US 20160228932A1

(19) **United States**

(12) **Patent Application Publication**

HAYASHI et al.

(10) **Pub. No.: US 2016/0228932 A1**

(43) **Pub. Date: Aug. 11, 2016**

(54) **EXTRUSION DIE FOR FORMING HOLLOW MATERIAL**

(71) Applicant: **NIPPON LIGHT METAL COMPANY, LTD.**, Shinagawa-ku, Tokyo (JP)

(72) Inventors: **Haisei HAYASHI**, Shizuoka (JP); **Yuji MOCHIZUKI**, Shizuoka (JP)

(73) Assignee: **NIPPON LIGHT METAL COMPANY, LTD.**, Shinagawa-ku, Tokyo (JP)

(21) Appl. No.: **15/023,201**

(22) PCT Filed: **Jun. 27, 2014**

(86) PCT No.: **PCT/JP2014/067285**

§ 371 (c)(1),
(2) Date: **Mar. 18, 2016**

(30) **Foreign Application Priority Data**

Sep. 26, 2013 (JP) 2013-200459

Publication Classification

(51) **Int. Cl.**

B21C 25/02	(2006.01)
B21C 23/00	(2006.01)
B21C 25/04	(2006.01)

(52) **U.S. Cl.**

CPC ***B21C 25/02*** (2013.01); ***B21C 25/04*** (2013.01); ***B21C 23/002*** (2013.01)

(57) **ABSTRACT**

An extrusion die for forming a hollow material that extrudes a billet comprising a high-strength alloy having high extrusion force and forms a hollow material including a partition wall, comprises a male-type member that extrudes a billet on a downstream side and forms the inner shape of a material and a female-type member that forms the outer shape of the material, wherein a billet guide hole that guides one part of the billet toward the downstream side is provided to the central area of a mandrel section that constitutes the male-type member, four inner formation pieces are mounted in a fixed manner to positions that face the downstream-side opening of the billet guide hole, and the female-type member is provided with an outer formation die hole that faces all of the outer peripheral surfaces of the inner formation pieces and that forms the outer shape of the hollow material.

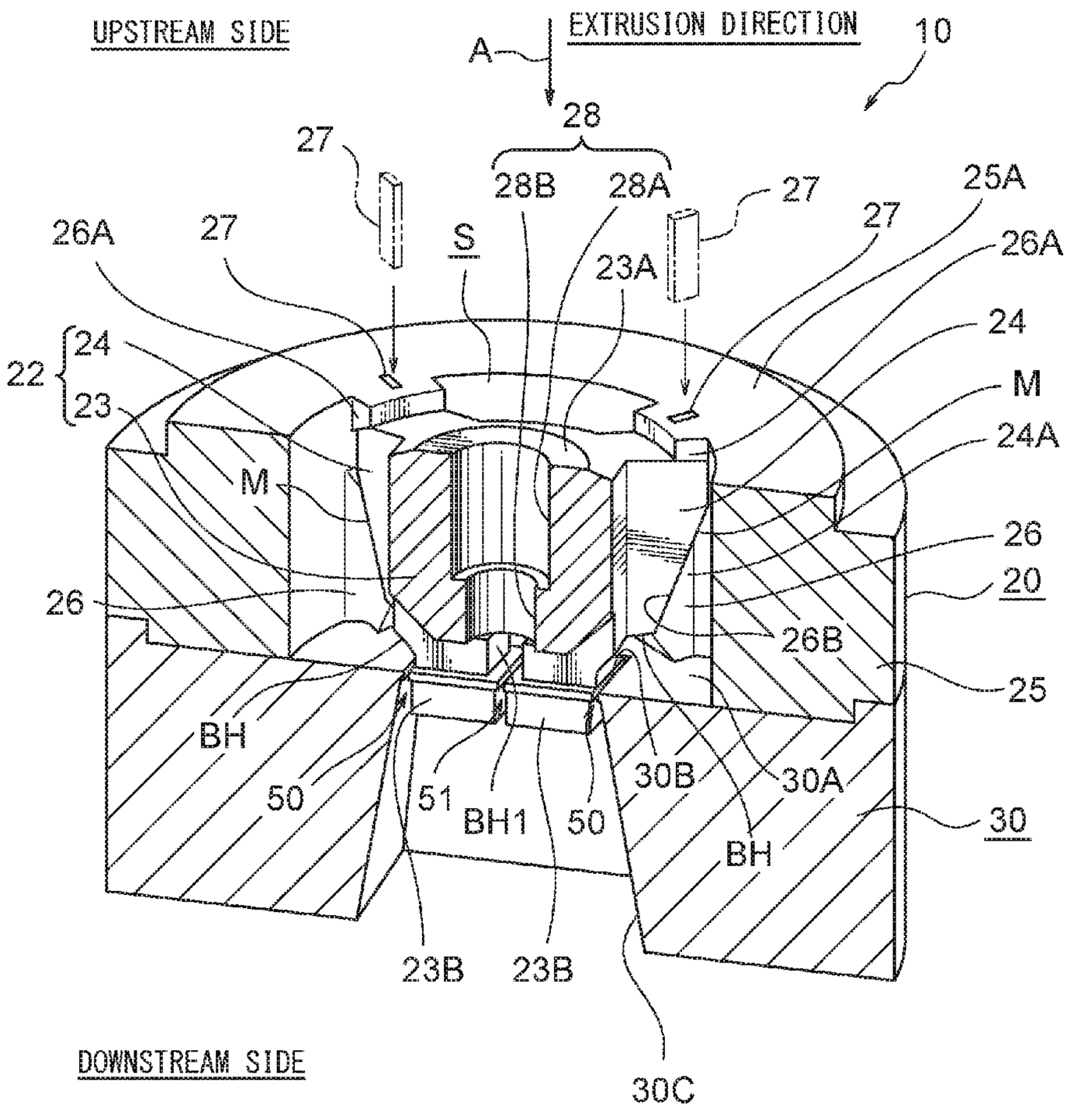


FIG. 1

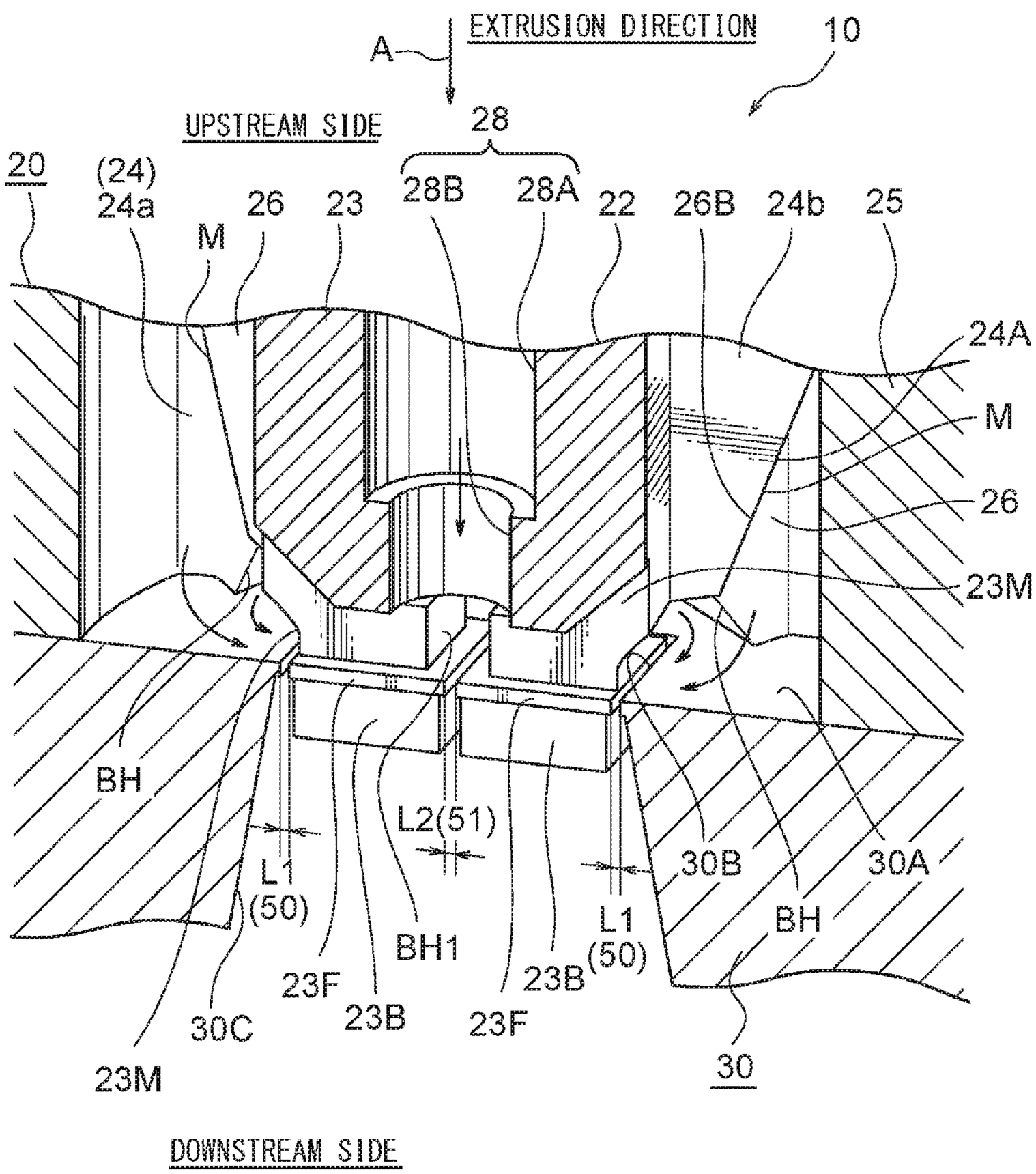

A
EXTRUSION DIRECTION
10
UPSTREAM SIDE
28
20
(24)
24a
26
23
28B
28A
22
26B
24b
25
M
24A
M
26
23M
BH
L2(51)
L1
(50)
30B
30A
BH
BH1
L1
(50)
23F
23B
23B
23F
30C
23M
30
DOWNSTREAM SIDE

FIG. 2

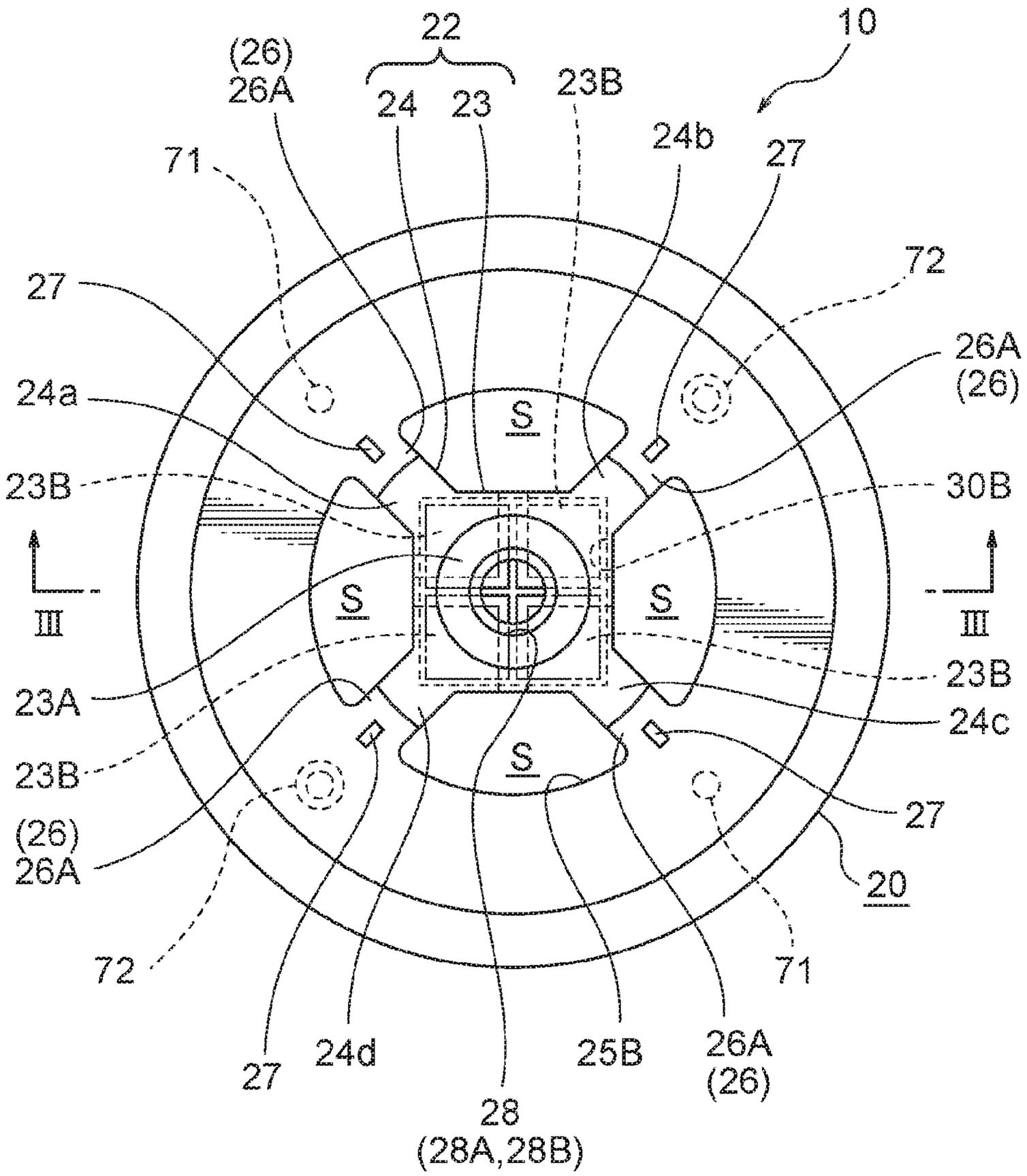

22
(26)
26A
24
23
23B
10
24b
27
71
72
27
24a
23B
26A
(26)
S
30B
III
III
S
S
23A
23B
24c
23B
(26)
26A
S
27
20
72
71
27
24d
25B
26A
(26)
28
(28A,28B)

FIG. 3

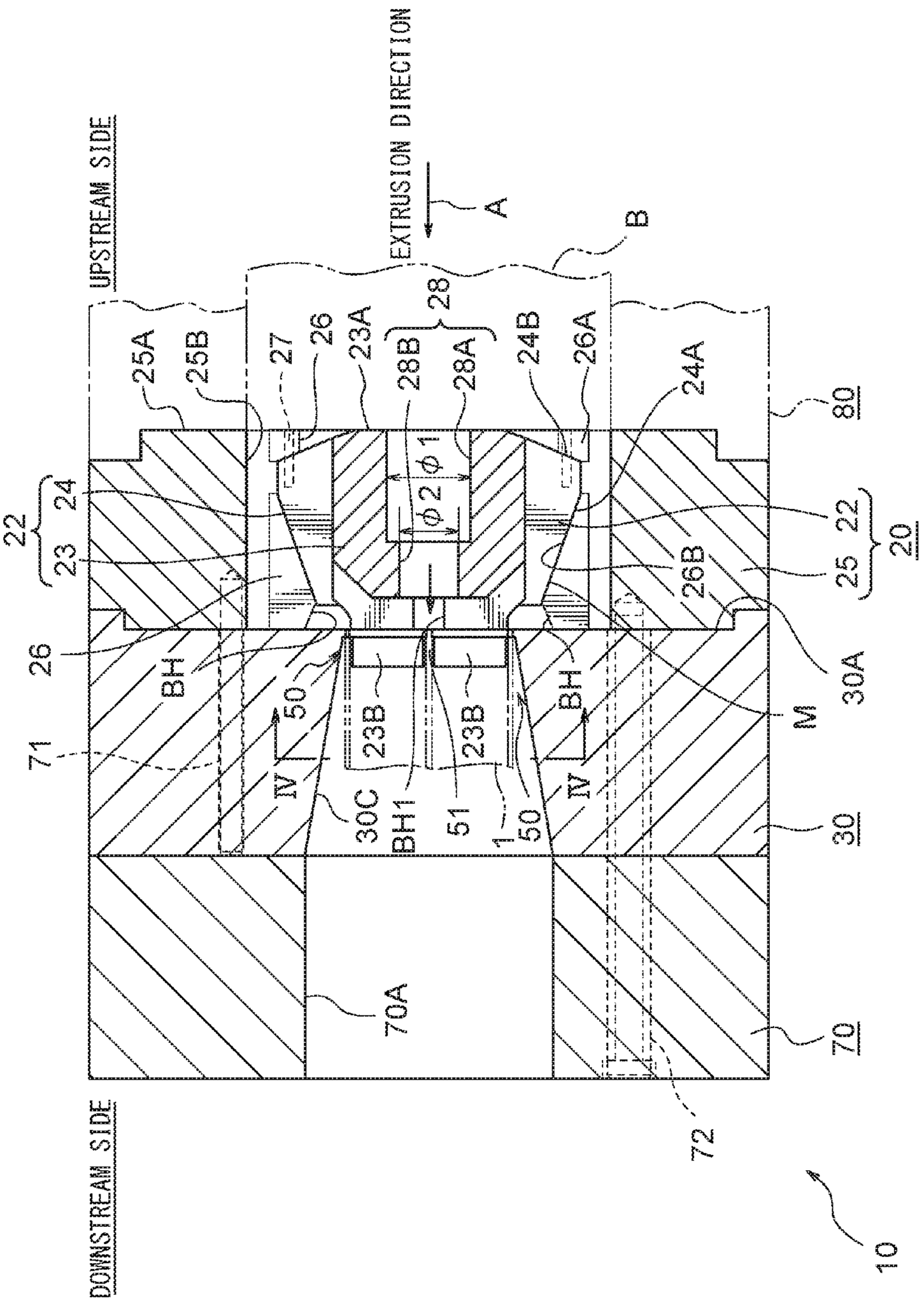

UPSTREAM SIDE
EXTRUSION DIRECTION
A
B
25A
25B
27
26
23A
28
28B
28A
24B
26A
24A
80
22
24
23
φ1
φ2
25
22
20
26
BH
26B
71
50
23B
IV
30C
BH1
51
1
30A
M
30
70A
70
72
DOWNSTREAM SIDE
10

FIG. 4

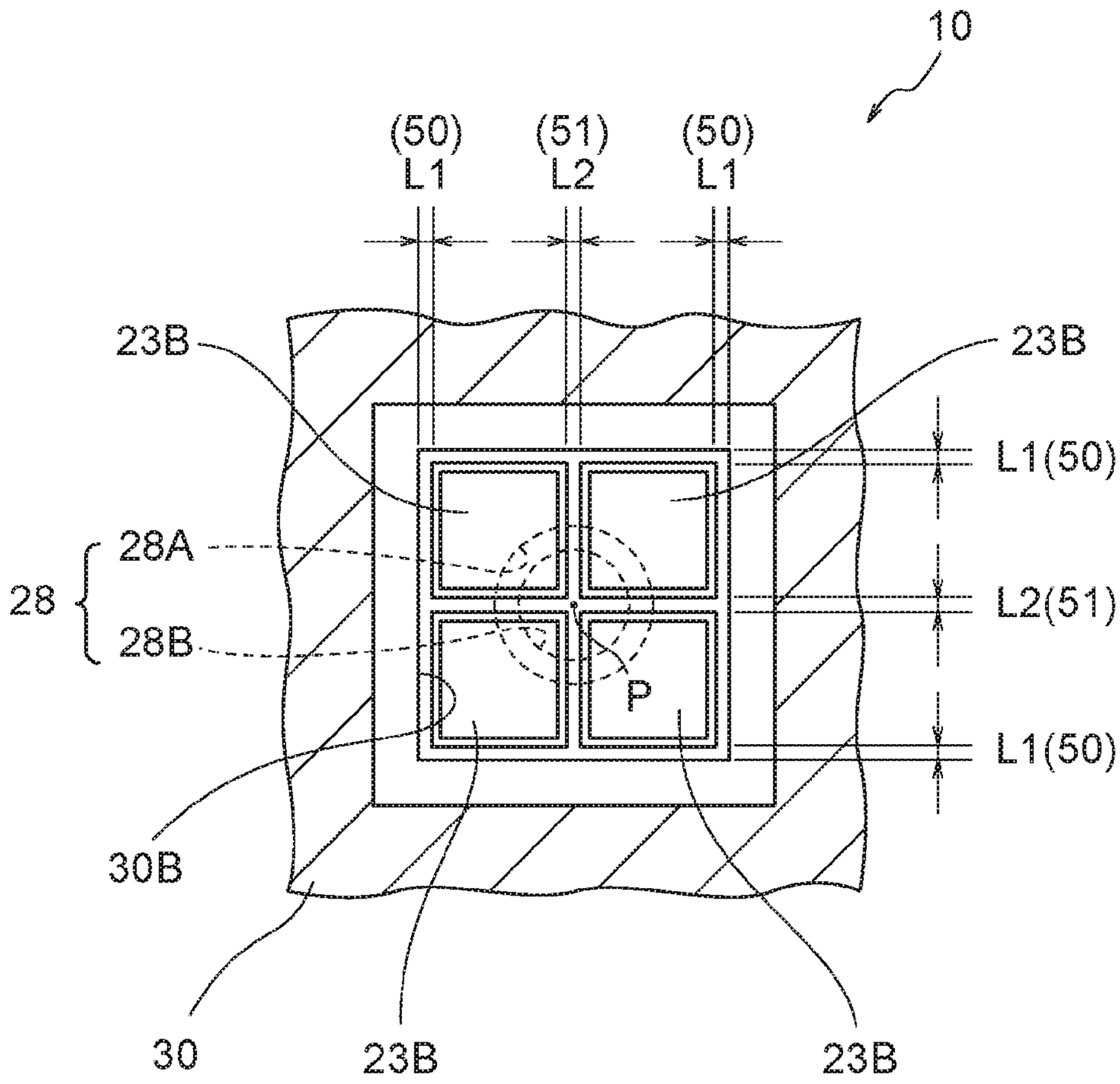

10
(50)
L1
(51)
L2
(50)
L1
23B
23B
L1(50)
28A
28
28B
L2(51)
P
L1(50)
30B
30
23B
23B

FIG. 5

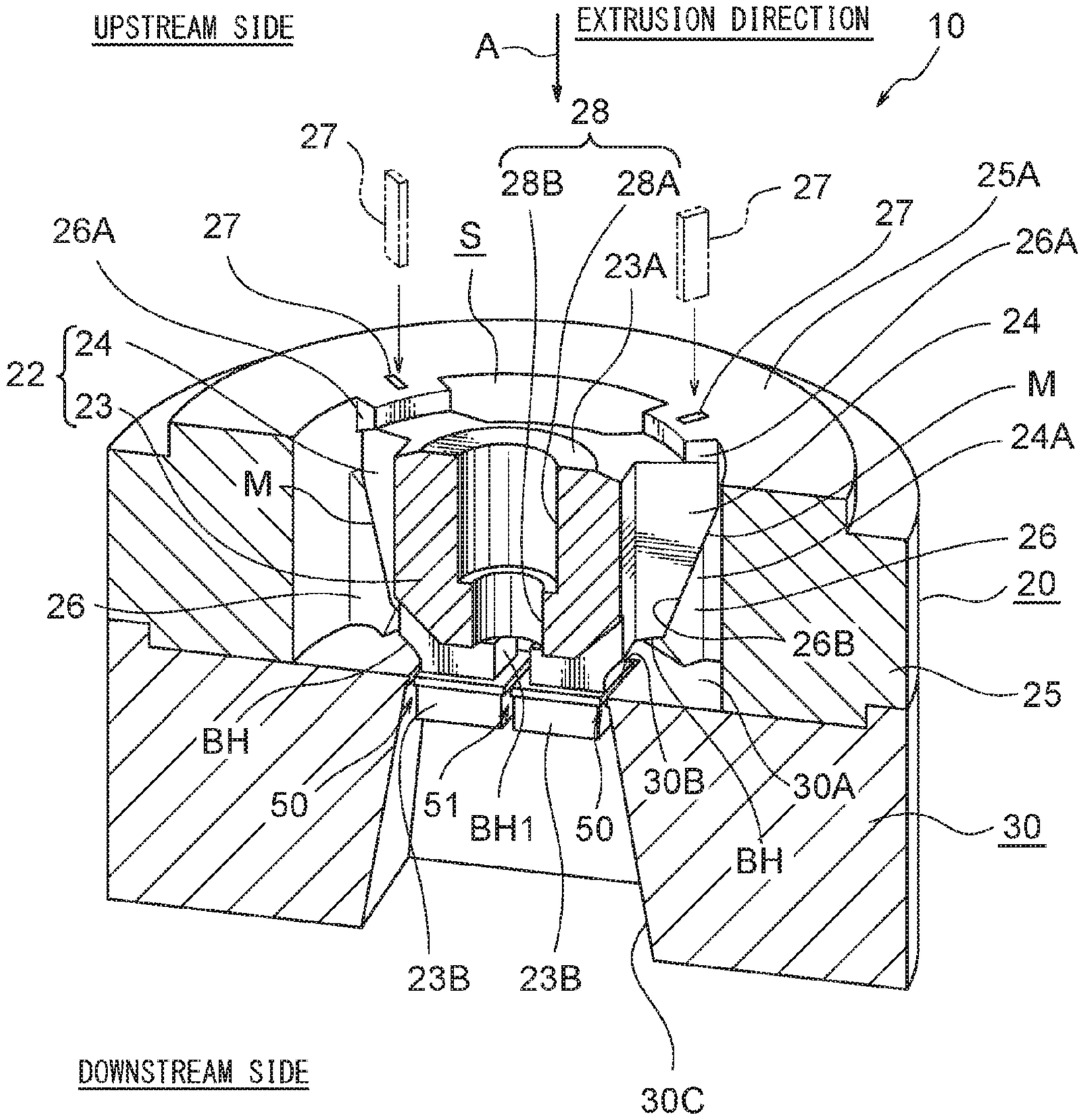

UPSTREAM SIDE
A
EXTRUSION DIRECTION
10
28
27
28B
28A
27
25A
26A
27
S
23A
27
26A
24
22
24
23
M
24A
M
26
26
20
26B
25
BH
50
51
BH1
50
30B
30A
30
BH
23B
23B
30C
DOWNSTREAM SIDE

FIG. 6

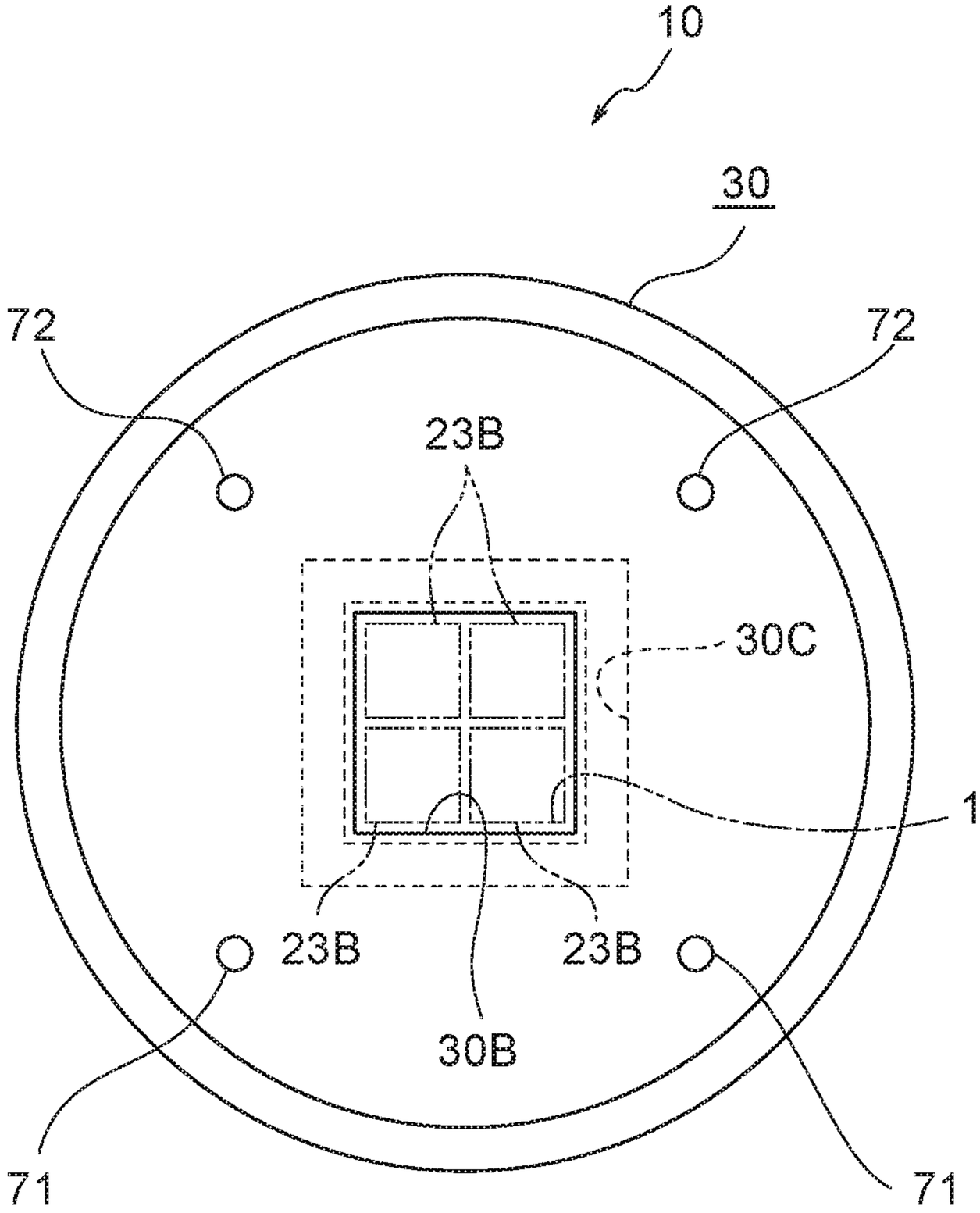


FIG. 7

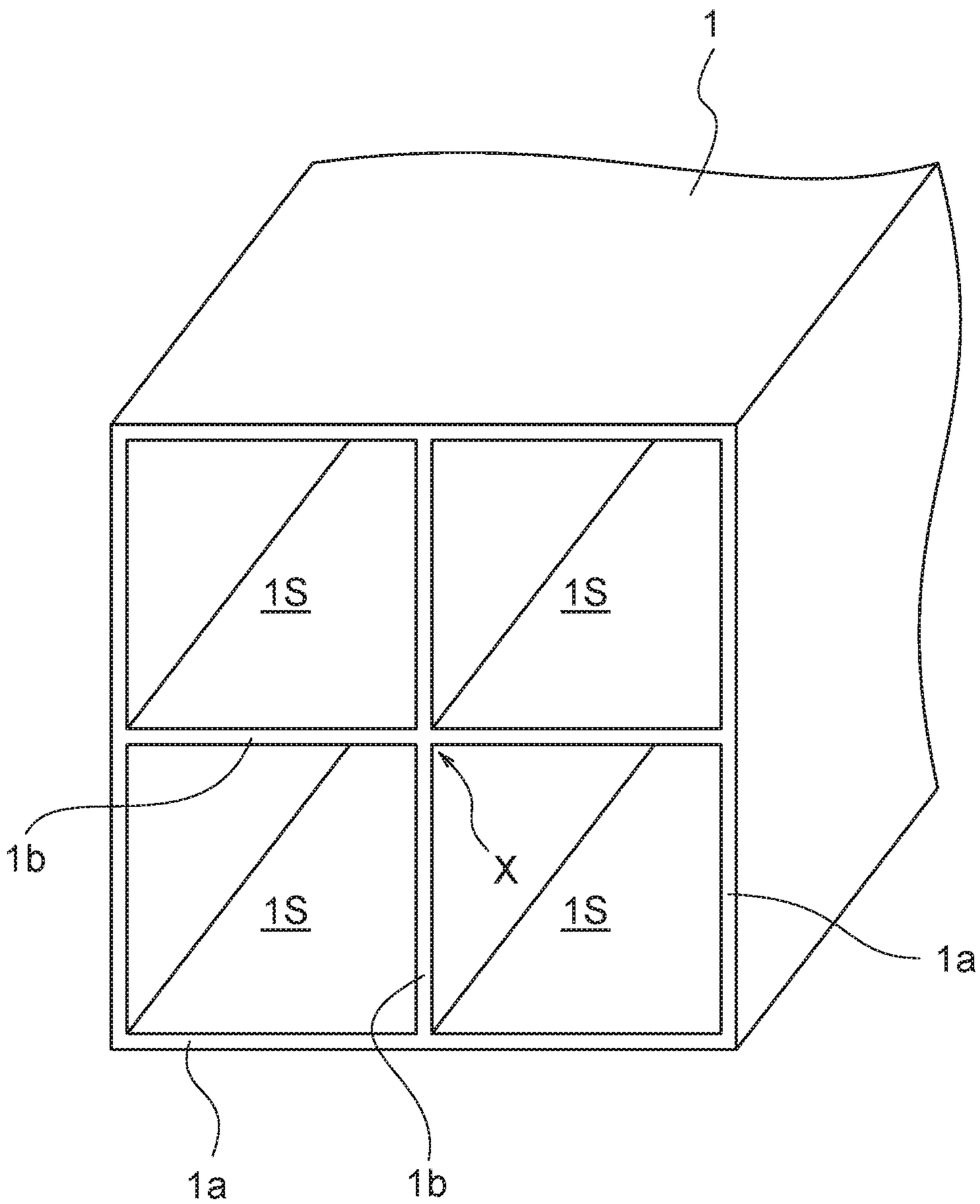


FIG. 8

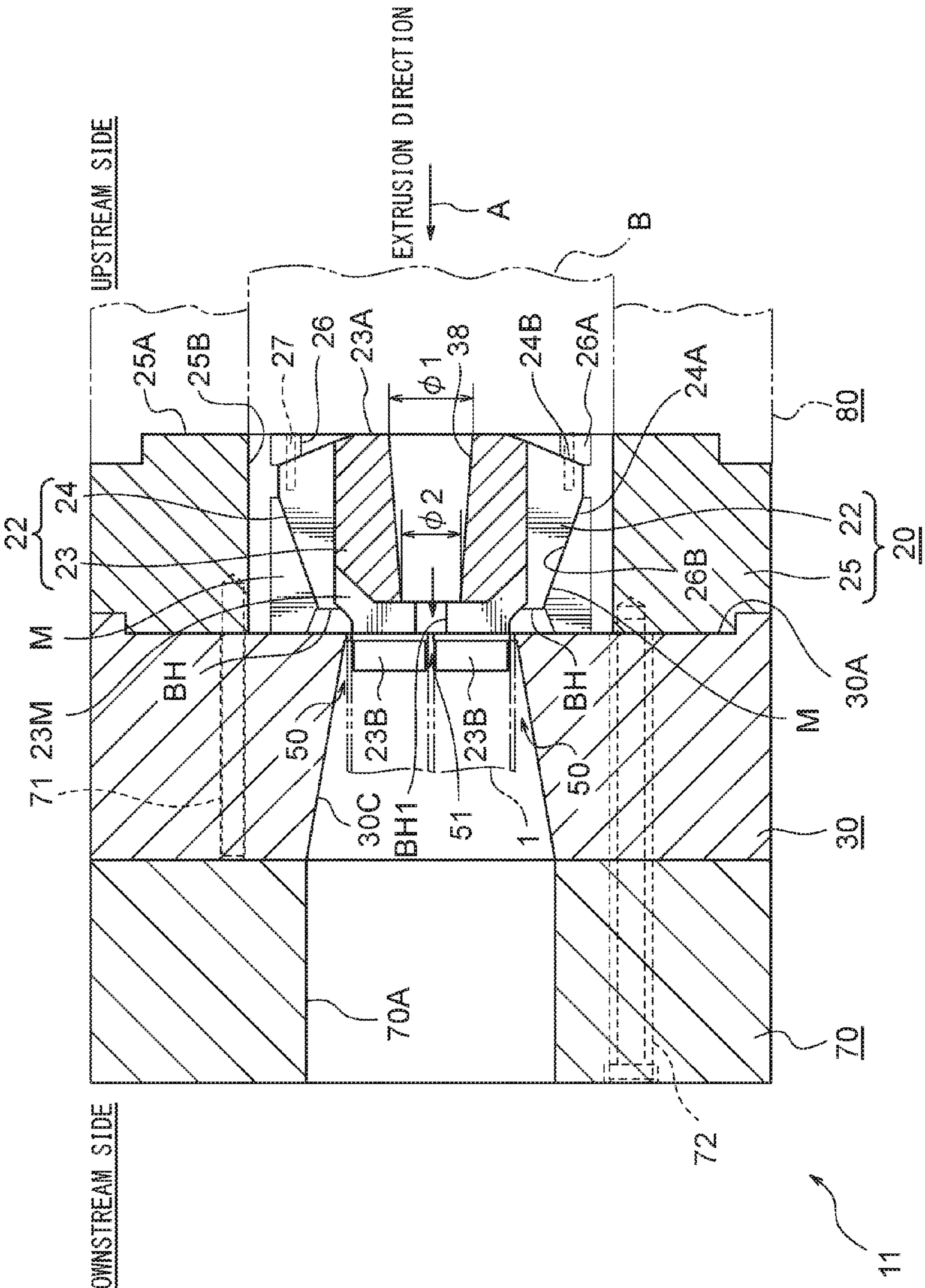

UPSTREAM SIDE
EXTRUSION DIRECTION
A
B
25A
25B
27
26
23A
φ1
38
24B
26A
24A
80
22
24
23
φ2
22
20
25
26B
M
BH
71
23M
50
23B
30C
BH1
51
1
30A
30
70A
70
72
11
DOWNSTREAM SIDE

FIG. 9

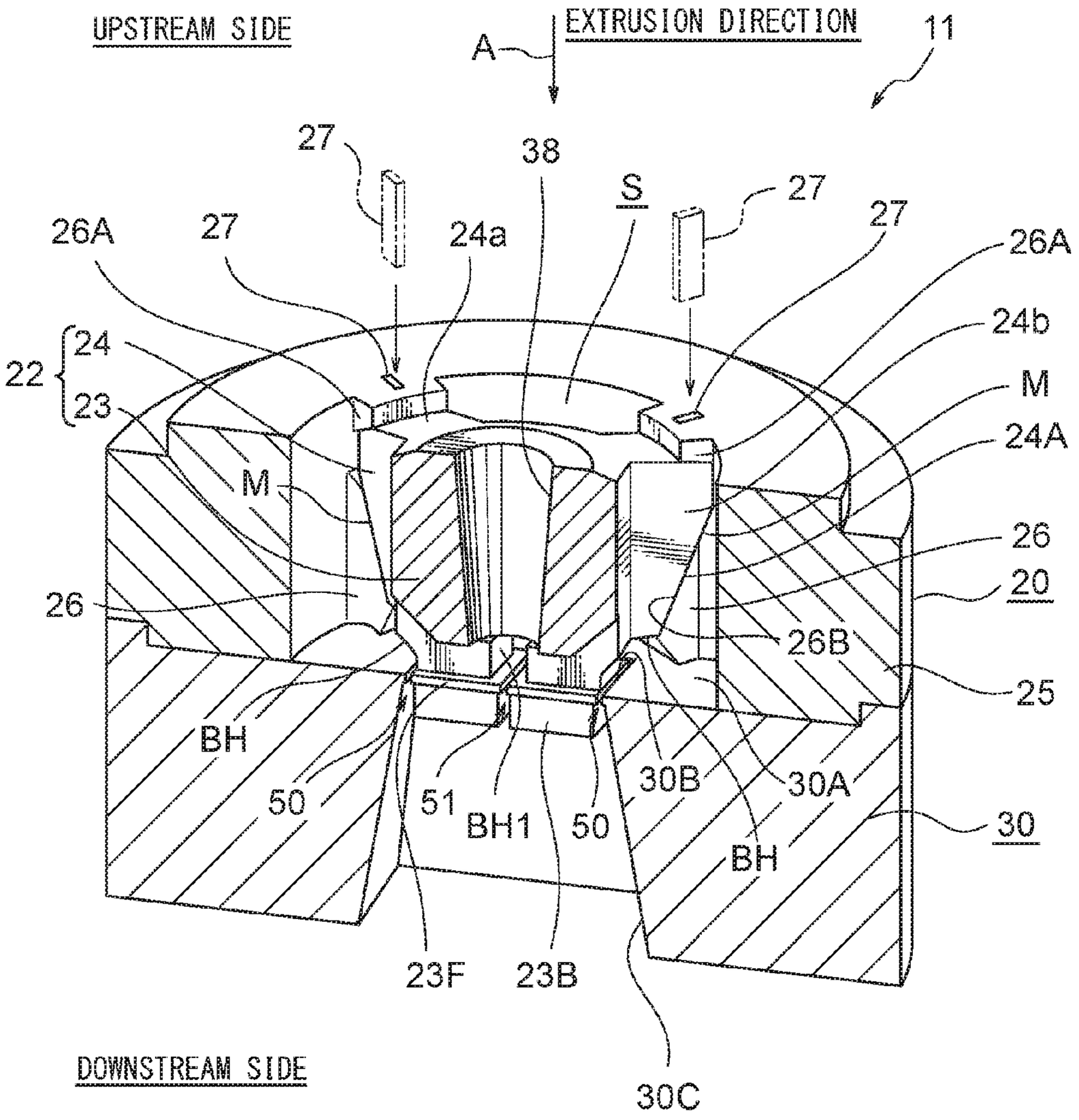

UPSTREAM SIDE
A
EXTRUSION DIRECTION
11
27
38
S
27
27
26A
27
24a
26A
24b
22
24
23
M
24A
M
26
26
20
26B
25
BH
50
51
BH1
50
30B
30A
30
BH
23F
23B
30C
DOWNSTREAM SIDE

FIG. 10

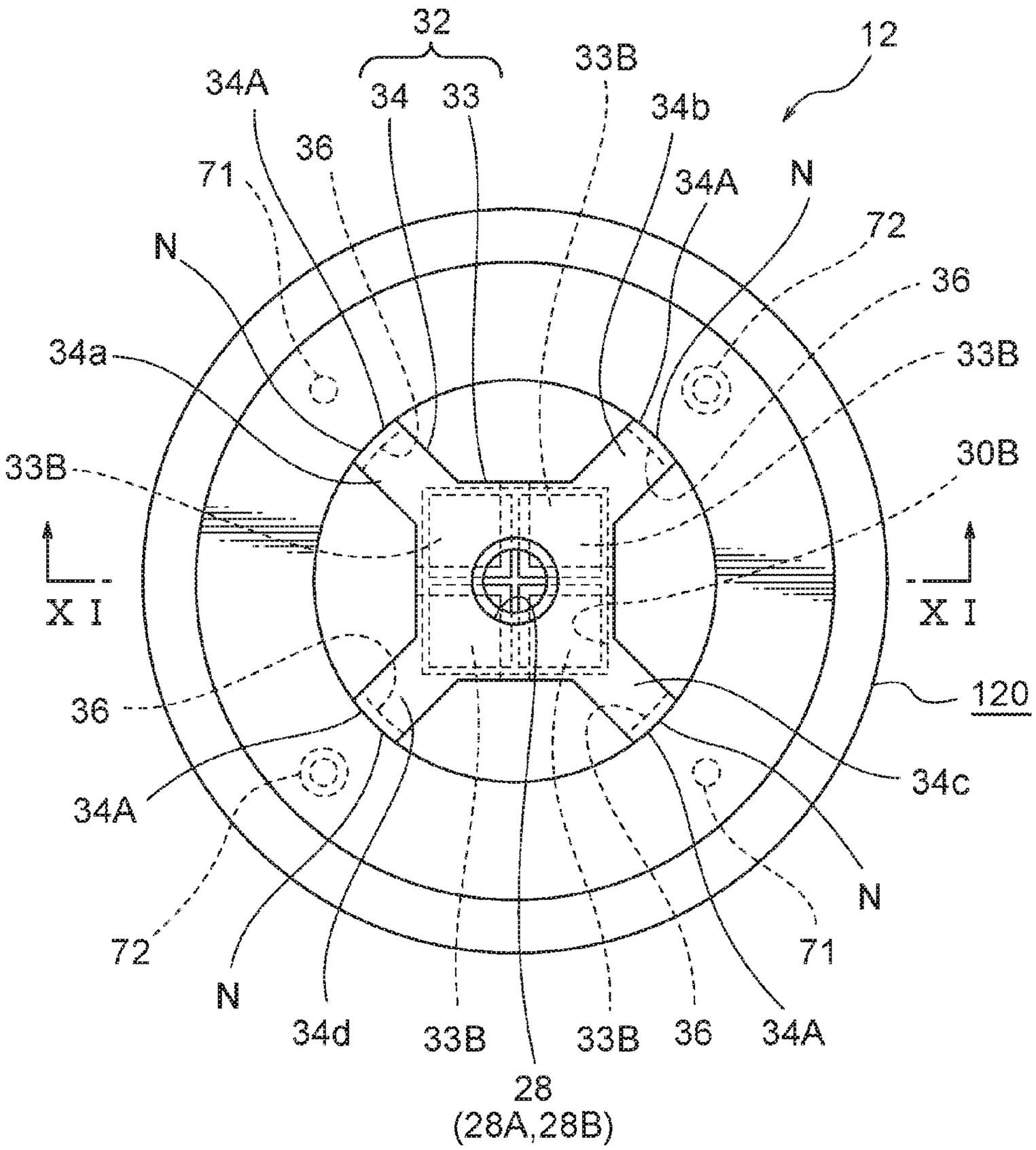

32
34
33
34A
33B
34b
12
36
71
N
34A
72
36
34a
33B
33B
30B
X I
X I
36
120
34A
34c
N
72
N
71
34d
33B
33B
36
34A
28
(28A,28B)

FIG. 11

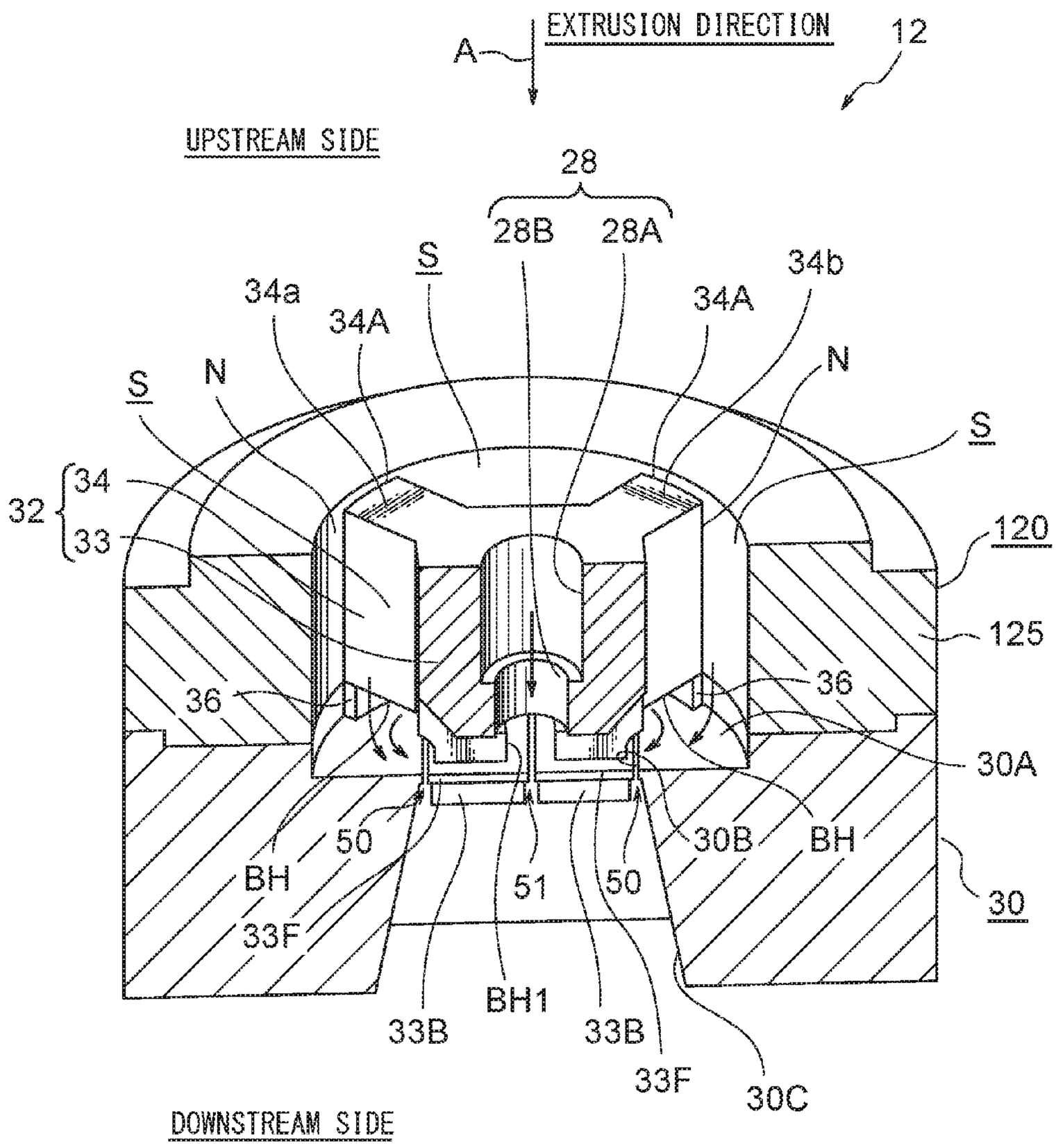

A
EXTRUSION DIRECTION
12
UPSTREAM SIDE
28
28B
28A
S
34a
34A
34A
34b
S
N
N
S
32
34
33
120
125
36
36
30A
50
30B
BH
BH
51
50
30
33F
BH1
33B
33B
33F
30C
DOWNSTREAM SIDE

FIG. 12

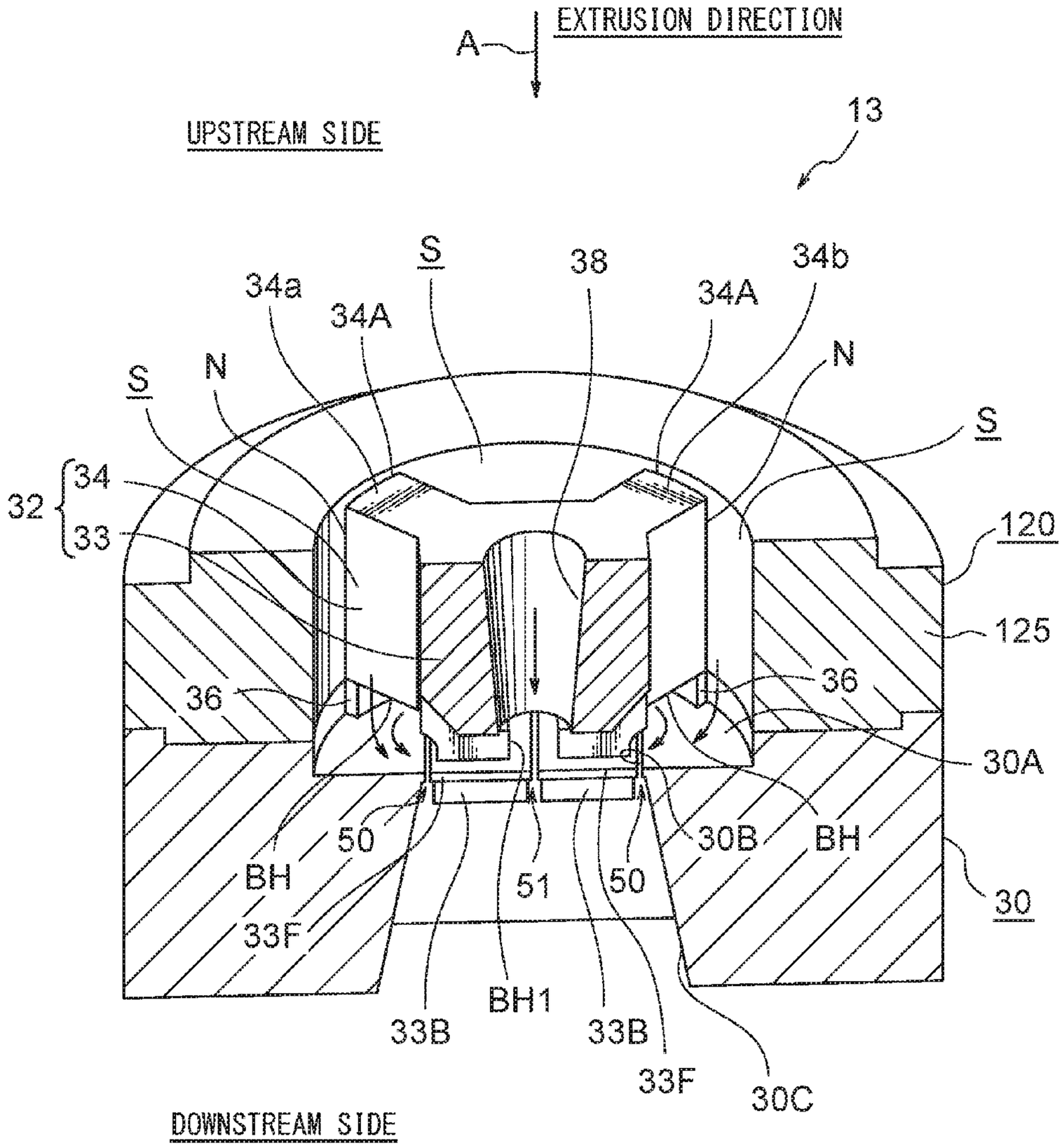

A
EXTRUSION DIRECTION
UPSTREAM SIDE
13
S
34a
34A
S
38
34A
34b
S
N
N
S
32
34
33
120
125
36
36
30A
BH
50
30B
BH
51
50
30
33F
BH1
33B
33B
33F
30C
DOWNSTREAM SIDE

FIG. 13

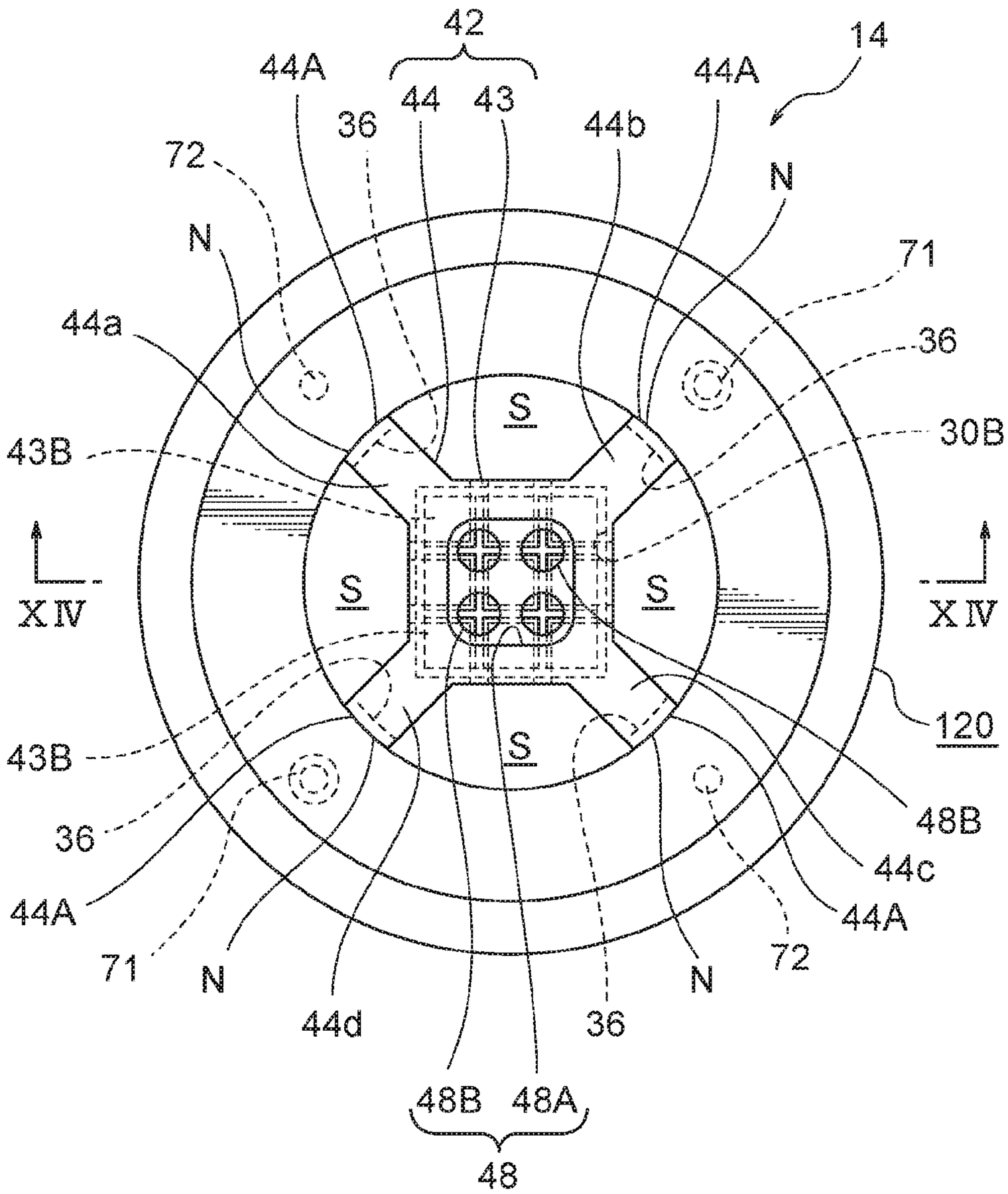

42
44A
44
43
14
44A
36
44b
72
N
N
71
44a
36
S
30B
43B
S
S
XIV
XIV
S
120
43B
48B
36
44c
44A
44A
71
72
N
N
44d
36
48B
48A
48

FIG. 14

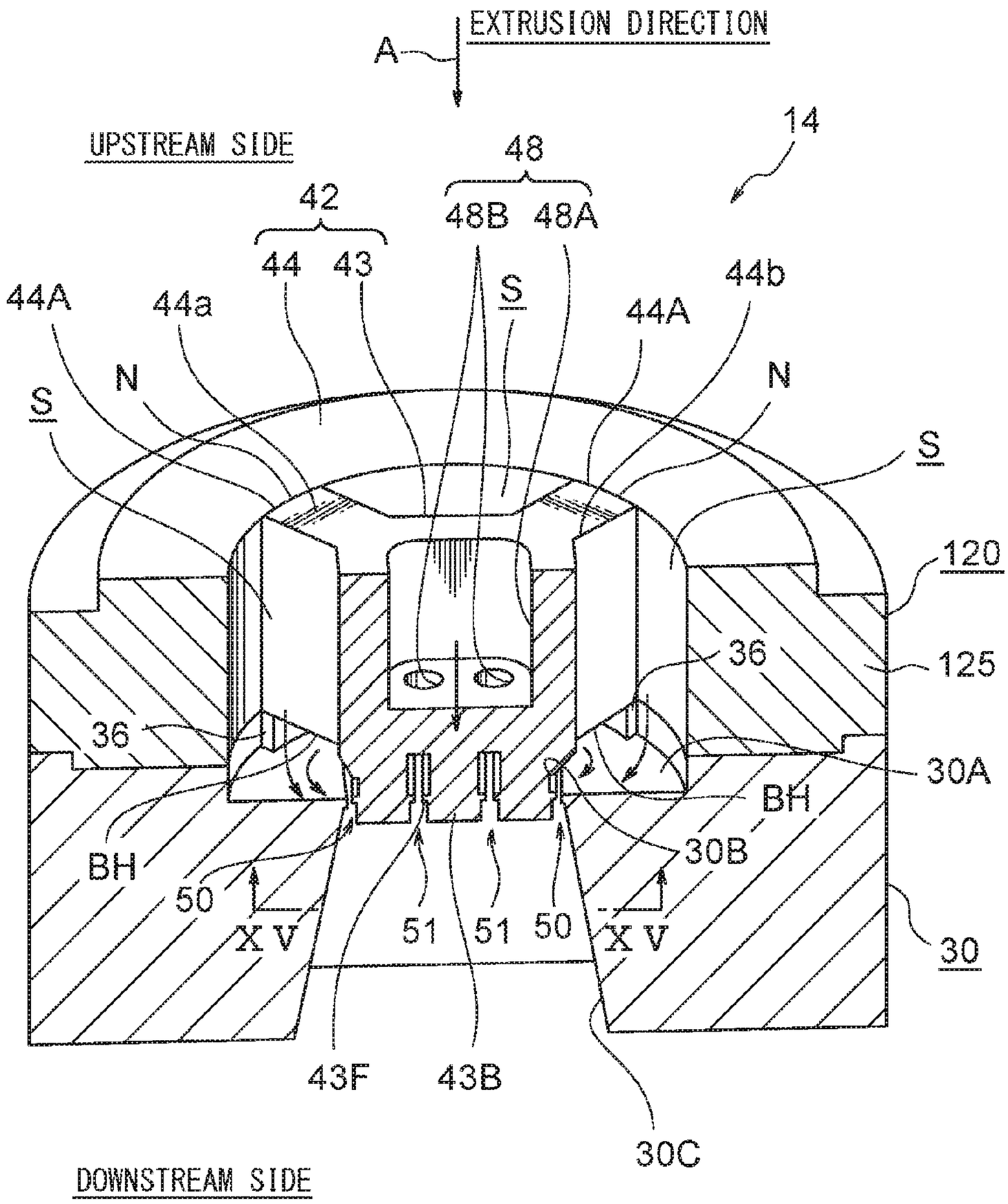

A
EXTRUSION DIRECTION
UPSTREAM SIDE
14
48
42
48B
48A
44
43
S
44b
44A
44a
N
S
N
44A
S
120
36
125
36
30A
BH
BH
30B
50
XV
51
51
50
XV
30
43F
43B
30C
DOWNSTREAM SIDE

FIG. 15

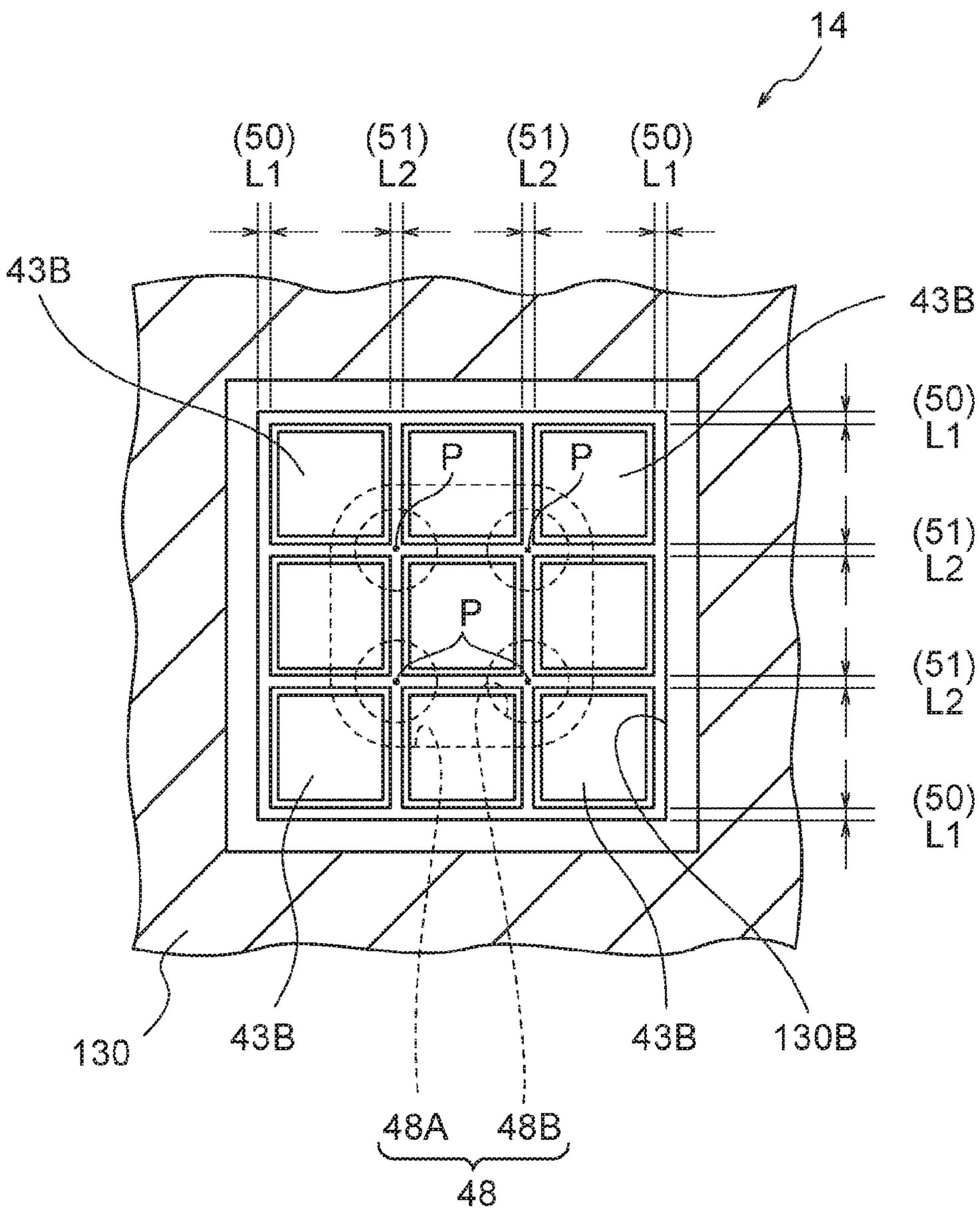

14
(50)
L1
(51)
L2
(51)
L2
(50)
L1
43B
43B
(50)
L1
(51)
L2
(51)
L2
(50)
L1
P
P
P
130
43B
43B
130B
48A
48B
48

FIG. 16

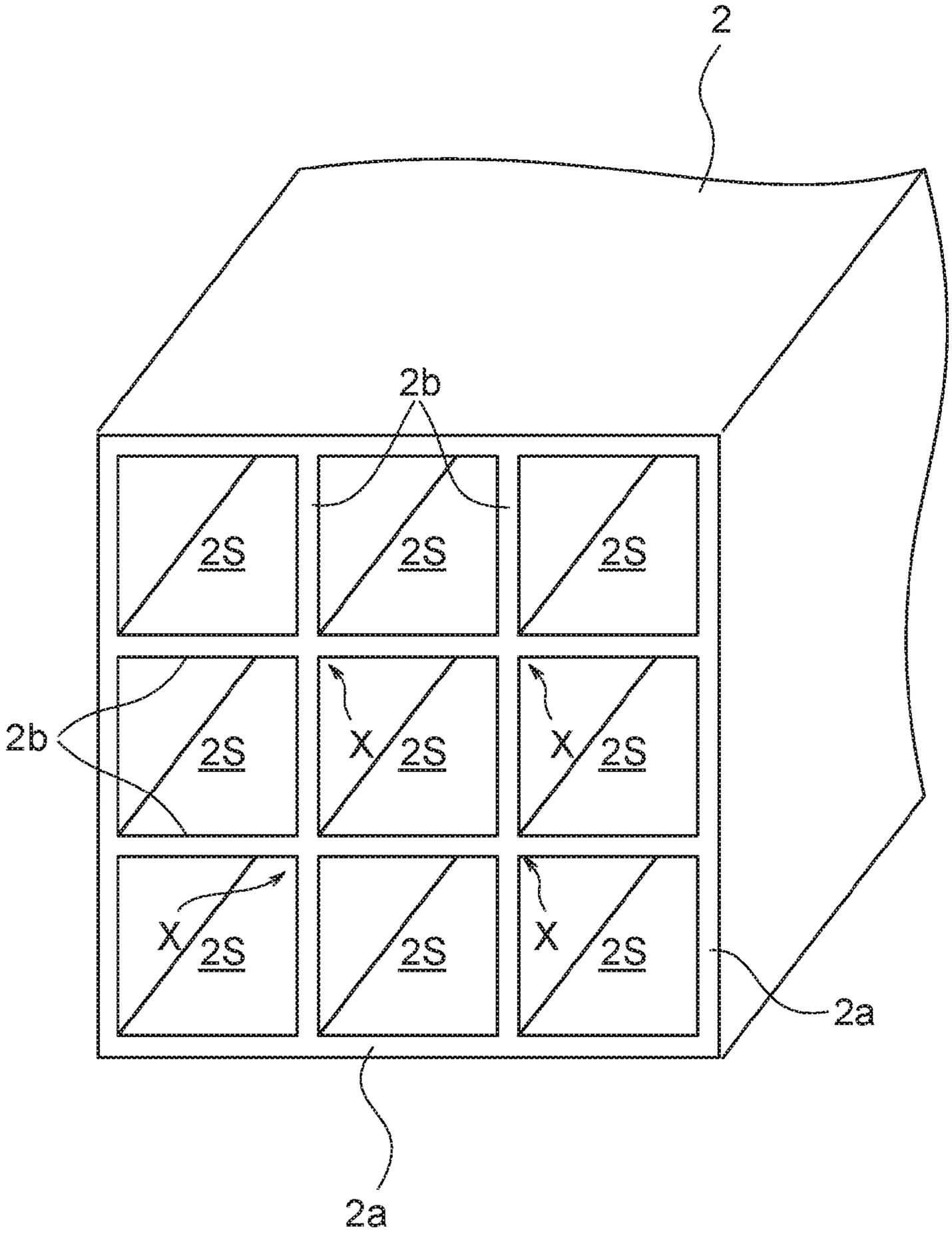


FIG. 17

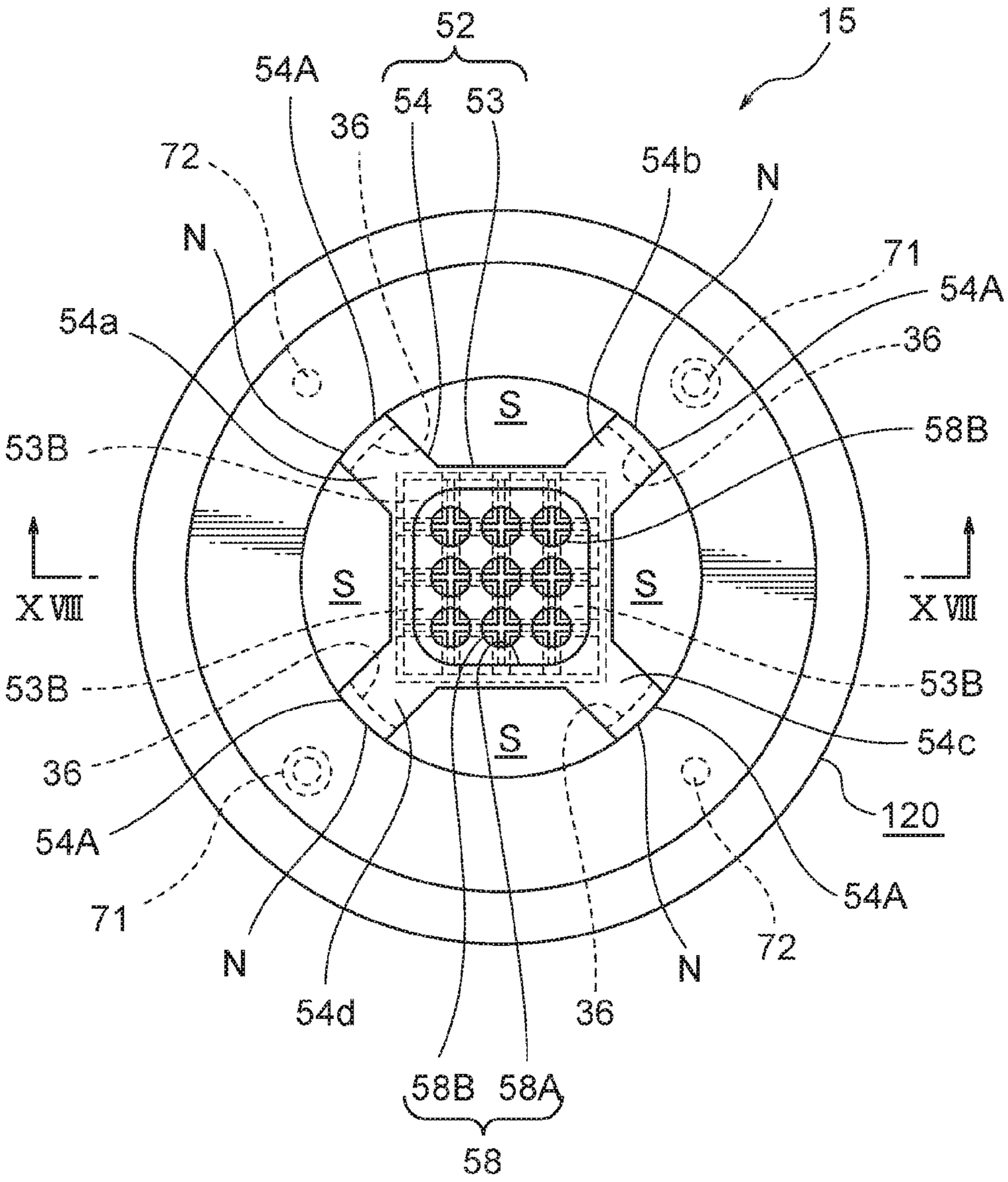

52
15
54A
54
53
36
72
54b
N
71
54A
54a
36
S
58B
53B
XVIII
XVIII
S
S
53B
53B
S
54c
36
120
54A
54A
71
72
N
N
54d
36
58B
58A
58

FIG. 18

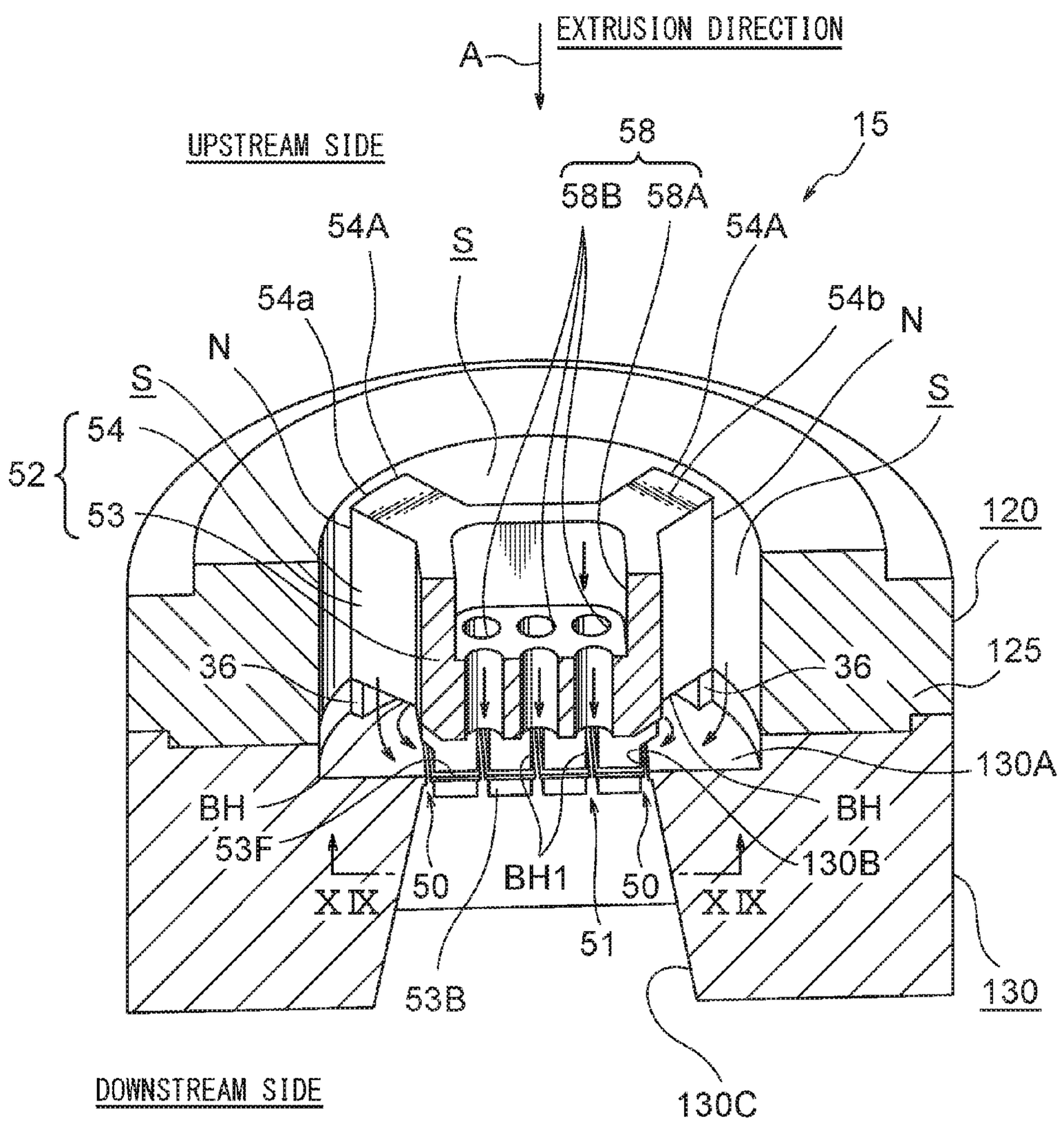

EXTRUSION DIRECTION
A
UPSTREAM SIDE
58
58B
58A
15
54A
S
54A
54a
54b
N
N
S
S
52
54
53
120
125
36
36
130A
BH
BH
53F
130B
XIX
50
BH1
50
XIX
51
53B
130
DOWNSTREAM SIDE
130C

FIG. 19

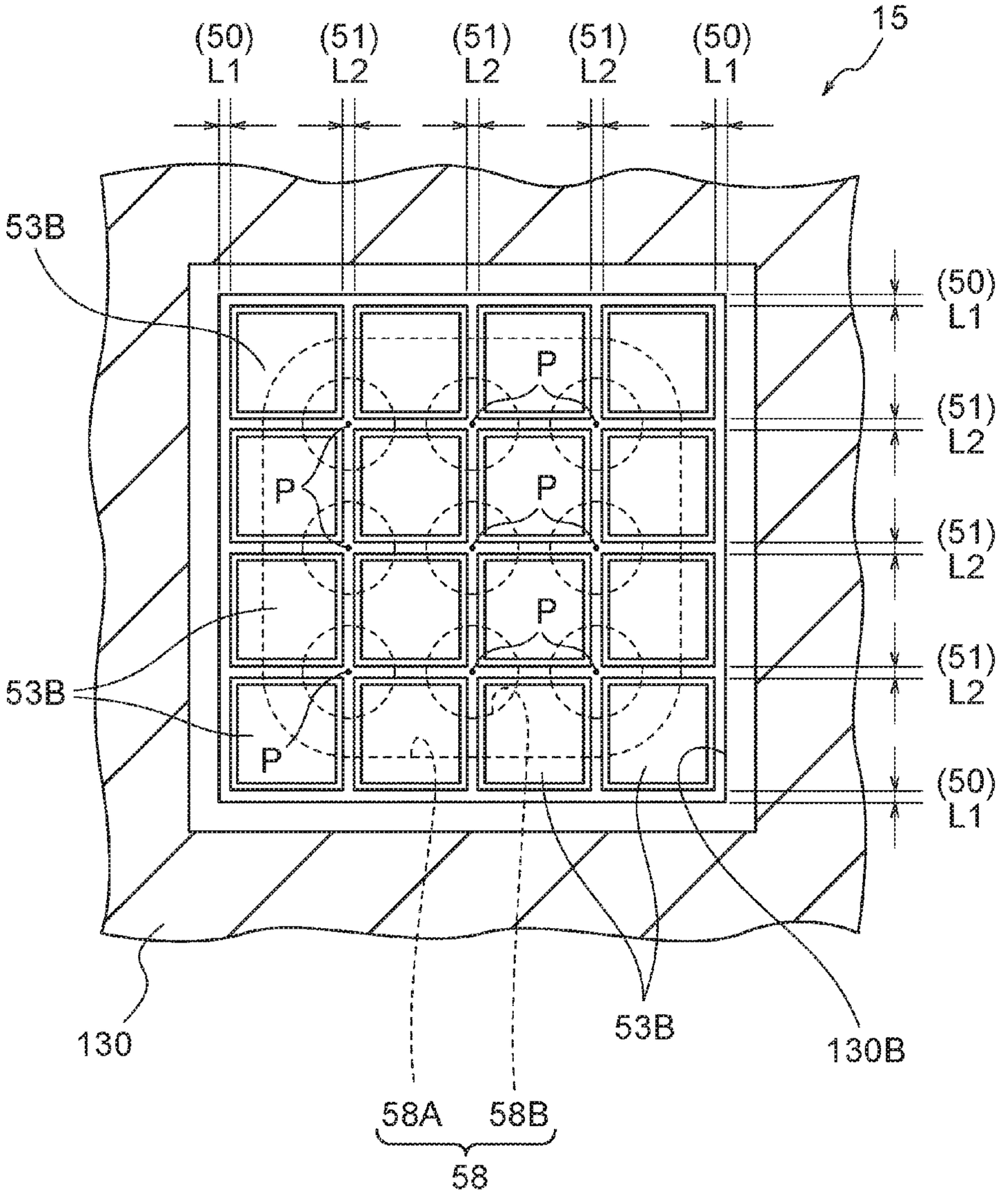

(50)
L1
(51)
L2
(51)
L2
(51)
L2
(50)
L1
15
53B
P
P
P
P
P
53B
(50)
L1
(51)
L2
(51)
L2
(51)
L2
(50)
L1
130
53B
130B
58A
58B
58

FIG. 20

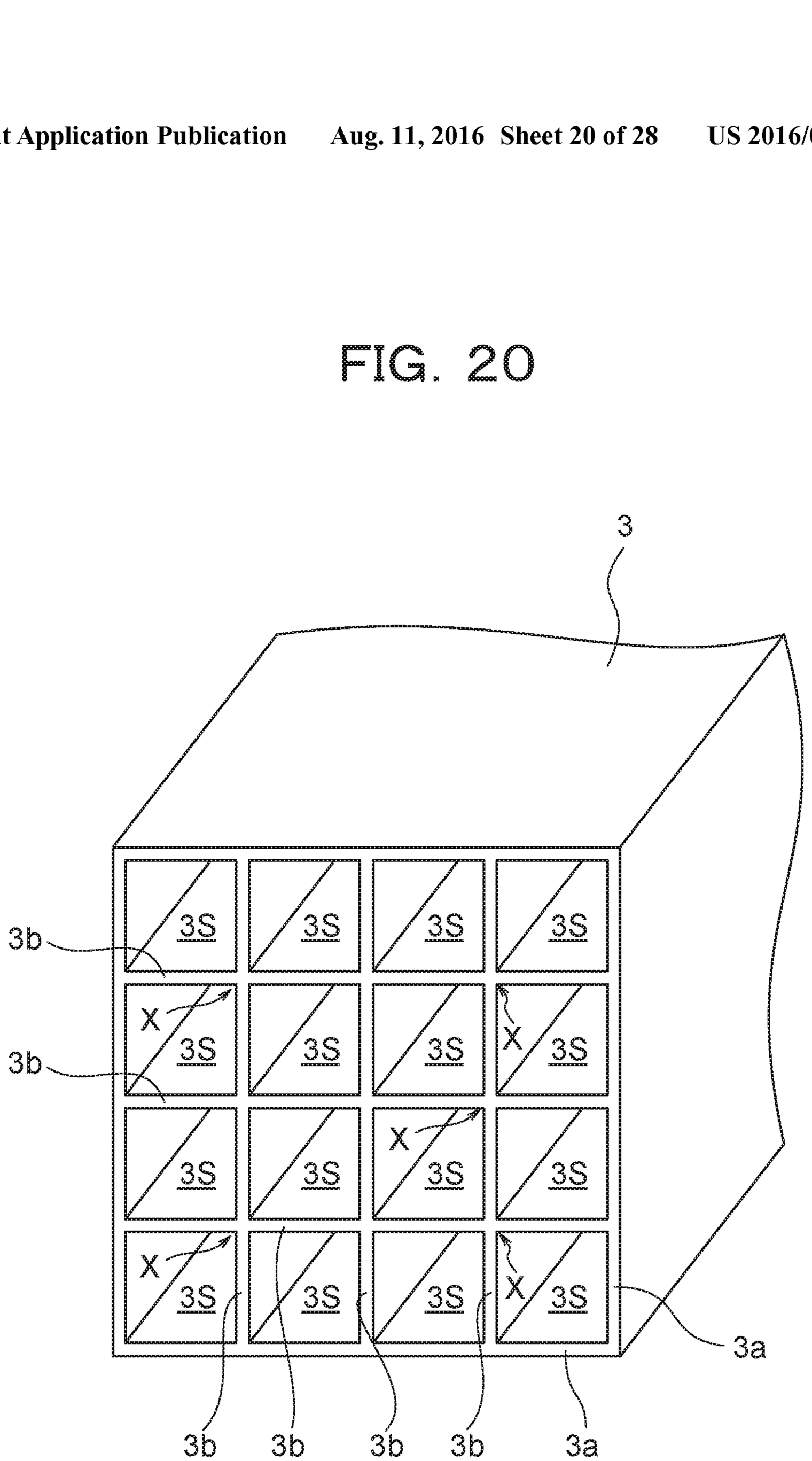


FIG. 21

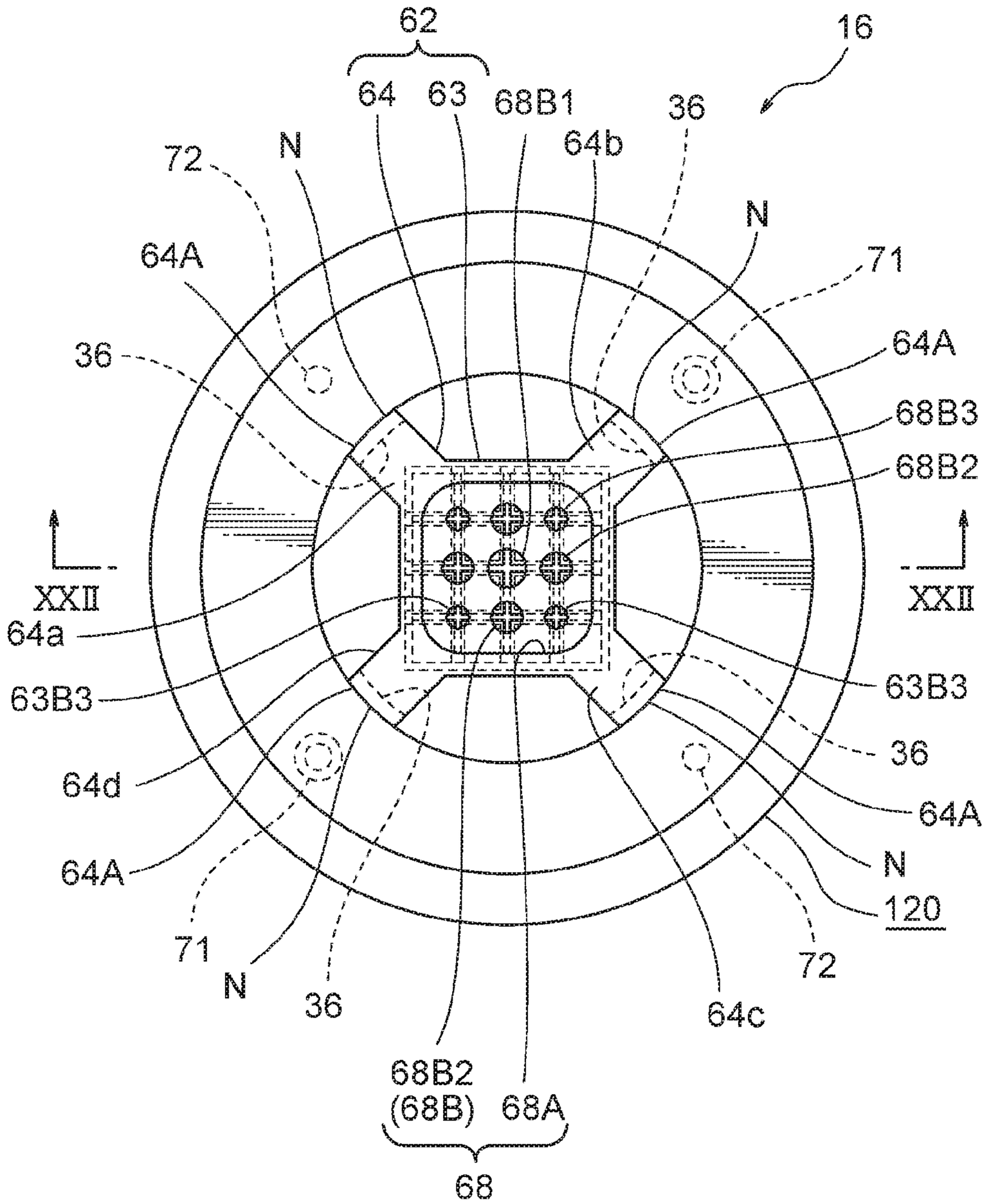

62
64
63
68B1
16
36
72
N
64b
N
64A
71
64A
36
68B3
68B2
XXII
XXII
64a
63B3
63B3
36
64d
64A
64A
N
120
71
N
36
72
64c
68B2
(68B)
68A
68

FIG. 22

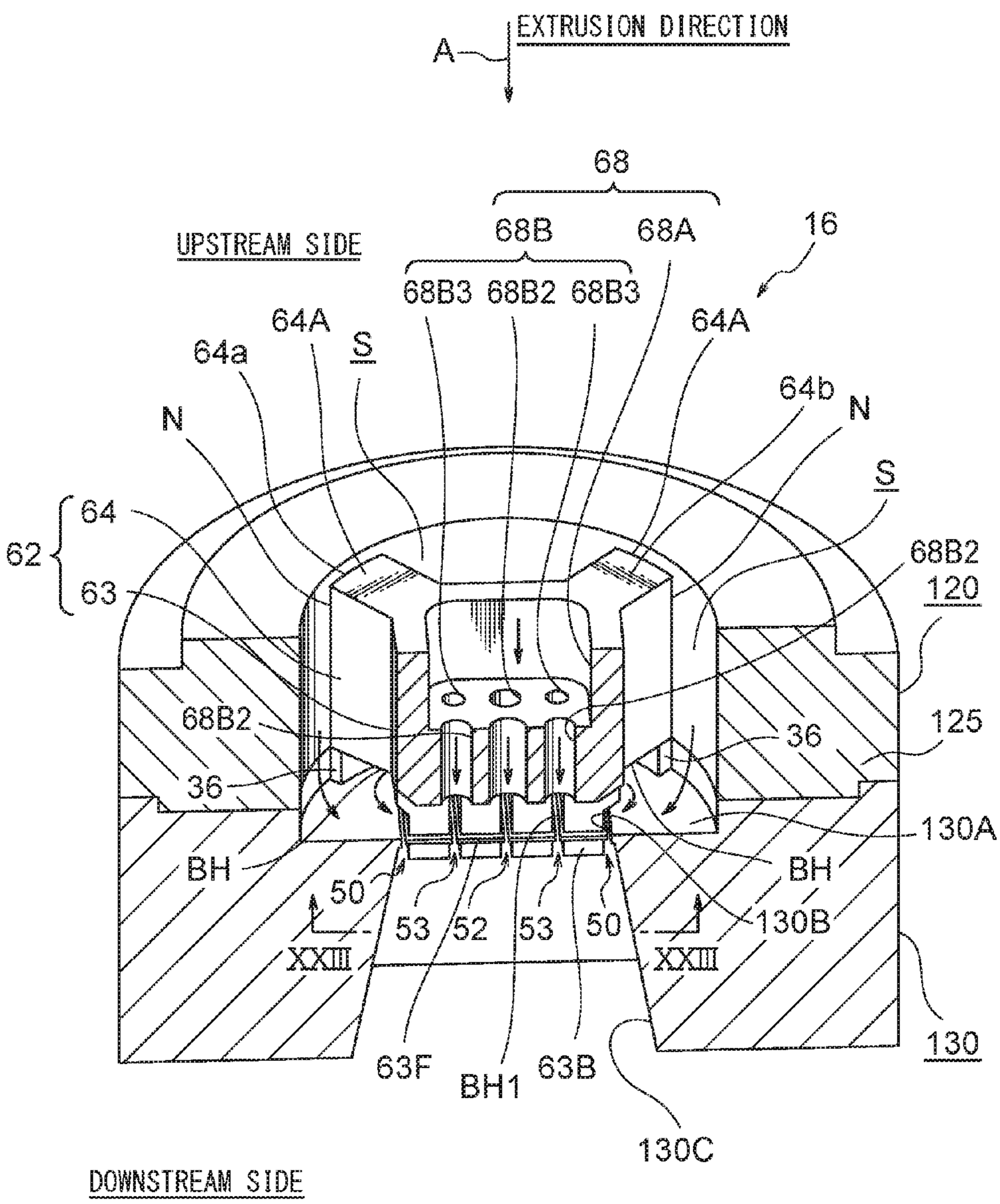

A
EXTRUSION DIRECTION
68
68B
68A
16
UPSTREAM SIDE
68B3 68B2 68B3
64A
64a
S
64A
64b
N
N
S
62
64
63
68B2
120
68B2
125
36
36
130A
BH
BH
50
53
52
53
50
130B
XXIII
XXIII
63F
BH1
63B
130C
130
DOWNSTREAM SIDE

FIG. 23

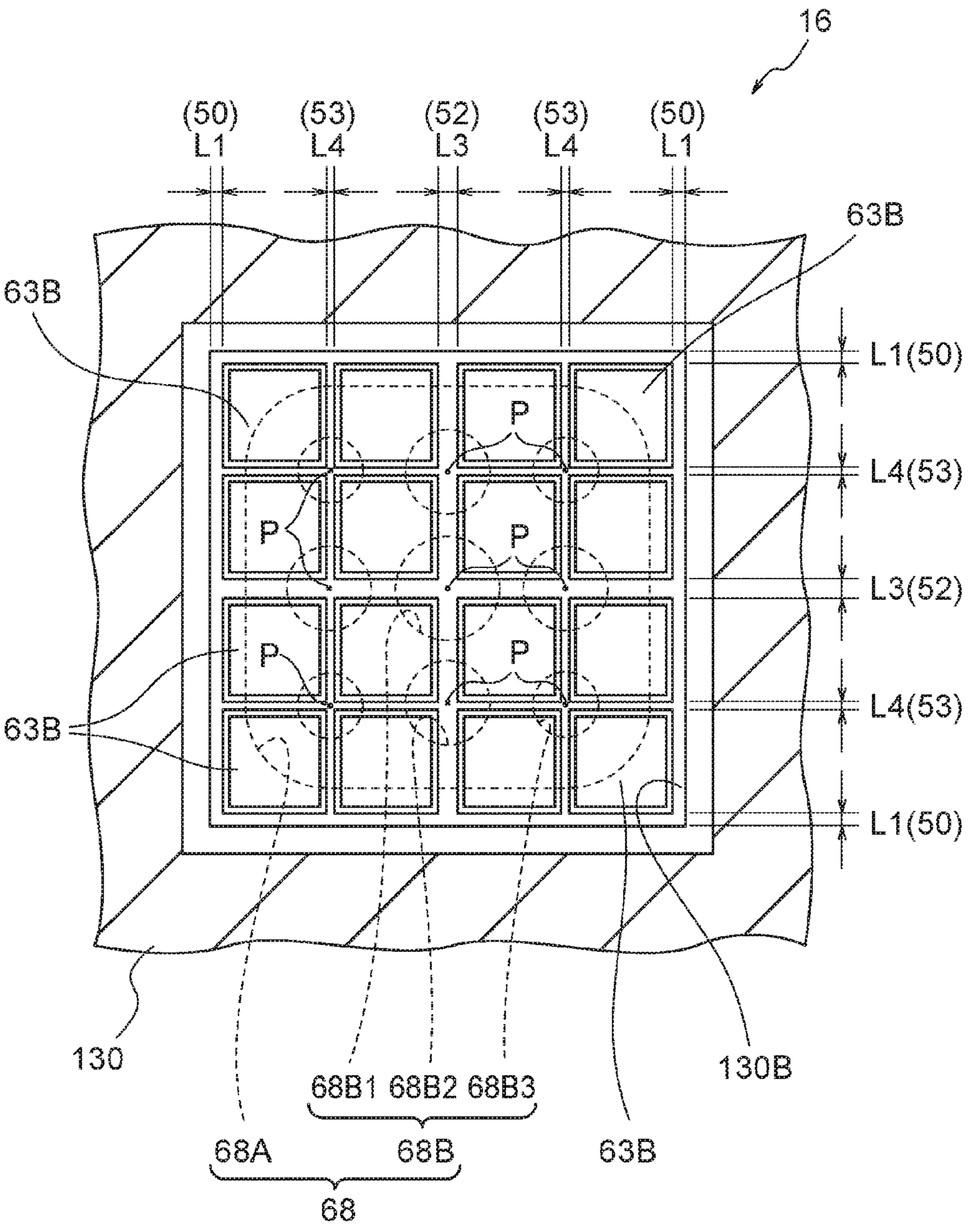

16
(50)
(53)
(52)
(53)
(50)
L1
L4
L3
L4
L1
63B
63B
L1(50)
L4(53)
L3(52)
L4(53)
L1(50)
P
P
P
P
P
P
63B
130
68B1 68B2 68B3
68A
68B
68
63B
130B

FIG. 24

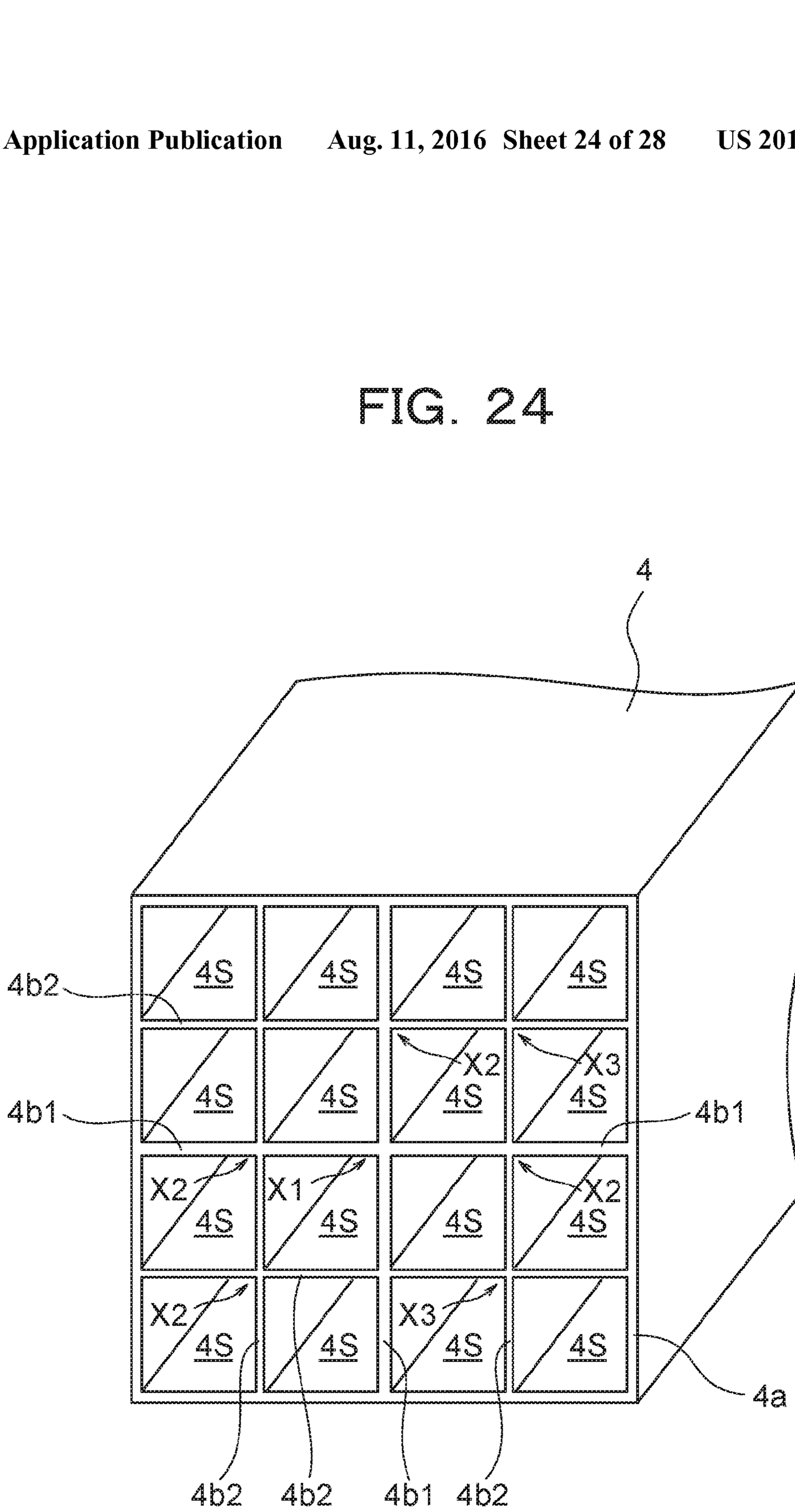


FIG.25A

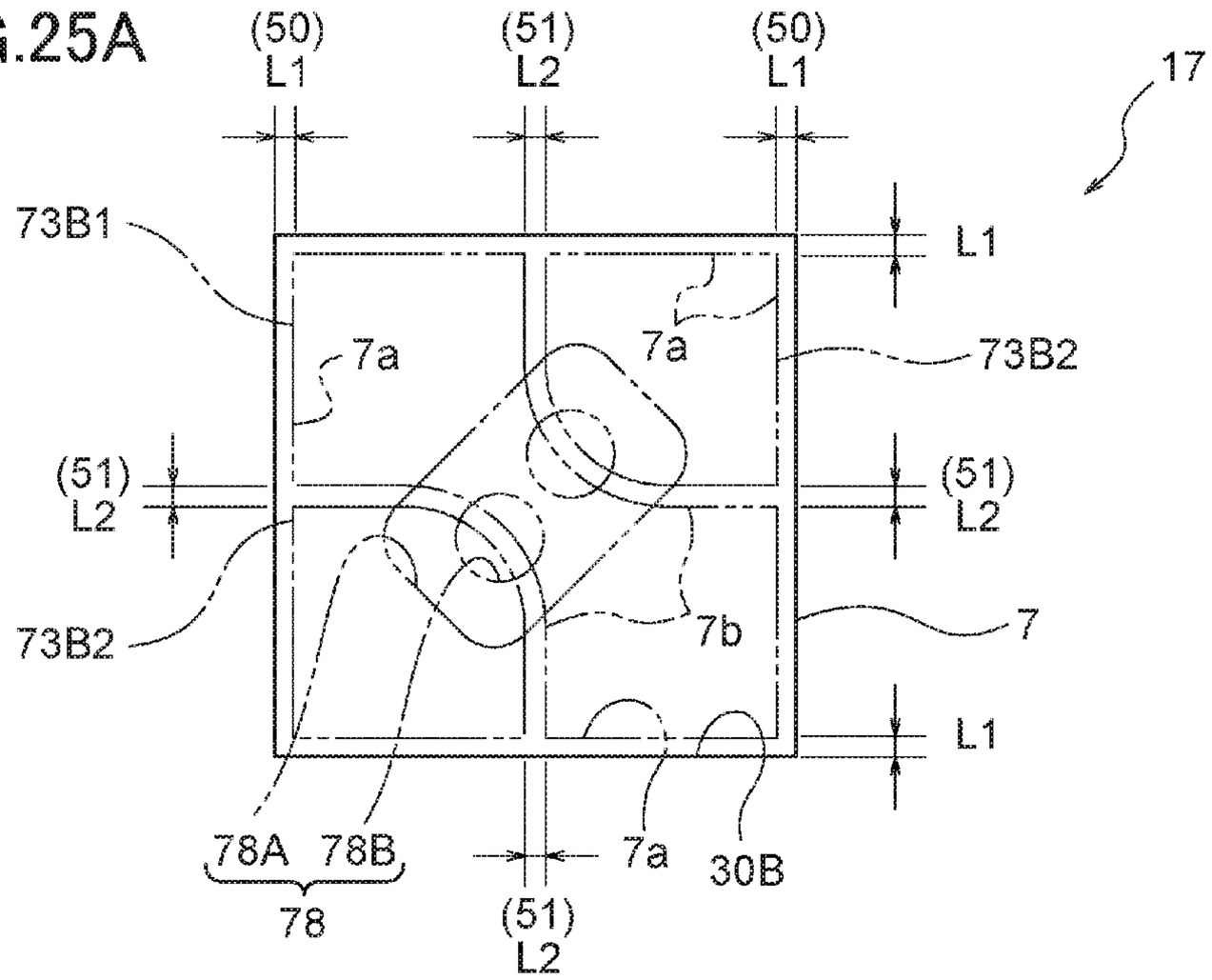


FIG.25B

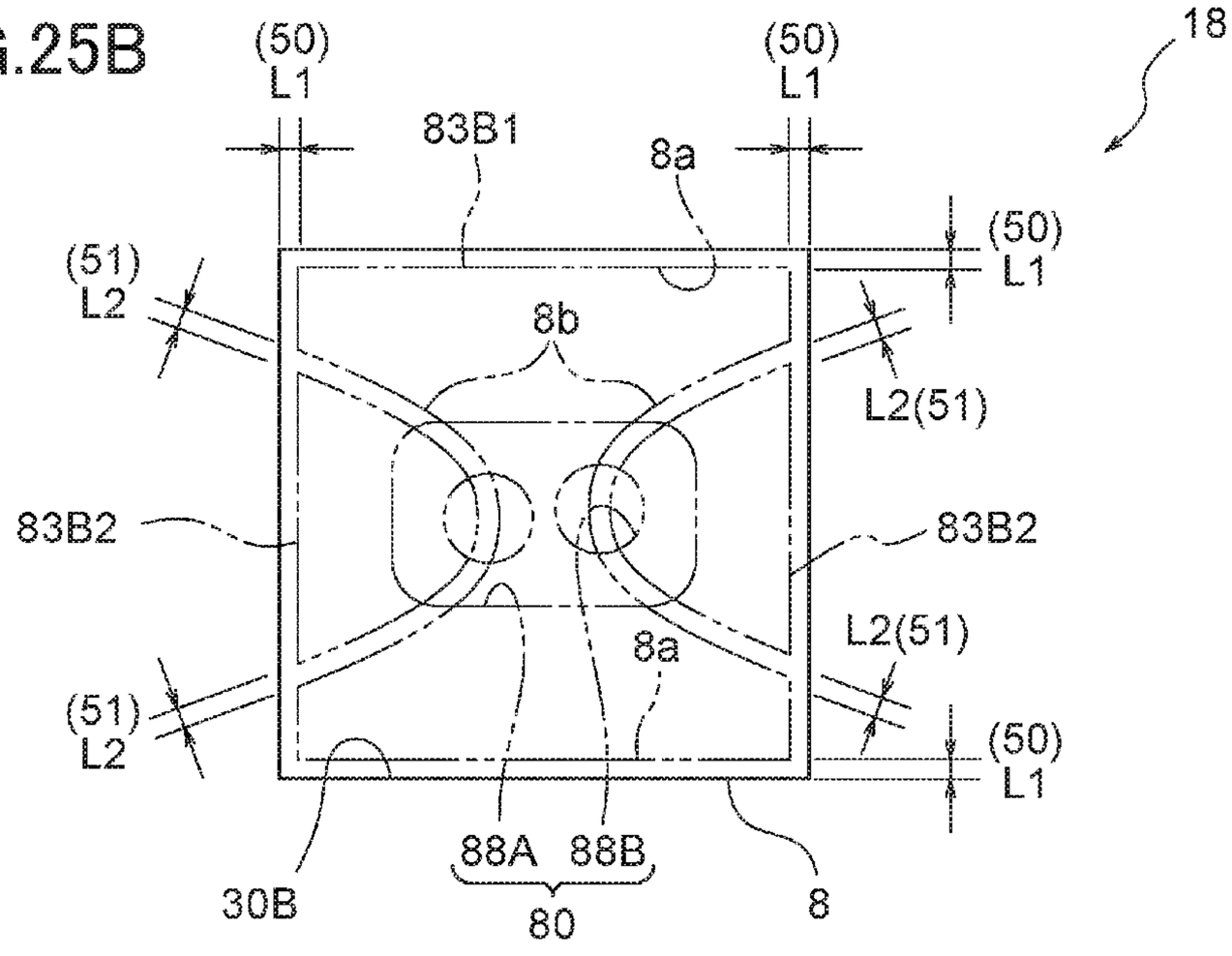


FIG. 26

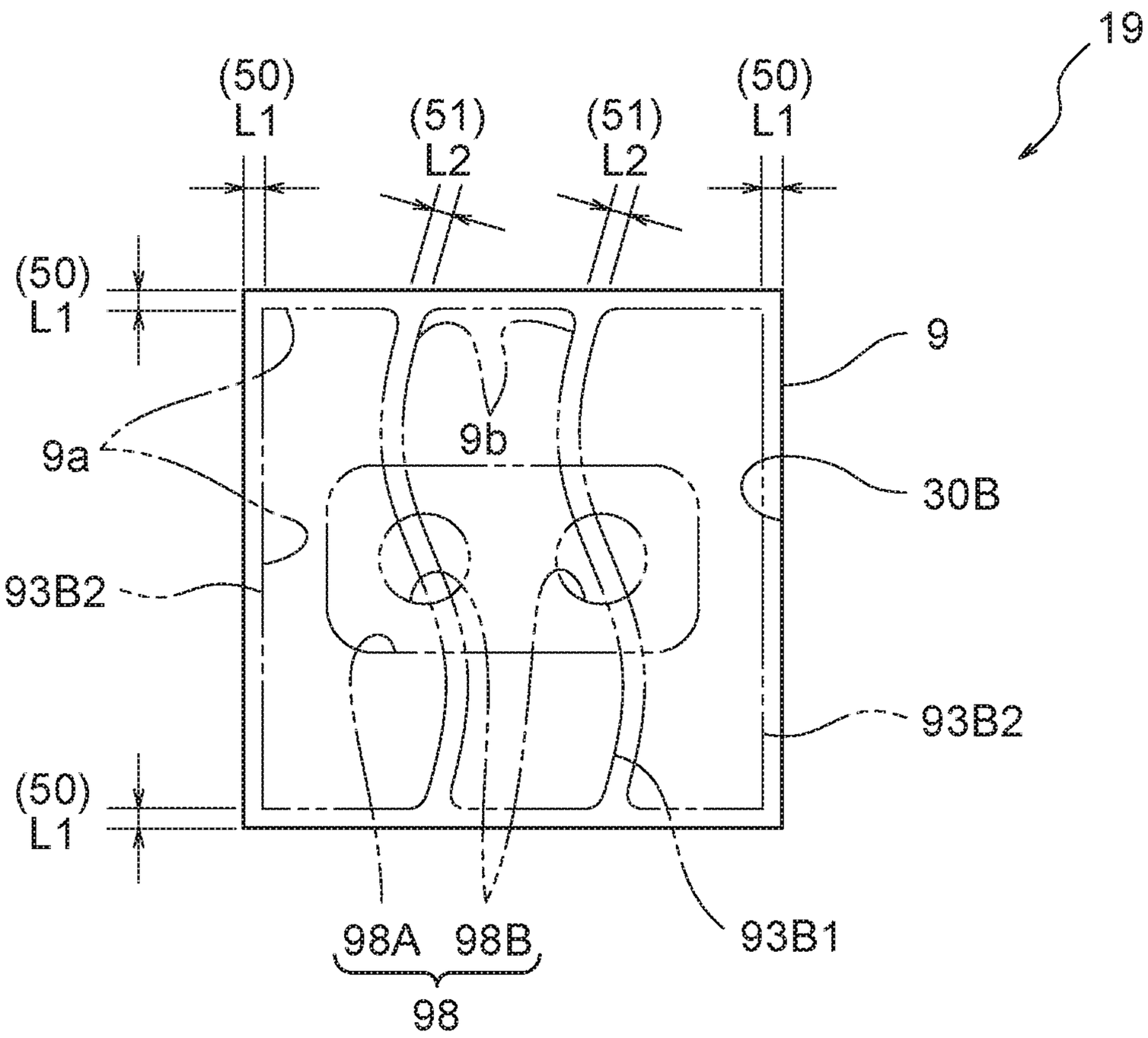

19
(50)
L1
(51)
L2
(51)
L2
(50)
L1
(50)
L1
9
9a
9b
30B
93B2
93B2
(50)
L1
98A
98B
98
93B1

FIG. 27

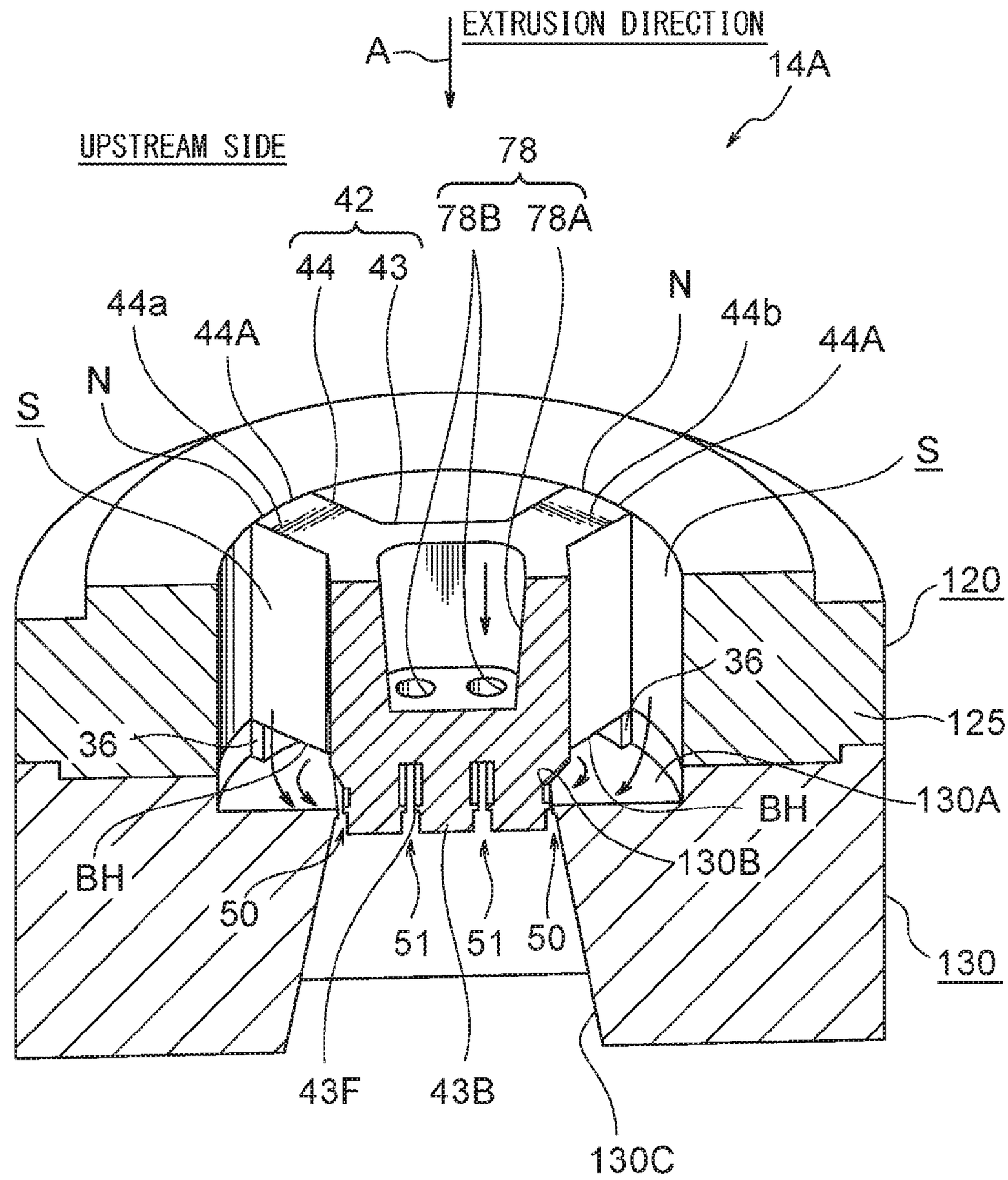

A
EXTRUSION DIRECTION
14A
UPSTREAM SIDE
78
42
78B 78A
44 43
44a
44A
N
44b
44A
S
N
S
120
36
125
36
BH
130A
BH
130B
50
51 51 50
130
43F 43B
130C
DOWNSTREAM SIDE

FIG.28A

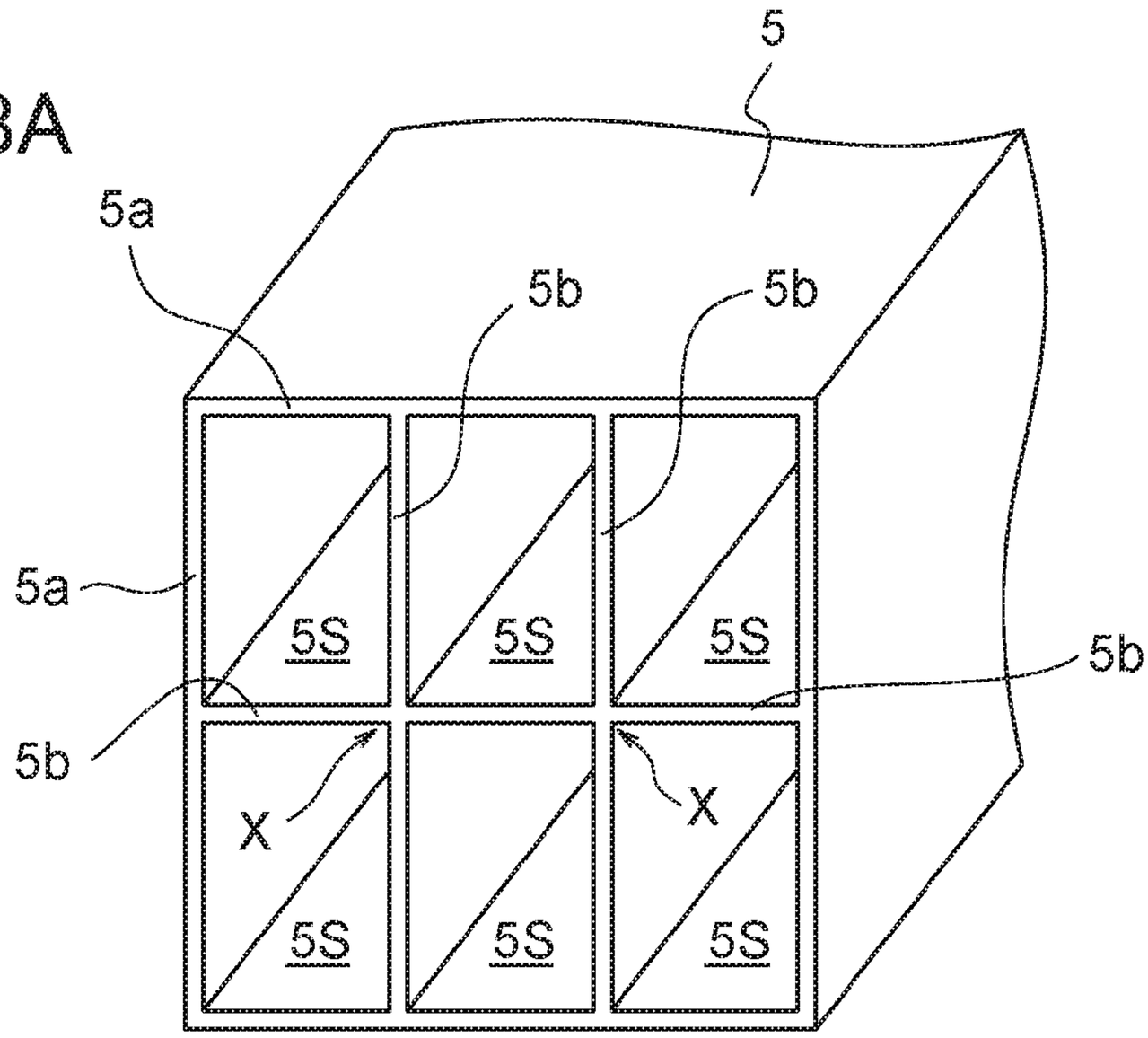
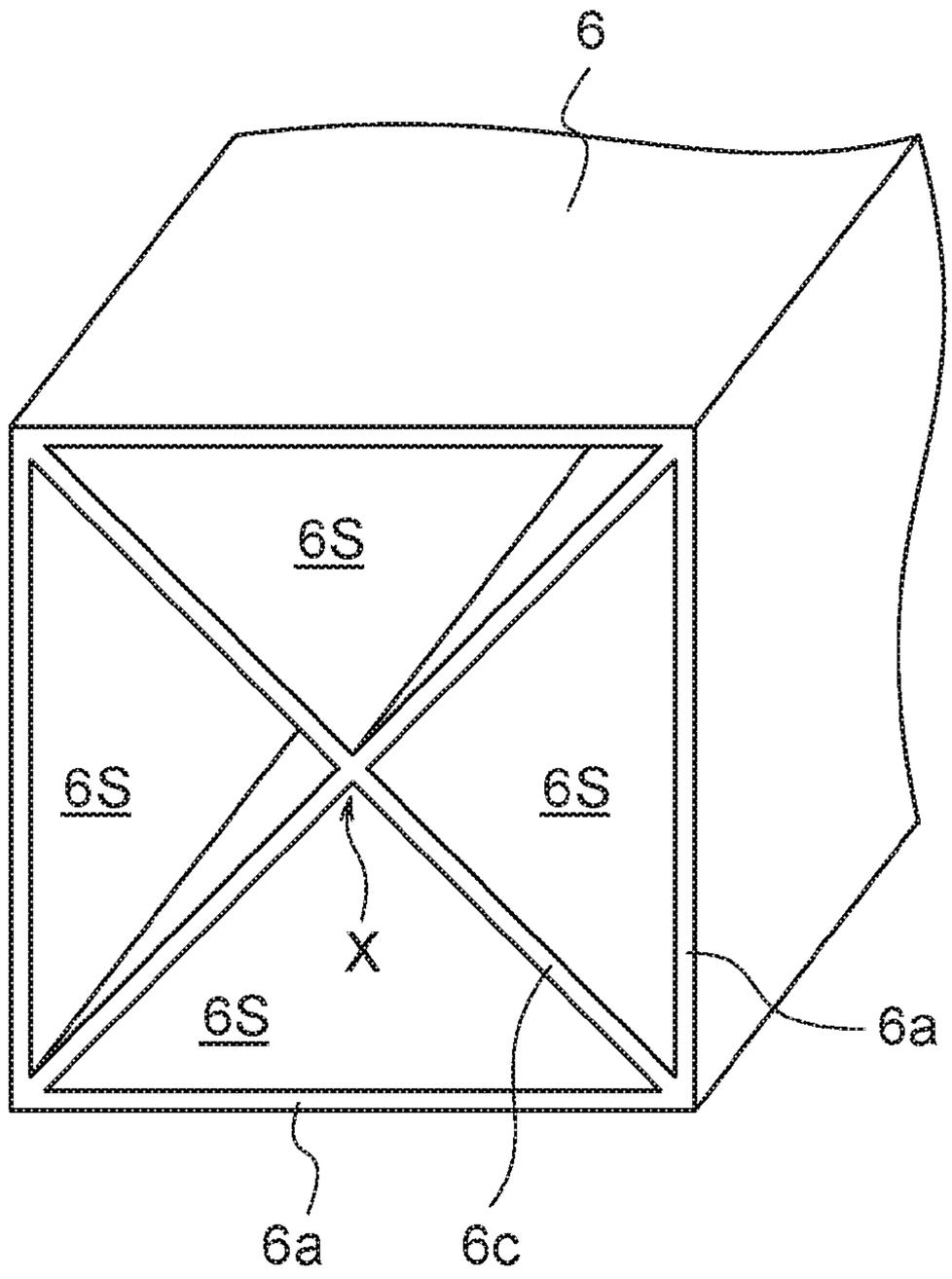


FIG.28B



EXTRUSION DIE FOR FORMING HOLLOW MATERIAL

TECHNICAL FIELD

[0001] The present invention relates to an extrusion die for forming a hollow material and, more specifically, to an extrusion die for forming a hollow material having a partition wall provided in the interior thereof by extruding a high-strength alloy, particularly a high-strength aluminum alloy such as the so-called 7000 series.

BACKGROUND ART

[0002] In general, extrusion processing of an aluminum alloy or the like is broadly employed nowadays since it can provide highly versatile sectional views and is excellent in acquiring hollow materials formed by extrusion.

[0003] That is, products formed by extrusion processing have come to be used broadly as strength members of structural materials, mechanical components, and the like, and demands for extrusion members formed with a high-strength alloy, particularly high-strength aluminum alloys of the so-called 7000 series such as 7075, 7N01, 7003, and the like have been increasing. Further, as hollow materials formed by extrusion, not only the angular columnar shapes but also those with complicated sectional views such as a type in a sectional view with a single lateral partition wall, a type in a sectional view with two lateral partition walls, and the like have recently been produced.

[0004] As an example of conventional extrusion die for molding hollow materials of complicated sectional views, known are a metal-made three-dimensional extrusion material manufacturing method and a manufacturing device thereof (e.g., see Patent Document 1).

[0005] The metal-made three dimensional extrusion material manufacturing method and the manufacturing device thereof are structured to be able to form a three-dimensional extrusion member in which a hollow part and a solid part exist in a mixed manner in the lengthwise direction.

[0006] Further, also known is a hollow material extrusion die for forming a hollow material having a partition wall (e.g., see Patent Document 2).

[0007] This extrusion die is structured to be able to form a hollow material having a laterally-long sectional view with a single partition wall and a hollow material having a sectional view with two partition walls.

[0008] Further, also known are an extrusion processing method and a device for a metal-made extrusion material with different lateral sectional views in the lengthwise direction (e.g., see Patent Document 3). With the extrusion processing method and the device, it is possible to extrusion-mold aluminum-made extrusion materials having different lateral sectional views in the lengthwise direction.

Patent Document 1: Japanese Unexamined Patent Publication Hei 4-305312

Patent Document 2: Japanese Examined Patent Publication Hei 5-9169

Patent Document 3: JP No. 3095916

[0009] Incidentally, in a case of forming a hollow material of a complicated sectional view such as a sectional view with two partition walls by using a high-strength alloy, particularly 7000 series high-strength aluminum as a hollow member molding material, a pair of opposing outer circumferential walls and two parallel partition walls are formed. Those partition walls are in a straight-line form, so that it is considered that billets can flow relatively easily.

[0010] However, recently, not only the hollow materials having the sectional view with two partition walls and the like but also hollow materials having still more complicated sectional views such as a hollow material having a sectional view with a cross-like partition walls, a hollow material having a sectional view with a curve-shaped partition wall, and the like are desired due to the reason for improving the strength of the hollow materials, for example.

[0011] In a case of the hollow material having a sectional view with a cross-like partition wall, the cross-like partition walls forming the sectional view with a cross-like shape intersect with each other at the centers thereof. Thus, the billet formed with an aluminum alloy that is fed from the upstream side and extruded is not easily flown to the direction orthogonal to each other from the intersection. This causes such an issue that the cross-like partition walls having the intersection cannot be formed sufficiently.

[0012] Further, even in a case where there is no intersection and in a case of a hollow material having a complicated curve-shaped partition wall, flow of the billet tends to slow down at the curved part. This causes such an issue that the curve-shaped partition wall cannot be formed sufficiently.

[0013] Further, while the manufacturing method and the manufacturing device of the metallic three-dimensional extrusion material disclosed in Patent Document 1 described above are structured to be able to mold the three-dimensional extrusion material in which the hollow part and the solid part exist in a mixed manner in the lengthwise direction, it is not possible with the device disclosed in Patent Document 1 to mold the hollow material having an intersection constituted with partition walls.

[0014] Further, while the hollow-type material extrusion die having the partition walls disclosed in Patent Document 2 can mold the hollow material having a laterally long sectional view with a partition wall and the hollow material having a sectional view with two partition walls, the intersection is formed with the partition walls as described above. Thus, the extruded billet can flow in one direction but cannot flow easily from the intersection in the direction orthogonal to that direction. Therefore, it is difficult to mold the hollow material having the sectional view with a cross-like form inside therein.

[0015] Further, while the extrusion processing method and the device for the metallic extrusion materials having different lateral sectional views in the lengthwise direction disclosed in Patent Document 3 described above can extrusion-mold aluminum-made extrusion materials having different lateral sectional views in the lengthwise direction, it is not possible with the device disclosed in Patent Document 3 to mold a hollow material having an intersection constituted with partition walls.

[0016] In order to overcome the above-described issues, it is an object of the present invention to provide an extrusion die for forming a hollow material capable of easily forming a hollow material having a partition wall provided inside thereof through extruding a billet formed with a high-strength alloy with a large extrusion processing force, particularly a high-strength aluminum alloy such as the so-called 7000 series.

DISCLOSURE OF THE INVENTION

[0017] In order to achieve the foregoing object, the extrusion die for forming a hollow material according to the present invention is an extrusion die for forming a hollow material, which includes: a male-type member which forms an inner shape of the hollow material while guiding a billet constituted with an aluminum alloy fed from an upstream side toward a downstream side; and a female-type member which holds the male-type member with an outer circumferential part and forms an outer shape of the hollow material, wherein: the male-type member includes a mandrel section for forming the inner shape, and a holder section connected integrally to an outer circumferential part of the mandrel section via a plurality of bridge sections; a billet guide hole for guiding a part of the billet toward the downstream side is provided in a center region of the mandrel section; an upstream-side opening area of the billet guide hole is formed larger than a downstream-side opening area; and a plurality of inner formation pieces are fixedly mounted on a downstream side of the billet guide hole and at positions for forming continuous partition walls inside the hollow material while keeping a billet flow-in gap space forming a merging space of the billet flowing in from each of the bridge sections toward the downstream side.

[0018] The extrusion die for forming a hollow material according to the present invention is structured in the manner described above, so that a part of the billet from the billet guide hole provided in the center region of the mandrel section is mixed with the billet flown-in from the bridge section side and extruded out from the billet flow-in space maintained toward the downstream side. The billet extruded out from the billet guide hole is extruded out toward the position of the partition wall part of the hollow material formed by a plurality of inner formation pieces, so that it can sufficiently reach even into complicated sectional views such as the intersection of the partition walls, the curved part of the curve-shaped partition walls, etc. As a result, it becomes possible to easily form the hollow material having partition walls provided therein through extruding out the billet formed with a high-strength alloy with a large extrusion processing force, particularly a high-strength aluminum alloy such as the so-called 7000 series.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a cross sectional perspective view showing a main part of a first embodiment of an extrusion die for forming a hollow material according to the present invention;

[0020] FIG. **2** is a plan view showing the entire extrusion die for forming the hollow material according to the first embodiment;

[0021] FIG. **3** is a cross sectional view taken along a line III-III of FIG. **2**, which is a cross sectional view showing a state where a holder and a bridge outer circumferential face are formed integrally by a bridge section press-fit structure and where a billet guide hole is in a two-stage structure;

[0022] FIG. **4** is a fragmentary sectional arrow view taken along a line IV-IV of FIG. **3**;

[0023] FIG. **5** is a sectional perspective view of a male-type member and a female-type member of the first embodiment, which is the entire view of FIG. **1**;

[0024] FIG. **6** is an overall plan view showing the surface of the female-type member of the first embodiment;

[0025] FIG. **7** is a perspective view showing a hollow material having a sectional view with a cross-like shape formed by the extrusion die for forming the hollow material according to the first embodiment;

[0026] FIG. **8** is a second embodiment of the extrusion die for forming a hollow material according to the present invention, which is a cross sectional view corresponding to FIG. **3** showing a state where a holder and a bridge outer circumferential face are formed integrally by a bridge section press-fit structure and where a billet guide hole is in a tapered shape;

[0027] FIG. **9** is a sectional perspective view of a male-type member and a female-type member shown in FIG. **8**;

[0028] FIG. **10** is an overall plan view showing a third embodiment of the extrusion die for forming a hollow material according to the present invention;

[0029] FIG. **11** is a cross sectional perspective view taken along a line X1-X1 of FIG. **10**, which is a cross sectional view showing a state where a holder and a bridge outer circumferential face are formed integrally by a bridge section shrink-fit structure and where a billet guide hole is in a two-stage structure;

[0030] FIG. **12** shows a fourth embodiment of the extrusion die for forming a hollow material according to the present invention, which is a cross sectional perspective view showing a state where a holder and a bridge outer circumferential face are formed integrally by a bridge section shrink-fit structure and where a billet guide hole is in a tapered shape;

[0031] FIG. **13** shows a fifth embodiment of the extrusion die for forming a hollow material according to the present invention, which is an overall plan view showing a state where a holder and a bridge outer circumferential face are formed integrally by a bridge section shrink-fit structure;

[0032] FIG. **14** is a cross sectional perspective view taken along a line XIV-XIV of FIG. **13**;

[0033] FIG. **15** is a fragmentary sectional arrow view taken along a line XV-XV of FIG. **14**;

[0034] FIG. **16** is a perspective view showing a hollow material having a sectional view with a lattice form which is formed by the extrusion die for forming a hollow material according to the fifth embodiment;

[0035] FIG. **17** is an overall plan view showing a sixth embodiment of the extrusion die for forming a hollow material according to the present invention;

[0036] FIG. **18** is a cross sectional view taken along a line XVIII-XVIII of FIG. **17**;

[0037] FIG. **19** is a fragmentary sectional arrow view taken along a line XIX-XIX of FIG. **18**;

[0038] FIG. **20** is a perspective view showing a hollow material having a sectional view with a lattice form which is formed by the extrusion die for forming a hollow material according to the sixth embodiment;

[0039] FIG. **21** shows a seventh embodiment of the extrusion die for forming a hollow material according to the present invention, which is an overall plan view showing a state where a holder and a bridge outer circumferential face are formed integrally by a bridge section shrink-fit structure;

[0040] FIG. **22** is a cross sectional perspective view taken along a line XXII-XXII of FIG. **21**;

[0041] FIG. **23** is a fragmentary sectional arrow view taken along a line XXIII-XXIII of FIG. **22**;

[0042] FIG. **24** is a perspective view showing a hollow material having a sectional view with a lattice form constituted with partition walls of different thicknesses, which is

formed by the extrusion die for forming a hollow material according to the seventh embodiment;

[0043] FIGS. **25**A and **25**B show schematic views of hollow materials having curve-shaped partition walls formed by utilizing eighth and ninth embodiments of the extrusion die for forming a hollow material according to the present invention, in which FIG. **25**A is a view showing a hollow material having curve-shaped partition walls formed by the extrusion die of the eighth embodiment and FIG. **25**B is a view showing a hollow material having curve-shaped partition walls formed by the extrusion die of the eighth embodiment;

[0044] FIG. **26** is a schematic view of a hollow material having curve-shaped partition walls formed by utilizing a tenth embodiment of the extrusion die for forming a hollow material according to the present invention, in which two wave-like curve-shaped partition walls are provided;

[0045] FIG. **27** is a cross sectional perspective view showing a modification example of the fifth embodiment (FIG. **14**) according to the present invention; and

[0046] FIGS. **28**A and **28**B show perspective views, in which both FIG. **28**A and FIG. **28**B show modification examples of a hollow material having partition walls with intersections formed by utilizing the extrusion die for forming a hollow material according to the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

[0047] Hereinafter, a first embodiment of an extrusion die for forming a hollow material (simply referred to as an extrusion die hereinafter) of the present invention will be described by referring to FIG. **1** to FIG. **6**.

[0048] An extrusion die **10** of the first embodiment is for forming a hollow material formed with a high-strength alloy, particularly a high-strength aluminum alloy that is the so-called 7000 series. Further, among hollow materials having complicated sectional views such as curve-shaped partition walls, partition walls forming an intersection, and the like, the extrusion die **10** forms a hollow material **1** having a sectional view with a cross formed with partition walls **1***b* and **1***b* provided in a cross-like form having an intersection X inside thereof as shown in FIG. **7**.

[0049] As shown in FIG. **1** and FIG. **3**, the extrusion die **10** is constituted by including: a male-type member **20** having a mandrel section **23** which forms the inner shape of the hollow material **1** while guiding a billet B formed with an aluminum alloy extruded out from the upstream side toward the downstream side; and a female-type member **30** which holds the male-type member **20** with the outer circumferential part and forms the outer shape of the hollow material **1**.

[0050] The male-type member **20** is constituted by including: the mandrel section **23**; and a holder section **25** which is integrally connected to the outer circumferential part of the mandrel section **23** via a plurality of bridge sections **24**.

[0051] The holder section **25** is formed in a disc shape as a whole with a prescribed thickness. On the end face of the upstream side of the extrusion direction thereof, formed is a billet introduction opening **25**B in a disc shape as a whole while being sectioned by each of the bridge sections **24**.

[0052] As will be described later in details, a billet guide hole **28** for guiding a part of the billet B toward the downstream side is provided in the center region of the mandrel section **23**.

[0053] Further, an upstream-side opening area **28**A of the billet guide hole **28** is formed to be larger than the opening area of a downstream-side opening **28**B.

[0054] Further, a plurality of (four in this embodiment) inner formation pieces **23**B are fixed on the side opposing to the downstream-side opening of the billet guide hole **28** and at positions for forming partition walls having an intersection X inside the hollow material **1** while keeping a billet insertion hole BH**1** (a billet flow-in gap space) forming a merging space with the flow-in billet B from each of the bridge sections **24** on the downstream side, i.e., towards the female-type member **30** side. The inner formation pieces **23**B are provided to the mandrel section **23** via a connecting section **23**M.

[0055] Further, in the female-type member **30**, an outer formation die hole **30**B for forming outer shapes of a plurality of the hollow materials **1** is provided by opposing to the entire outer circumferential face of the four inner formation pieces **23**.

[0056] Hereinafter, each structure will be described in more details.

[0057] First, the entire extrusion die **10** will be described by referring to FIGS. **2** and **3**.

[0058] As shown in FIG. **2**, the extrusion die **10** is formed in a disc shape as a whole. Further, as shown in FIG. **3**, the extrusion die **10** is constituted by including the male-type member **20**, the female-type member **30**, and a back die **70** for holding the female-type member **30**.

[0059] Further, the billet B is housed within a billet extrusion device **80** constituted with a chamber and the like disposed in the upstream side of the male-type member **20**, and extruded out by the billet extrusion device **80**.

[0060] The male-type member **20**, the female-type member **30**, and the back die **70** are connected integrally.

[0061] That is, as shown in FIG. **2** and FIG. **3**, after the male-type member **20** and the female-type member **30** are placed at the positions by two positioning pins **71**, for example, the male-type member **20**, the female-type member **30**, and the back die **70** are connected and fixed by two connection bolts **72**, for example.

[0062] As shown in details in FIGS. **3** and **5**, the male-type member **20** is constituted by including a spider **22**. The spider **22** is constituted by including: the mandrel section **23** which forms the inner shape of the hollow material **1**; the bridge section **24** which supports the mandrel section **23** and is projected substantially in an X-letter shape toward outer side from the periphery of the mandrel section **23**; and the holder section **25** which is connected integrally via the bridge section **24**.

[0063] As shown in FIG. **2**, the bridge section **24** is constituted with four pieces of a first bridge **24***a*, a second bridge **24***b*, a third bridge **24***c*, and a fourth bridge **24***d* disposed clockwise. Further, the spaces between each of the bridges **24***a* to **24***d* form the billet introducing spaces S.

[0064] A top face **23**A of the mandrel section **23** is formed in a disc-like flat surface, and the top faces of the bridges **24***a* to **24***d* are connected to the top face **23**A. The top faces of the bridges **24***a* to **24***d* are formed in a downward sloping shape from the top face **23**A of the mandrel section **23** toward the internal circumferential face of the holder section **25**.

[0065] Further, the top face **23**A of the mandrel section **23** is formed as the same height with a top end face **25**A of the holder section **25** (see FIGS. **3** and **5**) when the spider **22** and the holder section **25** are assembled integrally.

[0066] As shown in FIGS. **1**, **3**, and **5**, tip external circumferential faces **24**A of the bridges **24***a* to **24***d* are formed to be engaged with bridge receiving faces **26**B of a bridge holding section **26** of the holder section **25**.

[0067] That is, in the holder section **25**, provided by corresponding to each of the bridges **24***a* to **24***d* are: bridge presser sections **26**A which are formed on the top end of the holder section **25** for pressing the tip upper faces **24**B (see FIG. **3**) of the bridges **24***a* to **24***d*; and the bridge receiving faces **26**B which are formed continuously to the bridge presser sections **26**A and formed to be substantially equal (preferably a little wider) with respect to the width of the bridge **24***a* and the like.

[0068] Further, fixing members **27** in a flat square columnar shape, for example, are knocked into the bridge presser sections **26**A so that each of the bridges **24***a* to **24***d* does not rotate.

[0069] As shown in FIG. **5**, the fixing members **27** are knocked from the above into knock-in holes for the fixing members **27** opened over the upper-side parts of the bridge presser sections **26**A and the bridges **24***a* to **24***d* after precisely positioning each of the bridges **24***a* to **24***d* and the bridge presser sections **26**A.

[0070] Further, the engaging faces between the tip outer circumferential faces **24**A of the bridges **24***a* to **24***d* and the bridge receiving faces **26**B of the holder section **25** are formed as sloping faces approaching toward the center of the die from the upstream side of the extrusion direction toward the downstream direction. Thus, moment generated at the application point of extrusion by the inner formation pieces **23**B to be described later can be decreased, thereby making it possible to increase the strength of each of the bridges **24***a* to **24***d*. As a result, breakage of each of the bridges **24***a* to **24***d* can be prevented.

[0071] Note that the tip outer circumferential faces **24**A of the bridges **24***a* to **24***d* and the bridge receiving faces **26**B of the holder section **25** are integrated by press fitting by a bridge section press-fit structure M.

[0072] As shown in FIG. **1** in details, the bottom ends of the bridge sections **24***a* to **24***d* are located at positions distant from the holder receiving face **30**A of the female-type member **30** toward the upper side by a prescribed distance, and formed in a shape connected therefrom to a plurality (four in this embodiment) of the inner formation pieces **23**B for forming the inner shape of the hollow materials **1** (see FIG. **7**) via the connecting section **23**M of the mandrel section **23**.

[0073] Further, at each bottom end of each of the bridges **24***a* to **24***d*, a tunnel-like billet insertion hole BH is formed with the bottom end of each of the bridges **24***a* to **24***d* at the bottom end part of the bridge receiving face **26**B of the holder section **25** and the holder receiving face **30**A of the female-type member **30**. As shown with an arrow, the billet insertion hole BH forms a billet merging space where the billets B introduced from the billet introduction spaces S for introducing each billet B are merged.

[0074] Thereby, the billets B are introduced from the billet introduction space S for introducing each billet B, merged in the billet insertion hole BH, and extruded out to the downstream side.

[0075] As shown in FIGS. **1**, **3**, and **5**, the four inner formation pieces **23**B are provided at the downstream-side end of the flow of the billet B of the mandrel section **23**.

[0076] Each of those inner formation pieces **23**B is formed substantially in a square columnar shape and provided at the end of the mandrel section **23** via the connecting section **23**M as described above (also see FIG. **4**). Further, the four inner formation pieces **23**B are projected out toward the female-type member **30** side and, as shown in FIGS. **4** and **6** in details, formed to be inserted into the outer formation die hole **30**B formed in the female-type member **30**.

[0077] The female-type member **30** is formed to oppose to the outer circumferential face of the entire four inner formation pieces **23**B and in a size securing a gap L**1** of a prescribed size.

[0078] Further, each of the inner formation pieces **23**B is designed to be inserted into the outer formation die hole **30**B of the female-type member **30**, and the gap L**1** in the prescribed size set between the outer circumference of each of the inner formation pieces **23**B and the outer formation die hole **30**B forms a material outer formation hole **50** (see FIGS. **1**, **3**, and **5**). Furthermore, as shown in FIG. **3**, the outer formation die hole **30**B is formed with a straight-line part in a small size and a clearance hole **30**C expanded from the straight-line part toward the outer circumference direction of the female-type member **30**.

[0079] Each of such inner formation pieces **23**B is designed to form each of the four inside spaces **1**S of the hollow material **1** in a sectional view with a cross inside thereof as shown in FIG. **7**, and the four inner formation pieces **23**B are disposed so that the entire shape thereof forms substantially a square shape as shown in FIG. **4**.

[0080] As described above, each of the inner formation pieces **23**B is provided at the end on the downstream side of the extrusion direction of the material inner forming section **23** via the connecting section **23**M.

[0081] As shown in FIG. **1**, on the upstream side of the extrusion direction of each of the inner formation pieces **23**B, a band-like flange section **23**F projected toward the outer side from the respective outer circumferences is provided by being wrapped around the outer circumference of each of the inner formation pieces **23**B.

[0082] As shown in FIGS. **1** and **4**, a gap L**2** in a prescribed size is formed between the opposing flange sections **23**F of the inner formation pieces **23**B that are neighboring to each other. Further, with those gaps L**2**, the material formation inner hole **51** for forming the cross-like partition walls **1***b* and **1***b* of the hollow material **1** is constituted.

[0083] Further, the outer circumference of each of the flange sections **23**F of the inner formation pieces **23**B is disposed to oppose to the outer formation die hole **30**B formed in the female-type member **30**. Further, the gap L**1** in the prescribed size is formed between the both, and the material formation outer hole **50** for forming outer circumferential walls **2***a* and **2***a* of the hollow material **1** is formed with those gaps L**1**.

[0084] As shown in FIGS. **1**, **3**, and the like, the top faces of the flange sections **23**F of the respective inner formation pieces **23**B are on the same flat surface as that of the holder receiving face **30**A of the female-type member **30**. Thus, the billet B is also extruded out along the top end faces of the flange sections **23**F via the side face of the connecting section **23**M of the mandrel section **23** from the billet insertion hole BH.

[0085] As described above, in the hollow material **1**, the single intersection X is formed with the two partition walls **1***b* and **1***b*. Thus, the billets B extruded out only from the billet introduction space S for introducing the billet B, the billet insertion hole BH, and the billet insertion hole BH**1** may not be sufficient to fill up to the intersection X.

[0086] Thus, as shown in FIGS. **1** to **4**, the die **10** of the first embodiment is structured to include the billet guide hole **28** which guides a part of the billet B toward the downstream side provided in the center region of the mandrel section **23**.

[0087] The billet guide hole **28** is provided by corresponding to the intersection X of the partition walls **1***b* and **1***b*. Further, the upstream side opening area located on the billet B flow-in side of the mandrel section **23** is formed larger than the opening area of the downstream side opening located on the billet B flow-out side.

[0088] Further, on the side opposing to the downstream-side opening of the billet guide hole **28** and also between the opposing surfaces of the connecting section **23**M, the billet insertion hole BH**1** constituting the billet introduction gap space is provided. The billet insertion hole BH**1** is for constituting the billet merging space where the billets B introduced into the billet introduction spaces S for introducing the billets B are merged with each other, and the billets B introduced from the billet guide hole **28** are extruded out via the billet insertion hole BH**1**.

[0089] That is, as shown in details in FIGS. **1**, **3**, and **5**, the billet guide hole **28** of the first embodiment is constituted with a large opening hole **28**A formed with a diameter ϕ**1** on the upstream side including a step part in the midway of the mandrel section **23** and a small opening hole **28**B formed with a diameter ϕ**2** which introduces a part of the billet B on the lower side of the mandrel section **23**, i.e., on the side of the intersection X of the partition walls **1***b* and **1***b*.

[0090] Thus, a part of the billet B fed from the upstream side and extruded out is securely introduced into the small opening hole **28**B by being guided by the large opening hole **28**A.

[0091] Further, since the small opening hole **28**B is provided on the lower side of the mandrel section **23**, it is possible to secure thickness of the small opening hole **28**B to be large in the mandrel section **23**. Therefore, the strength of the die for the stress at the time of extrusion can be increased. As a result, cracking of the die can be prevented.

[0092] The region where one corner each of flange sections **23**F of the four inner formation pieces **23**B gathers, the position of the intersection point P corresponds to the intersection X formed with the partition walls. Further, the position of the small opening hole **28**B is set so that the position of the intersection point P and the center of the small opening hole **28**B of the billet guide hole **28** to be described later in details become consistent.

[0093] Next, a forming method of the hollow material **1** by the extrusion die **10** in the above-described structure will be described.

[0094] When the billet B is fed and extruded out by the billet extrusion device **80** provided on the upstream side of the extrusion direction of the billet B for the male-type member **20**, the billet B is first introduced into the billet introduction space S for introducing the billet B constituted with the gap formed in the mandrel section **23** of the male-type member **20**, the bridge section **24**, and the holder section **25**, and a part thereof is introduced into the larger opening hole **28**A of the billet guide hole **28**.

[0095] The billet B introduced into the billet introduction space S is introduced into the material formation outer hole **50** from the side faces of the first to fourth bridges **24***a* to **24***d*, the side face of the material inner formation section **23**, the billet insertion hole BH, the billet insertion hole BH**1**, and the top face of the flange section **23**F of each of the inner formation pieces **23**B, and extruded out from the material formation outer hole **50**.

[0096] Meanwhile, a part of the billet B introduced into the large opening hole **28**A of the billet guide hole **28** is securely introduced into the small opening hole **28**B by being guided by the large opening hole **28**A. At that time, the billet B from the billet insertion hole BH**1** is also merged and extruded out.

[0097] Then, the extruded and molded hollow material **1** is fed out from a material feed-out hole **70**A formed in the back die **70**. Thereafter, it is held by a holding mechanism, not shown, and conveyed into a prescribed stockyard or the like.

[0098] Next, the hollow material **1** molded by the above-described extrusion die **10** according to the above-described first embodiment will be described by referring to FIG. **7**.

[0099] The hollow material **1** is constituted with the outer circumferential walls **1***a*, **1** *a* having a square sectional view and the partition walls **1***b*, **1***b* in a cross-like form provided inside the outer circumferential walls **1***a*, **1***a*. The center part where the partition walls **1***b* and **1***b* intersect with each other is the intersection X. Thus, the hollow material **1** is formed in a sectional view with a cross having four spaces **1**S inside thereof.

[0100] The hollow material **1** having such sectional view with a cross is molded by continuously extruding out the billet B from the material formation outer hole **50** and the material formation inner hole **51** of the extrusion die **10**.

[0101] The extrusion die **10** of the first embodiment is structured in the manner described above, so that following effects can be acquired:

[0102] (1) A part of the billet B fed from the upstream side is extruded out from the billet guide hole **28** provided in the center region of the mandrel section **23** toward the intersection point P where the one corner each of the flange sections **23**F of the four inner formation pieces **23**B gathers. The position of the intersection point P corresponds to the intersection X formed by the partition walls and, further, the intersection point P and the center of the small opening hole **28**B of the billet guide hole **28** are consistent with each other on the same line, so that the billet B fed through the small opening hole **28**B is extruded out via the intersection point P. Thus, the intersection X can be molded easily. As a result, it becomes possible to easily mold the hollow material in which complicated-shape partition walls are provided through extruding out a billet formed with a high-strength alloy of a high extrusion processing force, particularly a high-strength aluminum alloy such as the so-called 7000 series.

[0103] (2) The Billet guide hole **28** is in a two-stage structure constituted with the large opening hole **28**A formed on the upper side of the mandrel section **23** and the small opening hole **28**B formed in the lower side of the mandrel section **23**. A part of the billet B extruded out from the upstream side is securely introduced into the small opening hole **28**B by being guided by the large opening hole **28**A. This makes it possible to secure the sufficient billet for forming the partition walls.

[0104] (3) The engaging face between the tip outer circumferential face **24**A of the first to fourth bridges **24***a* to **24***d* of the bridge section **24** and the bridge receiving face **26**B of the bridge holding section **26** is formed as a sloping surface approaching the center of the die toward the downstream side of the extrusion direction. Therefore, the distance between the base end of the bridge receiving face **26**B of the holder section **25** to the application point in the direction orthogonal to the extrusion direction at the inner formation piece **23** from the

base end can be made shorter. Thus, the moment generated at the application point of the inner formation piece **23** can be decreased, so that the strength of the first to fourth bridges **24***a* to **24***d* can be increased. This makes it possible to prevent breakage of the first to fourth bridges **24***a* to **24***d*. As a result, it becomes possible to perform high-speed extrusion and to extend the life of the die even when extrusion-molding the billet B formed with a high-strength alloy of a high extrusion processing force, particularly a high-strength aluminum alloy such as the so-called 7000 series.

[0105] (4) Each of the bridges **24***a* to **24***d* and the bridge receiving face **26**B are formed integrally by the bridge section press-fit structure M, so that the strength of each of the bridges **24***a* to **24***d* and in its turn the strength of the mandrel section **23** can be secured. Thus, the pressure at the time of extrusion of the billet B can be received by the entire male-type member **20**. As a result, it becomes possible to perform high-speed extrusion and to extend the life of the die even when extrusion-molding the billet B formed with a high-strength alloy of a high extrusion processing force, particularly a high-strength aluminum alloy such as the so-called 7000 series.

[0106] (5) Each of the bridges **24***a* to **24***d* and the bridge presser section **26**A is fixed by the whirl-stop fixing members **27** knocked into the knock-in holes opened over the spaces therebetween, so that rotation of each of the bridges **24***a* to **24***d* can be prevented. Thereby, the hollow materials **1** of high precision can be molded.

[0107] Next, a second embodiment of the extrusion die of the present invention will be described by referring to FIG. **8** and FIG. **9**.

[0108] The shape of the billet guide hole **28** of the extrusion die **10** according to the first embodiment is in a two-stage structure of the large opening hole **28**A and the small opening hole **28**B, whereas it is formed as a billet guide hole **38** in a tapered shape in an extrusion die **11** of the second embodiment. However, other members, structures, and the like are completely the same as those of the extrusion die **10** of the first embodiment.

[0109] Therefore, the same reference numerals are applied to the same structures and the same members as those of the first embodiment, and only the different points will be described. Note here that the mandrel section **23** is different only in terms of the shapes of the billet guide holes **28** and **38**, so that the reference numeral **23** that is the same as the case of the first embodiment is also applied in the second embodiment for explanation.

[0110] The shape of the billet guide hole **38** of the extrusion die **11** according to the second embodiment is formed in a tapered shape which becomes smaller toward the downstream-side opening side from the upstream-side opening of the mandrel section **23**.

[0111] Note here that the diameter ϕ**1** of the upstream-side opening of the mandrel section **38** is substantially equivalent to the diameter ϕ**1** of the large opening hole **28**A of the first embodiment, and the diameter ϕ**2** of the downstream-side opening of the tapered-shape hole is substantially equivalent to the diameter ϕ**2** of the small opening hole **28**B of the first embodiment.

[0112] With the billet guide hole **38** of the extrusion die **11** according to the second embodiment, as in the case of the first embodiment, in the region where one corner each of flange sections **23**F of the four inner formation pieces **23**B gathers, the position of the intersection point corresponds to the intersection X formed with the partition walls. Further, the position of the billet guide hole **38** is set so that the position of the intersection point and the center of the of the billet guide hole **38** become consistent with each other.

[0113] As in the case of the extrusion die **10** of the first embodiment, it is possible with the extrusion die **11** of the second embodiment described above to mold the hollow material **1** having a sectional view with a cross inside thereof as shown in FIG. **7**.

[0114] With the extrusion die **11** of the second embodiment described above, it is possible to acquire substantially the same actions as those of the extrusion die **10** of the first embodiment and substantially the same effects as those described in (1) to (5). In addition, it is possible to achieve the following effect:

[0115] (6) The flow of the billet B can become smooth since the billet guide hole **38** is formed in a tapered shape which becomes smaller from the upstream-side opening of the mandrel section **23** toward the downstream-side opening side.

[0116] Next, a third embodiment of the extrusion die according to the present invention will be described by referring to FIG. **10** and FIG. **11**.

[0117] In the extrusion dice **10** and **11** of the first and second embodiments, the lower part of the first to fourth bridges **24***a* to **24***d* of the bridge section **24** and the lower part of the bridge receiving face **26**B are sloping in the direction approaching the dice center side as going toward the female-type member **30**, and those are engaged by the bridge section press-fit structure M.

[0118] In the meantime, in an extrusion die **12** of the third embodiment, a tip outer circumferential face **34**A of first to fourth bridges **34***a* to **34***d* of a bridge section **34** for supporting a mandrel section **33** and a part of a holder section **125** for holding each of the bridges **34***a* to **34***d* are formed as an integrated structure by the bridge section shrink-fit structure N.

[0119] Note here that shrink fitting is a method for acquiring strong bonding by utilizing heat, which is a method with which a member such as a disc with a hole is thermally expanded, a shaft formed slightly larger than the diameter of the hole is fitted therein, and it is cooled thereafter to be fixed. The method is used as bonding of fastening type. Further, the both (the disc and the shaft in the above case) are tightly fixed by shrink fitting.

[0120] A male-type member **120** of the extrusion die **12** according to the third embodiment is substantially the same in terms of the entire shape as those of the extrusion dice **10** and **11** of the first and second embodiments, and the only difference is that there is no bridge presser section **26**A that is formed in the extrusion die **10** and the like.

[0121] A spider **32** of the third embodiment is constituted with: the mandrel section **33** corresponding to the inner shape of the hollow material **1**; and the bridge section **34** which supports the mandrel section **33** and supports the mandrel section **33**.

[0122] The bridge section **34** is constituted with a plurality of, i.e., four bridges of the first bridge **34***a*, the second bridge **34***b*, the third bridge **34***c*, and the fourth bridge **34***d* projected substantially in an X-letter shape from the periphery of the mandrel section **33** to the outer side, and the space between each of the bridges **34***a* to **34***d* forms the billet introduction space S.

[0123] In the center region of the mandrel section **33**, the billet guide hole **28** for guiding a part of the billet B toward the downstream side is provided. The billet guide hole **28** is

formed by corresponding to the intersection X of the partition walls **1***b* and **1***b*. Further, the billet guide hole **28** is constituted with the large opening hole **28**A and the small opening hole **28**B.

[0124] The billet guide hole **28** is in a similar structure as that of the billet guide hole **28** of the extrusion die **10** according to the first embodiment.

[0125] A supporting member **36** that is a bridge section supporting mechanism for supporting each of the bridges **34***a* to **34***d* is interposed between the lower end of the outer circumference of each of the bridges **34***a* to **34***d* and the holder receiving face **30**A of the female-type member **30**. The both ends of the supporting member **36** are fixed over the lower end of each of the bridges **34***a* to **34***d* and the holder receiving face **30**A of the female-type member **30**.

[0126] Therefore, a gap of the height of the supporting member **36** is to be formed between the lower end of each of the bridges **34***a* to **34***d* and the holder section receiving face **30**A of the female-type member **30**. This gap forms the tunnel-like billet insertion hole BH where the billets B introduced within the neighboring bridge insertion holes BH are merged with each other. The billet insertion hole BH has the same function as that of the billet insertion hole BH of the first embodiment, which constitutes the billet merging space and the billet flow-in gap space.

[0127] Further, four inner formation pieces **33**B substantially in the same shape as that of the inner formation piece **23**B are provided in the downstream-side end of the flow of the billet B of the mandrel section **33**, and respective flange sections **33**F are provided to those inner formation pieces **33**B.

[0128] Each of the inner formation pieces **33**B is projected toward the female-type member **30** side and inserted into the outer formation die hole **30**B formed in the female-type member **30**.

[0129] Such inner formation pieces **33**B form each of the four inside spaces **1**S of the hollow material **1** having a sectional view with a cross inside thereof as shown in FIG. **7**. Further, those inner formation pieces **33**B are formed in a square shape substantially in the same shape as that of the inner formation pieces **23**B of the first and second embodiments and also disposed in a square form.

[0130] With the extrusion die **12** of the third embodiment described above, it is possible to mold the hollow material **1** having the sectional view with a cross inside thereof as shown in FIG. **7**.

[0131] With the extrusion die **12** of the third embodiment described above, it is possible to acquire substantially the same actions as those of the extrusion die **10** of the first embodiment and substantially the same effects as those described in (1), (2), and (6). In addition, it is possible to achieve the following effect:

[0132] (7) The tip outer circumferential face **34**A of each of the bridges **34***a* to **34***d* and a part of the inner circumferential face of the holder section **125** are formed integrally by the bridge section shrink-fit structure N, so that the strength of each of the bridges **34***a* to **34***d* and in its turn the strength of the mandrel section **33** can be secured. Thus, the pressure at the time of extrusion of the billet B can be received by the entire male-type member **20**. As a result, it becomes possible to perform high-speed extrusion and to extend the life of the die even when extrusion-molding the billet B formed with a high-strength alloy of a high extrusion processing force, particularly a high-strength aluminum alloy such as the so-called 7000 series.

[0133] (8) At the lower end of each of the bridges **34***a* to **34***d*, the supporting member **36** is fixed over the lower end of each of those and the holder receiving face **30**A of the female-type member **30**, so that a gap of the height of the supporting member **36** is to be formed between the lower end of each of the bridges **34***a* to **34***d* and the holder section receiving face **30**A of the female-type member **30**. The supporting member **36** can form the tunnel-like billet insertion hole BH where the billets B introduced into the neighboring bridge insertion spaces S merge with each other and also can support each of the bridges **34***a* to **34***d*. Therefore, the supporting member **36** can serve two roles, so that it is possible to effectively utilize the member.

[0134] Next, a fourth embodiment of the extrusion die according to the present invention will be described by referring to FIG. **12**.

[0135] In an extrusion die **13** of the fourth embodiment, the shape of the billet guide hole **38** is formed different from that of the billet guide hole **28** of the extrusion die **12** of the third embodiment. Further, the shape of the billet guide hole **38** is the same as that of the billet guide hole **38** of the extrusion die **11** of the second embodiment.

[0136] Other members, structures, and the like are completely the same as those of the extrusion die **12** of the third embodiment. Therefore, the same reference numerals are applied to the same structures and the same members as those of the third embodiment, and only the different points will be described.

[0137] The shape of the billet guide hole **38** of the extrusion die **13** according to the fourth embodiment is formed in a tapered shape which becomes smaller toward the downstream-side opening from the upstream-side opening of the mandrel section **33**.

[0138] In the extrusion die **13** of the fourth embodiment, the four inner formation pieces **33**B are disposed in a square form, so that it is possible to mold the hollow material **1** having the sectional view with a cross inside thereof as shown in FIG. **7**.

[0139] With the extrusion die **13** of the fourth embodiment described above, it is possible to acquire substantially the same actions as those of the extrusion die **12** of the third embodiment and substantially the same effects as those described in (1), (2), (7), and (8).

[0140] Next, a fifth embodiment of the extrusion die according to the present invention will be described by referring to FIG. **13** to FIG. **16**.

[0141] As in the cases of the third and fourth embodiments, in an extrusion die **14** of the fifth embodiment, a tip outer circumferential face **44**A of each of first to fourth bridges **44***a* to **44***d* and a part of the inner circumferential face of the holder section **125** are fixed integrally by the bridge section shrink-fit structure N. Thus, the strength of each of the bridges **44***a* to **44***d* and a mandrel section **43** is secured.

[0142] In the extrusion die **14**, the structure of a billet guide hole **48** is designed to be different from those of the billet guide holes **28**, **38** of the extrusion dice **12**, **13** to the third and fourth embodiments. However, other members, structures, and the like are completely the same as those of the extrusion dice **13** and **14** of the third and fourth embodiments.

[0143] Therefore, the same reference numerals are applied to the same structures and the same members as those of the third embodiment, and only the different points will be described.

[0144] The extrusion die **14** of the fifth embodiment is structured to be able to mold a hollow material **2** having a sectional view with a lattice form having four intersections X as shown in FIG. **16**.

[0145] The male-type member **120** includes a spider **42** which is constituted with: the mandrel section **43** for molding the inner shape of the hollow material **2**; and a bridge section **44** which supports the mandrel section **43** and is projected substantially in an X-letter form toward the outer side from the periphery of the mandrel section **43**. The spider **42** is integrally connected with the holder section **125** via the bridge section **44**.

[0146] In FIG. **13**, the bridge section **44** is constituted with four bridges disposed clockwise, which are a first bridge **44***a*, a second bridge **44***b*, a third bridge **44***c*, and a fourth bridge **44***d*. Further, spaces between each of the bridges **44***a* to **44***d* form the billet introduction spaces S for introducing the billet B.

[0147] As shown in FIGS. **13** and **14**, the billet guide hole **48** is in a two-stage structure constituted with a large opening hole **48**A formed on the upstream side of the mandrel section **43** and a small opening hole **48**B formed in the downstream side of the mandrel section **43**, i.e., formed to correspond to the position where the intersection X of the partition walls **1***b* and **1***b* of the hollow material **2** can be formed.

[0148] The large opening hole **48**A is substantially in a square shape on a plan view and is formed in a recessed shape that is recessed by a prescribed size into the lower-part side of the mandrel section **43**. A plurality (four in this embodiment) of the small opening holes **48**B are formed at the large opening hole **48**A. The large opening hole **48**A is provided by opening the holes toward the downstream side of the mandrel section **43** from the bottom face of the large opening hole **48**A.

[0149] In the extrusion die **14** of the fifth embodiment, nine inner formation pieces **43**B are provided to be able to correspond to four intersections X. Those inner formation pieces **43**B are formed substantially in the same square shape as that of the inner formation pieces **23**B of the extrusion die **10** of the first embodiment, and are provided in the lower part of the mandrel **43** via a connecting section that is in the same structure as that of the connecting section **23**.

[0150] Further, those inner formation pieces **43**B are disposed to form a square shape as a whole as shown in FIG. **15**. Furthermore, the material formation inner hole **51** is formed by the gaps L**2** between each of the inner formation pieces **43**B. Further, the nine inner formation pieces **43**B are inserted into an outer formation die hole **130**B of the female-type member **130**.

[0151] In the extrusion die **14** of the fifth embodiment, the mandrel **43** is substantially in the same size as that of the mandrel sections **33** and **33** of the extrusion die **13** of the fourth embodiment, and the nine inner formation pieces **43**B are provided in the mandrel section **43**. Thus, the size of each of the inner formation pieces **43**B is formed to be smaller than the size of each of the four inner formation pieces **33**B of the extrusion die **13** of the fourth embodiment. The mandrel **43** may be formed larger in a case where each of the inner formation pieces **43**B is to be formed larger.

[0152] Further, the four regions where one corner each of flange sections **43**F of the nine inner formation pieces **43**B gathers, the positions of each of the intersection points P correspond to the intersections X formed with the partition walls. Further, the positions of the small opening holes **48**B are set so that the positions of the four intersection points P and the centers of each of the small opening holes **48**B of the four billet guide holes **48** become consistent with each other.

[0153] Next, the hollow material **2** molded by the extrusion die **14** of the above-described fifth embodiment will be described by referring to FIG. **16**.

[0154] The hollow material **2** is formed substantially in a square sectional shape and constituted with two pairs of outer circumferential walls **2***a*, **2***a* disposed to oppose to each other and two each of partition walls **2***b*, **2***b* provided laterally and vertically inside thereof. The sectional view thereof is a lattice form having nine spaces **2**S inside thereof. Further, there are four intersections X where the partition walls **2***b* and **2***b* intersect.

[0155] Note that the thickness of the partition walls **2***b* and **2***b* is the same.

[0156] With the extrusion die **14** of the fifth embodiment described above, it is possible to acquire substantially the same actions as those of the extrusion dice of the third and fourth embodiments and substantially the same effects as those described in (1), (2), (7), and (8). In addition, it is possible to achieve the following effect:

[0157] (9) A part of the billet B fed from the upstream side is extruded out from the large opening hole **48**A of the billet guide hole **48** provided in the center region of the mandrel section **43** via the small opening hole **48**B toward the four intersection points P where the one corner each of the flange sections **43**F of the nine inner formation pieces **43**B gathers. The positions of each of the intersection points P correspond to the four intersections X formed by the partition walls and, further, each of the intersection points P and the centers of the small opening holes **48**B of each of the billet guide holes **48** are consistent with each other on the same line, so that the billet B fed through each of the small opening holes **48**B is extruded out via each of the intersection points P. Thus, the four intersections X can be molded easily.

[0158] Next, a sixth embodiment of the extrusion die according to the present invention will be described by referring to FIGS. **17** to **20**.

[0159] In the extrusion die **14** of the fifth embodiment, there are the four small opening holes **48**B provided in the bottom face of the large opening hole **48**A. However, in an extrusion die **15** of the sixth embodiment, nine small opening holes **58**B are provided in the bottom face of a large opening hole **58**A.

[0160] As described above, the extrusion die **15** of the sixth embodiment is different from the extrusion die **14** of the fifth embodiment only in terms of the shapes of the billet guide holes **48**B and **58**B. Other members, structures, and the like are completely the same as those of the extrusion die **14** of the fifth embodiment. Therefore, the same reference numerals are applied to the same structures and the same members as those of the fifth embodiment, and only the different points will be described.

[0161] The extrusion die **15** of the sixth embodiment is structured to be able to form a hollow material **3** having a sectional view with a lattice form as shown in FIG. **20**. Further, in the hollow material **3**, nine intersections X are provided.

[0162] The male-type member **120** of the extrusion die **15** includes a spider **52** which is constituted with: a mandrel section **53** for molding the inner shape of the hollow material **2**; and a bridge section **54** which supports the mandrel section **53** and is projected substantially in an X-letter form toward the outer side from the periphery of the mandrel section **53**. The spider **52** is integrally connected with the holder section **125** via the bridge section **54**.

[0163] Further, a tip outer circumferential face **54**A of each of first to fourth bridges **54***a* to **54***d* and a part of the inner circumferential face of the holder section **125** are fixed integrally by the bridge section shrink-fit structure N. Thus, the strength of each of the bridges **54***a* to **54***d* and the mandrel section **53** is secured.

[0164] In FIG. **17**, the bridge section **54** is constituted with four bridges disposed clockwise, which are the first bridge **54***a*, the second bridge **54***b*, the third bridge **54***c*, and the fourth bridge **54***d*. Further, spaces between each of the bridges **54***a* to **54***d* form the billet introduction spaces S for introducing the billet B.

[0165] As shown in FIGS. **18** and **19**, the billet guide hole **58** is constituted with a large opening hole **58**A formed on the upstream side of the mandrel section **53** and a small opening hole **58**B formed in the downstream side of the mandrel section **53**, i.e., formed to correspond to the positions where the intersections X of the partition walls **1***b* and **1***b*.

[0166] The large opening hole **58**A is substantially in the same shape as that of the large opening hole **48**A of the extrusion die **14** of the fifth embodiment. That is, the large opening hole **58**A is formed substantially in a square shape on a plan view and is formed in a recessed shape that is recessed by a prescribed size into the lower-part side of the mandrel section **53**. The small opening holes **58**B are formed in the bottom face of the large opening hole **58***a*. Nine small opening holes **58**B are provided by opening the holes toward the downstream side of the mandrel section **53** from the bottom face of the large opening hole **58**A.

[0167] Further, those small opening holes **58**B are designed to correspond to the nine intersections X for forming the hollow material **3** having the sectional view with a lattice, and sixteen inner formation pieces **53**B are provided in the lower part of the mandrel **53** to be able to form the intersections X. In the nine regions where one corner each of flange sections **53**F of the sixteen inner formation pieces **53**B gathers, the positions of each of the intersection points P correspond to the intersections X. Further, the positions of the small opening holes **58**B are set so that the positions of the nine intersection points P and the centers of each of the small opening holes **58**B of the nine billet guide holes **58** become consistent with each other.

[0168] There are the nine small opening holes **58**B provided in the bottom face of the large opening hole **58**A, so that the plan shape of the large opening hole **58**A is formed larger than that of the large opening hole **48**A of the fifth embodiment. Further, the size of each of the inner formation pieces **53**B is substantially the same as the size of each of the inner formation pieces **43**B of the extrusion die **14** of the fifth embodiment, so that the size of the mandrel **53** of the extrusion die **15** is formed larger than the size of the mandrel **43** of the extrusion die **14** of the fifth embodiment.

[0169] Therefore, the size of the outer formation die hole **130**B of the female type 130 for housing the sixteen inner formation pieces **53**B is formed larger than the size of the outer formation die hole **30**B of the extrusion die **14** of the fifth embodiment.

[0170] Further, each of the sixteen inner formation pieces **53**B is in the same square shape and disposed to form a square shape as a whole as shown in FIG. **19**. Furthermore, the material formation inner hole **51** is formed by the gaps L**2** between each of the inner formation pieces **53**B. Further, the sixteen inner formation pieces **53**B disposed in a square shape are inserted into the outer formation die hole **130**B of the female-type member **130**.

[0171] Next, the hollow material **3** molded by the extrusion die **16** of the above-described sixth embodiment will be described by referring to FIG. **20**.

[0172] The hollow material **3** is formed substantially in a square sectional shape and constituted with two pairs of outer circumferential walls **3***a*, **3***a* disposed to oppose to each other and three each of partition walls **3***b*, **3***b* provided laterally and vertically inside thereof. The sectional view thereof is a lattice form having sixteen spaces **3**S inside thereof. Further, there are nine intersections X where the partition walls **3***b* and **3***b* intersect.

[0173] The three each of the partition walls **3***b* and **3***b* provided laterally and vertically are formed in the same thickness.

[0174] With the extrusion die **15** of the sixth embodiment described above, it is also possible to acquire substantially the same actions as those of the extrusion die **14** of the fifth embodiment and substantially the same effects as those described in (1), (2), (7), and (8). In addition, it is possible to achieve the following effect:

[0175] (10) A part of the billet B fed from the upstream side is extruded out from the large opening hole **58**A of the billet guide hole **58** provided in the center region of the mandrel section **53** via the small opening holes **58**B toward the nine intersection points P where the one corner each of the flange sections **53**F of the sixteen inner formation pieces **53**B gathers. The positions of each of the intersection points P correspond to the nine intersections X formed by the partition walls and, further, each of the intersection points P and the centers of the small opening holes **58**B of each of the billet guide holes **58** are consistent with each other on the same line, so that the billet B fed through each of the small opening holes **58**B is extruded out via each of the intersection points R Thus, the hollow material **3** with the lattice-form sectional view having the nine intersections X can be molded easily.

[0176] Next, a seventh embodiment of the extrusion die according to the present invention will be described by referring to FIGS. **21** to **24**.

[0177] In an extrusion die **16** of the seventh embodiment, the structure of a billet guide hole **68** is formed different from that of the billet guide hole **58** of the extrusion die **15** of the sixth embodiment. However, other members, structures, and the like are completely the same as those of the extrusion die **15** of the sixth embodiment. Therefore, the same reference numerals are applied to the same structures and the same members as those of the sixth embodiment, and only the different points will be described.

[0178] The male-type member **120** of the extrusion die **16** includes a spider **62** which is constituted with: a mandrel section **63** for molding the inner shape of the hollow material **3**; and a bridge section **64** which supports the mandrel section **63** and is projected substantially in an X-letter form toward

the outer side from the periphery of the mandrel section **63**. The spider **62** is integrally connected with the holder section **125** via the bridge section **64**.

[0179] Further, a tip outer circumferential face **64**A of each of bridges **64***a* to **64***d* and a part of the inner circumferential face of the holder section **125** are fixed integrally by the bridge section shrink-fit structure N. Thus, the strength of each of the bridges **64***a* to **64***d* and the mandrel section **63** is secured.

[0180] In FIG. **21**, the bridge section **64** is constituted with four bridges disposed clockwise, which are the first bridge **64***a*, the second bridge **64***b*, the third bridge **64***c*, and the fourth bridge **64***d*. Further, spaces between each of the bridges **64***a* to **64***d* form the billet introduction spaces S.

[0181] The extrusion die **16** of the seventh embodiment is structured to be able to form a hollow material **4** having a sectional view with a lattice form as shown in FIG. **24**. Further, in the hollow material **4**, there are nine intersections X that are formed by partition walls of different thicknesses. The billet guide hole **68** is structured to be able to correspond to those intersections X.

[0182] That is, the billet guide hole **68** is constituted with a large opening hole **68**A provided on the upper side of the mandrel section **63** and nine small opening holes **68**B formed in the lower side of the mandrel section **63** by corresponding to each of the nine intersections X. The large opening hole **68**A is substantially in the same shape as that of the large opening hole **58**A of the billet guide hole **58** of the extrusion die **15** of the sixth embodiment.

[0183] Further, the small opening holes **68**B are formed by opening the holes from the bottom face of the large opening hole **68**A toward the intersection X side, i.e., toward the female-type member **130** side.

[0184] The small opening holes **68**B are constituted with three kinds having different opening areas as shown in FIGS. **21** and **23**.

[0185] That is, among three each of the small opening holes **68**B disposed laterally and vertically in an equivalent manner, a single first small opening hole **68**B**1** of a largest opening area is disposed in the center, and second small opening holes **68**B2 of a second largest opening area are provided on cross-like lines with respect to the first small opening hole **68**B**1** on both sides thereof.

[0186] Further, on lines in parallel to the cross-like lines of the second small opening holes **68**B**2**, one each of third small opening holes **68**B**3** of a smaller opening area than that of the second small opening hole **68**B**2** is provided on the outer side of the second small opening holes **68**B**2**. That is, the third small opening holes **68**B**3** are disposed in the four corners of the bottom face of the large opening hole **68**A.

[0187] Further, those small opening holes **68**B are designed to be able to correspond to the nine intersections X for forming the hollow material **4** having the sectional view with a lattice form, and sixteen inner formation pieces **63**B are provided in the lower part of the mandrel **63** to be able to form the intersections X.

[0188] In the nine regions where one corner each of flange sections **63**F of the sixteen inner formation pieces **63**B gathers, the positions of each of the intersection points P correspond to the intersections X**1**, X**2**, and X**3**, respectively. Further, the positions of each of the small opening holes **68**B**1**, **68**B**2**, and **68**B**3** are set so that the positions of the nine intersection points P and the centers of each of the small opening holes **68**B**1**, **68**B**2**, and **68**B**3** of the nine billet guide holes **68** become consistent with each other.

[0189] Further, the size of each of the inner formation pieces **63**B is substantially the same as the size of each of the inner formation pieces **53**B of the extrusion die **15** of the sixth embodiment.

[0190] Each of the sixteen inner formation pieces **63**B is in the same square shape, and disposed in an equivalent manner to form a square shape as a whole as shown in FIG. **23**.

[0191] Note here that each of the inner formation pieces **63**B is disposed with different spaces provided with each other. That is, four each of the sixteen inner formation pieces **63**B are disposed by sandwiching a cross-like gap L**3**, and the four each of the inner formation pieces **63**B are disposed by sandwiching a cross-like gap L**4**.

[0192] Among the sixteen inner formation pieces **63**B, the side faces of the outermost twelve inner formation pieces **63**B oppose to the outer formation die **130**B formed in the female-type member **130** with the gap L**1** provided therebetween.

[0193] Note here that the gap space of the gap L**4** is designed to be a larger width gap space than the gap space of the gap L**3**, while the gap L**1** is set to be the gap space that is between the gap L**4** and the gap L**3**. Further, the material formation inner hole **52** is formed by the gap L**3**, the material formation inner hole **53** is formed by the gap L**4**, and the material formation outer hole **50** is formed by the gap L**1**.

[0194] Furthermore, those sixteen inner formation pieces **63**B are to be inserted into the outer formation die hole **130**B of the female-type member **130**.

[0195] Next, the hollow material **4** molded by the extrusion die **16** of the above-described seventh embodiment will be described by referring to FIG. **24**.

[0196] The hollow material **4** is formed in a lattice-form sectional shape, and constituted with outer circumferential wall **4***a*, **4***a* in a square columnar sectional shape, cross-like first partition walls **4***b***1**, **4***b***1** continuing from the outer circumferential walls **4***a*, **4***a*, and cross-like second partition walls **4***b***2**, **4***b***2** provided in the center part in the length direction of the first partition walls **4***b***1**, **4***b***1**.

[0197] Further, the first partition walls **4***b***1**, **4***b***1** are formed to be thicker compared to the second partition walls **4***b***2**, **4***b***2**.

[0198] Furthermore, the part where the first partition walls **4***b***1** and **4***b***1** intersect with each other is the intersection X in the greatest thickness, and the part where the first partition wall **4***b***1** and the second partition wall **4***b***2** intersect with each other is the intersection X**2** that is in the second greatest thickness. Further, the part where the second partition walls **4***b***2** and **4***b***2** intersect with each other is the intersection X**3** that is in the smallest thickness.

[0199] As shown in FIGS. **21** and **23**, the first small opening hole **68**B**1** corresponds to the thickest intersection X**1**, the second small opening hole **68**B**2** corresponds to the second thickest intersection X**2**, and the third small opening hole **68**B**3** corresponds to the thinnest intersection X**3**.

[0200] As a result, it becomes possible to form intersections of arbitrary thicknesses through changing the diameters of each of the small opening holes **68**B**1**, **68**B**2**, and **68**B**3**.

[0201] With the extrusion die **16** of the seventh embodiment described above, it is also possible to acquire substantially the same actions as those of the extrusion die **15** of the sixth embodiment and substantially the same effects as those described in (1), (2), (6), (7), and (9). In addition, it is possible to achieve the following effect:

[0202] (10) The large opening hole **68**A to the small opening holes **68**B of the billet guide hole **68** are constituted with three kinds of the holes with different diameters, i.e., the first small opening hole **68**B**1**, the second small opening hole **68**B**2**, and the third small opening hole **68**B**3**. Each of those corresponds to the intersections of different thicknesses, i.e., the intersection X**1** where the first partition walls **4***b***1** and **4***b***1** intersect, the intersection X**2** where the first partition wall **4***b***1** and the second partition wall **4***b***2** intersect, and the third intersection X**3** where the second partition walls **4***b***2** and **4***b***2** intersect. Therefore, the hollow material **4** in a lattice-form sectional shape having the partition walls of different thicknesses can be molded easily.

[0203] Next, eighth to tenth embodiments of the extrusion die of the present invention will be described by referring to FIGS. **25** and **26**.

[0204] In the first to seventh embodiments, the hollow materials **1** to **6** molded by each of the extrusion dice **10** to **16** have complicated sectional shapes with the intersections X formed by the partition walls **1***b* and the like. However, the hollow materials are not limited to such cases. With extrusion dice **17** to **19** of the eighth to tenth embodiments of the present invention, it is possible to mold hollow materials **7**, **8**, and **9** having curve-shaped partition walls **7***b*, **8***b*, and **9***b* inside thereof as shown in FIGS. **25**A, **25**B and FIG. **26**, through changing the shapes of the inner formation pieces, respectively.

[0205] That is, as shown in FIG. **25**A, the hollow material **7** molded by the extrusion die **17** of the eighth embodiment is constituted with: outer circumferential walls **7***a*, **7***a* in a square sectional shape; and curve-shaped partition walls **7***b*, **7***b* provided inside those outer circumferential walls **7***a*, **7***a*. Those partition walls **7***b*, **7***b* are formed to connect the center parts in the length direction of the orthogonal outer circumferential walls **7***a*, **7***a* with curve-shaped lines.

[0206] The partition walls **7***b* and **7***b* are constituted with a single inner formation piece **73**B**1** and two inner formation pieces **73**B**2** disposed by sandwiching the inner formation piece **73**B**1**. Those inner formation piece **73**B**1** and the inner formation pieces **73**B**2** are designed to be inserted into the outer formation die hole **30**B formed in the female-type member **30**.

[0207] Note here that the material formation outer hole **51** of the gap L**1** is formed between each of the inner formation piece **7381**, the inner formation piece **73**B**2**, and the outer formation die hole **30**B. Further, the thickness of the partition walls **7***b* and **7***b* is set to be the gap L**2**, and the material formation inner hole **51** is formed by the gap L**2**.

[0208] At the part where the curved sections of the partition walls **7***b* and **7***b* come closest to each other, the small openings **78**B and **78**B of the billet guide hole **78** are disposed opposing to each other. The large opening hole **28**A of the billet guide hole **78** is connected to those small openings **78**B and **78**B.

[0209] Note that the billet guide hole **78** is provided in the center part of the mandrel, not shown. Further, the entire structure of the extrusion die **17** is substantially the same as the entire structure of the extrusion die **10** and the like of the first embodiment.

[0210] With the structure described above, the billet is fed from the upstream side, a part thereof is introduced into the large opening hole **78**A of the billet guide **78**, and extruded out from the gap between the inner formation piece **73**B**1** and the inner formation pieces **73**B**2** via the small openings **78**B, **78**B. At that time, the billet introduced into the small openings **78**B, **78**B is extruded out from the material formation inner hole **51**. Therefore, the curved-shape partition walls **7***b* and **7***b* can be formed easily.

[0211] Next, the extrusion die **18** of the ninth embodiment will be described.

[0212] As shown in FIG. **25**B, the hollow material **8** molded by the extrusion die **18** is constituted with: outer circumferential walls **8***a*, **8***a* in a square sectional shape; and curve-shaped partition walls **8***b*, **8***b* provided inside those outer circumferential walls **8***a*, **8***a*. Each of those partition walls **8***b* and **8***b* is formed in a curved shape projected toward the center part of the sectional shape of the hollow material **8** from the opposing outer circumferential walls **8***a* and **8***a*.

[0213] The partition walls **8***b* and **8***b* are constituted with a single inner formation piece **83**B**1** and two inner formation pieces **83**B**2** disposed by sandwiching the inner formation piece **83**B**1**. Those inner formation piece **83**B**1** and the inner formation pieces **83**B**2** are designed to be inserted into the outer formation die hole **30**B formed in the female-type member **30**.

[0214] Note here that the material formation outer hole **50** of the gap L**1** is formed between each of the inner formation piece **83**B**1**, the inner formation piece **83**B**2**, and the outer formation die hole **30**B. Further, the thickness of the partition walls **8***b* and **8***b* is set to be the gap L**2**, and the material formation inner hole **51** is formed by the gap L**2**.

[0215] Further, at the part where the curved sections of the partition walls **8***b* and **8***b* come closest to each other, the small openings **88**B and **88**B of the billet guide hole **88** are disposed opposing to each other. The large opening hole **88**A of the billet guide hole **88** is connected to those small openings **88**B and **88**B.

[0216] Note that the billet guide hole **88** is provided in the center part of the mandrel, not shown. Further, the entire structure of the extrusion die **18** is substantially the same as the entire structure of the extrusion die **10** and the like of the first embodiment.

[0217] With the structure described above, the billet is fed from the upstream side, a part thereof is introduced into the large opening hole **88**A of the billet guide **88**, and extruded out from the gaps between the inner formation piece **83**B **1** and the inner formation pieces **83**B**2** via the small openings **88**B, **88**B.

[0218] At that time, the billet introduced into the small openings **88**B, **88**B is extruded out from the material formation inner hole **51**. Therefore, the curve-shaped partition walls **8***b* and **8***b* can be formed easily.

[0219] Next, the extrusion die **19** of the tenth embodiment will be described.

[0220] As shown in FIG. **26**, the hollow material **9** molded by the extrusion die **19** is constituted with: outer circumferential walls **9***a*, **9***a* in a square sectional shape; and wave-shaped partition walls **9***b*, **9***b* provided inside those outer circumferential walls **9***a*, **9***a*. Each of those partition walls **9***b* and **9***b* is formed in a wave-like shape connecting between the opposing outer circumferential walls **9***a* and **9***a*.

[0221] The partition walls **9***b* and **9***b* are constituted with a single inner formation piece **93**B**1** and two inner formation pieces **93**B**2** disposed by sandwiching the inner formation piece **93**B**1**. Those inner formation piece **93**B**1** and the inner formation pieces **93**B**2** are designed to be inserted into the outer formation die hole **30**B formed in the female-type member **30**.

[0222] Note here that the material formation outer hole **50** of the gap L**1** is formed between each of the inner formation piece **93**B**1**, the inner formation piece **93**B**2**, and the outer formation die hole **30**B. Further, the thickness of the partition walls **9***b* and **9***b* is set to be the gap L**2**, and the material formation inner hole **51** is formed by the gap L**2**.

[0223] Further, at substantially the center parts in the respective length directions of the partition walls **9***b* and **9***b*, the small openings **98**B and **98**B of the billet guide hole **98** are disposed opposing to each other. The large opening hole **98**A of the billet guide hole **98** is connected to those small openings **98**B and **98**B.

[0224] Note that the billet guide hole **98** is provided in the center part of the mandrel, not shown. Further, the entire structure of the extrusion die **19** is substantially the same as the entire structure of the extrusion die **10** and the like of the first embodiment.

[0225] With the structure described above, the billet is fed from the upstream side, a part thereof is introduced into the large opening hole **98**A of the billet guide **98**, and extruded out from the gaps between the inner formation piece **93**B **1** and the inner formation pieces **93**B**2** via the small openings **98**B, **98**B.

[0226] At that time, the billet introduced into the small openings **98**B, **98**B is extruded out from the material formation inner hole **51**. Therefore, the curve-shaped partition walls **9***b* and **9***b* can be formed easily.

[0227] While the present invention has been described above by referring to the embodiments, the present invention is not limited only to the embodiments. Various changes and modifications occurred to those skilled in the art can be applied to the structures and details of the present invention. Further, the present invention also includes mutual and proper combinations of a part of or a whole of each of the embodiments.

[0228] For example, in the fifth embodiment, the large opening hole **48**A of the billet guide hole **48** of the extrusion die **14** is formed substantially in a square shape on a plan shape and in a dented recessed shape toward the downstream side. However, as shown in FIG. **27**, the large opening hole **78**A in the extrusion die **14**A of a modification example is formed as a tapered-shape hole that becomes narrower from the top face of the mandrel section **43** toward the bottom face of the large opening hole **78**A.

[0229] Further, the large opening holes **58**A and **68**A of the billet guide holes **58** and **68** of the sixth and seventh embodiments may also be formed as a tapered-shape hole that becomes narrower from the top face of the mandrel sections **53** and **63** toward the bottom face of the large opening holes **58**A and **68**A as in the above case.

[0230] Further, while the billet guide hole **28** is formed as a two-stage structure of the large opening hole **28**A and the small opening hole **28**B and the bottom face of the large opening hole **28**A is formed as a flat face in the first and third embodiments, the structure thereof is not limited to such case. The bottom face of the large opening hole **28**A may be formed as a bottom face constituted with an angular part with a sloping face of 45°, for example. With this, flow of the billet B can become still smoother.

[0231] Further, while each of the extrusion dice **10** to **13** of the first to fourth embodiments can mold the hollow material **1** having a sectional shape with a cross inside thereof and each of the extrusion dice **14** to **16** of the fifth to seventh embodiments can mold the hollow materials **2** to **4** having a sectional shape with a lattice form inside thereof, the structures are not limited only to such cases. For example, as shown in FIG. **28**A, it is possible to employ a structure capable of molding the hollow material **5** in which two intersections X are formed laterally with two vertically disposed outer circumferential walls **5***a*, **5***a* and a single laterally disposed partition walls **5***b*, **5***b* through changing the shapes of a plurality of inner formation pieces.

[0232] Further, as shown in FIG. **28**B, it is also possible to employ a structure capable of forming the hollow material **6** having an external shape in which partition walls **6***c*, **6***c* are provided in an X-letter form at the four corners of the external circumferential walls **6***a*, **6***a* formed in a square columnar shape through changing the shapes of a plurality of inner formation pieces.

INDUSTRIAL APPLICABILITY

[0233] The extrusion die of the present invention is utilized when molding hollow materials having partition walls inside thereof by using a high-strength alloy, particularly a high-strength aluminum alloy such as the so-called 7000 series.

REFERENCE NUMERALS

[0234] **1** Hollow material having sectional shape with cross inside (hollow material formed by first to fourth embodiment)

[0235] **2** Hollow material having sectional shape with lattice inside (hollow material formed by fifth embodiment)

[0236] **3** Hollow material having sectional shape with lattice inside (hollow material formed by sixth embodiment)

[0237] **4** Hollow material having sectional shape with lattice inside (hollow material formed by seventh embodiment)

[0238] **10** Extrusion die for forming hollow material (first embodiment)

[0239] **11** Extrusion die for forming hollow material (second embodiment)

[0240] **12** Extrusion die for forming hollow material (third embodiment)

[0241] **13** Extrusion die for forming hollow material (fourth embodiment)

[0242] **14** Extrusion die for forming hollow material (fifth embodiment)

[0243] **15** Extrusion die for forming hollow material (sixth embodiment)

[0244] **16** Extrusion die for forming hollow material (seventh embodiment)

[0245] **20** Male-type member

[0246] **22** Spider

[0247] **23** Mandrel section

[0248] **23**B Inner formation piece

[0249] **24** Bridge section

[0250] **24***a* to **24***d* First to fourth bridges

[0251] **24**A Bridge tip outer circumferential face

[0252] **25** Holder section

[0253] **26** Bridge holding section

[0254] **26**B Bridge receiving face as bridge abutting/engaging face

[0255] **30** Female-type member

[0256] **30**B Outer formation die hole

[0257] **50** Material formation outer hole

[0258] **51** Material formation inner hole
[0259] BH Billet insertion hole (billet merging space)
[0260] BH**1** Billet insertion hole (billet merging space)
[0261] S Billet introducing part
[0262] M Bridge section press-fit structure
[0263] N Bridge section shrink-fit structure

1. An extrusion die for forming a hollow material, comprising: a male-type member which forms an inner shape of the hollow material while guiding a billet constituted with an aluminum alloy fed from an upstream side toward a downstream side; and a female-type member which holds the male-type member with an outer circumferential part and forms an outer shape of the hollow material, wherein:

the male-type member comprises a mandrel section for forming the inner shape, and a holder section connected integrally to an outer circumferential part of the mandrel section via a plurality of bridge sections;

a billet guide hole for guiding a part of the billet toward the downstream side is provided in a center region of the mandrel section;

an upstream-side opening area of the billet guide hole is formed larger than a downstream-side opening area; and

a plurality of inner formation pieces are fixedly mounted on a downstream side of the billet guide hole and at positions for forming continuous partition walls inside the hollow material while keeping a billet flow-in gap space forming a merging space of the billet flowing in from each of the bridge sections toward the downstream side.

2. The extrusion die for forming the hollow material as claimed in claim **1**, wherein

the billet guide hole is formed as a stepped hole constituted with an upstream-side large opening hole and a downstream-side small opening hole formed in the bottom part of the large opening hole.

3. The extrusion die for forming the hollow material as claimed in claim **2**, wherein

an inner wall face of the upstream-side large opening hole is formed in a tapered shape in which an opening side has a larger opening area than a bottom part of the large opening hole.

4. The extrusion die for forming the hollow material as claimed in claim **1**, wherein

the billet guide hole is formed in a tapered shape narrowed from the upstream-side opening toward the downstream-side opening.

5. The extrusion die for forming the hollow material as claimed in claim **2**, wherein a plurality of the downstream-side small opening holes are provided.

6. (canceled)

7. The extrusion die for forming the hollow material as claimed in claim **3**, wherein a plurality of the downstream-side small opening holes are provided.

8. The extrusion die for forming the hollow material as claimed in claim **5**, wherein the small opening holes of the billet guide hole are disposed by opposing to intersection points of gaps for forming a plurality of partition walls set by the plurality of inner formation pieces.

9. The extrusion die for forming the hollow material as claimed in claim **7**, wherein the small opening holes of the billet guide hole are disposed by opposing to intersection points of gaps for forming a plurality of partition walls set by the plurality of inner formation pieces.

* * * * *