(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 July 2021 (22.07.2021)

WIPO | PCT

(10) International Publication Number
WO 2021/146645 A2

(51) International Patent Classification:
G01N 21/51 (2006.01)

(21) International Application Number:
PCT/US2021/013758

(22) International Filing Date:
15 January 2021 (15.01.2021)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
16/744,172 15 January 2020 (15.01.2020) US

(71) Applicant: **WYATT TECHNOLOGY CORPORATION** [US/US]; 6330 Hollister Avenue, Goleta, California 93117 (US).

(72) Inventors: **AMARAL, Drew**; 22162 J Street, Santa Margarita, California 93453 (US). **HSIEH, Vincent**; 5348 Traci Drive, Santa Barbara, California 93111 (US).

(74) Agent: **GUZMAN, Leonard**; 6330 Hollister Avenue, Goleta, California 93117 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: FLOW CELL, READ HEAD, AND SKID ATTACHMENT

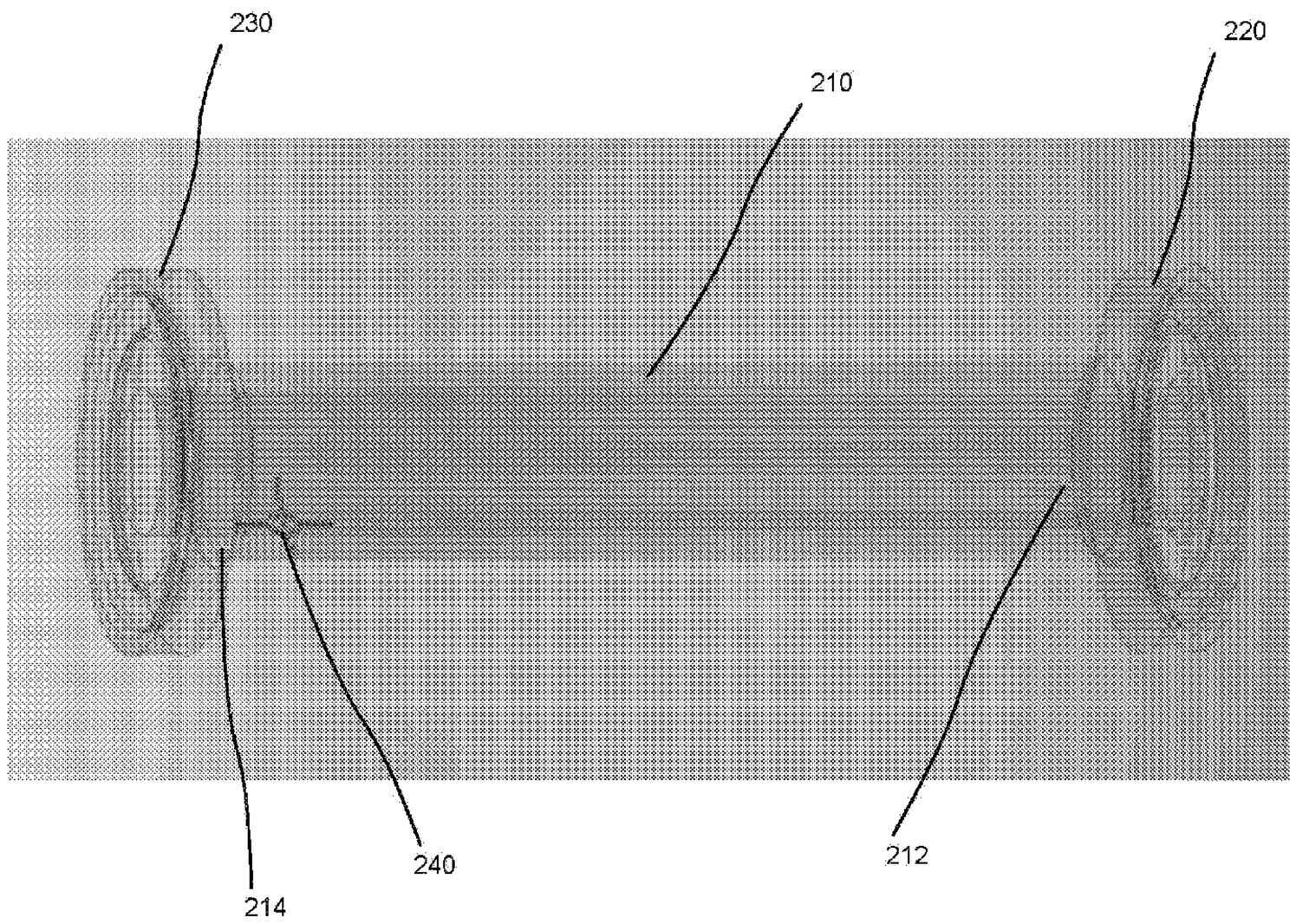


FIG. 2A

(57) Abstract: The present disclosure describes a flow cell, a read head, and a skid attachment for measuring real-time molecular weight for downstream process control. In an embodiment, the flow cell comprises a hollow cylindrical tube, an inlet flange connected to an inlet of the tube, and an outlet flange connected to an outlet of the tube. In an embodiment, the read head comprises at least one push rod, at least two line contacts, where the at least one push rod is configured to push an outer side wall of a flow cell against the at least two line contacts. In an embodiment, the skid attachment comprises a plurality of arms connected to an enclosure configured to house at least a multi-angle light scattering instrument comprising a read head.

[Continued on next page]

WO 2021/146645 A2

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

FLOW CELL, READ HEAD, AND SKID ATTACHMENT

PRIORITY

This application claims priority to U.S. Patent Application Serial No. 16/744,172, filed January 15, 2020.

BACKGROUND

[0001] The present disclosure relates to multi-angle light scattering, and more specifically, to a flow cell, a read head, and a skid attachment for measuring real-time molecular weight for downstream process control.

SUMMARY

[0002] The present disclosure describes a flow cell, a read head, and a skid attachment for measuring real-time molecular weight for downstream process control. In an exemplary embodiment, the flow cell comprises (1) a hollow cylindrical tube, (2) an inlet flange connected to an inlet of the tube, and (3) an outlet flange connected to an outlet of the tube. In an exemplary embodiment, the read head comprises (1) at least one push rod, (2) at least two line contacts, where the at least one push rod is configured to push an outer side wall of a flow cell against the at least two line contacts, thereby registering the flow cell within the read head. In an exemplary embodiment, the skid attachment comprises a plurality of arms connected to an enclosure configured to house at least a multi-angle light scattering instrument comprising a read head, where the enclosure is configured to be connected to a skid via the plurality of arms, where the skid is configured to house chemical processing equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] FIG. 1 depicts a block diagram in accordance with an exemplary embodiment.

[0004] FIG. 2A depicts a flow cell in accordance with an exemplary embodiment.

[0005] FIG. 2B depicts a flow cell in accordance with an exemplary embodiment.

[0006] FIG. 2C depicts a flow cell in accordance with an exemplary embodiment.

[0007] FIG. 2D depicts a flow cell in accordance with an exemplary embodiment.

[0008] FIG. 2E depicts a flow cell in accordance with an exemplary embodiment.

[0009] FIG. 2F depicts a flow cell in accordance with an exemplary embodiment.

[0010] FIG. 2G depicts a flow cell in accordance with an exemplary embodiment.

[0011] FIG. 3 depicts a flow cell in accordance with an exemplary embodiment.

[0012] FIG. 4A depicts a read head in accordance with an exemplary embodiment.

[0013] FIG. 4B depicts a read head in accordance with an exemplary embodiment.

[0014] FIG. 4C depicts a read head in accordance with an exemplary embodiment.

[0015] FIG. 4D depicts a read head in accordance with an exemplary embodiment.

[0016] FIG. 4E depicts a read head in accordance with an exemplary embodiment.

[0017] FIG. 4F depicts a read head in accordance with an exemplary embodiment.

[0018] FIG. 4G depicts a read head in accordance with an exemplary embodiment.

[0019] FIG. 4H depicts a read head in accordance with an exemplary embodiment.

[0020] FIG. 4I depicts a read head in accordance with an exemplary embodiment.

[0021] FIG. 4J depicts a read head in accordance with an exemplary embodiment

[0022] FIG. 4K depicts a read head in accordance with an exemplary embodiment.

[0023] FIG. 5A depicts a skid attachment in accordance with an exemplary embodiment.

[0024] FIG. 5B depicts a skid attachment in accordance with an exemplary embodiment.

[0025] FIG. 5C depicts a skid attachment in accordance with an exemplary embodiment.

[0026] FIG. 6A depicts a skid attachment in accordance with an exemplary embodiment.

[0027] FIG. 6B depicts a skid attachment in accordance with an exemplary embodiment.

[0028] FIG. 6C depicts a skid attachment in accordance with an exemplary embodiment.

[0029] FIG. 7A depicts a skid attachment in accordance with an exemplary embodiment.

[0030] FIG. 7B depicts a skid attachment in accordance with an exemplary embodiment.

[0031] FIG. 7C depicts a skid attachment in accordance with an exemplary embodiment.

[0032] FIG. 8 depicts a graph in accordance with an embodiment

DETAILED DESCRIPTION

[0033] The present disclosure describes a flow cell, a read head, and a skid attachment for measuring real-time molecular weight for downstream process control. In an exemplary embodiment, the flow cell comprises (1) a hollow cylindrical tube, (2) an inlet flange connected to an inlet of the tube, and (3) an outlet flange connected to an outlet of the tube. In an exemplary embodiment, the read head comprises (1) at least one push rod, (2) at least two line contacts, where the at least one push rod is configured to push an outer side wall of a flow cell against the at least two line contacts, thereby registering the flow cell within the read head. In an exemplary embodiment, the skid attachment comprises a plurality of arms connected to an enclosure configured to house at least a multi-angle light scattering instrument comprising a read head, where the enclosure is configured to be connected to a skid via the plurality of arms, where the skid is configured to house chemical processing equipment.

Flow Cell

[0034] In an exemplary embodiment, the flow cell is depicted in FIG. 2A, FIG. 2B, FIG. 2C, FIG. 2D, FIG. 2E, FIG. 2F, FIG. 2G, and FIG. 3. Referring to in FIG. 2A, FIG. 2B, FIG. 2C, FIG. 2D, FIG. 2E, FIG. 2F, FIG. 2G, in an exemplary embodiment, the flow cell includes a hollow cylindrical tube 210, an inlet flange 220 connected to an inlet 212 of tube 210, and an outlet flange 230 connected to an outlet 214 of tube 210. In an embodiment, tube 210 includes an orientation indicator 240 configured to allow the flow cell to be positioned within a read head.

[0035] In an embodiment, tube 210, inlet flange 220, and outlet flange 230 include an optically clear material. In a particular embodiment, tube 210, inlet flange 220, and outlet flange 230 are an optically clear material. In an embodiment, tube 210, inlet flange 220, and outlet flange 230 include a material with the optical qualities, the chemical resistivity, and the strength of fused quartz. In a particular embodiment, tube 210, inlet flange 220, and outlet flange 230 are a material with the optical qualities, the chemical resistivity, and the strength of fused quartz. In an embodiment, the material is one of fused silica, sapphire, borosilicate, Schott N-K5 glass, and fused quartz. In an embodiment, tube 210, inlet flange 220, and outlet flange 230 include fused quartz. In a particular embodiment, tube 210, inlet flange 220, and outlet flange 230 are fused quartz.

[0036] In an embodiment, tube 210, inlet flange 220, and outlet flange 230 include a material with at least the Young's modulus of fused silica, at least the tensile strength of fused silica, at least the sheer strength of fused silica, and at least the yield strength of fused silica. In a particular embodiment, tube 210, inlet flange 220, and outlet flange 230 are a material with at least the Young's modulus of fused silica, at least the tensile strength of fused silica, at least the sheer strength of fused silica, and at least the yield strength of fused silica.

[0037] In an embodiment, tube 210 has a concentricity of less than 0.13. In a particular embodiment, tube 210 has a concentricity greater than or equal to 0.05 and less than or equal to 0.07. In an embodiment, tube 210, inlet flange 220, and outlet flange 230 have a scratch dig between 10-5 and 20-10.

[0038] In an embodiment, tube 210, inlet flange 220, and outlet flange 230 are compatible with industry standard sanitary tri-clamp fittings. In an embodiment, tube 210, inlet flange 220, and outlet flange 230 are gamma-sterilizable. In an embodiment, tube 210, inlet flange 220, and outlet flange 230 are disposable. In an embodiment, tube 210, inlet flange 220, and outlet flange 230 are compatible with a volume flow rate of greater than or equal to 20 L/minute.

Read Head

[0039] In an exemplary embodiment, the read head is depicted in FIG. 4A, FIG. 4B, FIG. 4C, FIG. 4D, FIG. 4E, FIG. 4F, FIG. 4G, FIG. 4H, FIG. 4I, FIG. 4J, and FIG. 4K.

[0040] Referring to in FIG. 4A, FIG. 4B, FIG. 4C, FIG. 4D, FIG. 4E, FIG. 4F, FIG. 4G, FIG. 4H, FIG. 4I, FIG. 4J, and FIG. 4K, in an exemplary embodiment, the read head includes at least one push rod 410, at least two line contacts 420, 430, and where at least one push rod 410 is configured to push an outer side wall of a flow cell against at least two line contacts 420, 430, thereby registering the flow cell within the read head. In an embodiment, the read head is configured to hold the flow cell in a flow cell holder, where the flow cell and the flow cell holder are concentric.

[0041] In a further embodiment, the read head further includes a lever 440 connected to push rod 410, where lever 440 is configured to be moved in a first direction to move push rod 410 to push the outer side wall of the flow cell against at least two line contacts 420, 430, thereby registering the flow cell within the read head, and where lever 440 is configured to be moved in a second direction to move push rod 410 away from the outer side wall of the flow cell, thereby releasing the flow cell from at least two line contacts 420, 430, thereby releasing the flow cell from the read head. In an embodiment, each of at least two line contacts 420, 430 include a first line contact piece 425, 427; and a second line contact piece 435, 437 in line with first line contact piece 425, 427 and separated from first line contact piece 425, 427 by a distance. In a particular embodiment, the distance is at least 0.5 in. In an embodiment, a spring, a cam, a hydraulic press, an electric servo motor, a pneumatic press, or a screw is connected to push rod 410, where the spring, the cam, the hydraulic press, the electric servo motor, the pneumatic press, or the screw is configured to be moved in a first direction to move push rod 410 to push the outer side wall of the flow cell against at least two line contacts 420, 430, thereby registering the flow cell within the read head, and where the spring, the cam, the hydraulic press, the electric servo motor, the

pneumatic press, or the screw is configured to be moved in a second direction to move push rod 410 away from the outer side wall of the flow cell, thereby releasing the flow cell from at least two line contacts 420, 430, thereby releasing the flow cell from the read head. Registering the flow cell within the read head could allow for more accurate measurements from the flow cell.

[0042] In an exemplary embodiment, the read head includes at least one push rod, at least three point contacts, and where the at least one push rod is configured to push an outer side wall of a flow cell against the at least three point contacts, thereby registering the flow cell within the read head. In a further embodiment, a read head further includes a lever connected to the push rod, where the lever is configured to be moved in a first direction to move the push rod to push the outer side wall of the flow cell against the at least three point contacts, thereby registering the flow cell within the read head, and where the lever is configured to be moved in a second direction to move the push rod away from the outer side wall of the flow cell, thereby releasing the flow cell from the at least three point contacts, thereby releasing the flow cell from the read head.

Skid Attachment

[0043] In an exemplary embodiment, the skid attachment is depicted in FIG. 5A, FIG. 5B, FIG. 5C, FIG. 6A, FIG. 6B, FIG. 6C, FIG. 7A, FIG. 7B, and FIG. 7C. Referring to in FIG. 5A, FIG. 5B, FIG. 5C, FIG. 6A, FIG. 6B, FIG. 6C, FIG. 7A, FIG. 7B, and FIG. 7C, in an exemplary embodiment, the skid attachment includes a plurality of arms 510, 610, 710 connected to an enclosure 540, 640, 740, configured to house at least a multi-angle light scattering instrument comprising a read head. In an embodiment, plurality of arms 510, 610, 710 include at least four arms.

[0044] In a particular embodiment, plurality of arms 510, 610, 710 include at least two sets of arms 512, 516, 612, 616, 712, 716, wherein each of at least two sets of arms 512, 516, 612, 616, 712, 716 includes two arms 520, 522, 526, 528, 620, 622, 626, 628, 720, 722, 726, 728

connected to an enclosure holder 530, 532, 630, 632, 730, 732 configured to be connected to enclosure 540, 640, 740.

[0045] In an embodiment, enclosure 540, 640, 740 is configured to be connected to a skid via plurality of arms 510, 610, 710. In an embodiment, the skid is configured to house chemical processing equipment.

[0046] In a further embodiment, plurality of arms 510 and 610 further include at least two pins 550, 552, 650, 652, where at least two pins 550, 552, 650, 652 are configured to couple together at least two sets of arms 512, 516, 612, 616, thereby connecting plurality of arms 510, 610 and enclosure 540, 640 to the skid.

Example

[0047] As an example, FIG. 8 depicts the performance of the flow cell when connected to chemical processing equipment.

[0048] The descriptions of the various embodiments of the present disclosure have been presented for purposes of illustration, but are not intended to be exhaustive or limited to the embodiments disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the described embodiments. The terminology used herein was chosen to explain the principles of the embodiments, the practical application or technical improvement over technologies found in the marketplace, or to enable others of ordinary skill in the art to understand the embodiments disclosed herein.

CLAIMS

What is claimed is:

1. A flow cell comprising:

a hollow cylindrical tube;

an inlet flange connected to an inlet of the tube; and

an outlet flange connected to an outlet of the tube.

2. The flow cell of claim 1 wherein the tube, the inlet flange, and the outlet flange comprise an optically clear material.

3. The flow cell of claim 1 wherein the tube, the inlet flange, and the outlet flange comprise a material with the optical qualities, the chemical resistivity, and the strength of fused quartz.

4. The flow cell of claim 2 wherein the material is one of fused silica, sapphire, borosilicate, Schott N-K5 glass, and fused quartz.

5. The flow cell of claim 1 wherein the tube has a concentricity of less than 0.13.

6. The flow cell of claim 5 wherein the tube has a concentricity greater than or equal to 0.05 and less than or equal to 0.07.

7. The flow cell of claim 1 wherein the tube, the inlet flange, and the outlet flange have a scratch dig between 10-5 and 20-10.

8. The flow cell of claim 1 wherein the tube, the inlet flange, and the outlet flange are

compatible with industry standard sanitary tri-clamp fittings.

9. The flow cell of claim 1 wherein the tube, the inlet flange, and the outlet flange are compatible with a volume flow rate of greater than or equal to 20 L/minute.

10. The flow cell of claim 1 wherein the tube comprises an orientation indicator configured to allow the flow cell to be positioned within a read head.

11. A read head comprising:

at least one push rod;

at least two line contacts; and

wherein the at least one push rod is configured to push an outer side wall of a flow cell against the at least two line contacts, thereby registering the flow cell within the read head.

12. The read head of claim 11 further comprising a lever connected to the push rod,

wherein the lever is configured to be moved in a first direction to move the push rod to push the outer side wall of the flow cell against the at least two line contacts, thereby registering the flow cell within the read head, and

wherein the lever is configured to be moved in a second direction to move the push rod away from the outer side wall of the flow cell, thereby releasing the flow cell from the at least two line contacts, thereby releasing the flow cell from the read head.

13. The read head of claim 11 wherein each of the at least two line contacts comprise:

a first line contact piece; and

a second line contact piece in line with the first line contact piece and separated from first line contact piece by a distance.

14. The read head of claim 13 wherein the distance is at least 0.5 in.

15. A skid attachment comprising:

a plurality of arms connected to an enclosure configured to house at least a multi-angle light scattering instrument comprising a read head.

16. The skid attachment of claim 15 wherein the plurality of arms comprise at least four arms.

17. The skid attachment of claim 16 wherein the plurality of arms comprise at least two sets of arms,

wherein each of the at least two sets of arms comprise

two arms connected to an enclosure holder configured to be connected to the enclosure.

18. The skid attachment of claim 17 wherein the enclosure is configured to be connected to a skid via the plurality of arms.

19. The skid attachment of claim 18 wherein the skid is configured to house chemical processing equipment.

20. The skid attachment of claim 18 further comprising at least two pins,

wherein the at least two pins are configured to couple together the at least two sets of arms, thereby connecting the plurality of arms and the enclosure to the skid.

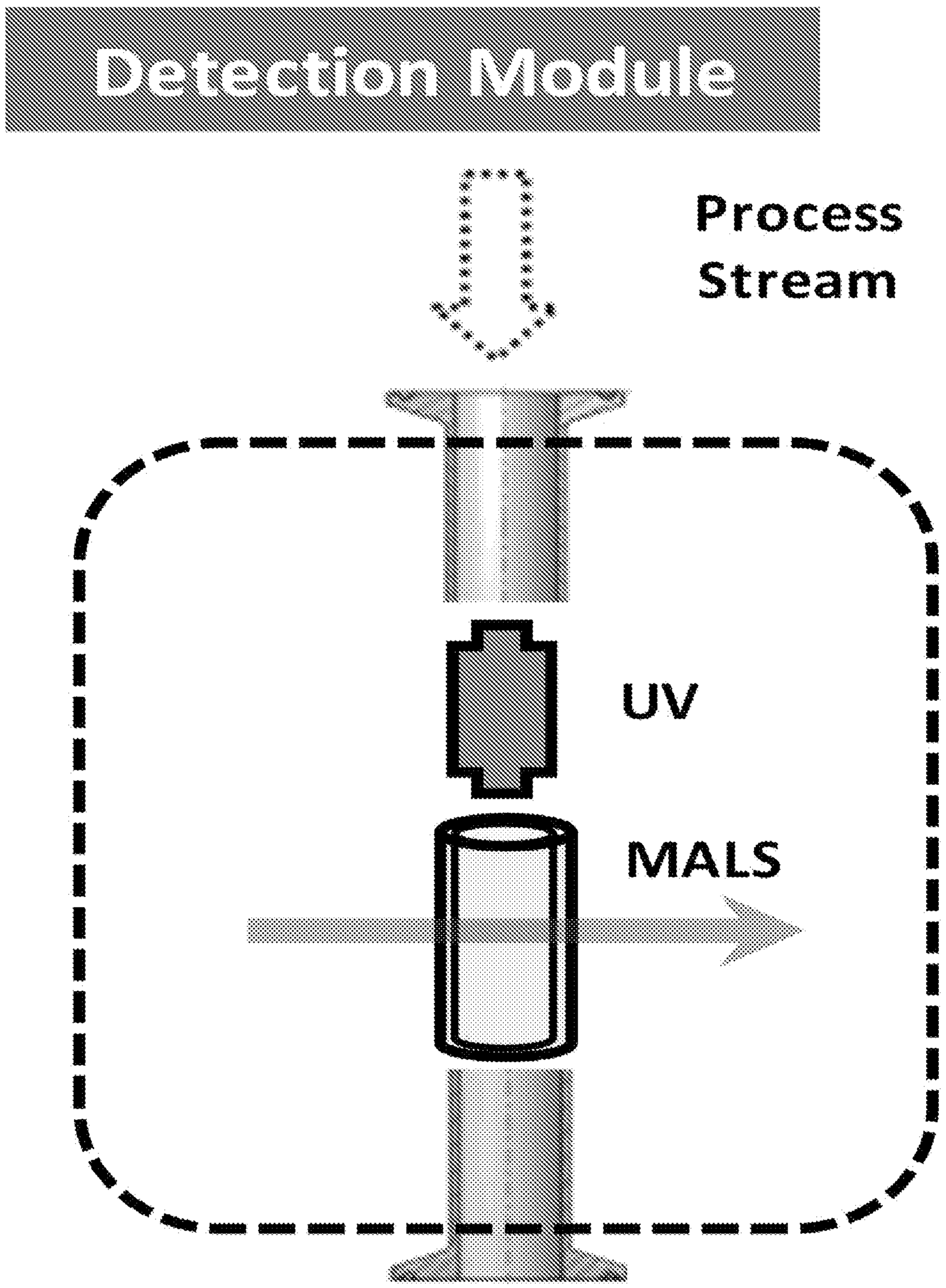

Detection Module
Process Stream
UV
MALS
Standard Sanitary Tri-Clamp Fitting

FIG. 1

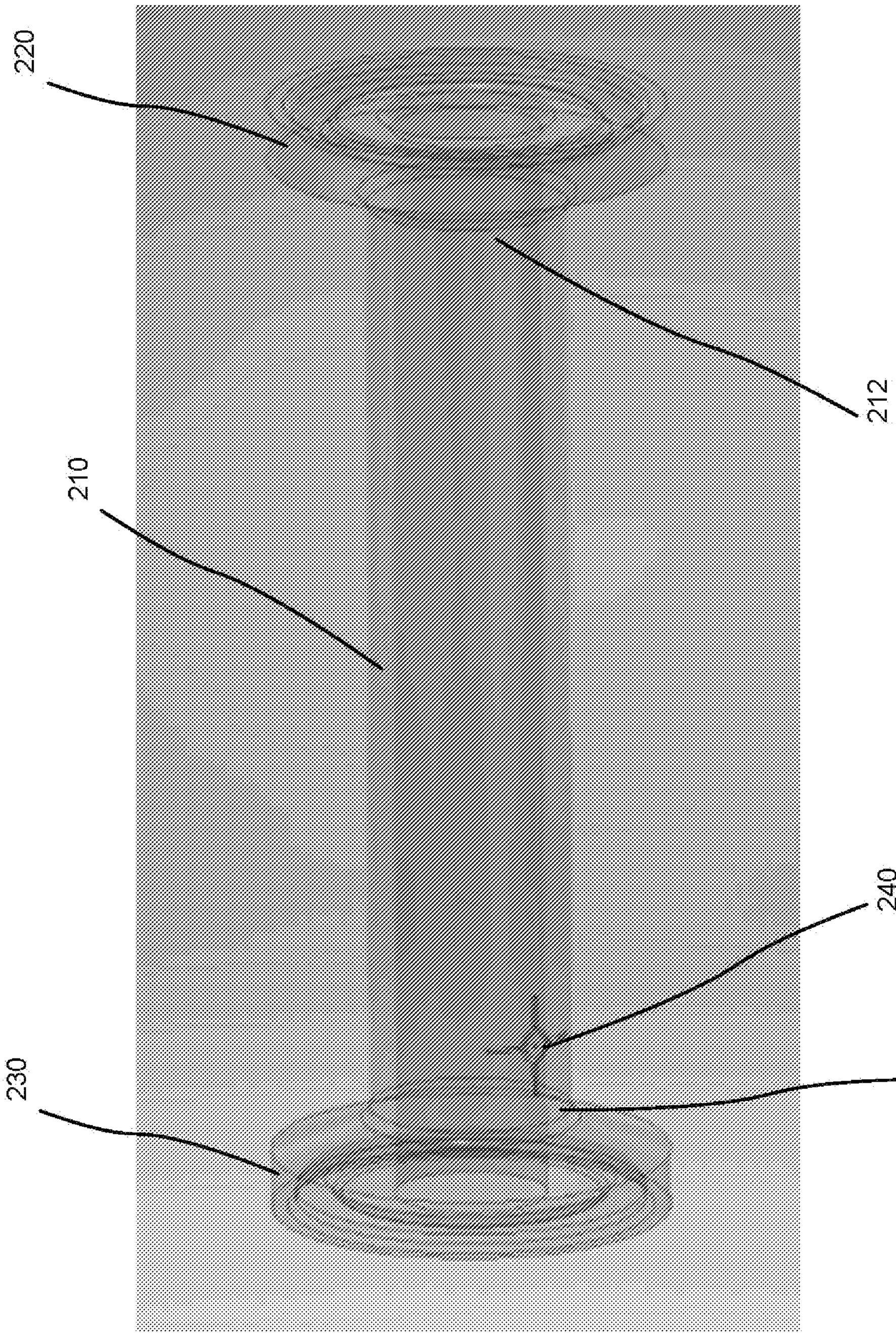


FIG. 2A

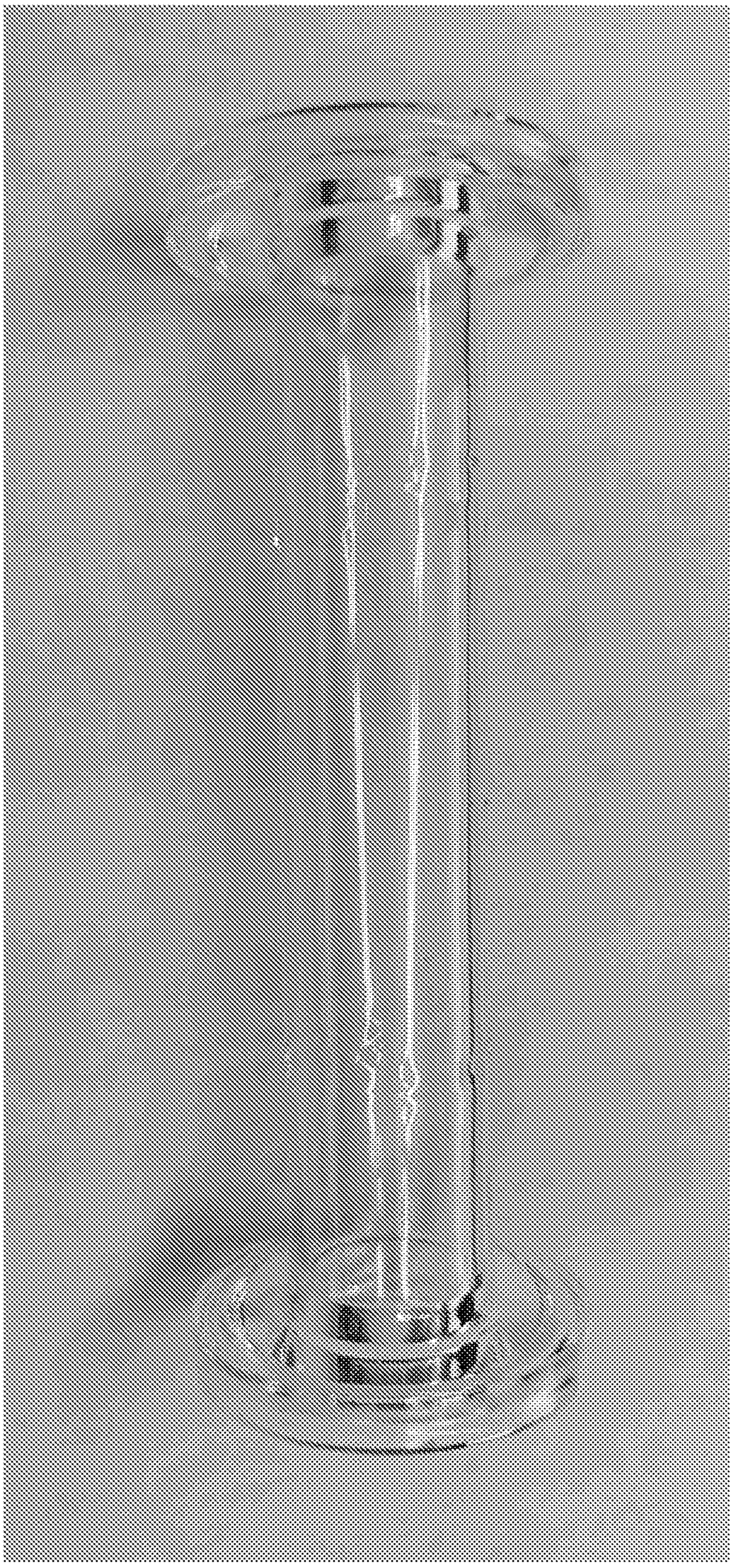


FIG. 2B

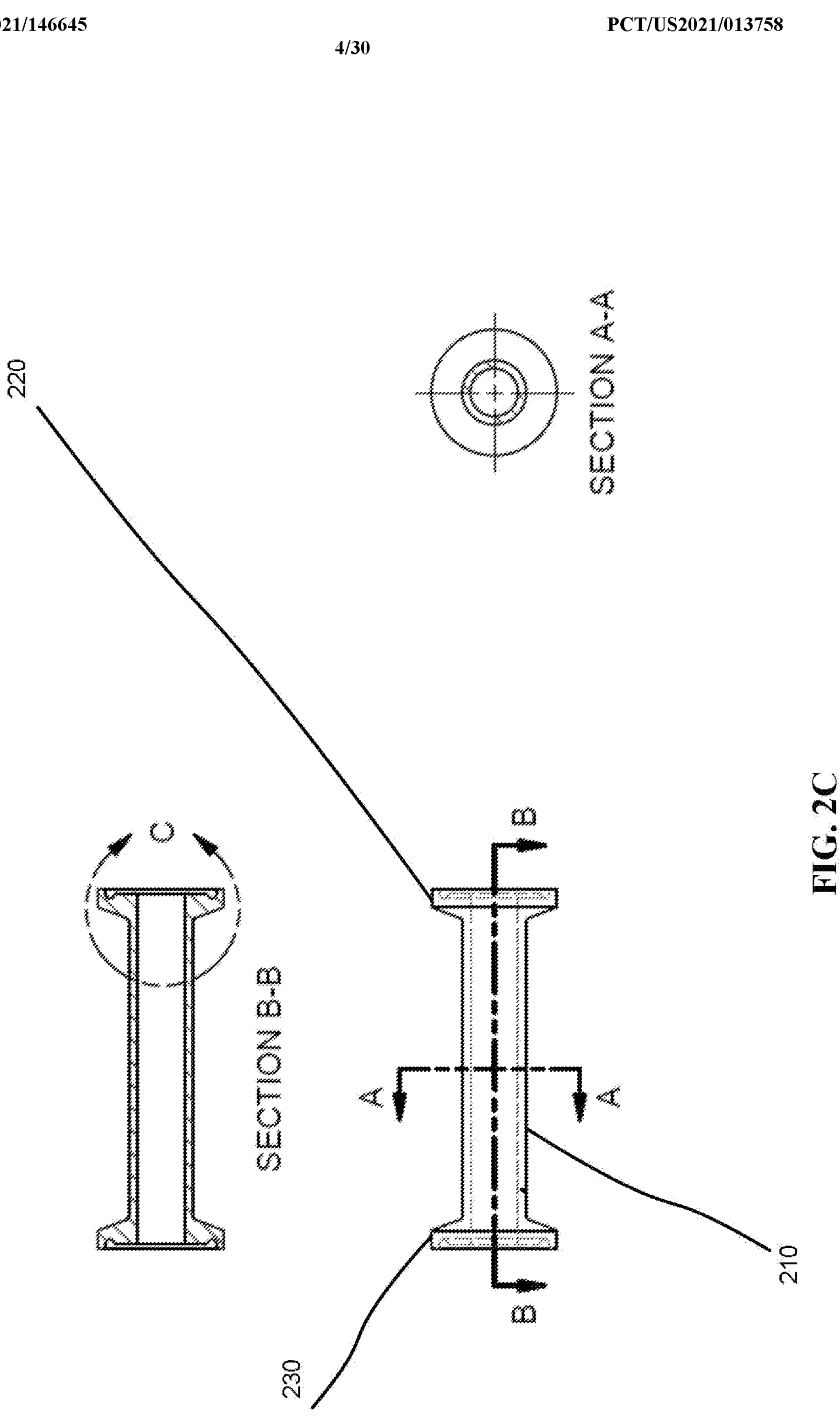


FIG. 2C

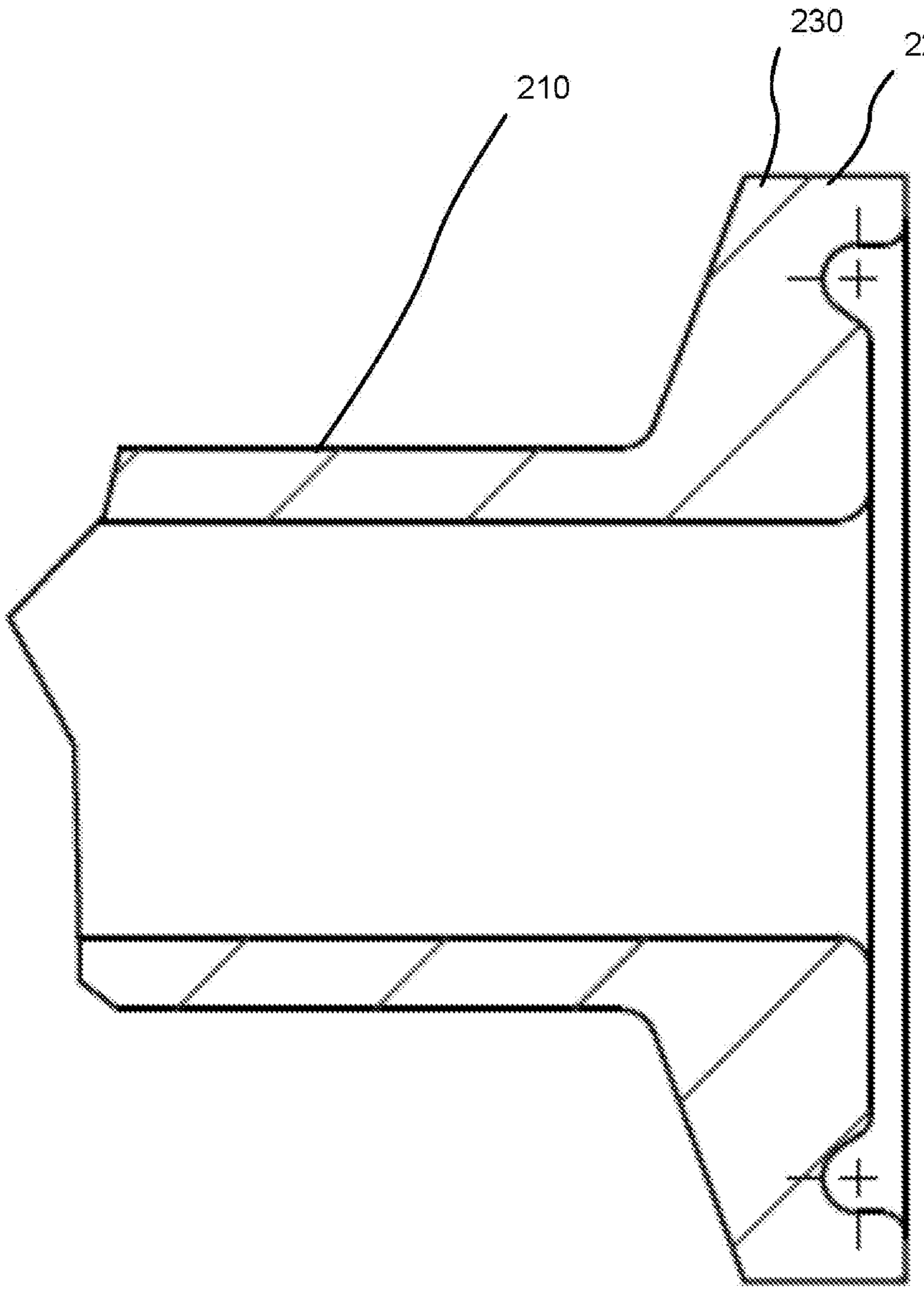


FIG. 2D

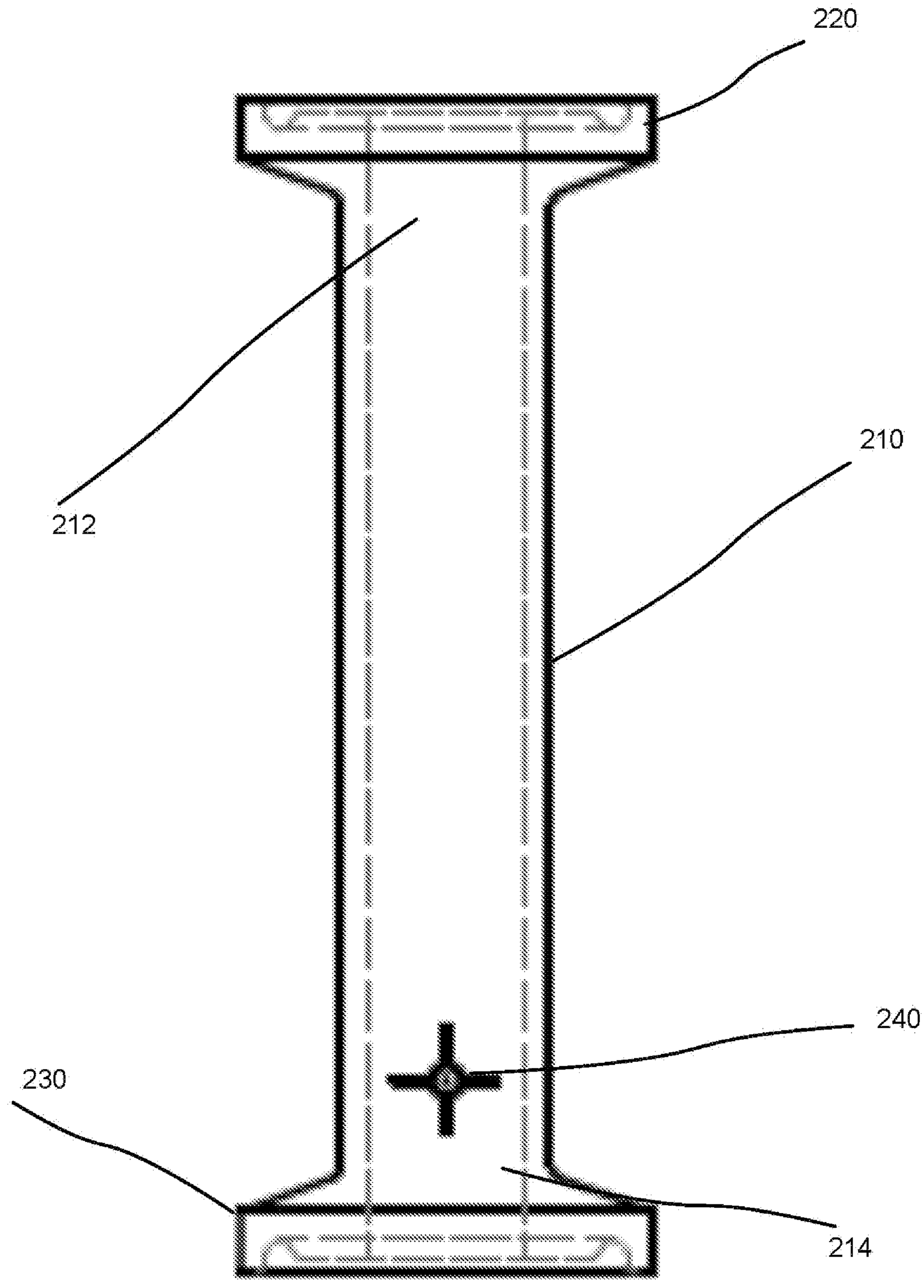


FIG. 2E

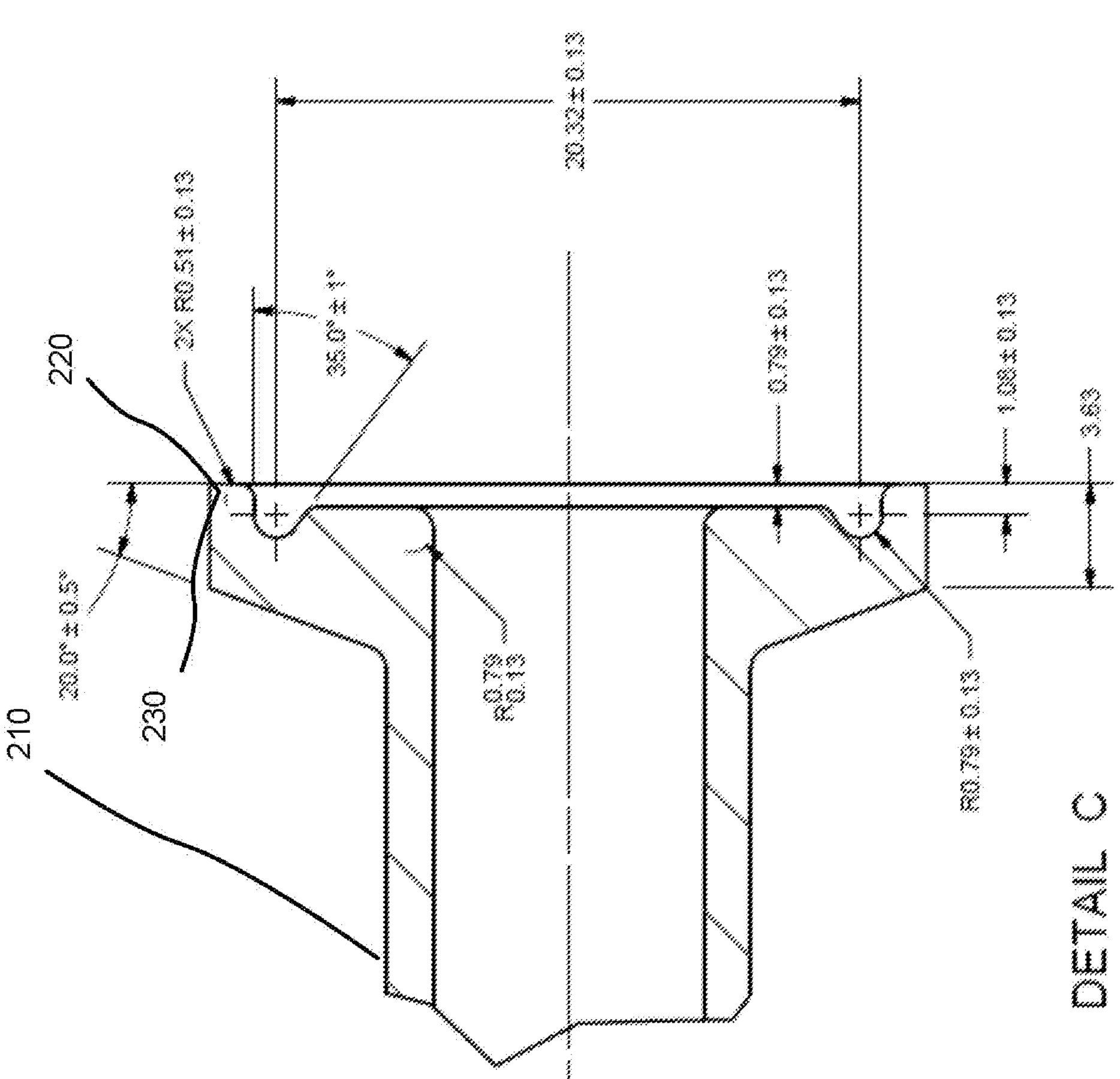


FIG. 2F

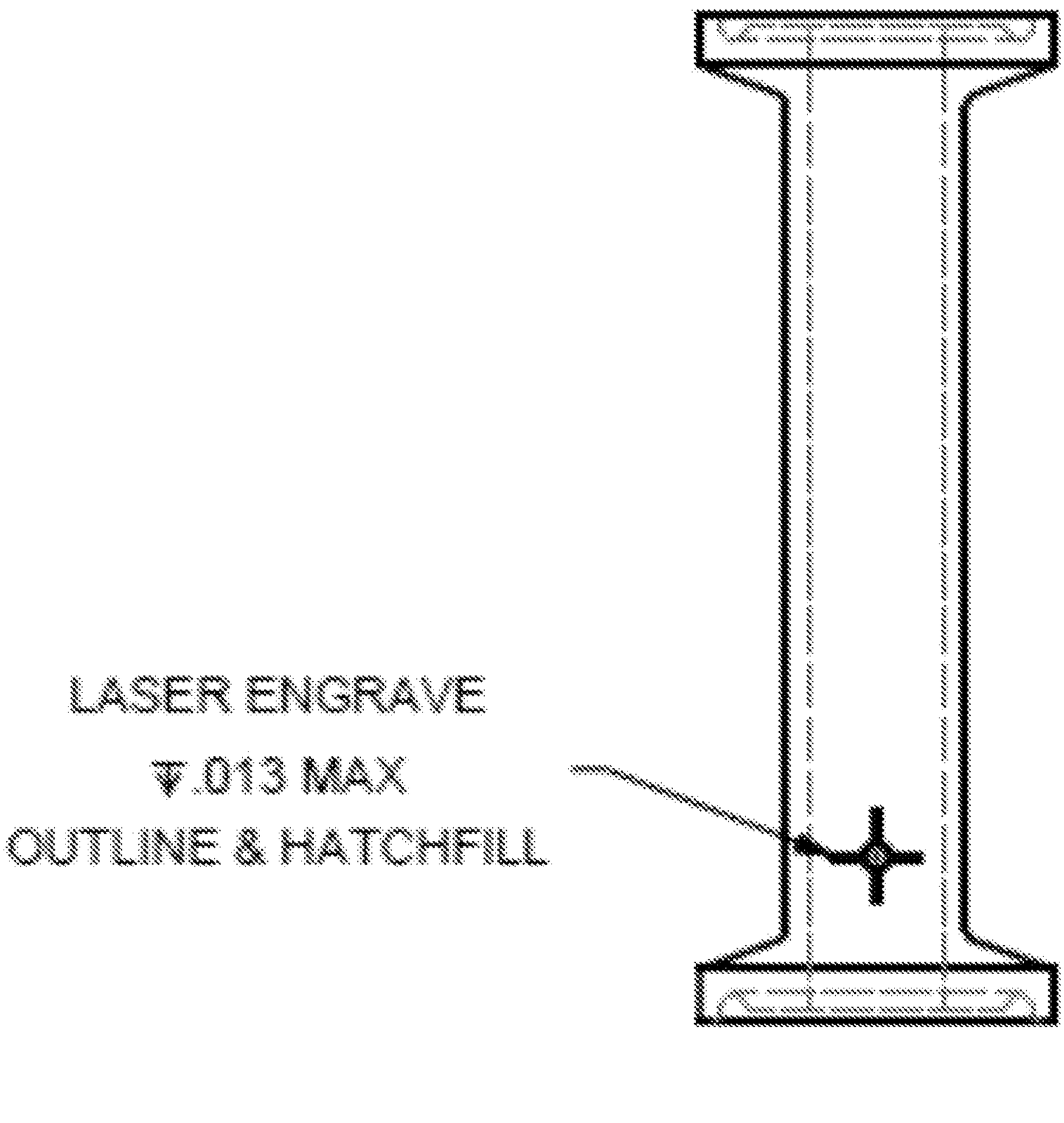


FIG. 2G

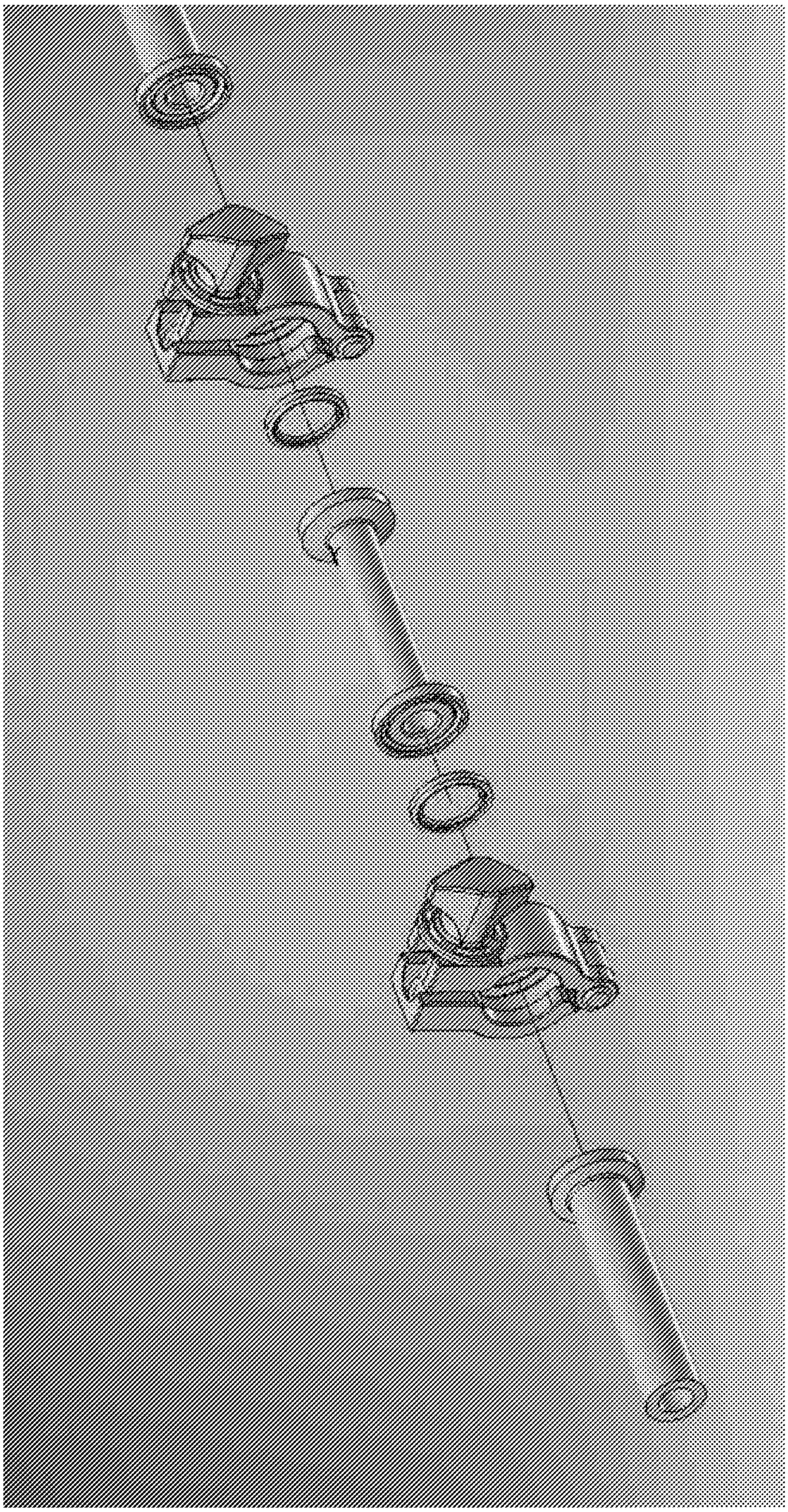


FIG. 3

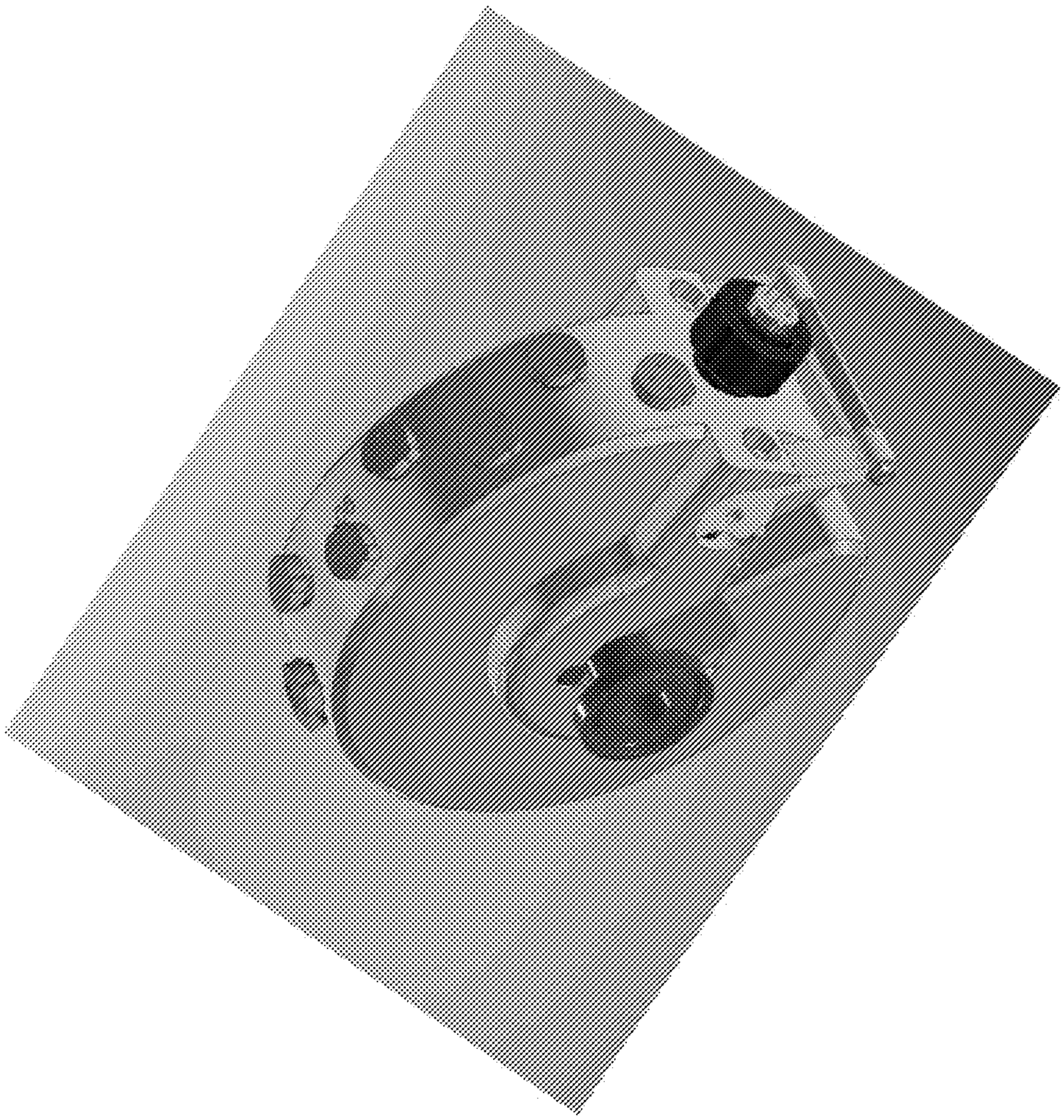


FIG. 4A

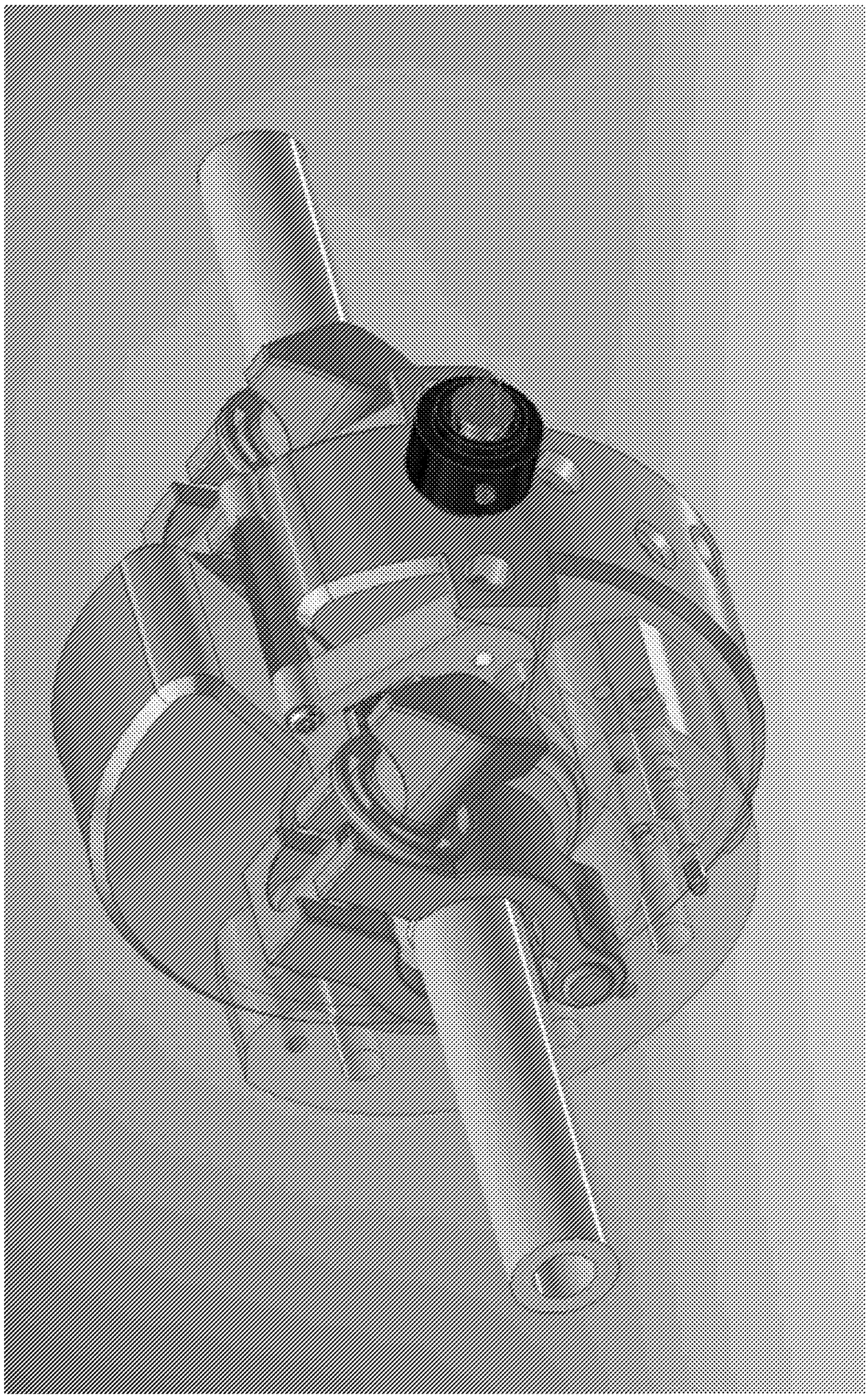


FIG. 4B

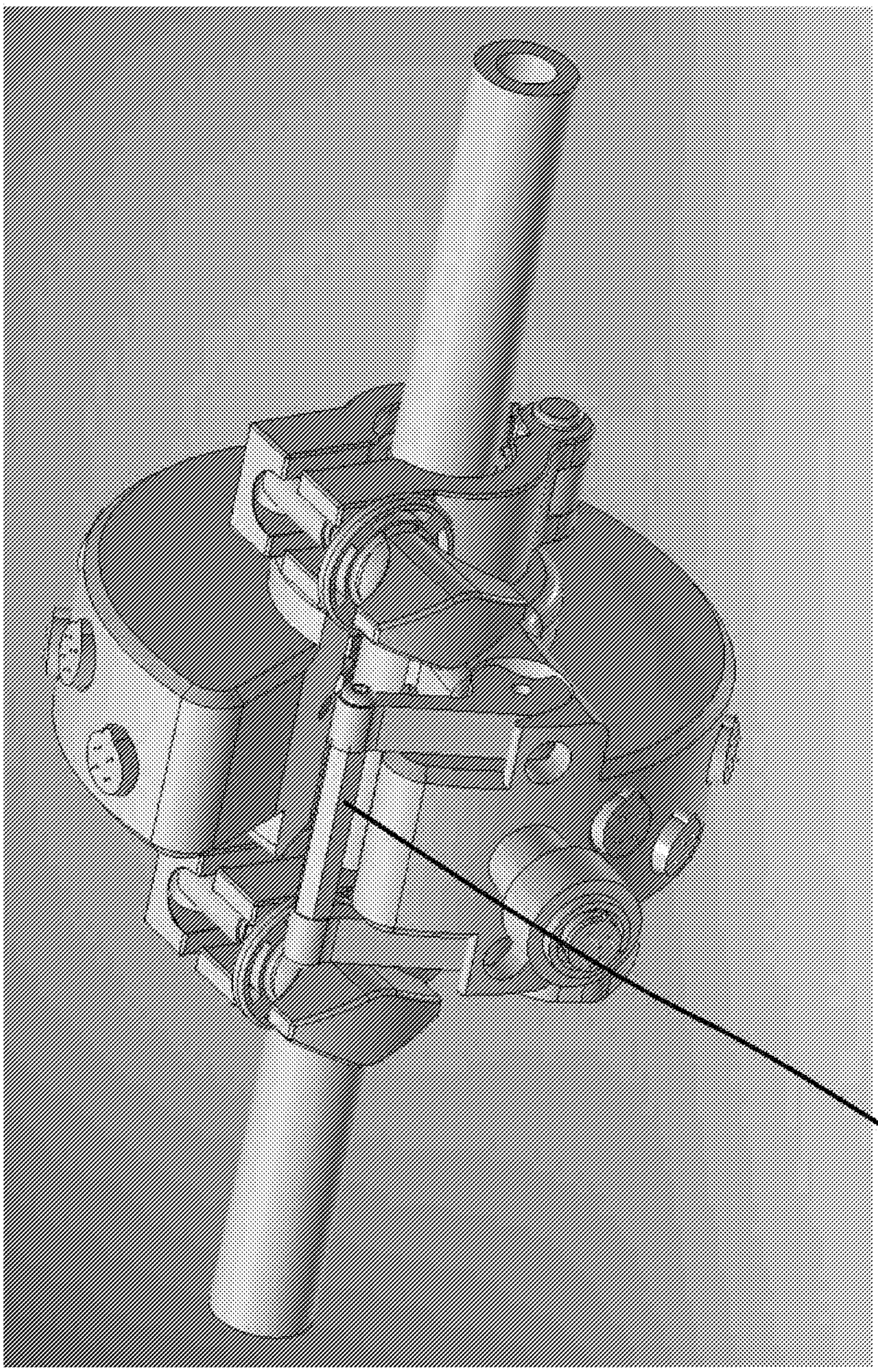


FIG. 4C

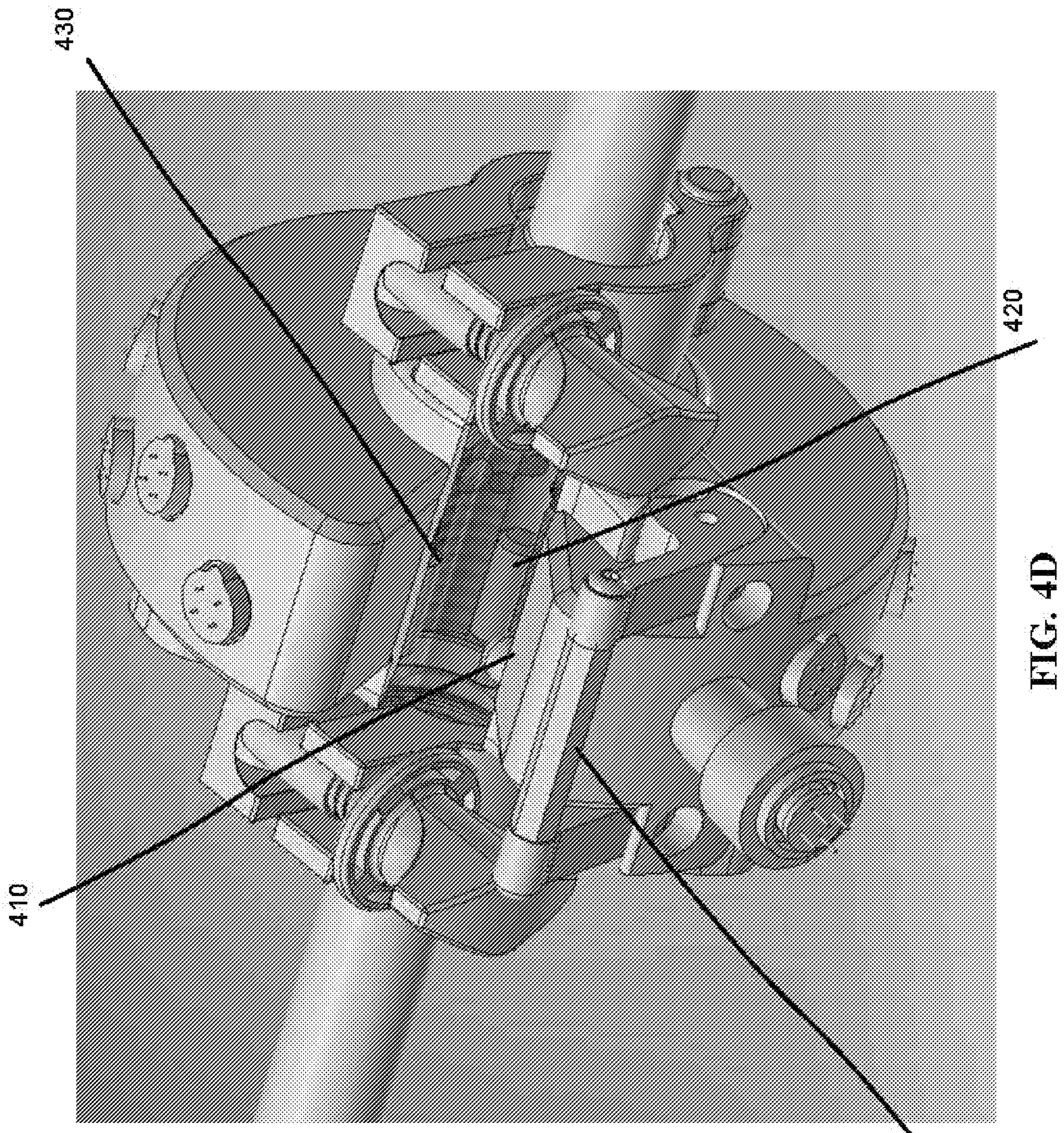


FIG. 4D

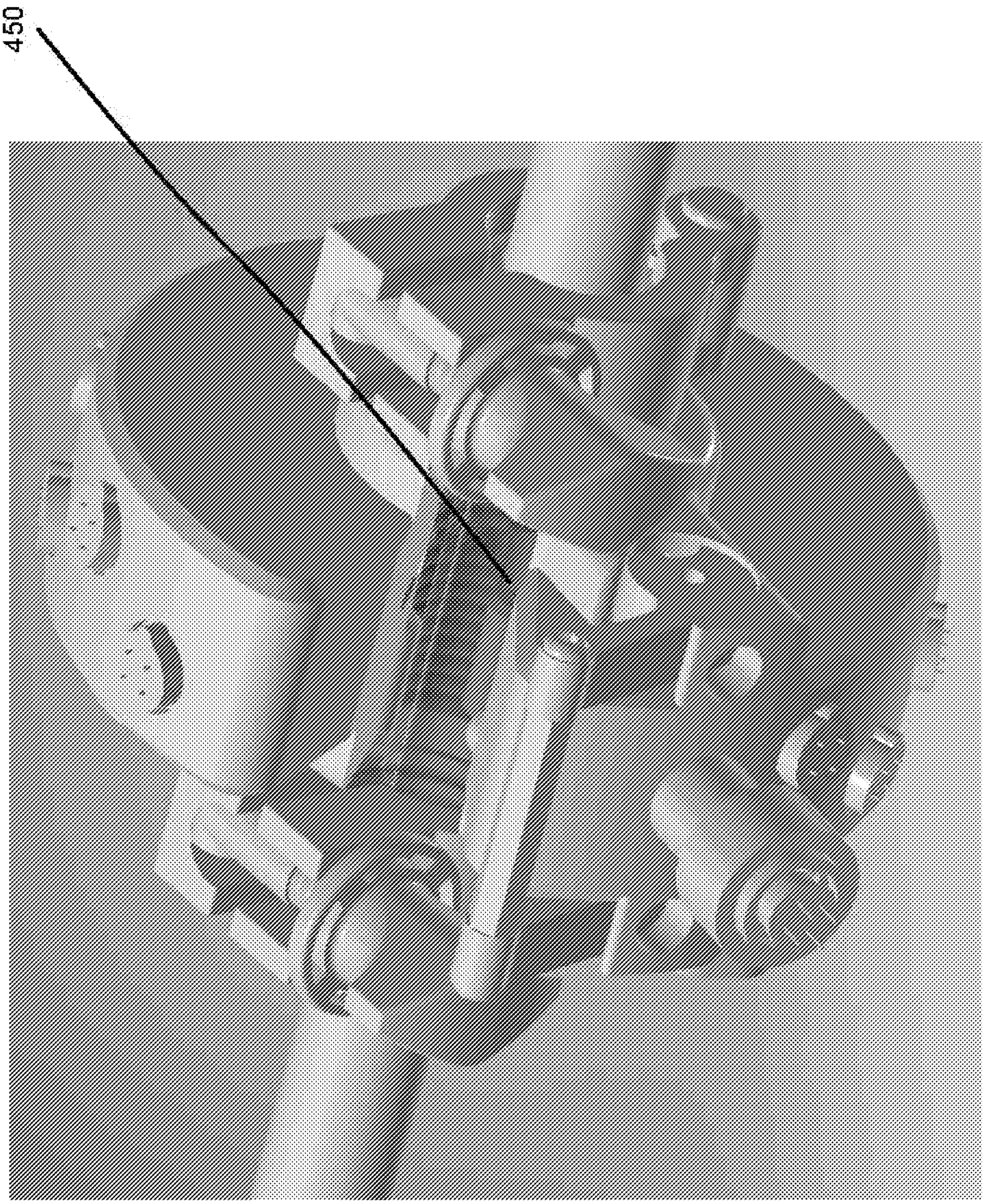


FIG. 4B

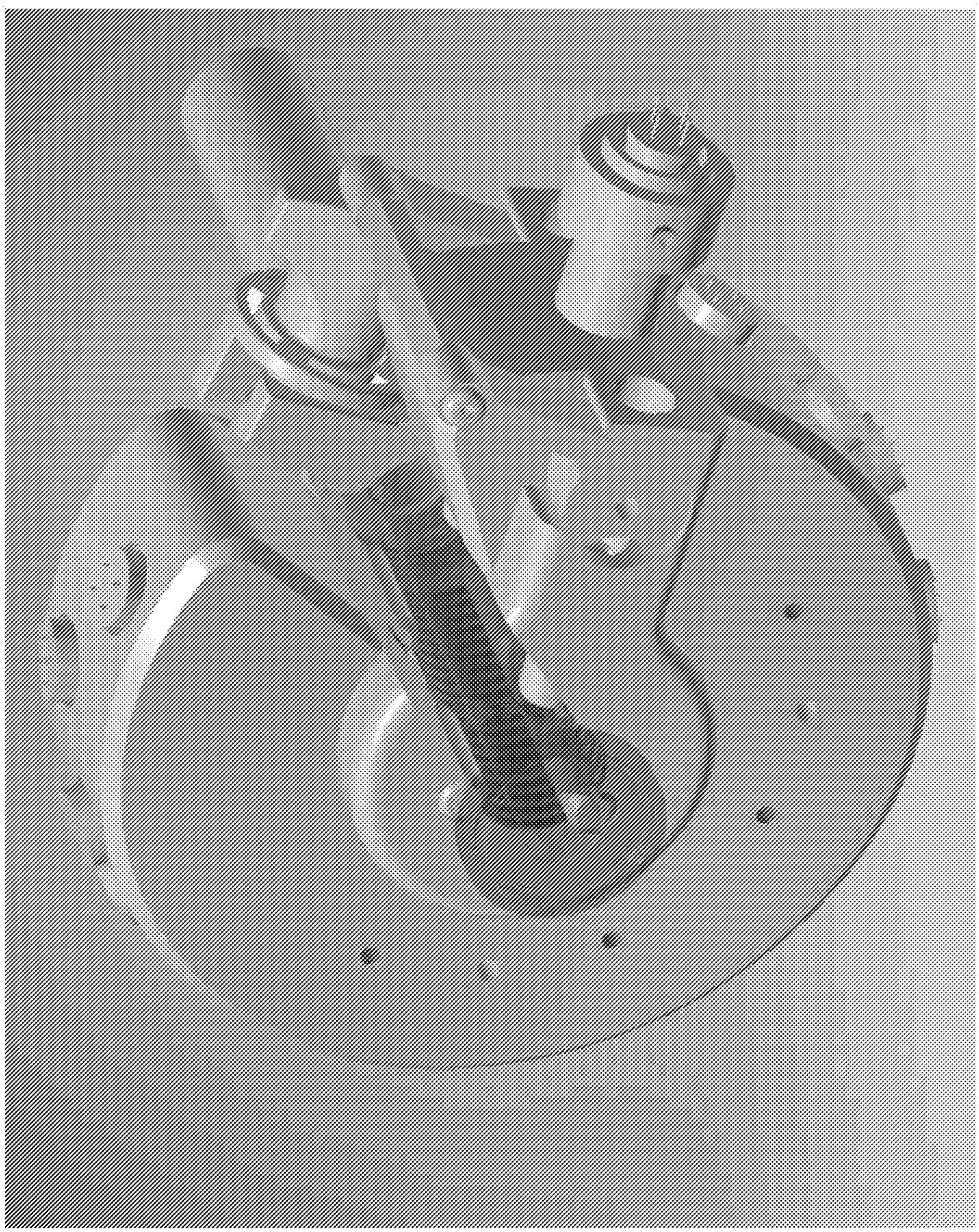


FIG. 4F

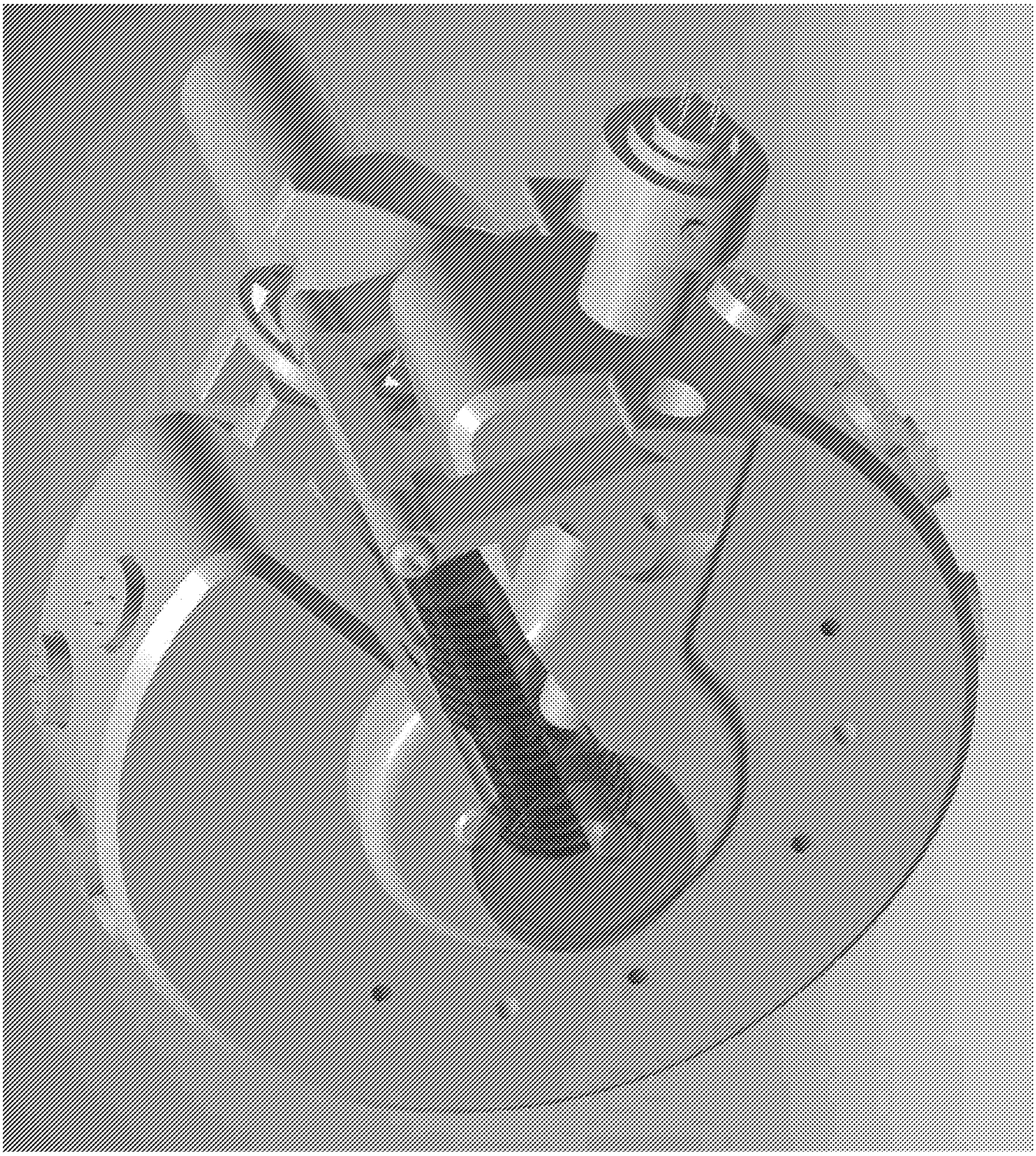


FIG. 4G

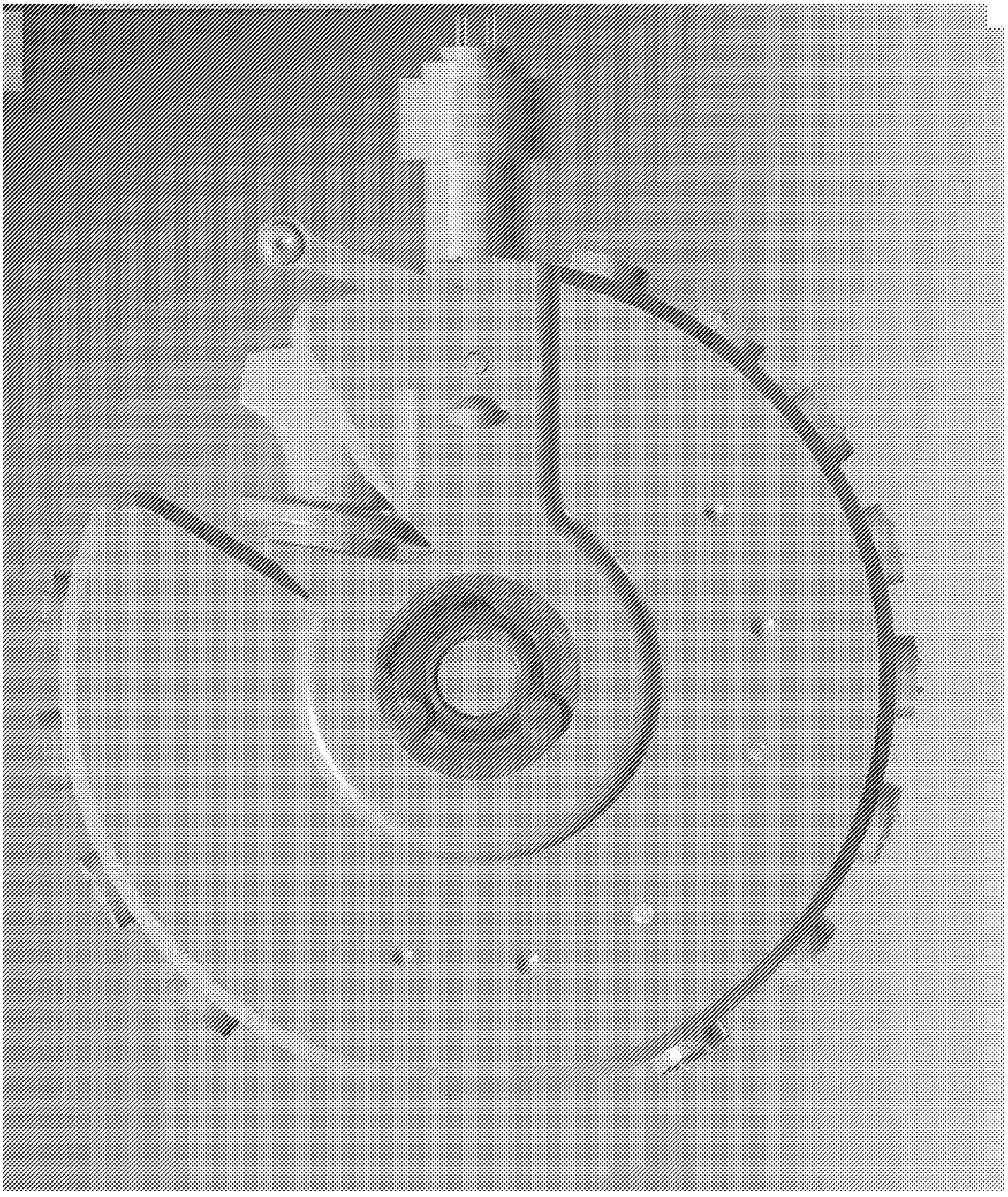


FIG. 4H

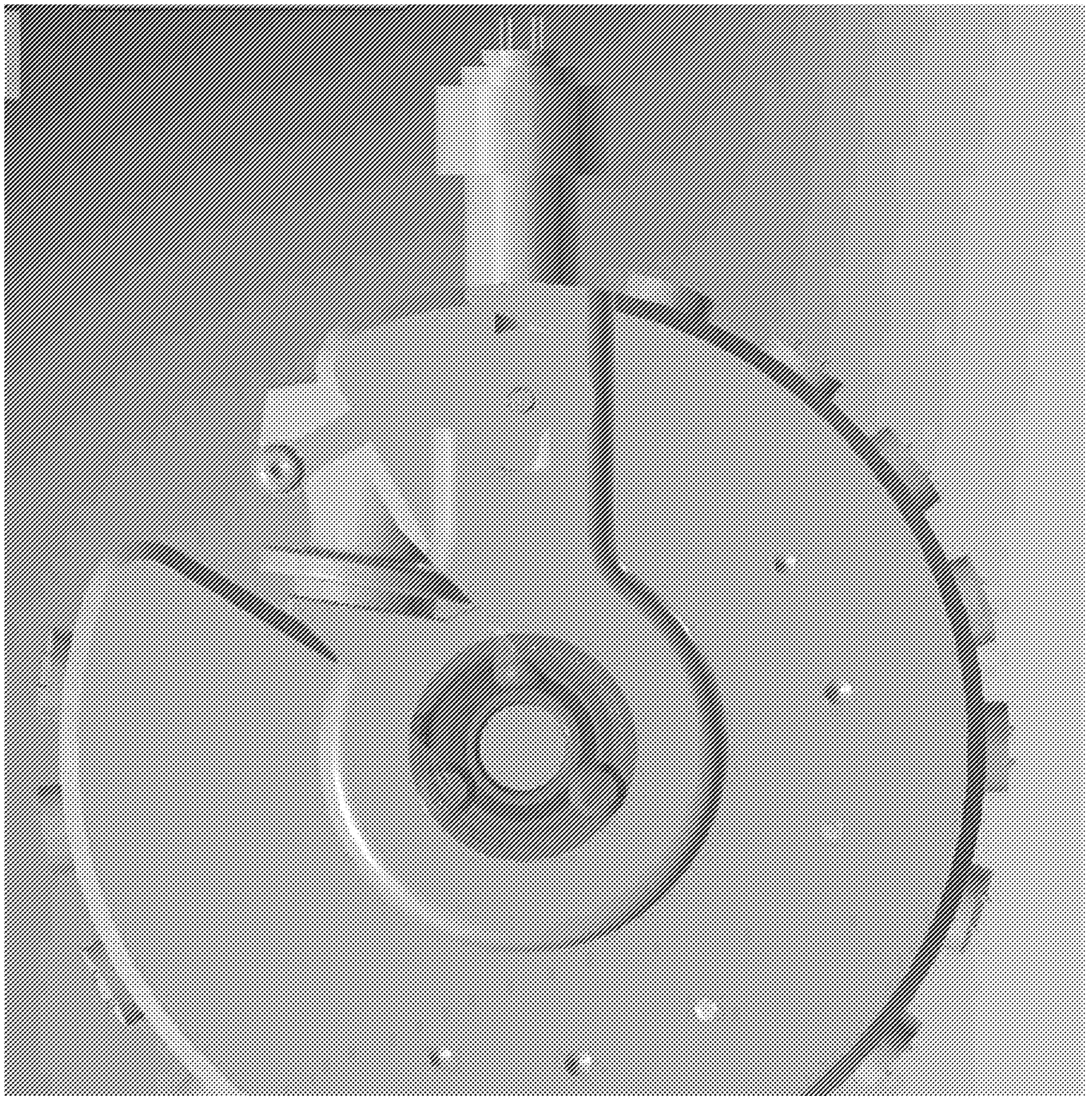


FIG. 41

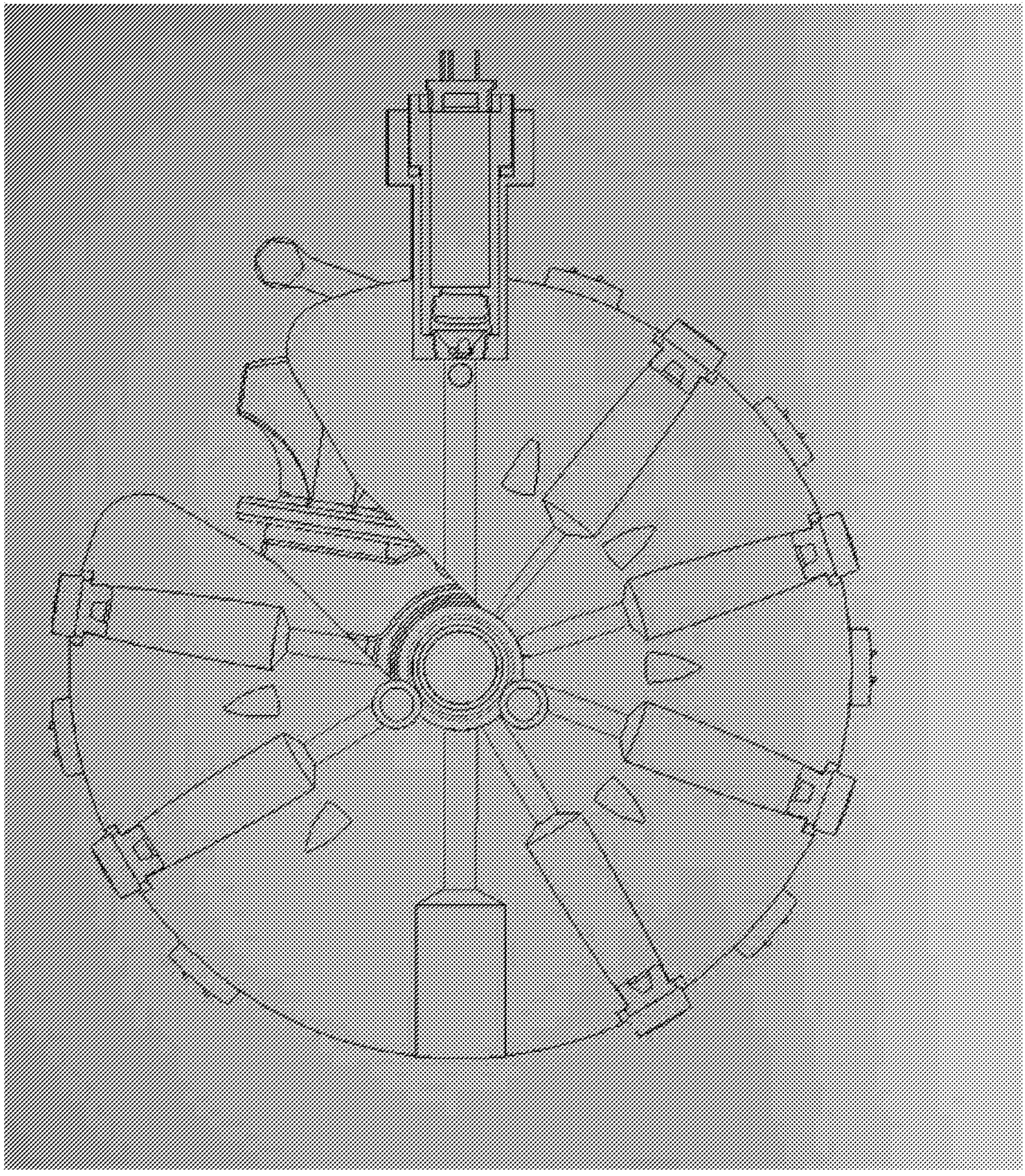


FIG. 4J

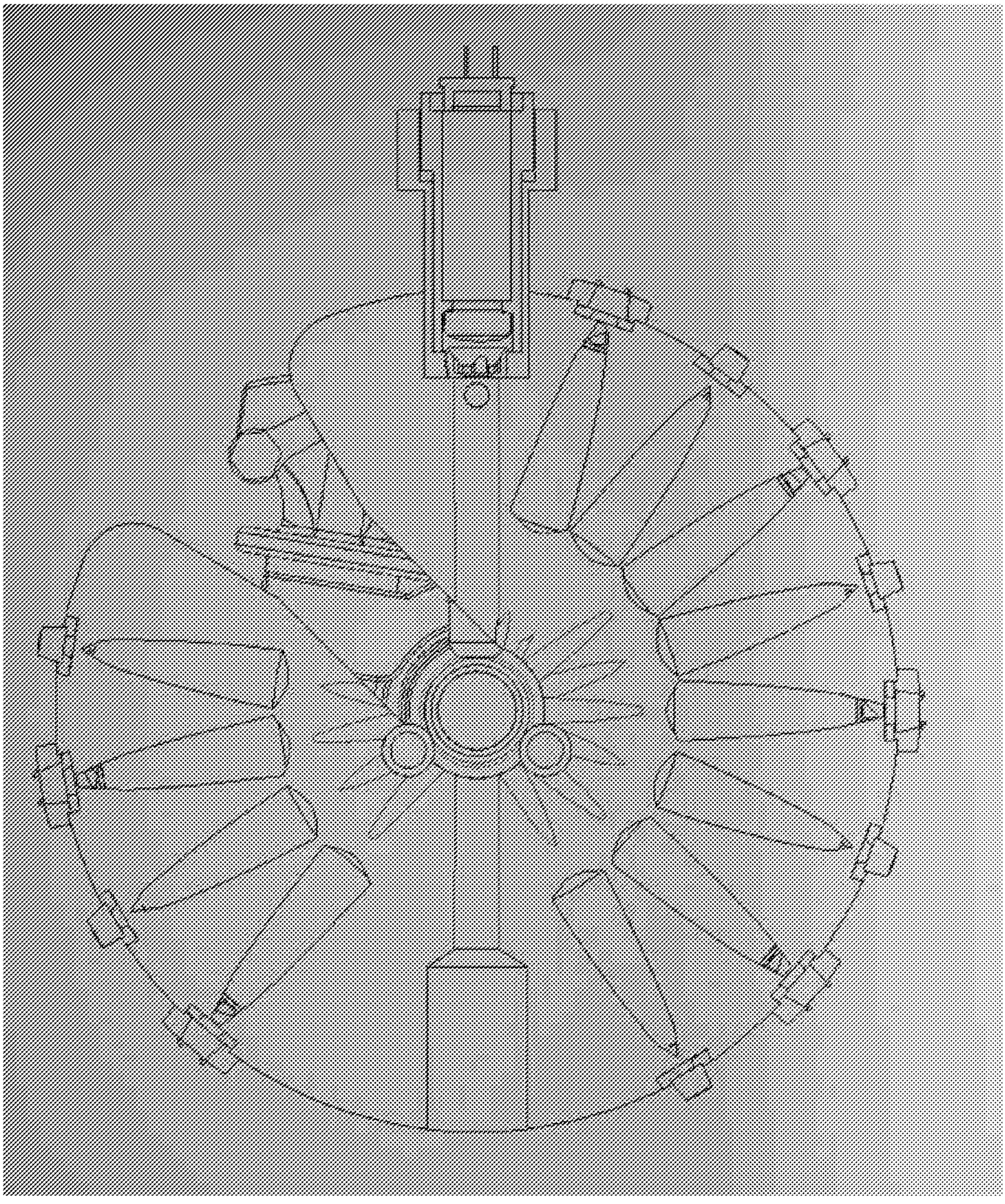


FIG. 4K

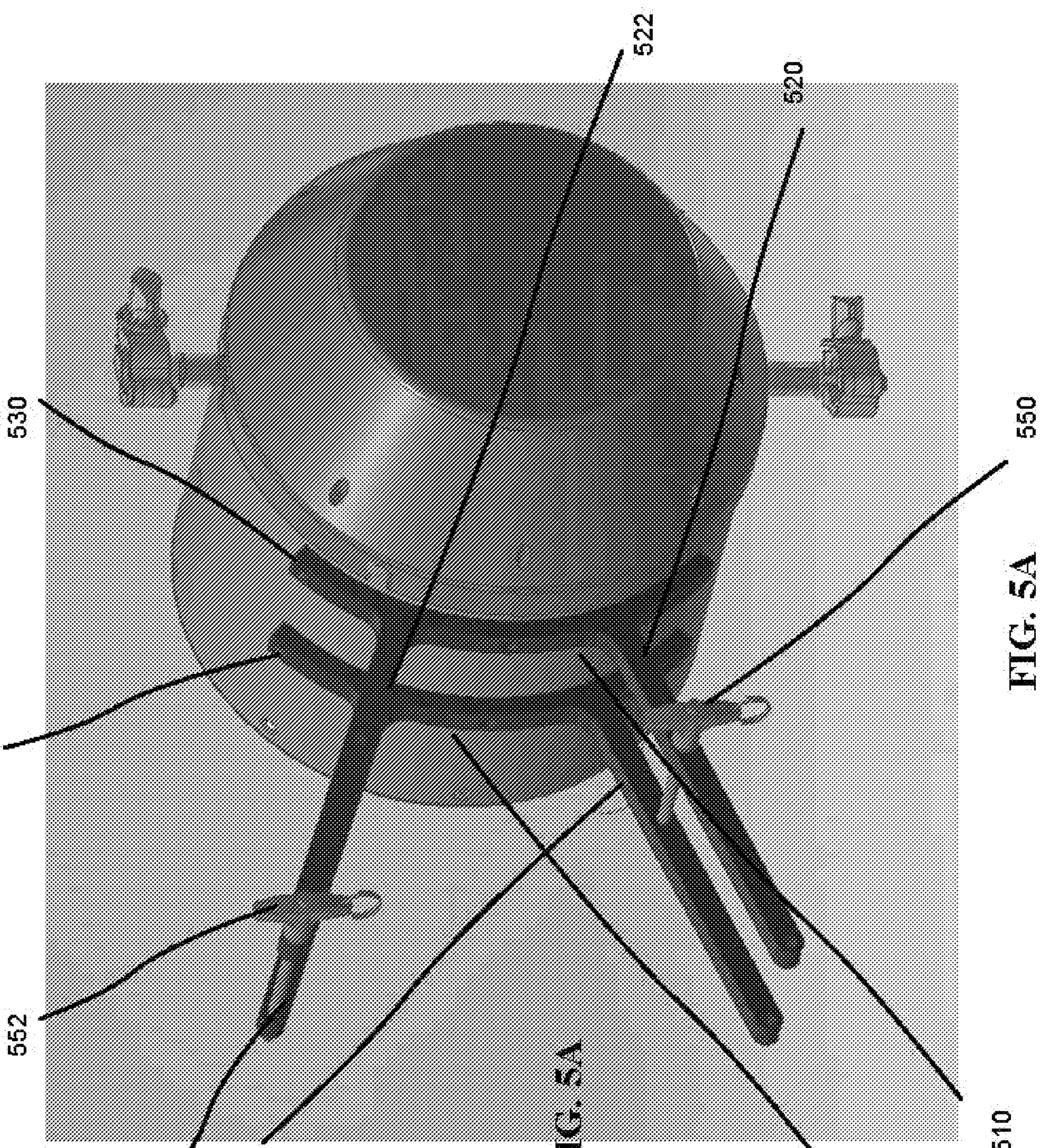


FIG. 5A

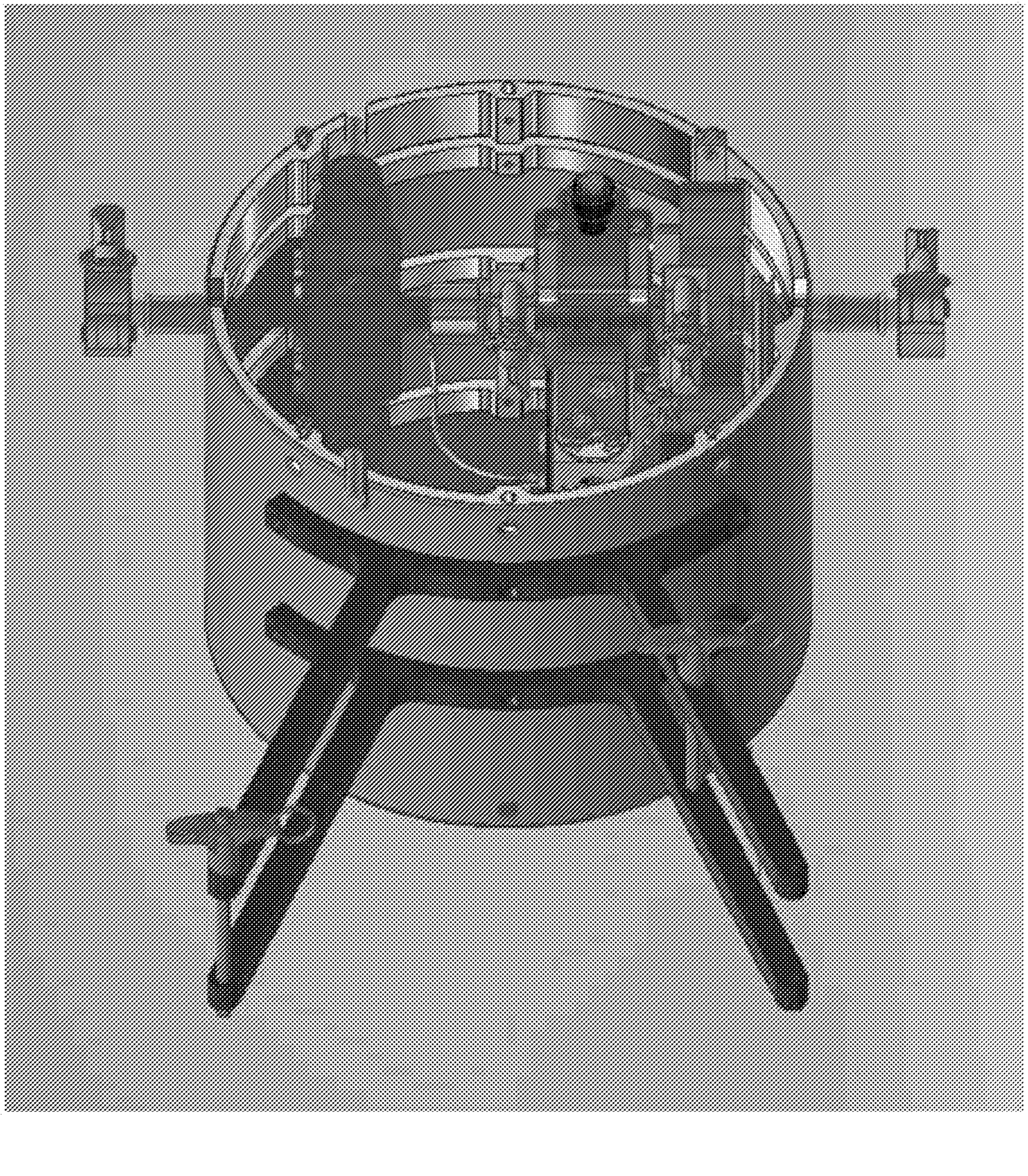


FIG. 5B

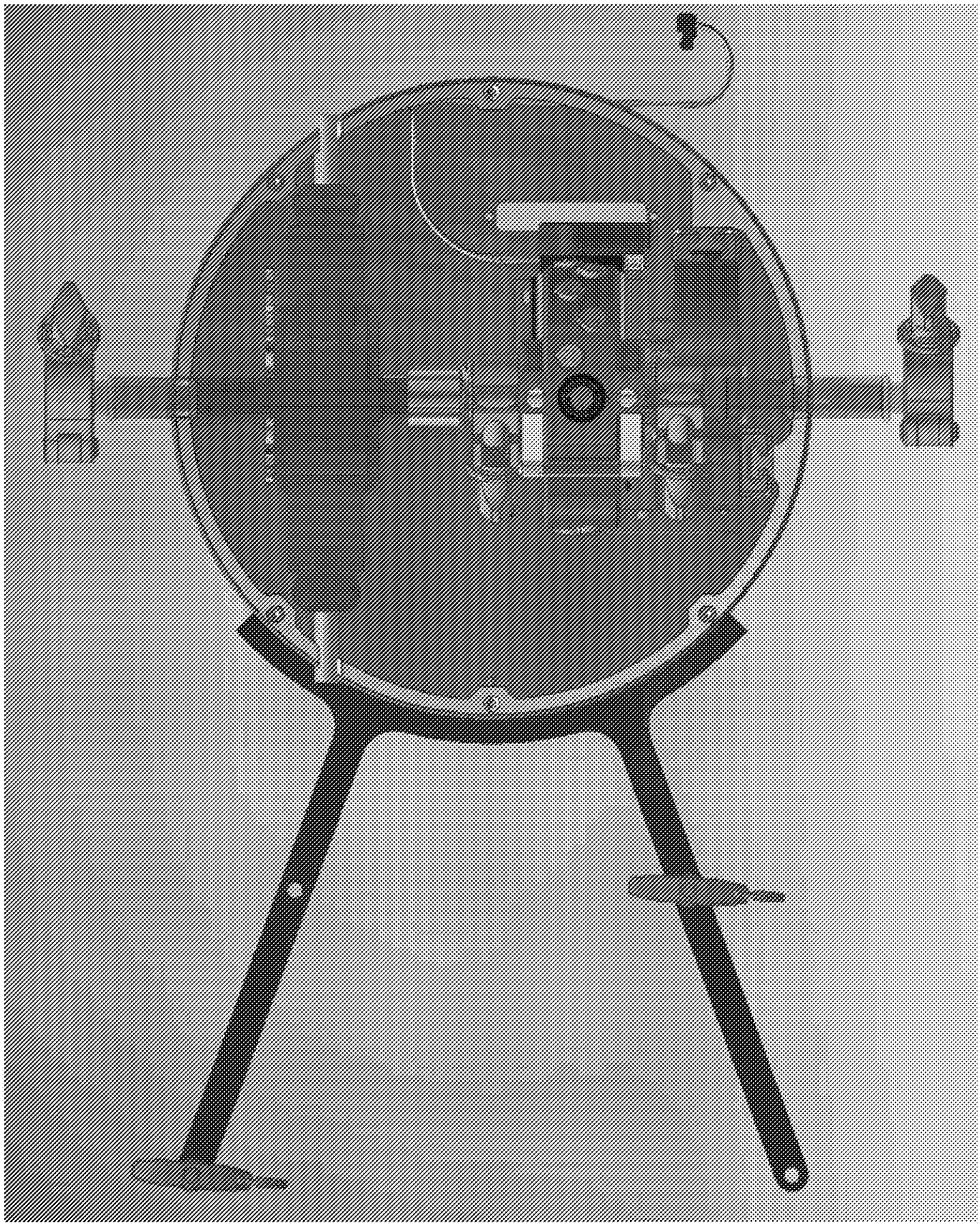


FIG. 5C



FIG. 6A

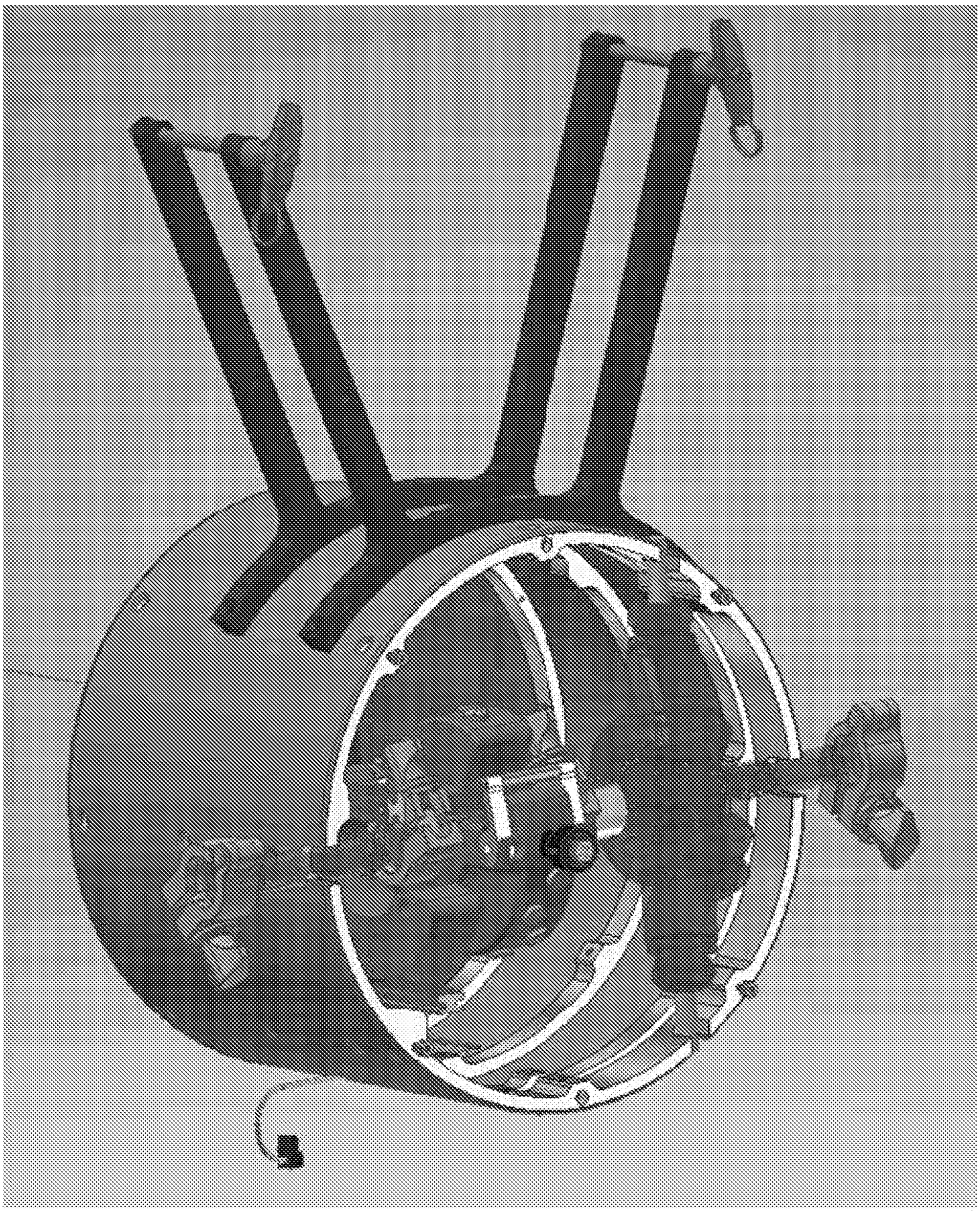


FIG. 6B

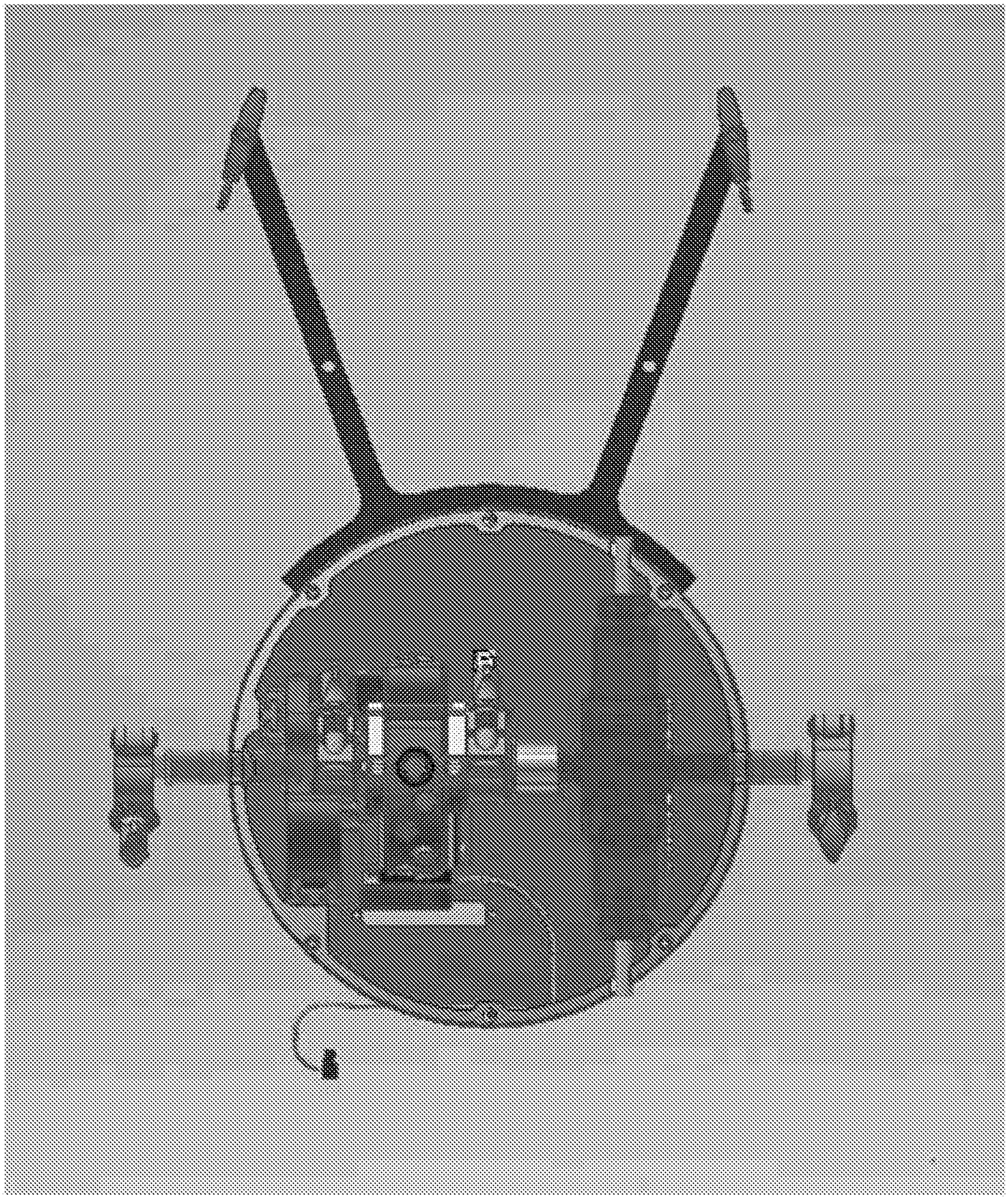


FIG. 6C



FIG. 7A

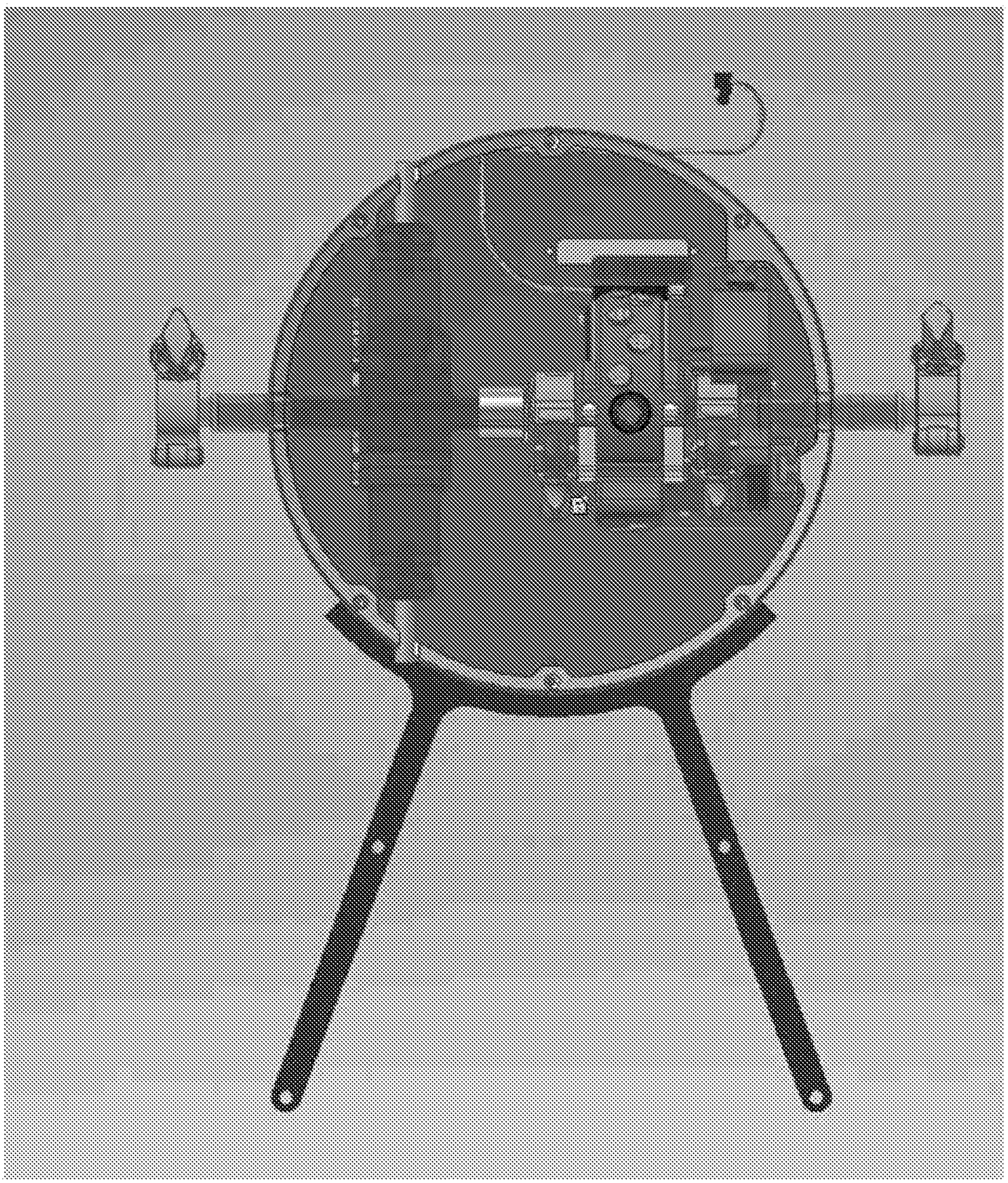


FIG. 7B

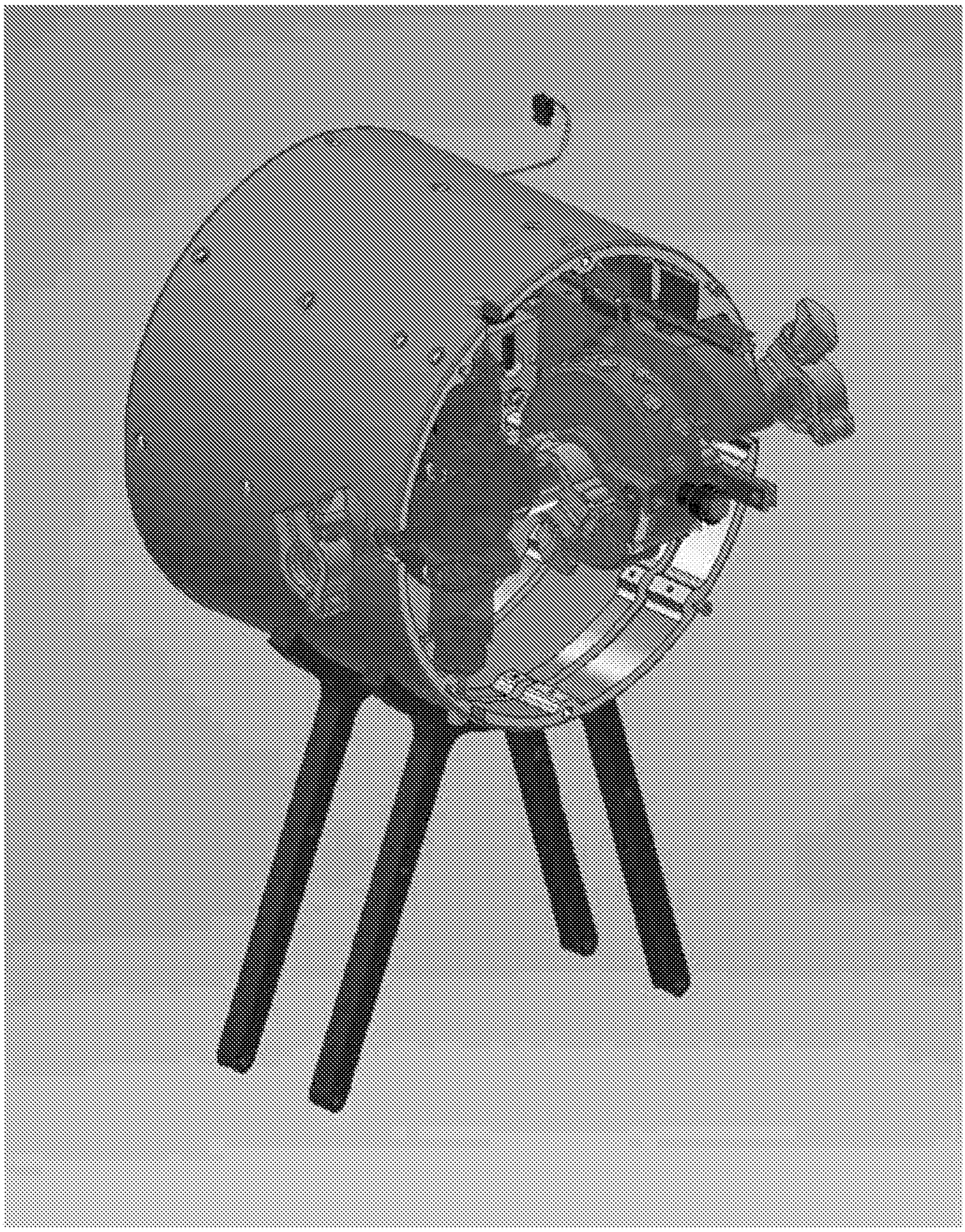


FIG. 7C

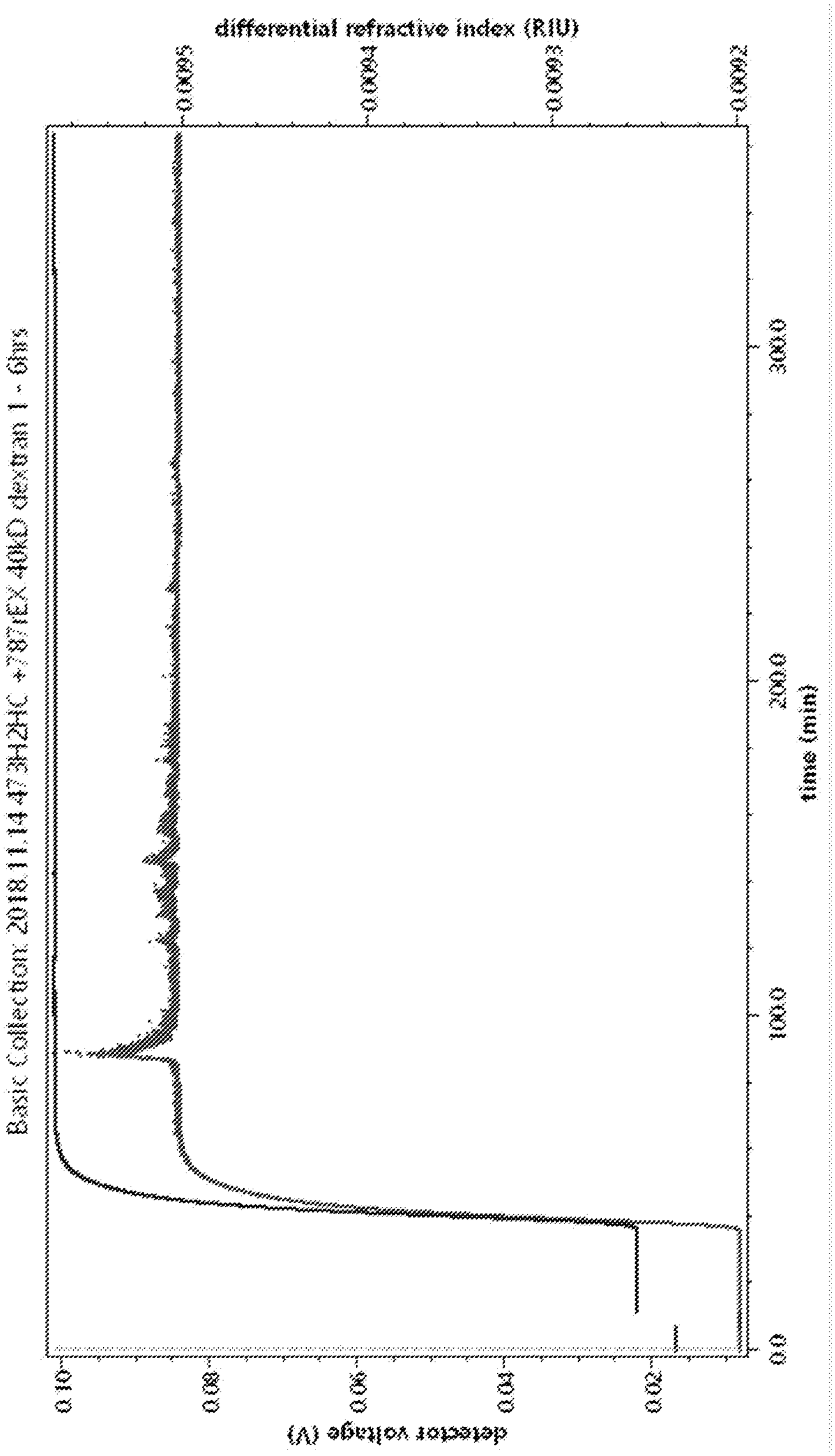

differential refractive index (RIU)
Basic Collection 2018.11.14 7:38:2HC +78rEX 40kD dextran 1 - 6mg
detector voltage (V)
time (min)

FIG. 8