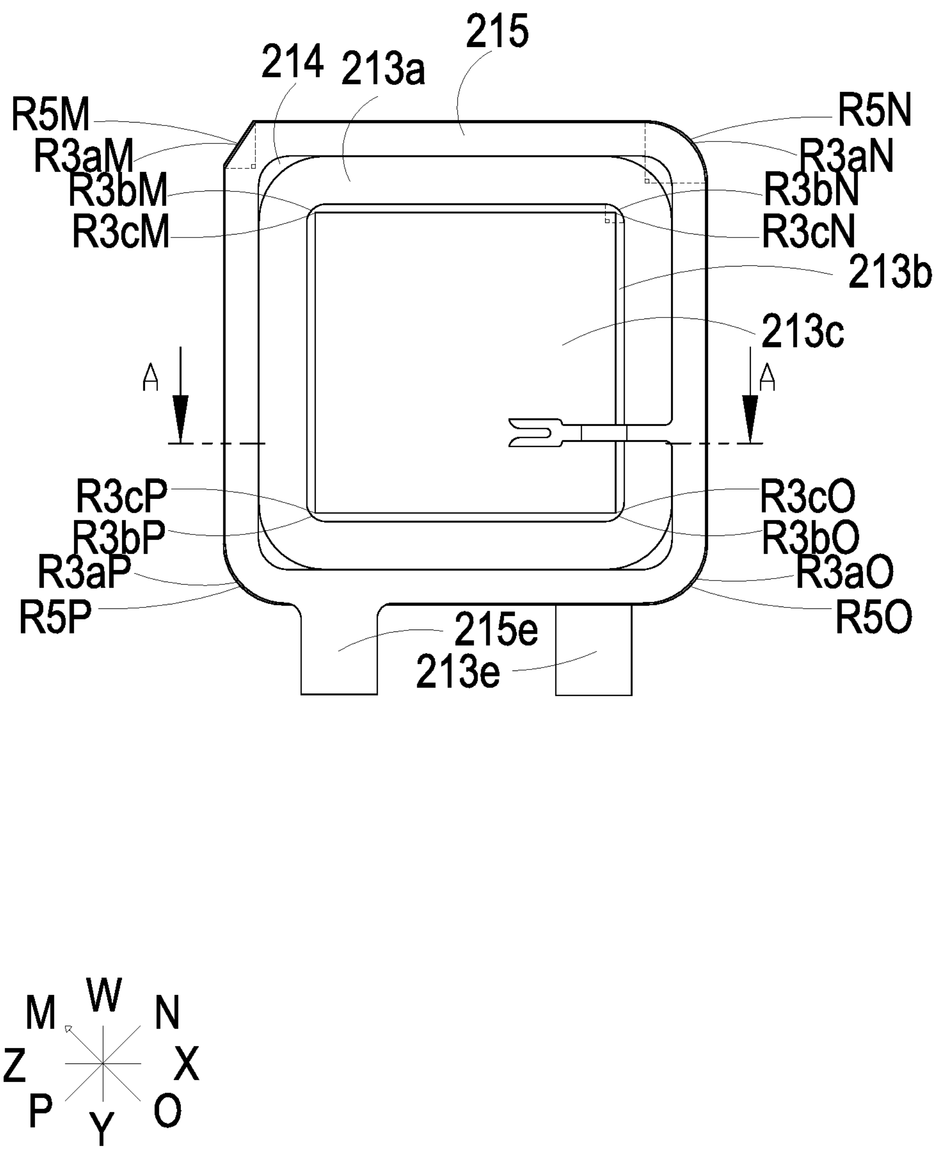
215
214
213a
R5M
R3aM
R3bM
R3cM
R5N
R3aN
R3bN
R3cN
213b
213c
A
A
R3cP
R3bP
R3aP
R5P
R3cO
R3bO
R3aO
R5O
215e
213e
M
W
N
Z
X
P
Y
O

FIG. 6

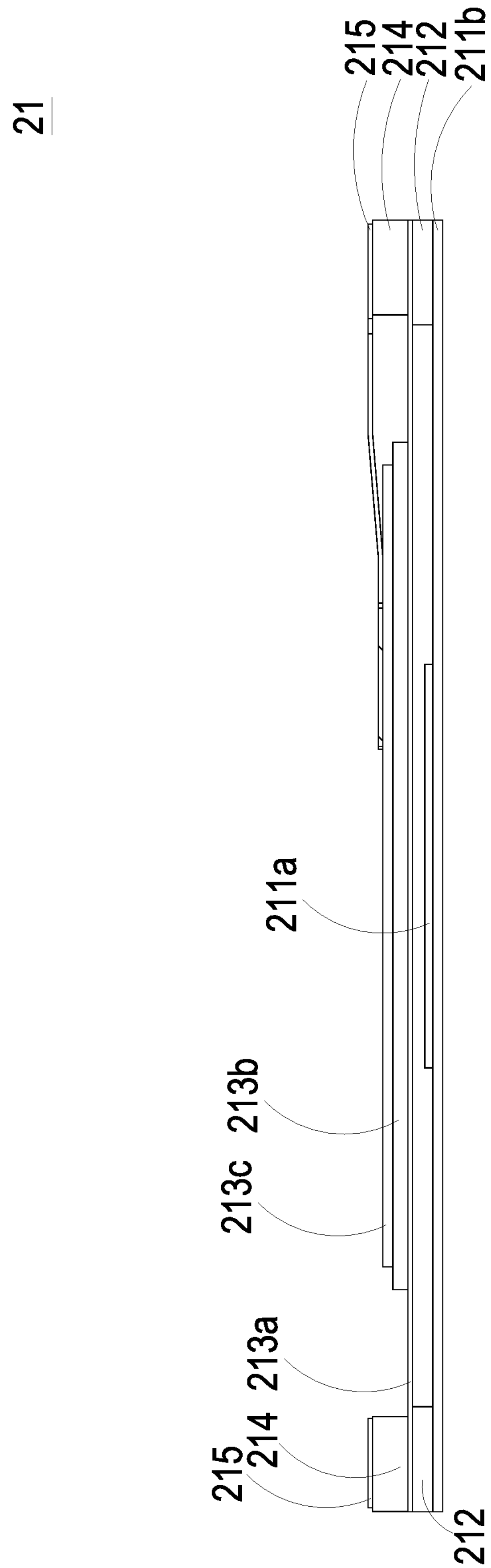

FIG. 7

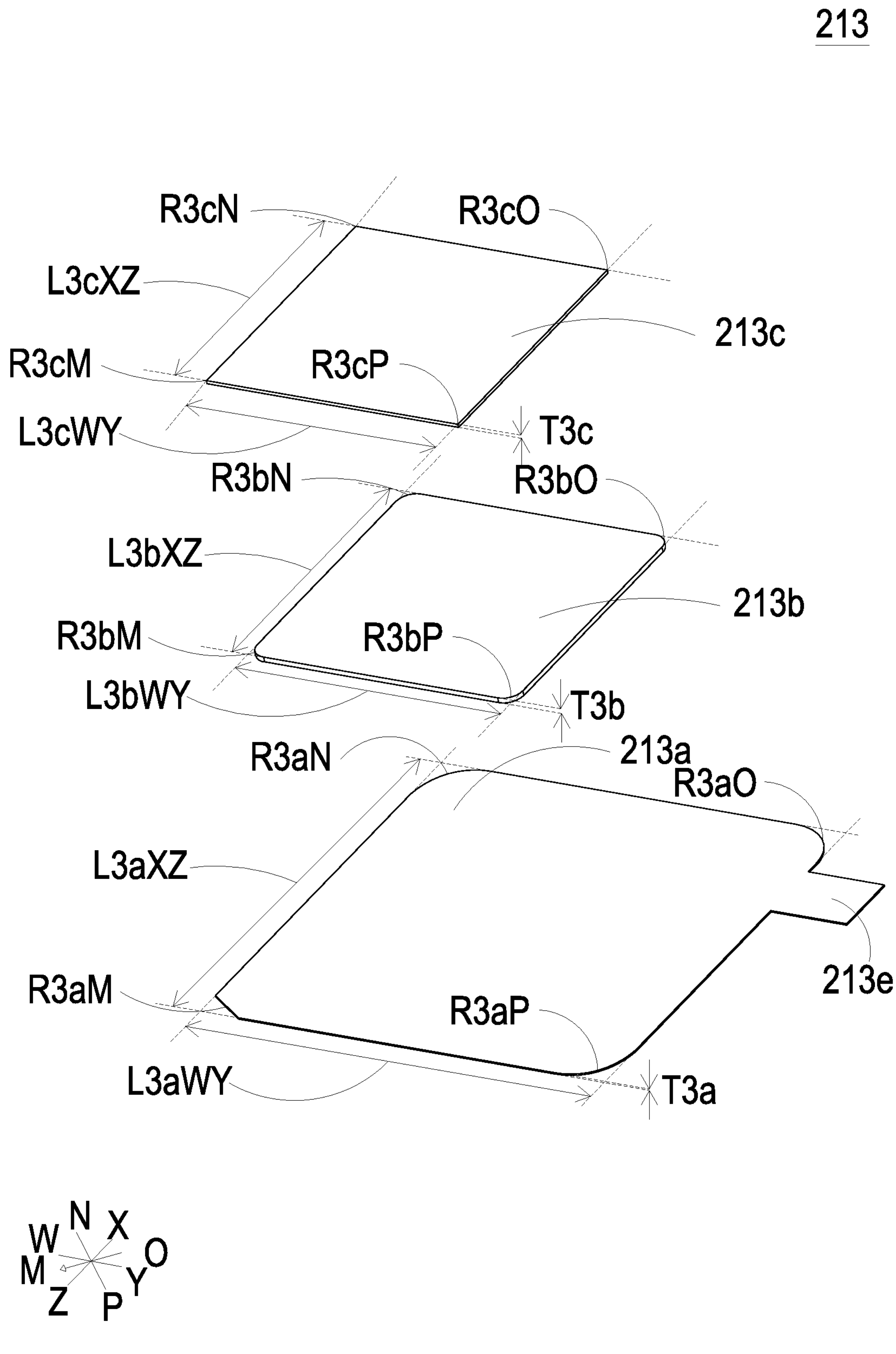
213
R3cN
R3cO
L3cXZ
213c
R3cM
R3cP
L3cWY
T3c
R3bN
R3bO
L3bXZ
213b
R3bM
R3bP
L3bWY
T3b
R3aN
213a
R3aO
L3aXZ
213e
R3aM
R3aP
L3aWY
T3a
W
N
X
O
M
Y
Z
P

FIG. 8

FLUID TRANSPORTATION ACTUATOR

FIELD OF THE INVENTION

[0001] The present disclosure relates to a fluid transportation actuator, and more particularly to a fluid transportation actuator assembled and combined with different metal materials.

BACKGROUND OF THE INVENTION

[0002] In the prior art, fluid transportation actuators are mainly constructed by stacking conventional mechanical components, and each mechanical component is miniaturized or thinned to achieve the goal of miniaturization and thinning of the overall device. However, while the conventional mechanical components are miniaturized, it is not easy to control the dimensional accuracy, and the assembly accuracy is also difficult to control. It results in different product yields and even unstable fluid flow rates. In addition, while the mechanical components are miniaturized, the single-material fluid transportation actuator has the problem of insufficient structural toughness during being driven and easy to result in the problems of interference and unrecognizable of the driving point.

[0003] Furthermore, in the conventional fluid transportation actuator, the output fluid cannot be converged effectively or the element size is too small results in insufficient fluid propulsion force. It leads to the problem of insufficient amount of fluid transportation.

SUMMARY OF THE INVENTION

[0004] An object of the present disclosure is to provide a fluid transportation actuator. In accordance with an aspect of the present disclosure, the fluid transportation actuator includes a silencing jet orifice plate, a chamber frame, an actuator, an insulation frame and a conductive frame. The silencing jet orifice plate includes a silencing plate, a suspension plate and a central aperture. The suspension plate is permitted to undergo a bending vibration. The central aperture is formed on a center of the suspension plate. The silencing plate is disposed and fixed on the central aperture disposed at the center of the suspension plate. The chamber frame is carried and stacked on the suspension plate. The actuator is carried and stacked on the chamber frame. The actuator generates the bending vibration in a reciprocating manner as a voltage is applied thereto, and includes a piezoelectric-thin-plate pin. The insulation frame is carried and stacked on the actuator. The conductive frame is carried and stacked on the insulation frame, and includes a conductive-frame pin. A resonance chamber is collaboratively defined by the actuator, the chamber frame and the silencing jet orifice plate. When the silencing jet orifice plate is driven by the actuator in resonance, the suspension plate of the silencing jet orifice plate is vibrated and displaced in the reciprocating manner, so as to achieve fluid transportation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The above contents of the present disclosure will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed description and accompanying drawings, in which:

[0006] FIG. **1** is a perspective exploded view illustrating a fluid transportation actuator according to an embodiment of the present disclosure and taken from a first perspective;

[0007] FIG. **2** is a perspective exploded view illustrating the fluid transportation actuator according to the embodiment of the present disclosure and taken from a second perspective;

[0008] FIG. **3** is a top view illustrating the fluid transportation actuator according to the embodiment of the present disclosure;

[0009] FIG. **4** is a bottom view illustrating the fluid transportation actuator according to the embodiment of the present disclosure;

[0010] FIG. **5** is a schematic diagram showing the dimensions of the fluid transportation actuator shown in FIG. **3**;

[0011] FIG. **6** is a schematic diagram showing the four corners of the fluid transportation actuator shown in FIG. **3**;

[0012] FIG. **7** is a cross-sectional view illustrating the fluid transportation actuator along the dash line AA; and

[0013] FIG. **8** is a schematic exploded view showing the respective dimensions of the fluid transportation actuator shown in FIG. **6**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0014] The present disclosure will now be described more specifically with reference to the following embodiments. It is to be noted that the following descriptions of preferred embodiments of this disclosure are presented herein for purpose of illustration and description only. It is not intended to be exhaustive or to be limited to the precise form disclosed.

[0015] In all the accompanying drawings of the present disclosure, if corner's orientations (M, N, O, P) or edge's orientations (W, X, Y, Z) are marked on at the lower left, it is to define the orientations of the fluid transportation actuator, so as to define the described corner or the described edge accurately.

[0016] A fluid transportation actuator is provided in the present disclosure. Please refer to FIGS. **1** and **2**. In the embodiment, the fluid transportation actuator **21** includes a silencing jet orifice plate **211**, a chamber frame **212**, an actuator **213**, an insulation frame **214** and a conductive frame **215**. The silencing jet orifice plate **211** includes a silencing plate **211***a*, a suspension plate **211***b* and a central aperture **211***c*. The suspension plate **211***b* is permitted to undergo a bending vibration. The central aperture **211***c* is formed on a center of the suspension plate **211***b*. The silencing plate **211***a* is disposed and fixed on the central aperture **211***c* formed at the center of the suspension plate **211***b*. The chamber frame **212** is carried and stacked on the suspension plate **211***b*. The actuator **213** is carried and stacked on the chamber frame **212**. The actuator **213** generates the bending vibration in a reciprocating manner as a voltage is applied thereto, and includes a piezoelectric-thin-plate pin **213***e*. The insulation frame **214** is carried and stacked on the actuator **213**. The conductive frame **215** is carried and stacked on the insulation frame **214**, and includes a conductive-frame pin **215***e*. A resonance chamber is collaboratively defined by the actuator **213**, the chamber frame **212** and the silencing jet orifice plate **211**. When the silencing jet orifice plate **211** is driven by the actuator **213** in resonance, the suspension plate **211***b* of the silencing jet orifice plate **211** is vibrated and displaced in the reciprocating manner, so as to achieve fluid transportation. In the embodiment, the actuator **213** includes a piezoelectric thin plate **213***a*, a piezoelectric thick plate **213***b* and a piezoelectric element **213***c*. The piezoelectric thin plate **213***a* is carried and stacked on the chamber frame **212**. Preferably but not exclusively, the piezoelectric-thin-plate pin **213***e* is a protrusion of the piezoelectric thin plate **213***a*. The piezoelectric thick plate **213***b* is carried and stacked on the piezoelectric thin plate **213***a*. The piezoelectric element **213***c* is carried and stacked on the piezoelectric thick plate **213***b*. When the voltage is applied to the piezoelectric element **213***c*, the piezoelectric thin plate **213***a* and the piezoelectric thick plate **213***b* are driven to generate the bending vibration in the reciprocating manner.

[0017] In the embodiment, the fluid transportation actuator **21** includes the silencing jet orifice plate **211**, the chamber frame **212**, the actuator **213**, the insulation frame **214** and the conductive frame **215**, which are sequentially stacked. The silencing jet orifice plate **211** includes a silencing plate **211***a*, a suspension plate **211***b* and a central aperture **211***c*. The suspension plate **211***b* has four piezoelectric-thin-plate corners (R1M, R1N, R1O and R1P). When the suspension plate **211***b* is driven by electricity, it is permitted to undergo a bending vibration. The central aperture **211***c* is formed on a center of the suspension plate **211***b*. The silencing plate **211***a* is disposed adjacent to and above the central aperture **211***c* disposed at the center of the suspension plate **211***b*. The chamber frame **212** has four chamber-frame corners (R2M, R2N, R2O and R2P). The chamber frame **212** is carried and stacked on the suspension plate **211***b*. The actuator **213** is carried and stacked on the chamber frame **212**. In the embodiment, the actuator **213** includes a piezoelectric thin plate **213***a*, a piezoelectric thick plate **213***b* and a piezoelectric element **213***c*. When a voltage is applied to the actuator **213**, the actuator **213** generates the bending vibration in a reciprocating manner. The actuator **213** further includes a piezoelectric-thin-plate pin **213***e*. Preferably but not exclusively, the piezoelectric-thin-plate pin **213***e* is a protrusion of the piezoelectric thin plate **213***a* for receiving the applied voltage. The piezoelectric thin plate **213***a* is carried and stacked on the chamber frame **212**. The piezoelectric thick plate **213***b* is carried and stacked on the piezoelectric thin plate **213***a*. The piezoelectric element **213***c* is carried and stacked on the piezoelectric thick plate **213***b*. When the voltage is applied to the piezoelectric element **213***c*, the piezoelectric thin plate **213***a* and the piezoelectric thick plate **213***b* are driven to generate bending vibration in the reciprocating manner. In the embodiment, the insulation frame **214** has four insulation-frame corners (R4M, R4N, R4O and R4P). The insulation frame **214** is carried and stacked on the actuator **213**. Preferably but not exclusively, the insulation frame **214** is carried and stacked on the piezoelectric thin plate **213***a* of the actuator **213**. The conductive frame **215** is carried and stacked on the insulation frame **214**, and includes a conductive-frame pin **215***e*. Preferably but not exclusively, the conductive-frame pin **215***e* is a protrusion of the conductive frame **215** for receiving the applied voltage. In the embodiment, a resonance chamber is collaboratively defined by the actuator **213**, the chamber frame **212** and the silencing jet orifice plate **211**. When the silencing jet orifice plate **211** is driven by the actuator **213** in resonance, the suspension plate **211***b* of the silencing jet orifice plate **211** is vibrated and displaced in the reciprocating manner, so as to achieve fluid transportation.

[0018] In the fluid transportation actuator **21** of the present disclosure, the piezoelectric thin plate **213***a* and the piezoelectric thick plate **213***b* are made of two metals having different thermal expansion coefficients, two different flexibilities and two different rigidities, and both are not stainless steel.

[0019] Notably, the piezoelectric thin plate **213***a* and the piezoelectric thick plate **213***b* are made of two metals having different thermal expansion coefficients. The actuator **213** made of metal materials having different thermal expansion coefficients can avoid to generate two adjacent resonance frequencies, so as to prevent the driving frequency offset result from the adjacent resonance frequencies. At the same time, the impedance (resistance and reactance) of the actuator **213** is reduced, so as to achieve effective electric driving and improve the working efficiency of the actuator **213**. Moreover, comparing to the actuators made of a single material (such as stainless steel) in the prior art, when the micro-blower actuator of a single material is driven, the structural strength and toughness thereof is insufficient, and it is susceptible to interference. In the embodiment, the material of the piezoelectric thin plate **213***a* or the piezoelectric thick plate **213***b* is phosphor bronze. In another embodiment, the materials of the piezoelectric thin plate **213***a* and the piezoelectric thick plate **213***b* are both phosphor bronzes, but each phosphor bronze has different chemical composition, respectively. It is understandable that the two phosphor bronzes with different chemical compositions have different thermal expansion coefficients, different flexibilities and different rigidities.

[0020] Please refer to FIGS. **3** and **4**, which are the views illustrating the assembly shown in FIGS. **1** and **2**. Moreover, please refer to FIG. **5**, which is a schematic diagram showing the dimensions of the fluid transportation actuator shown in FIG. **3**. In the fluid transportation actuator **21** of the present disclosure, the piezoelectric thin plate **213***a* has at least one first side length L**3***a*WY and at least one second side length L**3***a*XZ. Preferably but not exclusively, the length of the at least one first side length L**3***a*WY and the length of the at least one second side length L**3***a*XZ are the same. The piezoelectric thick plate **213***b* has at least one third side length L**3***b*WY and at least one fourth side length L**3***b*XZ. Preferably but not exclusively, the length of the at least one third side length L**3***b*WY and the length of the at least one fourth side length L**3***b*XZ are the same. The piezoelectric element **213***c* has at least one fifth side length L**3***c*WY and at least one sixth side length L**3***c*XZ. Preferably but not exclusively, the length of the at least one fifth side length L**3***c*WY and the length of the at least one sixth side length L**3***c*XZ are the same.

[0021] In the embodiment, the piezoelectric thin plate **213***a* has four side lengths, which are two first side lengths L**3***a*WY and two second side lengths L**3***a*XZ, respectively. Notably, the piezoelectric thin plate **213***a* may be square, but not limited thereto. In other embodiments, the piezoelectric thin plate **213***a* may be ring-shaped, circular, rectangular or polygonal. In the embodiment, the piezoelectric thick plate **213***b* has four side lengths, which are two third side lengths L**3***b*WY and two fourth side lengths L**3***b*XZ, respectively. Notably, the piezoelectric thick plate **213***b* may be square, but the present disclosure is not limited thereto. In other embodiments, the piezoelectric thick plate **213***b* may be ring-shaped, circular, rectangular or polygonal. In the embodiment, the piezoelectric element **213***c* has four side lengths, which are two fifth side lengths L**3***c*WY and two sixth side lengths L**3***c*XZ, respectively. Notably, the piezoelectric element **213***c* may be square, but not limited thereto.

In other embodiments, the piezoelectric element **213**c may be ring-shaped, circular, rectangular or polygonal. In the embodiment, the conductive frame **215** excluding the protrusion (Namely, the conductive-frame pin **215**e is excluded) has four side lengths, which are two ninth side lengths LSWYB and two eighth side lengths LSXZ, respectively. Notably, the conductive frame **215** has the longest side length, which includes the protrusion and is a seventh side length L**5**WYA.

[0022] Please refer to FIG. **6**, which shows the four corners of the fluid transportation actuator shown in FIG. **3**. In the fluid transportation actuator **21** of the present disclosure, the piezoelectric thin plate **213**a includes at least one piezoelectric-thin-plate corner (R**3**aN, R**3**aO or R**3**aP). Preferably but not exclusively, the at least one piezoelectric-thin-plate conner (R**3**aN, R**3**aO or R**3**aP) is a rounded corner, and the rounded corner has a radius less then 2.0 mm. In the embodiment, the piezoelectric thin plate **213**a includes at least another piezoelectric-thin-plate corner (R**3**aM), which is a non-rounded corner. In the fluid transportation actuator **21** of the present disclosure, the piezoelectric thick plate **213**b includes at least one piezoelectric-thick-plate corner (R**3**bM, R**3**bN, R**3**bO or R**3**bP), the at least one piezoelectric-thick-plate corner (R**3**bM, R**3**bN, R**3**bO or R**3**bP) is a rounded corner, and the rounded corner has a radius less than 2.0 mm. In the fluid transportation actuator **21** of the present disclosure, the piezoelectric element **213**c includes four piezoelectric-element corners (R**3**cM, R**3**cN, R**3**cO and R**3**cP), and the four piezoelectric-element corners (R**3**cM, R**3**cN, R**3**cO and R**3**cP) are square corners.

[0023] In the embodiment, the piezoelectric element **213**c has four corners, which are the piezoelectric-element corner R**3**cM, the piezoelectric-element corner R**3**cN, the piezoelectric-element corner R**3**cO and the piezoelectric-element corner R**3** cP, respectively. All four corners of the piezoelectric element **213**c are square corners. Notably, the four corners of the piezoelectric element **213**c are adjustable according to the practical requirements. For example, part or all of the corners of the piezoelectric element **213**c can be changed into square corners, bevel corners (single-edge corners) or polygonal corners. In the embodiment, the piezoelectric thick plate **213**b has four corners, which are the piezoelectric-thick-plate corner R**3**bM, the piezoelectric-thick-plate corner R**3**bN, the piezoelectric-thick-plate corner R**3**bO and the piezoelectric-thick-plate corner R**3**bP, respectively. All four corners of the piezoelectric thick plate **213**b are rounded corners, and the rounded corner has a radius less than 2.0 min. Notably, the four corners of the piezoelectric thick plate **213**b are adjustable according to the practical requirements. For example, part or all of the corners of the piezoelectric thick plate **213**b can be changed into square corners, bevel corners (single-edge corners) or polygonal corners. In the embodiment, the piezoelectric thin plate **213**a has four corners, which are the piezoelectric-thin-plate corner R**3**aM, the piezoelectric-thin-plate corner R**3**aN, the piezoelectric-thin-plate corner R**3**aO and the piezoelectric-thin-plate corner R**3**aP. Notably, the piezoelectric-thin-plate corner R**3**aM of the piezoelectric thin plate **213**a is a bevel corner. The piezoelectric-thin-plate conner R**3**aN, the piezoelectric-thin-plate conner R**3**aO and the piezoelectric-thin-plate corner R**3**aP of the piezoelectric thin plate **213**a are rounded corners, and the rounded corner has a radius less then 2.0 mm. The four corners of the piezoelectric thin plate **213**a are adjustable according to the practical requirements. For example, part or all of the corners of the piezoelectric thin plate **213**a can be changed into rounded corners, bevel corners (single-edge corners) or polygonal corners. In the embodiment, the conductive frame **215** has four corners, which are the conductive-frame corner RSM, the conductive-frame corner RSN, the conductive-frame corner R**50** and the conductive-frame corner RSP, respectively. Notably, the conductive-frame corner R**5**M of the conductive frame **215** is a bevel corner. The conductive-frame corner RSN, the conductive-frame corner R**50** and the conductive-frame corner R**5**P of the conductive frame **215** are rounded corners, and the rounded corner has a radius less then 2.0 mm. The four corners of the conductive frame **215** are adjustable according to the practical requirements. For example, part or all of the corners of the conductive frame **215** can be changed into rounded corners, bevel corners (single-edge corners) or polygonal corners.

[0024] Please refer to FIG. **7**, which is a cross-sectional view taken along the dash line AA in FIG. **6**. Please refer to FIG. **8**, which shows the respective dimensions of the piezoelectric thin plate **213**a, the piezoelectric thick plate **213**b and the piezoelectric element **213**c in FIG. **6**. In the fluid transportation actuator **21** of the present disclosure, the length of the first side length L**3**aWY is greater than the length of the third side length L**3**bWY. The length of the first side length L**3**aWY is greater than the length of the fifth side length L**3**cWY. The length of the third side length L**3**bWY is greater than or equal to the length of the fifth side L**3**cWY. In the fluid transportation actuator **21** of the present disclosure, the length of the first side length L**3**aWY and the length of the second side length L**3**aXZ range from 5.0 mm to 16.0 mm. In the fluid transportation actuator **21** of the present disclosure, the length of the third side length L**3**bWY and the length of the fourth side length L**3**bXZ range from 3.5 mm to 9.5 mm. In the fluid transportation actuator **21** of the present disclosure, the length of the fifth side length L**3**cWY and the length of the sixth side length L**3**cXZ range from 2.95 mm to 9.0 mm.

[0025] In the embodiment, the length of the first side length L**3**aWY of the piezoelectric thin plate **213**a is greater than the length of the third side length L**3**bWY of the piezoelectric thick **213**b. The length of the first side length L**3**aWY of the piezoelectric thin plate **213**a is greater than or equal to the length of the fifth side length L**3**cWY of the piezoelectric element **213**c. Notably, preferably but not exclusively, in the embodiment, the length of the first side length L**3**aWY and the length of the second side length L**3**aXZ of the piezoelectric thin plate **213**a are the same, the length of the third side length L**3**bWY and the length of the fourth side length L**3**bXZ of the piezoelectric thick plate **213**b are the same, the length of the fifth side length L**3**cWY and the length of the sixth side length L**3**cXZ of the piezoelectric element **213**c are the same, and the length of the ninth side length LSWYB and the length of the eighth side length LSXZ of the conductive frame **215** are the same, but not limited thereto. In other embodiments, the length of the first side length L**3**aWY and the length of the second side length L**3**aXZ of the piezoelectric thin plate **213**a are different, the length of the third side length L**3**bWY and the length of the fourth side length L**3**bXZ of the piezoelectric thick plate **213**b are different, the length of the fifth side length L**3**cWY and the length of the sixth side length L**3**cXZ of the piezoelectric element **213**c are different, and the length of the ninth side length L5WYB and the length of the eighth side length L5XZ of the conductive frame **215** are different. Preferably but not exclusively, the length of the third side length L3*b*WY and the length of the fourth side length L3*b*XZ of the piezoelectric thick plate **213***b* are 8.40 mm. Preferably but not exclusively, the length of the first side length L3*a*WY and the length of the second side length L3*a*XZ of the piezoelectric thin plate **213***a* are 12.80 mm. Preferably but not exclusively, the length of the seventh side length L5WYA is 15.20 mm, but not limited thereto. In other embodiments, the lengths of the first side length L3*a*WY, the second side length L3*a*XZ, the third side length L3*b*WY, the fourth side length L3*b*XZ, the fifth side length L3*c*WY, the sixth side length L3*c*XZ, the seventh side length L5WYA, the eighth side length L5XZ and the ninth side length L5WYB are adjustable according to the practical requirements.

[0026] In the fluid transportation actuator **21** of the present disclosure, a ratio of the length of the fifth side length L3*c*WY to the length of the third side length L3*b*WY is in a range of 1:1 to 1:1.5. Namely, the length of the fifth side length L3*c*WY of the piezoelectric element **213***c* is less than or equal to the length of the third side length L3*b*WY of the piezoelectric thick plate **213***b*.

[0027] In the fluid transportation actuator **21** of the present disclosure, the piezoelectric thick plate **213***b* has a piezoelectric-thick-plate thickness T3*b*, and the piezoelectric-thick-plate thickness T3*b* ranges from 0.05 mm to 0.5 mm. In the fluid transportation actuator **21** of the present disclosure, the piezoelectric thin plate **213***a* has a piezoelectric-thin-plate thickness T3*a*, and the piezoelectric-thin-plate thickness T3*a* ranges from 0.05 mm to 0.2 mm. The thickness of the actuator **213** is a combination of the piezoelectric-thin-plate thickness T3*a* of the piezoelectric thin plate **213***a*, the piezoelectric-thick-plate thickness T3*b* of the piezoelectric thick plate **213***b* and the piezoelectric-element thickness T3*c* of the piezoelectric element **213***c*. Preferably but not exclusively, the piezoelectric-thick-plate thickness T3*b* ranges from 0.05 to 0.5 mm, the piezoelectric-thin-plate thickness T3*a* ranges from 0.05 to 0.2, and the piezoelectric-thick-plate thickness T3*b* is thicker than the piezoelectric-thin-plate thickness T3*a*.

[0028] In summary, the present disclosure provides a fluid transportation actuator. Through the design of the piezoelectric thin plate and piezoelectric thick plate of the actuator made of metals with different thermal expansion coefficients, different flexibilities and different rigidities, the driving impedance of the conventional single-material fluid transportation actuator is improved. It prevents the driving frequency from offset result from the adjacent resonance frequencies. The structural strength and toughness is enhanced by utilizing the material of phosphor bronze. Moreover, with the design of the rounded corners in the piezoelectric thick plate, the physical damage to the piezoelectric thin plate is also reduced.

[0029] While the disclosure has been described in terms of what is presently considered to be the most practical and preferred embodiments, it is to be understood that the disclosure needs not be limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements included within the spirit and scope of the appended claims which are to be accorded with the broadest interpretation so as to encompass all such modifications and similar structures.

1. A fluid transportation actuator, comprising:

a silencing jet orifice plate, comprising;

a silencing plate;

a suspension plate permitted to undergo a bending vibration; and

a central aperture formed on a center of the suspension plate, wherein the silencing plate is disposed and fixed on the central aperture disposed at the center of the suspension plate;

a chamber frame carried and stacked on the suspension plate;

an actuator carried and stacked on the chamber frame, wherein the actuator generates the bending vibration in a reciprocating manner as a voltage is applied thereto;

an insulation frame carried and stacked on the actuator; and

a conductive frame carried and stacked on the insulation frame, and comprising a conductive-frame pin, wherein a resonance chamber is collaboratively defined by the actuator, the chamber frame and the silencing jet orifice plate, wherein when the silencing jet plate orifice is driven by the actuator in resonance, the suspension plate of the silencing jet orifice plate is vibrated and displaced in the reciprocating manner, so as to achieve fluid transportation.

2. The fluid transportation actuator according to claim **1**, wherein the actuator comprises:

a piezoelectric thin plate carried and stacked on the chamber frame;

a piezoelectric thick plate carried and stacked on the piezoelectric thin plate; and

a piezoelectric element is carried and stacked on the piezoelectric thick plate, wherein the piezoelectric element drives the piezoelectric thin plate and the piezoelectric thick plate as the voltage applied, and generates the bending vibration in the reciprocating manner.

3. The fluid transportation actuator according to claim **2**, wherein the piezoelectric thin plate and the piezoelectric thick plate are made of two metals having different thermal expansion coefficients, two different flexibilities and two different rigidities, and both are not stainless steel.

4. The fluid transportation actuator according to claim **3**, wherein the piezoelectric thin plate has at least one first side length and at least one second side length, and the length of the at least one first side length and the length of the at least one second side length are the same;

wherein the piezoelectric thick plate has at least one third side length and at least one fourth side length, and the length of the at least one third side length and the length of the at least one fourth side length are the same;

wherein the piezoelectric element has at least one fifth side length and at least one sixth side length, and the length of the at least one fifth side length and the length of the at least one sixth side length are the same.

5. The fluid transportation actuator according to claim **4**, wherein the length of the at least one first side length is greater than the length of the at least one third side length, the length of the at least one first side length is greater than the length of the at least one fifth side length, and the length of the at least one third side length is greater than or equal to the length of the at least one fifth side.

6. The fluid transportation actuator according to claim **5**, wherein a ratio of the length of the at least one fifth side length to the length of the at least one third side length is in a range of 1:1 to 1:1.5.

7. The fluid transportation actuator according to claim **5**, wherein the length of the at least one first side length and the length of the at least one second side length range from 5.0 mm to 16.0 mm.

8. The fluid transportation actuator according to claim **5**, wherein the length of the at least one third side length and the length of the at least one fourth side length range from 3.5 mm to 9.5 mm.

9. The fluid transportation actuator according to claim **5**, wherein the length of the at least one fifth side length and the length of the at least one sixth side length range from 2.95 mm to 9.0 mm.

10. The fluid transportation actuator according to claim **3**, wherein the piezoelectric thin plate comprises at least one piezoelectric-thin-plate corner, the at least one piezoelectric-thin-plate corner is a rounded corner, and the rounded corner has a radius less than 2.0 mm, wherein the piezoelectric thin plate comprises at least another piezoelectric-thin-plate corner, which is a non-rounded corner.

11. The fluid transportation actuator according to claim **3**, wherein the piezoelectric thick plate comprises at least one piezoelectric-thick-plate corner, the at least one piezoelectric-thick-plate corner is a rounded corner, and the rounded corner has a radius less than 2.0 mm.

12. The fluid transportation actuator according to claim **11**, wherein the piezoelectric thick plate has a piezoelectric-thick-plate thickness, and the piezoelectric-thick-plate thickness ranges from 0.05 mm to 0.5 mm.

13. The fluid transportation actuator according to claim **3**, wherein the piezoelectric element comprises four piezoelectric-element corners, and the four piezoelectric-element corners are square corners.

14. The fluid transportation actuator according to claim **13**, wherein the piezoelectric thin plate has a piezoelectric-thin-plate thickness, and the piezoelectric-thin-plate thickness ranges from 0.05 mm to 0.2 mm.

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