UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF NEW YORK

STEUBEN FOODS, INC.,

Plaintiff,

-*v*.-

JASPER PRODUCTS, LLC,

Defendant.

COMPLAINT

Civil Action No.

JURY TRIAL DEMANDED

The plaintiff, Steuben Foods, Inc. ("Steuben"), by its attorneys, Oblon, Spivak, McClelland, Maier & Neustadt, L.L.P. and Hiscock & Barclay, LLP, for its Complaint against the defendant, Jasper Products, LLC ("Jasper"), alleges as follows:

NATURE OF ACTION

1. This is an action brought pursuant to the Patent Laws of the United States of America, 35 U.S.C. § 100 *et seq*., for infringement of United States Patents.

PARTIES

2. Plaintiff Steuben is a New York corporation, which maintains a place of business at 1150 Maple Road in Elma, New York 14059.

3. Upon information and belief, Jasper is a Missouri limited liability company, which maintains a place of business at 3877 E. 27th Street Joplin, Missouri 64804.

4. Upon information and belief, Jasper is registered to do business in New York.

JURISDICTION AND VENUE

5. This Court possesses subject matter jurisdiction over this action under 28 U.S.C. §§ 1331 and 1338(a).

6. This Court possesses personal jurisdiction over Jasper in that Jasper is registered to do, is doing, and has done business in New York, including within this District. Additionally, Jasper contracts to supply goods or services throughout New York, including within this District.

7. Alternatively, this Court possesses personal jurisdiction over Jasper in that Jasper has committed tortious acts in New York.

8. Alternatively, this Court possesses personal jurisdiction over Jasper in that Jasper has committed acts of patent infringement outside of New York, which caused injury within the State, and it:

a) regularly does or solicits business in New York;

b) derives substantial revenue from goods used or consumed, or services rendered, in New York; or

c) expects or should reasonably expect its acts of patent infringement to have consequences in New York, and it derives substantial revenue from interstate or international commerce.

9. Venue is proper in the United States District Court for the Western District of New York under 28 U.S.C. §§ 1391(b), 1391(c) and/or 1400(b).

FACTUAL BACKGROUND

A. STEUBEN'S PATENTS

10. On September 20, 2005, the U.S. Patent and Trademark Office (the "PTO") issued U.S. Patent No. 6,945,013, entitled, "Method And Apparatus For Aseptic Packaging" ("'013 Patent"). The '013 Patent, a copy of which is annexed as Exhibit A, is fully incorporated into this Complaint by reference.

11. The ‘013 Patent is valid and subsisting, and Steuben is the exclusive owner of all rights, title and interests in the ‘013 Patent, including the right to sue for infringement of the ‘013 Patent.

12. On March 25, 2003, the PTO issued U.S. Patent No. 6,536,188, entitled, “Method And Apparatus For Aseptic Packaging” (“‘188 Patent”). The ‘188 Patent, a copy of which is annexed as Exhibit B, is fully incorporated into this Complaint by reference.

13. The ‘188 Patent is valid and subsisting, and Steuben is the exclusive owner of all rights, title and interests in the ‘188 Patent, including the right to sue for infringement of the ‘188 Patent.

14. On November 19, 2002, the PTO issued U.S. Patent No. 6,481,468, entitled, “Apparatus And Method For Providing Container Filling In An Aseptic Processing Apparatus” (“‘468 Patent”). The ‘468 Patent, a copy of which is annexed as Exhibit C, is fully incorporated into this Complaint by reference.

15. The ‘468 Patent is valid and subsisting, and Steuben is the exclusive owner of all rights, title, and interests in the ‘468 Patent, including the right to sue for infringement of the ‘468 Patent.

16. On November 5, 2002, the PTO issued U.S. Patent No. 6,475,435, entitled, “Apparatus And Method For Providing Sterilization Zones In An Aseptic Packaging Sterilization Tunnel” (“’435 Patent”). The ‘435 Patent, a copy of which is annexed as Exhibit D, is fully incorporated into this Complaint by reference.

17. The ‘435 Patent is valid and subsisting, and Steuben is the exclusive owner of all rights, title and interests in the ‘435 Patent, including the right to sue for infringement of the ‘435 Patent.

18. On April 3, 2001, the PTO issued U.S. Patent No. 6,209,591, entitled, "Apparatus and Method for Providing Container Filling In An Aseptic Processing Apparatus" ("'591 Patent"). The '591 Patent, a copy of which is annexed as Exhibit E, is fully incorporated into this Complaint by reference.

19. The '591 Patent is valid and subsisting, and Steuben is the exclusive owner of all rights, title and interests in the '591 Patent, including the right to sue for infringement of the '591 Patent.

20. The '013 Patent, '188 Patent, '468 Patent, '435 Patent and '591 Patent are collectively referred to below as the "Patents in Suit."

B. INFRINGEMENT BY JASPER

21. In contravention of 35 U.S.C. § 271, Jasper has infringed the Patents in Suit by using certain low-acid aseptic bottle filling machines embodying claims of the Patents in Suit (each an "Infringing Machine" and collectively the "Infringing Machines"), without authorization or license from Steuben Foods. Without limitation, the Infringing Machines include the "Unibloc" or "ECOSpin" system manufactured by GEA Procomac S.p.A. ("GEA") and/or an entity or entities affiliated with GEA, including without limitation the "Fillstar" bottle filling machine constituting a component thereof (the "Procomac System"), as well as the TetraPlast LFA-20 bottle filler manufactured by Tetra Pak, Inc. and/or an affiliated entity. (the "LFA Filler").

22. Upon information and belief, Jasper purchased a Procomac System from GEA and/or an affiliate thereof.

23. Upon information and belief, Jasper installed the Procomac System at Jasper's manufacturing facility in Joplin, Missouri.

24. Upon information and belief, Jasper purchased the LFA Filler from Tetra Pak, Inc. and/or an affiliate thereof.

25. Upon information and belief, Jasper installed the LFA Filler at Jasper's manufacturing facility in Joplin, Missouri.

26. Upon information and belief, Jasper has used, is using, and/or will use the Infringing Machines to aseptically fill containers such as bottles or jars with aseptically sterilized foodstuffs in violation of the Patents in Suit as set forth herein.

27. Upon information and belief, Jasper manufactures products including aseptically filled bottles containing aseptically sterilized foodstuffs for consumer package goods companies pursuant to a contract or other agreement.

C. NOTICE TO JASPER OF THE PATENTS IN SUIT

28. Jasper has had actual notice of the Patents in Suit since at least August 2013. On or about August 2, 2013, Steuben sent a letter to Jasper that placed Jasper on formal notice of the existence of the Patents in Suit and informed it of Steuben's assertion that its use of the Infringing Machines infringes the Patents in Suit.

29. Having actual and direct notice of the Patents in Suit, Jasper has knowingly and willfully infringed, and continues to infringe, the Patents in Suit in blatant disregard of Steuben's rights, title and interests in the Patents in Suit.

CAUSES OF ACTION

FIRST CAUSE OF ACTION
(Infringement of U.S. Patent No. 6,945,013)

30. Steuben repeats and realleges each of the allegations contained in paragraphs 1 through 29 as if fully set forth here.

31. Jasper has infringed, and continues to infringe, the '013 Patent by, without authorization or approval from Steuben, using the Infringing Machines.

32. Jasper has had actual and direct notice of the '013 Patent since at least August 2, 2013.

33. Despite being actually and directly on notice of the '013 Patent, and Steuben's rights, title and interests therein, Jasper has continued using the Infringing Machines without authority or license from Steuben.

34. Jasper is liable for direct infringement of the '013 Patent.

35. Jasper's infringement of the '013 Patent has irreparably injured and damaged Steuben, making Jasper liable for an amount of damages to be determined at trial, and Jasper will cause Steuben further irreparable injury and damage in the future unless Jasper is enjoined from further infringement.

36. Steuben is entitled to recovery of treble damages, attorneys' fees, and costs from Jasper in that Jasper's infringement of the '013 Patent has been willful, deliberate, and intentional.

SECOND CAUSE OF ACTION
(Infringement of U.S. Patent No. 6,536,188)

37. Steuben repeats and realleges each of the allegations contained in paragraphs 1 through 36 as if fully set forth here.

38. Jasper has infringed, and continues to infringes, the '188 Patent by, without authorization or approval from Steuben, using the Procomac System.

39. Jasper has had actual and direct notice of the '188 Patent since at least August 2, 2013.

40. Despite being actually and directly on notice of the '188 Patent, and Steuben's rights, title and interests therein, Jasper has continued using the Procomac System without authority or license from Steuben.

41. Jasper is liable for direct infringement of the '188 Patent.

42. Jasper's infringement of the '188 Patent has irreparably injured and damaged Steuben, making Jasper liable for an amount of damages to be determined at trial, and Jasper will cause Steuben further irreparable injury and damage in the future unless Jasper is enjoined from further infringement.

43. Steuben is entitled to recovery of treble damages, attorneys' fees, and costs from Jasper in that Jasper's infringement of the '188 Patent has been willful, deliberate, and intentional.

THIRD CAUSE OF ACTION
(Infringement of U.S. Patent No. 6,481,468)

44. Steuben repeats and realleges each of the allegations contained in paragraphs 1 through 43 as if fully set forth here.

45. Jasper has infringed, and continues to infringe, the '468 Patent by, without authorization or approval from Steuben, using the Procomac System.

46. Jasper has had actual and direct notice of the '468 Patent since at least August 2, 2013.

47. Despite being actually and directly on notice of the '468 Patent, and Steuben's rights, title and interests therein, Jasper has continued using the Procomac System without authority or license from Steuben.

48. Jasper is liable for direct infringement of the '468 Patent.

49. Jasper's infringement of the '468 Patent has irreparably injured and damaged Steuben, making Jasper liable for an amount of damages to be determined at trial, and Jasper will cause Steuben further irreparable injury and damage in the future unless Jasper is enjoined from further infringement.

50. Steuben is entitled to recovery of treble damages, attorneys' fees, and costs from Jasper in that Jasper's infringement of the '468 Patent has been willful, deliberate, and intentional.

FOURTH CAUSE OF ACTION
(Infringement of U.S. Patent No. 6,475,435)

51. Steuben repeats and realleges each of the allegations contained in paragraphs 1 through 50 as if fully set forth here.

52. Jasper, has infringed, and continues to infringe, the '435 Patent by, without authorization or approval from Steuben, using the Procomac System.

53. Jasper has had actual and direct notice of the '435 Patent since at least August 2, 2013.

54. Despite being actually and directly on notice of the '435 Patent, and Steuben's rights, title and interests therein, Jasper has continued using the Procomac System without authority or license from Steuben.

55. Jasper is liable for direct infringement of the '435 Patent.

56. Jasper's infringement of the '435 Patent has irreparably injured and damaged Steuben, making Jasper liable for an amount of damages to be determined at trial, and Jasper will cause Steuben further irreparable injury and damage in the future unless Jasper is enjoined from further infringement.

57. Steuben is entitled to recovery of treble damages, attorneys' fees, and costs from Jasper in that Jasper's infringement of the '435 Patent has been willful, deliberate, and intentional.

FIFTH CAUSE OF ACTION
(Infringement of U.S. Patent No. 6,209,591)

58. Steuben repeats and realleges each of the allegations contained in paragraphs 1 through 57 as if fully set forth here.

59. Jasper, has infringed, and continues to infringe, the '591 Patent by, without authorization or approval from Steuben, using the Procomac System.

60. Jasper has had actual and direct notice of the '591 Patent since at least August 2, 2013.

61. Despite being actually and directly on notice of the '591 Patent, and Steuben's rights, title and interests therein, Jasper has continued using the Infringing Machines without authority or license from Steuben.

62. Jasper is liable for direct infringement of the '591 Patent.

63. Jasper's infringement of the '591 Patent has irreparably injured and damaged Steuben, making Jasper liable for an amount of damages to be determined at trial, and Jasper will cause Steuben further irreparable injury and damage in the future unless Jasper is enjoined from further infringement.

64. Steuben is entitled to recovery of treble damages, attorneys' fees, and costs from Jasper in that Jasper's infringement of the '591 Patent has been willful, deliberate, and intentional.

REQUEST FOR RELIEF

WHEREFORE, Steuben respectfully requests that this Court enter judgment against Jasper, and in favor of Steuben, including the following relief:

1. A judgment that U.S. Patent Nos. 6,945,013, 6,536,188, 6,481,468, 6,475,435 and 6,209,591 are valid and enforceable;

2. A judgment declaring that Jasper has infringed the '013 Patent;

3. A judgment declaring that Jasper has infringed the '188 Patent;

4. A judgment declaring that Jasper has infringed the '468 Patent;

5. A judgment declaring that Jasper has infringed the '435 Patent;

6. A judgment declaring that Jasper has infringed the '591 Patent;

7. An injunction permanently enjoining Jasper, and its agents, employees, officers, directors, attorneys, successors, and assigns, and all persons in active concert and/or participation with each or any of them, from further infringing the Patents in Suit in accordance with 35 U.S.C. § 283;

8. An accounting of the profits derived by Jasper as a result of its infringement of the Patents in Suit and an assessment of the damages suffered by Steuben Foods;

9. An award of damages to Steuben adequate to compensate it for Jasper's infringement of the Patents in Suit;

10. A determination that Jasper's infringement of the Patents in Suit has been willful, deliberate, and/or intentional;

11. An award of treble damages for Jasper's willful, deliberate, and/or intentional infringement of the Patents in Suit;

12. An award of interest on the amount of damages found, including pre-judgment and post-judgment interest;

13. A determination that this is an exceptional case pursuant to 35 U.S.C. § 285, thereby entitling Steuben to an award of its costs, expenses, and attorneys' fees incurred in prosecuting this action; and

14. Such further relief that this Court deems proper.

JURY DEMAND

Steuben Foods demands a trial by jury on all issues so triable.

DATED: November 14, 2013

HISCOCK & BARCLAY, LLP

/s/ M. Eric Galvez

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Steuben Foods, Inc.

JS 44 (Rev. 12/12)

CIVIL COVER SHEET

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. *(SEE INSTRUCTIONS ON NEXT PAGE OF THIS FORM.)*

I. (a) PLAINTIFFS

STEUBEN FOODS, INC.

(b) County of Residence of First Listed Plaintiff Erie
(EXCEPT IN U.S. PLAINTIFF CASES)

(c) Attorneys *(Firm Name, Address, and Telephone Number)*
Hiscock & Barclay, LLP, 2000 HSBC Plaza, 100 Chestnut St., Rochester, NY 14604 Tel.: (585) 295-4400
Oblon, Spivak, McClelland, Maier & Neustadt, LLP, 1940 Duke St., Alexandria, VA 22314 Tel.: (703) 413-3000

DEFENDANTS

JASPER PRODUCTS, LLC

County of Residence of First Listed Defendant
(IN U.S. PLAINTIFF CASES ONLY)

NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE TRACT OF LAND INVOLVED.

Attorneys *(If Known)*

II. BASIS OF JURISDICTION *(Place an "X" in One Box Only)*

- ☐ 1 U.S. Government Plaintiff
- ☒ 3 Federal Question *(U.S. Government Not a Party)*
- ☐ 2 U.S. Government Defendant
- ☐ 4 Diversity *(Indicate Citizenship of Parties in Item III)*

III. CITIZENSHIP OF PRINCIPAL PARTIES *(Place an "X" in One Box for Plaintiff and One Box for Defendant)*
(For Diversity Cases Only)

	PTF	DEF		PTF	DEF
Citizen of This State	☐ 1	☐ 1	Incorporated *or* Principal Place of Business In This State	☐ 4	☐ 4
Citizen of Another State	☐ 2	☐ 2	Incorporated *and* Principal Place of Business In Another State	☐ 5	☐ 5
Citizen or Subject of a Foreign Country	☐ 3	☐ 3	Foreign Nation	☐ 6	☐ 6

IV. NATURE OF SUIT *(Place an "X" in One Box Only)*

CONTRACT
- ☐ 110 Insurance
- ☐ 120 Marine
- ☐ 130 Miller Act
- ☐ 140 Negotiable Instrument
- ☐ 150 Recovery of Overpayment & Enforcement of Judgment
- ☐ 151 Medicare Act
- ☐ 152 Recovery of Defaulted Student Loans (Excludes Veterans)
- ☐ 153 Recovery of Overpayment of Veteran's Benefits
- ☐ 160 Stockholders' Suits
- ☐ 190 Other Contract
- ☐ 195 Contract Product Liability
- ☐ 196 Franchise

REAL PROPERTY
- ☐ 210 Land Condemnation
- ☐ 220 Foreclosure
- ☐ 230 Rent Lease & Ejectment
- ☐ 240 Torts to Land
- ☐ 245 Tort Product Liability
- ☐ 290 All Other Real Property

TORTS

PERSONAL INJURY
- ☐ 310 Airplane
- ☐ 315 Airplane Product Liability
- ☐ 320 Assault, Libel & Slander
- ☐ 330 Federal Employers' Liability
- ☐ 340 Marine
- ☐ 345 Marine Product Liability
- ☐ 350 Motor Vehicle
- ☐ 355 Motor Vehicle Product Liability
- ☐ 360 Other Personal Injury
- ☐ 362 Personal Injury - Medical Malpractice

PERSONAL INJURY
- ☐ 365 Personal Injury - Product Liability
- ☐ 367 Health Care/ Pharmaceutical Personal Injury Product Liability
- ☐ 368 Asbestos Personal Injury Product Liability

PERSONAL PROPERTY
- ☐ 370 Other Fraud
- ☐ 371 Truth in Lending
- ☐ 380 Other Personal Property Damage
- ☐ 385 Property Damage Product Liability

CIVIL RIGHTS
- ☐ 440 Other Civil Rights
- ☐ 441 Voting
- ☐ 442 Employment
- ☐ 443 Housing/ Accommodations
- ☐ 445 Amer. w/Disabilities - Employment
- ☐ 446 Amer. w/Disabilities - Other
- ☐ 448 Education

PRISONER PETITIONS

Habeas Corpus:
- ☐ 463 Alien Detainee
- ☐ 510 Motions to Vacate Sentence
- ☐ 530 General
- ☐ 535 Death Penalty

Other:
- ☐ 540 Mandamus & Other
- ☐ 550 Civil Rights
- ☐ 555 Prison Condition
- ☐ 560 Civil Detainee - Conditions of Confinement

FORFEITURE/PENALTY
- ☐ 625 Drug Related Seizure of Property 21 USC 881
- ☐ 690 Other

LABOR
- ☐ 710 Fair Labor Standards Act
- ☐ 720 Labor/Management Relations
- ☐ 740 Railway Labor Act
- ☐ 751 Family and Medical Leave Act
- ☐ 790 Other Labor Litigation
- ☐ 791 Employee Retirement Income Security Act

IMMIGRATION
- ☐ 462 Naturalization Application
- ☐ 465 Other Immigration Actions

BANKRUPTCY
- ☐ 422 Appeal 28 USC 158
- ☐ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
- ☐ 820 Copyrights
- ☒ 830 Patent
- ☐ 840 Trademark

SOCIAL SECURITY
- ☐ 861 HIA (1395ff)
- ☐ 862 Black Lung (923)
- ☐ 863 DIWC/DIWW (405(g))
- ☐ 864 SSID Title XVI
- ☐ 865 RSI (405(g))

FEDERAL TAX SUITS
- ☐ 870 Taxes (U.S. Plaintiff or Defendant)
- ☐ 871 IRS—Third Party 26 USC 7609

OTHER STATUTES
- ☐ 375 False Claims Act
- ☐ 400 State Reapportionment
- ☐ 410 Antitrust
- ☐ 430 Banks and Banking
- ☐ 450 Commerce
- ☐ 460 Deportation
- ☐ 470 Racketeer Influenced and Corrupt Organizations
- ☐ 480 Consumer Credit
- ☐ 490 Cable/Sat TV
- ☐ 850 Securities/Commodities/ Exchange
- ☐ 890 Other Statutory Actions
- ☐ 891 Agricultural Acts
- ☐ 893 Environmental Matters
- ☐ 895 Freedom of Information Act
- ☐ 896 Arbitration
- ☐ 899 Administrative Procedure Act/Review or Appeal of Agency Decision
- ☐ 950 Constitutionality of State Statutes

V. ORIGIN *(Place an "X" in One Box Only)*

☒ 1 Original Proceeding ☐ 2 Removed from State Court ☐ 3 Remanded from Appellate Court ☐ 4 Reinstated or Reopened ☐ 5 Transferred from Another District *(specify)* ☐ 6 Multidistrict Litigation

VI. CAUSE OF ACTION

Cite the U.S. Civil Statute under which you are filing *(Do not cite jurisdictional statutes unless diversity)*:
28 USC 1331, 1338; 35 USC 271, 283, 285

Brief description of cause:
Infringement of patents

VII. REQUESTED IN COMPLAINT:

☐ CHECK IF THIS IS A CLASS ACTION UNDER RULE 23, F.R.Cv.P.

DEMAND $

CHECK YES only if demanded in complaint:
JURY DEMAND: ☒ Yes ☐ No

VIII. RELATED CASE(S) IF ANY

(See instructions): JUDGE SEE SHEET ATTACHED HERETO DOCKET NUMBER

DATE 11/14/2013

SIGNATURE OF ATTORNEY OF RECORD

FOR OFFICE USE ONLY

RECEIPT # AMOUNT APPLYING IFP JUDGE MAG. JUDGE

ATTACHMENT TO CIVIL COVER SHEET

VIII. RELATED CASE(S) IF ANY

JUDGE	DOCKET NUMBER
Skretny	12cv904
Skretny	13cv892
Arcara	12cv211
Arcara	10cv781
Skretny	10cv780

Exhibit A

US006945013B2

(12) **United States Patent**
Taggart

(10) **Patent No.: US 6,945,013 B2**
(45) **Date of Patent: Sep. 20, 2005**

(54) **METHOD AND APPARATUS FOR ASEPTIC PACKAGING**

(75) Inventor: **Thomas D. Taggart**, South Wales, NY (US)

(73) Assignee: **Steuben Foods Incorporated**, Jamaica, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/871,078**

(22) Filed: **May 31, 2001**

(65) **Prior Publication Data**

US 2002/0029543 A1 Mar. 14, 2002

Related U.S. Application Data

(62) Division of application No. 09/306,552, filed on May 6, 1999, now Pat. No. 6,536,188.
(60) Provisional application No. 60/118,404, filed on Feb. 2, 1999.

(51) **Int. Cl.**[7] **B67B 1/03**
(52) **U.S. Cl.** **53/426**; 53/425; 53/49
(58) **Field of Search** 53/426, 425, 49, 53/79; 422/28, 302, 292

(56) **References Cited**

U.S. PATENT DOCUMENTS

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5,673,535	A		10/1997	Jagger
5,720,148	A		2/1998	Bedin et al.
5,770,232	A		6/1998	Sizer et al.
5,799,464	A		9/1998	Olsson
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5,879,643	A		3/1999	Katschnig et al.
6,120,730	A		9/2000	Palaniappan et al.

FOREIGN PATENT DOCUMENTS

EP	0 569 754 B1	5/1998
KR	96-8699	6/1996

OTHER PUBLICATIONS

Bosch Product Literature: "Aseptically operating filling and closing lines for bottles, jars and wide-mouth containers of glass".

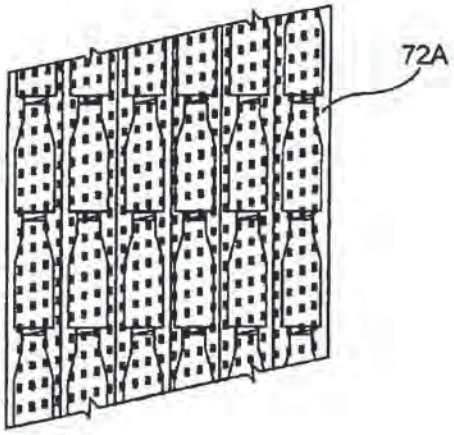
* cited by examiner

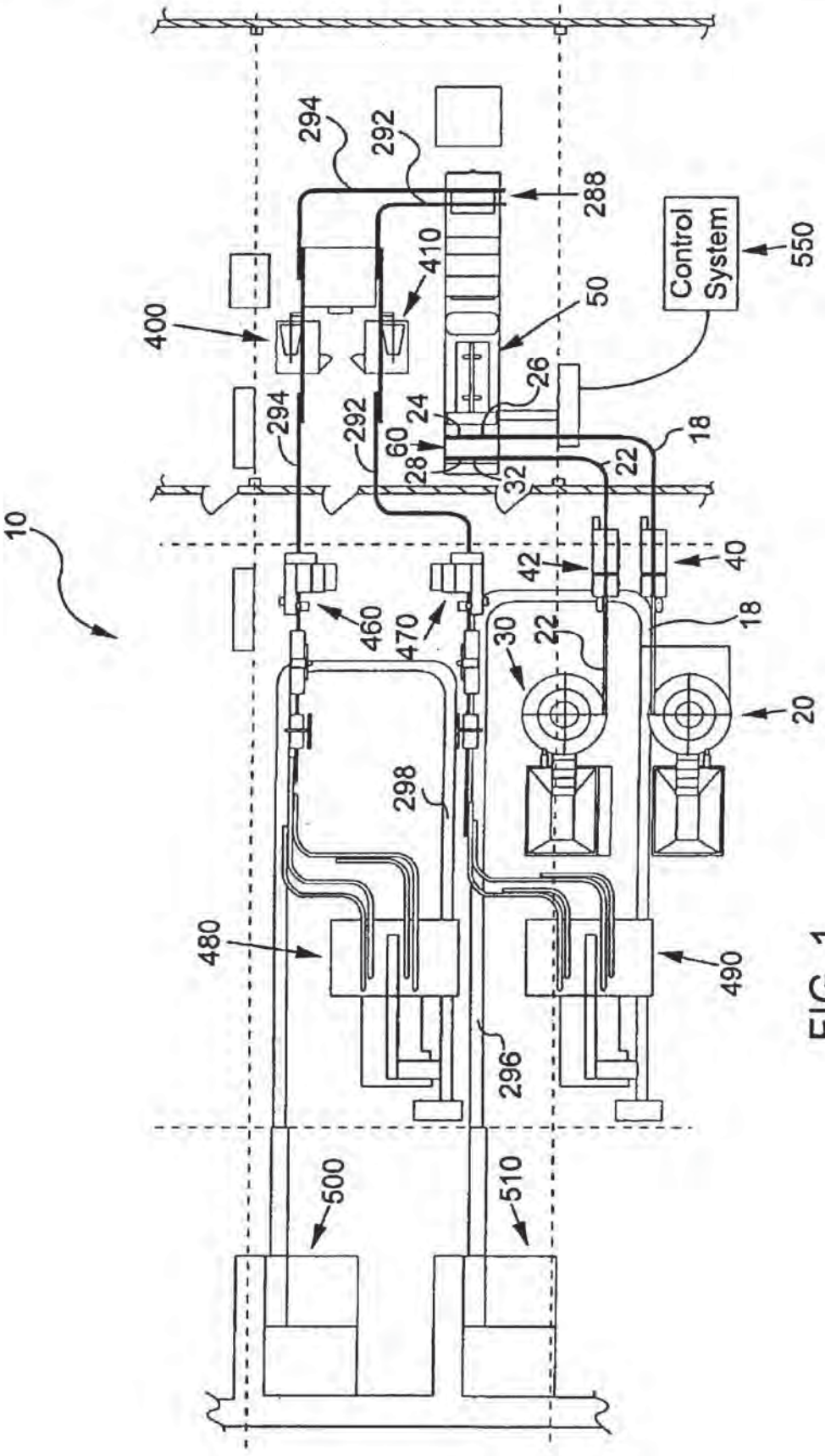
Primary Examiner—Sameh H. Tawfik
(74) *Attorney, Agent, or Firm*—Schmeiser, Olsen & Watts

(57) **ABSTRACT**

A method and apparatus for providing aseptically processed low acid products in a container having a small opening, such as a glass or plastic bottle or jar, at a high output processing speed.

20 Claims, 14 Drawing Sheets

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Control System
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FIG. 1

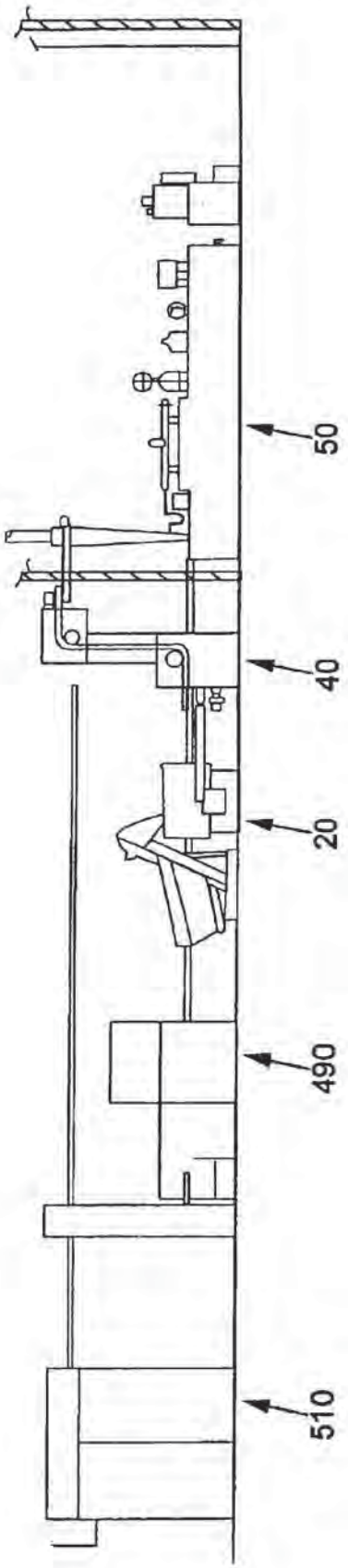
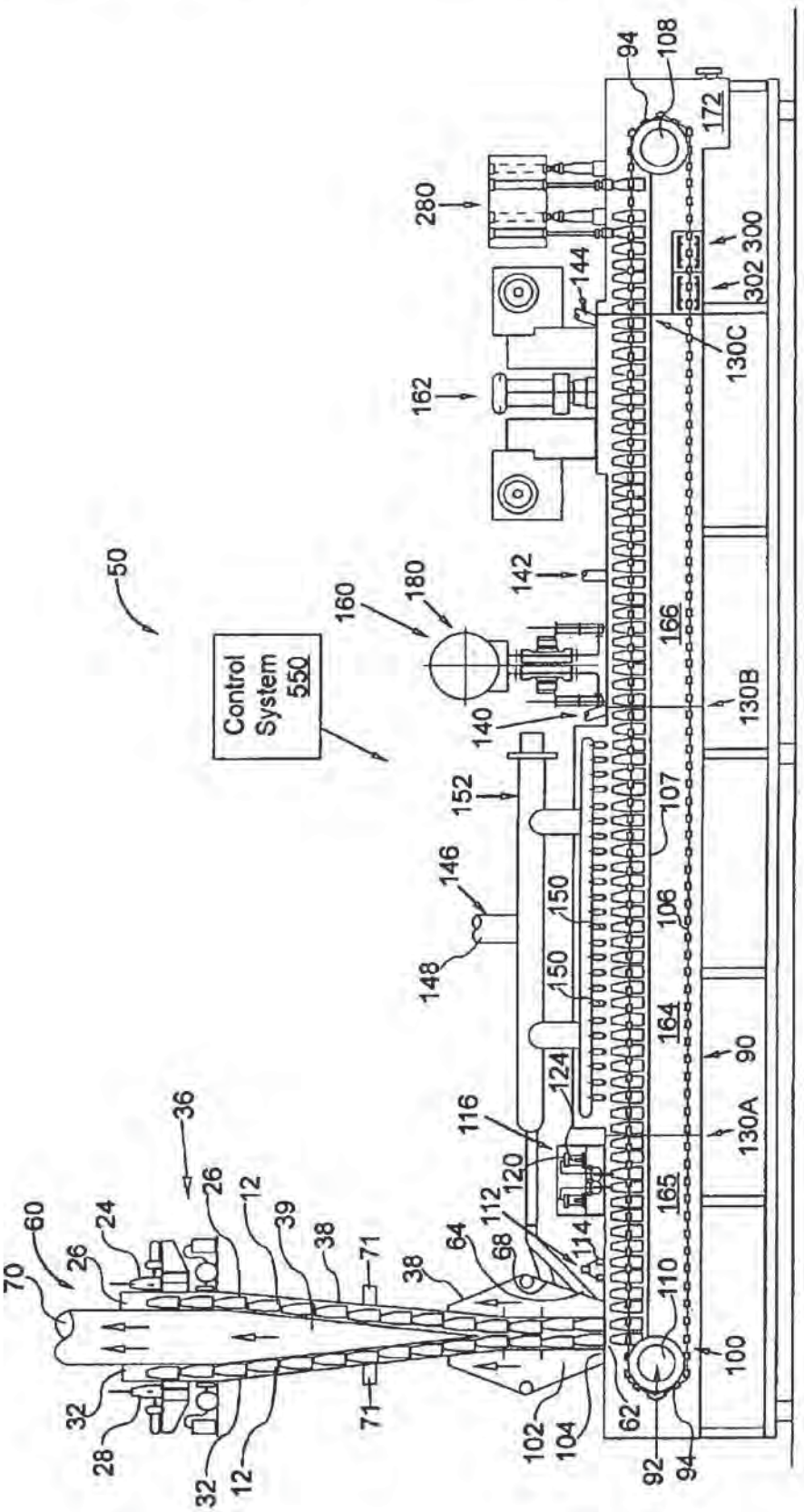


FIG. 2


Control System 550
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130A
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102
104
92
94
32
28
32
12
71
146
148
150
150
152
140
142
160
180
162
280
144
130C
302 300
172
94
108
166
130B
107
106

FIG. 3

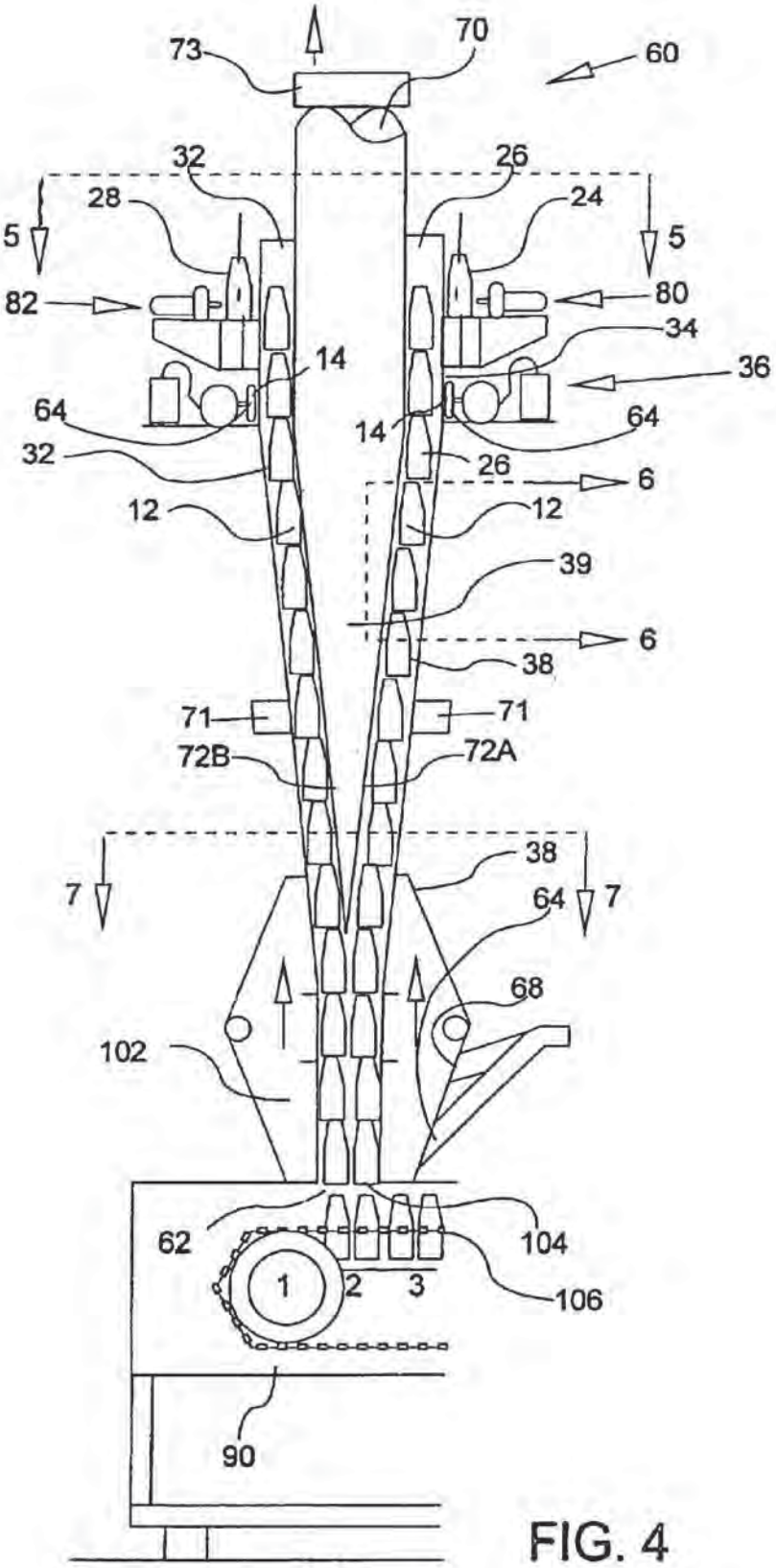
73
70
60
32
26
28
24
5
5
82
80
34
14
36
64
14
64
32
26
6
12
12
39
6
38
71
71
72B
72A
38
7
64
7
68
102
62
104
1
2
3
106
90

FIG. 4

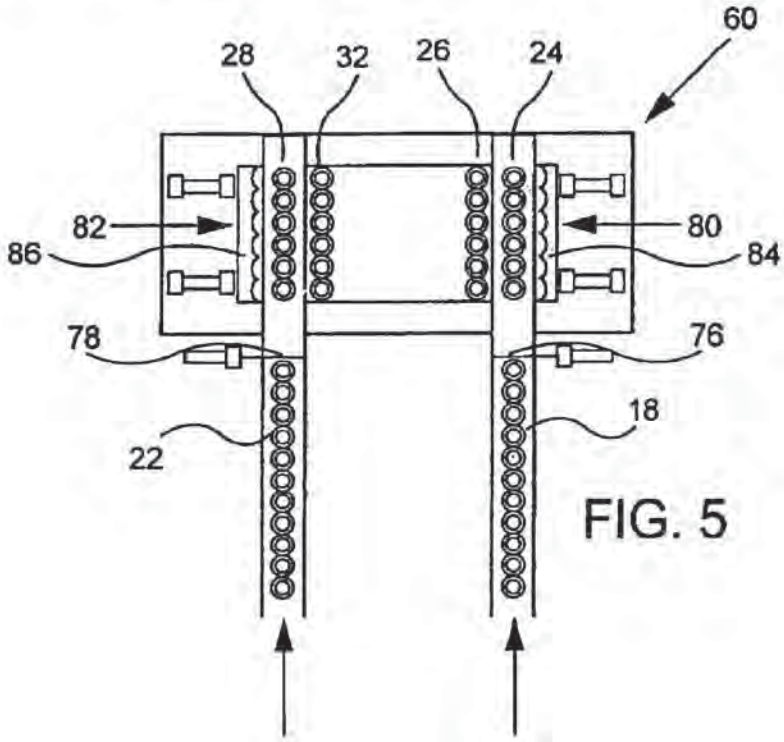

FIG. 5

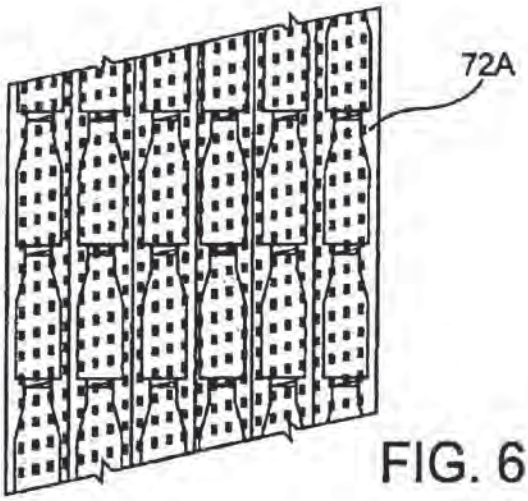

FIG. 6

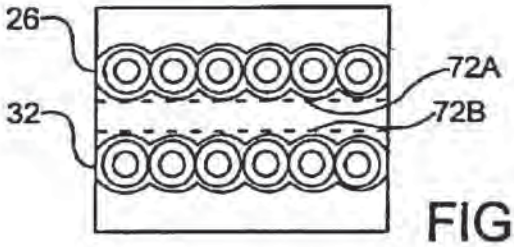

FIG. 7

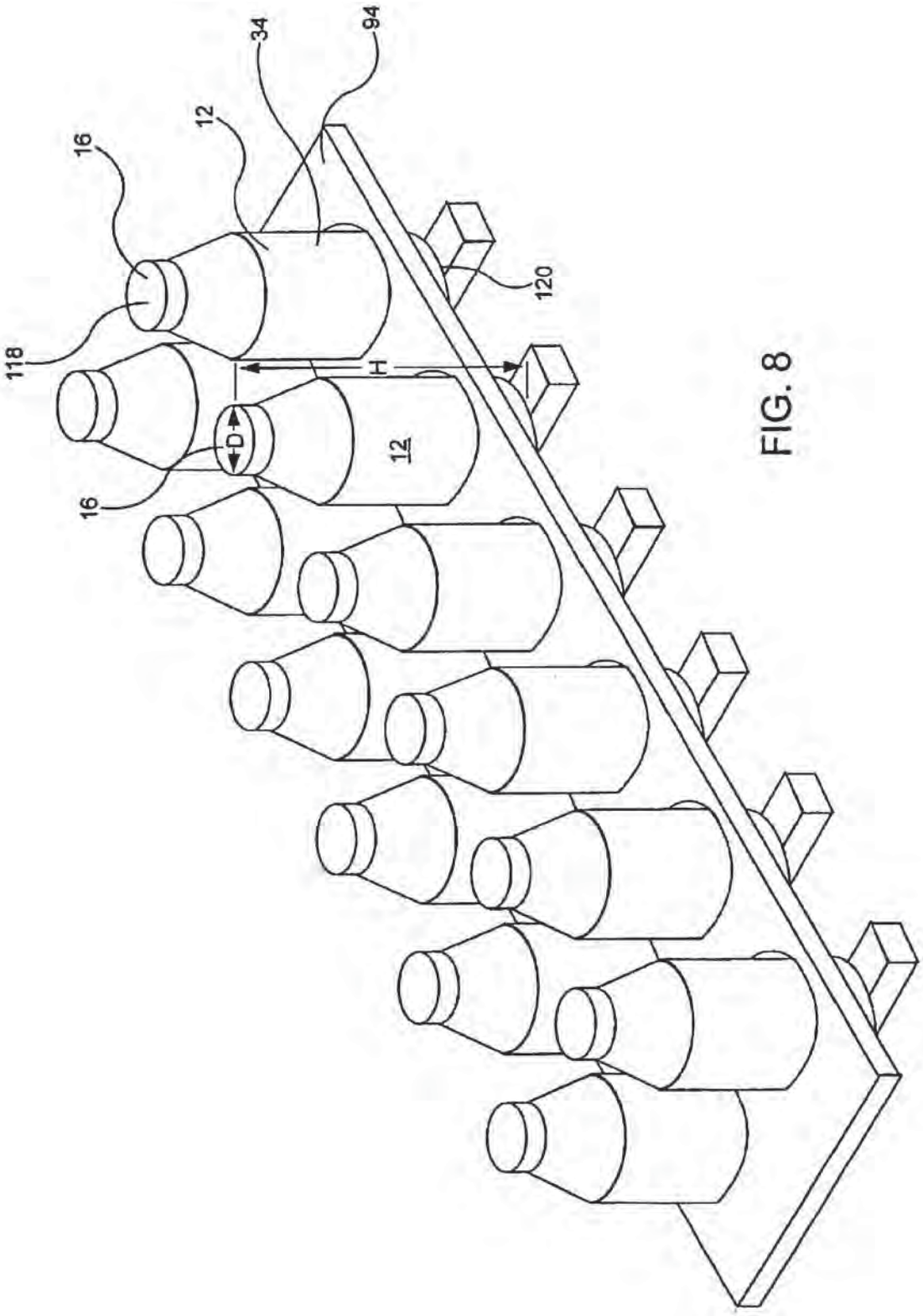

FIG. 8

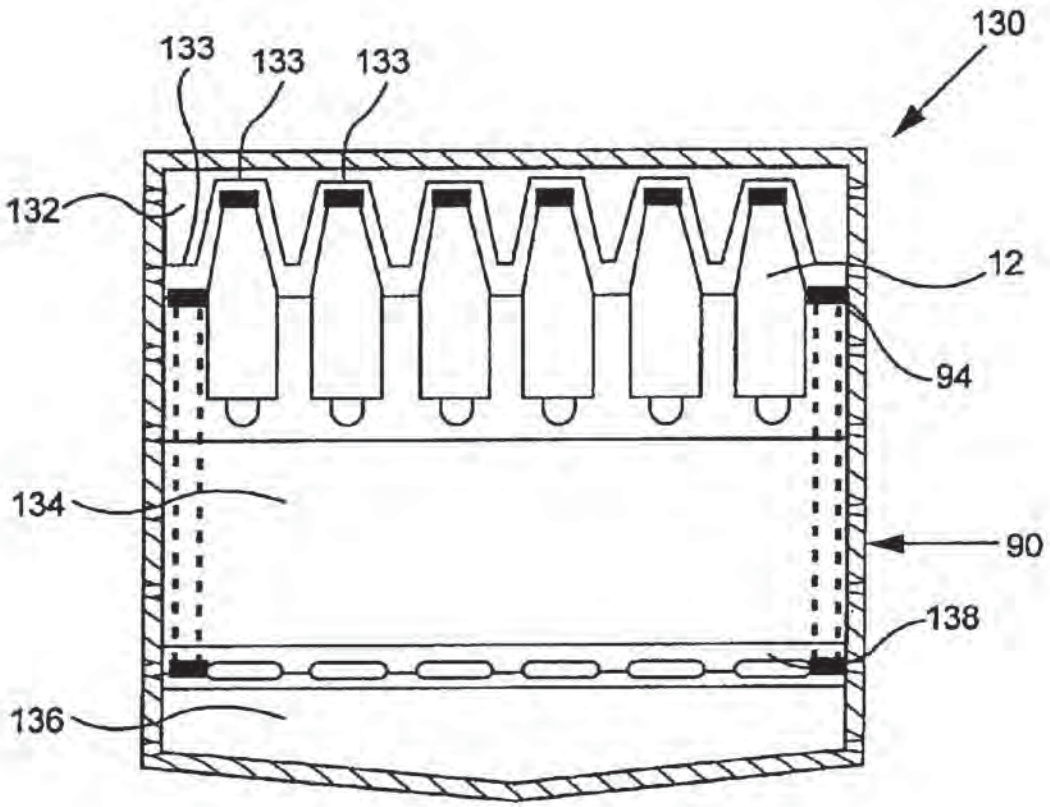

FIG. 9

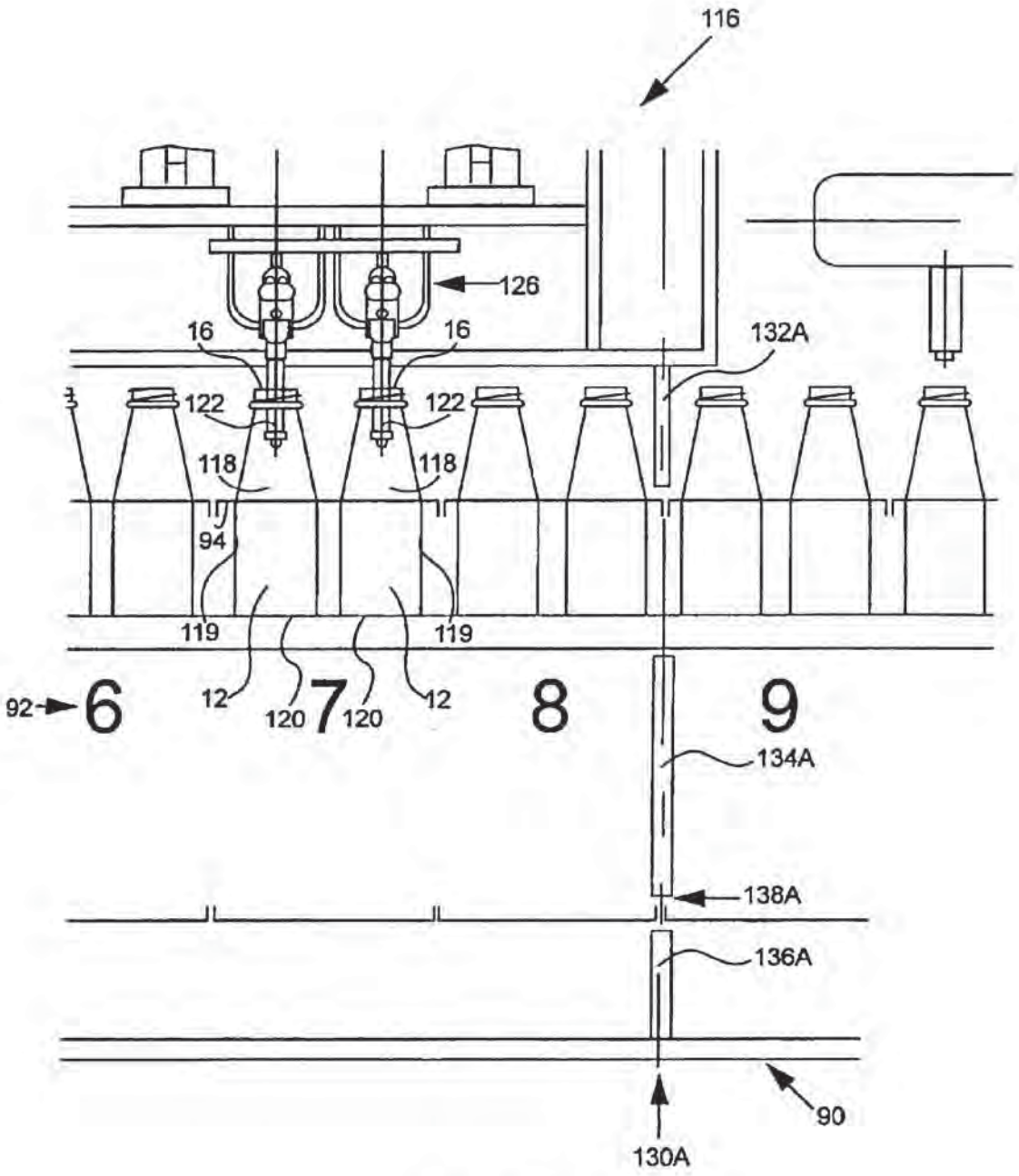
116
126
16
16
132A
122
122
118
118
94
119
119
92
6
12
120
7
120
12
8
9
134A
138A
136A
90
130A

FIG. 10

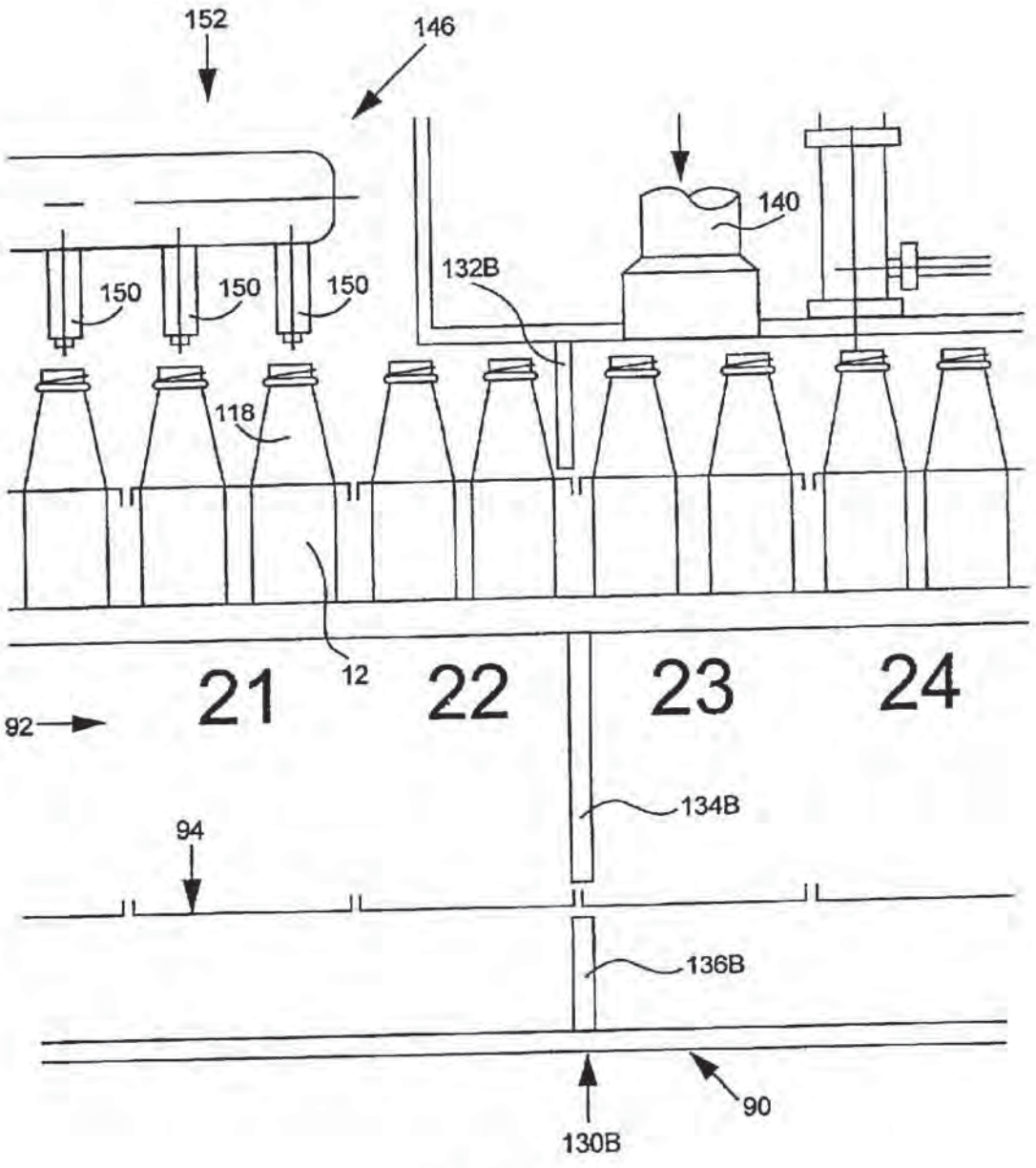
152
146
140
150
150
150
132B
118
12
21
22
23
24
92
134B
94
136B
90
130B

FIG. 11

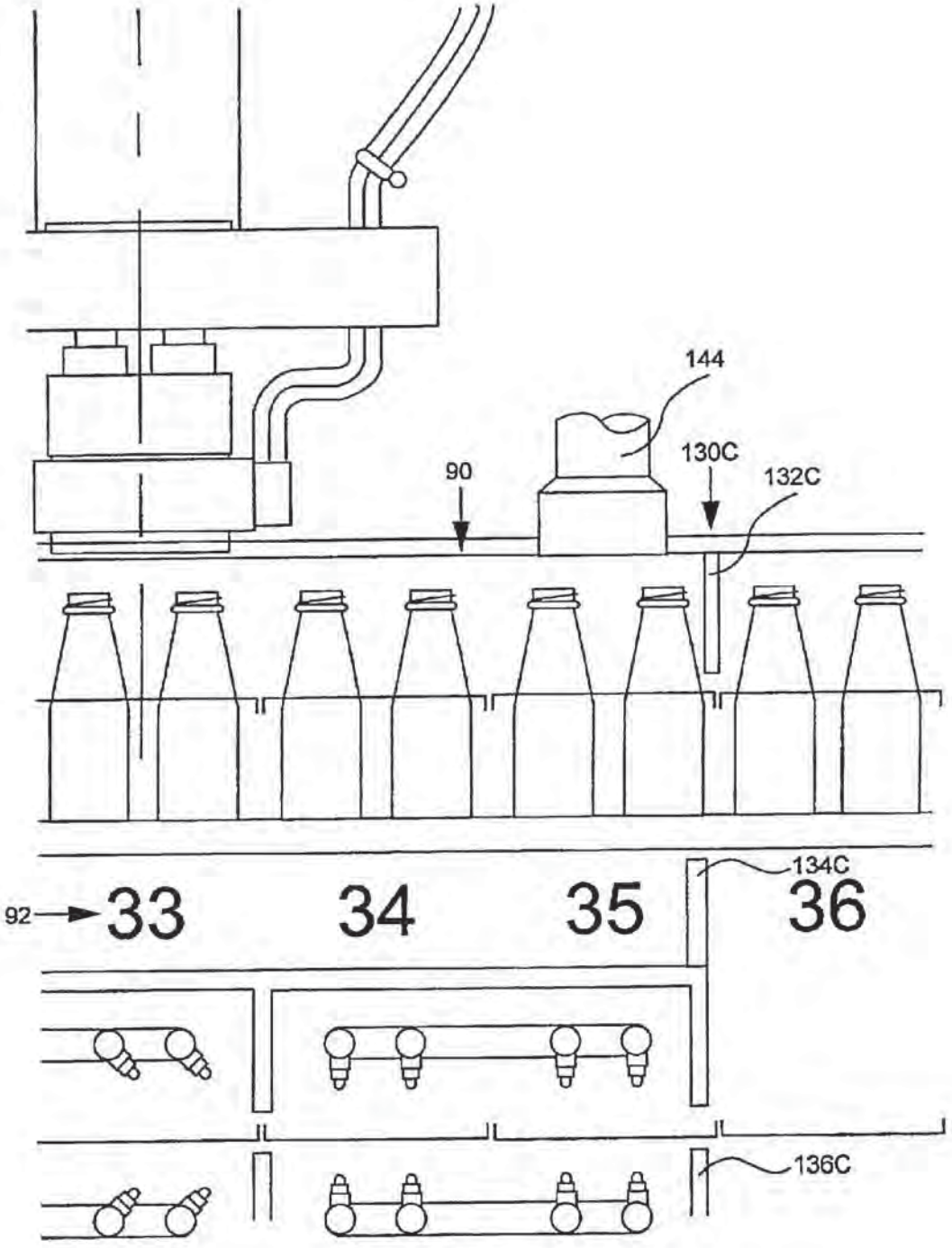

FIG. 12

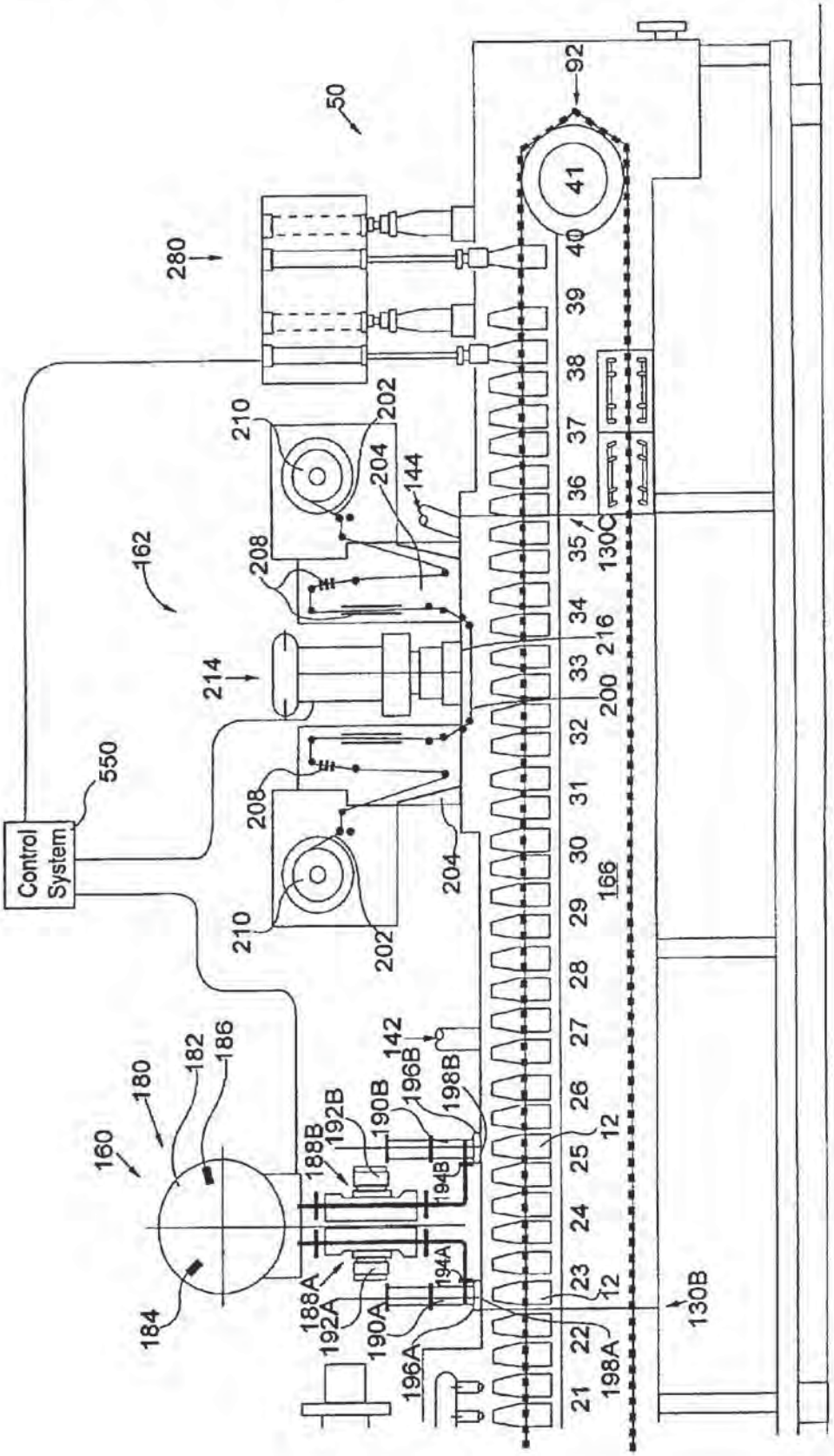
50
92
41
280
40
39
38
37
36
35
130C
210
202
204
144
208
162
34
216
214
33
200
32
550
Control System
31
208
30
204
166
210
202
29
28
27
142
186
182
180
160
196B
198B
190B
192B
188B
26
12
25
194B
24
194A
188A
192A
190A
23
12
130B
184
196A
22
198A
21

FIG. 13

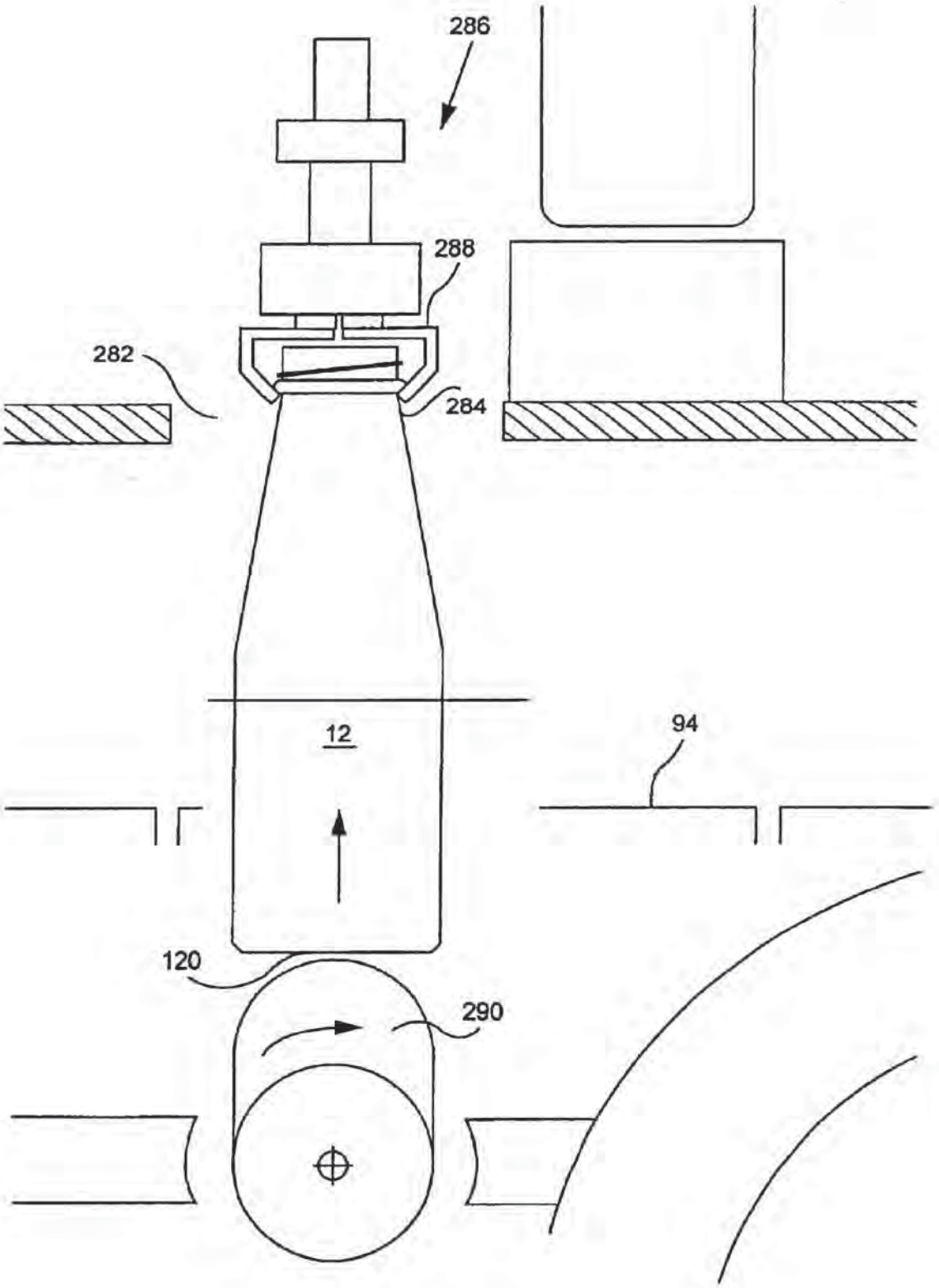

FIG. 14

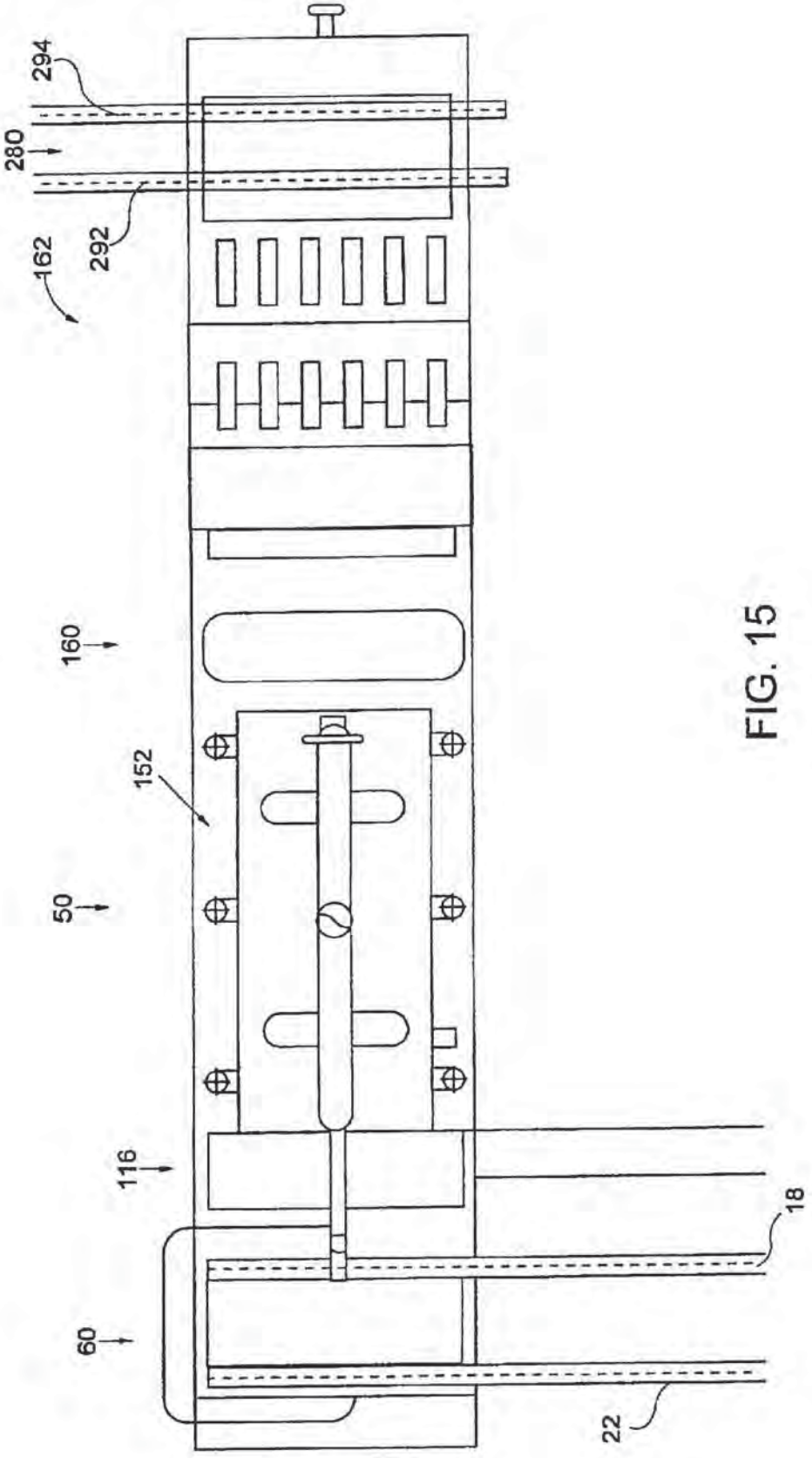

FIG. 15

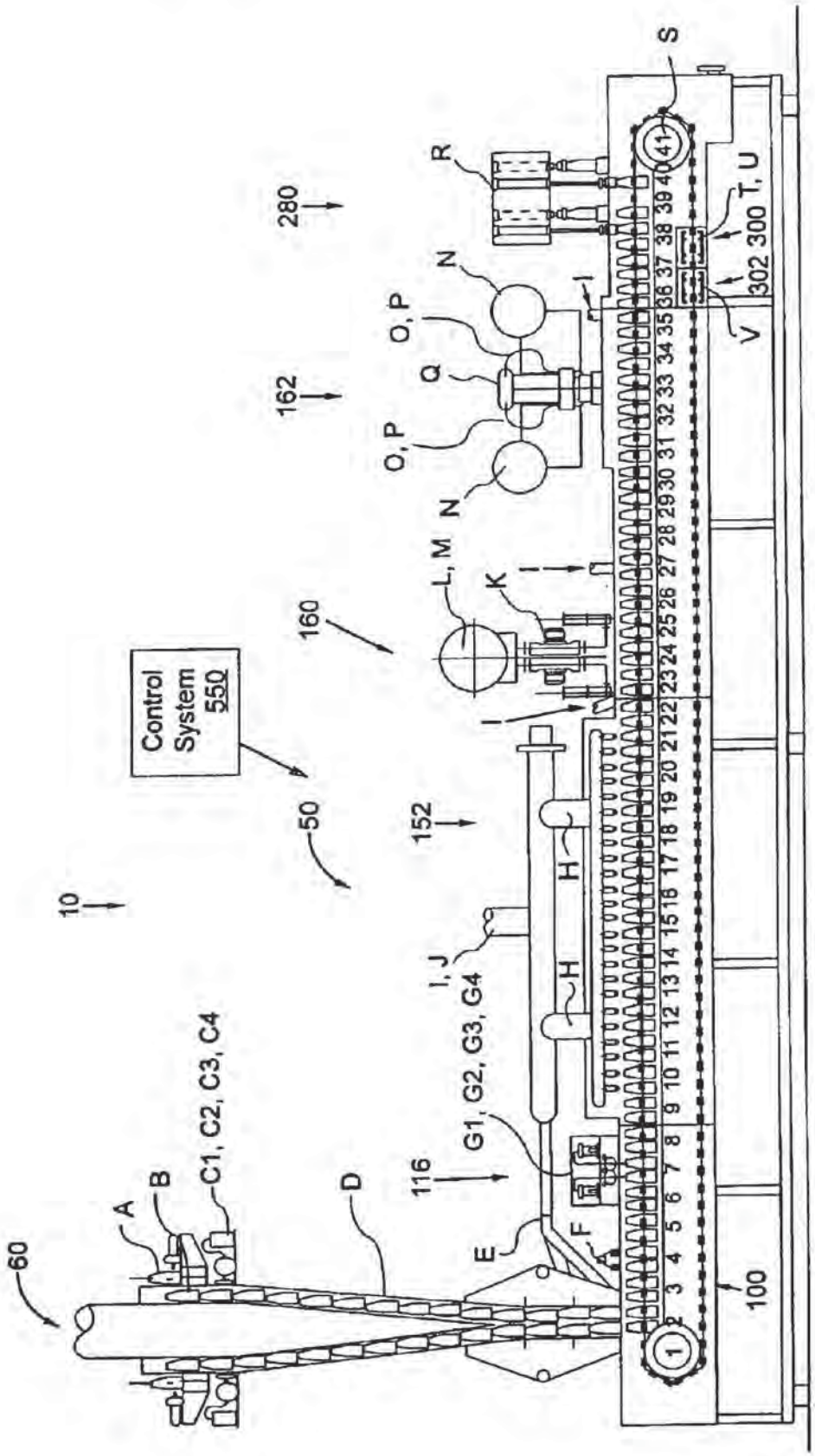
Control System 550
10
50
50
60
100
116
152
160
162
280
A
B
C1, C2, C3, C4
D
E
F
G1, G2, G3, G4
H
I, J
K
L, M
N
O, P
Q
R
S
T, U
V
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
300
302

FIG. 16

METHOD AND APPARATUS FOR ASEPTIC PACKAGING

This application is a divisional of Ser. No. 09/306,552, filed on May 6, 1999, now U.S. Pat. No. 6,536,188, which is a non-provisional of Ser. No. 60/118,404, filed on Feb. 2, 1999.

FIELD OF THE INVENTION

The present invention relates generally to systems for the aseptic packaging of food products. More particularly, the present invention relates to an aseptic packaging system for the aseptic packaging of food products in containers such as bottles or jars.

BACKGROUND OF THE INVENTION

Sterilized packaging systems in which a sterile food product is placed and sealed in a container to preserve the product for later use are well known in the art. Methods of sterilizing incoming containers, filling the containers with pasteurized product, and sealing the containers in an aseptic tunnel are also known.

Packaged food products can generally be categorized as high acid products (Ph below 4.5) or low acid products (Ph of 4.5 and above). The high acid content of a high acid product helps to reduce bacteria growth in the product, thereby increasing the shelf life of the product. The low acid content of a low acid product, however, necessitates the use of more stringent packaging techniques, and often requires refrigeration of the product at the point of sale.

Several packaging techniques, including extended shelf life (ESL) and aseptic packaging, have been developed to increase the shelf life of low acid products. During ESL packaging, for example, the packaging material is commonly sanitized and filled with a product in a presterilized tunnel under "ultra-clean" conditions. By using such ESL packaging techniques, the shelf life of an ESL packaged product is commonly extended from about 10 to 15 days to about 90 days. Aseptic packaging techniques, however, which require that the packaging take place in a sterile environment, using presterilized containers, etc., are capable of providing a packaged product having an even longer shelf life of 150 days or more. In fact, with aseptic packaging, the shelf life limitation is often determined by the quality of the taste of the packaged product, rather than by a limitation caused by bacterial growth.

For the aseptic packaging of food products, an aseptic filler must, for example, use an FDA (Food and Drug Administration) approved sterilant, meet FDA quality control standards, use a sterile tunnel or clean room, and must aseptically treat all packaging material. The food product must also be processed using an "Ultra High Temperature" (UHT) pasteurization process to meet FDA aseptic standards. The packaging material must remain in a sterile environment during filling, closure, and sealing operations.

Many attempts have been made, albeit unsuccessfully, to aseptically fill containers, such as bottles or jars having small openings, at a high output processing speed. In addition, previous attempts for aseptically packaging a low acid product in plastic bottles or jars (e.g., formed of polyethylene terepthalate (PET) or high density polyethylene (HDPE)), at a high output processing speed, have also failed. Furthermore, the prior art has not been successful in providing a high output aseptic filler that complies with the stringent United States FDA standards for labeling a packaged product as "aseptic." In the following description of the present invention, the term "aseptic" denotes the United States FDA level of aseptic.

SUMMARY OF THE INVENTION

In order to overcome the above deficiencies, the present invention provides a method and apparatus for providing aseptically processed low acid products in a container having a small opening, such as a glass or plastic bottle or jar, at a high output processing speed.

Many features are incorporated into the aseptic processing apparatus of the present invention in order to meet the various United States FDA aseptic standards and the 3A Sanitary Standards and Accepted Practices.

The aseptic processing apparatus of the present invention uses filtered air to maintain a positive pressure within a filler apparatus. The filler apparatus includes a sterile tunnel that is pressurized to a level greater than atomospheric pressure using filtered sterile air. The filler apparatus includes three interfaces with the ambient environment, each of which eliminates the possibility of external contamination. The first interface is where containers first enter the sterile tunnel through a bottle infeed and sterilization apparatus. In accordance with the present invention, there is always an outflow of aseptic sterilant (e.g., hydrogen peroxide) enriched sterile air from the first interface to prevent contaminants from entering the sterile tunnel. The second interface with the sterile tunnel is the path where incoming lid stock enters a lid sealing and heat sealing apparatus. To prevent contamination, the lid stock passes through a hydrogen peroxide bath that provides an aseptic barrier for any contaminants that enter the sterile tunnel through the second interface. The third interface with the sterile tunnel is at an exit opening of a discharge apparatus where sealed containers leave the sterile tunnel. Positive sterile air pressure within the sterile tunnel ensures that sterile air is continuously flowing out of the exit opening of the discharge apparatus, thereby preventing contaminants from entering the sterile tunnel through this interface.

The aseptic processing apparatus includes a conveying apparatus for transporting the containers through a plurality of processing stations located within the sterile tunnel. The entire conveying apparatus is enclosed within the sterile tunnel, and is never is exposed to unsterile conditions.

The interior surface of a container such as a bottle or jar is much more difficult to aseptically sterilize than the interior surface of a cup. A cup generally has a large opening compared to its height, whereas a bottle or jar generally has a small opening compared to its height and its greatest width (e.g., the ratio of the opening diameter to the height of the container is less than 1.0). A sterilant can be introduced, activated, and removed in a cup much more rapidly than in a bottle or jar. The processing speed when using a bottle or jar is limited, in part, by the time required to aseptically sterilize the interior surface of the bottle or jar. The aseptic processing apparatus of the present invention overcomes the processing speed limitations associated with the use of containers such as bottles or jars.

A high output processing speed is achieved in the present invention by applying a hot atomized sterilant, such as a hydrogen peroxide spray onto the interior surface of each container, and by subsequently activating and removing the sterilant in a plurality of drying stations using hot sterile air. For example hydrogen peroxide breaks down into water and oxygen, and thus oxidizes and kills bacteria within the container. To achieve aseptic sterilization, a minimum container temperature is developed and held for a predetermined

period of time (e.g., 131° F. for 5 seconds) after application of the sterilant. Hot sterile air is delivered at a high volume and a relatively low temperature to dry the container and to prevent the container (if formed of plastic) from being heated to its softening temperature. After container drying, the residual hydrogen peroxide in the container is below a predetermined level (e.g., about 0.5 PPM (parts per million)).

The present invention generally provides a method for aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the plurality of bottles;

aseptically filling the aseptically disinfected plurality of bottles with the aseptically sterilized foodstuffs; and

filling the aseptically disinfected plurality of bottles at a rate greater than 100 bottles per minute.

The present invention additionally provides a method for aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the bottles at a rate greater than 100 bottles per minute; and

aseptically filling the bottles with aseptically sterilized foodstuffs.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention will best be understood from a detailed description of the invention and a preferred embodiment, thereof selected for the purposes of illustration, and shown in the accompanying drawings in which:

FIG. **1** is a plan view of an aseptic processing apparatus in accordance with a preferred embodiment of the present invention;

FIG. **2** is a side view of the aseptic processing apparatus of FIG. **1**;

FIG. **3** is a partial cross-sectional side view of the aseptic processing apparatus of FIG. **1**;

FIG. **4** is a cross-sectional side view of a bottle infeed and sterilization apparatus;

FIG. **5** illustrates a cross-sectional top view of the bottle infeed and sterilization apparatus taken along line **5**—**5** of FIG. **4**;

FIG. **6** is an interior sectional view of an interior wall taken along line **6**—**6** of FIG. **4**;

FIG. **7** is a cross-sectional view of the bottle infeed and sterilization apparatus taken along line **7**—**7** of FIG. **4**;

FIG. **8** is a perspective view of a conveying plate for use in the aseptic processing apparatus of the present invention;

FIG. **9** is a perspective view of a partition in a sterile tunnel;

FIG. **10** is a cross-sectional side view of an interior bottle sterilization apparatus and the partition located between stations **8** and **9**;

FIG. **11** is a cross-sectional side view of the partition located between stations **22** and **23**;

FIG. **12** is a cross-sectional side view of the partition located between stations **35** and **36**;

FIG. **13** is a cross-sectional side view of a lid sterilization and heat sealing apparatus;

FIG. **14** is a side view of a lifting apparatus with a gripper mechanism for lifting the bottles from the sterile tunnel;

FIG. **15** is a top view of the aseptic processing apparatus; and

FIG. **16** is a side view of the aseptic processing apparatus indicating the control and monitoring locations that are interfaced with a control system.

DETAILED DESCRIPTION OF THE INVENTION

Although certain preferred embodiments of the present invention will be shown and described in detail, it should be understood that various changes and modifications may be made without departing from the scope of the appended claims. The scope of the present invention will in no way be limited to the number of constituting components, the materials thereof, the shapes thereof, the relative arrangement thereof, etc., and are disclosed simply as an example of the preferred embodiment. The features and advantages of the present invention are illustrated in detail in the accompanying drawings, wherein like reference numerals refer to like elements throughout the drawings. Although the drawings are intended to illustrate the present invention, the drawings are not necessarily drawn to scale.

The present invention provides an aseptic processing apparatus **10** that will meet the stringent FDA (Food and Drug Administration) requirements and 3A Sanitary Standards and Accepted Practices required to label a food product (foodstuffs) as "aseptic". Hereafter, "aseptic" will refer to the FDA level of aseptic. The present invention provides a method and apparatus for producing at least about a 12 log reduction of *Clostridium botulinum* in food products. In addition, the present invention produces packaging material with at least about a 6 log reduction of spores. Actual testing of the aseptic processing apparatus is accomplished with spore test organisms. These test organisms are selected on their resistance to the media selected used to achieve sterility. For example, when steam is the media, the test organism is *Bacillus stearothermophilus*. When hydrogen peroxide is the media, then the test organism is *Bacillus subtilis* var. globigii.

The present invention processes containers such as bottles or jars that have a small opening compared to its height and its greatest width (e.g., the ratio of the opening diameter to the height of the container is less than 1.0). In the preferred embodiment, a bottle **12** (see, e.g., FIG. **8**) is illustrated as the container. The container may alternately comprise a jar. The bottle **12** is preferably formed of a plastic such as polyethylene terepthalate (PET) or high density polyethylene (HDPE), although other materials such as glass may also be used. The present invention uses an aseptic sterilant such as hydrogen peroxide (H_2O_2) or oxonia to sterilize the bottles **12**. In the preferred embodiment of the present invention, hydrogen peroxide is used as the sterilant. The present invention uses hydrogen peroxide with a concentration of less than about 35% and ensures that the bottles **12** have less than about 0.5 ppm of residual hydrogen peroxide after each bottle **12** is sterilized.

FIGS. **1**–**3** illustrate several views of an aseptic processing apparatus **10** in accordance with a preferred embodiment of the present invention. As shown, the aseptic processing apparatus **10** includes a first bottle unscrambler **20**, a second bottle unscramble **30**, and a bottle lifter **40** for providing a supply of properly oriented empty bottles. The empty bottles are delivered to a filler apparatus **50** after passing through a bottle infeed and sterilization apparatus **60** for aseptic sterilization. The filled bottles are sealed at a first capping apparatus **400** or a second capping apparatus **410**. A control

system **550** monitors and controls the operation of the aseptic processing apparatus **10**. The filled and sealed bottles are packed and palletized using a first case packing apparatus **480**, a second case packing apparatus **490**, a first palletizer **500**, and a second palletizer **510**.

The bottles **12** arrive at a first bottle unscrambler **20** with a random orientation, such that an opening **16** (see FIG. **8**) of each bottle **12** can be oriented in any direction. The first bottle unscrambler **20** manipulates the bottles **12** until the opening **16** of each bottle **12** is in a top vertical position. The bottles **12** leave the first bottle unscrambler **20** in a series formation with the opening **16** of each bottle **12** oriented vertically. The bottles **12** travel in single file in a first lane **18** to a first bottle lifter **40**. The first bottle lifter **40** lifts and transports the bottles **12** to a bottle infeed and sterilization apparatus **60**. A second bottle unscrambler **30** may also used to provide a supply of vertically oriented bottles **12**. The bottles **12** output from the second bottle unscrambler **30** travel in single file in a second lane **22** to a second bottle lifter **42**, which lifts and transports the bottles **12** to the bottle infeed and sterilization apparatus **60**.

FIG. **3** illustrates the bottle infeed, sterilization, and conveying apparatus **60** attached to the filler apparatus **50**. FIG. **4** illustrates a cross-sectional side view of the bottle infeed, sterilization, and conveying apparatus **60**. FIG. **5** illustrates a cross-sectional top view of the bottle infeed, sterilization, and conveying apparatus **60** taken along line **5—5** of FIG. **4**. The bottle infeed and sterilization apparatus **60** preferably inputs six bottles **12** in a horizontal direction from the first lane **18** and six bottles in a horizontal direction from the second lane **22** (FIG. **5**). A gate **76** in the first lane **18** selectively groups six bottles **12** at a time in first horizontal row **24**. A gate **78** in the second lane **22** selectively groups six bottles **12** at a time in a second horizontal row **28**. An infeed apparatus **80** includes a pushing element **84** for pushing the bottles **12** in the first horizontal row **24** into a first vertical lane **26**. A corresponding infeed apparatus **80** includes a pushing element **86** for pushing the bottles **12** in the second horizontal row **28** into a second vertical lane **32**. The six bottles **12** in the first vertical lane **26** and the six bottles **12** in the second vertical lane **32** are directed downward into the bottle infeed and sterilization apparatus **60**.

Referring to FIG. **4**, as the bottles **12** move downward in the first vertical lane **26** and the second vertical lane **32**, a sterilant **14**, such as heated hydrogen peroxide, oxonia, or other aseptic sterilant, is applied to an outside surface **34** of each bottle **12** by a sterilant application apparatus **36**. The outside surface **34** of a bottle **12** is illustrated in greater detail in FIG. **8**. The bottles **12** may move downward in the first vertical lane **26** and the second vertical lane **32** by the force of gravity. Alternatively, controlled downward movement of the bottles **12** can be created by the use of a conveying device such as a moving conveying chain. A plurality of pins are attached to the conveying chain. Each bottle **12** rests on one of the pins attached to the conveying chain. Therefore, the motion of each bottle is controlled by the speed of the moving conveying chain.

A sterilant such as hydrogen peroxide may be provided to the sterilant application apparatus **36** in many ways. For example, liquid hydrogen peroxide may be provided in a reservoir at a level maintained by a pump and overflow pipe. A plurality of measuring cups (e.g., approximately 0.5 ml each) connected by an air cylinder are submerged into the reservoir and are lifted above the liquid level. Thus, a measured volume of liquid hydrogen peroxide is contained in each measuring cup.

Each measuring cup may include a conductivity probe that is configured to send a signal to the control system **550** indicating that the measuring cup is full. A tube (e.g., having a diameter of about 1/16") is positioned in the center of the measuring cup. A first end of the tube is positioned near the bottom of the measuring cup. A second end of the tube is connected to the sterilant application apparatus **36**. The sterilant application apparatus **36** includes a venturi and a heated double tube heat exchanger. When the measuring cup is full, and a signal is received from the control system **550**, a valve is opened allowing pressurized sterile air to enter the venturi. The pressurized air flow causes a vacuum to be generated in second end of the tube causing liquid hydrogen peroxide to be pulled out of the measuring cup. The liquid hydrogen peroxide is sprayed into a sterile air stream which atomizes the hydrogen peroxide into a spray. The atomized hydrogen peroxide enters the double tube heat exchanger in order to heat the atomized hydrogen peroxide to its vaporization phase. The double tube heat exchanger is heated with steam and the temperature is monitored and controlled by the control system **550**. In FIG. **4**, the application of the sterilant **14** by the sterilant application apparatus **36** is accomplished through the use of spray nozzles **64** that produce a sterilant fog which is directed to the outside surface **34** of each bottle **12**.

Alternatively, a direct spray of heated hydrogen peroxide may be continuously applied to the outside surface **34** of each bottle **12**. For producing the direct spray, a metering pump regulates the amount of hydrogen peroxide, a flow meter continuously measures and records the quantity of hydrogen peroxide being dispensed, a spray nozzle produces a fine mist, and a heat exchanger heats the hydrogen peroxide above the vaporization point.

FIGS. **3** and **4** illustrate the sterilization chamber **38** for activation and drying of bottles **12** which is included in the bottle infeed, sterilization, and conveying apparatus **60**. The sterilization chamber **38** sterilizes the outside surface **34** of each bottle **12**. The sterilization chamber **38** encloses a conduit **39**. Sterile heated air, which is generated by a sterile air supply system **146** (FIG. **3**), enters the conduit **39** of the sterilization chamber **38** through ports **64** and **68** located at the bottom of the sterilization chamber **38**. The sterile heated air also enters through a bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The sterile heated air travels up through the conduit **39** of the sterilization chamber **38**, and exits the top of the sterilization chamber **38** through an exhaust conduit **70**. The sterile heated air continuously flows in an upward direction through the sterilization chamber **38**, thus preventing any contaminants from entering the bottle infeed and sterilization apparatus **60**. To create the sterile heated air, the air is first passed through a filtering system (e.g., a group of double sterile air filters) to sterilize the air. The air is then heated in a heating system (e.g., an electric heater) to about 230° F. The air temperature is regulated by the control system **550**. Other techniques for providing the sterile heated air may also be used. The control system **550** monitors the air pressure and flow rate of the sterile heated air to ensure that an adequate flow of the hot sterile air is maintained in the bottle sterilization chamber **38** of the bottle infeed and sterilization apparatus **60**.

As illustrated in FIGS. **4**, **6**, and **7**, the sterilization chamber **38** includes two opposing, interior, perforated walls **72A**, **72B**. The perforated walls **72A** and **72B** guide the bottles **12** downward in the first vertical lane **26** and the second vertical lane **32**, respectively. The perforated walls **72A**, **72B** also allow the complete circulation of hot sterile air around the outside surface **34** of each bottle **12** in the sterilization chamber **38**. The sterilization chamber **38** supplies hot sterile air to the outside surface **34** of each bottle

12 between the sterilant application apparatus **36** and the bottom opening **62** of the bottle infeed and sterilization apparatus **60**. This sterilant may be hydrogen peroxide or oxonia (hydrogen peroxide and peroxyacetic acid).

In accordance with the preferred embodiment of the present invention, twelve drying positions are provided in the sterilization chamber **38**. Each bottle **12** is exposed to the hot sterile air in the sterilization chamber **38** for about at least 24 seconds. This provides time sufficient time for the hydrogen peroxide sterilant to break down into water and oxygen, to kill any bacteria on the bottles **12**, and to evaporate from the outside surface **34** of the bottles **12**.

An exhaust fan **73** is located at a top of the exhaust conduit **70** to provide an outlet from a sterile tunnel **90**, and to control the sterile air flow rate through the sterilization chamber **38**. The exhaust fan **73** is controlled by the control system **550**. The control system **550** controls the sterile air temperature preferably to about 230° F., and controls the sterile air flow rate through the sterilization chamber **38**. The flow rate is preferably about 1800 scfm through the sterilization chamber **38**. The bottles **12** leave the sterilization chamber **38** with a hydrogen peroxide concentration of less than 0.5 PPM.

As shown in FIGS. **3** and **4**, a plurality of proximity sensors **71** located along the sides of the vertical lanes **26**, **32** detect any bottle **12** jams that occur within the sterilization chamber **38**. The proximity sensors **71** transmit an alarm signal to the control system **550**. The bottles **12** leave the bottle infeed and sterilization apparatus **60** through the bottom opening **62**, and enter the sterile tunnel **90** of the filler apparatus **50**.

In the preferred embodiment of the present invention, the filler apparatus **50** includes forty-one (41) index stations **92**, hereafter referred to as "stations." Various index stations **92** are illustrated in FIGS. **3**, **4**, and **11–15**. The conveying motion of the bottles **12** to the various stations **92** through the filler apparatus **50** is based on an indexing motion. The filler apparatus **50** is designed to convey the bottles **12** through the various operations of the filler **50** in a two by six matrix. The twelve bottles **12** in the two by six matrix are positioned in, and displaced by, a conveying plate **94** as illustrated in FIG. **8**. Therefore, twelve bottles **12** are exposed to a particular station **92** at the same time. A conveying apparatus **100** moves the set of twelve bottles **12** in each conveying plate **94** sequentially through each station **92**.

Referring to FIGS. **3** and **4**, the bottles **12** are supplied from an infeed chamber **102** to station **2** of the filler apparatus **50** through the bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The infeed chamber **102** is enclosed to direct heated hydrogen peroxide laden air completely around the outer surface **34** of the bottles **12**. A mechanical scissors mechanism and a vacuum "pick and place" apparatus **104** position twelve bottles **12** at a time (in a two by six matrix, FIG. **8**) into one of the conveying plates **94**.

A plurality of conveying plates **94** are attached to a main conveyor **106**. The main conveyor **106** forms a continuous element around conveyor pulleys **108** and **110** as illustrated in FIG. **3**. A bottle support plate **107** supports a bottom **120** of each bottle **12** as the bottles **12** are conveyed from station to station through the filler apparatus **50**. Each conveying plate **94** passes through stations **1** through **41**, around pulley **108**, and returns around pulley **110** to repeat the process. The main conveyor **106**, conveying plates **94**, and pulleys **108** and **110** are enclosed in the sterile tunnel **90**.

At station **4**, the bottles **12** in the conveying plate **94** enter a bottle detection apparatus **112**. The bottle detection apparatus **112** determines whether all twelve bottles **12** are actually present and correctly positioned in the conveying plate **94**. Proximity sensors **114** detect the presence and the alignment of each bottle **12**. In the present invention, a bottle **12** with correct alignment is in an upright position with the opening **16** of the bottle **12** located in an upward position. Information regarding the location of any misaligned or missing bottles **12** is relayed to the control system **550**. The control system **550** uses this location information to ensure that, at future stations **92**, bottle filling or sealing will not occur at the locations corresponding to the misaligned or missing bottles **12**.

At station **7**, as illustrated in FIGS. **3** and **10**, the bottles **12** in the conveying plate **94** enter an interior bottle sterilization apparatus **116**. A sterilant, such as hydrogen peroxide, oxonia, or any other suitable aseptic sterilant is applied as a heated vapor fog into the interior **118** of each bottle **12**. Preferably, hydrogen peroxide is used as the sterilant in the present invention. The application of sterilant is accomplished with the use of a plurality of sterilant measuring devices **120** and applicator spray nozzles **122**. A separate measuring device **120** and applicator spray nozzle **122** are used for each of the twelve bottle **12** locations in the conveying plate **94**. Each bottle **12** is supplied with the same measured quantity of sterilant, preferably in the form of a hot vapor fog. The measured quantity of sterilant may be drawn from a reservoir **124** of sterilant, heated, vaporized, etc., in a manner similar to that described above with regard to the sterilant application apparatus **36**.

The control system **550** monitors and controls a spray apparatus **126** that includes the applicator spray nozzles **122**. Each applicator spray nozzle **122** sprays the sterilant into the interior **118** of a corresponding bottle **12** as a hot vapor fog. The applicator spray nozzles **122** are designed to extend through the bottle openings **16**. The applicator spray nozzles **122** descends into the interior **118** and toward the bottom of the bottles **12**. This ensures the complete application of sterilant to the entire interior **118** and interior surface **119** of each bottle **12**. Alternately, the applicator spray nozzles **122** may be positioned immediately above the bottle openings **16** prior to the application of sterilant.

FIG. **9** illustrates a perspective view of a partition **130** that provides control of sterile air flow within the sterile tunnel **90** of the filler apparatus **50**. The partition **130** includes a top baffle plate **132**, a middle baffle plate **134**, and a bottom baffle plate **136**. The top baffle plate **132** and the middle baffle plate **134** are provided with cut-outs **133** which correspond to the outer shape of each bottle **12** and to the outer shape of the conveyor plate **94**. The cut-outs **133** allow each bottle **12** and each conveyor plate **94** to pass through the partition **130**. A space **138** between the middle baffle plate **134** and the bottom baffle plate **136** allows each empty conveyor plate **94** to pass through the partition **130** as it travels on its return trip from the pulley **108** toward the pulley **110**.

As illustrated in FIG. **3**, partitions **130A**, **130B**, and **130C**, are located within the sterile tunnel **90**. FIG. **10** illustrates a cross-sectional view of partition **130A** including baffle plates **132A**, **134A**, and **136A**. The partition **130A** is located between stations **8** and **9**. FIG. **11** illustrates a cross-sectional view of partition **130B** including baffle plates **132B**, **134B**, and **136B**. The partition **130B** is located between stations **22** and **23**. FIG. **12** illustrates a cross-sectional view of partition **130C** including baffles **132C**, **134C**, and **136C**. The partition **130C** is located between stations **35** and **36**. As illustrated in

FIG. **3**, sterile air is introduced through sterile air conduits **140**, **142**, and **144** into the sterile tunnel **90**. The sterile air conduit **140** is located at station **23** (FIG. **11**), the sterile air conduit **142** is located at station **27** (FIG. **3**), and the sterile air conduit **144** is located at station **35** (FIG. **12**).

The partition **130**A separates an activation and drying apparatus **152** from the interior bottle sterilization apparatus **116**. The partition **130**B separates the activation and drying apparatus **152** from a main product filler apparatus **160** and a lid sterilization and heat sealing apparatus **162**. Thus, a first sterilization zone **164** is created that includes the activation and drying apparatus **152**. Partition **130**C separates the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** from a bottle discharge apparatus **280**. Thus, partitions **130**B and **130**C create a second sterilization zone **166** that includes the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162**. A third sterilization zone **172** includes the bottle discharge apparatus **280**. A fourth sterilization zone **165** includes the interior bottle sterilization apparatus **116**. The second sterilization zone **166** provides a highly sterile area where the bottles **12** are filled with a product and sealed. The second sterilization zone **166** is at a higher pressure than the first sterilization zone **164** and the third sterilization zone **172**. Therefore, any gas flow leakage is in the direction from the second sterilization zone **166** out to the first sterilization zone **164** and the third sterilization zone **172**. The first sterilization zone **164** is at a higher pressure than the fourth sterilization zone **165**. Therefore, gas flow is in the direction from the first sterilization zone **164** to the fourth sterilization zone **165**.

The partitions **130**A, **130**B, and **130**C create sterilization zones **164**, **165**, **166**, and **172** with different concentration levels of gas laden sterilant (e.g., hydrogen peroxide in air). The highest concentration level of sterilant is in the fourth sterilization zone **165**. An intermediate concentration level of sterilant is in the first sterilization zone **164**. The lowest concentration level of sterilant is in the second sterilization zone **166**. Advantageously, this helps to maintain the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** at a low sterilant concentration level. This prevents unwanted high levels of sterilant to enter the food product during the filling and lidding process.

Stations **10** through **21** include twelve stations for directing hot sterile air into each bottle **12** for the activation and removal of the sterilant from the interior of the bottle **12**. The sterile air supply system **146** supplies hot sterile air to a plurality of nozzles **150** in the activation and drying apparatus **152**. Hot sterile air is supplied to the sterile air supply system **146** through conduit **148**. The air is first passed through a filtration system to sterilize the air. The air is then heated in a heating system to about 230° F. The air temperature is regulated by the control system **550**. Also, the control system **550** monitors the air pressure and flow rate to ensure that an adequate flow of hot sterile air is maintained in the sterile tunnel **90** of the application and drying apparatus **152**.

As shown in FIG. **8**, each bottle **12** generally has a small opening **16** compared to its height "H." A ratio of a diameter "D" of the bottle **12** to the height "H" of the bottle **12** is generally less than 1.0. The small bottle opening **16** combined with a larger height "H" restricts the flow of hot gas into the interior **118** of the bottle **12**. Also, PET and HDPE bottle materials have low heat resistance temperatures. These temperatures commonly are about 55° C. for PET and about 121° C. for HDPE. Typically, in the aseptic packaging industry, a low volume of air at a high temperature is applied to the packaging materials. This often results in deformation and softening of packaging materials formed of PET and HDPE. In order to prevent softening and deformation of the bottles **12**, when formed from these types of materials, the present invention applies high volumes of air at relatively low temperatures over an extended period of time in the activation and drying apparatus **152**. The plurality of nozzles **150** of the activation and drying apparatus **152** direct hot sterile air into the interior **118** of each bottle **12** (FIG. **11**). A long exposure time is predicated by the geometry of the bottle **12** and the softening temperature of the material used to form the bottle **12**. In the present invention, about 24 seconds are allowed for directing hot sterile air from the plurality of nozzles **150** into each bottle for the activation and removal of sterilant from the interior surface **119** of the bottle **12**. To achieve aseptic sterilization, a minimum bottle temperature of about 131° F. should be held for at least 5 seconds. To achieve this bottle temperature and time requirements, including the time required to heat the bottle, the sterilant is applied for about 1 second and the hot sterile air is introduced for about 24 seconds. The hot sterile air leaves the nozzles **150** at about 230° F. and cools to about 131° F. when it enters the bottle **12**. The hot sterile air is delivered at a high volume so that the bottle **12** is maintained at about 131° F. for at least 5 seconds. The about 24 seconds provides adequate time for the bottle **12** to heat up to about 131° F. and to maintain this temperature for at least 5 seconds. After bottle **12** has dried, the residual hydrogen peroxide remaining on the bottle **12** surface is less than 0.5 PPM.

A foodstuff product is first sterilized to eliminate bacteria in the product. An "Ultra High Temperature" (UHT) pasteurization process is required to meet the aseptic FDA standard. The time and temperature required to meet the aseptic FDA standard depends on the type of foodstuff. For example, milk must be heated to 282° F. for not less than 2 seconds in order to meet the aseptic standards.

After UHT pasteurization, the product is delivered to a main product filler apparatus **160**. The main product filler apparatus is illustrated in FIGS. **3** and **13**. The main product filler **160** can be sterilized and cleaned in place to maintain aseptic FDA and 3A standards. A pressurized reservoir apparatus **180** that can be steam sterilized is included in the main product filler apparatus **160**. As illustrated in FIG. **13**, the pressurized reservoir apparatus **180** includes an enclosed product tank **182** with a large capacity (e.g., 15 gallons). The product tank **182** is able to withstand elevated pressures of about 60 psig or more. The pressurized reservoir apparatus **180** also includes a level sensor **184**, a pressure sensor **186**, a volumetric measuring device **188**, and a filling nozzle **190**. The product tank **182** includes a single inlet with a valve cluster including a sterile barrier to separate the product process system from aseptic surge tanks and the main product filler apparatus **160**. The product tank **182** has an outlet with twelve connections. At each connections is a volumetric measuring device **188** such as a mass or volumetric flow meter. A plurality of filling nozzles **190**A, **190**B are provided at stations **23**, **25**, respectively. In addition, there are a plurality of volumetric measuring devices **188**A and **188**B to measure the volume of product entering each bottle **12** at stations **23** and **25**, respectively. The control system **550** calculates the desired volume of product to be inserted into each bottle **12**, and controls the product volume by opening or closing a plurality of valves **194**A and **194**B. The activation mechanisms for valves **194**A and **194**B have a sterile barrier to prevent contamination of the product. The plurality of valves **194**A control the volume of product

flowing through a corresponding plurality of nozzles **196**A into the bottles **12** at station **23**. The plurality of valves **194**B control the volume of product flowing through a corresponding plurality of nozzles **196**B into the bottles **12** at station **25**. The control system **550** uses the previously stored information provided by the bottle detection apparatus **112** to only allow filling to occur at the locations where bottles **12** are actually present and correctly aligned.

The initial sterilization process for the pressurized reservoir apparatus **180** includes the step of exposing all of the surfaces of the pressurized reservoir apparatus **180** that come in contact with the product to steam at temperatures above about 250° F. for a minimum of about 30 minutes. Elements such as cups **198**A and **198**B are used to block off nozzle outlets **196**A and **196**B respectively, to allow a build-up of steam pressure to about 50 psig inside the pressurized reservoir apparatus **180**. Condensate generated as the steam heats the interior surfaces of the pressurized reservoir apparatus **180** is collected and released from the nozzles **198**A and **198**B. This condensate is released when the cups **198**A and **198**B are removed from the nozzle outlets **196**A and **196**B. Once the interior surfaces of the pressurized reservoir apparatus **180** are sterilized, the steam is shut off, and sterile air is used to replace the steam. The sterile air reduces the interior temperature of the pressurized reservoir apparatus **180** to the temperature of the product before the product is allowed to enter the enclosed product tank **182**. Sterile air is directed through sterile air conduits **142** and **144** into the second sterilization zone **166** at a volume rate of about 800 scfm (FIG. **13**). The sterile air flow entering the second sterilization zone **166** provides sterile air to the main product filler apparatus **160** and to the lid sterilization and heat sealing apparatus **162**.

The main product filler apparatus **160** includes a separate filling position for each bottle. The bottle **12** filling operation is completed for six bottles at station **23** and for six bottles at station **25**.

FIGS. **3** and **13** illustrate the lid sterilization and heat sealing apparatus **162**. A lid **200** is applied to each of the twelve bottles **12** at station **31**. For a fully aseptic bottle filler, complete lid **200** sterilization is necessary, and therefore a sterilant such as hydrogen peroxide is typically used. In the present invention, the lids are formed of a material such as foil or plastic. The lids **200** are joined together by a small interconnecting band that holds them together to form a long connected chain of lids **200**, hereinafter referred to as a "daisy chain" **202**. A daisy chain **202** of lids **200** is placed on each of a plurality of reels **210**. For the twelve bottle configuration of the present invention, six of the reels **210**, each holding a daisy chain **202** of lids **200**, are located on each side of a heat sealing apparatus **214**. Each daisy chain **202** of lids **200** winds off of a corresponding reel **210** and is sterilized, preferably using a hydrogen peroxide bath **204**. A plurality of hot sterile air knives **208**, which are formed by jets of hot sterile air, activate the hydrogen peroxide to sterilize the lids **200** on the daisy chain **202**. The hot sterile air knives **208** also remove the hydrogen peroxide from the lids **200** so that the residual concentration of hydrogen peroxide is less than 0.5 PPM. The hydrogen peroxide bath **204** prevents any contaminants from entering the sterile tunnel **90** via the lidding operation. Once sterilized, the lids **200** enter the sterile tunnel **90** where they are separated from the daisy chain **202** and placed on a bottle **12**. Each lid is slightly larger in diameter then that of the opening **16** of a bottle **12**. During the placement of the lid **200** on the bottle **12**, a slight mechanical crimp of the lid **200** is formed to locate and hold the lid **200** on the bottle **12**. The crimp holds the lid **200** in place on the bottle **12** until the bottle **12** reaches a station **33** for sealing.

At station **33**, the lids **200** are applied to the bottles **12**. The heat sealing apparatus **214** includes a heated platen **216** that applies heat and pressure against each lid **200** for a predetermined length of time, to form a seal between the lid **200** and the bottle **12**. The heated platen **216** is in a two by six configuration to seal twelve of the bottles **12** at a time.

At station **37**, the lid **200** seal and bottle **12** integrity are checked in a known manner by a seal integrity apparatus (not shown) comprising, for example, a bottle squeezing mechanism and a proximity sensor. Each bottle **12** is squeezed by the bottle squeezing mechanism which causes the lid **200** on the bottle **12** to extend upward. The proximity sensor detects if the lid **200** has extended upward, which indicates an acceptable seal, or whether the seal remains flat, which indicates a leaking seal or bottle **12**. The location of the defective bottles **12** are recorded by the control system **550** so that the defective bottles will not be packed.

Bottle discharge from the sterile tunnel **90** of the filler apparatus **50** occurs at stations **38** and **40** as illustrated in FIGS. **3**, **13** and **14**. A bottle discharge apparatus **280** is located at stations **38** and **40**. At this point in the filler apparatus **50**, the filled and sealed bottles **12** are forced in an upward direction such that a top portion **284** of each bottle **12** protrudes through an opening **282** in the sterile tunnel **90** (FIG. **14**). A rotating cam **290** or other suitable means (e.g., an inflatable diaphragm, etc.) may be used to apply a force against the bottom **120** of each bottle **12** to force the bottle **12** in an upward direction.

As illustrated in FIG. **14**, the bottle discharge apparatus **280** comprises a lifting apparatus **286** that includes a gripper **288** that grasps the top portion **284** of each bottle **12** and lifts the bottle **12** out through the opening **282** in the sterile tunnel **90**. In order to ensure that contaminated air cannot enter the sterile tunnel **90**, the sterile air in the sterile tunnel **90** is maintained at a higher pressure than the air outside the sterile tunnel **90**. Thus, sterile air is always flowing out of the sterile tunnel **90** through the opening **282**. In addition, the gripper **288** never enters the sterile tunnel **90**, because the top portion **284** of the bottle **12** is first lifted out of the sterile tunnel **90** by the action of the rotating cam **290** before being grabbed by the gripper **288**.

FIG. **15** illustrates a top view of the filler apparatus **50** including the bottle infeed and sterilization apparatus **60**, the interior bottle sterilization apparatus **116**, and the activation and drying apparatus **152**. FIG. **15** additionally illustrates the main filler apparatus **160**, the lid sterilization and heat sealing apparatus **162**, and the bottle discharge apparatus **280**.

Referring again to FIGS. **1** and **14**, the lifting apparatus **286** lifts the bottles **12** at station **38** and places the bottles **12** in a first lane **292** that transports the bottles **12** to a first capping apparatus **410**. In addition, the lifting apparatus **286** lifts the bottles **12** at station **40** and places the bottles **12** in a second lane **294** that transports the bottles **12** to a second capping apparatus **400**.

The first capping apparatus **410** secures a cap (not shown) on the top of each bottle **12** in the first lane **292**. The second capping apparatus **400** secures a cap on the top of each bottle **12** in the second lane **294**. The caps are secured to the bottles **12** in a manner known in the art. It should be noted that the capping process may be performed outside of the sterile tunnel **90** because each of the bottles **12** have previously been sealed within the sterile tunnel **90** by the lid sterilization and heat sealing apparatus **162** using a sterile lid **200**.

After capping, the bottles **12** are transported via the first and second lanes **292**, **294** to labelers **460** and **470**. The first labeling apparatus **470** applies a label to each bottle **12** in the first lane **292**. The second labeling apparatus **460** applies a label to each bottle **12** in the second lane **294**.

From the first labeling apparatus **470**, the bottles **12** are transported along a first set of multiple lanes (e.g., **4**) to a first case packing apparatus **490**. From the second labeling apparatus **460**, the bottles **12** are transported along a second set of multiple lanes to a second case packing apparatus **480**. Each case packing apparatus **480**, **490** gathers and packs a plurality of the bottles **12** (e.g., twelve) in each case in a suitable (e.g., three by four) matrix.

A first conveyor **296** transports the cases output by the first case packer **490** to a first palletizer **510**. A second conveyor **298** transports the cases output by the second case packer **480** to a second palletizer **500**. A vehicle, such as a fork lift truck, then transports the pallets loaded with the cases of bottles **12** to a storage warehouse.

Referring again to FIG. **3**, the main conveyor **106** and each conveying plate **94** are cleaned and sanitized once during each revolution of the main conveyor **106**. Specifically, after each empty conveying plate **94** passes around the pulley **108**, the conveying plate **94** is passed through a liquid sanitizing apparatus **300** and a drying apparatus **302**. The liquid sanitizing apparatus **300** sprays a mixture of a sterilizing agent (e.g., oxonia, (hydrogen peroxide and peroxyacetic acid)) over the entire surface of each conveying plate **94** and associated components of the main conveyor **106**. In the drying apparatus **302**, heated air is used to dry the main conveyor **106** and conveying plates **94**.

Stations **1** through **40** are enclosed in the sterile tunnel **90**. The sterile tunnel **90** is supplied with air that is pressurized and sterilized. The interior of the sterile tunnel **90** is maintained at a pressure higher than the outside environment in order to eliminate contamination during the bottle processing. In addition, to further ensure a sterile environment within the sterile tunnel **90**, the sterile air supply provides a predetermined number of air changes (e.g., 2.5 changes of air per minute) in the sterile tunnel **90**.

The bottle infeed and sterilization apparatus **60** and the filler apparatus **50** meet the 3A Sanitary Standards of the Sanitary Standards Symbol Administrative Council. The 3A Sanitary Standards ensure that all product contact surfaces can be cleaned and sterilized on a regular basis such as daily. The present invention allows the product contact surfaces to be cleaned-in-place without dismantling the bottle infeed and sterilization apparatus **60** or the filler apparatus **50**. The 3A Sanitary Standards includes requirements such as the material type, the material surface finish, the elastomer selection, the radius of machined parts and the ability of all surfaces to be free draining. For example, the material type is selected from the 300 series of stainless steel and all product contact surfaces have a finish at least as smooth as No. 4 ground finish on stainless steel sheets.

Before bottle production is initiated, the bottle infeed and sterilization apparatus **60** and the filler apparatus **50** are preferably sterilized with an aseptic sterilant. For example, a sterilant such as a hot hydrogen peroxide mist may be applied to all interior surfaces of the bottle infeed and sterilization apparatus **60** and the filler apparatus **50**. Then, hot sterile air is supplied to activate and remove the hydrogen peroxide, and to dry the interior surfaces of the bottle infeed and sterilization apparatus **60** and the filler apparatus **50**.

FIG. **16** is a side view of the aseptic processing apparatus **10** of the present invention indicating the location of the control and monitoring devices that are interfaced with the control system **550**. The control system **550** gathers information and controls process functions in the aseptic processing apparatus **10**. A preferred arrangement of the control and monitoring devices are indicated by encircled letters in FIG. **16**. A functional description of each of the control and monitoring devices is listed below. It should be noted that these control and monitoring devices are only representative of the types of devices that may be used in the aseptic processing apparatus **10** of the present invention. Other types and combinations of control and monitoring devices may be used without departing from the intended scope of the present invention. Further, control system **550** may respond in different ways to the outputs of the control and monitoring devices. For example, the control system **550** may automatically adjust the operational parameters of the various components of the aseptic processing apparatus **10**, may generate and/or log error messages, or may even shut down the entire aseptic processing apparatus **10**. In the preferred embodiment of the present invention, the control and monitoring devices include:

A. A bottle counter to ensure that a predetermined number of the bottles **12** (e.g., six bottles) on each upper horizontal row **24**, **28** enter the loading area of the bottle infeed and sterilization apparatus **60**.

B. A proximity sensor to ensure that the first group of bottles **12** has dropped into the first bottle position in the bottle infeed and sterilization apparatus **60**.

C1. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus **36** is full.

C2. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus **36** is emptied in a predetermined time.

C3. A pressure sensor to ensure that the pressure of the air used by the sterilant application apparatus **36** is within predetermined atomization requirements.

C4. A temperature sensor to ensure that each heat heating element used by the sterilant application apparatus **36** is heated to the correct temperature.

D. A proximity sensor (e.g., proximity sensor **71**, FIG. **3**) to ensure that a bottle jam has not occurred within the bottle infeed and sterilization apparatus **60**.

E. A temperature sensor to ensure that the temperature of the heated sterile air entering the bottle infeed and sterilization apparatus **60** is correct.

F. A proximity sensor that to ensure that each conveying plate **94** is fully loaded with bottles **12**.

G1. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus **116** is full.

G2. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus **116** is emptied in a predetermined time.

G3. A pressure sensor to ensure that the pressure of the air used by the interior bottle sterilization apparatus **116** is within predetermined atomization requirements.

G4. A temperature sensor to ensure that each heat heating element used by the interior bottle sterilization apparatus **116** is heated to the correct temperature.

H. A temperature sensor to ensure that the air drying temperature within the activation and drying apparatus **152** is correct.

I. A plurality of flow sensors to ensure that the airflow rate of the sterile air entering the sterile tunnel **90** is correct.

J. A pressure sensor to ensure that the pressure of the sterile air entering the activation and drying apparatus **152** is correct.

K. A measuring device (e.g., volumetric measuring device **188**, FIG. **3**) to ensure that each bottle **12** is filled to a predetermined level.

L. A pressure sensor to ensure that the pressure in the product tank **182** is above a predetermined level.

M. A level sensor to ensure that the level of product in the product tank **182** is maintained at a predetermined level.

N. Proximity sensors to ensure that the daisy chains **202** of lids **200** are present in the lid sterilization and heat sealing apparatus **162**

O. A level sensor to ensure that the hydrogen peroxide level in the hydrogen peroxide bath **204** in the lid sterilization and heat sealing apparatus **162** is above a predetermined level.

P. A temperature sensor to ensure that the temperature of the hot sterile air knives **208** of the lid sterilization and heat sealing apparatus **162** is correct.

Q. A temperature sensor to ensure that the heat sealing apparatus **214** is operating at the correct temperature.

R. Proximity sensors to ensure that the bottles **12** are discharged from the filler.

S. A speed sensor to measure the speed of the conveying apparatus **100**.

T. A concentration sensor to ensure that the concentration of oxonia is maintained at a predetermined level in the sanitizing apparatus **300**.

U. A pressure sensor to ensure that the pressure of the oxonia is maintained above a predetermined level in the sanitizing apparatus **300**.

V. A temperature sensor to ensure that the drying temperature of the drying apparatus **302** is correct.

The foregoing description of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and many modifications and variations are possible in light of the above teaching. Such modifications and variations that may be apparent to a person skilled in the art are intended to be included within the scope of this invention defined by the accompanying claims.

I claim:

1. A method for automatically aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the bottles at a rate greater than 100 bottles per minute wherein the disinfecting is with hot atomized hydrogen peroxide, wherein said plurality of bottles are in an upright position during disinfecting; and

aseptically filling the bottles with aseptically sterilized foodstuffs.

2. The method according to claim **1**, wherein the aseptically disinfecting the bottles includes an application of the hot hydrogen peroxide spray for about 1 second into an interior of the bottle and an activation and removal of the hot hydrogen peroxide using hot aseptically sterilized air for about 24 seconds.

3. The method according to claim **1**, wherein the aseptically disinfecting the bottles includes an application of the hot hydrogen peroxide spray for about 1 second onto an outside surface of the bottle and an activation and removal of the hot hydrogen peroxide using hot aseptically sterilized air for about 24 seconds.

4. The method according to claim **1**, wherein the plurality of bottles are made from a glass.

5. The method according to claim **1**, wherein the plurality of bottles are made from a plastic.

6. The method according to claim **5**, wherein the plastic is selected from the group: polyethyelene terepthatlate, and high density polyethylene.

7. The method according to claim **1**, wherein the aseptic filling is at a rate greater than 100 bottles per minute.

8. The method according to claim **1**, further including capping the bottle with a aseptically disinfected lid.

9. The method according to claim **1**, further including a feedback control system for maintaining aseptic bottling conditions.

10. The method according to claim **1**, wherein the step of aseptically filling the bottles further comprises: filling the aseptically disinfected bottling at a rate greater then 360 bottles per minute.

11. The method according to claim **1**, wherein the aseptically sterilized foodstuffs are not a beverage.

12. The method according to claim **1**, wherein the plurality of bottles are made from one of glass and plastic.

13. The method according to claim **1**, wherein the aseptic filling is at a rate greater than 100 bottles per minute.

14. The method according to claim **1**, wherein the disinfecting the bottles is with hot hydrogen peroxide spray.

15. The method according to claim **14**, wherein the aseptically disinfecting the bottles includes an application of the hot hydrogen peroxide spray into an interior of the bottle and an activation and removal of the hot hydrogen peroxide using hot aseptically sterilized air.

16. The method according to claim **1**, wherein the step of aseptically filling the bottles further comprises: filling the aseptically disinfected bottling at a rate greater than 360 bottles per minute.

17. The method according to claim **1**, wherein aseptically denotes meeting the United States FDA level of aseptic.

18. A method for automatically aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the bottles at a rate greater than 100 bottles per minute; and

aseptically filling the bottles with aseptically sterilized foodstuffs, wherein the aseptically sterilized foodstuffs are sterilized to a level producing at least a 12 log reduction in *Clostridium, botulinum*.

19. A method for automatically aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the bottles at a rate greater than 100 bottles per minute, wherein the aseptically disinfected plurality of bottles are sterilized to a level producing at least a 6 log reduction in spore organism; and

aseptically filling the bottles with aseptically sterilized foodstuffs.

20. A method for automatically aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the bottles at a rate greater than 100 bottles per minute, wherein the disinfecting the bottles is with hot hydrogen peroxide spray, wherein a residual level of hydrogen peroxide is less than 0.5 PPM; and

aseptically filling the bottles with aseptically sterilized foodstuffs.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,945,013 B2
DATED : September 20, 2005
INVENTOR(S) : Taggart

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 4,
Line 40, delete "*subtilis var. globigii*" and insert -- *subtilis var. globigii* --.

Column 16,
Line 41, delete "*Clostridium, botulinum*" and insert -- *Clostridium botulinum* --.
Line 48, delete "organism" and insert -- organisms --.

Signed and Sealed this

Tenth Day of January, 2006

JON W. DUDAS
Director of the United States Patent and Trademark Office

Exhibit B

US006536188B1

(12) **United States Patent**
Taggart

(10) **Patent No.: US 6,536,188 B1**
(45) **Date of Patent: Mar. 25, 2003**

(54) **METHOD AND APPARATUS FOR ASEPTIC PACKAGING**

(75) Inventor: **Thomas D. Taggart**, South Wales, NY (US)

(73) Assignee: **Steuben Foods, Inc.**, Elma, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 205 days.

(21) Appl. No.: **09/306,552**

(22) Filed: **May 6, 1999**

Related U.S. Application Data

(60) Provisional application No. 60/118,404, filed on Feb. 2, 1999.

(51) **Int. Cl.**[7] **B65B 55/02**

(52) **U.S. Cl.** **53/425**; 53/426; 53/79; 141/1; 141/4; 422/24; 422/29

(58) **Field of Search** 53/426, 425, 403, 53/405, 79; 141/1, 4, 64, 236; 422/29, 24, 302, 28, 292

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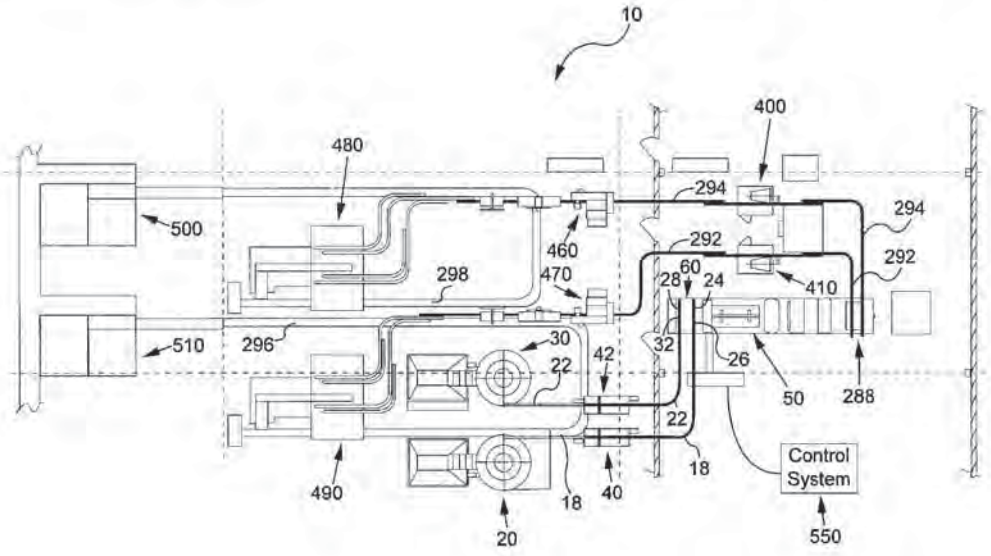
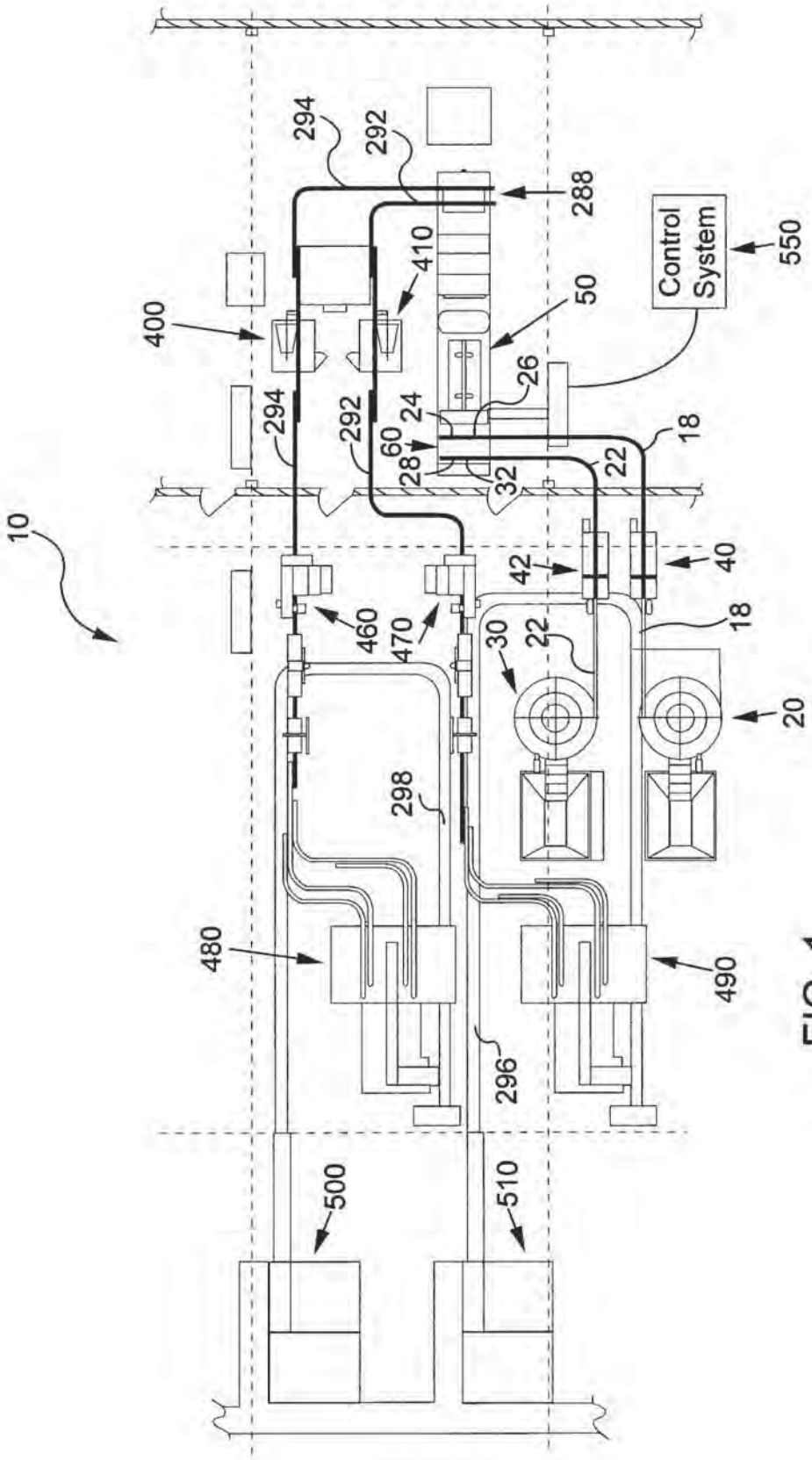
Primary Examiner—Eugene Kim
Assistant Examiner—Sameh Tawfik
(74) *Attorney, Agent, or Firm*—Schmeiser, Olsen & Watts

(57) **ABSTRACT**

A method and apparatus for providing aseptically processed low acid products in a container having a small opening, such as a glass or plastic bottle or jar, at a high output processing speed.

20 Claims, 14 Drawing Sheets

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292
288
410
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550
400
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292
24
60
28
32
22
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42
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460
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298
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296
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510

FIG. 1

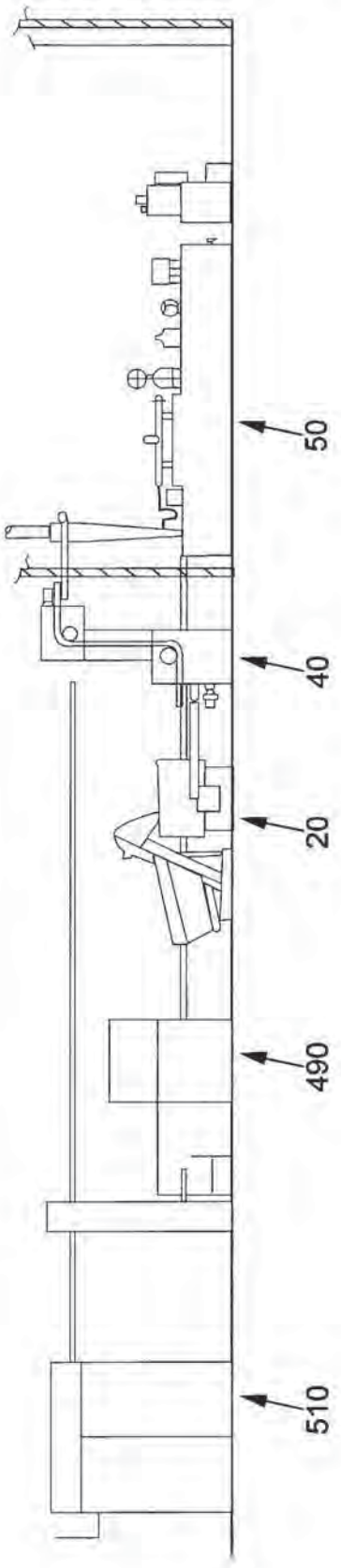
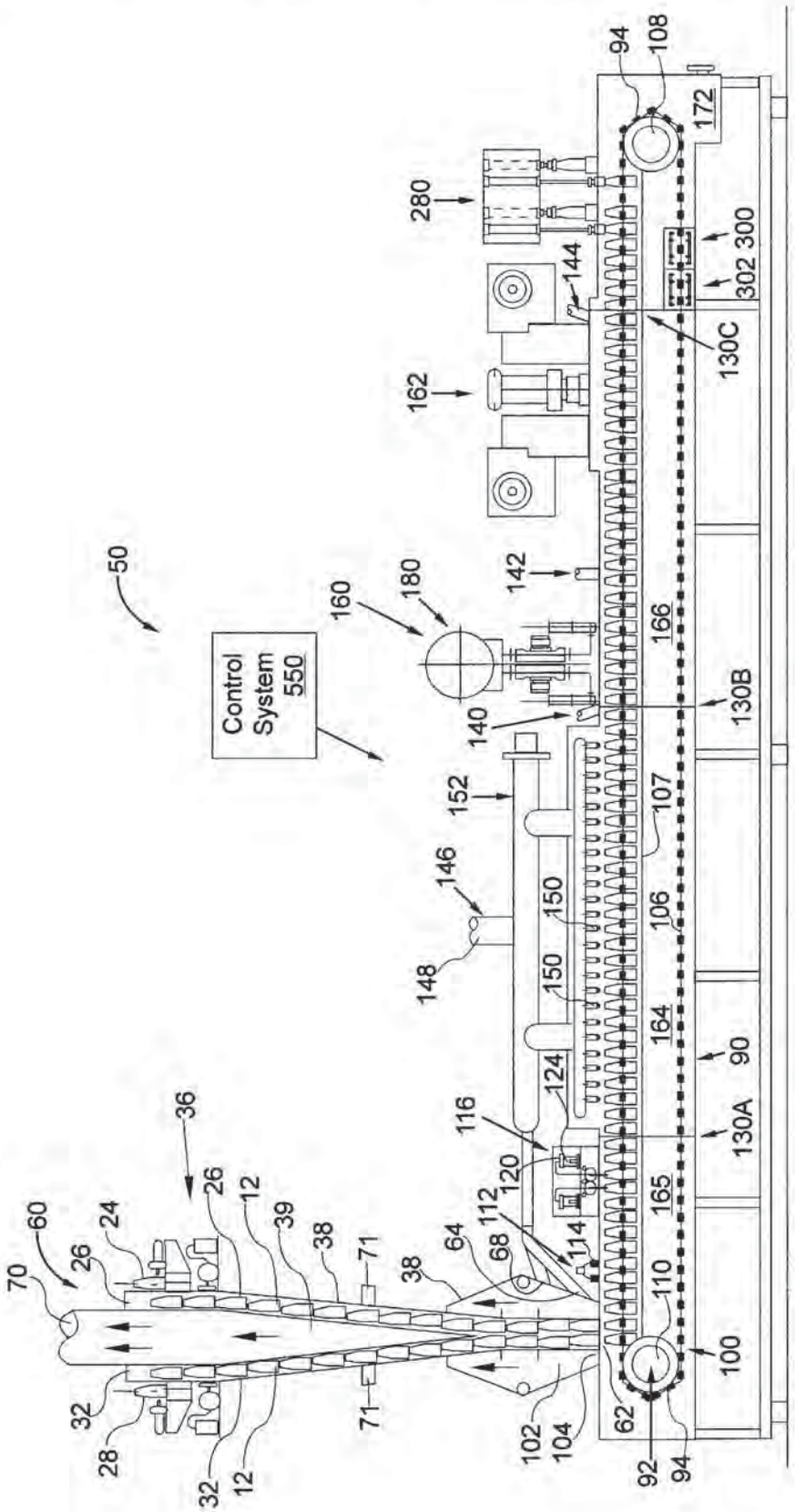


FIG. 2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116
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150
152
160
162
180
140
142
144
280
94
108
172
300
302
130C
130B
130A
166
107
106
164
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90
110
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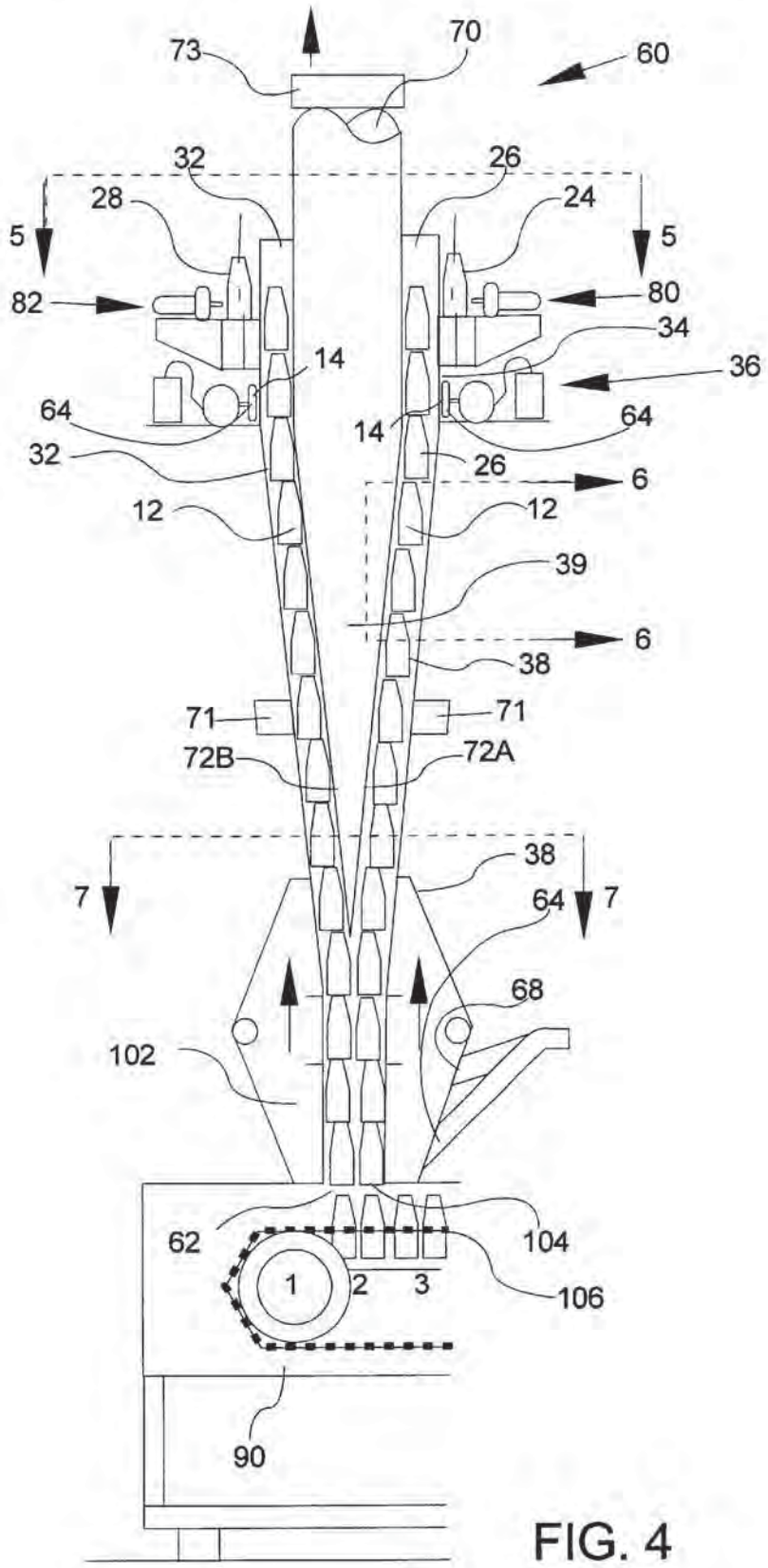
62
92
102
104

FIG. 3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39
6
38
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102
62
104
1
2
3
106
90

FIG. 4

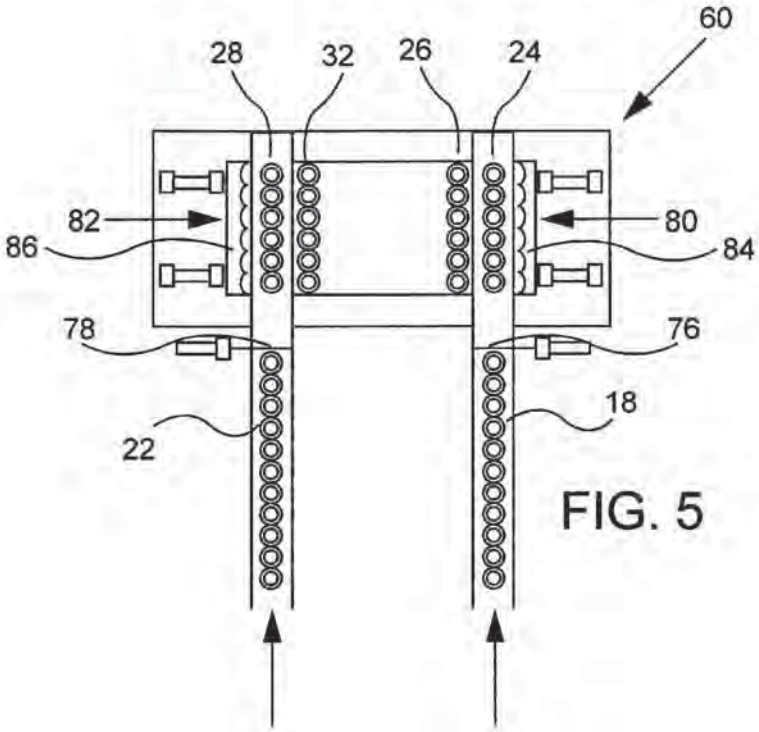


FIG. 5

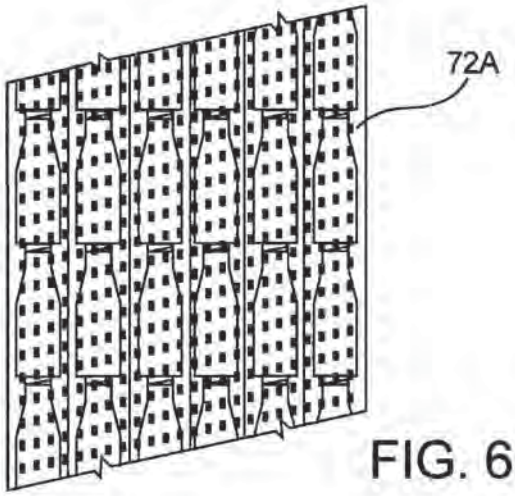


FIG. 6

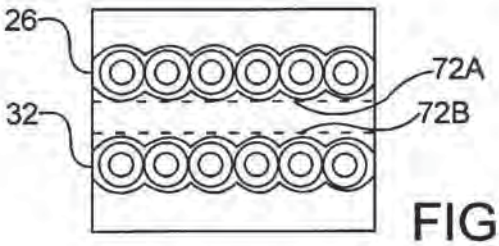


FIG. 7

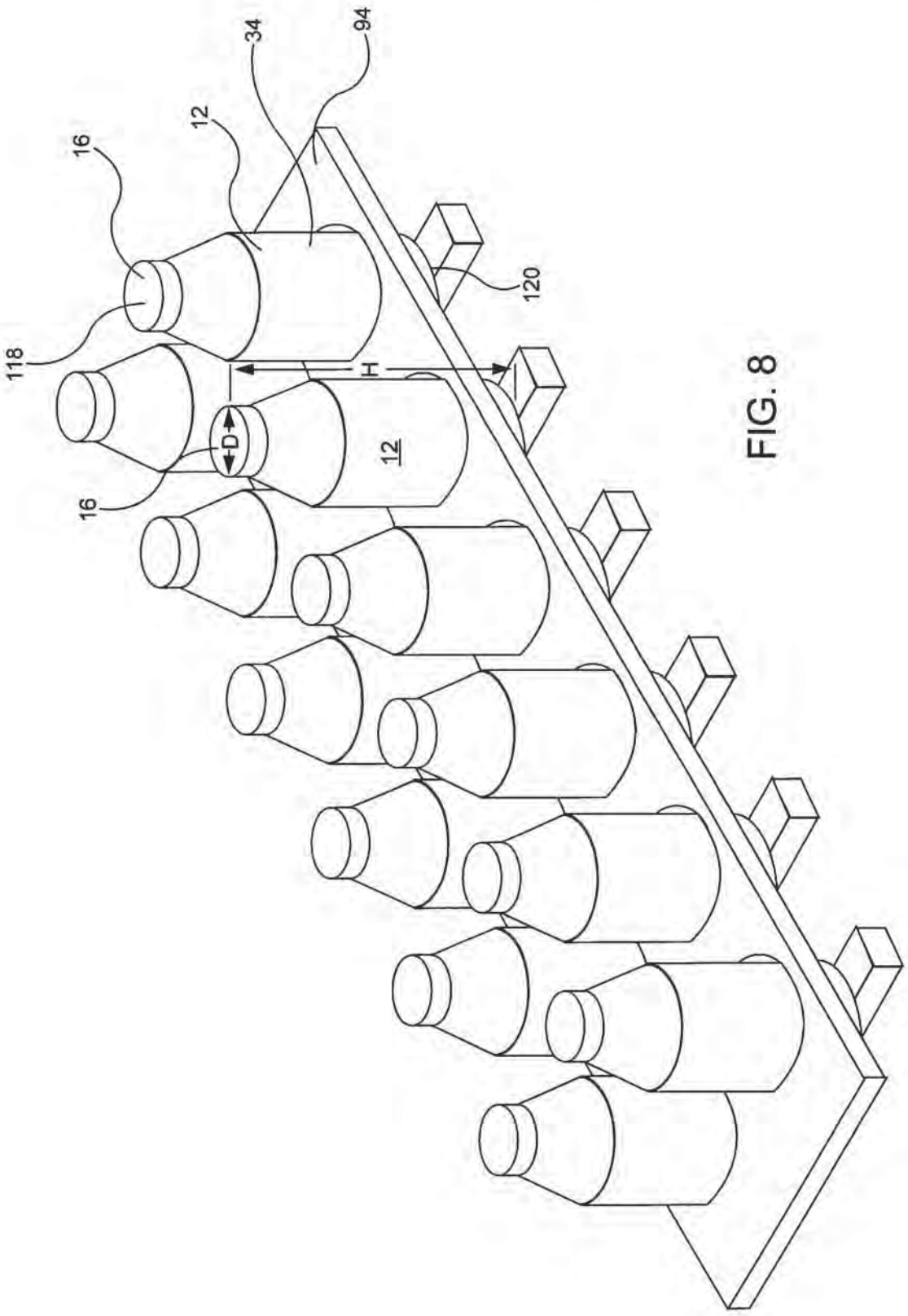


FIG. 8

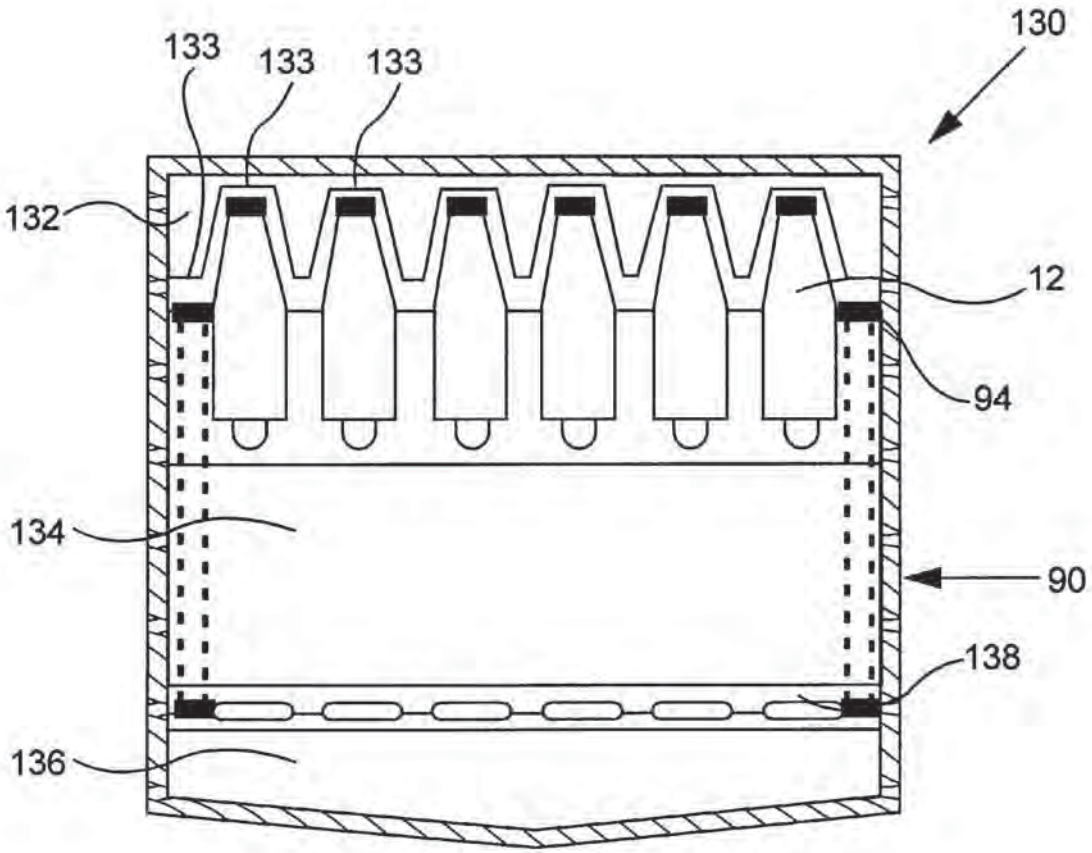
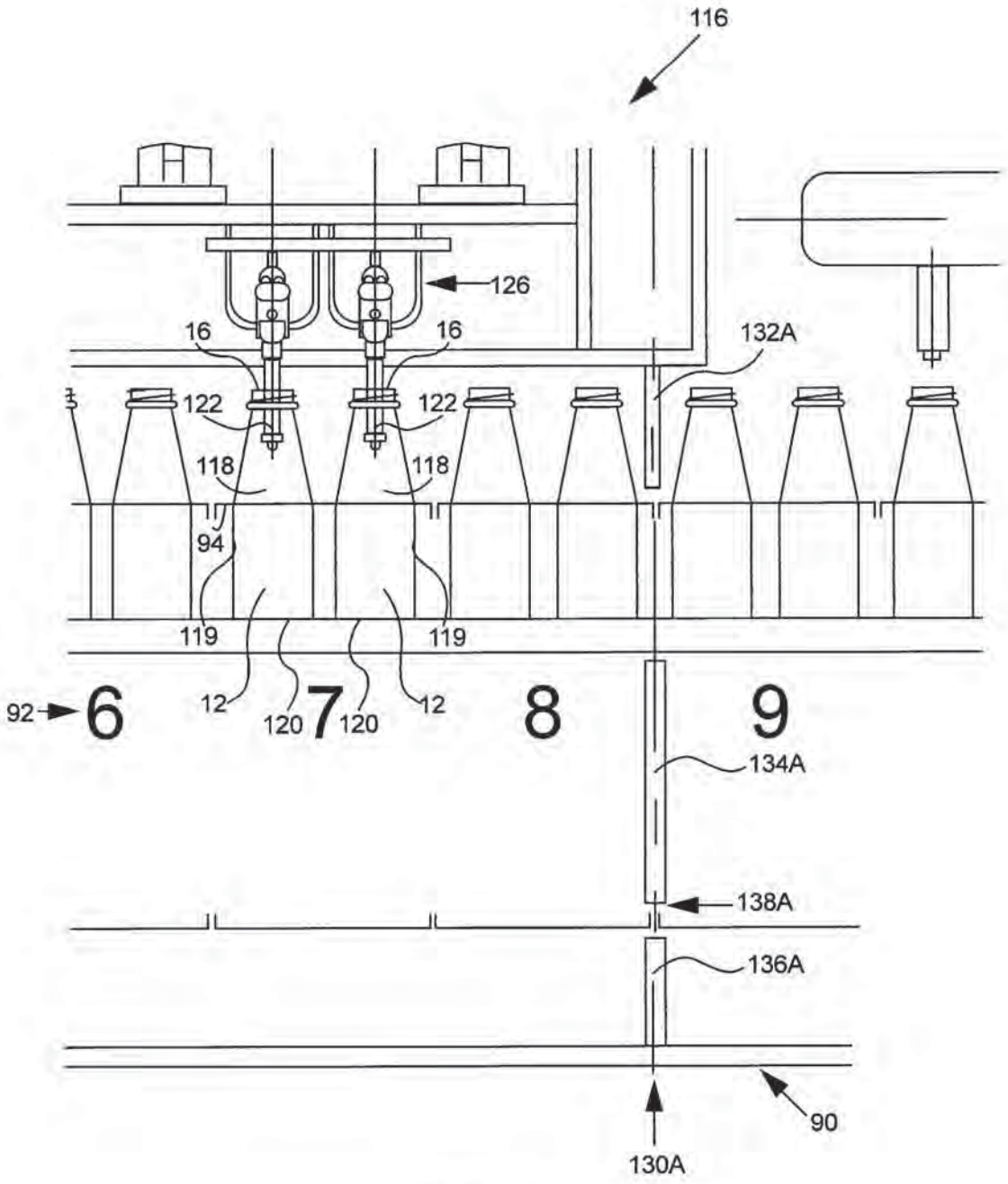


FIG. 9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126
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132A
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134A
138A
136A
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130A

FIG. 10

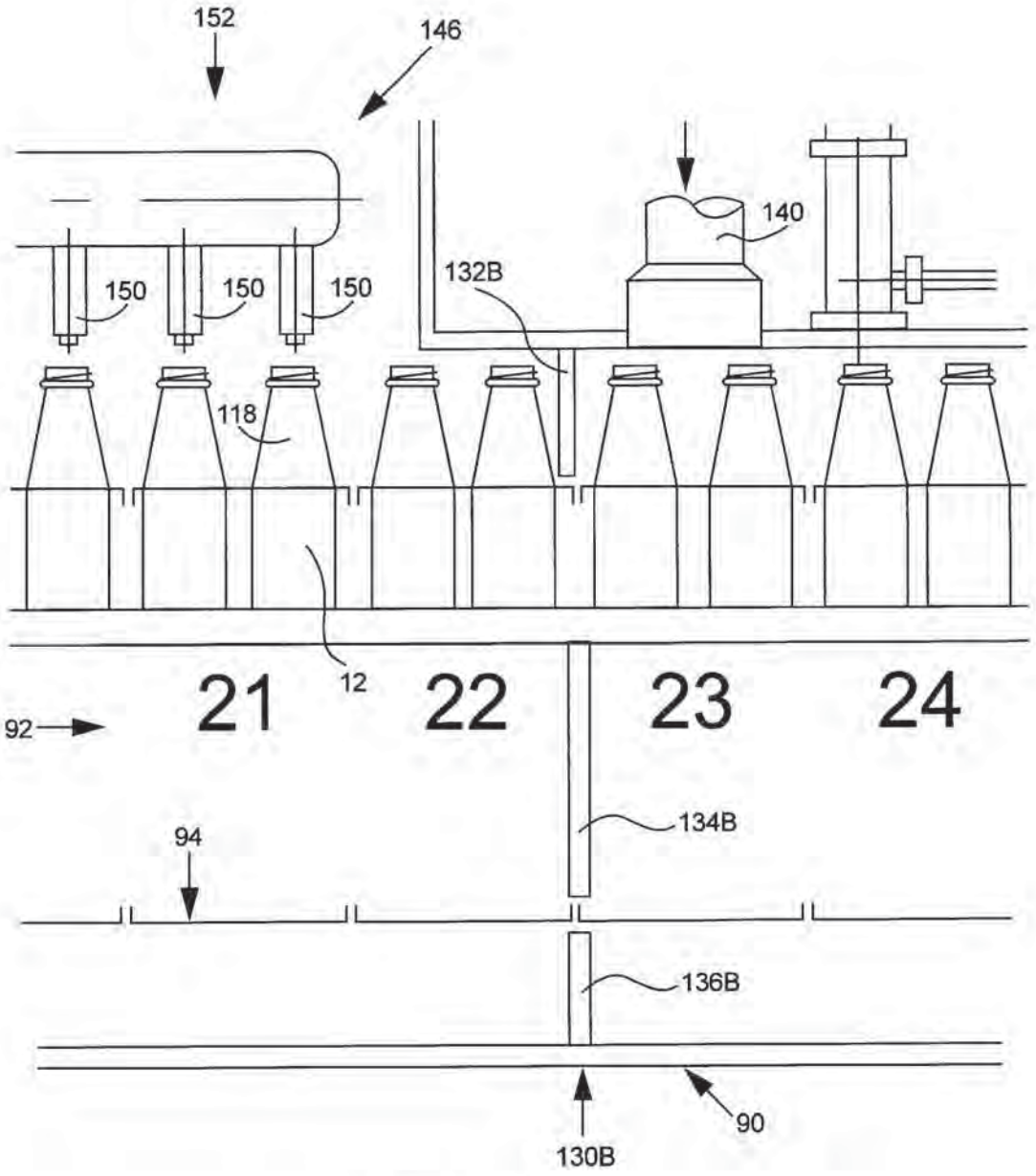
152
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FIG. 11

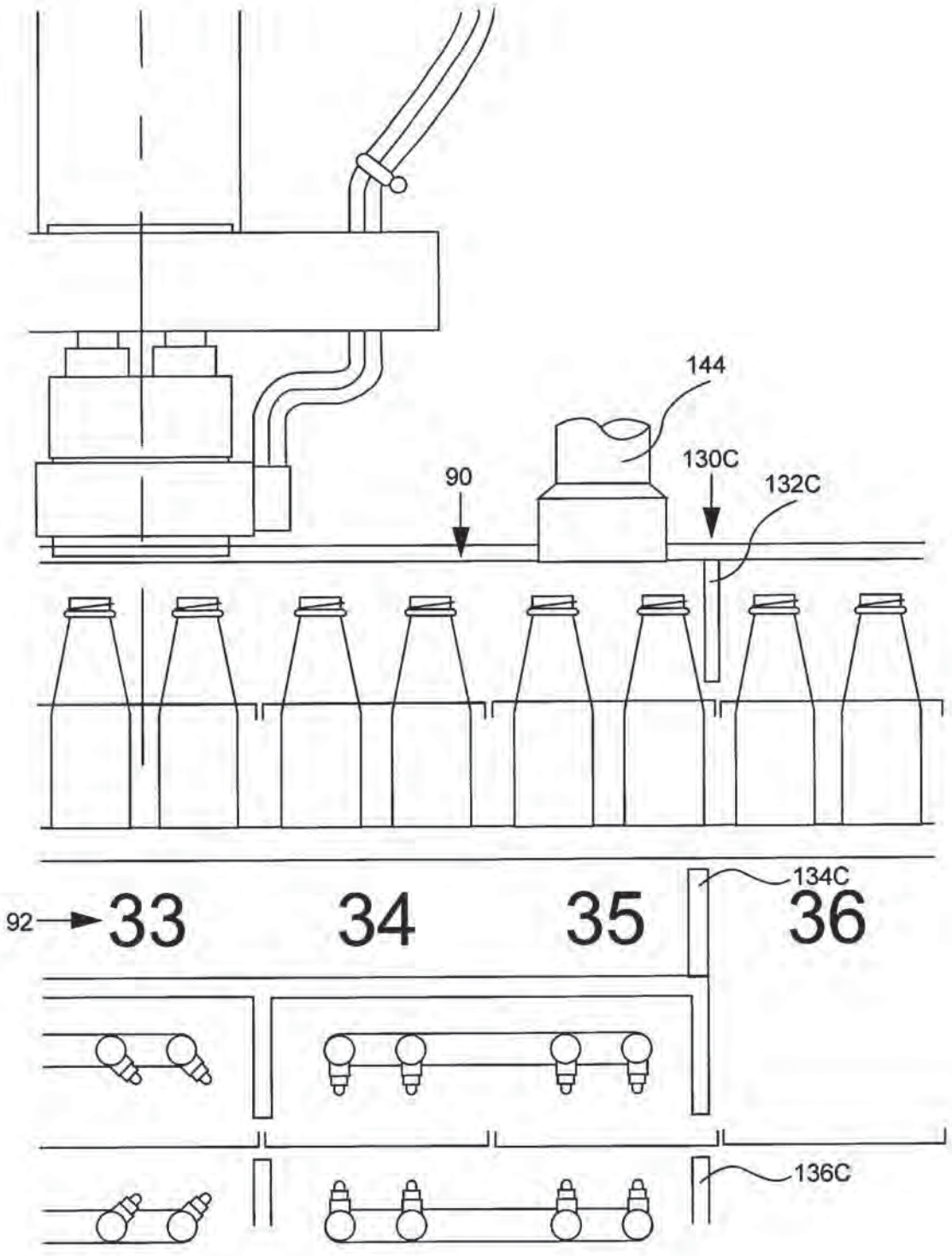
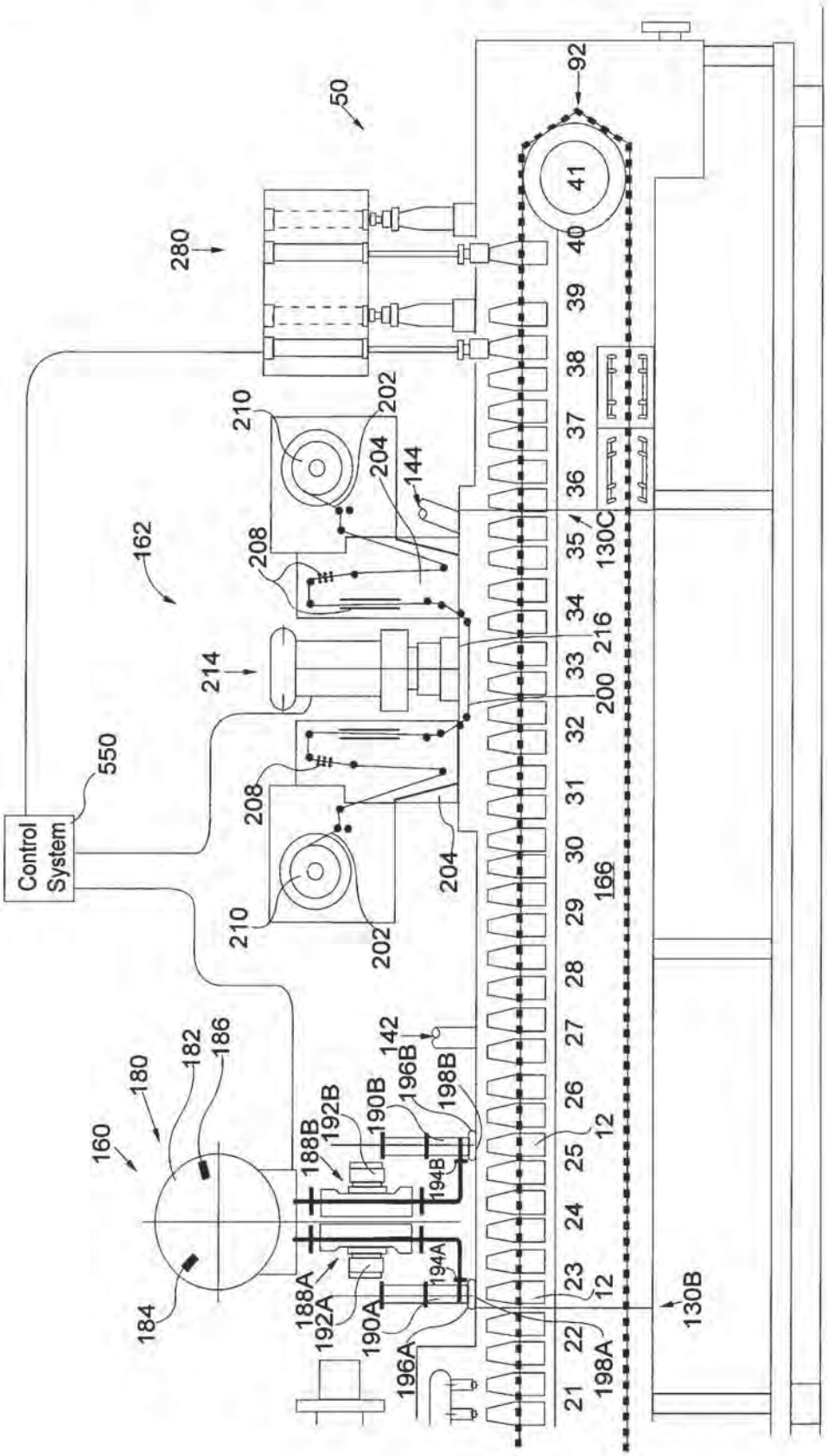


FIG. 12


Control System
550
50
92
41
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130C
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23
22
21
12
130B
280
162
214
210
202
204
144
208
216
200
166
142
160
180
182
186
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188A
192A
190A
196A
194A
198A

FIG. 13

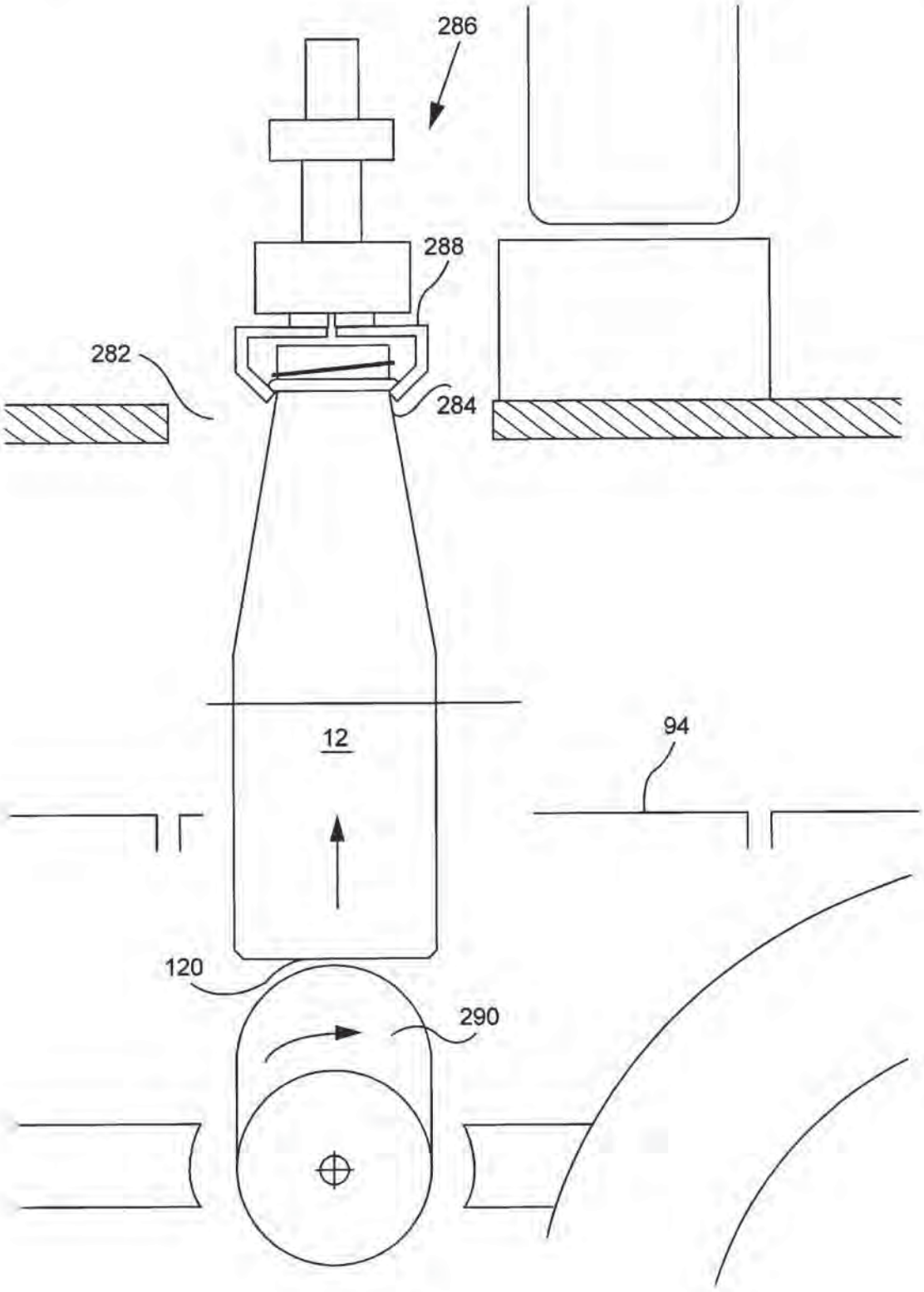


FIG. 14

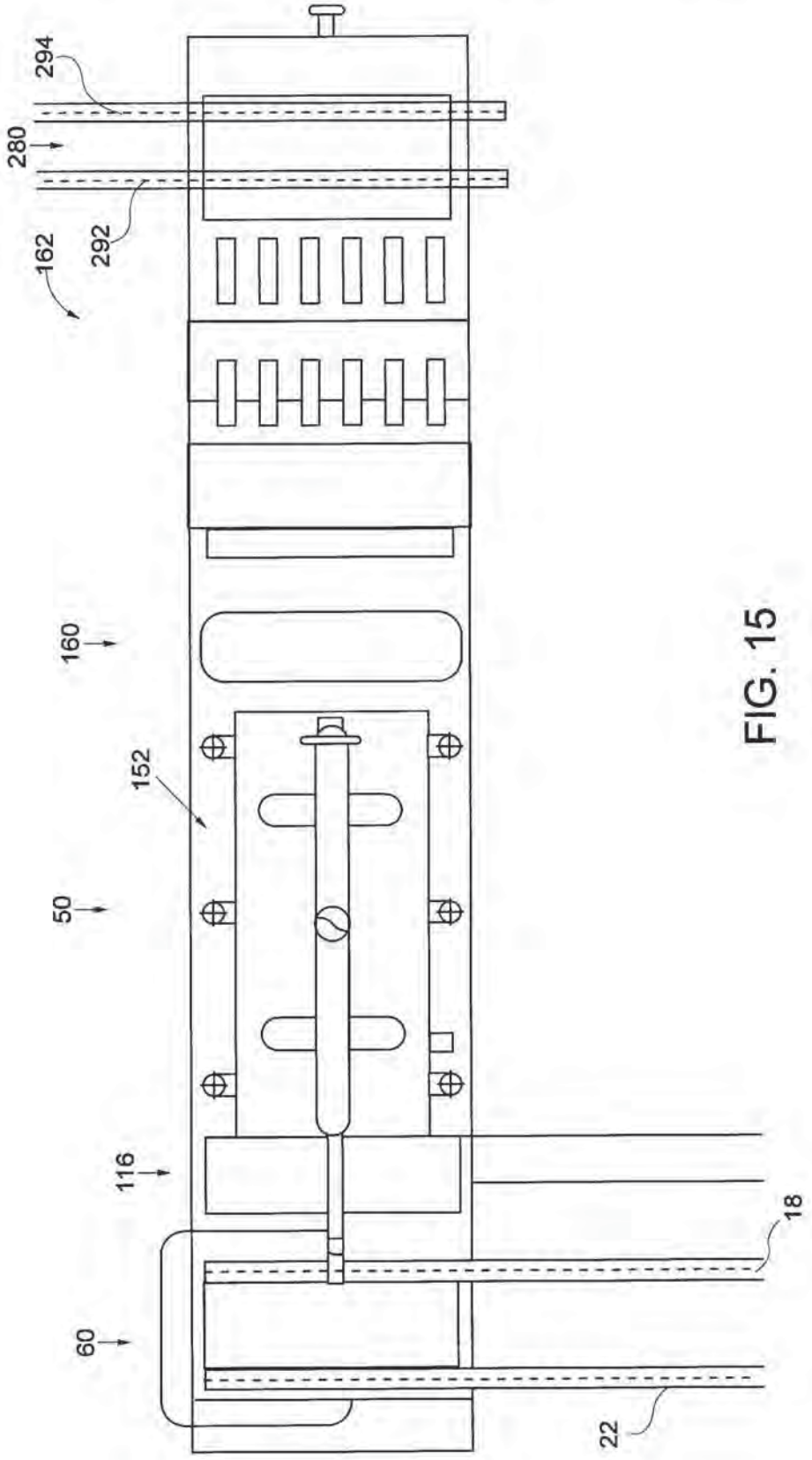
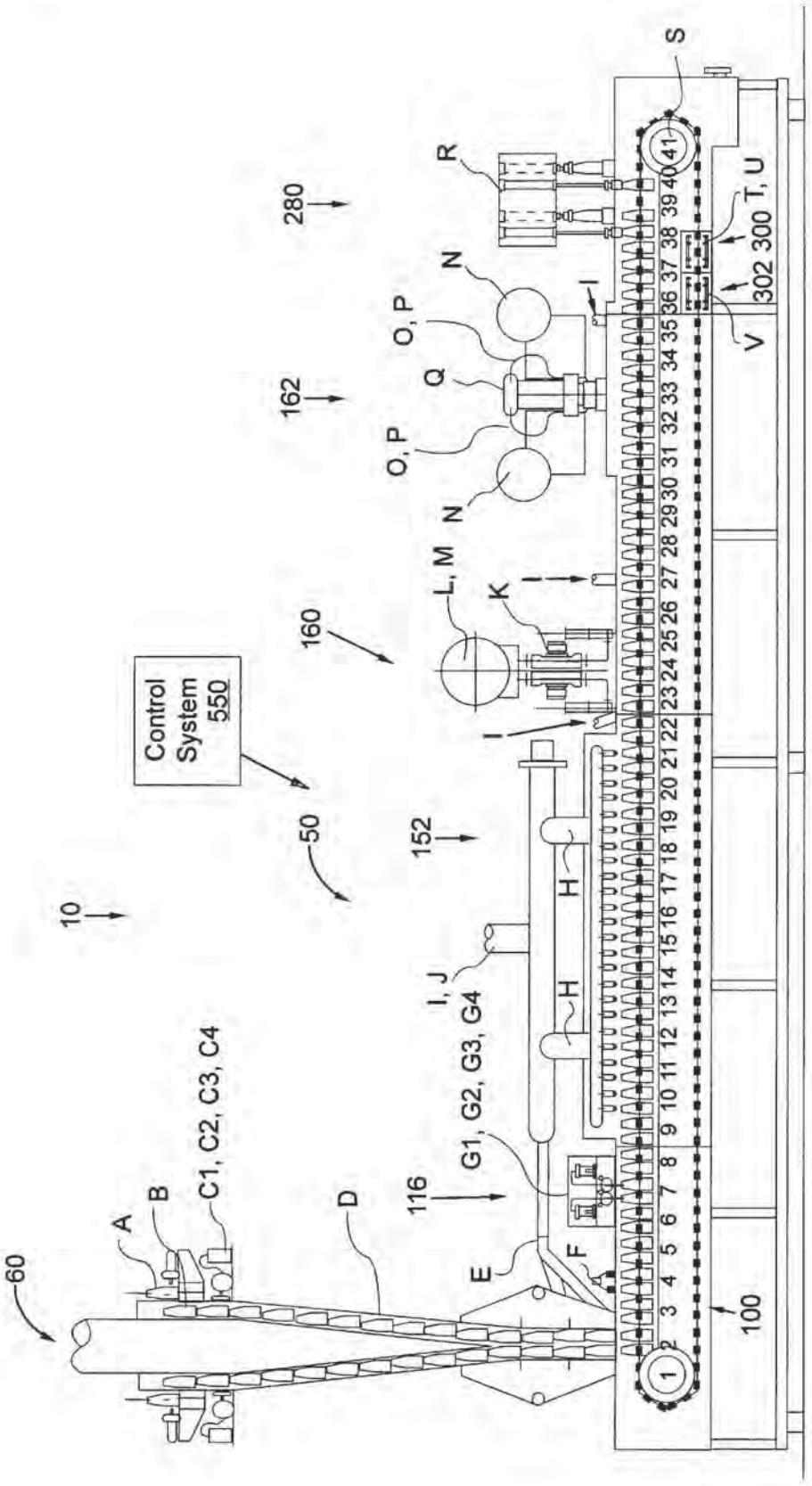


FIG. 15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D
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H
I, J
I
K
L, M
N
O, P
Q
O, P
N
R
S
T, U
V
300
302
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41

FIG. 16

METHOD AND APPARATUS FOR ASEPTIC PACKAGING

This application claims the benefit of Provisional Application No. 60/118,404, filed Feb. 2, 1999.

FIELD OF THE INVENTION

The present invention relates generally to systems for the aseptic packaging of food products. More particularly, the present invention relates to an aseptic packaging system for the aseptic packaging of food products in containers such as bottles or jars.

BACKGROUND OF THE INVENTION

Sterilized packaging systems in which a sterile food product is placed and sealed in a container to preserve the product for later use are well known in the art. Methods of sterilizing incoming containers, filling the containers with pasteurized product, and sealing the containers in an aseptic tunnel are also known.

Packaged food products can generally be categorized as high acid products (Ph below 4.5) or low acid products (Ph of 4.5 and above). The high acid content of a high acid product helps to reduce bacteria growth in the product, thereby increasing the shelf life of the product. The low acid content of a low acid product, however, necessitates the use of more stringent packaging techniques, and often requires refrigeration of the product at the point of sale.

Several packaging techniques, including extended shelf life (ESL) and aseptic packaging, have been developed to increase the shelf life of low acid products. During ESL packaging, for example, the packaging material is commonly sanitized and filled with a product in a presterilized tunnel under "ultra-clean" conditions. By using such ESL packaging techniques, the shelf life of an ESL packaged product is commonly extended from about 10 to 15 days to about 90 days. Aseptic packaging techniques, however, which require that the packaging take place in a sterile environment, using presterilized containers, etc., are capable of providing a packaged product having an even longer shelf life of 150 days or more. In fact, with aseptic packaging, the shelf life limitation is often determined by the quality of the taste of the packaged product, rather than by a limitation caused by bacterial growth.

For the aseptic packaging of food products, an aseptic filler must, for example, use an FDA (Food and Drug Administration) approved sterilant, meet FDA quality control standards, use a sterile tunnel or clean room, and must aseptically treat all packaging material. The food product must also be processed using an "Ultra High Temperature" (UHT) pasteurization process to meet FDA aseptic standards. The packaging material must remain in a sterile environment during filling, closure, and sealing operations.

Many attempts have been made, albeit unsuccessfully, to aseptically fill containers, such as bottles or jars having small openings, at a high output processing speed. In addition, previous attempts for aseptically packaging a low acid product in plastic bottles or jars (e.g., formed of polyethylene terepthalate (PET) or high density polyethylene (HDPE)), at a high output processing speed, have also failed. Furthermore, the prior art has not been successful in providing a high output aseptic filler that complies with the stringent United States FDA standards for labeling a packaged product as "aseptic." In the following description of the present invention, the term "aseptic" denotes the United States FDA level of aseptic.

SUMMARY OF THE INVENTION

In order to overcome the above deficiencies, the present invention provides a method and apparatus for providing aseptically processed low acid products in a container having a small opening, such as a glass or plastic bottle or jar, at a high output processing speed.

Many features are incorporated into the aseptic processing apparatus of the present invention in order to meet the various United States FDA aseptic standards and the 3A Sanitary Standards and Accepted Practices.

The aseptic processing apparatus of the present invention uses filtered air to maintain a positive pressure within a filler apparatus. The filler apparatus includes a sterile tunnel that is pressurized to a level greater than atomospheric pressure using filtered sterile air. The filler apparatus includes three interfaces with the ambient environment, each of which eliminates the possibility of external contamination. The first interface is where containers first enter the sterile tunnel through a bottle infeed and sterilization apparatus. In accordance with the present invention, there is always an outflow of aseptic sterilant (e.g., hydrogen peroxide) enriched sterile air from the first interface to prevent contaminants from entering the sterile tunnel. The second interface with the sterile tunnel is the path where incoming lid stock enters a lid sealing and heat sealing apparatus. To prevent contamination, the lid stock passes through a hydrogen peroxide bath that provides an aseptic barrier for any contaminants that enter the sterile tunnel through the second interface. The third interface with the sterile tunnel is at an exit opening of a discharge apparatus where sealed containers leave the sterile tunnel. Positive sterile air pressure within the sterile tunnel ensures that sterile air is continuously flowing out of the exit opening of the discharge apparatus, thereby preventing contaminants from entering the sterile tunnel through this interface.

The aseptic processing apparatus includes a conveying apparatus for transporting the containers through a plurality of processing stations located within the sterile tunnel. The entire conveying apparatus is enclosed within the sterile tunnel, and is never is exposed to unsterile conditions.

The interior surface of a container such as a bottle or jar is much more difficult to aseptically sterilize than the interior surface of a cup. A cup generally has a large opening compared to its height, whereas a bottle or jar generally has a small opening compared to its height and its greatest width (e.g., the ratio of the opening diameter to the height of the container is less than 1.0). A sterilant can be introduced, activated, and removed in a cup much more rapidly than in a bottle or jar. The processing speed when using a bottle or jar is limited, in part, by the time required to aseptically sterilize the interior surface of the bottle or jar. The aseptic processing apparatus of the present invention overcomes the processing speed limitations associated with the use of containers such as bottles or jars.

A high output processing speed is achieved in the present invention by applying a hot atomized sterilant, such as a hydrogen peroxide spray onto the interior surface of each container, and by subsequently activating and removing the sterilant in a plurality of drying stations using hot sterile air. For example hydrogen peroxide breaks down into water and oxygen, and thus oxidizes and kills bacteria within the container. To achieve aseptic sterilization, a minimum container temperature is developed and held for a predetermined period of time (e.g., 131° F. for 5 seconds) after application of the sterilant. Hot sterile air is delivered at a high volume and a relatively low temperature to dry the container and to

prevent the container (if formed of plastic) from being heated to its softening temperature. After container drying, the residual hydrogen peroxide in the container is below a predetermined level (e.g., about 0.5 PPM (parts per million)).

The present invention generally provides a method for aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the plurality of bottles;

aseptically filling the aseptically disinfected plurality of bottles with the aseptically sterilized foodstuffs; and

filling the aseptically disinfected plurality of bottles at a rate greater than 100 bottles per minute.

The present invention additionally provides a method for aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the bottles at a rate greater than 100 bottles per minute; and

aseptically filling the bottles with aseptically sterilized foodstuffs.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention will best be understood from a detailed description of the invention and a preferred embodiment, thereof selected for the purposes of illustration, and shown in the accompanying drawings in which:

FIG. **1** is a plan view of an aseptic processing apparatus in accordance with a preferred embodiment of the present invention;

FIG. **2** is a side view of the aseptic processing apparatus of FIG. **1**;

FIG. **3** is a partial cross-sectional side view of the aseptic processing apparatus of FIG. **1**;

FIG. **4** is a cross-sectional side view of a bottle infeed and sterilization apparatus;

FIG. **5** illustrates a cross-sectional top view of the bottle infeed and sterilization apparatus taken along line **5**—**5** of FIG. **4**;

FIG. **6** is an interior sectional view of an interior wall taken along line **6**—**6** of FIG. **4**;

FIG. **7** is a cross-sectional view of the bottle infeed and sterilization apparatus taken along line **7**—**7** of FIG. **4**;

FIG. **8** is a perspective view of a conveying plate for use in the aseptic processing apparatus of the present invention;

FIG. **9** is a perspective view of a partition in a sterile tunnel;

FIG. **10** is a cross-sectional side view of an interior bottle sterilization apparatus and the partition located between stations **8** and **9**;

FIG. **11** is a cross-sectional side view of the partition located between stations **22** and **23**;.

FIG. **12** is a cross-sectional side view of the partition located between stations **35** and **36**;

FIG. **13** is a cross-sectional side view of a lid sterilization and heat sealing apparatus;

FIG. **14** is a side view of a lifting apparatus with a gripper mechanism for lifting the bottles from the sterile tunnel;

FIG. **15** is a top view of the aseptic processing apparatus; and

FIG. **16** is a side view of the aseptic processing apparatus indicating the control and monitoring locations that are interfaced with a control system.

DETAILED DESCRIPTION OF THE INVENTION

Although certain preferred embodiments of the present invention will be shown and described in detail, it should be understood that various changes and modifications may be made without departing from the scope of the appended claims. The scope of the present invention will in no way be limited to the number of constituting components, the materials thereof, the shapes thereof, the relative arrangement thereof, etc., and are disclosed simply as an example of the preferred embodiment. The features and advantages of the present invention are illustrated in detail in the accompanying drawings, wherein like reference numerals refer to like elements throughout the drawings. Although the drawings are intended to illustrate the present invention, the drawings are not necessarily drawn to scale.

The present invention provides an aseptic processing apparatus **10** that will meet the stringent FDA (Food and Drug Administration) requirements and 3A Sanitary Standards and Accepted Practices required to label a food product (foodstuffs) as "aseptic". Hereafter, "aseptic" will refer to the FDA level of aseptic. The present invention provides a method and apparatus for producing at least about a 12 log reduction of *Clostridium botulinum* in food products. In addition, the present invention produces packaging material with at least about a 6 log reduction of spores. Actual testing of the aseptic processing apparatus is accomplished with spore test organisms. These test organisms are selected on their resistance to the media selected used to achieve sterility. For example, when steam is the media, the test organism is *Bacillus stearothermophilus*. When hydrogen peroxide is the media, then the test organism is *Bacillus subtilis* var. *globigii*.

The present invention processes containers such as bottles or jars that have a small opening compared to its height and its greatest width (e.g., the ratio of the opening diameter to the height of the container is less than 1.0). In the preferred embodiment, a bottle **12** (see, e.g., FIG. **8**) is illustrated as the container. The container may alternately comprise a jar. The bottle **12** is preferably formed of a plastic such as polyethylene terepthalate (PET) or high density polyethylene (HDPE), although other materials such as glass may also be used. The present invention uses an aseptic sterilant such as hydrogen peroxide (H_2O_2) or oxonia to sterilize the bottles **12**. In the preferred embodiment of the present invention, hydrogen peroxide is used as the sterilant. The present invention uses hydrogen peroxide with a concentration of less than about 35% and ensures that the bottles **12** have less than about 0.5 ppm of residual hydrogen peroxide after each bottle **12** is sterilized.

FIGS. **1**–**3** illustrate several views of an aseptic processing apparatus **10** in accordance with a preferred embodiment of the present invention. As shown, the aseptic processing apparatus **10** includes a first bottle unscrambler **20**, a second bottle unscramble **30**, and a bottle lifter **40** for providing a supply of properly oriented empty bottles. The empty bottles are delivered to a filler apparatus **50** after passing through a bottle infeed and sterilization apparatus **60** for aseptic sterilization. The filled bottles are sealed at a first capping apparatus **400** or a second capping apparatus **410**. A control system **550** monitors and controls the operation of the aseptic processing apparatus **10**. The filled and sealed bottles

are packed and palletized using a first case packing apparatus **480**, a second case packing apparatus **490**, a first palletizer **500**, and a second palletizer **510**.

The bottles **12** arrive at a first bottle unscrambler **20** with a random orientation, such that an opening **16** (see FIG. **8**) of each bottle **12** can be oriented in any direction. The first bottle unscrambler **20** manipulates the bottles **12** until the opening **16** of each bottle **12** is in a top vertical position. The bottles **12** leave the first bottle unscrambler **20** in a series formation with the opening **16** of each bottle **12** oriented vertically. The bottles **12** travel in single file in a first lane **18** to a first bottle lifter **40**. The first bottle lifter **40** lifts and transports the bottles **12** to a bottle infeed and sterilization apparatus **60**. A second bottle unscrambler **30** may also used to provide a supply of vertically oriented bottles **12**. The bottles **12** output from the second bottle unscrambler **30** travel in single file in a second lane **22** to a second bottle lifter **42**, which lifts and transports the bottles **12** to the bottle infeed and sterilization apparatus **60**.

FIG. **3** illustrates the bottle infeed, sterilization, and conveying apparatus **60** attached to the filler apparatus **50**. FIG. **4** illustrates a cross-sectional side view of the bottle infeed, sterilization, and conveying apparatus **60**. FIG. **5** illustrates a cross-sectional top view of the bottle infeed, sterilization, and conveying apparatus **60** taken along line **5**—**5** of FIG. **4**. The bottle infeed and sterilization apparatus **60** preferably inputs six bottles **12** in a horizontal direction from the first lane **18** and six bottles in a horizontal direction from the second lane **22** (FIG. **5**). A gate **76** in the first lane **18** selectively groups six bottles **12** at a time in first horizontal row **24**. A gate **78** in the second lane **22** selectively groups six bottles **12** at a time in a second horizontal row **28**. An infeed apparatus **80** includes a pushing element **84** for pushing the bottles **12** in the first horizontal row **24** into a first vertical lane **26**. A corresponding infeed apparatus **80** includes a pushing element **86** for pushing the bottles **12** in the second horizontal row **28** into a second vertical lane **32**. The six bottles **12** in the first vertical lane **26** and the six bottles **12** in the second vertical lane **32** are directed downward into the bottle infeed and sterilization apparatus **60**.

Referring to FIG. **4**, as the bottles **12** move downward in the first vertical lane **26** and the second vertical lane **32**, a sterilant **14**, such as heated hydrogen peroxide, oxonia, or other aseptic sterilant, is applied to an outside surface **34** of each bottle **12** by a sterilant application apparatus **36**. The outside surface **34** of a bottle **12** is illustrated in greater detail in FIG. **8**. The bottles **12** may move downward in the first vertical lane **26** and the second vertical lane **32** by the force of gravity. Alternatively, controlled downward movement of the bottles **12** can be created by the use of a conveying device such as a moving conveying chain. A plurality of pins are attached to the conveying chain. Each bottle **12** rests on one of the pins attached to the conveying chain. Therefore, the motion of each bottle is controlled by the speed of the moving conveying chain.

A sterilant such as hydrogen peroxide may be provided to the sterilant application apparatus **36** in many ways. For example, liquid hydrogen peroxide may be provided in a reservoir at a level maintained by a pump and overflow pipe. A plurality of measuring cups (e.g., approximately 0.5 ml each) connected by an air cylinder are submerged into the reservoir and are lifted above the liquid level. Thus, a measured volume of liquid hydrogen peroxide is contained in each measuring cup.

Each measuring cup may include a conductivity probe that is configured to send a signal to the control system **550** indicating that the measuring cup is full. A tube (e.g., having a diameter of about 1/16") is positioned in the center of the measuring cup. A first end of the tube is positioned near the bottom of the measuring cup. A second end of the tube is connected to the sterilant application apparatus **36**. The sterilant application apparatus **36** includes a venturi and a heated double tube heat exchanger. When the measuring cup is full, and a signal is received from the control system **550**, a valve is opened allowing pressurized sterile air to enter the venturi. The pressurized air flow causes a vacuum to be generated in second end of the tube causing liquid hydrogen peroxide to be pulled out of the measuring cup. The liquid hydrogen peroxide is sprayed into a sterile air stream which atomizes the hydrogen peroxide into a spray. The atomized hydrogen peroxide enters the double tube heat exchanger in order to heat the atomized hydrogen peroxide to its vaporization phase. The double tube heat exchanger is heated with steam and the temperature is monitored and controlled by the control system **550**. In FIG. **4**, the application of the sterilant **14** by the sterilant application apparatus **36** is accomplished through the use of spray nozzles **64** that produce a sterilant fog which is directed to the outside surface **34** of each bottle **12**.

Alternatively, a direct spray of heated hydrogen peroxide may be continuously applied to the outside surface **34** of each bottle **12**. For producing the direct spray, a metering pump regulates the amount of hydrogen peroxide, a flow meter continuously measures and records the quantity of hydrogen peroxide being dispensed, a spray nozzle produces a fine mist, and a heat exchanger heats the hydrogen peroxide above the vaporization point.

FIGS. **3** and **4** illustrate the sterilization chamber **38** for activation and drying of bottles **12** which is included in the bottle infeed, sterilization, and conveying apparatus **60**. The sterilization chamber **38** sterilizes the outside surface **34** of each bottle **12**. The sterilization chamber **38** encloses a conduit **39**. Sterile heated air, which is generated by a sterile air supply system **146** (FIG. **3**), enters the conduit **39** of the sterilization chamber **38** through ports **64** and **68** located at the bottom of the sterilization chamber **38**. The sterile heated air also enters through a bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The sterile heated air travels up through the conduit **39** of the sterilization chamber **38**, and exits the top of the sterilization chamber **38** through an exhaust conduit **70**. The sterile heated air continuously flows in an upward direction through the sterilization chamber **38**, thus preventing any contaminants from entering the bottle infeed and sterilization apparatus **60**. To create the sterile heated air, the air is first passed through a filtering system (e.g., a group of double sterile air filters) to sterilize the air. The air is then heated in a heating system (e.g., an electric heater) to about 230° F. The air temperature is regulated by the control system **550**. Other techniques for providing the sterile heated air may also be used. The control system **550** monitors the air pressure and flow rate of the sterile heated air to ensure that an adequate flow of the hot sterile air is maintained in the bottle sterilization chamber **38** of the bottle infeed and sterilization apparatus **60**.

As illustrated in FIGS. **4**, **6**, and **7**, the sterilization chamber **38** includes two opposing, interior, perforated walls **72**A, **72**B. The perforated walls **72**A and **72**B guide the bottles **12** downward in the first vertical lane **26** and the second vertical lane **32**, respectively. The perforated walls **72**A, **72**B also allow the complete circulation of hot sterile air around the outside surface **34** of each bottle **12** in the sterilization chamber **38**. The sterilization chamber **38** supplies hot sterile air to the outside surface **34** of each bottle

12 between the sterilant application apparatus 36 and the bottom opening 62 of the bottle infeed and sterilization apparatus 60. This sterilant may be hydrogen peroxide or oxonia (hydrogen peroxide and peroxyacetic acid).

In accordance with the preferred embodiment of the present invention, twelve drying positions are provided in the sterilization chamber 38. Each bottle 12 is exposed to the hot sterile air in the sterilization chamber 38 for about at least 24 seconds. This provides time sufficient time for the hydrogen peroxide sterilant to break down into water and oxygen, to kill any bacteria on the bottles 12, and to evaporate from the outside surface 34 of the bottles 12.

An exhaust fan 73 is located at a top of the exhaust conduit 70 to provide an outlet from a sterile tunnel 90, and to control the sterile air flow rate through the sterilization chamber 38. The exhaust fan 73 is controlled by the control system 550. The control system 550 controls the sterile air temperature preferably to about 230° F., and controls the sterile air flow rate through the sterilization chamber 38. The flow rate is preferably about 1800 scfm through the sterilization chamber 38. The bottles 12 leave the sterilization chamber 38 with a hydrogen peroxide concentration of less than 0.5 PPM.

As shown in FIGS. 3 and 4, a plurality of proximity sensors 71 located along the sides of the vertical lanes 26, 32 detect any bottle 12 jams that occur within the sterilization chamber 38. The proximity sensors 71 transmit an alarm signal to the control system 550. The bottles 12 leave the bottle infeed and sterilization apparatus 60 through the bottom opening 62, and enter the sterile tunnel 90 of the filler apparatus 50.

In the preferred embodiment of the present invention, the filler apparatus 50 includes forty-one (41) index stations 92, hereafter referred to as "stations." Various index stations 92 are illustrated in FIGS. 3, 4, and 11–15. The conveying motion of the bottles 12 to the various stations 92 through the filler apparatus 50 is based on an indexing motion. The filler apparatus 50 is designed to convey the bottles 12 through the various operations of the filler 50 in a two by six matrix. The twelve bottles 12 in the two by six matrix are positioned in, and displaced by, a conveying plate 94 as illustrated in FIG. 8. Therefore, twelve bottles 12 are exposed to a particular station 92 at the same time. A conveying apparatus 100 moves the set of twelve bottles 12 in each conveying plate 94 sequentially through each station 92.

Referring to FIGS. 3 and 4, the bottles 12 are supplied from an infeed chamber 102 to station 2 of the filler apparatus 50 through the bottom opening 62 of the bottle infeed and sterilization apparatus 60. The infeed chamber 102 is enclosed to direct heated hydrogen peroxide laden air completely around the outer surface 34 of the bottles 12. A mechanical scissors mechanism and a vacuum "pick and place" apparatus 104 position twelve bottles 12 at a time (in a two by six matrix, FIG. 8) into one of the conveying plates 94.

A plurality of conveying plates 94 are attached to a main conveyor 106. The main conveyor 106 forms a continuous element around conveyor pulleys 108 and 110 as illustrated in FIG. 3. A bottle support plate 107 supports a bottom 120 of each bottle 12 as the bottles 12 are conveyed from station to station through the filler apparatus 50. Each conveying plate 94 passes through stations 1 through 41, around pulley 108, and returns around pulley 110 to repeat the process. The main conveyor 106, conveying plates 94, and pulleys 108 and 110 are enclosed in the sterile tunnel 90.

At station 4, the bottles 12 in the conveying plate 94 enter a bottle detection apparatus 112. The bottle detection apparatus 112 determines whether all twelve bottles 12 are actually present and correctly positioned in the conveying plate 94. Proximity sensors 114 detect the presence and the alignment of each bottle 12. In the present invention, a bottle 12 with correct alignment is in an upright position with the opening 16 of the bottle 12 located in an upward position. Information regarding the location of any misaligned or missing bottles 12 is relayed to the control system 550. The control system 550 uses this location information to ensure that, at future stations 92, bottle filling or sealing will not occur at the locations corresponding to the misaligned or missing bottles 12.

At station 7, as illustrated in FIGS. 3 and 10, the bottles 12 in the conveying plate 94 enter an interior bottle sterilization apparatus 116. A sterilant, such as hydrogen peroxide, oxonia, or any other suitable aseptic sterilant is applied as a heated vapor fog into the interior 118 of each bottle 12. Preferably, hydrogen peroxide is used as the sterilant in the present invention. The application of sterilant is accomplished with the use of a plurality of sterilant measuring devices 120 and applicator spray nozzles 122. A separate measuring device 120 and applicator spray nozzle 122 are used for each of the twelve bottle 12 locations in the conveying plate 94. Each bottle 12 is supplied with the same measured quantity of sterilant, preferably in the form of a hot vapor fog. The measured quantity of sterilant may be drawn from a reservoir 124 of sterilant, heated, vaporized, etc., in a manner similar to that described above with regard to the sterilant application apparatus 36.

The control system 550 monitors and controls a spray apparatus 126 that includes the applicator spray nozzles 122. Each applicator spray nozzle 122 sprays the sterilant into the interior 118 of a corresponding bottle 12 as a hot vapor fog. The applicator spray nozzles 122 are designed to extend through the bottle openings 16. The applicator spray nozzles 122 descends into the interior 118 and toward the bottom of the bottles 12. This ensures the complete application of sterilant to the entire interior 118 and interior surface 119 of each bottle 12. Alternately, the applicator spray nozzles 122 may be positioned immediately above the bottle openings 16 prior to the application of sterilant.

FIG. 9 illustrates a perspective view of a partition 130 that provides control of sterile air flow within the sterile tunnel 90 of the filler apparatus 50. The partition 130 includes a top baffle plate 132, a middle baffle plate 134, and a bottom baffle plate 136. The top baffle plate 132 and the middle baffle plate 134 are provided with cut-outs 133 which correspond to the outer shape of each bottle 12 and to the outer shape of the conveyor plate 94. The cut-outs 133 allow each bottle 12 and each conveyor plate 94 to pass through the partition 130. A space 138 between the middle baffle plate 134 and the bottom baffle plate 136 allows each empty conveyor plate 94 to pass through the partition 130 as it travels on its return trip from the pulley 108 toward the pulley 110.

As illustrated in FIG. 3, partitions 130A, 130B, and 130C, are located within the sterile tunnel 90. FIG. 10 illustrates a cross-sectional view of partition 130A including baffle plates 132A, 134A, and 136A. The partition 130A is located between stations 8 and 9. FIG. 11 illustrates a cross-sectional view of partition 130B including baffle plates 132B, 134B, and 136B. The partition 130B is located between stations 22 and 23. FIG. 12 illustrates a cross-sectional view of partition 130C including baffles 132C, 134C, and 136C. The partition 130C is located between stations 35 and 36. As illustrated in

FIG. **3**, sterile air is introduced through sterile air conduits **140**, **142**, and **144** into the sterile tunnel **90**. The sterile air conduit **140** is located at station **23** (FIG. **11**), the sterile air conduit **142** is located at station **27** (FIG. **3**), and the sterile air conduit **144** is located at station **35** (FIG. **12**).

The partition **130**A separates an activation and drying apparatus **152** from the interior bottle sterilization apparatus **116**. The partition **130**B separates the activation and drying apparatus **152** from a main product filler apparatus **160** and a lid sterilization and heat sealing apparatus **162**. Thus, a first sterilization zone **164** is created that includes the activation and drying apparatus **152**. Partition **130**C separates the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** from a bottle discharge apparatus **280**. Thus, partitions **130**B and **130**C create a second sterilization zone **166** that includes the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162**. A third sterilization zone **172** includes the bottle discharge apparatus **280**. A fourth sterilization zone **165** includes the interior bottle sterilization apparatus **116**. The second sterilization zone **166** provides a highly sterile area where the bottles **12** are filled with a product and sealed. The second sterilization zone **166** is at a higher pressure than the first sterilization zone **164** and the third sterilization zone **172**. Therefore, any gas flow leakage is in the direction from the second sterilization zone **166** out to the first sterilization zone **164** and the third sterilization zone **172**. The first sterilization zone **164** is at a higher pressure than the fourth sterilization zone **165**. Therefore, gas flow is in the direction from the first sterilization zone **164** to the fourth sterilization zone **165**.

The partitions **130**A, **130**B, and **130**C create sterilization zones **164**, **165**, **166**, and **172** with different concentration levels of gas laden sterilant (e.g., hydrogen peroxide in air). The highest concentration level of sterilant is in the fourth sterilization zone **165**. An intermediate concentration level of sterilant is in the first sterilization zone **164**. The lowest concentration level of sterilant is in the second sterilization zone **166**. Advantageously, this helps to maintain the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** at a low sterilant concentration level. This prevents unwanted high levels of sterilant to enter the food product during the filling and lidding process.

Stations **10** through **21** include twelve stations for directing hot sterile air into each bottle **12** for the activation and removal of the sterilant from the interior of the bottle **12**. The sterile air supply system **146** supplies hot sterile air to a plurality of nozzles **150** in the activation and drying apparatus **152**. Hot sterile air is supplied to the sterile air supply system **146** through conduit **148**. The air is first passed through a filtration system to sterilize the air. The air is then heated in a heating system to about **230°** F. The air temperature is regulated by the control system **550**. Also, the control system **550** monitors the air pressure and flow rate to ensure that an adequate flow of hot sterile air is maintained in the sterile tunnel **90** of the application and drying apparatus **152**.

As shown in FIG. **8**, each bottle **12** generally has a small opening **16** compared to its height "H." A ratio of a diameter "D" of the bottle **12** to the height "H" of the bottle **12** is generally less than 1.0. The small bottle opening **16** combined with a larger height "H" restricts the flow of hot gas into the interior **118** of the bottle **12**. Also, PET and HDPE bottle materials have low heat resistance temperatures. These temperatures commonly are about 55° C. for PET and about 121° C. for HDPE. Typically, in the aseptic packaging industry, a low volume of air at a high temperature is applied to the packaging materials. This often results in deformation and softening of packaging materials formed of PET and HDPE. In order to prevent softening and deformation of the bottles **12**, when formed from these types of materials, the present invention applies high volumes of air at relatively low temperatures over an extended period of time in the activation and drying apparatus **152**. The plurality of nozzles **150** of the activation and drying apparatus **152** direct hot sterile air into the interior **118** of each bottle **12** (FIG. **11**). A long exposure time is predicated by the geometry of the bottle **12** and the softening temperature of the material used to form the bottle **12**. In the present invention, about 24 seconds are allowed for directing hot sterile air from the plurality of nozzles **150** into each bottle for the activation and removal of sterilant from the interior surface **119** of the bottle **12**. To achieve aseptic sterilization, a minimum bottle temperature of about 131° F. should be held for at least 5 seconds. To achieve this bottle temperature and time requirements, including the time required to heat the bottle, the sterilant is applied for about 1 second and the hot sterile air is introduced for about 24 seconds. The hot sterile air leaves the nozzles **150** at about 230° F. and cools to about 131° F. when it enters the bottle **12**. The hot sterile air is delivered at a high volume so that the bottle **12** is maintained at about 131° F. for at least 5 seconds. The about 24 seconds provides adequate time for the bottle **12** to heat up to about 131° F. and to maintain this temperature for at least 5 seconds. After bottle **12** has dried, the residual hydrogen peroxide remaining on the bottle **12** surface is less than 0.5 PPM.

A foodstuff product is first sterilized to eliminate bacteria in the product. An "Ultra High Temperature" (UHT) pasteurization process is required to meet the aseptic FDA standard. The time and temperature required to meet the aseptic FDA standard depends on the type of foodstuff. For example, milk must be heated to 282° F. for not less than 2 seconds in order to meet the aseptic standards.

After UHT pasteurization, the product is delivered to a main product filler apparatus **160**. The main product filler apparatus is illustrated in FIGS. **3** and **13**. The main product filler **160** can be sterilized and cleaned in place to maintain aseptic FDA and **3**A standards. A pressurized reservoir apparatus **180** that can be steam sterilized is included in the main product filler apparatus **160**. As illustrated in FIG. **13**, the pressurized reservoir apparatus **180** includes an enclosed product tank **182** with a large capacity (e.g., 15 gallons). The product tank **182** is able to withstand elevated pressures of about 60 psig or more. The pressurized reservoir apparatus **180** also includes a level sensor **184**, a pressure sensor **186**, a volumetric measuring device **188**, and a filling nozzle **190**. The product tank **182** includes a single inlet with a valve cluster including a sterile barrier to separate the product process system from aseptic surge tanks and the main product filler apparatus **160**. The product tank **182** has an outlet with twelve connections. At each connections is a volumetric measuring device **188** such as a mass or volumetric flow meter. A plurality of filling nozzles **190**A, **190**B are provided at stations **23**, **25**, respectively. In addition, there are a plurality of volumetric measuring devices **188**A and **188**B to measure the volume of product entering each bottle **12** at stations **23** and **25**, respectively. The control system **550** calculates the desired volume of product to be inserted into each bottle **12**, and controls the product volume by opening or closing a plurality of valves **194**A and **194**B. The activation mechanisms for valves **194**A and **194**B have a sterile barrier to prevent contamination of the product. The plurality of valves **194**A control the volume of product

flowing through a corresponding plurality of nozzles **196**A into the bottles **12** at station **23**. The plurality of valves **194**B control the volume of product flowing through a corresponding plurality of nozzles **196**B into the bottles **12** at station **25**. The control system **550** uses the previously stored information provided by the bottle detection apparatus **112** to only allow filling to occur at the locations where bottles **12** are actually present and correctly aligned.

The initial sterilization process for the pressurized reservoir apparatus **180** includes the step of exposing all of the surfaces of the pressurized reservoir apparatus **180** that come in contact with the product to steam at temperatures above about 250° F. for a minimum of about 30 minutes. Elements such as cups **198**A and **198**B are used to block off nozzle outlets **196**A and **196**B respectively, to allow a build-up of steam pressure to about 50 psig inside the pressurized reservoir apparatus **180**. Condensate generated as the steam heats the interior surfaces of the pressurized reservoir apparatus **180** is collected and released from the nozzles **198**A and **198**B. This condensate is released when the cups **198**A and **198**B are removed from the nozzle outlets **196**A and **196**B. Once the interior surfaces of the pressurized reservoir apparatus **180** are sterilized, the steam is shut off, and sterile air is used to replace the steam. The sterile air reduces the interior temperature of the pressurized reservoir apparatus **180** to the temperature of the product before the product is allowed to enter the enclosed product tank **182**. Sterile air is directed through sterile air conduits **142** and **144** into the second sterilization zone **166** at a volume rate of about 800 scfm (FIG. **13**). The sterile air flow entering the second sterilization zone **166** provides sterile air to the main product filler apparatus **160** and to the lid sterilization and heat sealing apparatus **162**.

The main product filler apparatus **160** includes a separate filling position for each bottle. The bottle **12** filling operation is completed for six bottles at station **23** and for six bottles at station **25**.

FIGS. **3** and **13** illustrate the lid sterilization and heat sealing apparatus **162**. A lid **200** is applied to each of the twelve bottles **12** at station **31**. For a fully aseptic bottle filler, complete lid **200** sterilization is necessary, and therefore a sterilant such as hydrogen peroxide is typically used. In the present invention, the lids are formed of a material such as foil or plastic. The lids **200** are joined together by a small interconnecting band that holds them together to form a long connected chain of lids **200**, hereinafter referred to as a "daisy chain" **202**. A daisy chain **202** of lids **200** is placed on each of a plurality of reels **210**. For the twelve bottle configuration of the present invention, six of the reels **210**, each holding a daisy chain **202** of lids **200**, are located on each side of a heat sealing apparatus **214**. Each daisy chain **202** of lids **200** winds off of a corresponding reel **210** and is sterilized, preferably using a hydrogen peroxide bath **204**. A plurality of hot sterile air knives **208**, which are formed by jets of hot sterile air, activate the hydrogen peroxide to sterilize the lids **200** on the daisy chain **202**. The hot sterile air knives **208** also remove the hydrogen peroxide from the lids **200** so that the residual concentration of hydrogen peroxide is less than 0.5 PPM. The hydrogen peroxide bath **204** prevents any contaminants from entering the sterile tunnel **90** via the lidding operation. Once sterilized, the lids **200** enter the sterile tunnel **90** where they are separated from the daisy chain **202** and placed on a bottle **12**. Each lid is slightly larger in diameter then that of the opening **16** of a bottle **12**. During the placement of the lid **200** on the bottle **12**, a slight mechanical crimp of the lid **200** is formed to locate and hold the lid **200** on the bottle **12**. The crimp holds the lid **200** in place on the bottle **12** until the bottle **12** reaches a station **33** for sealing.

At station **33**, the lids **200** are applied to the bottles **12**. The heat sealing apparatus **214** includes a heated platen **216** that applies heat and pressure against each lid **200** for a predetermined length of time, to form a seal between the lid **200** and the bottle **12**. The heated platen **216** is in a two by six configuration to seal twelve of the bottles **12** at a time.

At station **37**, the lid **200** seal and bottle **12** integrity are checked in a known manner by a seal integrity apparatus (not shown) comprising, for example, a bottle squeezing mechanism and a proximity sensor. Each bottle **12** is squeezed by the bottle squeezing mechanism which causes the lid **200** on the bottle **12** to extend upward. The proximity sensor detects if the lid **200** has extended upward, which indicates an acceptable seal, or whether the seal remains flat, which indicates a leaking seal or bottle **12**. The location of the defective bottles **12** are recorded by the control system **550** so that the defective bottles will not be packed.

Bottle discharge from the sterile tunnel **90** of the filler apparatus **50** occurs at stations **38** and **40** as illustrated in FIGS. **3**, **13** and **14**. A bottle discharge apparatus **280** is located at stations **38** and **40**. At this point in the filler apparatus **50**, the filled and sealed bottles **12** are forced in an upward direction such that a top portion **284** of each bottle **12** protrudes through an opening **282** in the sterile tunnel **90** (FIG. **14**). A rotating cam **290** or other suitable means (e.g., an inflatable diaphragm, etc.) may be used to apply a force against the bottom **120** of each bottle **12** to force the bottle **12** in an upward direction.

As illustrated in FIG. **14**, the bottle discharge apparatus **280** comprises a lifting apparatus **286** that includes a gripper **288** that grasps the top portion **284** of each bottle **12** and lifts the bottle **12** out through the opening **282** in the sterile tunnel **90**. In order to ensure that contaminated air cannot enter the sterile tunnel **90**, the sterile air in the sterile tunnel **90** is maintained at a higher pressure than the air outside the sterile tunnel **90**. Thus, sterile air is always flowing out of the sterile tunnel **90** through the opening **282**. In addition, the gripper **288** never enters the sterile tunnel **90**, because the top portion **284** of the bottle **12** is first lifted out of the sterile tunnel **90** by the action of the rotating cam **290** before being grabbed by the gripper **288**.

FIG. **15** illustrates a top view of the filler apparatus **50** including the bottle infeed and sterilization apparatus **60**, the interior bottle sterilization apparatus **116**, and the activation and drying apparatus **152**. FIG. **15** additionally illustrates the main filler apparatus **160**, the lid sterilization and heat sealing apparatus **162**, and the bottle discharge apparatus **280**.

Referring again to FIGS. **1** and **14**, the lifting apparatus **286** lifts the bottles **12** at station **38** and places the bottles **12** in a first lane **292** that transports the bottles **12** to a first capping apparatus **410**. In addition, the lifting apparatus **286** lifts the bottles **12** at station **40** and places the bottles **12** in a second lane **294** that transports the bottles **12** to a second capping apparatus **400**.

The first capping apparatus **410** secures a cap (not shown) on the top of each bottle **12** in the first lane **292**. The second capping apparatus **400** secures a cap on the top of each bottle **12** in the second lane **294**. The caps are secured to the bottles **12** in a manner known in the art. It should be noted that the capping process may be performed outside of the sterile tunnel **90** because each of the bottles **12** have previously been sealed within the sterile tunnel **90** by the lid sterilization and heat sealing apparatus **162** using a sterile lid **200**.

After capping, the bottles **12** are transported via the first and second lanes **292**, **294** to labelers **460** and **470**. The first labeling apparatus **470** applies a label to each bottle **12** in the first lane **292**. The second labeling apparatus **460** applies a label to each bottle **12** in the second lane **294**.

From the first labeling apparatus **470**, the bottles **12** are transported along a first set of multiple lanes (e.g., **4**) to a first case packing apparatus **490**. From the second labeling apparatus **460**, the bottles **12** are transported along a second set of multiple lanes to a second case packing apparatus **480**. Each case packing apparatus **480**, **490** gathers and packs a plurality of the bottles **12** (e.g., twelve) in each case in a suitable (e.g., three by four) matrix.

A first conveyor **296** transports the cases output by the first case packer **490** to a first palletizer **510**. A second conveyor **298** transports the cases output by the second case packer **480** to a second palletizer **500**. A vehicle, such as a fork lift truck, then transports the pallets loaded with the cases of bottles **12** to a storage warehouse.

Referring again to FIG. **3**, the main conveyor **106** and each conveying plate **94** are cleaned and sanitized once during each revolution of the main conveyor **106**. Specifically, after each empty conveying plate **94** passes around the pulley **108**, the conveying plate **94** is passed through a liquid sanitizing apparatus **300** and a drying apparatus **302**. The liquid sanitizing apparatus **300** sprays a mixture of a sterilizing agent (e.g., oxonia, (hydrogen peroxide and peroxyacetic acid)) over the entire surface of each conveying plate **94** and associated components of the main conveyor **106**. In the drying apparatus **302**, heated air is used to dry the main conveyor **106** and conveying plates **94**.

Stations **1** through **40** are enclosed in the sterile tunnel **90**. The sterile tunnel **90** is supplied with air that is pressurized and sterilized. The interior of the sterile tunnel **90** is maintained at a pressure higher than the outside environment in order to eliminate contamination during the bottle processing. In addition, to further ensure a sterile environment within the sterile tunnel **90**, the sterile air supply provides a predetermined number of air changes (e.g., 2.5 changes of air per minute) in the sterile tunnel **90**.

The bottle infeed and sterilization apparatus **60** and the filler apparatus **50** meet the 3A Sanitary Standards of the Sanitary Standards Symbol Administrative Council. The 3A Sanitary Standards ensure that all product contact surfaces can be cleaned and sterilized on a regular basis such as daily. The present invention allows the product contact surfaces to be cleaned-in-place without dismantling the bottle infeed and sterilization apparatus **60** or the filler apparatus **50**. The 3A Sanitary Standards includes requirements such as the material type, the material surface finish, the elastomer selection, the radius of machined parts and the ability of all surfaces to be free draining. For example, the material type is selected from the 300 series of stainless steel and all product contact surfaces have a finish at least as smooth as No. **4** ground finish on stainless steel sheets.

Before bottle production is initiated, the bottle infeed and sterilization apparatus **60** and the filler apparatus **50** are preferably sterilized with an aseptic sterilant. For example, a sterilant such as a hot hydrogen peroxide mist may be applied to all interior surfaces of the bottle infeed and sterilization apparatus **60** and the filler apparatus **50**. Then, hot sterile air is supplied to activate and remove the hydrogen peroxide, and to dry the interior surfaces of the bottle infeed and sterilization apparatus **60** and the filler apparatus **50**.

FIG. **16** is a side view of the aseptic processing apparatus **10** of the present invention indicating the location of the control and monitoring devices that are interfaced with the control system **550**. The control system **550** gathers information and controls process functions in the aseptic processing apparatus **10**. A preferred arrangement of the control and monitoring devices are indicated by encircled letters in FIG. **16**. A functional description of each of the control and monitoring devices is listed below. It should be noted that these control and monitoring devices are only representative of the types of devices that may be used in the aseptic processing apparatus **10** of the present invention. Other types and combinations of control and monitoring devices may be used without departing from the intended scope of the present invention. Further, control system **550** may respond in different ways to the outputs of the control and monitoring devices. For example, the control system **550** may automatically adjust the operational parameters of the various components of the aseptic processing apparatus **10**, may generate and/or log error messages, or may even shut down the entire aseptic processing apparatus **10**. In the preferred embodiment of the present invention, the control and monitoring devices include:

A. A bottle counter to ensure that a predetermined number of the bottles **12** (e.g., six bottles) on each upper horizontal row **24**, **28** enter the loading area of the bottle infeed and sterilization apparatus **60**.

B. A proximity sensor to ensure that the first group of bottles **12** has dropped into the first bottle position in the bottle infeed and sterilization apparatus **60**.

C1. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus **36** is full.

C2. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus **36** is emptied in a predetermined time.

C3. A pressure sensor to ensure that the pressure of the air used by the sterilant application apparatus **36** is within predetermined atomization requirements.

C4. A temperature sensor to ensure that each heat heating element used by the sterilant application apparatus **36** is heated to the correct temperature.

D. A proximity sensor (e.g., proximity sensor **71**, FIG. **3**) to ensure that a bottle jam has not occurred within the bottle infeed and sterilization apparatus **60**.

E. A temperature sensor to ensure that the temperature of the heated sterile air entering the bottle infeed and sterilization apparatus **60** is correct.

F. A proximity sensor that to ensure that each conveying plate **94** is fully loaded with bottles **12**.

G1. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus **116** is full.

G2. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus **116** is emptied in a predetermined time.

G3. A pressure sensor to ensure that the pressure of the air used by the interior bottle sterilization apparatus **116** is within predetermined atomization requirements.

G4. A temperature sensor to ensure that each heat heating element used by the interior bottle sterilization apparatus **116** is heated to the correct temperature.

H. A temperature sensor to ensure that the air drying temperature within the activation and drying apparatus **152** is correct.

I. A plurality of flow sensors to ensure that the airflow rate of the sterile air entering the sterile tunnel **90** is correct.

J. A pressure sensor to ensure that the pressure of the sterile air entering the activation and drying apparatus **152** is correct.

K. A measuring device (e.g., volumetric measuring device **188**, FIG. **3**) to ensure that each bottle **12** is filled to a predetermined level.

L. A pressure sensor to ensure that the pressure in the product tank **182** is above a predetermined level.

M. A level sensor to ensure that the level of product in the product tank **182** is maintained at a predetermined level.

N. Proximity sensors to ensure that the daisy chains **202** of lids **200** are present in the lid sterilization and heat sealing apparatus **162**.

O. A level sensor to ensure that the hydrogen peroxide level in the hydrogen peroxide bath **204** in the lid sterilization and heat sealing apparatus **162** is above a predetermined level.

P. A temperature sensor to ensure that the temperature of the hot sterile air knives **208** of the lid sterilization and heat sealing apparatus **162** is correct.

Q. A temperature sensor to ensure that the heat sealing apparatus **214** is operating at the correct temperature.

R. Proximity sensors to ensure that the bottles **12** are discharged from the filler.

S. A speed sensor to measure the speed of the conveying apparatus **100**.

T. A concentration sensor to ensure that the concentration of oxonia is maintained at a predetermined level in the sanitizing apparatus **300**.

U. A pressure sensor to ensure that the pressure of the oxonia is maintained above a predetermined level in the sanitizing apparatus **300**.

V. A temperature sensor to ensure that the drying temperature of the drying apparatus **302** is correct.

The foregoing description of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and many modifications and variations are possible in light of the above teaching. Such modifications and variations that may be apparent to a person skilled in the art are intended to be included within the scope of this invention defined by the accompanying claims.

I claim:

1. A method for aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the plurality of bottles to a level producing at least about a 6 log reduction in spore organisms;

filling the aseptically disinfected plurality of bottles with the aseptically sterilized foodstuffs; and

filling the aseptically disinfected plurality of bottles at a rate greater than 100 bottles per minute.

2. The method according to claim **1**, wherein the plurality of bottles are made from a glass.

3. The method according to claim **1**, wherein the plurality of bottles are made from a plastic.

4. The method according to claim **3**, wherein the plastic is polyethylene terepthalate.

5. The method according to claim **3**, wherein the plastic is high density polyethylene.

6. The method according to claim **1**, further including capping the bottle with an aseptically disinfected lid.

7. The method according to claim **1**, wherein the plurality of bottles has an opening size to height ratio of less than one.

8. The method according to claim **1**, further including disinfecting the interior of the plurality of bottles with a hot hydrogen peroxide spray.

9. The method according to claim **8**, wherein disinfecting the interior of the plurality of bottles includes the application of the hot hydrogen peroxide spray for about 1 second and the activation and removal of the hot hydrogen peroxide using hot aseptically sterilized air for about 24 seconds.

10. The method according to claim **1**, further including a feedback control system for maintaining aseptic bottling conditions.

11. The method according to claim **1**, wherein disinfecting is provided by hydrogen peroxide.

12. The method according to claim **1**, wherein disinfecting is provided by oxonia.

13. The method according to claim **1**, wherein disinfecting the outside surfaces of the plurality of bottles is provided by oxonia.

14. The method according to claim **1**, wherein the step of filling the aseptically disinfected bottling further comprises: filling the aseptically disinfected bottling at a rate greater than 360 bottles per minute.

15. The method for aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the plurality of bottles;

filling the aseptically disinfected plurality of bottles with the aseptically sterilized foodstuffs; and

filling the aseptically disinfected plurality of bottles at a rate greater than 100 bottles per minute wherein disinfecting the outside surfaces of the plurality of bottles is provided by hydrogen peroxide.

16. The method according to claim **15**, wherein disinfecting the outside surface of the plurality of bottles includes about 1 second for the application of the hot hydrogen peroxide spray and about 24 seconds for the activation and removal of the hot hydrogen peroxide using hot aseptically sterilized air.

17. The method for asepctically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

filling the aseptically disinfected plurality of bottles with the aseptically sterilized foodstuffs wherein the aseptically sterilized foodstuffs are sterilized to a level producing at least about 12 log reduction in *Clostridium botulinum;* and

filling the aseptically disinfected plurality of bottles at a rate greater than 100 bottles per minute.

18. The method for aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

filling the aseptically disinfected plurality of bottles with the aseptically sterilized foodstuffs; and

filling the aseptically disinfected plurality of bottles at a rate greater than 100 bottles per minute, further including disinfecting the interior of the plurality of bottles with a hot hydrogen peroxide spray wherein the residual level of hydrogen peroxide is less than about 0.5 ppm.

19. A device for aseptically bottling aseptically sterilized foodstuffs having at least about a 12 log reduction in *Clostridium botulinum* comprising:

means for providing a plurality of bottles;

means for aseptically disinfecting the plurality of bottles;

means for aseptically filling the aseptically disinfected plurality of bottles with the aseptically sterilized foodstuffs; and

means for filling the aseptically disinfected plurality of bottles at a rate greater than 100 bottles per minute.

20. A method for aseptically bottling aseptically sterilized foodstuffs comprising the steps of:

providing a plurality of bottles;

aseptically disinfecting the plurality of bottles to a level producing at least about a 6 log reduction in spore organisms;

filling the aseptically disinfected plurality of bottles with the aseptically sterilized foodstuffs wherein the aseptically sterilized foodstuffs are sterilized to a level producing at least about a 12 log reduction in *Clostridium botulinum;* and

filling the aseptically disinfected plurality of bottles at a rate greater than 100 bottles per minute, further including disinfecting the interior of the plurality of bottles with a hot hydrogen peroxide spray wherein the residual level of hydrogen peroxide is less than about 0.5 ppm.

* * * * *

Exhibit C

US006481468B1

(12) **United States Patent**
Taggart

(10) **Patent No.: US 6,481,468 B1**
(45) **Date of Patent: Nov. 19, 2002**

(54) **APPARATUS AND METHOD FOR PROVIDING CONTAINER FILLING IN AN ASEPTIC PROCESSING APPARATUS**

(75) Inventor: **Thomas D. Taggart**, South Wales, NY (US)

(73) Assignee: **Steuben Foods Incorporated**, Elma, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/781,636**

(22) Filed: **Feb. 12, 2001**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/376,992, filed on Aug. 18, 1999, now Pat. No. 6,209,591.
(60) Provisional application No. 60/118,404, filed on Feb. 2, 1999.

(51) **Int. Cl.**[7] **B65B 1/04**
(52) **U.S. Cl.** ..... **141/85**; 141/90; 141/93; 141/301; 134/169 R
(58) **Field of Search** ..... 141/85, 89–93, 141/4–7, 37, 39, 40, 301, 97, 172, 129, 275–278, 48, 63; 134/169 R, 169 C, 166 C

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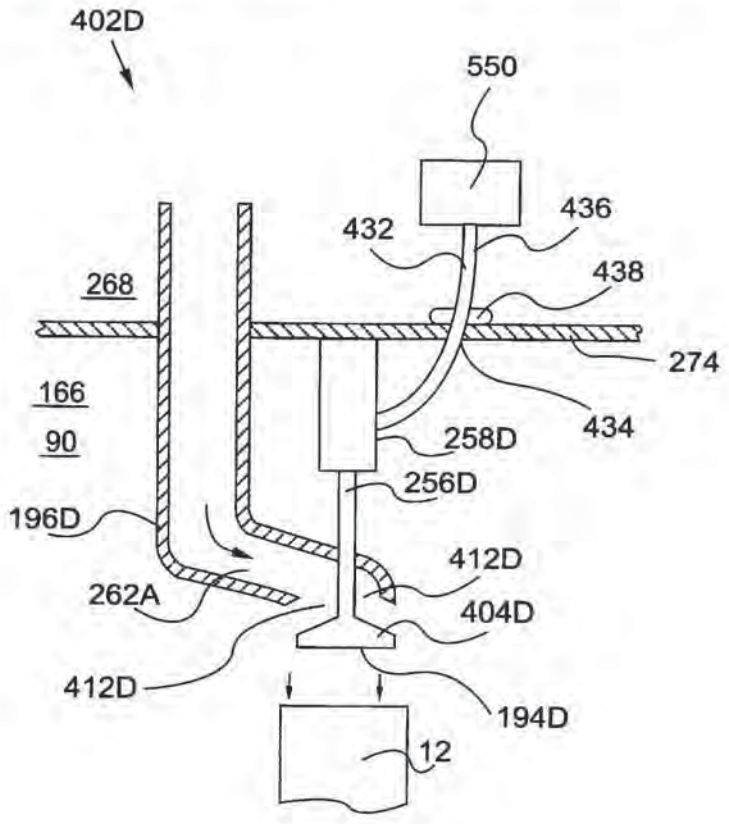
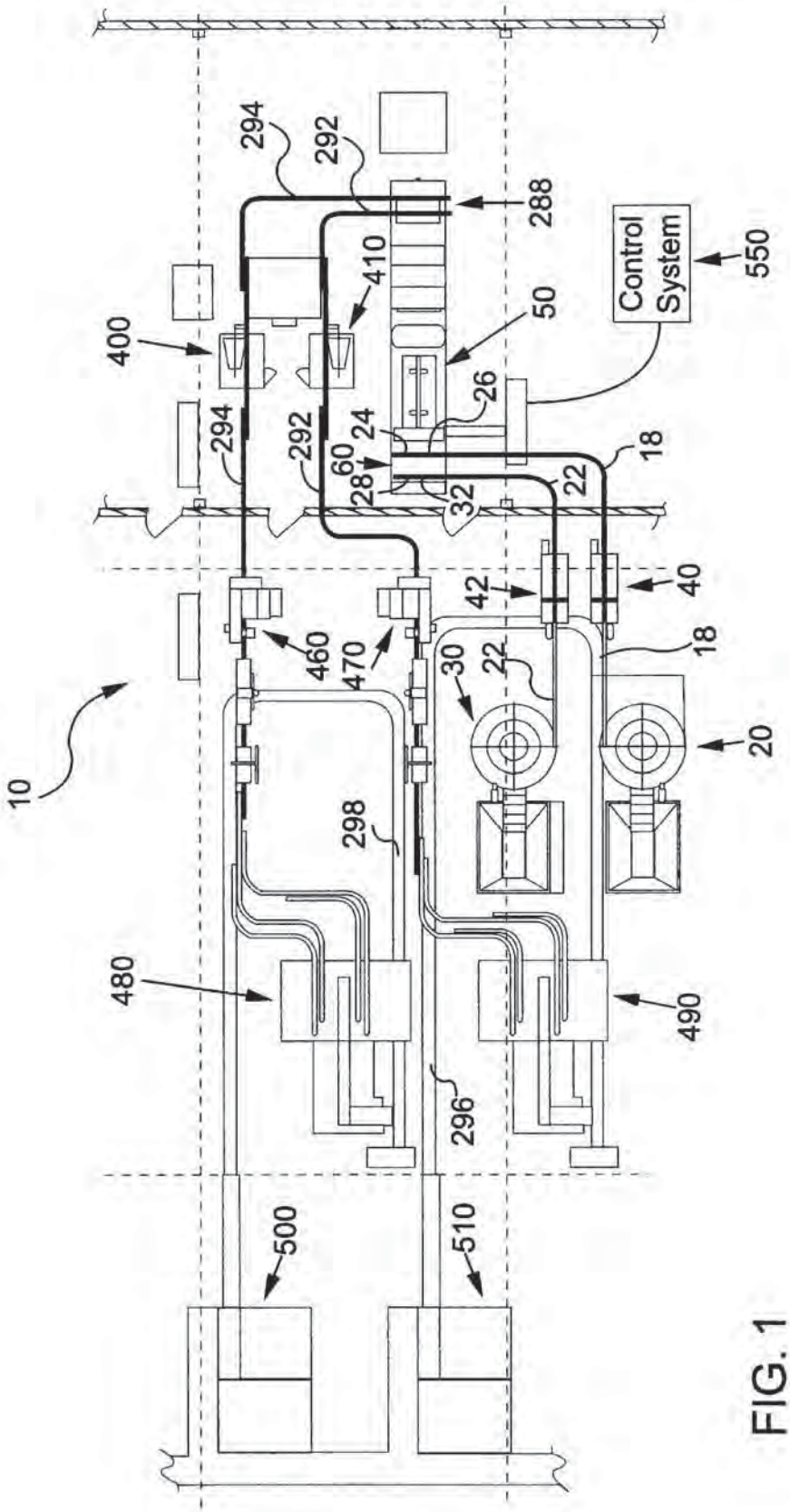
Primary Examiner—Steven O. Douglas
(74) *Attorney, Agent, or Firm*—Schmeiser, Olsen & Watts

(57) **ABSTRACT**

An apparatus and method for filling aseptic containers with an aseptic product in an aseptic processing apparatus. An apparatus including a valve mechanism for controlling the opening or closing of a valve. The aseptic product is delivered through the valve to the aseptic container. The valve mechanism remains in a sterile tunnel, preventing contaminants from being carried into the aseptic product.

35 Claims, 31 Drawing Sheets

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18
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296
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510

FIG. 1

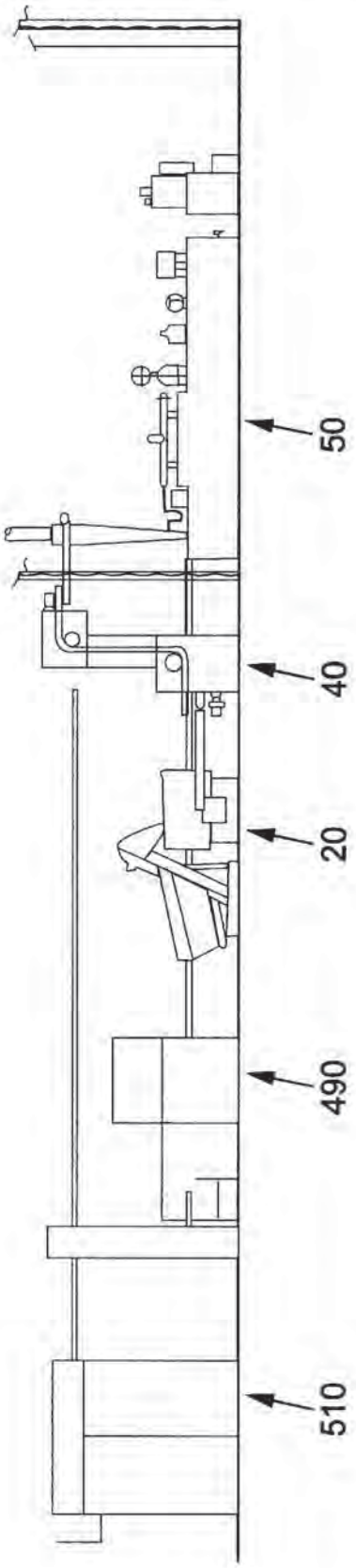
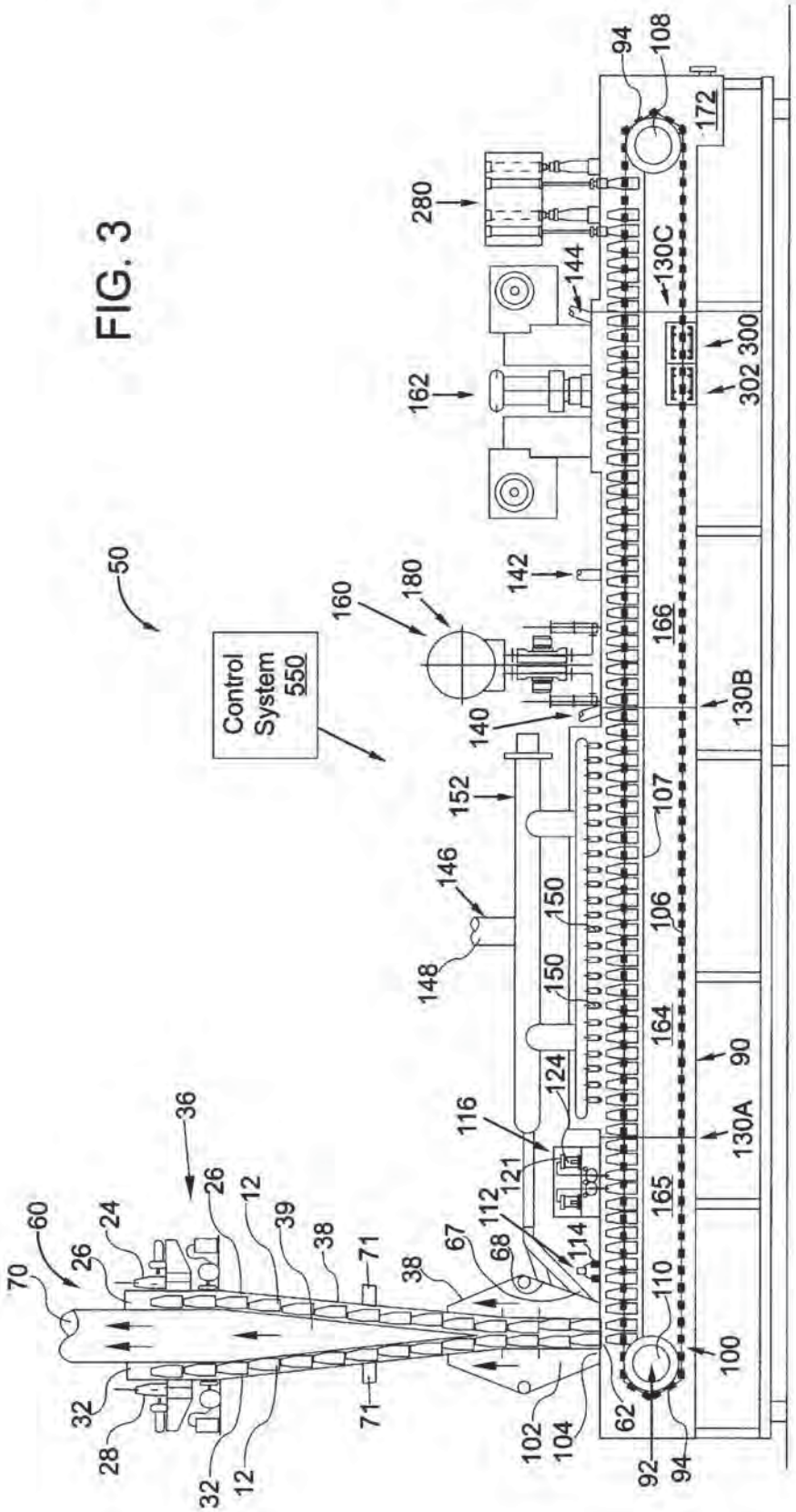


FIG. 2

FIG. 3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70
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24
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71
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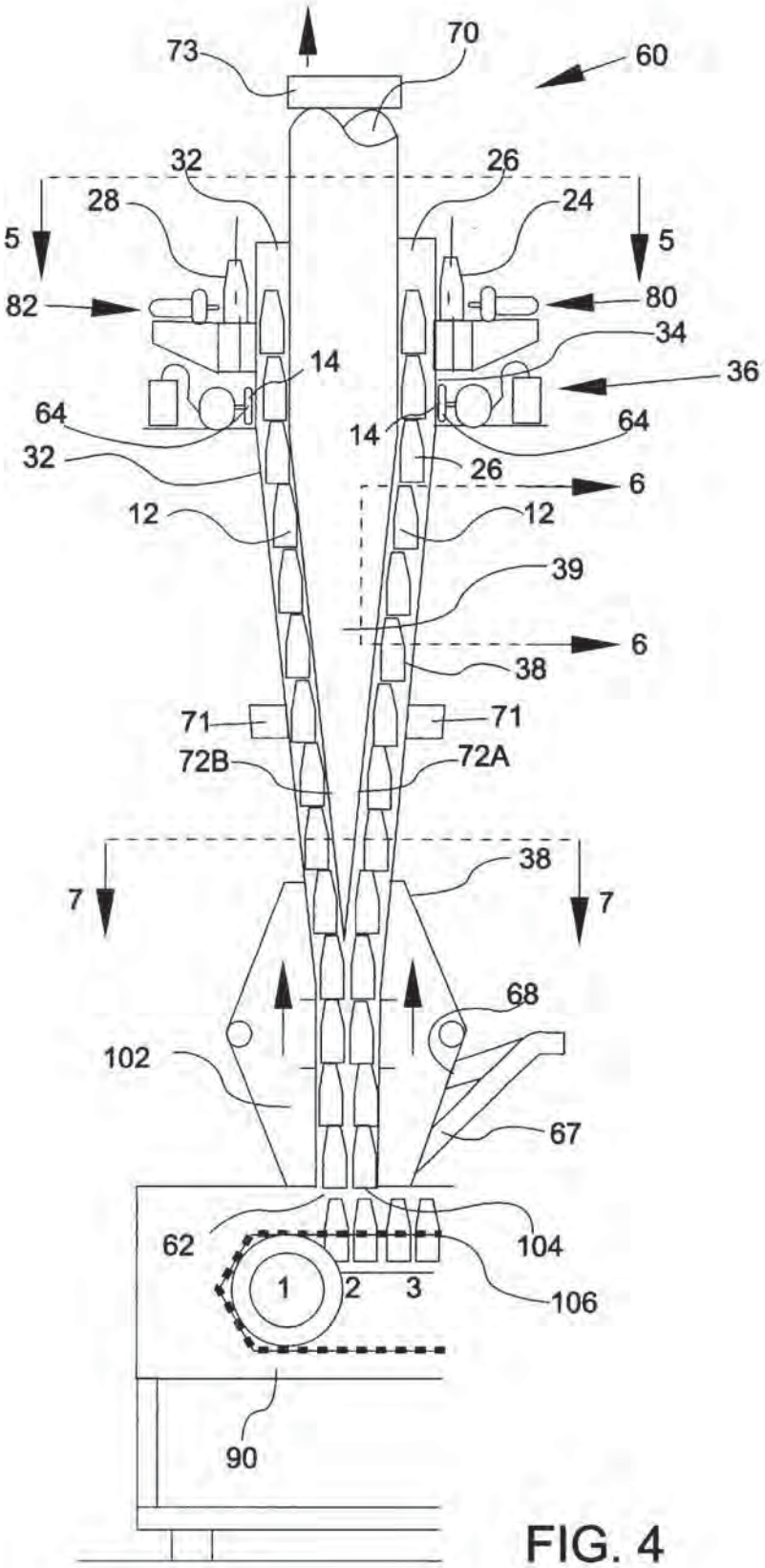
165
110
100
62
92
94
102
104
71
32
28
32
12
146
148
150
150
106
107
152
140
160
180
142
166
130B
130A
90
162
144
130C
280
172
94
108
300
302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39
6
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67
62
104
1
2
3
106
90

FIG. 4

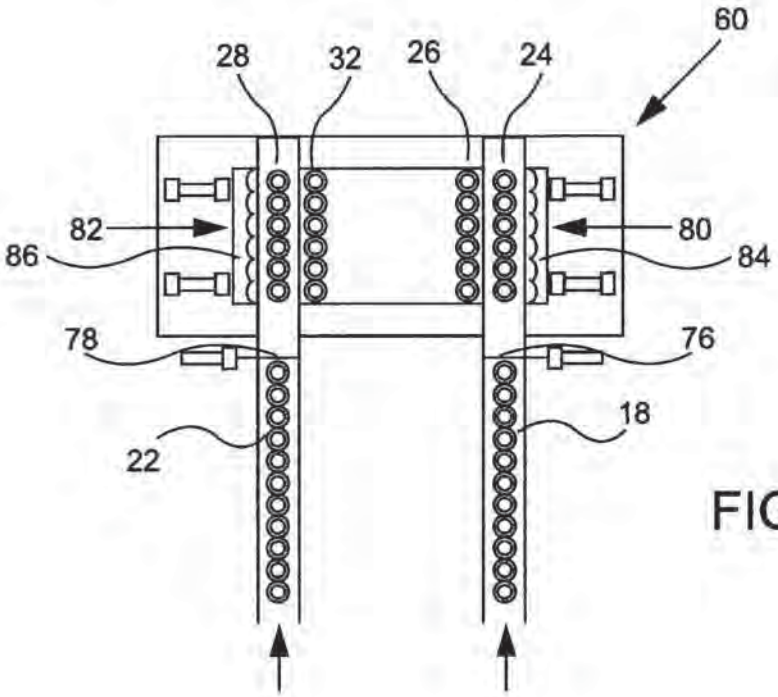


FIG. 5

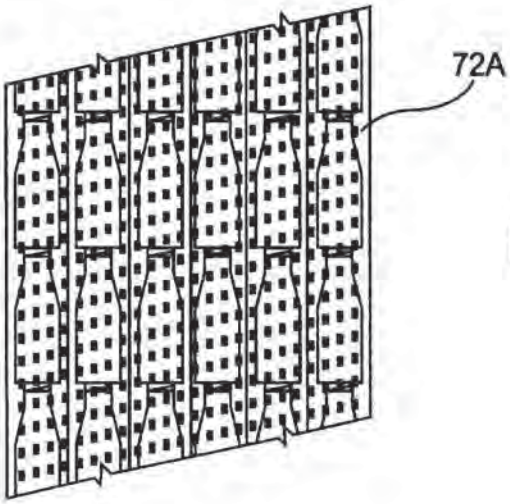


FIG. 6

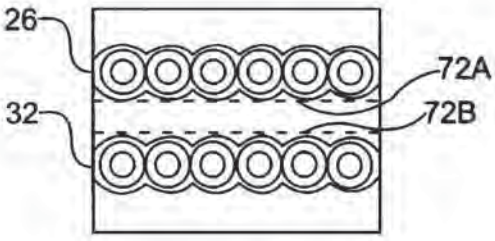


FIG. 7

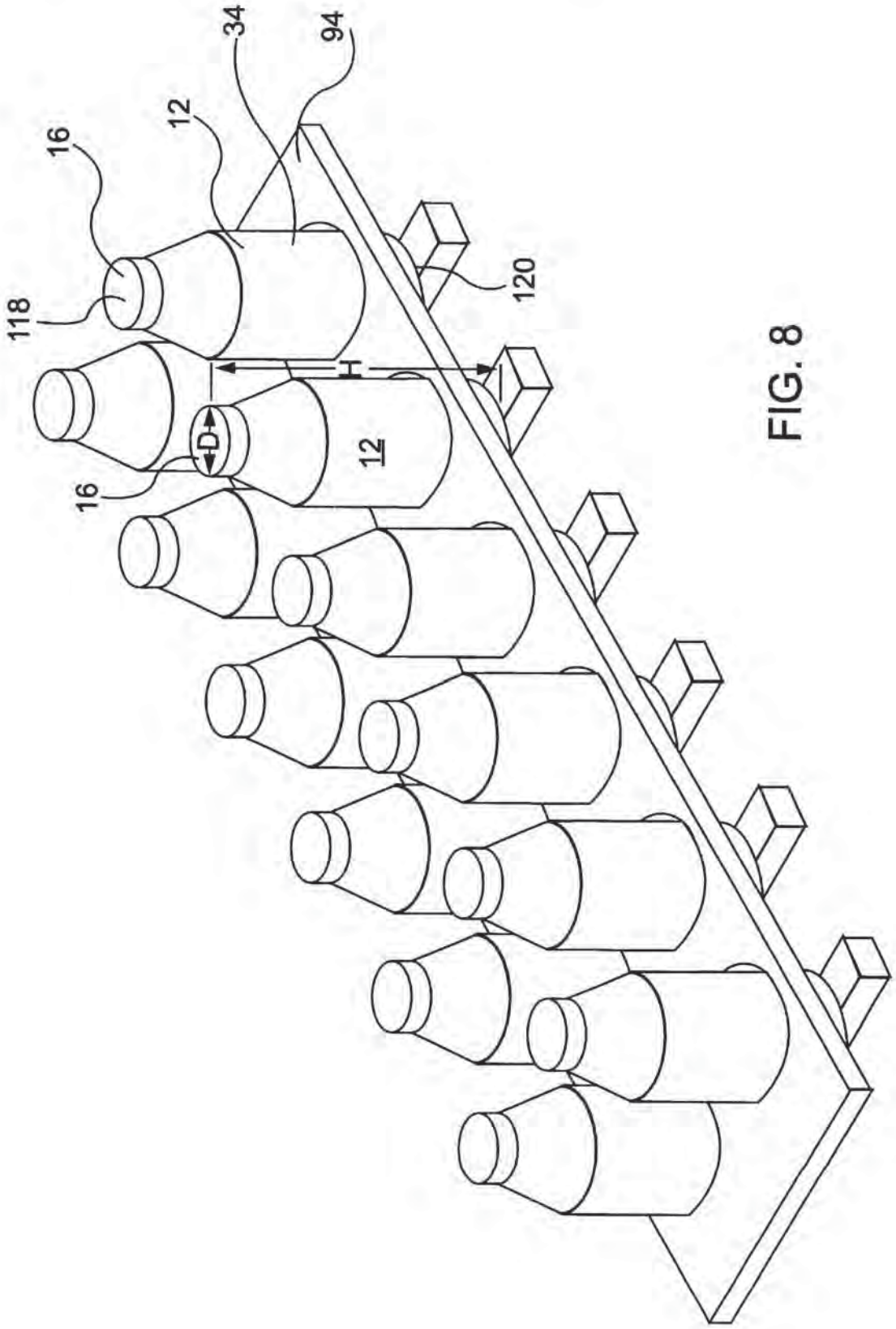


FIG. 8

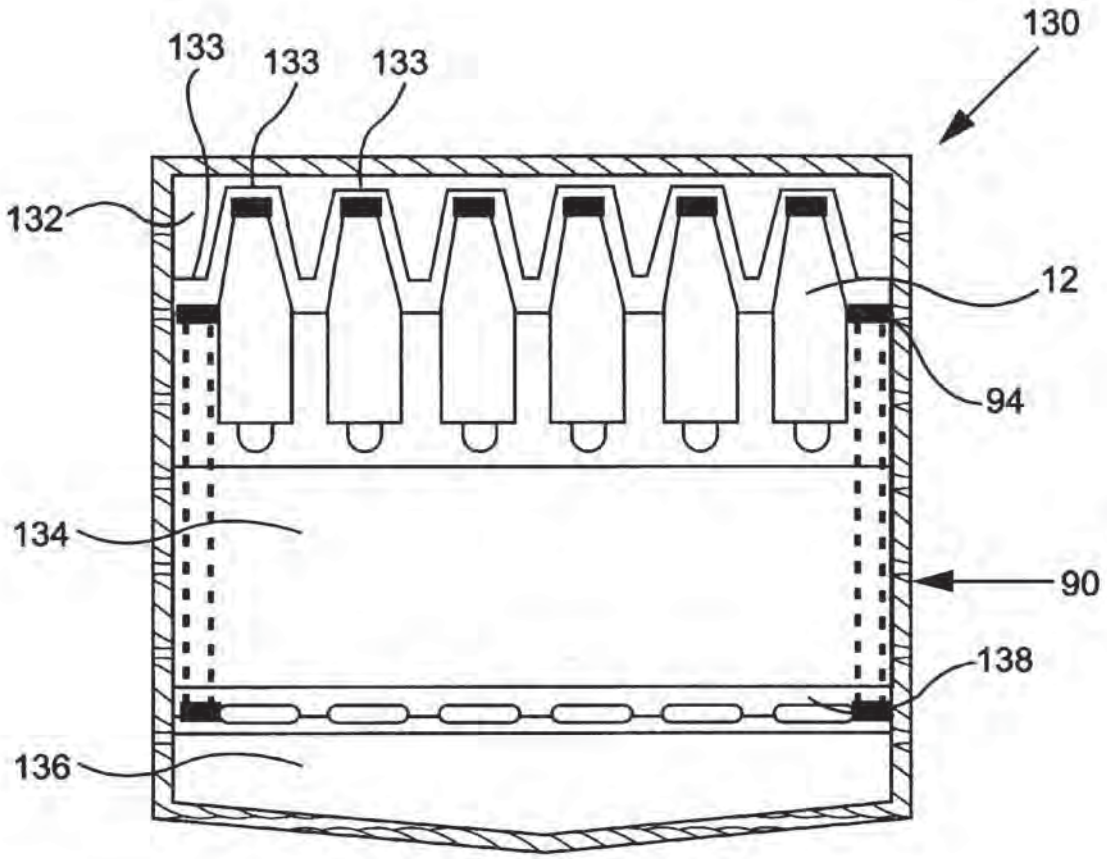
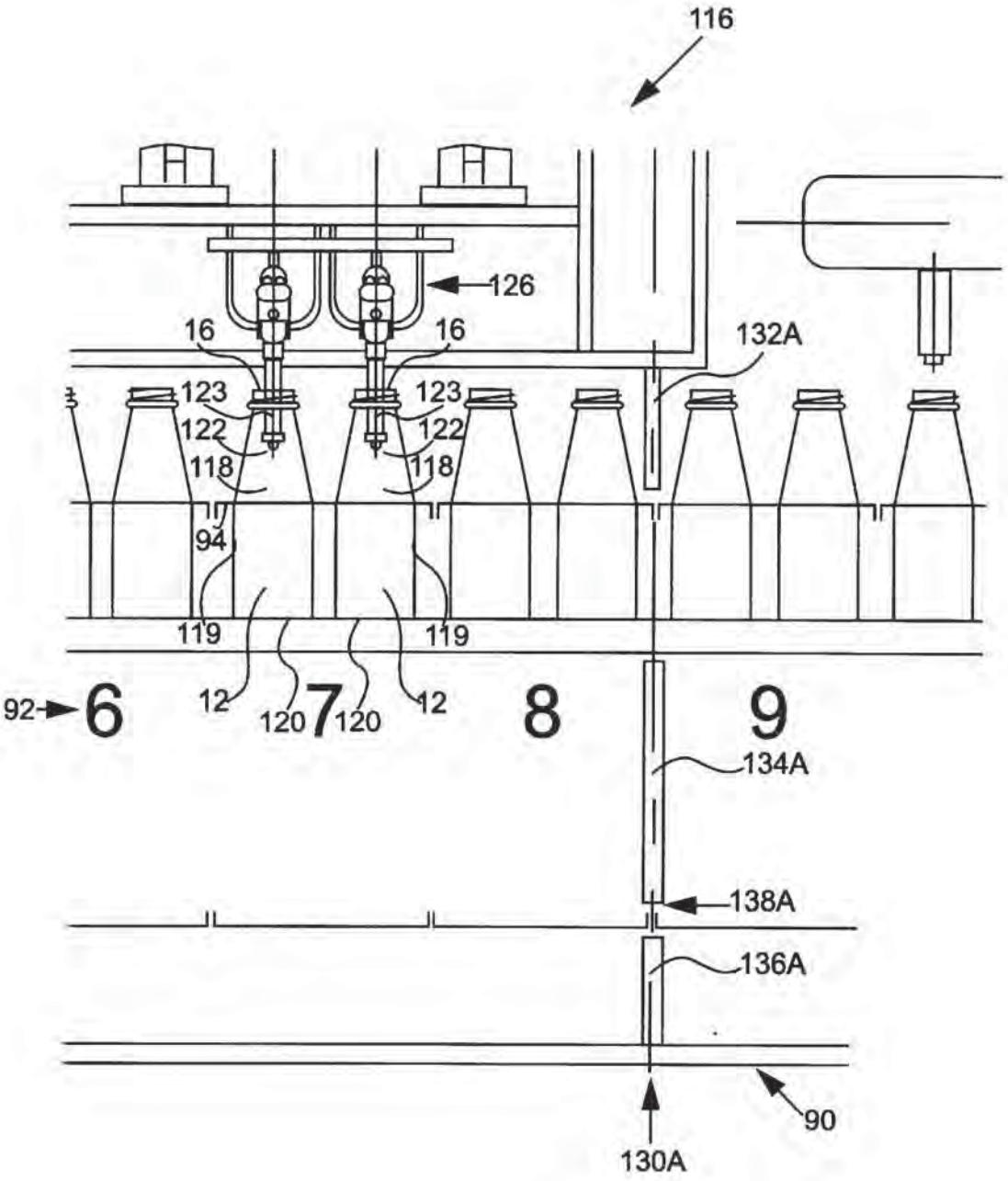


FIG. 9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132A
123
123
122
122
118
118
94
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6
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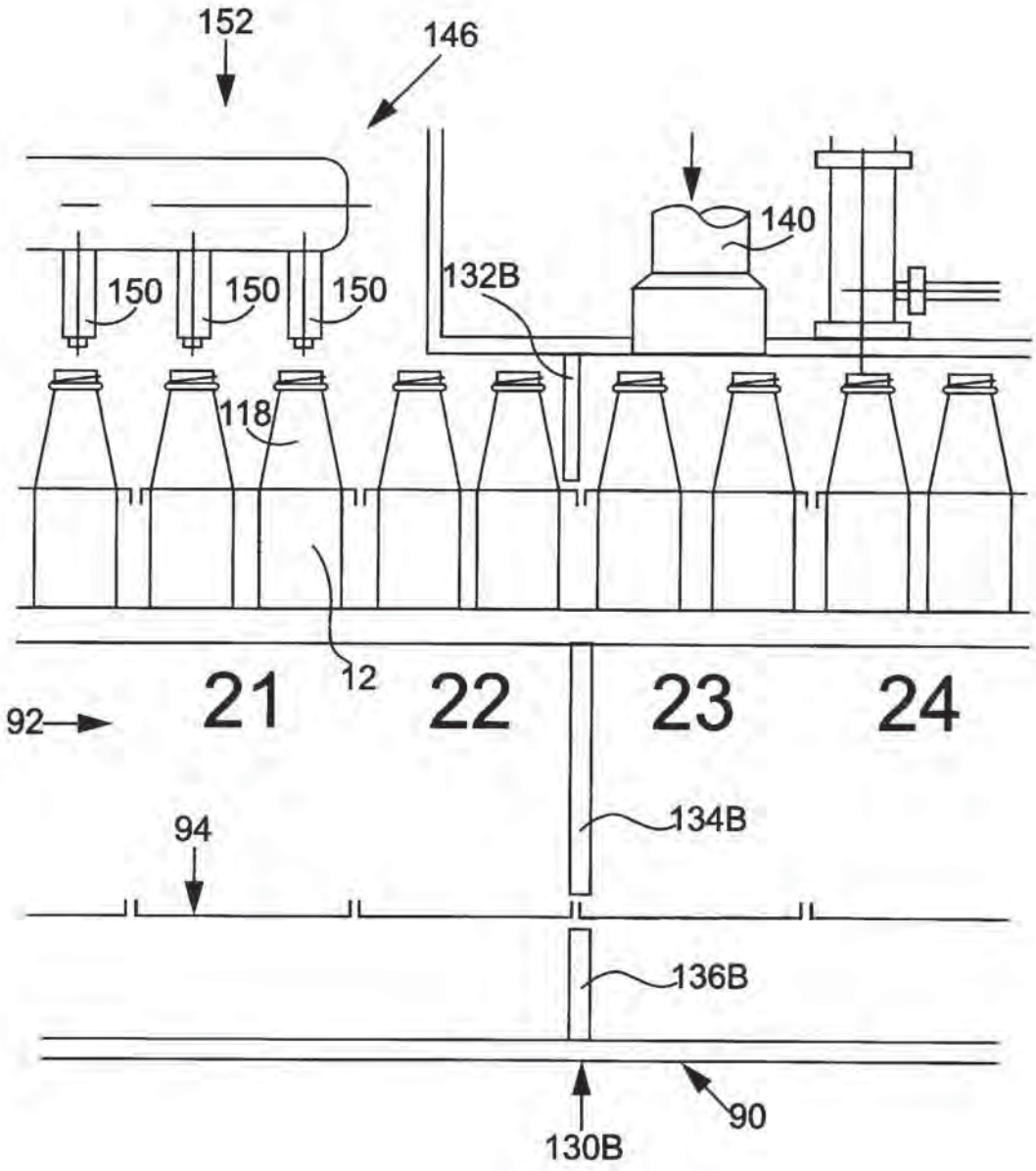
7
120
12
8
9
134A
138A
136A
90
130A

FIG. 10


152
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132B
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130B

FIG. 11

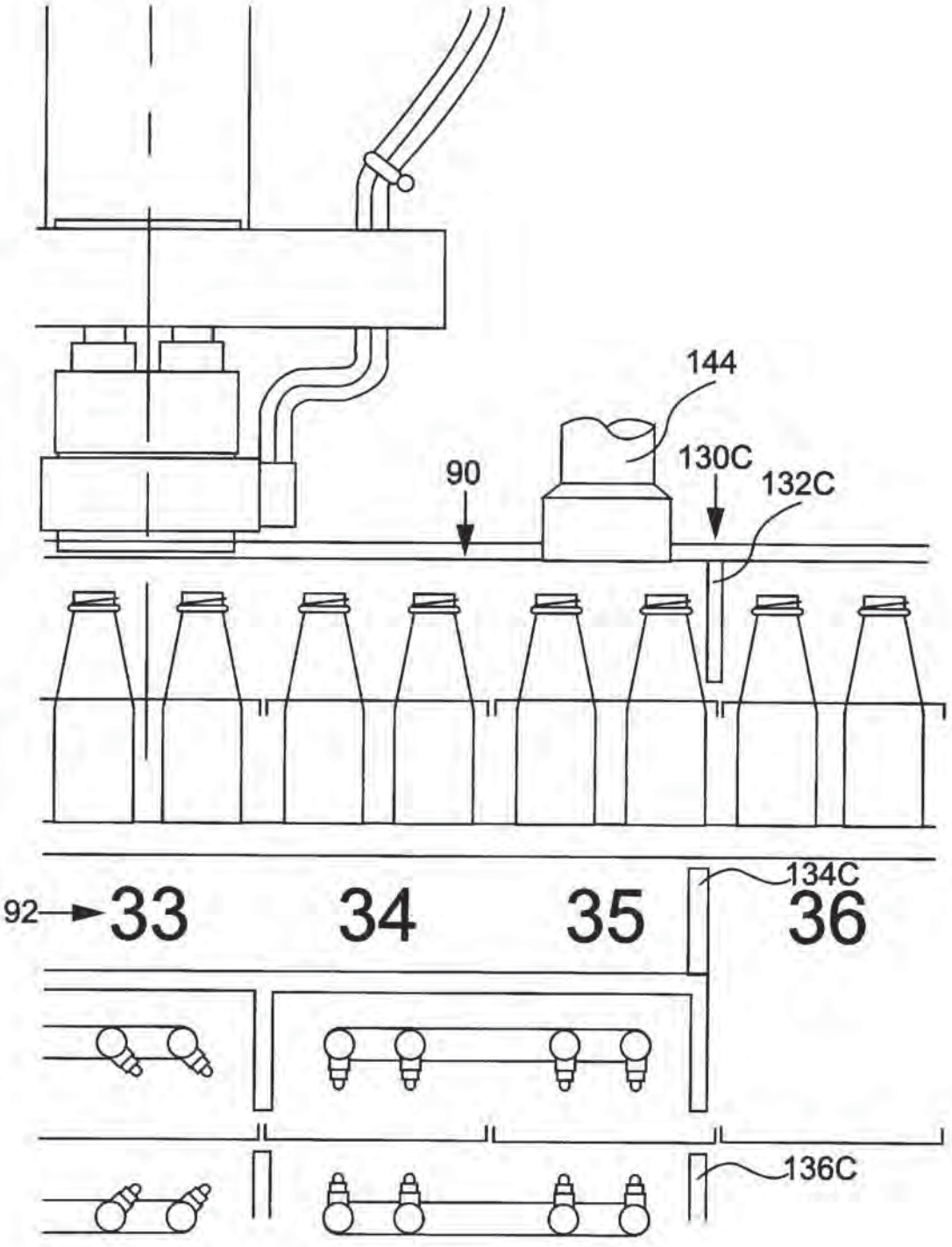
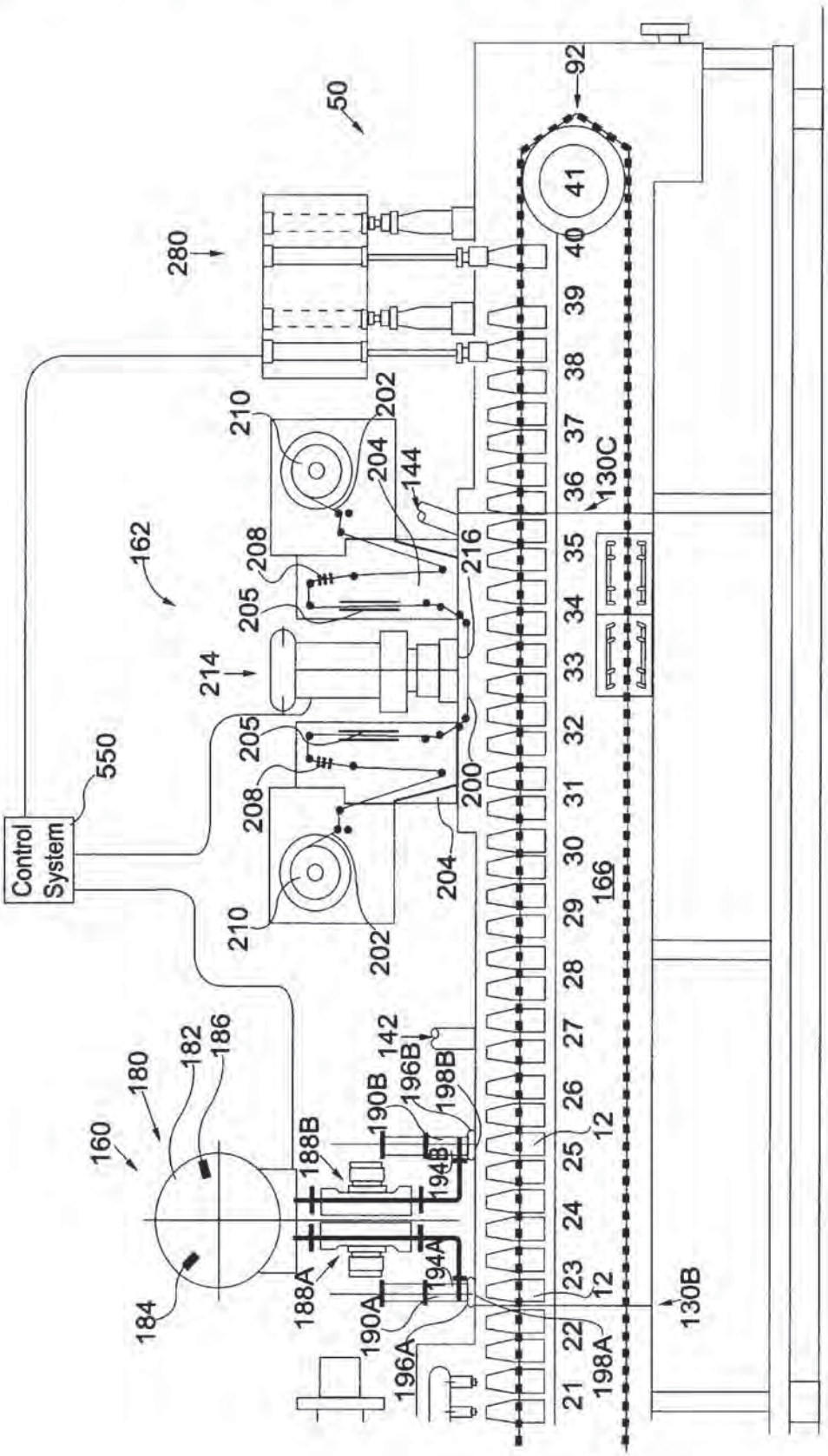


FIG. 12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23
22
21
280
210
202
204
144
130C
162
208
216
205
214
200
166
Control System
550
142
196B
198B
190B
188B
194B
12
160
180
182
186
184
188A
194A
190A
196A
198A
130B

FIG. 13

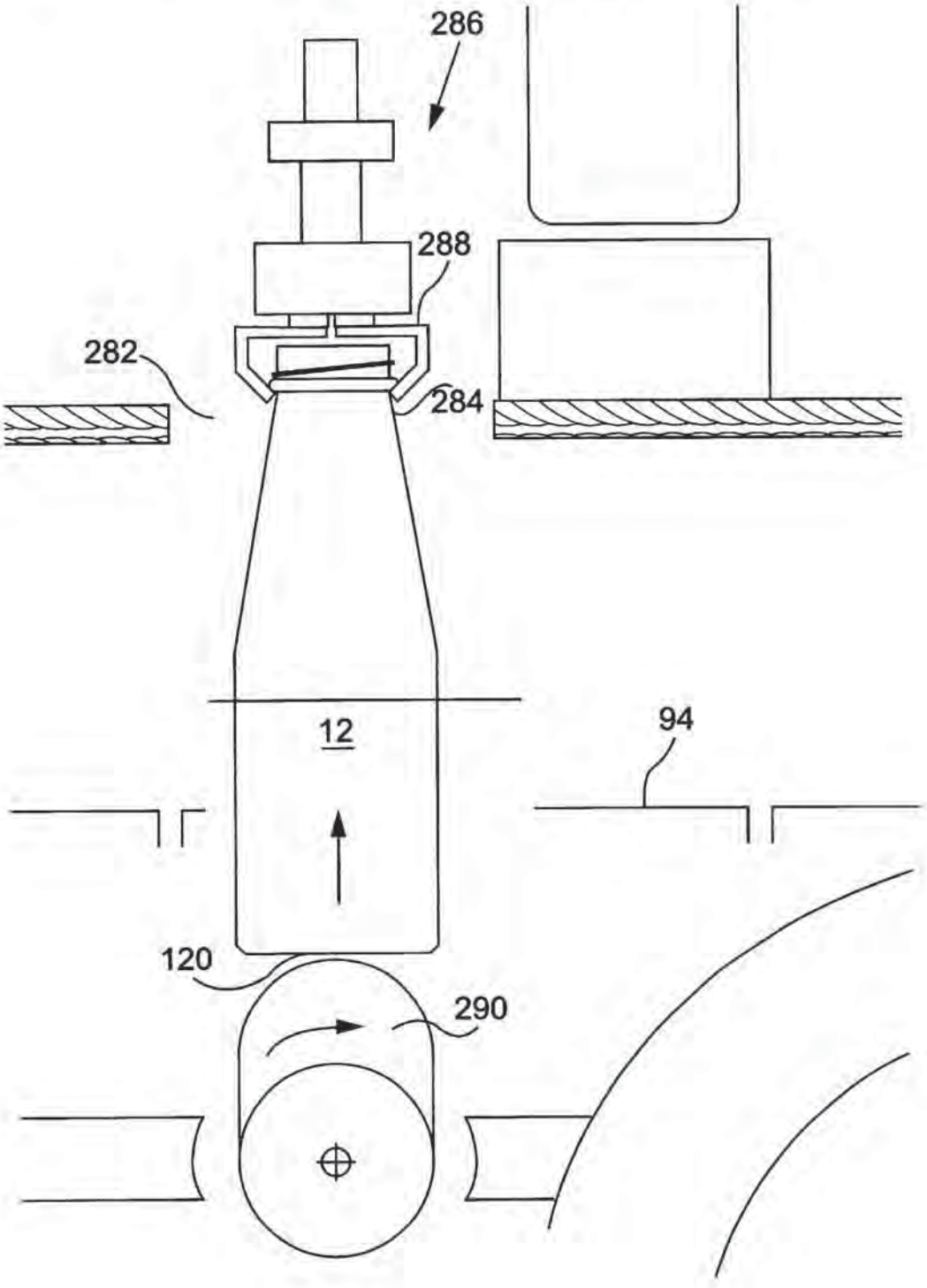


FIG. 14

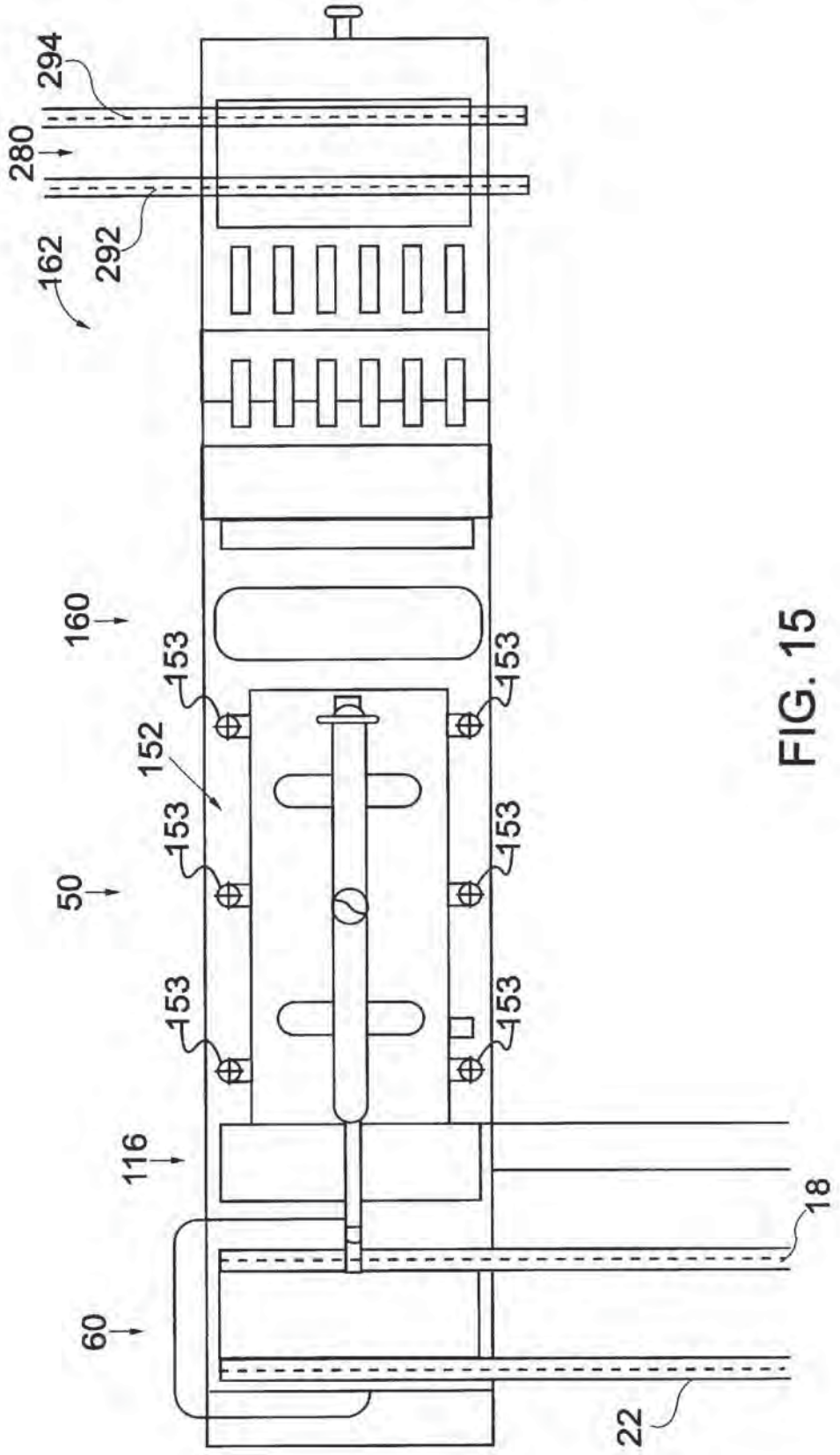
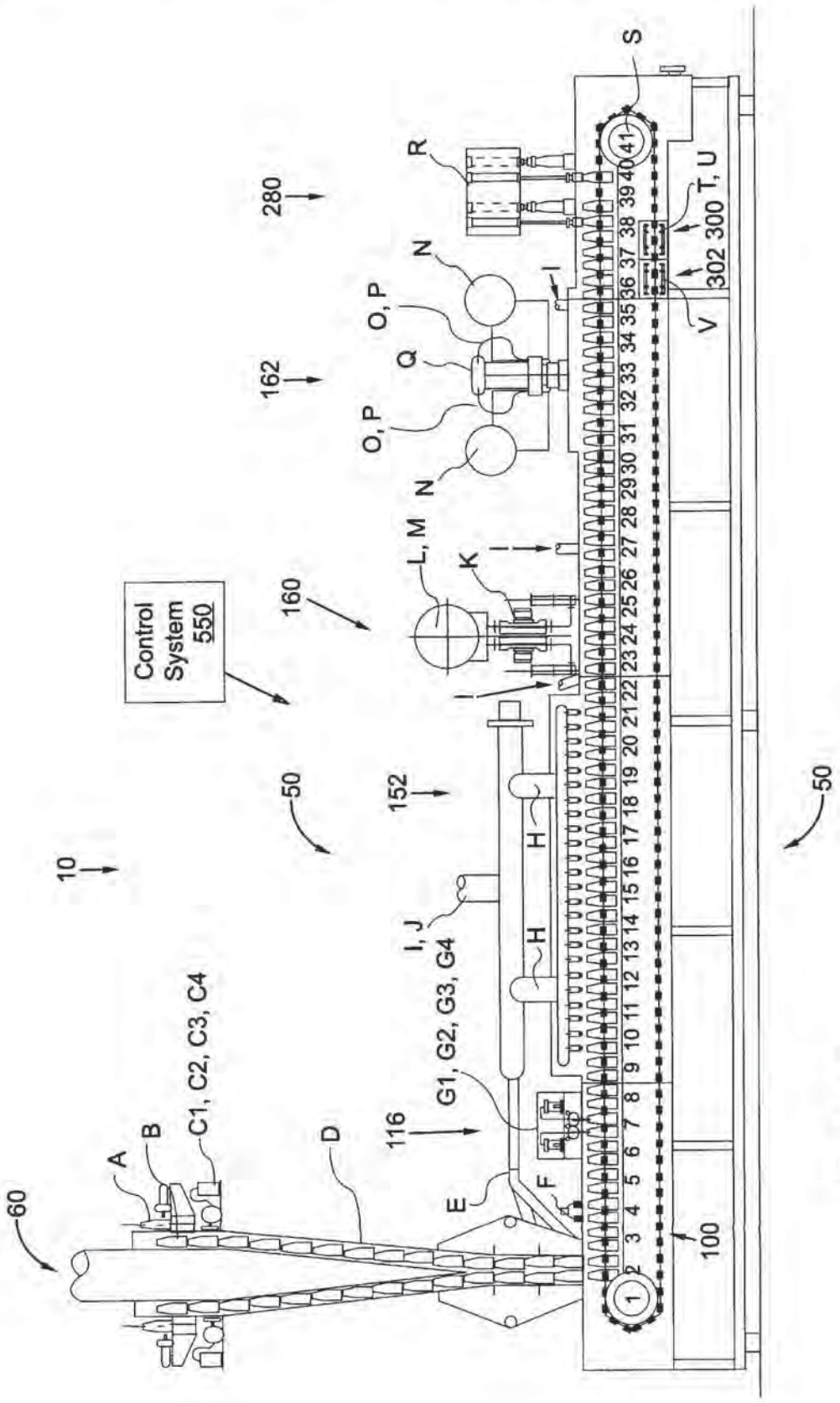


FIG. 15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50
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100
116
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I
K
L, M
N
O, P
Q
O, P
N
R
S
T, U
V
300
302
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FIG. 16

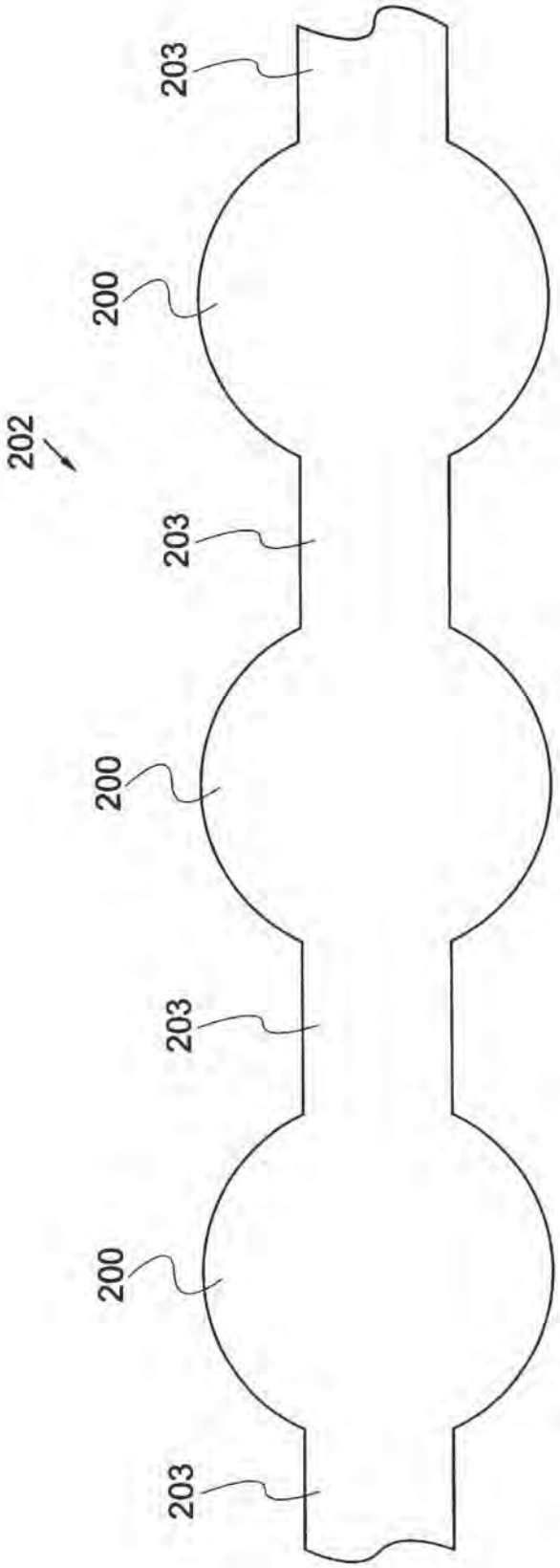


FIG. 17

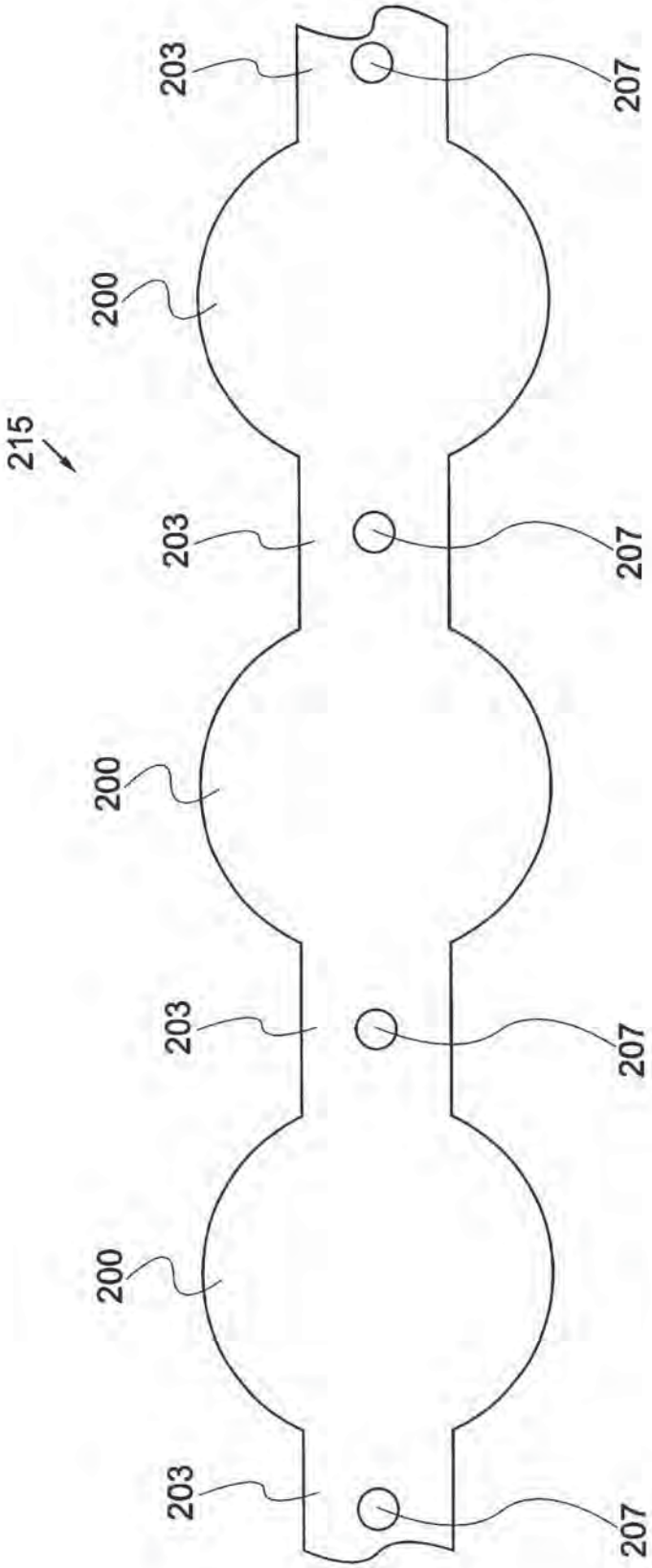
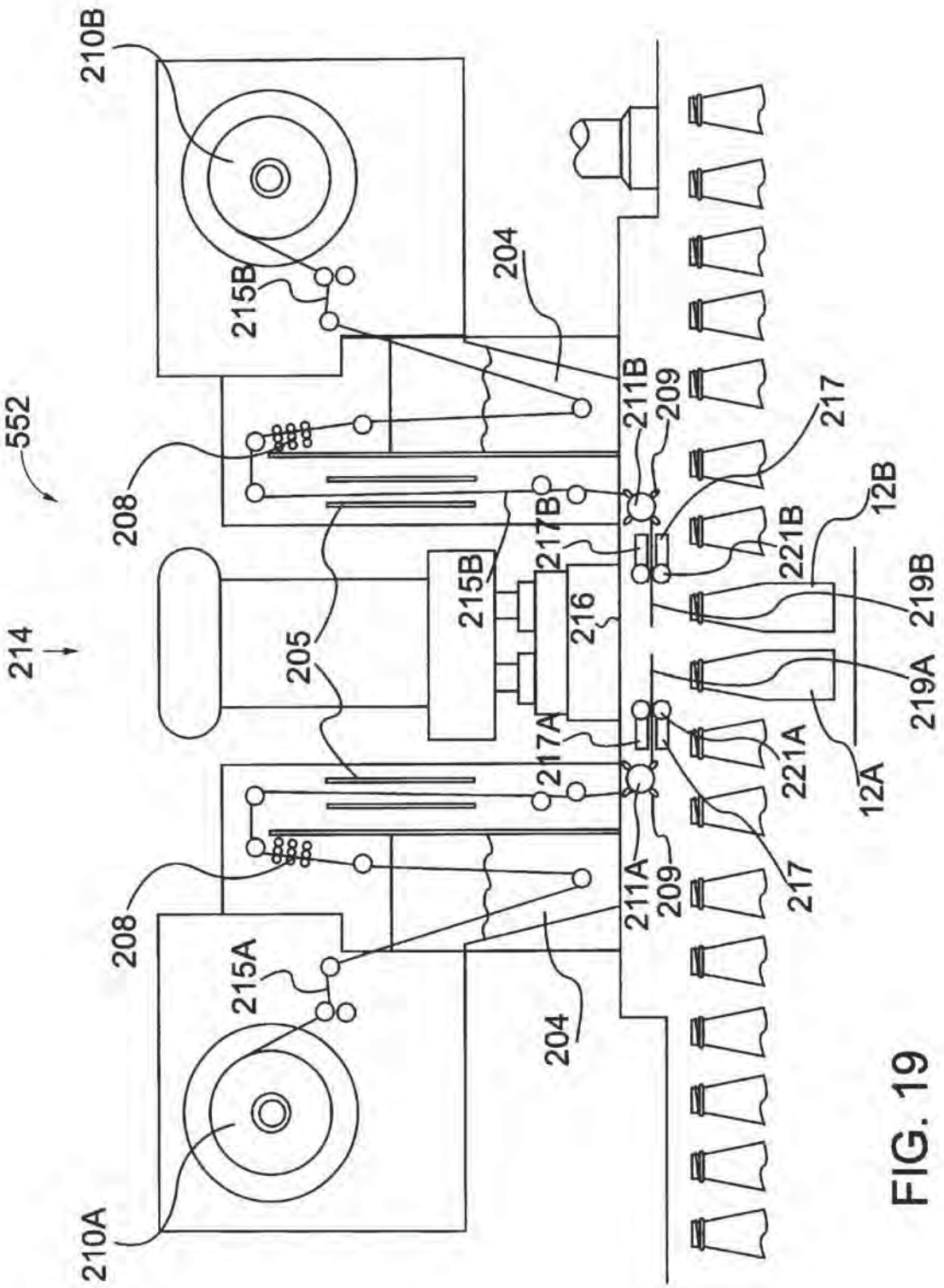


FIG. 18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210A

FIG. 19

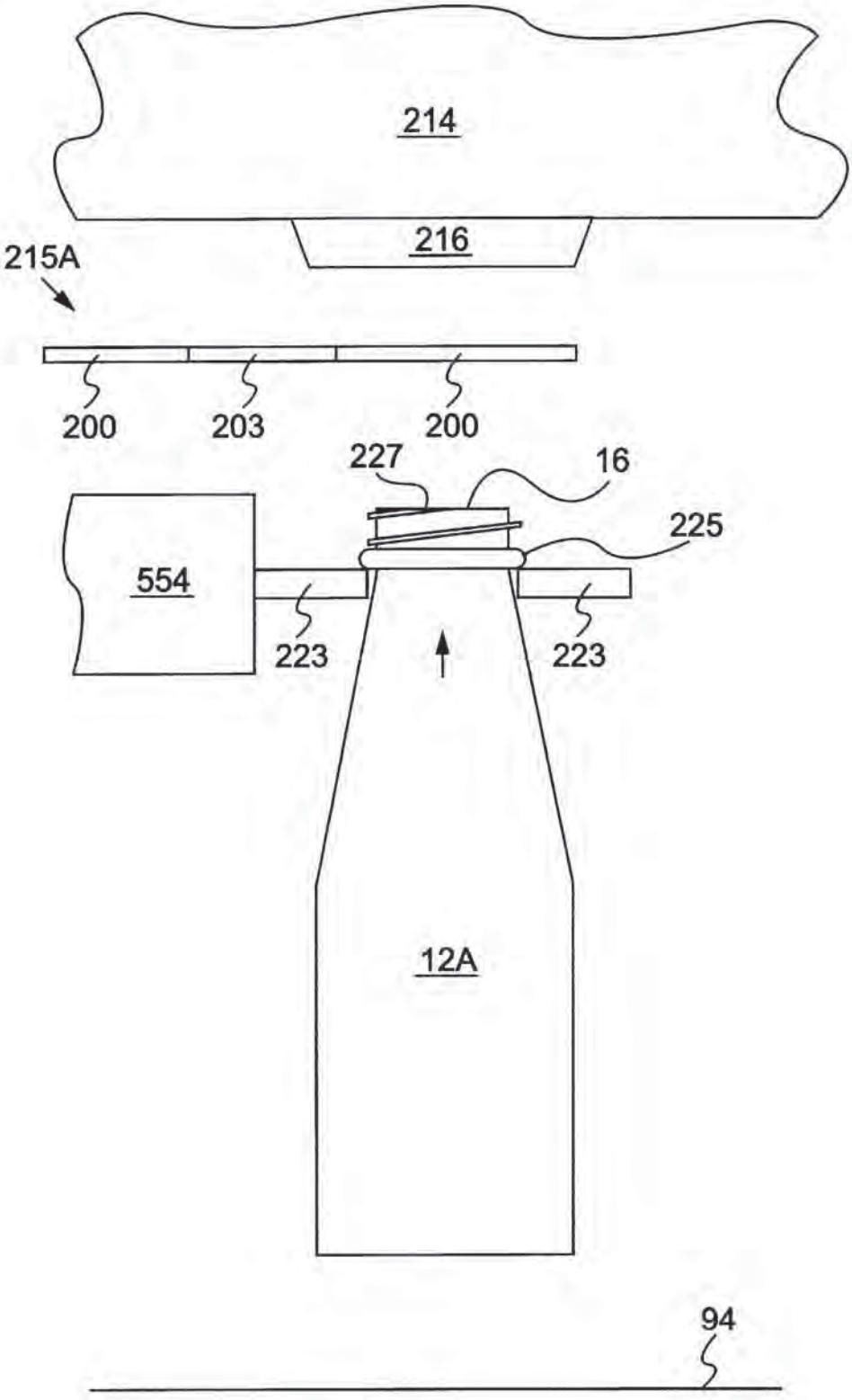
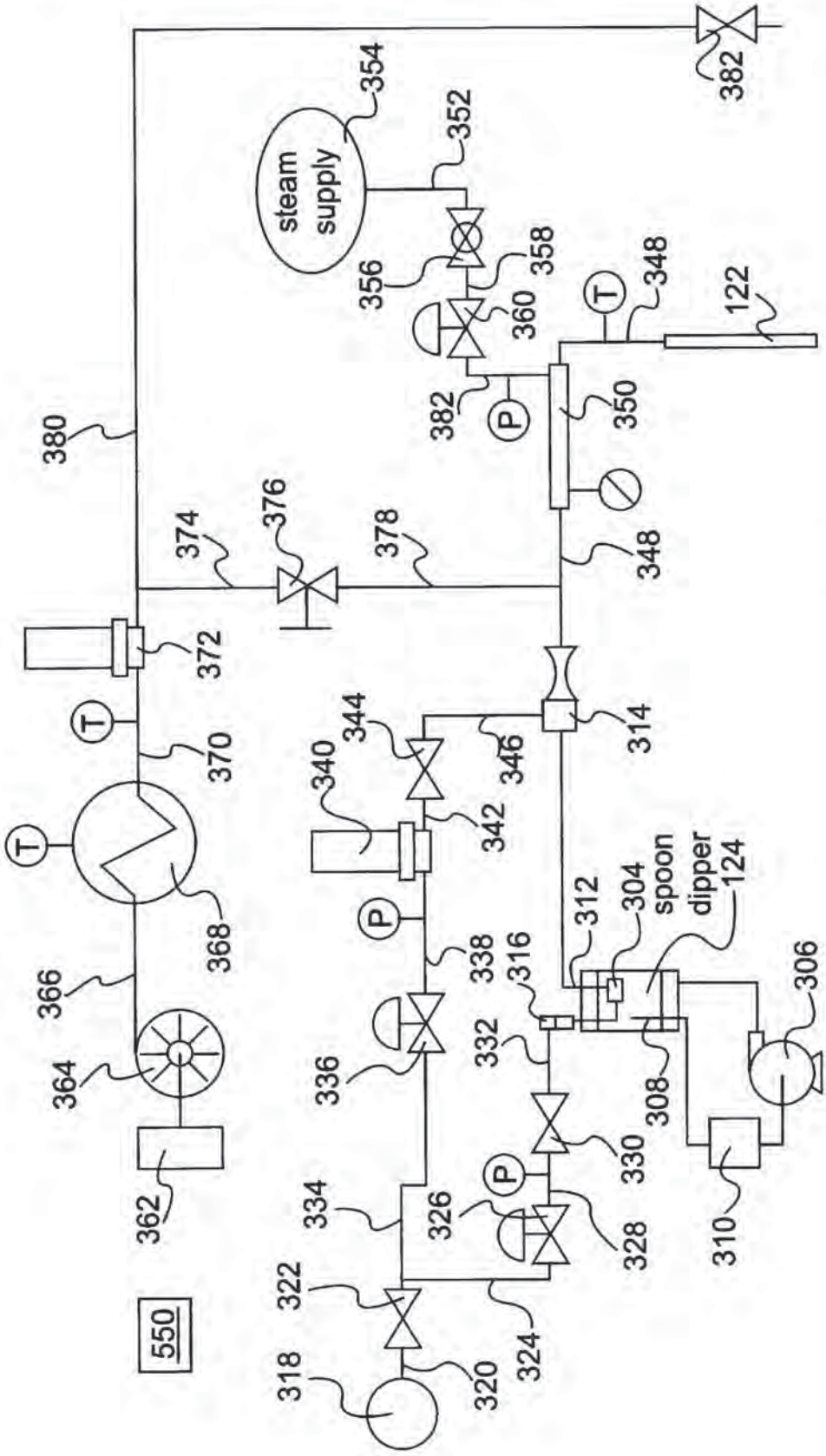


FIG. 20


steam supply
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304
spoon
dipper
124
306
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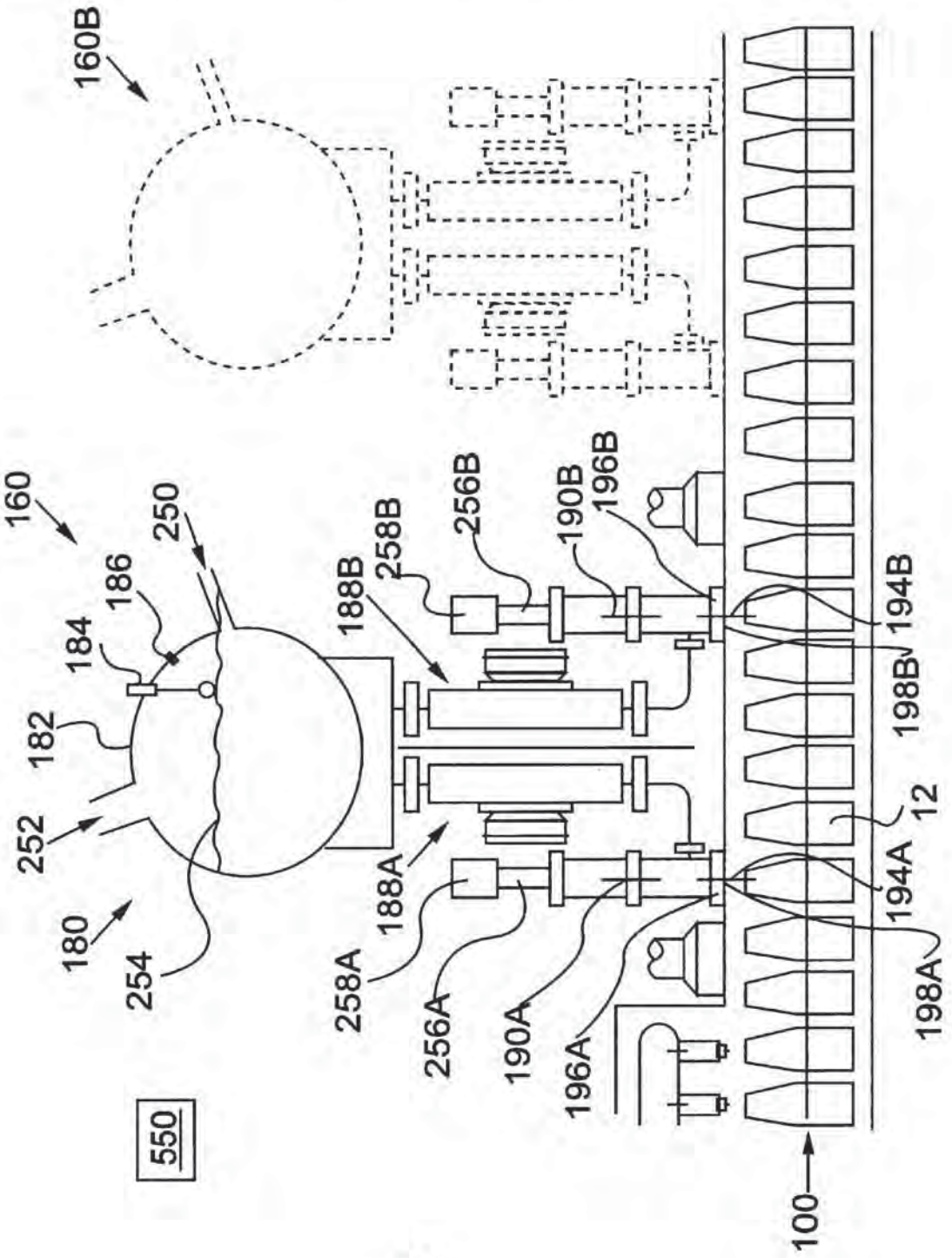
550

FIG. 21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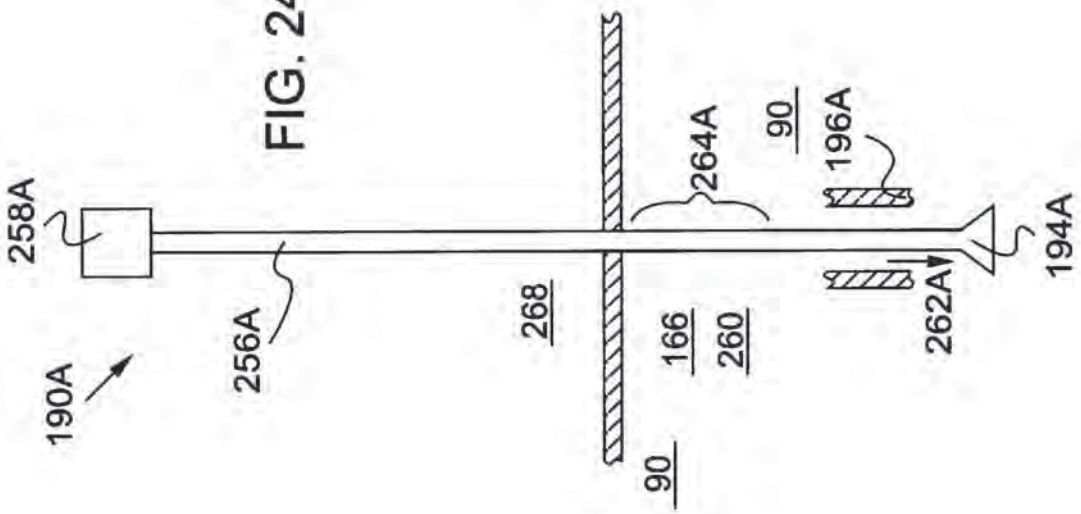
12
550
100

FIG. 22

FIG. 24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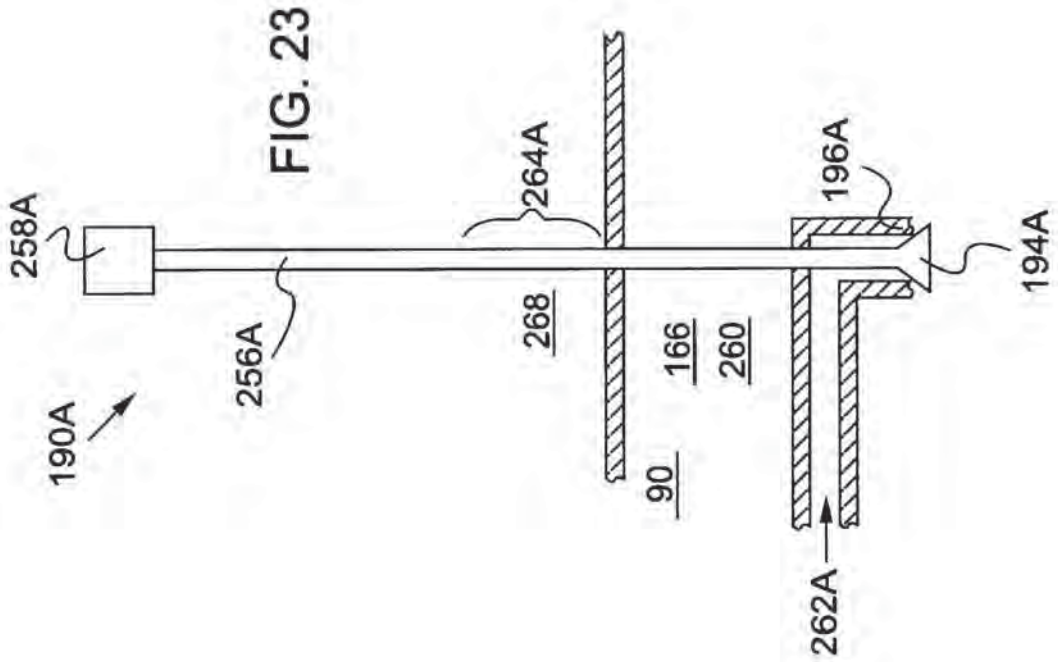
194A

FIG. 23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90
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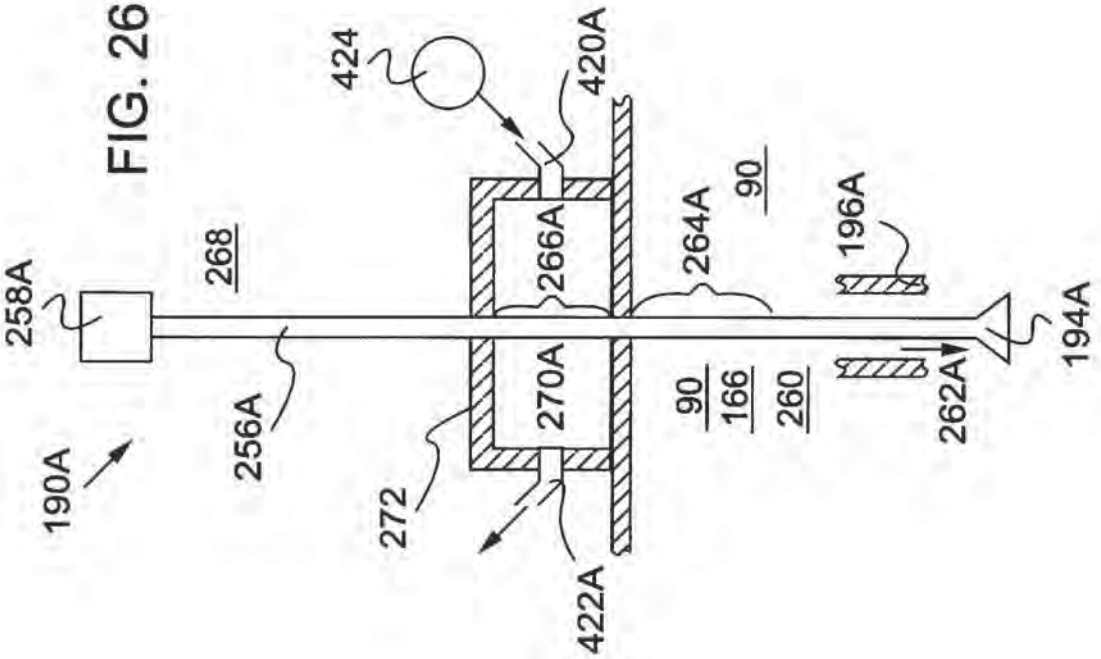
194A
262A

FIG. 26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420A
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256A
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90
166
260
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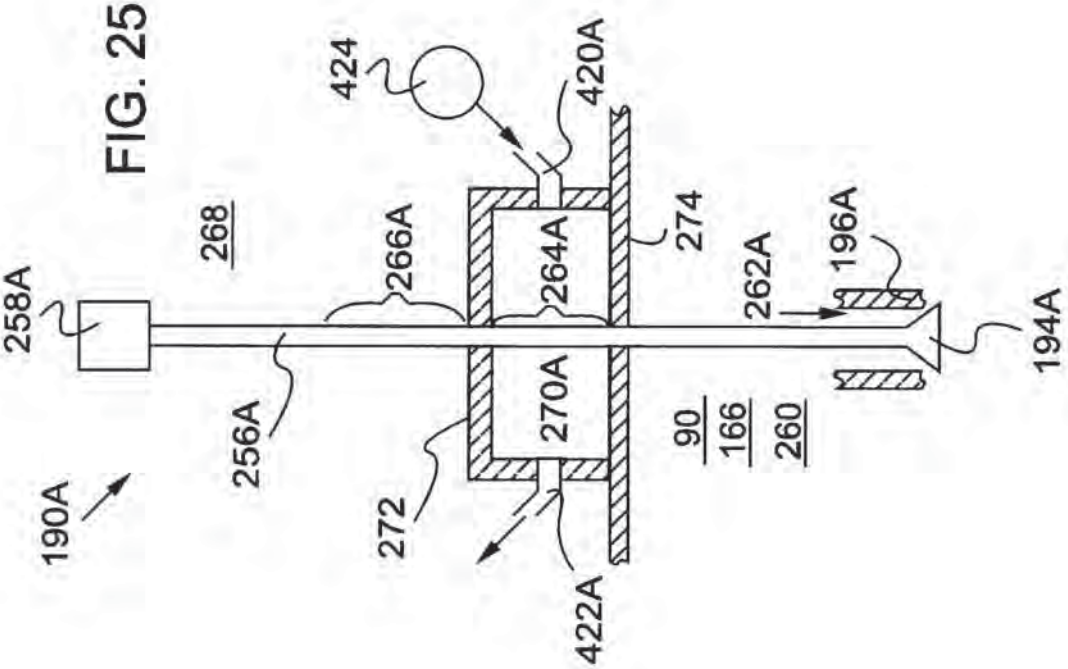
190A
272
422A

FIG. 25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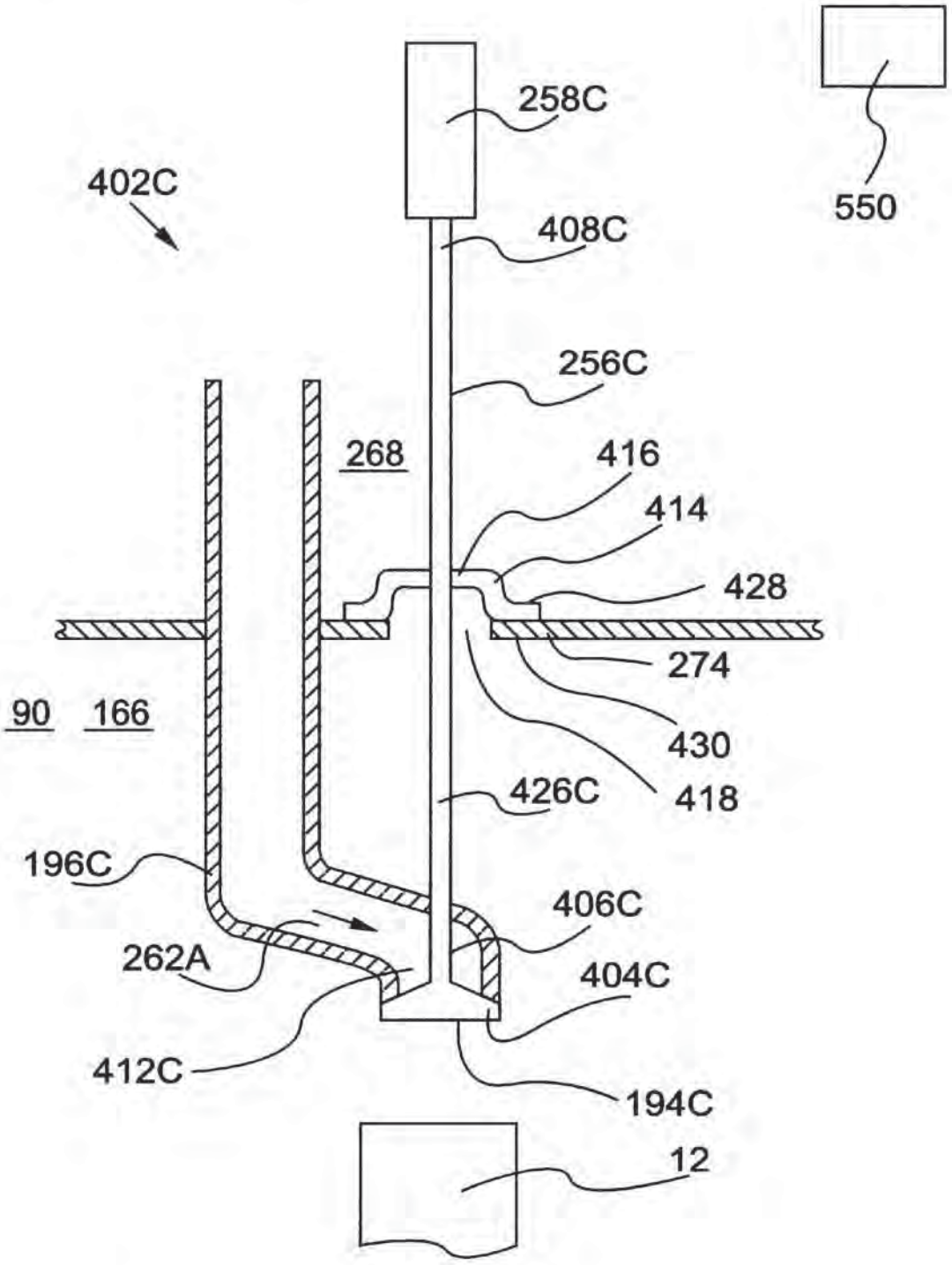
422A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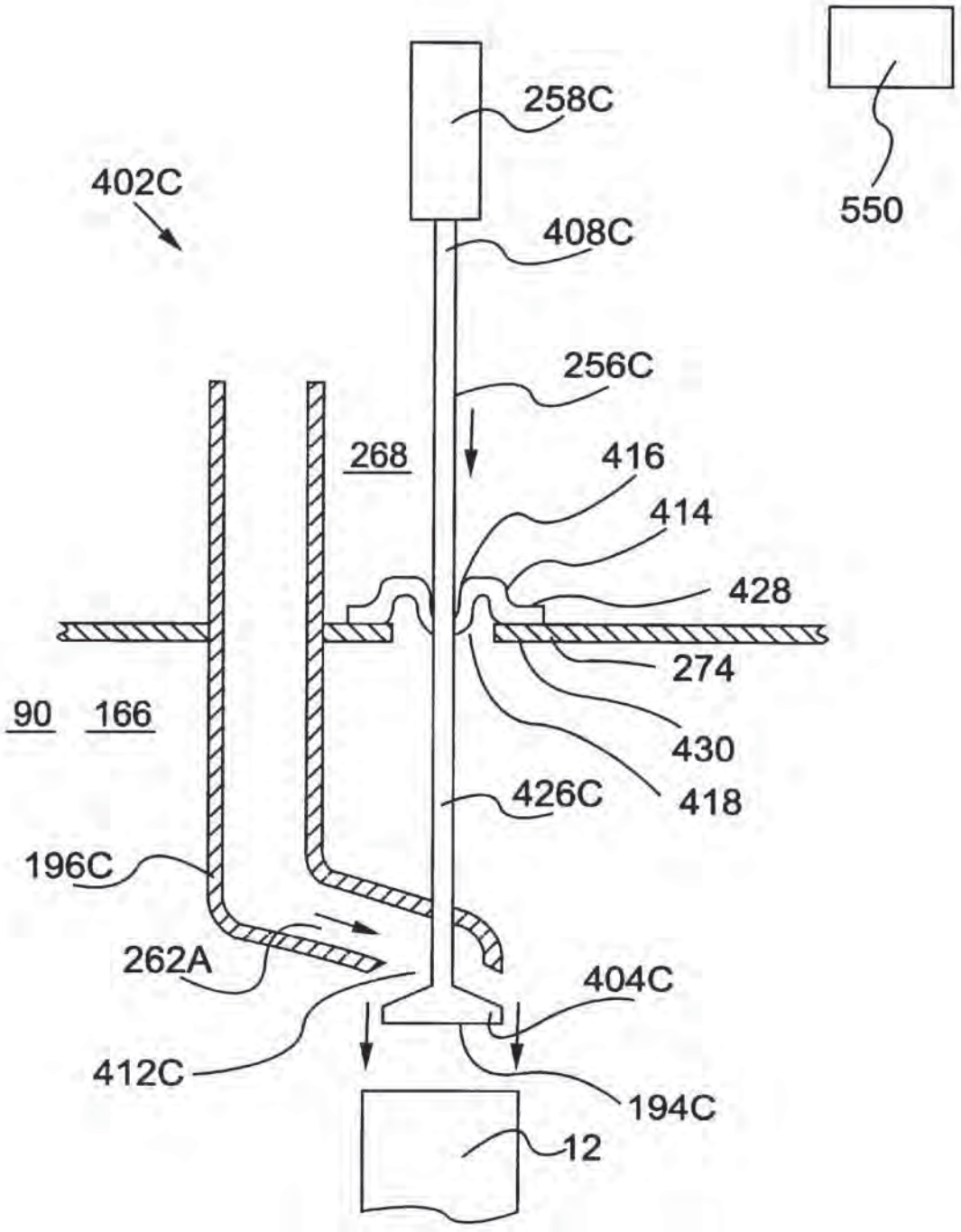
550
402C
408C
256C
268
416
414
428
274
90
166
430
418
426C
196C
406C
262A
404C
412C
194C
12

FIG. 27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274
90
166
430
418
426C
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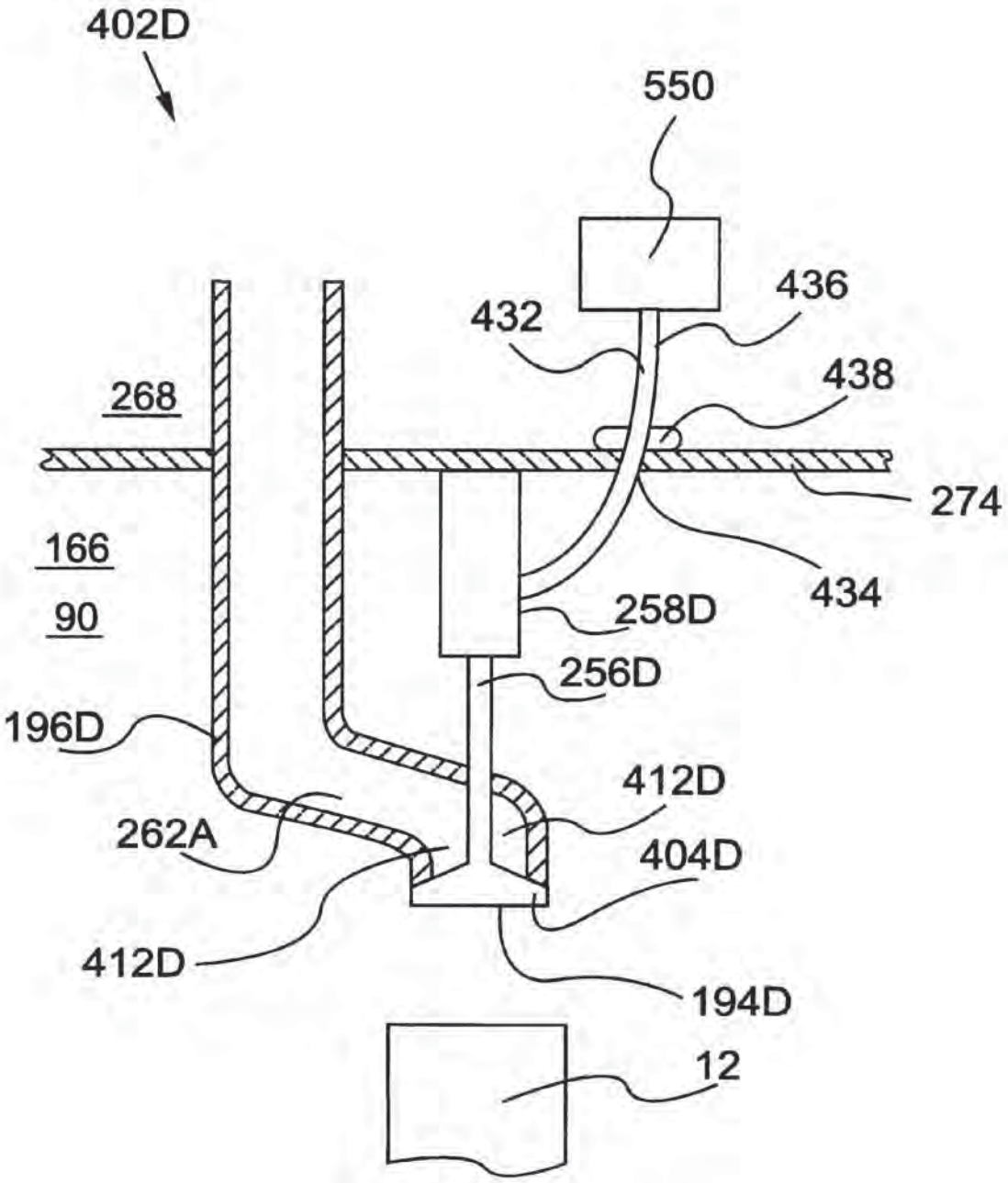
262A
404C
412C
194C
12

FIG. 28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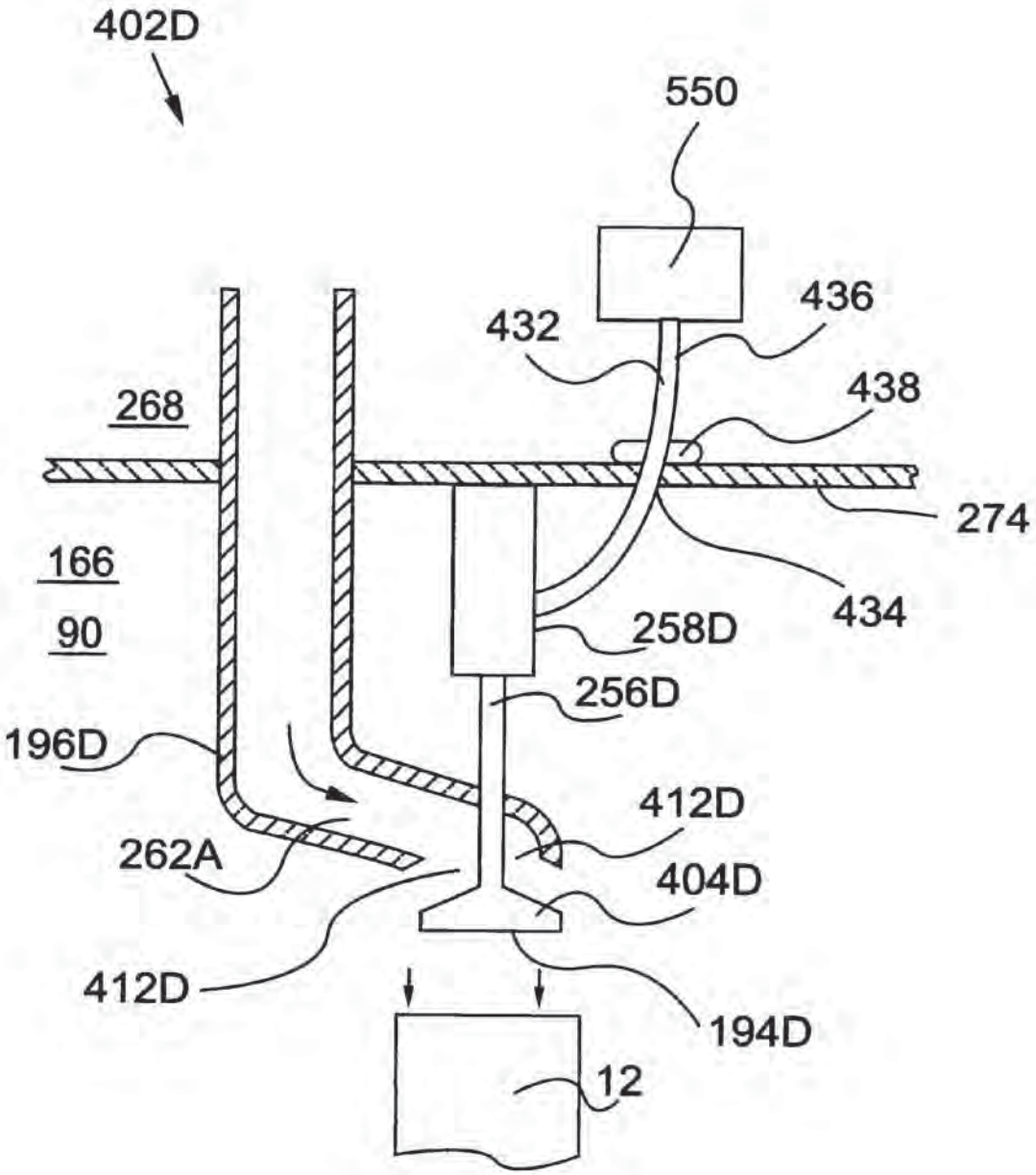
550
436
432
438
268
274
166
90
434
258D
256D
196D
412D
262A
404D
412D
194D
12

FIG. 29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550
436
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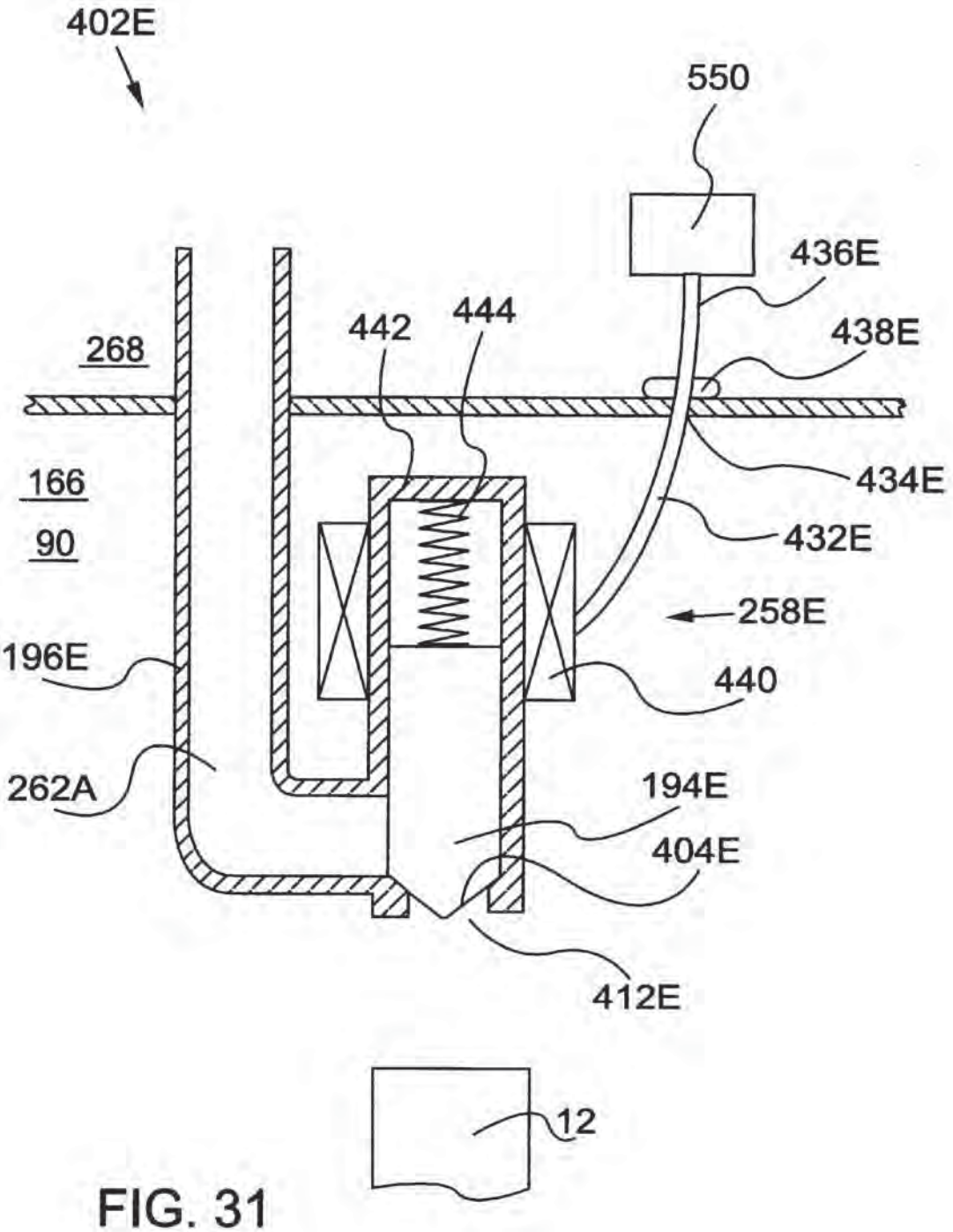
438
268
274
166
90
434
258D
256D
196D
412D
262A
404D
412D
194D
12

FIG. 30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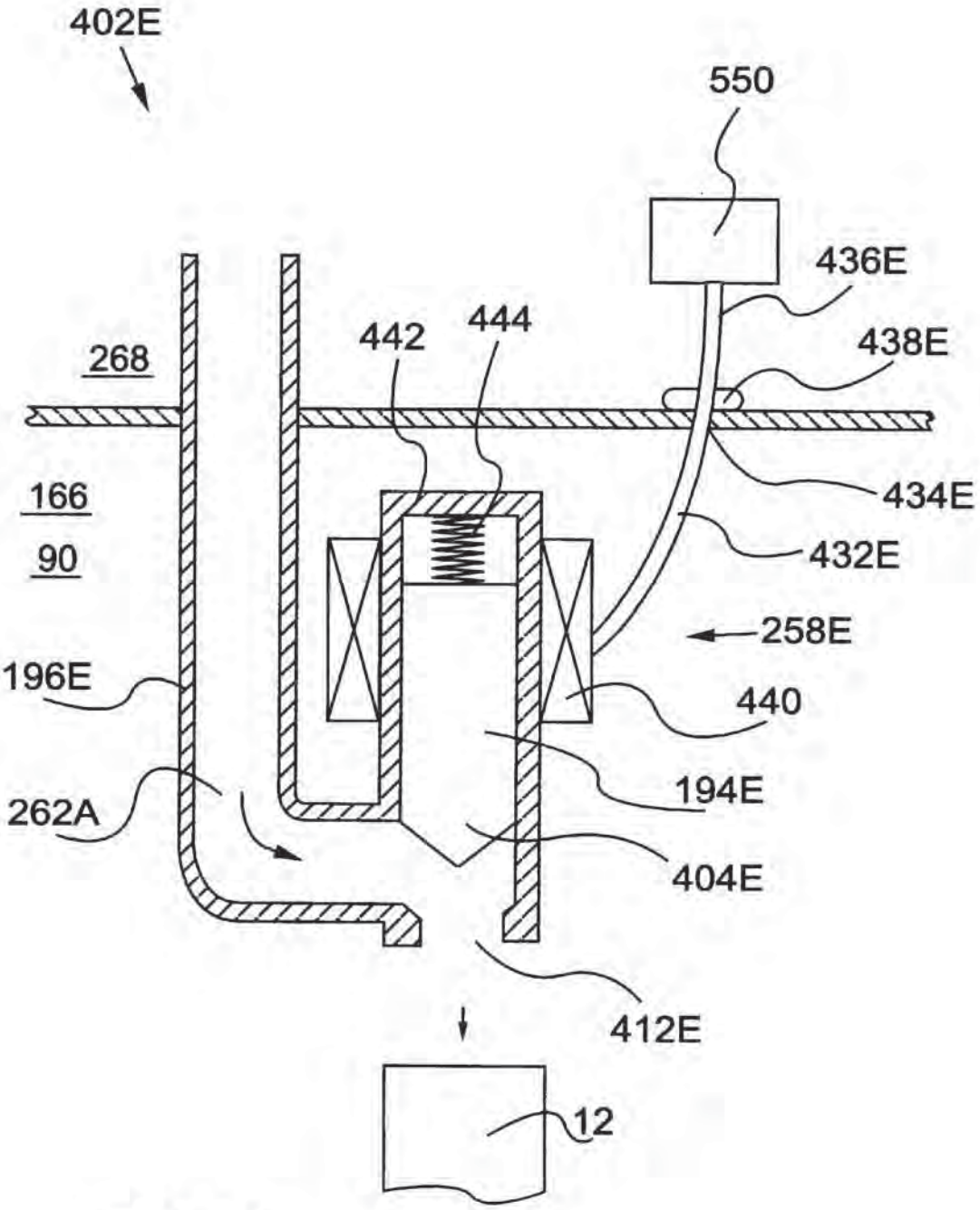
550
436E
438E
442
444
268
434E
166
90
432E
258E
196E
440
262A
194E
404E
412E
12

FIG. 31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434E
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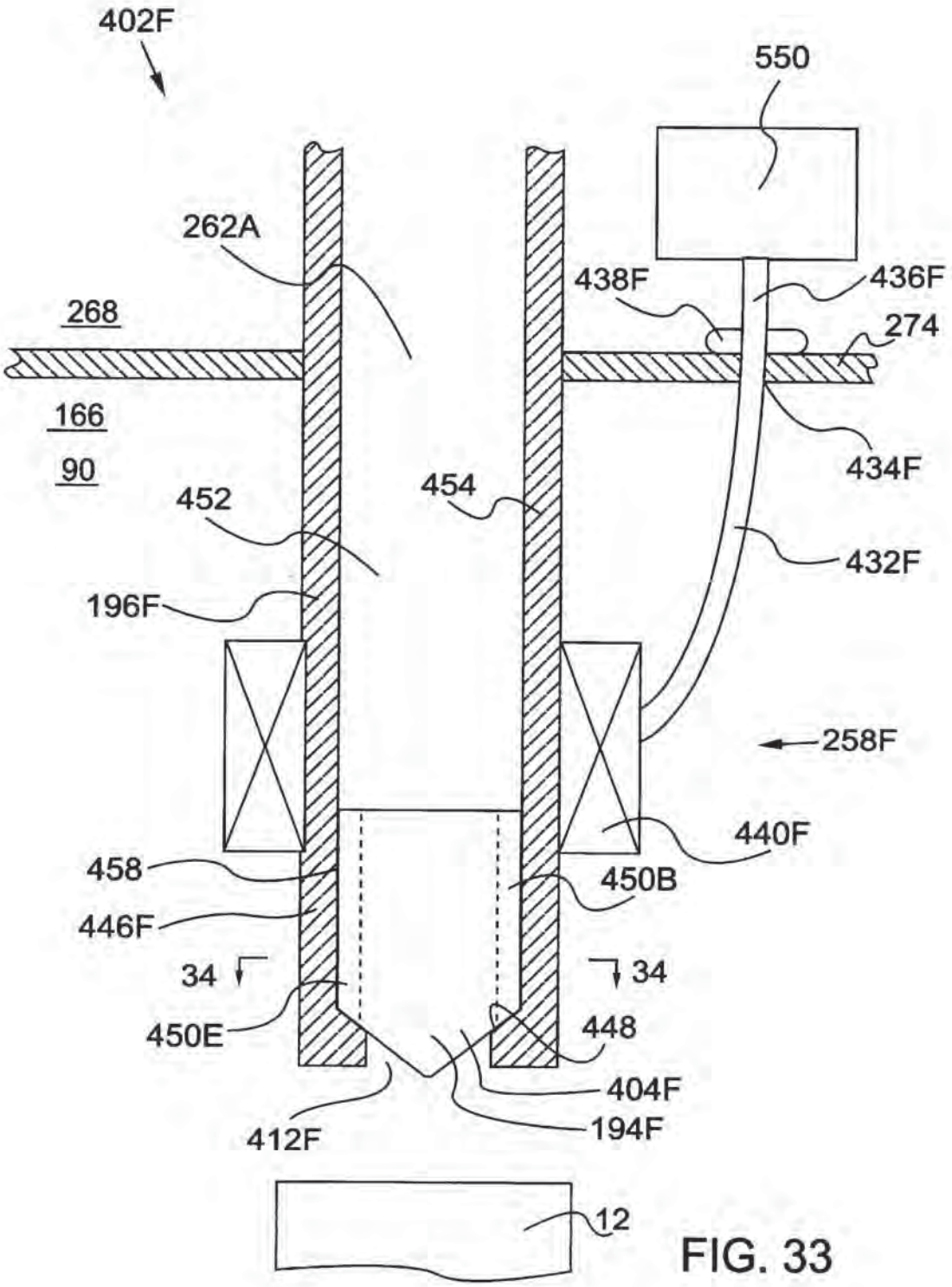
90
432E
258E
196E
440
194E
262A
404E
412E
12

FIG. 32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438F
436F
268
274
166
90
434F
454
452
432F
196F
258F
440F
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446F
34
34
450E
448
404F
194F
412F
12

FIG. 33

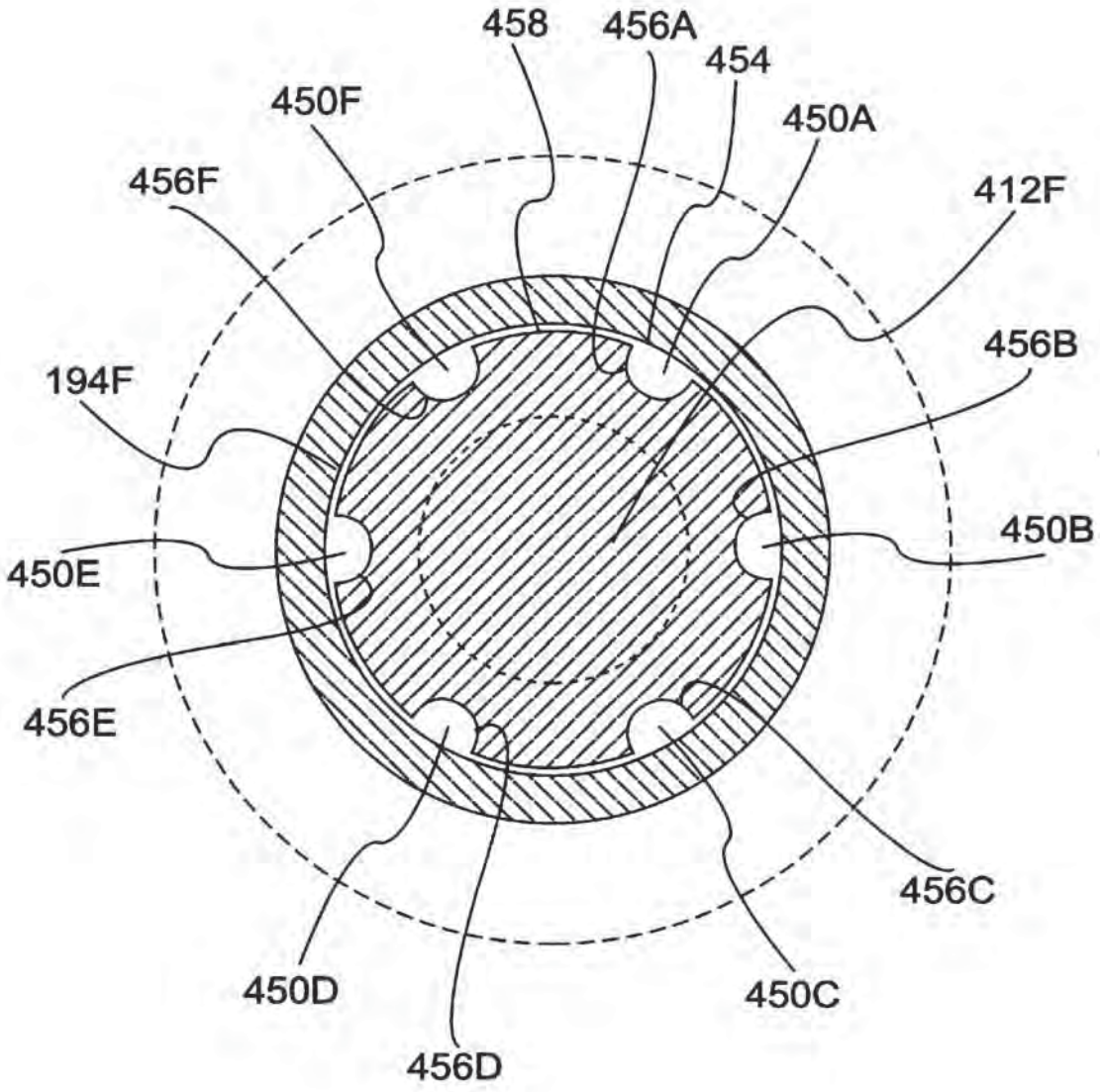
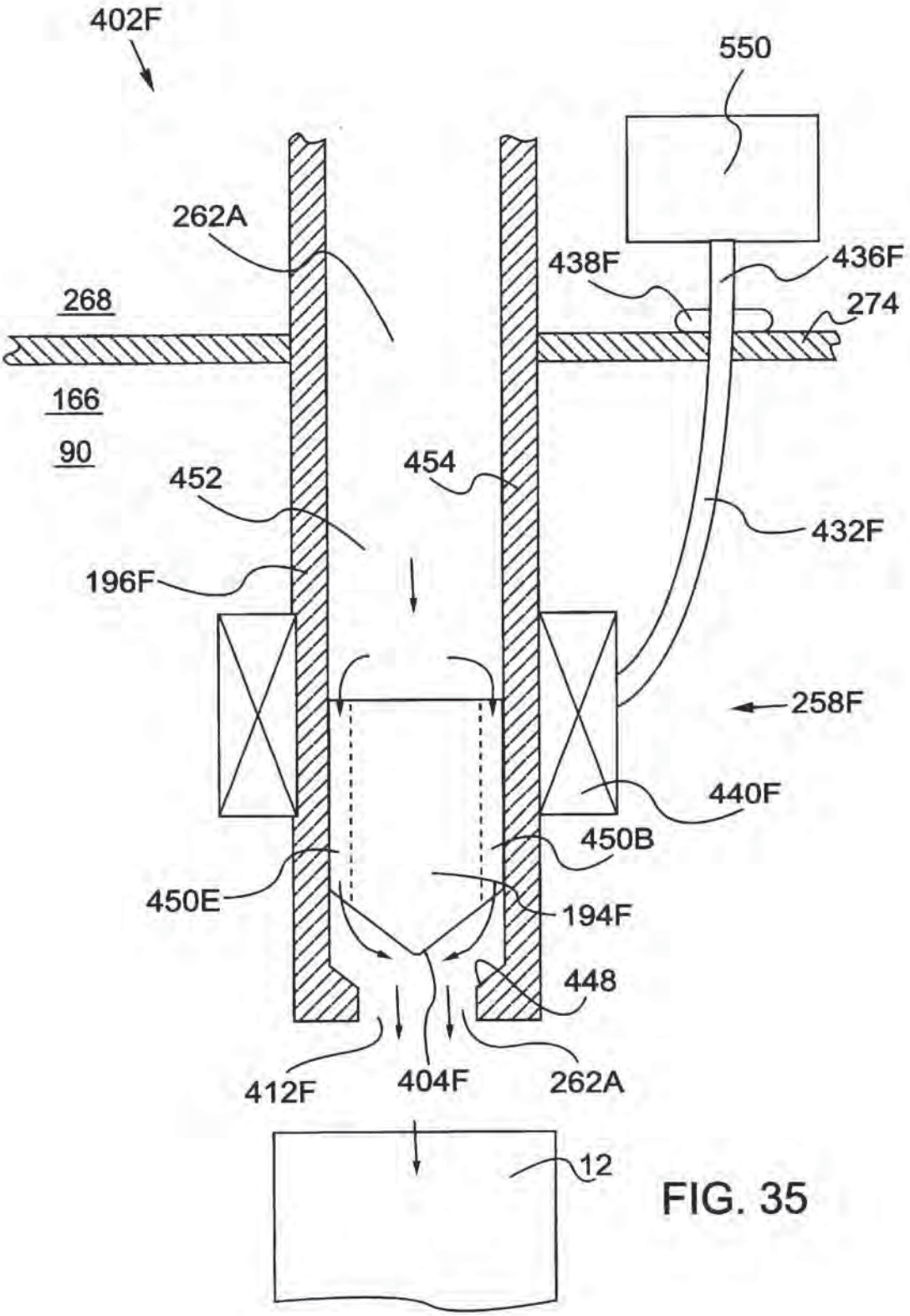

458
456A
454
450F
450A
456F
412F
456B
194F
450B
450E
456E
456C
450D
450C
456D

FIG. 34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90
452
454
432F
196F
258F
440F
450B
450E
194F
448
412F
404F
262A
12

FIG. 35

APPARATUS AND METHOD FOR PROVIDING CONTAINER FILLING IN AN ASEPTIC PROCESSING APPARATUS

The present patent application is a continuation-in-part of copending U.S. patent application Ser. No.: 09/376,992, filed Aug. 18, 1999 now U.S. Pat. No. 6,209,591; and provisional U.S. patent application Ser. No.: 60/118,404, filed Feb. 2, 1999 and entitled "Apparatus and method for providing container filling in an aseptic processing apparatus."

FIELD OF THE INVENTION

The present invention relates generally to systems for the aseptic packaging of food products. More particularly, the present invention relates to an apparatus and method for providing container product filling in an aseptic processing apparatus.

BACKGROUND OF THE INVENTION

Sterilized packaging systems in which a sterile food product is placed and sealed in a container to preserve the product for later use are well known in the art. Methods of sterilizing incoming containers, filling the containers with pasteurized product, and sealing the containers in an aseptic sterilization tunnel are also known.

Liquid product fillers are known in the art. Generally, a container is placed under a filler head. The filler head opens and dispenses the liquid product. When the container is filled to a desired level, the filler head closes and stops the flow of liquid product into the container. Commonly, in line aseptic fillers use completely mechanical devices for measuring and dosing product into containers. These devices include a first apparatus for measuring the amount of material to be dispensed, and a second apparatus which functions as a filling nozzle. Typically, the first apparatus includes a piston cylinder apparatus for measuring the amount of material. The amount of material measured by the piston cylinder apparatus is limited by the diameter and stroke of the piston. The first and second apparatus include complicated mechanical members which are difficult to sterilize, clean, and maintain.

Typically, rotary fillers include multiple filling stations and allow about 7 to 15 seconds for filling. Some of the rotary bottle filers use electronic measuring devices for dosing the desired amount of product into a bottle. In order to meet FDA (Food and Drug Administration) "aseptic" standards and 3A Sanitary Standards, all surfaces of the filler that come into contact with the liquid product must be sterilized. Before filling commences, a plurality of interior parts of the filler must be removed, sterilized, and replaced. This time consuming and expensive process is necessary in order to ensure the complete sterilization of all surfaces that come into contact with the liquid product.

Packaged food products can generally be categorized as high acid products (Ph below 4.5) or low acid products (Ph of 4.5 and above). The high acid content of a high acid product helps to reduce bacteria growth in the product, thereby increasing the shelf life of the product. The low acid content of a low acid product, however, necessitates the use of more stringent packaging techniques, and often requires refrigeration of the product at the point of sale.

Several packaging techniques, including extended shelf life (ESL) and aseptic packaging, have been developed to increase the shelf life of low acid products. During ESL packaging, for example, the packaging material is commonly sanitized and filled with a product in a presterilized tunnel under "ultra-clean" conditions. By using such ESL packaging techniques, the shelf life of an ESL packaged product is commonly extended from about 10 to 15 days to about 90 days. Aseptic packaging techniques, however, which require that the packaging take place in a sterile environment, using presterilized containers, etc., are capable of providing a packaged product having an even longer shelf life of 150 days or more. In fact, with aseptic packaging, the shelf life limitation is often determined by the quality of the taste of the packaged product, rather than by a limitation caused by bacterial growth.

For the aseptic packaging of food products, an aseptic filler must, for example, use an FDA (Food and Drug Administration) approved sterilant, meet FDA quality control standards, use a sterile tunnel or clean room, and must aseptically treat all packaging material. The food product must also be processed using an "Ultra High Temperature" (UHT) pasteurization process to meet FDA aseptic standards. The packaging material must remain in a sterile environment during filling, closure, and sealing operations.

Many attempts have been made, albeit unsuccessfully, to aseptically fill containers, such as bottles or jars having small openings, at a high output processing speed. In addition, previous attempts for aseptically packaging a low acid product in plastic bottles or jars (e.g., formed of polyethylene terepthalate (PET) or high density polyethylene (HDPE)), at a high output processing speed, have also failed. Furthermore, the prior art has not been successful in providing a high output aseptic filler that complies with the stringent United States FDA standards for labeling a packaged product as "aseptic." In the following description of the present invention, the term "aseptic" denotes the United States FDA level of aseptic.

SUMMARY OF THE INVENTION

In order to overcome the above deficiencies, the present invention provides an apparatus and method for providing container product filling in an aseptic processing apparatus. Additionally, the present invention provides both a "Clean In Place" (CIP) process for cleaning, and a "Sterilizing in Place" for sterilizing all of the interior surfaces of the filler without having to disassemble the filler. The filler apparatus includes a smooth filling tube which is easy to clean and sterilize. The filler apparatus is used in a system for providing aseptically processed low acid products in a container having a small opening, such as a glass or plastic bottle or jar, at a high output processing speed. Many features are incorporated into the filler apparatus in order to meet various FDA aseptic standards and 3A Sanitary Standards and Accepted Practices.

The present invention generally provides an apparatus comprising:

- a sterile tunnel for surrounding a plurality of aseptically sterilized containers with pressurized sterile air;
- a valve head for controlling the flow of an aseptically sterilized product by opening and closing an outlet port of a nozzle carrying the aseptically sterilized product;
- a first end of a valve stem attached to the valve head;
- a second end of the valve stem attached to a valve actuator system for displacing the valve stem;
- an opening in a wall of the sterile tunnel through which the valve stem passes; and
- a flexible diaphragm attached to the valve stem and to an outer peripheral portion of the opening in the wall of

the sterile tunnel for preventing contaminants from passing into the sterile tunnel through the opening in the wall of the sterile tunnel.

The present invention provides another embodiment of the apparatus comprising:

a sterile tunnel for surrounding a plurality of aseptically sterilized containers with pressurized sterile air;

a nozzle for carrying an aseptically sterilized product into the sterile tunnel;

a valve head for controlling the flow of aseptically sterilized product by opening and closing an outlet port of the nozzle;

a first end of a valve stem attached to the valve head;

a second end of the valve stem attached to a sealed actuator system for displacing the valve stem, wherein the valve head, the valve stem and the sealed actuator system are surrounded by the sterile tunnel;

a control conduit connecting the sealed actuator system with a control system;

an opening in a wall of the sterile tunnel through which the control conduit passes; and

a sealing member for sealing the control conduit within the opening in the wall of the sterile tunnel.

The present invention provides another embodiment of the apparatus comprising:

a sterile tunnel for surrounding a plurality of aseptically sterilized containers with pressurized sterile air;

a valve for controlling the flow of an aseptically sterilized product through an outlet port of a nozzle;

a plurality of flow passages formed between an inner wall of the nozzle and a plurality of indentations on an outer surface of the valve, wherein the plurality of flow passages transport the aseptically sterilized product to the outlet port;

a valve seat in the nozzle for stopping the flow of aseptically sterilized product through the plurality of flow passages;

a sealed actuator system for displacing the valve into an open position; and

a control conduit connecting the sealed actuator system with a control system.

The present invention provides a method comprising:

controlling the flow of an aseptic product using a valve;

surrounding a region where the aseptic product exits the valve with a sterile region; and

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region.

The present invention provides another method comprising:

controlling the flow of an aseptic product through a nozzle using a valve;

surrounding a region where the aseptic product exits the valve with a sterile region; and

displacing the valve with an electromagnetic actuator, wherein an electrical current applied to the electromagnetic actuator displaces the valve into an open position allowing the aseptic product to flow through an outlet port of the nozzle.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention will best be understood from a detailed description of the invention and a preferred embodiment, thereof selected for the purposes of illustration, and shown in the accompanying drawings in which:

FIG. **1** is a plan view of an aseptic processing apparatus in accordance with a preferred embodiment of the present invention;

FIG. **2** is a side view of the aseptic processing apparatus of FIG. **1**;

FIG. **3** is a partial cross-sectional side view of the aseptic processing apparatus of FIG. **1**;

FIG. **4** is a cross-sectional side view of a bottle infeed and sterilization apparatus;

FIG. **5** illustrates a cross-sectional top view of the bottle infeed and sterilization apparatus taken along line **5**—**5** of FIG. **4**;

FIG. **6** is an interior sectional view of an interior wall taken along line **6**—**6** of FIG. **4**;

FIG. **7** s a cross-sectional view of the bottle infeed and sterilization apparatus taken along line **7**—**7** of FIG. **4**;

FIG. **8** is a perspective view of a conveying plate for use in the aseptic processing apparatus of the present invention;

FIG. **9** is a perspective view of a partition in a sterilization tunnel;

FIG. **10** is a cross-sectional side view of an interior bottle sterilization apparatus and the partition located between stations **8** and **9**;

FIG. **11** is a cross-sectional side view of the partition located between stations **22** and **23**;

FIG. **12** is a cross-sectional side view of the partition located between stations **35** and **36**;

FIG. **13** is a cross-sectional side view of a lid sterilization and heat sealing apparatus;

FIG. **14** is a side view of a lifting apparatus with a gripper mechanism for lifting the bottles from the sterilization tunnel;

FIG. **15** is a top view of the aseptic processing apparatus;

FIG. **16** is a side view of the aseptic processing apparatus indicating the control and monitoring locations that are interfaced with a control system;

FIG. **17** is a plan view of a daisy chain of lids;

FIG. **18** is a plan view of another embodiment of a daisy chain of lids with holes for receiving pins of a drive wheel;

FIG. **19** is another embodiment of the lid sterilization and heat sealing apparatus including a pin drive apparatus;

FIG. **20** is a perspective view of the heat sealing and gripper apparatus;

FIG. **21** is a schematic diagram of a sterilization control system for the interior bottle sterilization apparatus;

FIG. **22** is a side view of a main product filler apparatus;

FIG. **23** is a cross-sectional view of a first embodiment of an activation mechanism including a valve in a closed position in a first sterile region;

FIG. **24** is a cross-sectional view with a portion of a valve stem displaced from a non-sterile region into the first sterile region;

FIG. **25** is a cross-sectional view of the valve in a closed position in a first sterile region, and with the portion of the valve stem located in a second sterile region;

FIG. **26** is a cross-sectional view of the valve in an open position where the portion of the valve located in the second sterile region has been displaced into the first sterile region;

FIG. **27** is a cross-sectional view of a second embodiment of an activation mechanism including a valve in a closed

position with a flexible diaphragm attached to a valve stem and to a wall off the sterile tunnel;

FIG. **28** is a cross-sectional view of the valve of FIG. **27** in an open position;

FIG. **29** is a cross-sectional view of a third embodiment of an activation mechanism including a sealed actuator in the sterile tunnel with a valve in a closed position;

FIG. **30** is a cross-sectional view of the valve of FIG. **29** in an open position;

FIG. **31** is a cross-sectional view of a fourth embodiment of an activation mechanism including a sealed actuator with an electromagnet with a valve in a closed position;

FIG. **32** is a cross-sectional view of the valve of FIG. **32** in an open position;

FIG. **33** is a cross-sectional view of a fifth embodiment of an activation mechanism including a sealed actuator with an electromagnet with a valve in a closed position;

FIG. **34** is a cross-sectional view taken along the line **34**—**34** as shown in FIG. **33**.; and

FIG. **35** is a cross-sectional view of the valve of FIG. **33** in an open position.

DETAILED DESCRIPTION OF THE INVENTION

Although certain preferred embodiments of the present invention will be shown and described in detail, it should be understood that various changes and modifications may be made without departing from the scope of the appended claims. The scope of the present invention will in no way be limited to the number of constituting components, the materials thereof, the shapes thereof, the relative arrangement thereof, etc., and are disclosed simply as an example of the preferred embodiment. The features and advantages of the present invention are illustrated in detail in the accompanying drawings, wherein like reference numerals refer to like elements throughout the drawings. Although the drawings are intended to illustrate the present invention, the drawings are not necessarily drawn to scale.

The present invention provides an aseptic processing apparatus **10** that will meet the stringent United States FDA (Food and Drug Administration) requirements and 3A Sanitary Standards and Accepted Practices required to label a food product (foodstuffs) as "aseptic." Hereafter, "aseptic" will refer to the FDA level of aseptic. The present invention provides an aseptic processing apparatus **10** for producing at least about a 12 log reduction of *Clostridium botulinum* in food products. In addition, the present invention produces packaging material with at least about a 6 log reduction of spores. Actual testing of the aseptic processing apparatus is accomplished with spore test organisms. These test organisms are selected on their resistance to the media selected used to achieve sterility. For example, when steam is the media, the test organism is *Bacillus stearothermophilus*. When hydrogen peroxide is the media, then the test organism is *Bacillus subtilis var. globigii*.

The present invention processes containers such as bottles or jars that have a small opening compared to its height and its greatest width (e.g., the ratio of the opening diameter to the height of the container is less than 1.0). In the preferred embodiment, a bottle **12** (see, e.g., FIG. **8**) is illustrated as the container. The container may alternately comprise a jar. The bottle **12** is preferably formed of a plastic such as polyethylene terepthalate (PET) or high density polyethylene (HDPE), although other materials such as glass may also be used. The present invention uses an aseptic sterilant such as hydrogen peroxide (H_2O_2) or oxonia (hydrogen peroxide and peroxyacetic acid) to sterilize the bottles **12**. In the preferred embodiment of the present invention, hydrogen peroxide is used as the sterilant. The present invention uses hydrogen peroxide with a concentration of less than about 35% and ensures that the bottles **12** have less than about 0.5 ppm of residual hydrogen peroxide after each bottle **12** is sterilized.

FIGS. **1**—**3** illustrate several views of an aseptic processing apparatus **10** in accordance with a preferred embodiment of the present invention. As shown, the aseptic processing apparatus **10** includes a first bottle unscrambler **20**, a second bottle unscrambler **30**, and a bottle lifter **40** for providing a supply of properly oriented empty bottles. The empty bottles are delivered to a filler apparatus **50** after passing through a bottle infeed and sterilization apparatus **60** for aseptic sterilization. The filled bottles are sealed at a first capping apparatus **400** or a second capping apparatus **410**. A control system **550** monitors and controls the operation of the aseptic processing apparatus **10**. The filled and sealed bottles are packed and palletized using a first case packing apparatus **480**, a second case packing apparatus **490**, a first palletizer **500**, and a second palletizer **510**.

The bottles **12** arrive at a first bottle unscrambler **20** with a random orientation, such that an opening **16** (see FIG. **8**) of each bottle **12** can be oriented in any direction. The first bottle unscrambler **20** manipulates the bottles **12** until the opening **16** of each bottle **12** is in a top vertical position. The bottles **12** leave the first bottle unscrambler **20** in a series formation with the opening **16** of each bottle **12** oriented vertically. The bottles **12** travel in single file in a first lane **18** to a first bottle lifter **40**. The first bottle lifter **40** lifts and transports the bottles **12** to a bottle infeed and sterilization apparatus **60**. A second bottle unscrambler **30** may also used to provide a supply of vertically oriented bottles **12**. The bottles **12** output from the second bottle unscrambler **30** travel in single file in a second lane **22** to a second bottle lifter **42**, which lifts and transports the bottles **12** to the bottle infeed and sterilization apparatus **60**.

FIG. **3** illustrates the bottle infeed, sterilization, and conveying apparatus **60** attached to the filler apparatus **50**. FIG. **4** illustrates a cross-sectional side view of the bottle infeed, sterilization, and conveying apparatus **60**. FIG. **5** illustrates a cross-sectional top view of the bottle infeed, sterilization, and conveying apparatus **60** taken along line **5**—**5** of FIG. **4**. The bottle infeed and sterilization apparatus **60** preferably inputs six bottles **12** in a horizontal direction from the first lane **18** and six bottles in a horizontal direction from the second lane **22** (FIG. **5**). A gate **76** in the first lane **18** selectively groups six bottles **12** at a time in first horizontal row **24**. A gate **78** in the second lane **22** selectively groups six bottles **12** at a time in a second horizontal row **28**. An infeed apparatus **80** includes a pushing element **84** for pushing the bottles **12** in the first horizontal row **24** into a first vertical lane **26**. A corresponding infeed apparatus **80** includes a pushing element **86** for pushing the bottles **12** in the second horizontal row **28** into a second vertical lane **32**. The six bottles **12** in the first vertical lane **26** and the six bottles **12** in the second vertical lane **32** are directed downward into the bottle infeed and sterilization apparatus **60**.

Referring to FIG. **4**, as the bottles **12** move downward in the first vertical lane **26** and the second vertical lane **32**, a sterilant **14**, such as heated hydrogen peroxide, oxonia, or other aseptic sterilant, is applied to an outside surface **34** of each bottle **12** by a sterilant application apparatus **36**. The outside surface **34** of a bottle **12** is illustrated in greater detail in FIG. **8**. The bottles **12** may move downward in the first

vertical lane **26** and the second vertical lane **32** by the force of gravity. Alternatively, controlled downward movement of the bottles **12** can be created by the use of a conveying device such as a moving conveying chain. A plurality of pins are attached to the conveying chain. Each bottle **12** rests on one of the pins attached to the conveying chain. Therefore, the motion of each bottle is controlled by the speed of the moving conveying chain.

A sterilant such as hydrogen peroxide may be provided to the sterilant application apparatus **36** in many ways. For example, liquid hydrogen peroxide may be provided in a reservoir at a level maintained by a pump and overflow pipe. A plurality of measuring cups (e.g., approximately 0.5 ml each) connected by an air cylinder are submerged into the reservoir and are lifted above the liquid level. Thus, a measured volume of liquid hydrogen peroxide is contained in each measuring cup.

Each measuring cup may include a conductivity probe that is configured to send a signal to the control system **550** indicating that the measuring cup is full. A tube (e.g., having a diameter of about 1/16") is positioned in the center of the measuring cup. A first end of the tube is positioned near the bottom of the measuring cup. A second end of the tube is connected to the sterilant application apparatus **36**. The sterilant application apparatus **36** includes a venturi and a heated double tube heat exchanger. When the measuring cup is full, and a signal is received from the control system **550**, a valve is opened allowing pressurized sterile air to enter the venturi. The pressurized air flow causes a vacuum to be generated in second end of the tube causing liquid hydrogen peroxide to be pulled out of the measuring cup. The liquid hydrogen peroxide is sprayed into a sterile air stream which atomizes the hydrogen peroxide into a spray. The atomized hydrogen peroxide enters the double tube heat exchanger in order to heat the atomized hydrogen peroxide above its vaporization phase. The double tube heat exchanger is heated with steam and the temperature is monitored and controlled by the control system **550**. In FIG. **4**, the application of the sterilant **14** by the sterilant application apparatus **36** is accomplished through the use of spray nozzles **64** that produce a sterilant fog which is directed to the entire outside surface **34** of each bottle **12**.

Alternatively, a direct spray of heated hydrogen peroxide may be continuously applied to the outside surface **34** of each bottle **12**. For producing the direct spray, a metering pump regulates the amount of hydrogen peroxide, a flow meter continuously measures and records the quantity of hydrogen peroxide being dispensed, a spray nozzle produces a fine mist, and a heat exchanger heats the hydrogen peroxide above the vaporization point.

FIGS. **3** and **4** illustrate the sterilization chamber **38** for activation and drying of bottles **12** which is included in the bottle infeed, sterilization, and conveying apparatus **60**. The sterilization chamber **38** sterilizes the outside surface **34** of each bottle **12**. The sterilization chamber **38** encloses a conduit **39**. Sterile heated air, which is generated by a sterile air supply system **146** (FIG. **3**), enters the conduit **39** of the sterilization chamber **38** through ports **67** and **68** located at the bottom of the sterilization chamber **38**. The sterile heated air also enters through a bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The sterile heated air travels is up through the conduit **39** of the sterilization chamber **38**, and exits the top of the sterilization chamber **38** through an exhaust conduit **70**. The sterile heated air continuously flows in an upward direction through the sterilization chamber **38**, thus preventing any contaminants from entering the bottle infeed and sterilization apparatus **60**. To create the sterile heated air, the air is first passed through a filtering system (e.g., a group of double sterile air filters to sterilize the air. The air is then heated in a heating system (e.g., an electric heater) to about 230° F. The air temperature is regulated by the control system **550**. Other techniques for providing the sterile heated air may also be used. The control system **550** monitors the air pressure and flow rate of the sterile heated air to ensure that an adequate flow of the hot sterile air is maintained in the bottle sterilization chamber **38** of the bottle infeed and sterilization apparatus **60**.

As illustrated in FIGS. **4**, **6**, and **7**, the sterilization chamber **38** includes two opposing, interior, perforated walls **72A**, **72B**. The perforated walls **72A** and **72B** guide the bottles **12** downward in the first vertical lane **26** and the second vertical lane **32**, respectively. The perforated walls **72A**, **72B** also allow the complete circulation of hot sterile air around the outside surface **34** of each bottle **12** in the sterilization chamber **38**. The sterilization chamber **38** supplies hot sterile air to the outside surface **34** of each bottle **12** between the sterilant application apparatus **36** and the bottom opening **62** of the bottle infeed and sterilization apparatus **60**. This sterilant may be hydrogen peroxide or oxonia (hydrogen peroxide and peroxyacetic acid).

In accordance with the preferred embodiment of the present invention, twelve drying positions are provided in the sterilization chamber **38**. Each bottle **12** is exposed to the hot sterile air in the sterilization chamber **38** for about at least 24 seconds. This provides time sufficient time for the hydrogen peroxide sterilant to break down into water and oxygen, to kill any bacteria on the bottles **12**, and to evaporate from the outside surface **34** of the bottles **12**.

An exhaust fan **73** is located at a top of the exhaust conduit **70** to provide an outlet from the sterilization tunnel **90**, and to control the sterile air flow rate through the sterilization chamber **38**. The exhaust fan **73** is controlled by the control system **550**. The control system **550** controls the sterile air temperature preferably to about 230° F., and controls the sterile air flow rate through the sterilization chamber **38**. The flow rate is preferably about 1800 scfm through the sterilization chamber **38**. The bottles **12** leave the sterilization chamber **38** with a hydrogen peroxide concentration of less than 0.5 PPM.

As shown in FIGS. **3** and **4**, a plurality of proximity sensors **71** located along the sides of the vertical lanes **26**, **32** detect any bottle **12** jams that occur within the sterilization chamber **38**. The proximity sensors **71** transmit an alarm signal to the control system **550**. The bottles **12** leave the bottle infeed and sterilization apparatus **60** through the bottom opening **62**, and enter a sterilization tunnel **90** of the filler apparatus **50**.

In the preferred embodiment of the present invention, the filler apparatus **50** includes forty-one (41) index stations **92**, hereafter referred to as "stations." Various index stations **92** are illustrated in FIGS. **3**, **4**, and **11–15**. The conveying motion of the bottles **12** to the various stations **92** through the filler apparatus **50** is based on an indexing motion. The filler apparatus **50** is designed to convey the bottles **12** through the various operations of the filler **50** in a two by six matrix. The twelve bottles **12** in the two by six matrix are positioned in, and displaced by, a conveying plate **94** as illustrated in FIG. **8**. Therefore, twelve bottles **12** are exposed to a particular station **92** at the same time. A conveying apparatus **100** moves the set of twelve bottles **12** in each conveying plate **94** sequentially through each station **92**.

Referring to FIGS. **3** and **4**, the bottles **12** are supplied from an infeed chamber **102** to station **2** of the filler

apparatus **50** through the bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The infeed chamber **102** is enclosed to direct heated hydrogen peroxide laden air completely around the outer surface **34** of the bottles **12**. A mechanical scissors mechanism and a vacuum "pick and place" apparatus **104** position twelve bottles **12** at a time (in a two by six matrix, FIG. **8**) into one of the conveying plates **94**.

A plurality of conveying plates **94** are attached to a main conveyor **106**. The main conveyor **106** forms a continuous element around conveyor pulleys **108** and **110** as illustrated in FIG. **3**. A bottle support plate **107** supports a bottom **120** of each bottle **12** as the bottles **12** are conveyed from station to station through the filler apparatus **50**. Each conveying plate **94** passes through stations **1** through **41**, around pulley **108**, and returns around pulley **110** to repeat the process. The main conveyor **106**, conveying plates **94**, and pulleys **108** and **110** are enclosed in the sterilization tunnel **90**.

At station **4**, the bottles **12** in the conveying plate **94** enter a bottle detection apparatus **112**. The bottle detection apparatus **112** determines whether all twelve bottles **12** are actually present and correctly positioned in the conveying plate **94**. Proximity sensors **114** detect the presence and the alignment of each bottle **12**. In the present invention, a bottle **12** with correct alignment is in an upright position with the opening **16** of the bottle **12** located in an upward position. Information regarding the location of any misaligned or missing bottles **12** is relayed to the control system **550**. The control system **550** uses this location information to ensure that, at future stations **92**, bottle filling or sealing will not occur at the locations corresponding to the misaligned or missing bottles **12**.

At station **7**, as illustrated in FIGS. **3** and **10**, the bottles **12** in the conveying plate **94** enter an interior bottle sterilization apparatus **116**. A sterilant, such as hydrogen peroxide, oxonia, or any other suitable aseptic sterilant is applied as a heated vapor fog into the interior **118** of each bottle **12**. Preferably, hydrogen peroxide is used as the sterilant in the present invention. The application of sterilant is accomplished with the use of a plurality of sterilant measuring devices **121** and a plurality of probes **123**. Each probe **123** includes any practical means for transferring the sterilant from the probe **123** to the interior surface **119** of the bottle **12**. For example, an opening or a plurality of openings may be used for ejecting the sterilant onto the interior surface **119**. Preferably, in the present invention, an applicator spray nozzle **122** is included in each probe **123**. The applicator spray nozzle **122** provides uniform sterilant application without droplet formation on the interior surface **119** of the bottle **12**. A separate measuring device **121** and the probe **123** are used for each of the twelve bottle **12** locations in the conveying plate **94**. Each sterilant measuring device **121** may include a spoon dipper **304** (e.g., approximately 0.5 ml each) as illustrated in FIG. **21**. Each bottle **12** is supplied with the same measured quantity of sterilant, preferably in the form of a hot vapor fog. A pump **306** provides a sterilant (e.g., hydrogen peroxide) from a sterilant supply tank **310** to a reservoir **124**. An overflow pipe **308** maintains the sterilant liquid level in the reservoir **124** by returning excess sterilant to the sterilant supply tank **310**. The spoon dipper **304** connected to an air cylinder **316** is submerged into the reservoir **124** and is lifted above the liquid level. Thus, a measured volume of liquid hydrogen peroxide (e.g., approximately 0.5 ml) is contained in each spoon dipper **304**.

Each spoon dipper **304** may include a conductivity probe that is configured to send a signal to the control system **550** indicating that the spoon dipper **304** is full. A tube **312** (e.g., having a diameter of about 1/16") is positioned in the center of the spoon dipper **304**. A first end of the tube **312** is positioned near the bottom of the spoon dipper **304**. A second end of the tube **312** is connected to an atomizing venturi **314**.

A pressurized air source **318** is connected by a conduit **320** to a flow adjust valve **322**. A conduit **324** connects the flow adjust valve **322** to a regulator valve **326**. A conduit **328** connects the regulator valve **326** with a solenoid actuated valve **330**. A conduit **332** connects the solenoid actuated valve **330** with the air cylinder **316**. The control system **550** controls the solenoid actuated valve **330** which controls the compressed air supplied to the air cylinder **316**. Compressed air supplied to the air cylinder **316** lowers or lifts the spoon dipper **304** into or out of the liquid sterilant.

A conduit **334** connects the flow adjust valve **322** with the regulator valve **336**. A conduit **338** connects the regulator valve **336** with a sterile air filter **340**. A conduit **342** connects the sterile air filter **340** with a solenoid actuated valve **344**. A conduit **346** connects the solenoid actuated valve **344** with the atomizing venturi **314**. When the spoon dipper **304** is full, and a signal is received from the control system **550**, the solenoid actuated valve **344** is opened allowing pressurized sterile air to enter the atomizing venturi **314** through the conduit **346**. The pressurized air flow causes a vacuum to be generated in the second end of the tube **312** causing liquid hydrogen peroxide to be pulled out of the spoon dipper **304**.

A first supply of sterile air is supplied through conduit **346**. The pressurized air supplied through conduit **346** is used to atomize the hydrogen peroxide sterilant in the atomizing venturi **314**. Atomization of the liquid hydrogen peroxide may be provided by other means such as by using ultrasonic frequencies to atomize the liquid hydrogen peroxide.

A conduit **348** connects with the atomizing venturi **314**, passes through a heat exchanger **350** (e.g., double tube heat exchanger), and connects with a probe **123** including the applicator spray nozzle **122**. A conduit **352** connects a steam supply **354** with a valve **356**. A conduit **358** connects the valve **356** with a regulator valve **360**. A conduit **382** connects the regulator valve **360** with the heat exchanger **350**.

A second supply of hot sterile air is supplied to the atomized sterilant through a conduit **378**. A humidity control apparatus **362** maintains the humidity level of the air entering a blower **364**. A conduit **366** connects the blower **364** with a heater **368**. A conduit **370** connects the heater **368** with a sterile filter **372**. A conduit **374** connects the sterile filter **372** with a flow adjust valve **376**. The conduit **378** connects the flow adjust valve **376** with the conduit **348**. A conduit **380** connects the sterile filter **372** with a bypass valve **382**. The blower **364** operates continuously supplying humidity controlled air to the heater **368**. The flow of heated sterile air is controlled with the flow adjust valve **376** and travels through conduit **378**.

Exiting conduit **378**, the second supply of hot sterile air enters the conduit **348** to mix with the atomized hydrogen peroxide from the atomizing venturi **314**. Excess flow of heated sterile air travels through conduit **380** and passes through the bypass valve **382**. The second supply of hot sterile air assists in obtaining a uniform concentration of hydrogen peroxide in the air stream in conduit **348** and provides enough momentum to ensure that all portions of the bottle **12** interior **118** are contacted by hydrogen peroxide. Furthermore, the second supply of hot sterile air is continuously blowing, whereas the first supply of sterile air and

hydrogen peroxide in conduit **346** is intermittent corresponding to the movement of the bottles **12**. Since the second supply of hot sterile air is continuous, hydrogen peroxide does not have the ability to fall out of the air stream and deposit in the delivery conduit **348** in the form of drops. This ensures that the delivery of hydrogen peroxide is consistent from one bottle **12** application to the next and does not allow a drop to be directed into the bottle **12** interior **118**.

The mixture of heated sterile air and atomized hydrogen peroxide in conduit **348** passes through the double tube heat exchanger **350**. The double tube heat exchanger **350** adds additional heat to the atomized hydrogen peroxide. Heat is supplied to the double tube heat exchanger **350** from the steam supply **354** controlled by the regulator valve **360**. Generally, hydrogen peroxide has chemical stabilizers in it that may cause a white powder precipitate to form on the inner surfaces of the double tube heat exchanger **350**. This occurs when the temperature differential between the supplied steam heat and the gas to be heated is large. In the present invention, the temperature of the atomized hydrogen peroxide is typically about the same as the supplied steam heat so that a minimal amount of precipitate occurs. Another embodiment of the invention eliminates the need for the double tube heat exchanger **350** because the temperature of the atomized hydrogen peroxide is already at the desired temperature.

The temperature of the atomized gas entering the interior **118** of the bottle **12** is in the range of about 100° C. to 120° C. This temperature is limited to prevent the plastic bottles **12** from melting. The droplet size occurring on the interior surface **119** of the bottles **12** is in the range of about 300 to 500 micrometers. The initial concentration level of hydrogen peroxide on the interior surface **119** of the bottle **12** is about 35%.

As illustrated in FIG. **21**, the control system **550** monitors the temperatures at locations denoted as "T" in the interior bottle sterilization apparatus **116**. The temperartures "T" are measured in the conduit **348**, in the heater **368**, and in the conduit **370**. Additionally, the control system **550** monitors the pressures at locations denoted as "P" as illustrated in FIG. **21**. The pressures "P" are measured in the conduit **328**, conduit **338**, and in the conduit **382**.

The control system **550** monitors and controls a spray apparatus **126** that includes the probe **123** including the applicator spray nozzles **122** FIG. **10**. Each applicator spray nozzle **122** sprays the sterilant into the interior **118** of a corresponding bottle **12** as a hot vapor fog. The probe **123** including applicator spray nozzles **122** are designed to extend through the bottle openings **16**. The probe **123** including applicator spray nozzles **122** descends into the interior **118** and toward the bottom of the bottles **12**. This ensures the complete application of sterilant to the entire interior **118** and interior surface **119** of each bottle **12**. Alternately, the probe **123** including the applicator spray nozzles **122** may be positioned immediately above the bottle openings **16** prior to the application of sterilant.

FIG. **9** illustrates a perspective view of a partition **130** that provides control of sterile air flow within the sterilization tunnel **90** of the filler apparatus **50**. The partition **130** includes a top baffle plate **132**, a middle baffle plate **134**, and a bottom baffle plate **136**. The top baffle plate **132** and the middle baffle plate **134** are provided with cut-outs **133** which correspond to the outer shape of each bottle **12** and to the outer shape of the conveyor plate **94**. The cut-outs **133** allow each bottle **12** and each conveyor plate **94** to pass through the partition **130**. A space **138** between the middle baffle plate **134** and the bottom baffle plate **136** allows each empty conveyor plate **94** to pass through the partition **130** as it travels on its return trip from the pulley **108** toward the pulley **110**.

As illustrated in FIG. **3**, partitions **130**A, **130**B, and **130**C, are located within the sterilization tunnel **90**. FIG. **10** illustrates a cross-sectional view of partition **130**A including baffle plates **132**A, **134**A, and **136**A. The partition **130**A is located between stations **8** and **9**. FIG. **11** illustrates a cross-sectional view of partition **130**B including baffle plates **132**B, **134**B, and **136**B. The partition **130**B is located between stations **22** and **23**. FIG. **12** illustrates a cross-sectional view of partition **130**C including baffles **132**C, **134**C, and **136**C. The partition **130**C is located between stations **35** and **36**. As illustrated in FIG. **3**, sterile air is introduced through sterile air supply sources (e.g., conduits **140, 142,** and **144**) into the sterilization tunnel **90**. The sterile air conduit **140** is located at station **23** (FIG. **11**), the sterile air conduit **142** is located at station **27** (FIG. **3**), and the sterile air conduit **144** is located at station **35** (FIG. **12**).

The partition **130**A separates an activation and drying apparatus **152** from the interior bottle sterilization apparatus **116**. The partition **130**B separates the activation and drying apparatus **152** from a main product filler apparatus **160** and a lid sterilization and heat sealing apparatus **162**. Thus, a first sterilization zone **164** is created that includes the activation and drying apparatus **152**. Partition **130**C separates the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** from a bottle discharge apparatus **280**. Thus, partitions **130**B and **130**C create a second sterilization zone **166** that includes the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162**. A third sterilization zone **172** includes the bottle discharge apparatus **280**. A fourth sterilization zone **165** includes the interior bottle sterilization apparatus **116**. The second sterilization zone **166** provides a highly sterile area where the bottles **12** are filled with a product and sealed. The second sterilization zone **166** is at a higher pressure than the first sterilization zone **164** and the third sterilization zone **172**. Therefore, any gas flow leakage is in the direction from the second sterilization zone **166** out to the first sterilization zone **164** and the third sterilization zone **172**. The first sterilization zone **164** is at a higher pressure than the fourth sterilization zone **165**. Therefore, gas flow is in the direction from the first sterilization zone **164** to the fourth sterilization zone **165**.

The partitions **130**A, **130**B, and **130**C create sterilization zones **164, 165, 166,** and **172** with different concentration levels of gas laden sterilant (e.g., hydrogen peroxide in air). The highest concentration level of sterilant is in the fourth sterilization zone **165**. For example, with the sterilant hydrogen peroxide, the concentration level of hydrogen peroxide is about 1000 ppm (parts per million) in the fourth sterilization zone **165**. The hydrogen peroxide sterilant level is about 3 ppm in the first sterilization zone **164**. The lowest concentration level of sterilant is in the second sterilization zone **166**. In the second sterilization zone **166**, the hydrogen peroxide sterilant concentration level is less than .5ppm and typically about 0.1 ppm. Advantageously, this helps to maintain the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** at a low sterilant concentration level. This prevents unwanted high levels of sterilant to enter the food product during the filling and lidding process. The hydrogen peroxide sterilant concentration level is about 0.1 ppm in the third sterilization zone **172**.

As illustrated in FIG. **3**, a gas such as hot sterile air enters the first sterilization zone **164** at a rate of about 2400 cfm

(cubic feet per minute). The temperature of the hot sterile air is about 230° F. The hot sterile air enters the first sterilization zone **164** through conduit **148**. Additional hot sterile air enters the second sterile zone through sterile air conduits **140**, **142**, and **144** at a total rate of about 1000 cfm (FIG. **3**). Also, hot sterile air enters at a rate of about 1800 cfm through ports **67** and **68** leading into the infeed and sterilization apparatus **60**. A portion of the hot sterile air exits the sterilization tunnel **90** at a rate of about 1500 cfm through a plurality of exhaust ports **153** located in the first sterilization zone **164** (FIG. **15**). A portion of the hot sterile air exits the sterilization tunnel **90** at a rate about 100 cfm through an opening **282** (FIG. **14**). The bottles **12** exit the sterilization tunnel **90** through the opening **282**. The continuous flow of sterile air flow out through the opening **282** prevents contaminants from entering the sterilization tunnel **90**.

As illustrated in FIG. **3**, the hot sterile air is drawn out of the fourth sterilization zone **165** of the sterilization tunnel **90** through the bottom opening **62** in the bottle infeed and sterilization apparatus **60**. Next, the hot sterile air from the infeed and sterilization apparatus together with the fourth sterilization zone **165** exits out of the exhaust conduit **70** of the infeed and sterilization apparatus at a rate of about 3600 cfm. This outflow of hot sterile air from the bottle infeed and sterilization apparatus **60** prevents contaminants from entering the bottle infeed sterilization apparatus **60** and the sterilization tunnel **90**.

Stations **10** through **21** include twelve stations for directing hot sterile air into each bottle **12** for the activation and removal of the sterilant from the interior of the bottle **12**. In these twelve stations, a third supply of hot sterile air is provided through the sterile air supply system **146**. The sterile air supply system **146** supplies hot sterile air to a plurality of nozzles **150** in the activation and drying apparatus **152**. The hot sterile air flow in each bottle **12** is about 40 SCFM. Hot sterile air is supplied to the sterile air supply system **146** through conduit **148**. The air is first passed through a filtration system to sterilize the air. The air is then heated in a heating system to about 230° F. The air temperature is regulated by the control system **550**. Also, the control system **550** monitors the air pressure and flow rate to ensure that an adequate flow of hot sterile air is maintained in the sterilization tunnel **90** of the application and drying apparatus **152**.

As shown in FIG. **8**, each bottle **12** generally has a small opening **16** compared to its height "H." A ratio of a diameter "D" of the bottle **12** to the height "H" of the bottle **12** is generally less than 1.0. The small bottle opening **16** combined with a larger height "H" restricts the flow of hot gas into the interior **118** of the bottle **12**. Also, PET and HDPE bottle materials have low heat resistance temperatures. These temperatures commonly are about 55° C. for PET and about 121° C. for HDPE. Typically, in the aseptic packaging industry, a low volume of air at a high temperature is applied to the packaging materials. This often results in deformation and softening of packaging materials formed of PET and HDPE. In order to prevent softening and deformation of the bottles **12**, when formed from these types of materials, the present invention applies high volumes of air at relatively low temperatures over an extended period of time in the activation and drying apparatus **152**. The plurality of nozzles **150** of the activation and drying apparatus **152** direct hot sterile air into the interior **118** of each bottle **12** (FIG. **11**). A long exposure time is predicated by the geometry of the bottle **12** and the softening temperature of the material used to form the bottle **12**. In the present invention, about 24 seconds are allowed for directing hot sterile air from the plurality of nozzles **150** into each bottle for the activation and removal of sterilant from the interior surface **119** of the bottle **12**. To achieve aseptic sterilization, a minimum bottle temperature of about 131° F. should be held for at least 5 seconds. To achieve this bottle temperature and time requirements, including the time required to heat the bottle, the sterilant is applied for about 1 second and the hot sterile air is introduced for about 24 seconds. The hot sterile air leaves the nozzles **150** at about 230° F. and cools to about 131° F. when it enters the bottle **12**. The hot sterile air is delivered at a high volume so that the bottle **12** is maintained at about 131° F. for at least 5 seconds. The about 24 seconds provides adequate time for the bottle **12** to heat up to about 131° F. and to maintain this temperature for at least 5 seconds. After bottle **12** has dried, the residual hydrogen peroxide remaining on the bottle **12** surface is less than 0.5 PPM.

A foodstuff product is first sterilized to eliminate bacteria in the product. An "Ultra High Temperature" (UHT) pasteurization process is required to meet the aseptic FDA standard. The time and temperature required to meet the aseptic FDA standard depends on the type of foodstuff. For example, milk must be heated to 282° F. for not less than 2 seconds in order to meet the aseptic standards.

After UHT pasteurization, the product is delivered to a main product filler apparatus **160**. The main product filler apparatus is illustrated in FIGS. **3**, **13**, and **22**. The main product filler **160** can be sterilized and cleaned in place to maintain aseptic FDA and 3A standards. A pressurized reservoir apparatus **180** that can be steam sterilized is included in the main product filler apparatus **160**. As illustrated in FIG. **22**, the pressurized reservoir apparatus **180** includes an enclosed product tank **182** with a large capacity (e.g., 15 gallons). The product tank **182** is able to withstand elevated pressures of about 60 psig or more. The pressurized reservoir apparatus **180** also includes a level sensor **184**, a pressure sensor **186**, at least one volumetric measuring device **188** (two are shown as **188**A, **188**B), and at least one filling nozzle **190** (two are shown as **190**A, **190**B). The product tank **182** includes a single product inlet **250** with a valve cluster (not shown) including a sterile barrier to separate the product supply system (not shown) from the main product filler apparatus **160**. The product tank **182** has an outlet with twelve connections. At each connections is a volumetric measuring device **188** such as a mass or volumetric flow meter. Pressurized steam or sterile air is supplied into the product tank **182** through the inlet **252**. The product level **254** in the product tank **182** is measured by the level sensor **184**. The control system **550** maintains the product level and pressure in the product tank **182**. This supplies each filling nozzle **190** (e.g. **190**A, **190**B) with a constant pressure that ensures proper product delivery to the bottles **12**.

Filling nozzles **190**A, **190**B are provided at stations **23**, **25**, respectively. Additionally, there are a plurality of corresponding volumetric measuring devices **188**A and **188**B to measure the volume of product entering each bottle **12** at stations **23** and **25**, respectively. In accordance with the present invention, the volumetric measuring devices **188**A and **188**B are preferably electronic measuring devices such as a magnetic flow meter which measures the volume of product flow, or a mass flow meter which measures the weight of product flow. The electronic measuring devices provide filling accuracies of about 0.5%. The control system **550** calculates the desired volume of product to be inserted into each bottle **12**, and controls the product volume by opening or closing a plurality of valves **194**A and **194**B

included in the filling nozzles **190**A and **190**B, respectively. The amount of product delivered to the bottles **12** is controlled by the duration of time that the plurality of valves **194**A and **194**B are open. The control system **550** controls the duration of time. Thus, any desired quantity of product may be selected by controlling the duration of time that the valves **194**A and **194**B are open.

A first embodiment of activation mechanisms **402**A and **402**B for valves **194**A and **194**B include valve stems **256**A and **256**B attached to actuators **258**A and **258**B, respectively (FIG. **22**). Each actuator **258**A, **258**B may include any suitable actuating apparatus (e.g. hydraulic, pneumatic, electrical, etc.). Preferably, in the present invention, the actuators **258**A and **258**B include air cylinders controlled by the control system **550**. The actuators **258**A and **258**B are attached to the valve stems **256**A and **256**B, respectively. The actuators **258**A and **258**B displace the valve stems **256**A and **256**B in an upward and downward direction.

FIG. **23** illustrates the valve stem **256**A attached to the valve **194**A. A first sterile region **260** surrounds the nozzle **196**A through which product **262**A exits. The first sterile region **260** is connected to, and is at the same sterilization level as, the second sterilization zone **166** (FIG. **3**) of the sterile tunnel **90**. The valve **194**A is in a closed position against nozzle **196**A blocking the flow of product **262**A into a bottle **12** (not shown) located in the first sterile region **260**. A first portion **264**A of the valve stem **256**A is surrounded by a non-sterile region **268**, for example, the area located outside of the sterile tunnel **90**. Thus, the first portion **264**A of the valve stem **256**A is exposed with contaminants.

As illustrated in FIG. **24**, the actuator **258**A has displaced the valve stem **256**A in a downward direction. The valve **194**A is removed from the nozzle **196**A allowing product **262**A to flow into a bottle **12** (not shown). The first portion **264**A of the valve stem **256**A has entered the first sterile region **260**. This may create a problem because the first portion **264**A of the valve stem **256**A may carry contaminants from the non-sterile region **268** into the first sterile region **260**. In order to overcome this difficulty, the present invention has introduced a second sterile region **270** as illustrated in FIG. **25**.

The second sterile region **270**A is enclosed by a housing **272** and by a wall **274**. The wall **274** separates the second sterile region **270**A from the first sterile region **260**. The first sterile region **260** is connected to, and is at the same sterilization level, as the second sterilization zone **166** of the sterile tunnel **90**. A sterilizing media **424** is supplied to the second sterile region **270**A through the inlet conduit **420**A. An outlet conduit **422**A may be added to allow the sterilizing media **424** to leave the second sterile region **270**A. The sterilizing media **424** may include any suitable sterilant (e.g. steam, hydrogen peroxide, oxonia, etc.). The non-sterile region **268** lies outside of the housing **272**. A second portion **266**A of the valve stem lies in the nonsterile region **268**. As illustrated in FIG. **25**, the valve **194**A is in a closed position against the nozzle **196**A blocking the flow of product **262**A into a bottle **12** (not shown) in the first sterile region **260**. The first portion **264**A of the valve stem **256**A is surrounded by the second sterile region **270**A. Thus, the first portion **266**A of the valve stem **256**A is maintained in a sterile condition.

As illustrated in FIG. **26**, the actuator **258**A has displaced the valve stem **256**A in a downward direction. The valve **194**A is removed from the nozzle **196**A allowing product **262**A to flow into a bottle **12** (not shown). The first portion **264**A of the valve stem **256**A has entered the first sterile region **260**. In the present invention, the first portion **264**A of the valve stem **256**A has not introduced contaminants into the first sterile region **260** because the first portion **264**A of the valve stem **256**A was pre-sterilized in the second sterile region **270**A before entering the first sterile region **260**. The second portion **266**A of the valve stem **256**A has entered the second sterile region **270**A from the non-sterile region **268**. The second portion **266**A of the valve stem **256**A is sterilized in the second sterile region **270**A removing any contaminants. Therefore, the second sterile region **270**A removes any contaminants from the valve stem **256**A before any portion of the valve stem **256**A enters the first sterile region **260**. Thus, contaminants are prevented from entering the sterile tunnel **90** through the filling nozzles **190**A and **190**B, and the valves **194**A and **194**B, respectively.

The plurality of valves **194**A control the volume of product flowing through a corresponding plurality of nozzles **196**A into the bottles **12** at station **23**. The plurality of valves **194**B control the volume of product flowing through a corresponding plurality of nozzles **196**B into the bottles **12** at station **25**. The control system **550** uses previously stored information provided by the bottle detection apparatus **112** to only allow filling to occur at the locations where bottles **12** are actually present and correctly aligned.

The initial sterilization process for the first embodiment of the activation mechanisms **402**A, **402**B, and the pressurized reservoir apparatus **180** includes the step of exposing all of the surfaces of the pressurized reservoir apparatus **180** that come in contact with the product to steam at temperatures above about 250° F. for a minimum of about 30 minutes. Elements such as cups **198**A and **198**B (FIG. **22**) are used to block off nozzle outlets **196**A and **196**B, respectively, to allow a build-up of steam pressure to about 50 psig inside the pressurized reservoir apparatus **180**. Condensate generated as the steam heats the interior surfaces of the pressurized reservoir apparatus **180** is collected in the cups **198**A and **198**B. This condensate is released when the cups **198**A and **198**B are removed from the nozzle outlets **196**A and **196**B. Once the interior surfaces of the pressurized reservoir apparatus **180** are sterilized, the steam is shut off, and sterile air is used to replace the steam. The sterile air reduces the interior temperature of the pressurized reservoir apparatus **180** to the temperature of the product before the product is allowed to enter the enclosed product tank **182**. As shown in FIG. **13**, sterile air is directed through sterile air conduits **142** and **144** into the second sterilization zone **166** at a volume rate of about 800 scfm. The sterile air flow entering the second sterilization zone **166** provides sterile air to the main product filler apparatus **160** and to the lid sterilization and heat sealing apparatus **162**.

The main product filler apparatus **160** includes a separate filling position for each bottle. A bottle **12** moves into position under a nozzle **196**. The bottle stops and the valve **194** opens allowing product **262** to enter the bottle **12**. The volumetric measuring device **188** measure the amount of product entering the bottle **12**. Next, when the desired bottle **12** fill level is achieved, the valve **194** is closed. The control system **550** controls the valve opening and closing. Additionally, the control system **550** does not allow product **262** to flow if a bottle **12** is not present. The bottle **12** filling operation is completed for six bottles at station **23** and for six bottles at station **25**. The filling cycle is repeated for each cycle of the aseptic processing apparatus **10**. In the present invention the bottle filling time is about 1.5 seconds. Another embodiment of the present invention adds a second main product filler apparatus **160**B located at, for example, stations **27** and **29** (FIG. **22**). In this embodiment, the bottles

12 are partially filled by the first main product filler apparatus 160 at stations 23 and 25. Next, the bottles are moved to the second main product filler apparatus 160B where the filling of each bottle is completed at stations 27 and 29. For example, in filling each 16 fluid ounce bottle 12, the first main product filler apparatus 160 would fill the first 8 ounces in about 1.5 seconds. Next, the second main product filler apparatus 160 would fill the remaining 8 ounces in each bottle 12 in another about 1.5 seconds. The second main product filler 160B allows the operation to be kept to about 1.5 seconds at each main product filler apparatus 160, 160B. This allows the conveying apparatus 100 to move the bottles through the aseptic processing apparatus 10 at speeds greater than about 350 bottles 12 per minute.

A second embodiment of an activation mechanism 402C is illustrated in FIG. 27. The activation mechanism for valve 194C includes a valve stem 256C attached to an actuator 258C. The actuator 258C may include any suitable actuating means (e.g., hydraulic, pneumatic, electrical, etc.). In the present example, the actuator 258C includes an air cylinder controlled by the control system 550. The valve 194C includes a valve head 404C. The valve head 404C is attached to a first end 406C of the valve stem 256C. The actuator 258C is attached to a second end 408C of the valve stem 256C. The actuator 258C displaces the valve stem 256C in an upward and downward direction.

As illustrated in FIG. 27, the second sterilization zone 166 of the sterile tunnel 90 (FIG. 3) surrounds a nozzle 196C and an outlet port 412C of the nozzle 196C through which the product 262A exits. The valve head 404C opens and closes the outlet port 412C of the nozzle 196C. The valve stem 256C passes through an opening 418 in the wall 274 of the sterile tunnel 90. A central portion 416 of a flexible diaphragm 414 is attached to the valve stem 256C. A peripheral portion 428 of the flexible diaphragm 414 is attached to a peripheral region 430 surrounding the opening 418 in the wall 274 of the sterile tunnel 90. The flexible diaphragm 414 may be any suitable material used for containing an aseptic food product (e.g., "EPDM" ethylene-propylene-dieneterpolymers, "Teflon™" polytetrafluoroethylene, "Viton™" fluoroelastomer, etc.). The flexible diaphragm 414 prevents contaminants from traveling from the non-sterile region 268 to the second sterilization zone 166 of the sterile tunnel 90. The lower portion 426C of the valve stem 256C remains in the second sterilization zone 166 as the valve stem 256C moves in an upward and downward direction.

FIG. 27 illustrates the valve 194C in a closed position with the valve head 404C closing the outlet port 412C of the nozzle 196C. Thus, the valve head 404C of the valve 194C blocks the flow of product 262A into the bottle 12. The bottle 12 is located in the second sterilization zone 166.

As illustrated in FIG. 28, the actuator 258C has displaced the valve stem 256C in a downward direction. The valve head 404C of the valve 194C uncovers the outlet port 412C allowing product 262A to flow into the bottle 12. The central portion 416 of the flexible diaphragm 414 is deflected downward into the opening 418 in the wall 274 as the valve stem 256C moves downward. The central portion 416 of the flexible diaphragm 414 remains attached to the valve stem 256C and the peripheral portion 428 of the flexible diaphragm 414 remains attached to the peripheral region 430 of the wall 274 surrounding the opening 418. The flexible diaphragm 414 prevents contaminants from traveling from the non-sterile region 268 to the second sterilization zone 166 of the sterile tunnel 90. Thus, the lower portion 426C of the valve stem 256C remains in the second sterilization zone 166 as the valve stem 256C moves in an upward and downward direction. The initial sterilization process for the second embodiment of the activation mechanism 402C is similar to the process described above for the first embodiment of the activation mechanisms 402A and 402B.

FIG. 29 illustrates a third embodiment of an activation mechanism 402D. The activation mechanism 402D for a valve 194D includes a valve stem 256D attached to a sealed actuator 258D. The sealed actuator 258D may include any suitable actuating means (e.g., hydraulic, pneumatic, electrical, etc.). The sealed actuator 258D displaces the valve stem 256D in an upward and downward direction.

As illustrated in FIG. 29, the second sterilization zone 166 of the sterile tunnel 90 (FIG. 3) surrounds a nozzle 196D, the sealed actuator 258D, and an outlet port 412D of the nozzle 196D through which the product 262A exits. The valve 194D includes a valve head 404D that opens and closes the outlet port 412C of the nozzle 196D. The sealed actuator 258D is attached to the wall 274 of the sterile tunnel 90. The sealed actuator 258D is located within the second sterilization zone 166 of the sterile tunnel 90. A control conduit 432 connects the sealed actuator 258D with the control system 550. The control conduit 432 carries a control signal 436 from the control system 550 to the sealed actuator 258D. The control signal 436 directs the sealed actuator 258D to raise or lower the valve stem 256D of the valve 194D. The control conduit 432 passes through an opening 434 in the wall 274 of the sterile tunnel 90. A sealing member 438 (e.g., gasket, grommet, compression fitting, etc.) fills the space between the control conduit 432 and the opening 434, and prevents contaminants from traveling from the non-sterile region 268 to the second sterilization zone 166.

FIG. 29 illustrates the valve 194D in a closed position with the valve head 404D closing the outlet port 412D of the nozzle 196D. The valve head 404D blocks the flow of product 262A into the bottle 12. The bottle 12 is located in the second sterilization zone 166.

As illustrated in FIG. 30, the actuator 258D has displaced the valve stem 256D in a downward direction. The valve head 404D of the valve 194D uncovers the outlet port 412D allowing product 262A to flow into the bottle 12. The valve 194D, the valve stem 256D and the sealed actuator 258D remain in the second sterilization zone 166 during actuation of the valve 194D. Thus, no contamination is introduced into the second sterilization zone 166 from the non-sterile zone 268. The initial sterilization process for the third embodiment of the activation mechanism 402D is similar to the process described above for the first embodiment of the activation mechanism 194A.

FIG. 31 illustrates a fourth embodiment of an activation mechanism 402E. The activation mechanism 402E includes a valve 194E attached to an electromagnet actuator 258E. The electromagnet actuator 258E displaces the valve 194E in an upward and downward direction.

As illustrated in FIG. 31, the second sterilization zone 166 of the sterile tunnel 90 (FIG. 3) surrounds a nozzle 196E, the electromagnet actuator 258E, and an outlet port 412E of the nozzle 196E through which the product 262A exits. The valve 194E includes a valve head 404E that opens and closes the outlet port 412E of the nozzle 196E. The electromagnet actuator 258E is located within the second sterilization zone 166 of the sterile tunnel 90. The electromagnet actuator 258E includes an electromagnet 440, a body 442 and a spring 444. The spring 444 is located between the body 442 and the valve 194E. When electrical current is introduced into the electromagnet 440, the valve 194E is pulled in an

upward direction. When the electrical current is removed from the electromagnet **440**, the valve **194**E is released and the spring **444** forces the valve **194**E in a downward direction. A control conduit **432**E connects the electromagnet actuator **258**E with the control system **550**. The control conduit **432**E carries the electrical current control signal **436**E from the control system **550** to the electromagnet **440** in the electromagnet actuator **258**E. The control conduit **432**E passes through an opening **434**E in the wall **274** of the sterile tunnel **90**. A sealing member **438**E (e.g., gasket, grommet, compression fitting, etc.) fills the space between the control conduit **432**E and the opening **434**E, and prevents contaminants from traveling from the non-sterile region **268** into the second sterilization zone **166**.

FIG. **31** illustrates the valve **194**E in a closed position with the valve head **404**E sealing the outlet port **412**E of the nozzle **196**E. The electromagnet **440** is deactivated and the spring **444** forces the valve **194**E downward against the outlet port **412**E of the nozzle **196**E. The valve head **404**E blocks the flow of product **262**A into the bottle **12**. The bottle **12** is located in the second sterilization zone **166**.

As illustrated in FIG. **32**, an electric current is applied to the electromagnet actuator **258**E to displace the valve **194**E in an upward direction. The valve head **404**E of the valve **194**E uncovers the outlet port **412**E allowing product **262**A to flow into the bottle **12**. The valve **194**E and the electromagnet actuator **258**E remain in the second sterilization zone **166** during actuation of the valve **194**E. Thus, no contamination is introduced from the non-sterile zone **268** into the second sterilization zone **166**. The initial sterilization process for the fourth embodiment of the activation mechanism **402**E is similar to the process described above for the first embodiment of the activation mechanisms **402**A and **402**B.

FIG. **33** illustrates a fifth embodiment of an activation mechanism **402**F. The activation mechanism **402**F includes a valve **194**F attached to a sealed actuator **258**F. The sealed actuator **258**F includes an electromagnet **440**F that displaces the valve **194**F in an upward direction.

As illustrated in FIG. **33**, the second sterilization zone **166** of the sterile tunnel **90** (FIG. **3**) surrounds a nozzle **196**F, the sealed actuator **258**F, and an outlet port **412**F of the nozzle **196**F through which the product **262**A exits. The valve **194**F includes a valve head **404**F that opens and closes the outlet port **412**F of the nozzle **196**F. The sealed actuator **258**F is located within the second sterilization zone **166** of the sterile tunnel **90**. The sealed actuator **258**F includes the electromagnet **440**F and a cylindrical portion **446**F of the nozzle **196**F. The valve **194**F slides up and down in the cylindrical portion **446**F of the nozzle **196**F. The clearance between the outer surface **458** of the valve **440**F and an inner wall **454** of the nozzle **196**F is a running fit preventing product **262**A flow from leaking past the outer surface **458** of the valve **194**F (FIG. **34**). When an electrical current **436**F is introduced into the electromagnet **440**F, the valve **194**F is pulled in an upward direction. When the electrical current **436**F is removed from the electromagnet **440**F, the valve **194**F is released and the pressure of the product **262**A forces the valve **194**F in a downward direction. A control conduit **432**F connects the electromagnet **440**F of the sealed actuator **258**F with the control system **550**. The control conduit **432**F carries the electrical current **436**F from the control system **550** to the electromagnet **440**F in the sealed actuator **258**F. The control conduit **432**F passes through an opening **434**F in the wall **274** of the sterile tunnel **90**. A sealing member **438**F (e.g., gasket, grommet, compression fitting, etc.) fills the space between the control conduit **432**F and the opening **434**F, and prevents contaminants from traveling from the non-sterile region **268** into the second sterilization zone **166**.

As illustrated in FIGS. **33–35**, the valve **194**F includes a plurality of indentations **456**A–**456**F formed on the outer surface **458** of the valve **194**F. A plurality of flow passages **450**A–**450**F are formed between the inner wall **454** of the nozzle **196**F and the indentations **456**A–**456**F in the valve **194**F. The flow passages **450**A–**450**F fill with the product **262**A and transport product **262**A from an upper portion **452** of the nozzle **196**F to the outlet port **412**F. FIG. **33** illustrates the valve **194**F in a closed position with the valve head **404**F pressing against a valve seat **448** of the nozzle **196**F. Each indentation **456**A–**456**F is pressed against the valve seat **448** which prevents the product **262**A from reaching the outlet port **412**F of the nozzle **196**F. Thus, product **262**A is prevented from flowing from the nozzle **196**F to the bottle **12**.

As illustrated in FIG. **35**, the electrical current **436**F is applied to the sealed actuator **258**F to displace the valve **194**F in an upward direction. The valve head **404**F of the valve **194**F uncovers the outlet port **412**F, and the plurality of indentations **456**A–**456**F are retracted from the valve seat **448**. The product **262**A flows from the upper portion **452** of the nozzle **196**A, through the flow passages **450**A–**450**F, through the outlet port **412**F, and into the bottle **12**. The sealed actuator **258**F and the valve **194**F remain within the second sterilization zone **166** during actuation of the valve **194**F. Thus, no contamination is introduced from the non-sterile zone **268** into the second sterilization zone **166**. The initial sterilization process for the fifth embodiment of the activation mechanism **402**F is similar to the process described above for the first embodiment of the activation mechanisms **402**A and **402**B.

The nozzles **196**A–**196**F of the activation mechanisms **402**A–**402**F, respectively, are supplied aseptic product **262***a* by the pressurized reservoir apparatus **180** of the main product filler apparatus **160** as illustrated in FIGS. **3**, **13**, and **22**. Additionally, as previously described, the pressurized reservoir apparatus **180** includes the product tank **182**, the level sensor **184**, the pressure apparatus **180**, and the volumetric measuring device **188**.

FIGS. **3**, **13**, **16** and **19** illustrate the lid sterilization and heat sealing apparatus **162**. A lid **200** is applied to each of the twelve bottles **12** at station **33**. For a fully aseptic bottle filler, complete lid **200** sterilization is necessary, and therefore a sterilant such as hydrogen peroxide is typically used. In the present invention, the lids are formed of a material such as foil or plastic. The lids **200** are joined together by a small interconnecting band **203** that holds them together to form a long continuous chain of lids **200**, hereinafter referred to as a "daisy chain" **202**. The daisy chain **202** of lids is illustrated in FIGS. **17**. A daisy chain **202** of lids **200** is placed on each of a plurality of reels **210**. For the twelve bottle configuration of the present invention, six of the reels **210**, each holding a daisy chain **202** of lids **200**, are located on each side of a heat sealing apparatus **214**. Each daisy chain **202** of lids **200** winds off of a corresponding reel **210** and is sterilized, preferably using a hydrogen peroxide bath **204**. The concentration of hydrogen peroxide can range from about **30** to 40%, however, preferably the concentration is about 35%. Each lid **200** remains in the hydrogen peroxide bath **204** for at least about 6 seconds. A plurality of hot sterile air knives **208**, which are formed by jets of hot sterile air, activate the hydrogen peroxide to sterilize the lids **200** on the daisy chain **202**. The hot sterile air temperature is about 135° C. The hot air knives **208** also remove excess hydrogen peroxide from the lids **200**. A plurality of heated platens **205**

further dry the lids **200** so that the residual concentration of hydrogen peroxide is less than 0.5 PPM. The hydrogen peroxide bath **204** prevents any contaminants from entering the sterilization tunnel **90** via the lidding operation.

Once sterilized, the lids **200** enter the sterilization tunnel **90** where they are separated from the daisy chain **202** and placed on a bottle **12**. Each lid is slightly larger in diameter then that of the opening **16** of a bottle **12**. During the placement of the lid **200** on the bottle **12**, a slight mechanical crimp of the lid **200** is formed to locate and hold the lid **200** on the bottle **12**. The crimp holds the lid **200** in place on the bottle **12** until the bottle **12** reaches a station **33** for sealing. Sealing may also be accomplished without having to provide the mechanical crimp on the lid **200**.

Another embodiment of a lid sterilization and heat sealing apparatus **552** is illustrated in FIG. **19**. As illustrated in FIG. **18**, the daisy chain **215** of lids **200** includes a hole **207** located in each interconnecting band **203**. Each hole **207** receives a pin **209** of a drive sprocket **211**.

The daisy chain **215A**, **215B** of lids **200** is placed on each of a plurality of reels **210** (e.g. **210A** and **210B**). For the twelve bottle configuration of the present invention, six of the reels **210**, each holding a daisy chain **215A**, **215B** of lids **200**, are located on each side of a heat sealing apparatus **214**. Each daisy chain **215A**, **215B** of lids **200** winds off of a corresponding reel **210** and is sterilized preferably using a hydrogen peroxide bath **204**. The concentration of hydrogen peroxide can range from about 30 to 40%, however, preferably the concentration is about 35%. The lids **200** remain in the hydrogen peroxide bath **204** for at least about 6 seconds. A plurality of hot sterile air knives **208**, which are formed by jets of hot sterile air, activate the hydrogen peroxide to sterilize the lids **200** on the daisy chain **215A**, **215B**. The hot sterile air temperature is about 135° C. The hot air knives **208** also remove excess hydrogen peroxide form the lids **200**. A plurality of heated platens **205** further dry the lids **200** so that the residual concentration of hydrogen peroxide is less than 0.5 PPM. The hydrogen peroxide bath **204** prevents any contaminants from entering the sterilization tunnel **90** via the lidding operation. The drive sprocket **211A** includes a plurality of pins **209** that engage with the holes **207** of the daisy chain **215A**. The drive sprocket **211A** rotates in a counterclockwise direction and indexes and directs the daisy chain **215A**, through a plurality of guides **217A**. The guides **217A** may include a plurality of rollers **221A** to further guide and direct an end **219A** of the daisy chain **215A** over the bottle **12A**. The drive sprocket **211B** includes a plurality of pins **209** that engage with the holes **207** of the daisy chain **215B**. The drive sprocket **211B** rotates in a clockwise direction and indexes and directs the daisy chain **215B** through a plurality of guides **217B**. The guides **217B** may include a plurality of rollers **221B** to further guide and direct an end **219B** of the daisy chain **215B** over the bottle **12B**.

Once sterilized, the lids **200** enter the sterilization tunnel **90** where they are separated from the daisy chain **215A**, **217B** and placed on the bottle **12A**, **12B**. At station **33**, the lids **200** are applied to the bottles **12**. As illustrated in FIGS. **13** and **20**, the heat sealing apparatus **214** includes a heated platen **216** that applies heat and pressure against each lid **200** for a predetermined length of time, to form a seal between the lid **200** and the bottle **12A**, **12B**. Although lidding for a bottle has been described, it should be appreciated that lidding of other containers (e.g. jars) can be provided by the present invention. FIG. **20** illustrates a perspective view of the heat sealing apparatus **214**, the daisy chain **215A**, the gripper apparatus **554**, the bottle **12A**, and the conveying plate **94**. The lid **200** is located above the bottle opening **16**. The gripper apparatus **554** includes a grip **223** for capturing the bottle **12A** by a bottle lip **225**. The gripper apparatus **554** lifts the bottle **12A** in an upward direction so that the lid **200** is pressed between a bottle top lip **227** and the heated platen **216**. The interconnecting band **203** severs and separates the lid **200** on the bottle **12** from the next lid on the daisy chain **215A**. The heated platen **216** is in a two by six configuration to seal twelve of the bottles **12** at a time. There is a separate gripper apparatus **554** for each of the twelve bottles **12**. After each bottle **12** is sealed, its gripper apparatus **554** lowers and releases the bottle **12** and each bottle **12** continues to station **37**.

At station **37**, the lid **200** seal and bottle **12** integrity are checked in a known manner by a seal integrity apparatus (not shown) comprising, for example, a bottle squeezing mechanism and a proximity sensor. Each bottle **12** is squeezed by the bottle squeezing mechanism which causes the lid **200** on the bottle **12** to extend upward. The proximity sensor detects if the lid **200** has extended upward, which indicates an acceptable seal, or whether the seal remains flat, which indicates a leaking seal or bottle **12**. The location of the defective bottles **12** are recorded by the control system **550** so that the defective bottles will not be packed.

Bottle discharge from the sterilization tunnel **90** of the filler apparatus **50** occurs at stations **38** and **40** as illustrated in FIGS. **3**, **13** and **14**. A bottle discharge apparatus **280** is located at stations **38** and **40**. At this point in the filler apparatus **50**, the filled and sealed bottles **12** are forced in an upward direction such that a top portion **284** of each bottle **12** protrudes through the opening **282** in the sterilization tunnel **90** (FIG. **14**). A rotating cam **290** or other suitable means (e.g., an inflatable diaphragm, etc.) may be used to apply a force against the bottom **120** of each bottle **12** to force the bottle **12** in an upward direction.

As illustrated in FIG. **14**, the bottle discharge apparatus **280** comprises a lifting apparatus **286** that includes a gripper **288** that grasps the top portion **284** of each bottle **12** and lifts the bottle **12** out through the opening **282** in the sterilization tunnel **90**. In order to ensure that contaminated air cannot enter the sterilization tunnel **90**, the sterile air in the sterilization tunnel **90** is maintained at a higher pressure than the air outside the sterilization tunnel **90**. Thus, sterile air is always flowing out of the sterilization tunnel **90** through the opening **282**. In addition, the gripper **288** never enters the sterilization tunnel **90**, because the top portion **284** of the bottle **12** is first lifted out of the sterilization tunnel **90** by the action of the rotating cam **290** before being grabbed by the gripper **288**.

FIG. **15** illustrates a top view of the filler apparatus **50** including the bottle infeed and sterilization apparatus **60**, the interior bottle sterilization apparatus **116**, and the activation and drying apparatus **152**. FIG. **15** additionally illustrates the main filler apparatus **160**, the lid sterilization and heat sealing apparatus **162**, and the bottle discharge apparatus **280**.

Referring again to FIGS. **1** and **14**, the lifting apparatus **286** lifts the bottles **12** at station **38** and places the bottles **12** in a first lane **292** that transports the bottles **12** to a first capping apparatus **410**. In addition, the lifting apparatus **286** lifts the bottles **12** at station **40** and places the bottles **12** in a second lane **294** that transports the bottles **12** to a second capping apparatus **400**.

The first capping apparatus **410** secures a cap (not shown) on the top of each bottle **12** in the first lane **292**. The second capping apparatus **400** secures a cap on the top of each bottle

12 in the second lane 294. The caps are secured to the bottles 12 in a manner known in the art. It should be noted that the capping process may be performed outside of the sterilization tunnel 90 because each of the bottles 12 have previously been sealed within the sterilization tunnel 90 by the lid sterilization and heat sealing apparatus 162 using a sterile lid 200.

After capping, the bottles 12 are transported via the first and second lanes 292, 294 to labelers 460 and 470. The first labeling apparatus 470 applies a label to each bottle 12 in the first lane 292. The second labeling apparatus 460 applies a label to each bottle 12 in the second lane 294.

From the first labeling apparatus 470, the bottles 12 are transported along a first set of multiple lanes (e.g., 4) to a first case packing apparatus 490. From the second labeling apparatus 460, the bottles 12 are transported along a second set of multiple lanes to a second case packing apparatus 480. Each case packing apparatus 480, 490 gathers and packs a plurality of the bottles 12 (e.g., twelve) in each case in a suitable (e.g., three by four) matrix.

A first conveyor 296 transports the cases output by the first case packer 490 to a first palletizer 510. A second conveyor 298 transports the cases output by the second case packer 480 to a second palletizer 500. A vehicle, such as a fork lift truck, then transports the pallets loaded with the cases of bottles 12 to a storage warehouse.

Referring again to FIG. 3, the main conveyor 106 and each conveying plate 94 are cleaned and sanitized once during each revolution of the main conveyor 106. Specifically, after each empty conveying plate 94 passes around the pulley 108, the conveying plate 94 is passed through a liquid sanitizing apparatus 300 and a drying apparatus 302. The liquid sanitizing apparatus 300 sprays a mixture of a sterilizing agent (e.g., oxonia, (hydrogen peroxide and peroxyacetic acid)) over the entire surface of each conveying plate 94 and associated components of the main conveyor 106. In the drying apparatus 302, heated air with is used to dry the main conveyor 106 and conveying plates 94.

Stations 1 through 40 are enclosed in the sterilization tunnel 90. The sterilization tunnel 90 is supplied with air that is pressurized and sterilized. The interior of the sterilization tunnel 90 is maintained at a pressure higher than the outside environment in order to eliminate contamination during the bottle processing. In addition, to further ensure a sterile environment within the sterilization tunnel 90, the sterile air supply provides a predetermined number of air changes (e.g., 2.5 changes of air per minute) in the sterilization tunnel 90.

Before bottle production is initiated, the bottle infeed and sterilization apparatus 60 and the filler apparatus 50 are preferably sterilized with an aseptic sterilant. For example, a sterilant such as a hot hydrogen peroxide mist may be applied to all interior surfaces of the bottle infeed and sterilization apparatus 60 and the filler apparatus 50. Then, hot sterile air is supplied to activate and remove the hydrogen peroxide, and to dry the interior surfaces of the bottle infeed and sterilization apparatus 60 and the filler apparatus 50.

FIG. 16 is a side view of the aseptic processing apparatus 10 of the present invention indicating the location of the control and monitoring devices that are interfaced with the control system 550. The control system 550 gathers information and controls process functions in the aseptic processing apparatus 10. A preferred arrangement of the control and monitoring devices are indicated by encircled letters in FIG. 16. A functional description of each of the control and monitoring devices is listed below. It should be noted that these control and monitoring devices are only representative of the types of devices that may be used in the aseptic processing apparatus 10 of the present invention. Other types and combinations of control and monitoring devices may be used without departing from the intended scope of the present invention. Further, control system 550 may respond in different ways to the outputs of the control and monitoring devices. For example, the control system 550 may automatically adjust the operational parameters of the various components of the aseptic processing apparatus 10, may generate and/or log error messages, or may even shut down the entire aseptic processing apparatus 10. In the preferred embodiment of the present invention, the control and monitoring devices include:

A. A bottle counter to ensure that a predetermined number of the bottles 12 (e.g., six bottles) on each upper horizontal row 24, 28 enter the loading area of the bottle infeed and sterilization apparatus 60.

B. A proximity sensor to ensure that the first group of bottles 12 has dropped into the first bottle position in the bottle infeed and sterilization apparatus 60.

C1. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus 36 is full.

C2. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus 36 is emptied in a predetermined time.

C3. A pressure sensor to ensure that the pressure of the air used by the sterilant application apparatus 36 is within predetermined atomization requirements.

C4. A temperature sensor to ensure that each heat heating element used by the sterilant application apparatus 36 is heated to the correct temperature.

D. A proximity sensor (e.g., proximity sensor 71, FIG. 3) to ensure that a bottle jam has not occurred within the bottle infeed and sterilization apparatus 60.

E. A temperature sensor to ensure that the temperature of the heated sterile air entering the bottle infeed and sterilization apparatus 60 is correct.

F. A proximity sensor that to ensure that each conveying plate 94 is fully loaded with bottles 12.

G1. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus 116 is full.

G2. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus 116 is emptied in a predetermined time.

G3. A pressure sensor to ensure that the pressure of the air used by the interior bottle sterilization apparatus 116 is within predetermined atomization requirements.

G4. A temperature sensor to ensure that each heat heating element used by the interior bottle sterilization apparatus 116 is heated to the correct temperature.

H. A temperature sensor to ensure that the air drying temperature within the activation and drying apparatus 152 is correct.

I. A plurality of flow sensors to ensure that the airflow rate of the sterile air entering the sterilization tunnel 90 is correct.

J. A pressure sensor to ensure that the pressure of the sterile air entering the activation and drying apparatus 152 is correct.

K. A measuring device (e.g., volumetric measuring device 188, FIG. 3) to ensure that each bottle 12 is filled to a predetermined level.

L. A pressure sensor to ensure that the pressure in the product tank **182** is above a predetermined level.

M. A level sensor to ensure that the level of product in the product tank **182** is maintained at a predetermined level.

N. Proximity sensors to ensure that the daisy chains **202** of lids **200** are present in the lid sterilization and heat sealing apparatus **162**

O. A level sensor to ensure that the hydrogen peroxide level in the hydrogen peroxide bath **204** in the lid sterilization and heat sealing apparatus **162** is above a predetermined level.

P. A temperature sensor to ensure that the temperature of the hot sterile air knives **208** of the lid sterilization and heat sealing apparatus **162** is correct.

Q. A temperature sensor to ensure that the heat sealing apparatus **214** is operating at the correct temperature.

R. Proximity sensors to ensure that the bottles **12** are discharged from the filler.

S. A speed sensor to measure the speed of the conveying apparatus **100**.

T. A concentration sensor to ensure that the concentration of oxonia is maintained at a predetermined level in the sanitizing apparatus **300**.

U. A pressure sensor to ensure that the pressure of the oxonia is maintained above a predetermined level in the sanitizing apparatus **300**.

V. A temperature sensor to ensure that the drying temperature of the drying apparatus **302** is correct. The following steps are performed during the "Clean In Place" (CIP) process in the filler apparatus **50**.

23. Conductivity sensor to verify caustic and acid concentrations.

24. Temperature sensor to verify "Clean In Place" solution temperatures.

25. Flow meter to verify "Clean In Place" flow rates.

26. Time is monitored to ensure that adequate cleaning time is maintained.

The follow steps are performed during sterilization of the bottle filler apparatus **50**;

27. Temperature sensors for measuring steam temperatures.

28. Proximity sensors to ensure filler nozzle cleaning/sterilization cups are in position.

29. Temperature sensors for air heating and cooling.

30. Flow meter for hydrogen peroxide injection.

31. Time is monitored to ensure the minimum time periods are met (steam, hydrogen peroxide application and activation/drying).

The foregoing description of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and many modifications and variations are possible in light of the above teaching. Such modifications and variations that may be apparent to a person skilled in the art are intended to be included within the scope of this invention.

I claim:

1. A method comprising:

controlling the flow of an aseptic product using a valve;

surrounding a region where the asepetic product exits the valve with a sterile region wherein the sterile region is a sterile tunnel; and

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region.

2. The method of claim **1**, further including providing a tank for containing a supply of pressurized aseptic product flowing to the valve.

3. The method of claim **2**, further including providing a measuring device for measuring the amount of pressurized aseptic product flowing from the tank to the valve.

4. The method of claim **1**, further wherein the sealed actuator is partially within the sterile tunnel.

5. The method of claim **1**, further wherein the sealed actuator is fully within the sterile tunnel.

6. The method of claim **1**, further wherein the sealed actuator is attached to a wall of the sterile tunnel.

7. The method of claim **1**, further including:

connecting the sealed actuator to a control system with a control conduit.

8. The method of claim **7**, wherein a penetration of the control conduit through a wall of the sterile tunnel is a sealed member.

9. The method of claim **1**, further comprising:

aseptically disinfecting a plurality of bottles to a level producing at least about a 6 log reduction in spore organisms.

10. A method comprising:

controlling the flow of an aseptic product using a valve;

surrounding a region where the aseptic product exits the valve with a sterile region;

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region; and

providing a second apparatus wherein a container is filled to a first level with the product exiting from the first apparatus, and the container is filled to a second level with the product exiting from the second apparatus.

11. The method of claim **10**, wherein the container is filled to a first level of at least about 100 containers per minute.

12. The method of claim **11**, wherein the container is filled to a second level of at least about 100 containers per minute.

13. The method of claim **10**, wherein the aseptic product has been sterilized to a level producing at least about a 12 log reduction in *Clostridium botulinum*.

14. A method comprising:

controlling the flow of an aseptic product using a valve;

surrounding a region where the aseptic product exits the valve with a sterile region;

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region;

providing a tank for containing a supply of pressurized aseptic product flowing to the valve;

providing a measuring device for measuring the amount of pressurized aseptic product flowing from the tank to the valve;

exposing the valve, an interior surface of the tank, and an interior surface of the measuring device to steam;

covering an exit of the valve; and

allowing a build-up of steam pressure inside the tank to above a temperature of about 250° F., a steam pressure of about 50 psig, for about 30 minutes.

15. A method comprising:

controlling the flow of an aseptic product using a valve;

surrounding a region where the aseptic product exits the valve with a sterile region;

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region;

providing a tank for containing a supply of pressurized aseptic product flowing to the valve;

providing a measuring device for measuring the amount of pressurized aseptic product flowing from the tank to the valve;

exposing the valve, an interior surface of the tank, and an interior surface of the measuring device to steam;

covering an exit of the valve;

allowing a build-up of steam pressure inside the tank to above a temperature of about 250° F., a steam pressure of about 50 psig, for about 30 minutes;

uncovering the exit of the valve; and

providing sterile air to reduce the temperature of the valve, the interior surface of the tank, and the interior surface of the measuring device to the temperature of the product.

16. A method comprising:

controlling the flow of an aseptic product through a nozzle using a valve;

surrounding a region where the aseptic product exits the valve with a sterile region wherein the sterile region is a sterile tunnel; and

displacing the valve with an electromagnetic actuator, wherein an electrical current applied to the electromagnetic actuator displaces the valve into an open position allowing the aseptic product to flow through an outlet port of the nozzle.

17. The method of claim **16**, further including providing a pressurized aseptic product into the nozzle.

18. The method of claim **17**, further including removing the electric current to the electromagnet actuator allowing the valve to be displaced by the pressurized aseptic product into a closed position sealing the outlet port of the nozzle.

19. A method comprising:

controlling the flow of an aseptic product through a nozzle using a valve wherein an outer surface of the valve includes indentations for forming aseptic product flow passages between an inner wall of the nozzle and the outer surface of the valve for transporting the aseptic product to the outlet port of the nozzle;

surrounding a region where the aseptic product exits the valve with a sterile region; and

displacing the valve with an electromagnetic actuator, wherein an electrical current applied to the electromagnetic actuator displaces the valve into an open position allowing the aseptic product to flow through an outlet port of the nozzle.

20. A method comprising:

aseptically disinfecting a plurality of containers in a sterile tunnel;

controlling the flow of an aseptic product into the plurality of containers using a valve;

surrounding a region where the aseptic product exits the valve with a sterile region wherein the sterile region is the sterile tunnel; and

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region.

21. The method of claim **20**, wherein the aseptically disinfecting is to a level producing at least about a 6 log reduction in spore organisms.

22. The method of claim **20**, wherein the aseptic product has been sterilized to a level producing at least about a 12 log reduction in *Clostridium botulinum*.

23. The method of claim **20**, wherein the plurality of containers are filled at least about 100 containers per minute.

24. A method comprising:

controlling the flow of an aseptic product using a valve;

surrounding a region where the aseptic product exits the valve with a sterile region;

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region; and

providing a second apparatus wherein an aseptically disinfected container is filled to a first level with the product exiting from a first apparatus, and the container is filled to a second level with the product exiting from the second apparatus, wherein the exiting of the aseptic product and the aseptic disinfecting of the container occur in the same sterile region.

25. The method of claim **24**, wherein the aseptically disinfecting is to a level producing at least about a 6 log reduction in spore organisms.

26. The method of claim **24**, wherein the aseptic product has been sterilized to a level producing at least about a 12 log reduction in *Clostridium botulinum*.

27. The method of claim **24**, wherein a plurality of containers are filled at least about 100 containers per minute.

28. A method comprising:

controlling the flow of an aseptic product using a valve;

filling an aseptically disinfected container with the aseptic product;

surrounding a region where the aseptic product exits the valve with a sterile region, wherein the exiting of the aseptic product and aseptic disinfecting of the container occur in the sterile region;

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region;

providing a tank for containing a supply of pressurized aseptic product flowing to the valve;

providing a measuring device for measuring the amount of pressurized aseptic product flowing from the tank to the valve;

exposing the valve, an interior surface of the tank, and an interior surface of the measuring device to steam;

covering an exit of the valve; and

allowing a build-up of steam pressure inside the tank to above a temperature of about 250° F., a steam pressure of about 50 psig, for about 30 minutes.

29. The method of claim **28**, wherein the aseptically disinfecting is to a level producing at least about a 6 log reduction in spore organisms.

30. The method of claim **28**, wherein the aseptic product has been sterilized to a level producing at least about a 12 log reduction in *Clostridium botulinum*.

31. The method of claim **28**, wherein containers are filled at least about 100 containers per minute.

32. A method comprising:

controlling the flow of an aseptic product using a valve;

filling an aseptically disinfected container with the aseptic product;

surrounding a region where the aseptic product exits the valve with a sterile region, wherein the exiting of the aseptic product and aseptic disinfecting of the container occur in the sterile region;

controlling the opening or closing of the valve with a sealed actuator, wherein the sealed actuator is surrounded with the sterile region;

providing a tank for containing a supply of pressurized aseptic product flowing to the valve;

providing a measuring device for measuring the amount of pressurized aseptic product flowing from the tank to the valve;

exposing the valve, an interior surface of the tank, and an interior surface of the measuring device to steam;

covering an exit of the valve;

allowing a build-up of steam pressure inside the tank to above a temperature of about 250° F., a steam pressure of about 50 psig, for about 30 minutes;

uncovering the exit of the valve; and

providing sterile air to reduce the temperature of the valve, the interior surface of the tank, and the interior surface of the measuring device to the temperature of the product.

33. method of claim **32**, wherein the aseptically disinfecting is to a level producing at least about a 6 log reduction in spore organisms.

34. The method of claim **32**, wherein the aseptic product has been sterilized to a level producing at least about a 12 log reduction in *Clostridium botulinum*.

35. The method of claim **32**, wherein containers are filled at least about 100 containers per minute.

* * * * *

Exhibit D

US006475435B1

(12) **United States Patent**
Taggart

(10) **Patent No.: US 6,475,435 B1**
(45) **Date of Patent: Nov. 5, 2002**

(54) **APPARATUS AND METHOD FOR PROVIDING STERILIZATION ZONES IN AN ASEPTIC PACKAGING STERILIZATION TUNNEL**

(75) Inventor: **Thomas D. Taggart**, South Wales, NY (US)

(73) Assignee: **Steuben Foods Incorporated**, Elma, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/330,763**

(22) Filed: **Jun. 11, 1999**

Related U.S. Application Data

(60) Provisional application No. 60/118,404, filed on Feb. 2, 1999.

(51) **Int. Cl.**[7] **A61L 2/00**; A61L 9/00; A01N 1/00; B65B 55/00; B65B 55/02

(52) **U.S. Cl.** **422/33**; 422/28; 422/295; 422/302; 422/304; 53/167; 53/168; 53/425; 53/426

(58) **Field of Search** 53/167, 425, 426, 53/453, 28, 33; 422/302, 304

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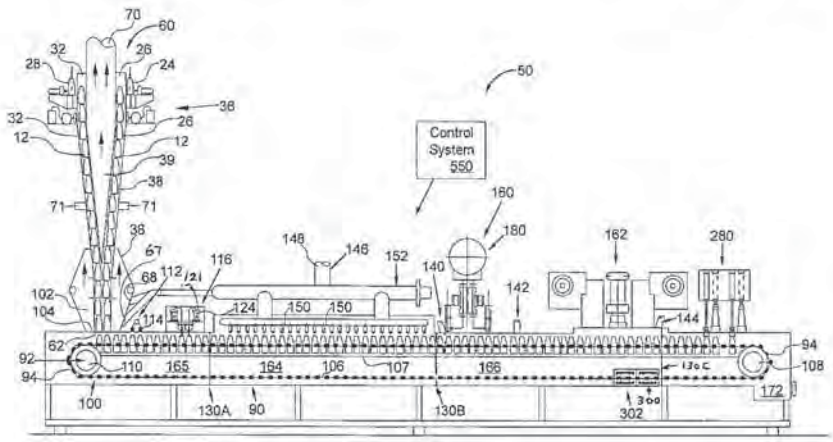
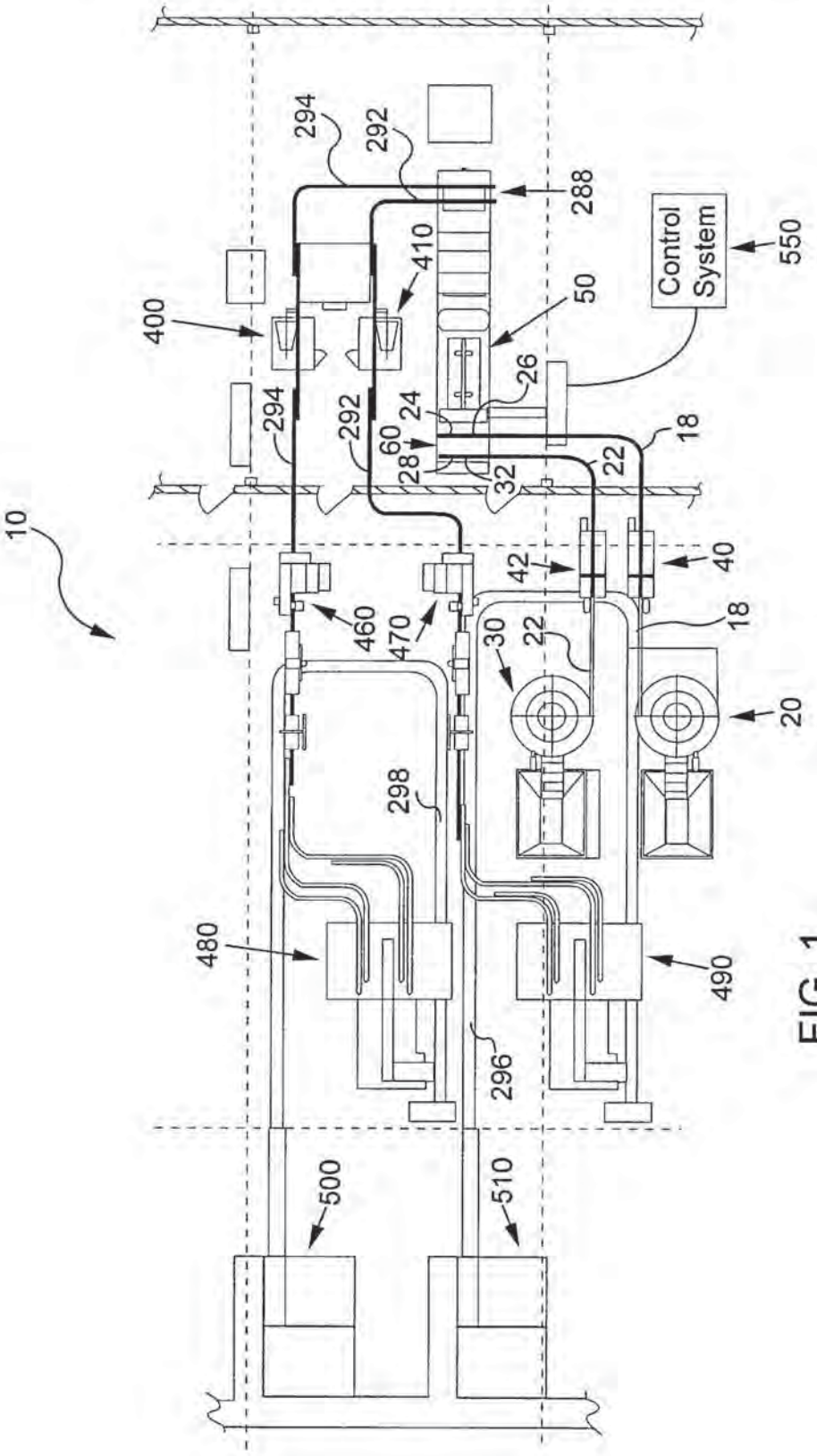
Primary Examiner—Robert J. Warden, Sr.
Assistant Examiner—Imad Soubra
(74) *Attorney, Agent, or Firm*—Schmeiser, Olsen & Watts

(57) **ABSTRACT**

A method and apparatus is disclosed providing a plurality of sterile zones within a sterilization tunnel in an aseptic packaging apparatus. The sterile zones provide a plurality of sterilant concentration levels within the sterilization tunnel. Additionally, the sterile zones provide a plurality of gas flow rates within the sterilization tunnel.

37 Claims, 14 Drawing Sheets

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296
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FIG. 1

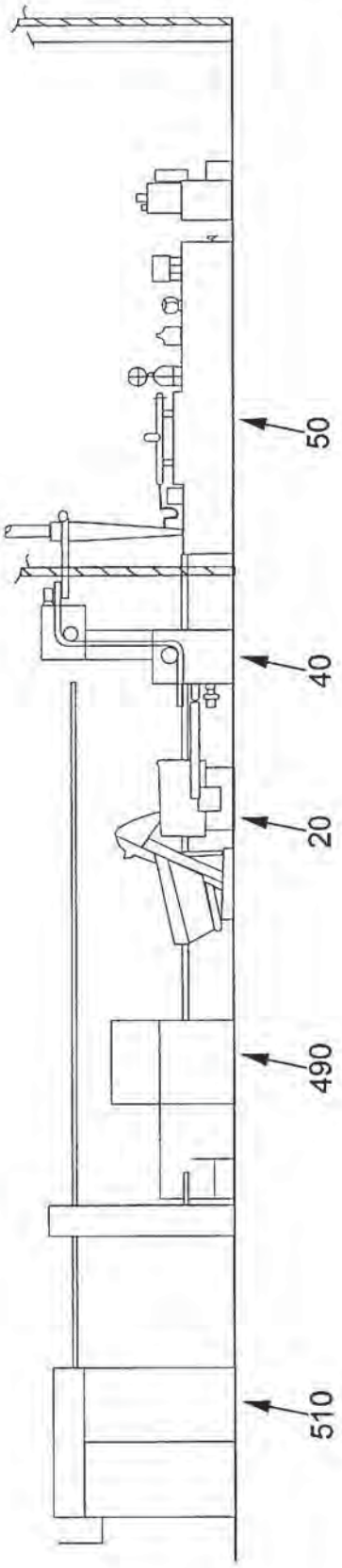


FIG. 2

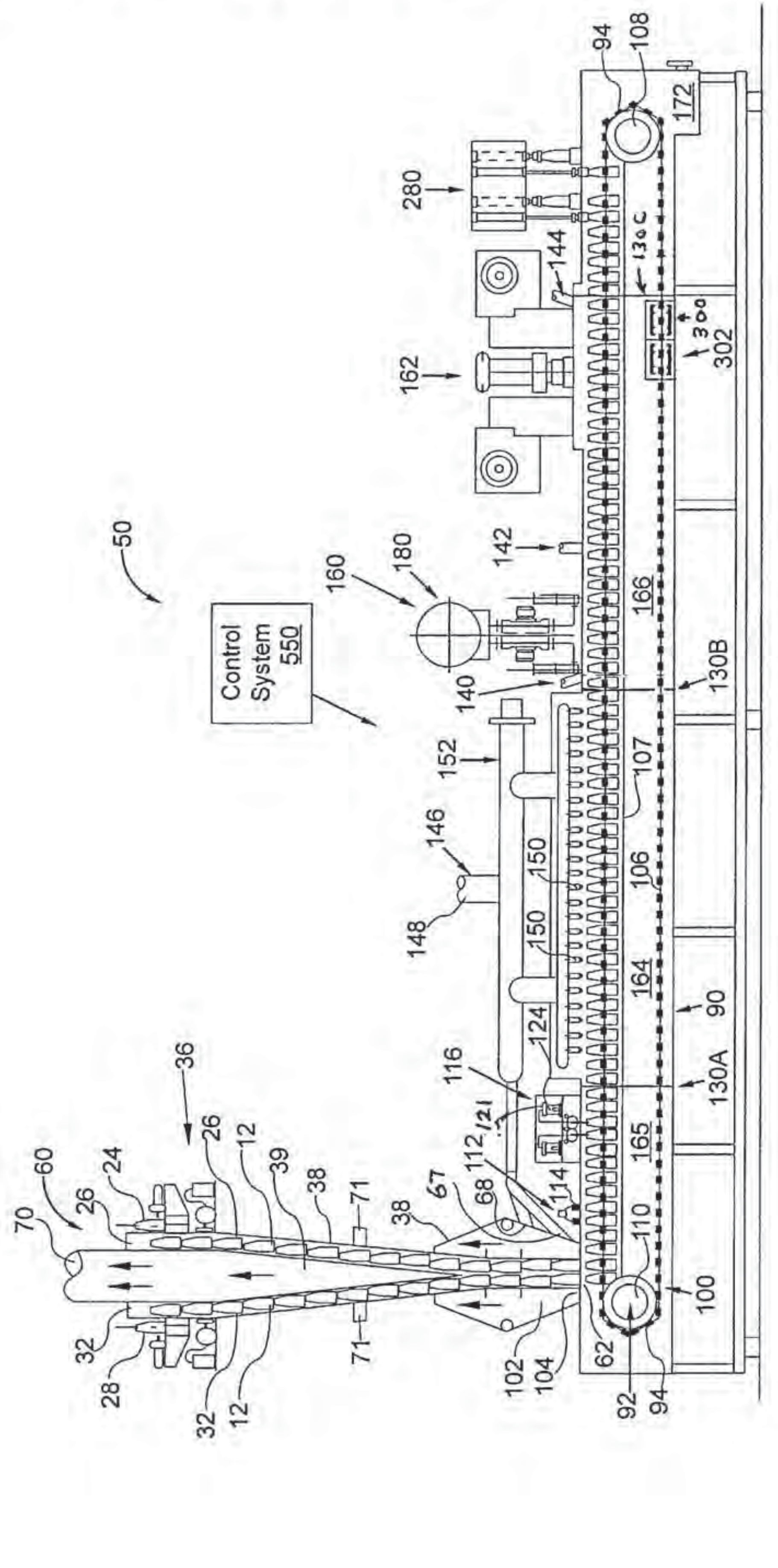
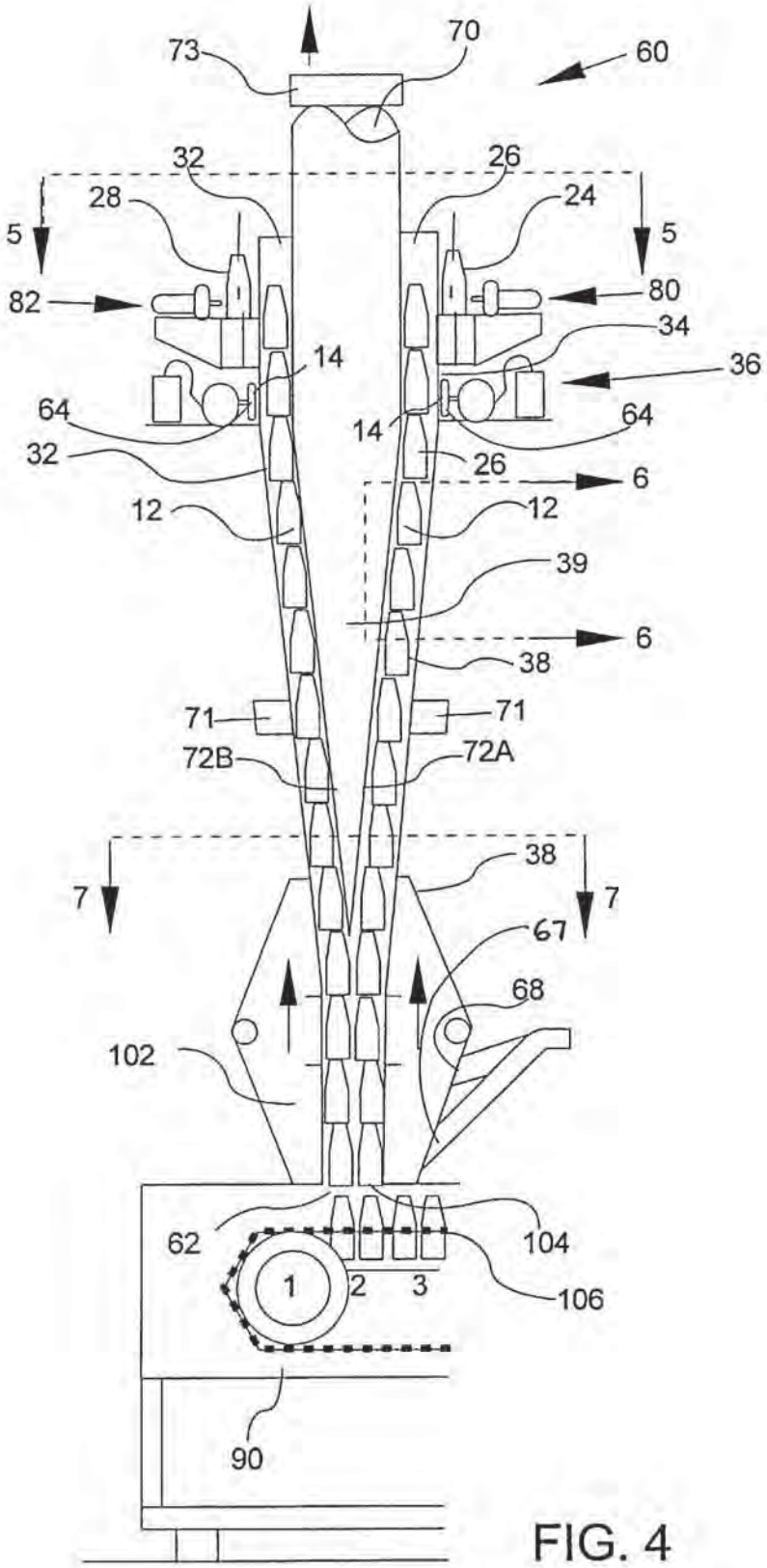


FIG. 3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12
39
6
38
71
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72B
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7
7
67
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1
2
3
106
90

FIG. 4

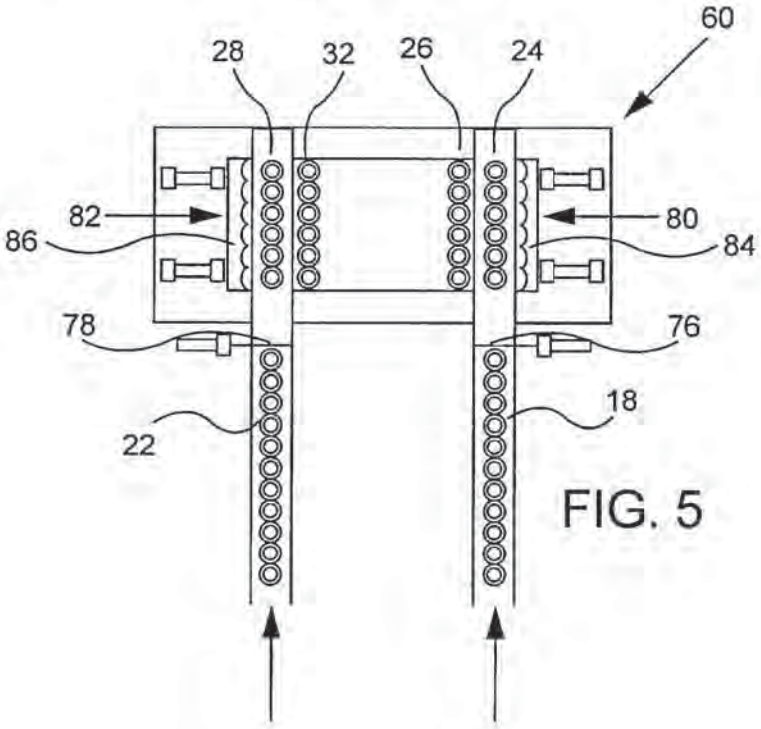

FIG. 5

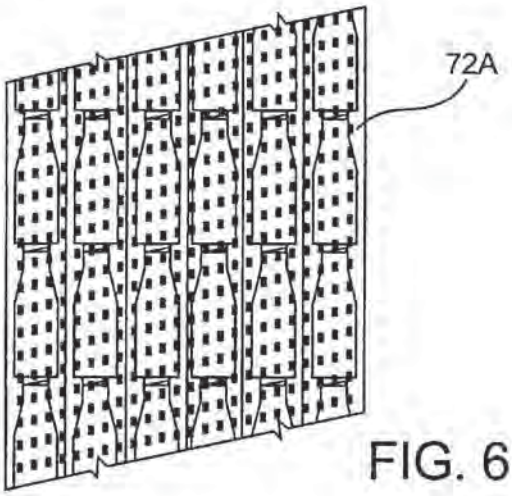

FIG. 6

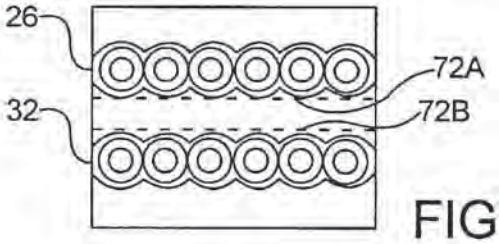

FIG. 7

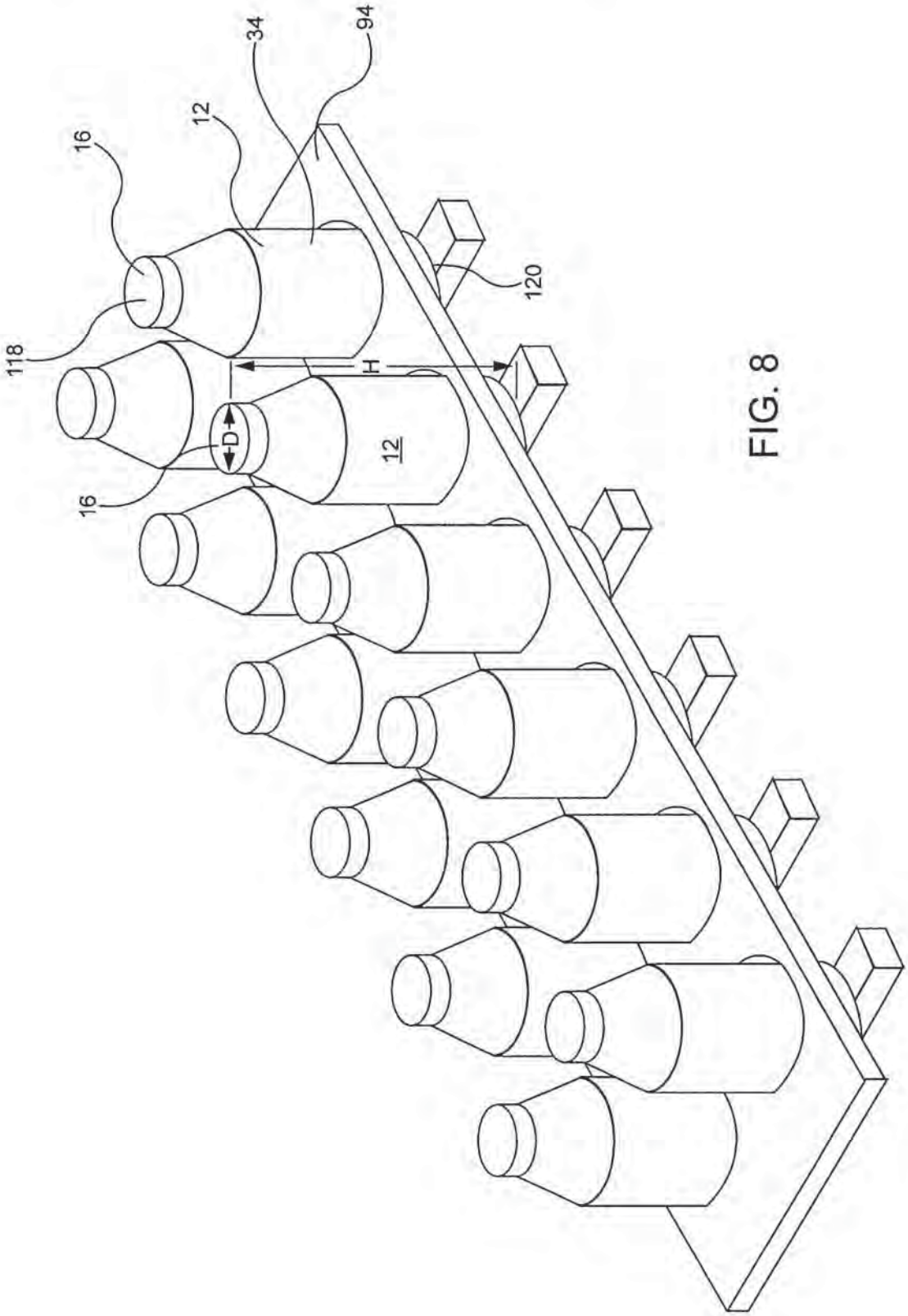

FIG. 8

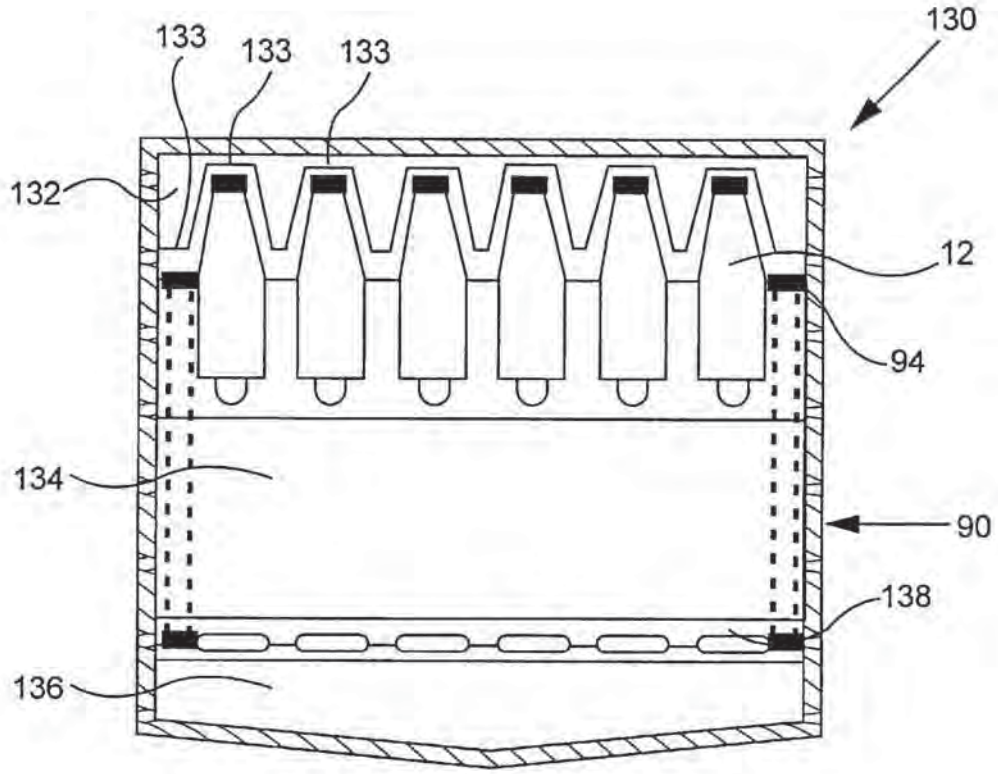

FIG. 9

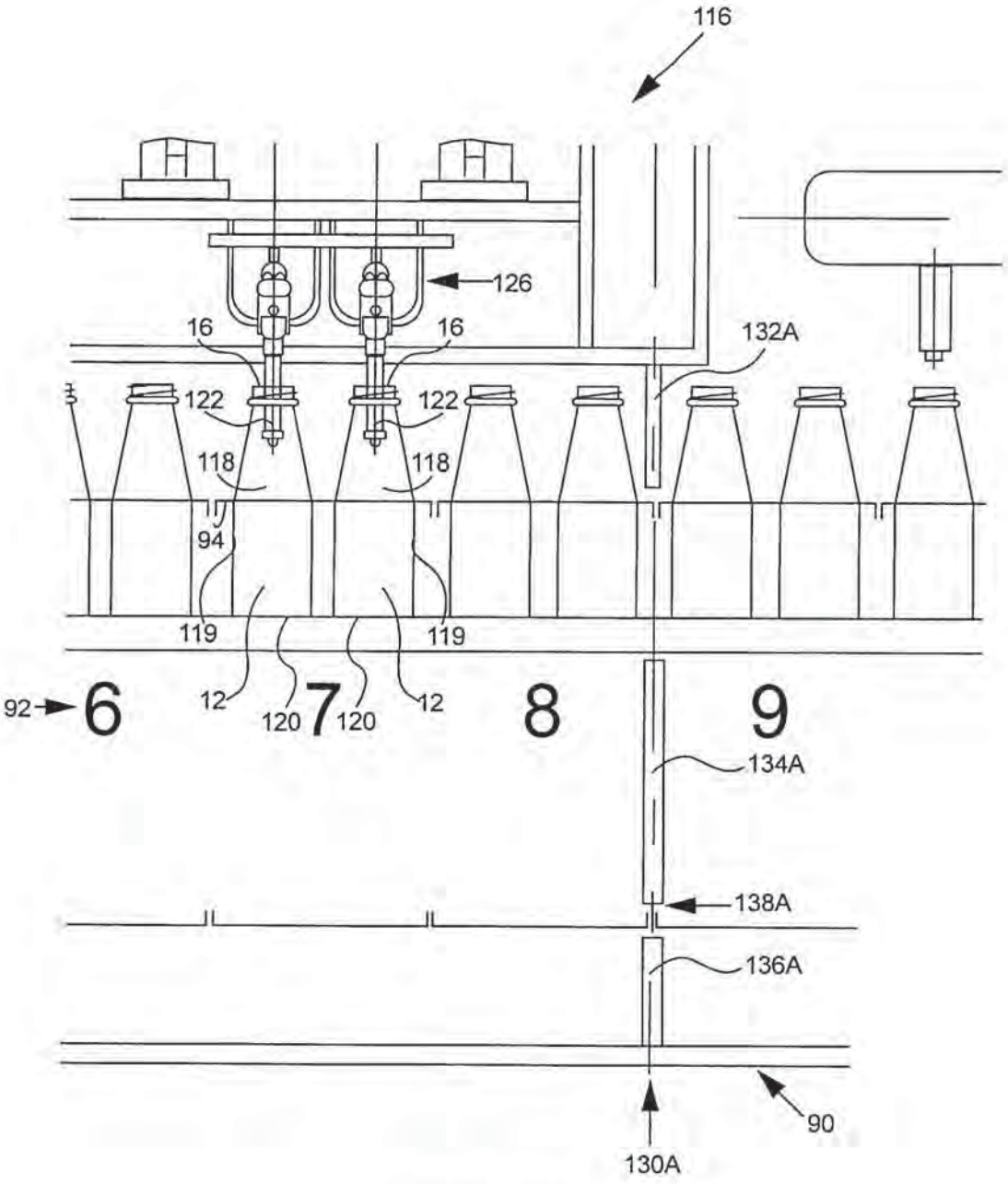
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FIG. 10

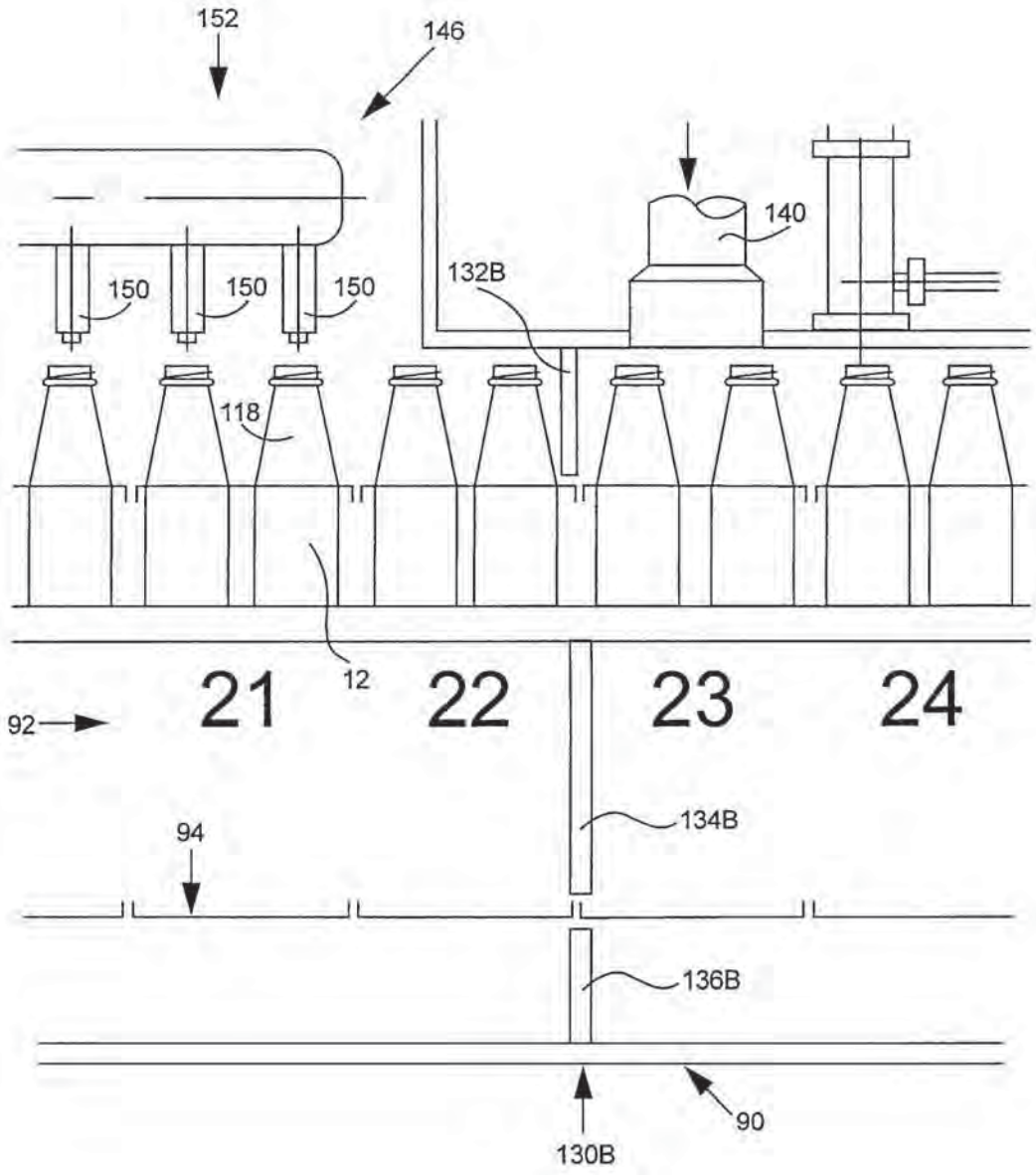
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FIG. 11

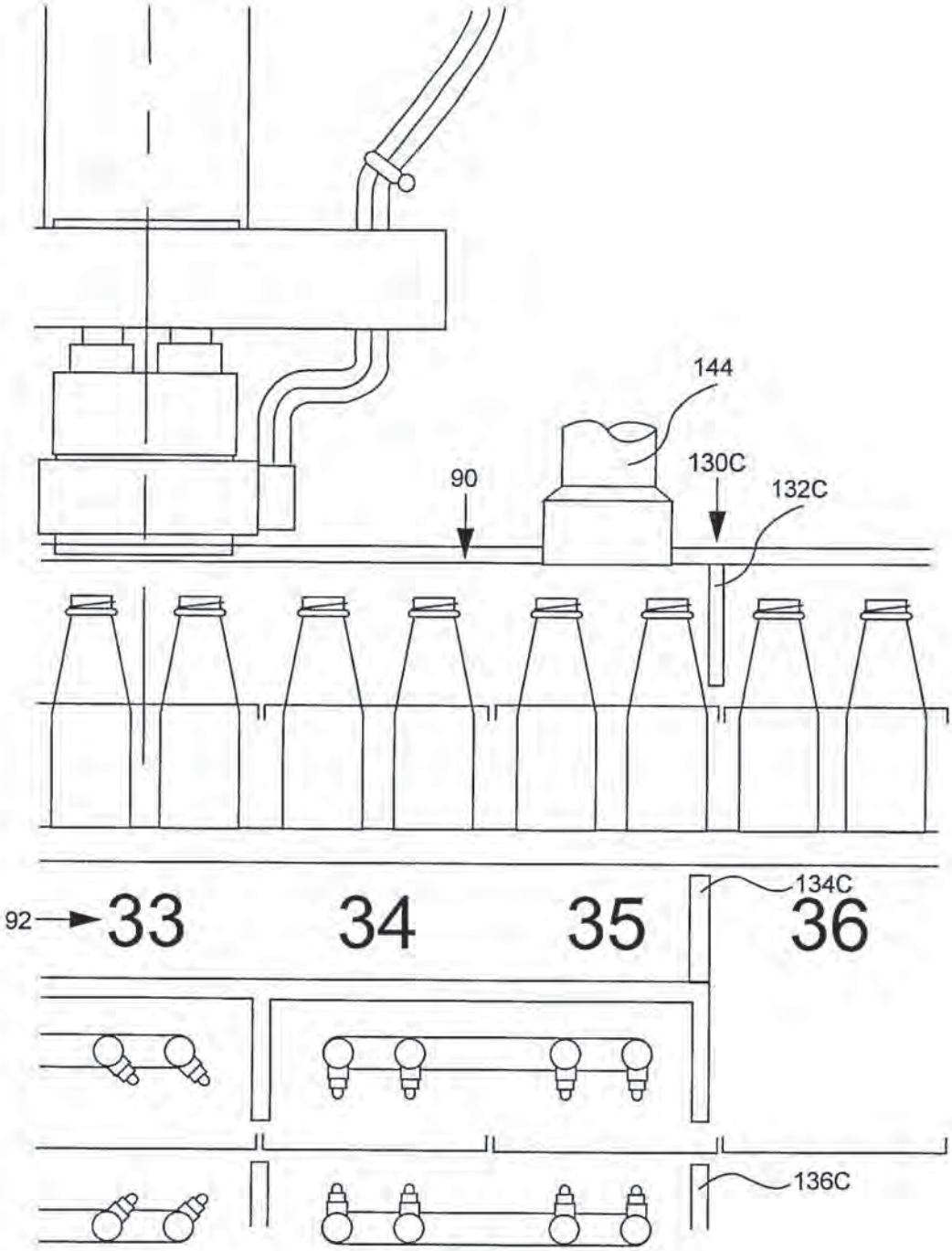
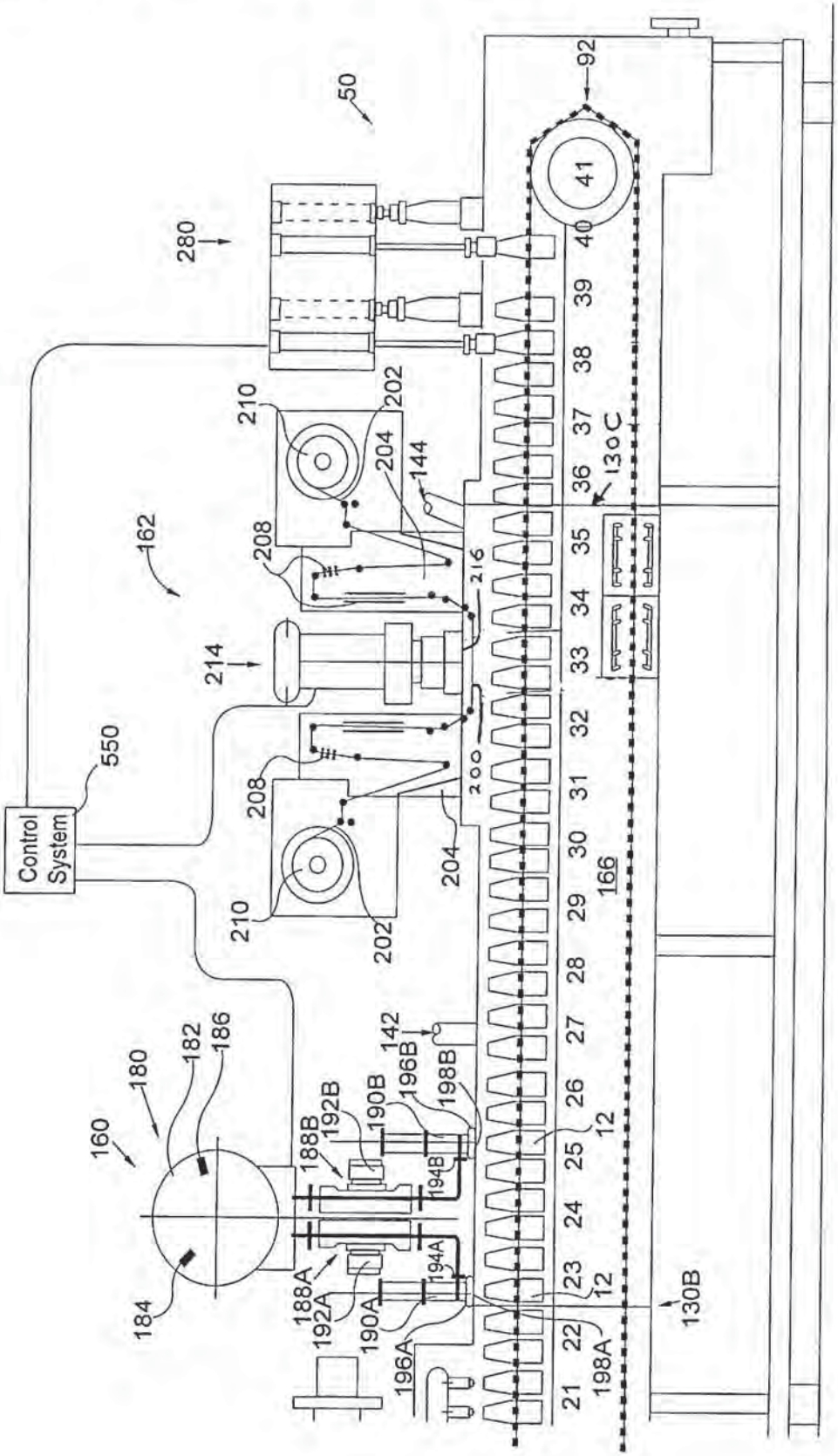


FIG. 12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25
24
23
22
21
12
166
130B
280
162
214
210
202
204
144
208
216
200
550
Control System
180
182
186
160
184
142
196B
198B
190B
192B
188B
194B
188A
192A
190A
194A
196A
198A

FIG. 13

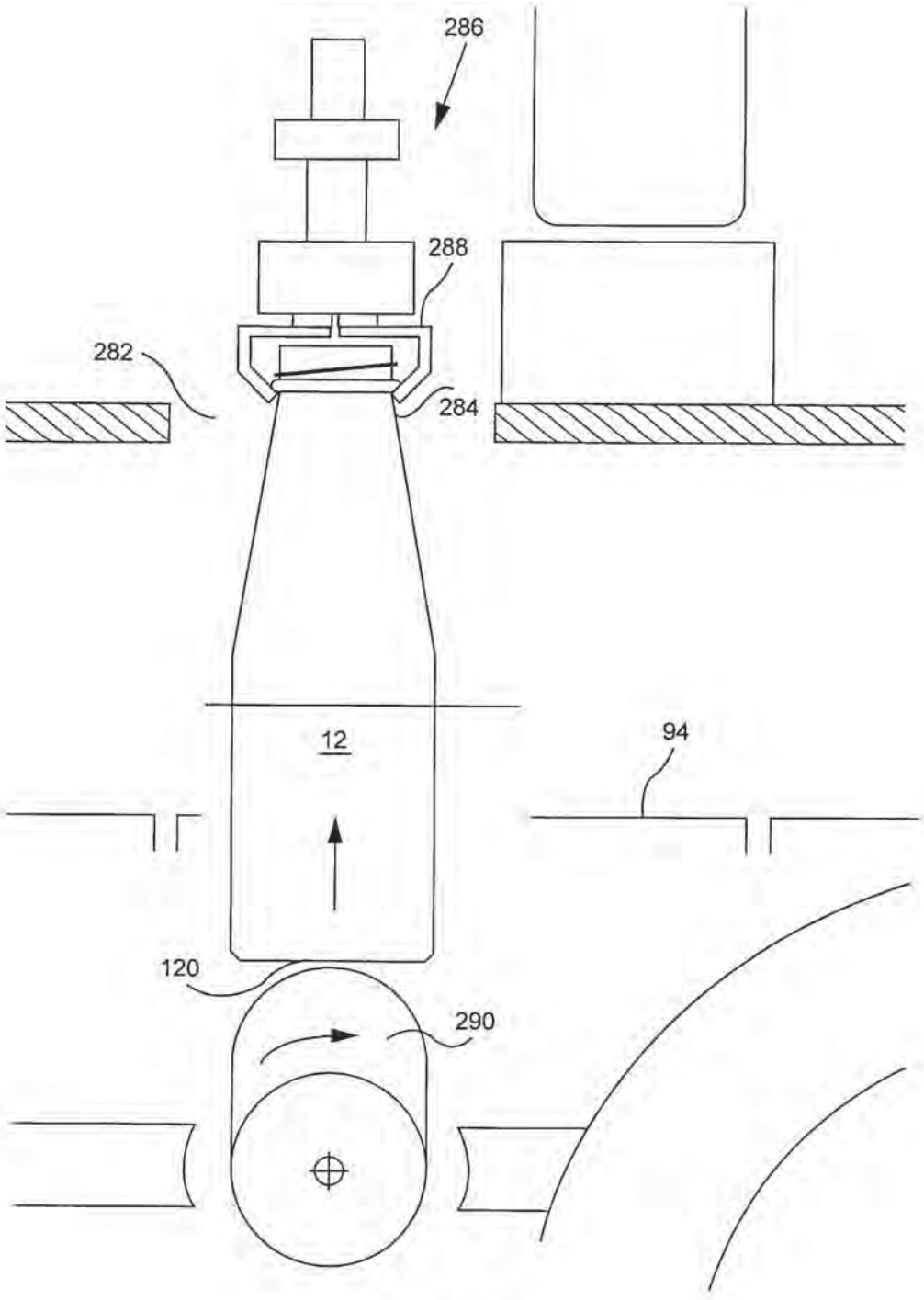


FIG. 14

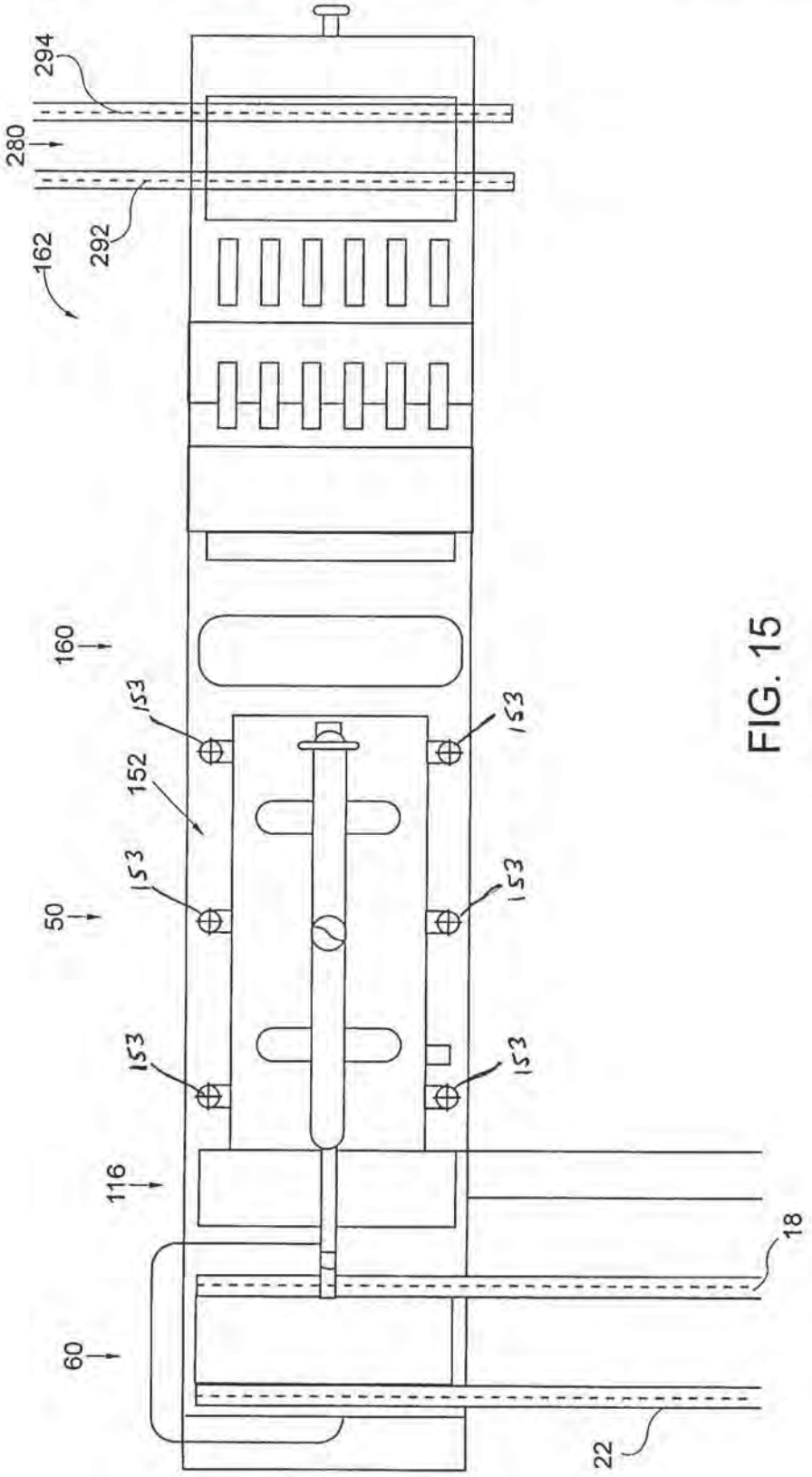
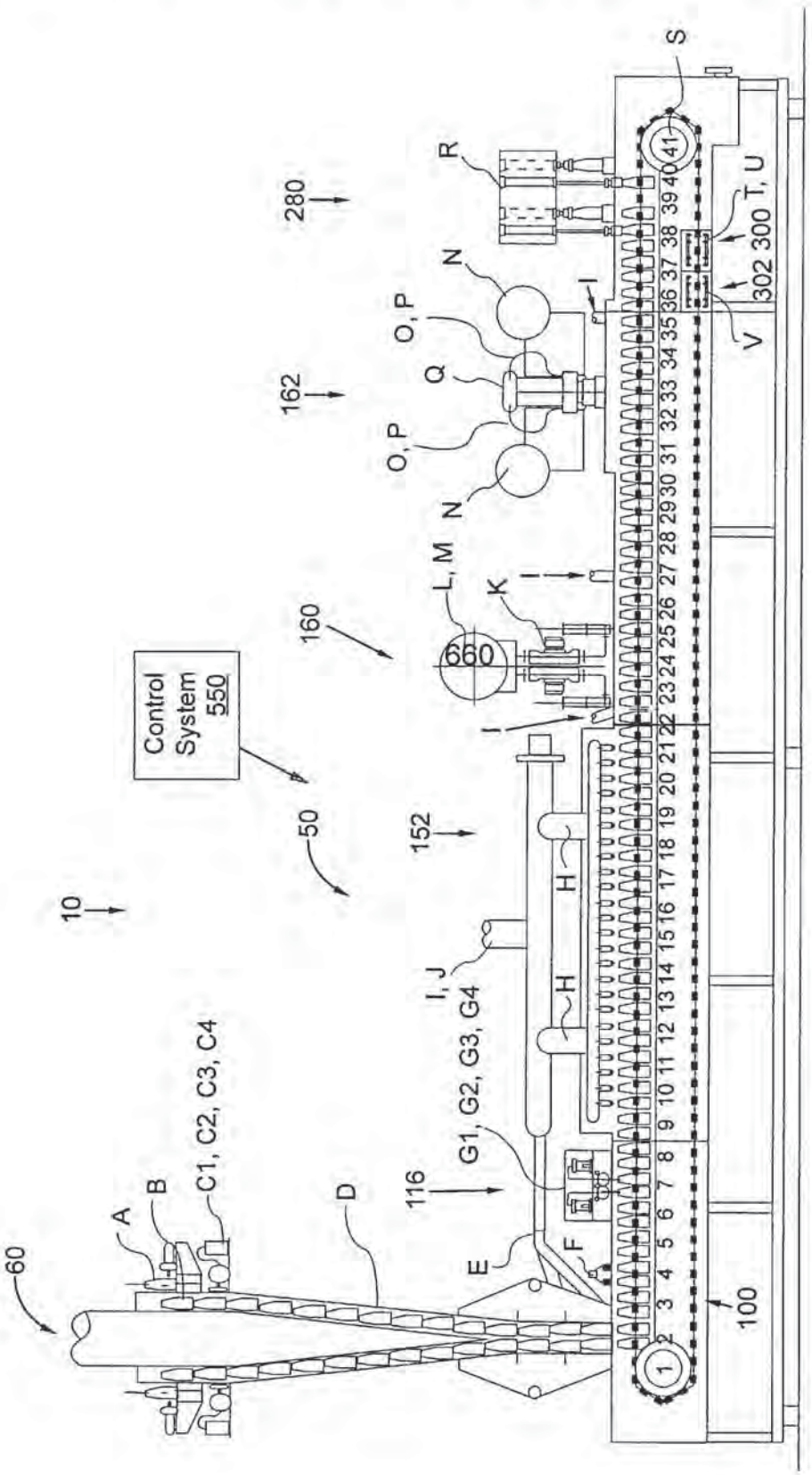


FIG. 15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C1, C2, C3, C4
D
E
F
G1, G2, G3, G4
H
I, J
K
L, M
N
O, P
Q
R
S
T, U
V
300
302

FIG. 16

APPARATUS AND METHOD FOR PROVIDING STERILIZATION ZONES IN AN ASEPTIC PACKAGING STERILIZATION TUNNEL

This application claims the benefit of provisional application No. 60/118,404 filed Feb. 2, 1999.

FIELD OF THE INVENTION

The present invention relates generally to systems for the aseptic packaging of food products. More particularly, the present invention relates to an apparatus and method for providing sterilization zones in an aseptic packaging sterilization tunnel.

BACKGROUND OF THE INVENTION

Sterilized packaging systems in which a sterile food product is placed and sealed in a container to preserve the product for later use are well known in the art. Methods of sterilizing incoming containers, filling the containers with pasteurized product, and sealing the containers in an aseptic tunnel are also known.

Packaged food products can generally be categorized as high acid products (Ph below 4.5) or low acid products (Ph of 4.5 and above). The high acid content of a high acid product helps to reduce bacteria growth in the product, thereby increasing the shelf life of the product. The low acid content of a low acid product, however, necessitates the use of more stringent packaging techniques, and often requires refrigeration of the product at the point of sale.

Several packaging techniques, including extended shelf life (ESL) and aseptic packaging, have been developed to increase the shelf life of low acid products. During ESL packaging, for example, the packaging material is commonly sanitized and filled with a product in a presterilized tunnel under "ultra-clean" conditions. By using such ESL packaging techniques, the shelf life of an ESL packaged product is commonly extended from about 10 to 15 days to about 90 days. Aseptic packaging techniques, however, which require that the packaging take place in a sterile environment, using presterilized containers, etc., are capable of providing a packaged product having an even longer shelf life of 150 days or more. In fact, with aseptic packaging, the shelf life limitation is often determined by the quality of the taste of the packaged product, rather than by a limitation caused by bacterial growth.

For the aseptic packaging of food products, an aseptic filler must, for example, use an FDA (Food and Drug Administration) approved sterilant, meet FDA quality control standards, use a sterile tunnel or clean room, and must aseptically treat all packaging material. The food product must also be processed using an "Ultra High Temperature" (UHT) pasteurization process to meet FDA aseptic standards. The packaging material must remain in a sterile environment during filling, closure, and sealing operations.

Many attempts have been made, albeit unsuccessfully, to aseptically fill containers, such as bottles or jars having small openings, at a high output processing speed. In addition, previous attempts for aseptically packaging a low acid product in plastic bottles or jars (e.g., formed of polyethylene terepthalate (PET) or high density polyethylene (HDPE)), at a high output processing speed, have also failed. Furthermore, the prior art has not been successful in providing a high output aseptic filler that complies with the stringent United States FDA standards for labeling a packaged product as "aseptic." In the following description of the present invention, the term "aseptic" denotes the United States FDA level of aseptic.

SUMMARY OF THE INVENTION

In order to overcome the above deficiencies, the present invention provides a method and apparatus for providing aseptically processed low acid products in a container having a small opening, such as a glass or plastic bottle or jar, at a high output processing speed.

Many features are incorporated into the aseptic processing apparatus of the present invention in order to meet the various FDA aseptic standards and the 3A Sanitary Standards and Accepted Practices.

The aseptic processing apparatus of the present invention uses a gas such as filtered air to maintain a positive pressure within a filler apparatus. The filler apparatus includes a sterilization tunnel that is pressurized to a level greater than atmospheric pressure using filtered sterile air. The filler apparatus includes three interfaces with the ambient environment, each of which eliminates the possibility of external contamination. The first interface is where containers first enter the sterilization tunnel through a bottle infeed and sterilization apparatus. In accordance with the present invention, there is always an outflow of aseptic sterilant (e.g., hydrogen peroxide) enriched sterile air from the first interface to prevent contaminants from entering the sterilization tunnel. The second interface with the sterilization tunnel is the path where incoming lid stock enters a lid sealing and heat sealing apparatus. To prevent contamination, the lid stock passes through a hydrogen peroxide bath that provides an aseptic barrier for any contaminants that enter the sterilization tunnel through the second interface. The third interface with the sterilization tunnel is at an exit opening of a discharge apparatus where sealed containers leave the sterilization tunnel. Positive sterile air pressure within the sterilization tunnel ensures that sterile air is continuously flowing out of the exit opening of the discharge apparatus, thereby preventing contaminants from entering the sterilization tunnel through this interface.

The aseptic processing apparatus includes a conveying apparatus for transporting the containers through a plurality of processing stations located within the sterilization tunnel. The entire conveying apparatus is enclosed within the sterilization tunnel, and is never is exposed to unsterile conditions.

A plurality of partitions and a plurality of hot sterile air supply sources (e.g., conduits) provide a plurality of sterile zones within the sterilization tunnel. The sterile zones provide a plurality of sterilant concentration levels withing the sterilization tunnel. Additionally, the sterile zones provide a plurality of gas flow rates within the sterilization tunnel.

The interior surface of a container such as a bottle or jar is much more difficult to aseptically sterilize than the interior surface of a cup. A cup generally has a large opening compared to its height, whereas a bottle or jar generally has a small opening compared to its height and its greatest width (e.g., the ratio of the opening diameter to the height of the container is less than 1.0). A sterilant can be introduced, activated, and removed in a cup much more rapidly than in a bottle or jar. The processing speed when using a bottle or jar is limited, in part, by the time required to aseptically sterilize the interior surface of the bottle or jar. The aseptic processing apparatus of the present invention overcomes the processing speed limitations associated with the use of containers such as bottles or jars.

A high output processing speed is achieved in the present invention by applying a hot atomized sterilant, such as

hydrogen peroxide spray onto the interior surface of each container, and by subsequently activating and removing the sterilant in a plurality of drying stations using hot sterile air. For example hydrogen peroxide breaks down into water and oxygen, and thus oxidizes and kills bacteria within the container. To achieve aseptic sterilization, a minimum container temperature is developed and held for a predetermined period of time (e.g., 131° F. for 5 seconds) after application of the sterilant. Hot sterile air is delivered at a high volume and a relatively low temperature to dry the container and to prevent the container (if formed of plastic) from being heated to its softening temperature. After container drying, the residual hydrogen peroxide in the container is below a predetermined level (e.g., about 0.5 PPM (parts per million)).

The present invention generally provides an apparatus comprising:

- a sterilization tunnel for surrounding a plurality of containers with pressurized gas; and
- a plurality of zones within a sterilization tunnel having different sterilant concentration levels.

Also provided is a method comprising:

- providing a sterilization tunnel for surrounding a plurality of containers with pressurized gas;
- introducing sterilant from a sterilant supply source into the sterilization tunnel;
- providing a plurality of sterilant concentration zones within the sterilization tunnel;
- introducing pressurized gas from at least one gas supply source into the sterilization tunnel; and
- allowing the pressurized gas to escape the sterilization tunnel.

The invention further provides an apparatus comprising:

- means for providing a plurality of containers in a sterilization tunnel;
- means for providing a plurality of sterilant concentration zones within the sterilization tunnel; and
- means for providing a plurality of gas flow rates within the sterilization tunnel.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention will best be understood from a detailed description of the invention and a preferred embodiment, thereof selected for the purposes of illustration, and shown in the accompanying drawings in which:

FIG. **1** is a plain view of an aseptic processing apparatus in accordance with a preferred embodiment of the present invention;

FIG. **2** is a side view of the aseptic processing apparatus of FIG. **1**;

FIG. **3** is a partial cross-sectional side view of the aseptic processing apparatus of FIG. **1**;

FIG. **4** is a cross-sectional side view of a bottle infeed and sterilization apparatus;

FIG. **5** illustrates a cross-sectional top view of the bottle infeed and sterilization apparatus taken along line **5**—**5** of FIG. **4**;

FIG. **6** is an interior sectional view of an interior wall taken along line **6**—**6** of FIG. **4**;

FIG. **7** is a cross-sectional view of the bottle infeed and sterilization apparatus taken along line **7**—**7** of FIG. **4**;

FIG. **8** is a perspective view of a conveying plate for use in the aseptic processing apparatus of the present invention;

FIG. **9** is a perspective view of a partition in a sterilization tunnel;

FIG. **10** is a cross-sectional side view of an interior bottle sterilization apparatus and the partition located between stations **8** and **9**;

FIG. **11** is a cross-sectional side view of the partition located between stations **22** and **23**;

FIG. **12** is a cross-sectional side view of the partition located between stations **35** and **36**;

FIG. **13** is a cross-sectional side view of a lid sterilization and heat sealing apparatus;

FIG. **14** is a side view of a lifting apparatus with a gripper mechanism for lifting the bottles from the sterilization tunnel;

FIG. **15** is a top view of the aseptic processing apparatus; and

FIG. **16** is a side view of the aseptic processing apparatus indicating the control and monitoring locations that are interfaced with a control system.

DETAILED DESCRIPTION OF THE INVENTION

Although certain preferred embodiments of the present invention will be shown and described in detail, it should be understood that various changes and modifications may be made without departing from the scope of the appended claims. The scope of the present invention will in no way be limited to the number of constituting components, the materials thereof, the shapes thereof, the relative arrangement thereof, etc., and are disclosed simply as an example of the preferred embodiment. The features and advantages of the present invention are illustrated in detail in the accompanying drawings, wherein like reference numerals refer to like elements throughout the drawings. Although the drawings are intended to illustrate the present invention, the drawings are not necessarily drawn to scale.

The present invention provides an aseptic processing apparatus **10** that will meet the stringent United States FDA (Food and Drug Administration) requirements and **3**A Sanitary Standards and Accepted Practices required to label a food product (foodstuffs) as "aseptic". Hereafter, "aseptic" will refer to the FDA level of aseptic. The present invention provides an aseptic processing apparatus **10** for producing at least about a 12 log reduction of *Clostridium botulinum* in food products. In addition, the present invention produces packaging material with at least about a 6 log reduction of spores. Actual testing of the aseptic processing apparatus is accomplished with spore test organisms. These test organisms are selected on their resistance to the media selected used to achieve sterility. For example, when steam is the media, the test organism is *Bacillus stearothermophilus*. When hydrogen peroxide is the media, then the test organism is *Bacillus subtilis* var. globigii.

The present invention processes containers such as bottles or jars that have a small opening compared to its height and its greatest width (e.g., the ratio of the opening diameter to the height of the container is less than 1.0). In the preferred embodiment, a bottle **12** (see, e.g., FIG. **8**) is illustrated as the container. The container may alternately comprise a jar. The bottle **12** is preferably formed of a plastic such as polyethylene terepthalate (PET) or high density polyethylene (HDPE), although other materials such as glass may also be used. The present invention uses an aseptic sterilant such as hydrogen peroxide (H_2O_2) or oxonia (hydrogen peroxide and peroxyacetic acid) to sterilize the bottles **12**. In the

preferred embodiment of the present invention, hydrogen peroxide is used as the sterilant. The present invention uses hydrogen peroxide with a concentration of less than about 35% and ensures that the bottles **12** have less than about 0.5 ppm of residual hydrogen peroxide after each bottle **12** is sterilized.

FIGS. **1**—**3** illustrate several views of an aseptic processing apparatus **10** in accordance with a preferred embodiment of the present invention. As shown, the aseptic processing apparatus **10** includes a first bottle unscrambler **20**, a second bottle unscrambler **30**, and a bottle lifter **40** for providing a supply of properly oriented empty bottles. The empty bottles are delivered to a filler apparatus **50** after passing through a bottle infeed and sterilization apparatus **60** for aseptic sterilization. The filled bottles are sealed at a first capping apparatus **400** or a second capping apparatus **410**. A control system **550** monitors and controls the operation of the aseptic processing apparatus **10**. The filled and sealed bottles are packed and palletized using a first case packing apparatus **480**, a second case packing apparatus **490**, a first palletizer **500**, and a second palletizer **510**.

The bottles **12** arrive at a first bottle unscrambler **20** with a random orientation, such that an opening **16** (see FIG. **8**) of each bottle **12** can be oriented in any direction. The first bottle unscrambler **20** manipulates the bottles **12** until the opening **16** of each bottle **12** is in a top vertical position. The bottles **12** leave the first bottle unscrambler **20** in a series formation with the opening **16** of each bottle **12** oriented vertically. The bottles **12** travel in single file in a first lane **18** to a first bottle lifter **40**. The first bottle lifter **40** lifts and transports the bottles **12** to a bottle infeed and sterilization apparatus **60**. A second bottle unscrambler **30** may also used to provide a supply of vertically oriented bottles **12**. The bottles **12** output from the second bottle unscrambler **30** travel in single file in a second lane **22** to a second bottle lifter **42**, which lifts and transports the bottles **12** to the bottle infeed and sterilization apparatus **60**.

FIG. **3** illustrates the bottle infeed, sterilization, and conveying apparatus **60** attached to the filler apparatus **50**. FIG. **4** illustrates a cross-sectional side view of the bottle infeed, sterilization, and conveying apparatus **60**. FIG. **5** illustrates a cross-sectional top view of the bottle infeed, sterilization, and conveying apparatus **60** taken along line **5**—**5** of FIG. **4**. The bottle infeed and sterilization apparatus **60** preferably inputs six bottles **12** in a horizontal direction from the first lane **18** and six bottles in a horizontal direction from the second lane **22** (FIG. **5**). A gate **76** in the first lane **18** selectively groups six bottles **12** at a time in first horizontal row **24**. A gate **78** in the second lane **22** selectively groups six bottles **12** at a time in a second horizontal row **28**. An infeed apparatus **80** includes a pushing element **84** for pushing the bottles **12** in the first horizontal row **24** into a first vertical lane **26**. A corresponding infeed apparatus **80** includes a pushing element **86** for pushing the bottles **12** in the second horizontal row **28** into a second vertical lane **32**. The six bottles **12** in the first vertical lane **26** and the six bottles **12** in the second vertical lane **32** are directed downward into the bottle infeed and sterilization apparatus **60**.

Referring to FIG. **4**, as the bottles **12** move downward in the first vertical lane **26** and the second vertical lane **32**, a sterilant **14**, such as heated hydrogen peroxide, oxonia, or other aseptic sterilant, is applied to an outside surface **34** of each bottle **12** by a sterilant application apparatus **36**. The outside surface **34** of a bottle **12** is illustrated in greater detail in FIG. **8**. The bottles **12** may move downward in the first vertical lane **26** and the second vertical lane **32** by the force of gravity. Alternatively, controlled downward movement of the bottles **12** can be created by the use of a conveying device such as a moving conveying chain. A plurality of pins are attached to the conveying chain. Each bottle **12** rests on one of the pins attached to the conveying chain. Therefore, the motion of each bottle is controlled by the speed of the moving conveying chain.

A sterilant such as hydrogen peroxide may be provided to the sterilant application apparatus **36** in many ways. For example, liquid hydrogen peroxide may be provided in a reservoir at a level maintained by a pump and overflow pipe. A plurality of measuring cups (e.g., approximately 0.5 ml each) connected by an air cylinder are submerged into the reservoir and are lifted above the liquid level. Thus, a measured volume of liquid hydrogen peroxide is contained in each measuring cup.

Each measuring cup may include a conductivity probe that is configured to send a signal to the control system **550** indicating that the measuring cup is full. A tube (e.g., having a diameter of about 1/16") is positioned in the center of the measuring cup. A first end of the tube is positioned near the bottom of the measuring cup. A second end of the tube is connected to the sterilant application apparatus **36**. The sterilant application apparatus **36** includes a venturi and a heated double tube heat exchanger. When the measuring cup is full, and a signal is received from the control system **550**, a valve is opened allowing pressurized sterile air to enter the venturi. The pressurized air flow causes a vacuum to be generated in second end of the tube causing liquid hydrogen peroxide to be pulled out of the measuring cup. The liquid hydrogen peroxide is sprayed into a sterile air stream which atomizes the hydrogen peroxide into a spray. The atomized hydrogen peroxide enters the double tube heat exchanger in order to heat the atomized hydrogen peroxide above its vaporization phase. The double tube heat exchanger is heated with steam and the temperature is monitored and controlled by the control system **550**. In FIG. **4**, the application of the sterilant **14** by the sterilant application apparatus **36** is accomplished through the use of spray nozzles **64** that produce a sterilant fog which is directed to the entire outside surface **34** of each bottle **12**.

Alternatively, a direct spray of heated hydrogen peroxide may be continuously applied to the outside surface **34** of each bottle **12**. For producing the direct spray, a metering pump regulates the amount of hydrogen peroxide, a flow meter continuously measures and records the quantity of hydrogen peroxide being dispensed, a spray nozzle produces a fine mist, and a heat exchanger heats the hydrogen peroxide above the vaporization point.

FIGS. **3** and **4** illustrate the sterilization chamber **38** for activation and drying of bottles **12** which is included in the bottle infeed, sterilization, and conveying apparatus **60**. The sterilization chamber **38** sterilizes the outside surface **34** of each bottle **12**. The sterilization chamber **38** encloses a conduit **39**. Sterile heated air, which is generated by a sterile air supply system **146** (FIG. **3**), enters the conduit **39** of the sterilization chamber **38** through ports **67** and **68** located at the bottom of the sterilization chamber **38**. The sterile heated air also enters through a bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The sterile heated air travels up through the conduit **39** of the sterilization chamber **38**, and exits the top of the sterilization chamber **38** through an exhaust conduit **70**. The sterile heated air continuously flows in an upward direction through the sterilization chamber **38**, thus preventing any contaminants from entering the bottle infeed and sterilization apparatus **60**. To create the sterile heated air, the air is first passed through a filtering system (e.g., a group of double sterile air filters to

sterilize the air. The air is then heated in a heating system (e.g., an electric heater) to about 230° F. The air temperature is regulated by the control system **550**. Other techniques for providing the sterile heated air may also be used. The control system **550** monitors the air pressure and flow rate of the sterile heated air to ensure that an adequate flow of the hot sterile air is maintained in the bottle sterilization chamber **38** of the bottle infeed and sterilization apparatus **60**.

As illustrated in FIGS. **4**, **6**, and **7**, the sterilization chamber **38** includes two opposing, interior, perforated walls **72**A, **72**B. The perforated walls **72**A and **72**B guide the bottles **12** downward in the first vertical lane **26** and the second vertical lane **32**, respectively. The perforated walls **72**A, **72**B also allow the complete circulation of hot sterile air around the outside surface **34** of each bottle **12** in the sterilization chamber **38**. The sterilization chamber **38** supplies hot sterile air to the outside surface **34** of each bottle **12** between the sterilant application apparatus **36** and the bottom opening **62** of the bottle infeed and sterilization apparatus **60**. This sterilant may be hydrogen peroxide or oxonia (hydrogen peroxide and peroxyacetic acid).

In accordance with the preferred embodiment of the present invention, twelve drying positions are provided in the sterilization chamber **38**. Each bottle **12** is exposed to the hot sterile air in the sterilization chamber **38** for about at least 24 seconds. This provides time sufficient time for the hydrogen peroxide sterilant to break down into water and oxygen, to kill any bacteria on the bottles **12**, and to evaporate from the outside surface **34** of the bottles **12**.

An exhaust fan **73** is located at a top of the exhaust conduit **70** to provide an outlet from the sterilization tunnel **90**, and to control the sterile air flow rate through the sterilization chamber **38**. The exhaust fan **73** is controlled by the control system-**550**. The control system **550** controls the sterile air temperature preferably to about 230° F., and controls the sterile air flow rate through the sterilization chamber **38**. The flow rate is preferably about 1800 scfm through the sterilization chamber **38**. The bottles **12** leave the sterilization chamber **38** with a hydrogen peroxide concentration of less than 0.5 PPM.

As shown in FIGS. **3** and **4**, a plurality of proximity sensors **71** located along the sides of the vertical lanes **26**, **32** detect any bottle **12** jams that occur within the sterilization chamber **38**. The proximity sensors **71** transmit an alarm signal to the control system **550**. The bottles **12** leave the bottle infeed and sterilization apparatus **60** through the bottom opening **62**, and enter a sterilization tunnel **90** of the filler apparatus **50**.

In the preferred embodiment of the present invention, the filler apparatus **50** includes forty-one (41) index stations **92**, hereafter referred to as "stations." Various index stations **92** are illustrated in FIGS. **3**, **4**, and **11**–**15**. The conveying motion of the bottles **12** to the various stations **92** through the filler apparatus **50** is based on an indexing motion. The filler apparatus **50** is designed to convey the bottles **12** through the various operations of the filler **50** in a two by six matrix. The twelve bottles **12** in the two by six matrix are positioned in, and displaced by, a conveying plate **94** as illustrated in FIG. **8**. Therefore, twelve bottles **12** are exposed to a particular station **92** at the same time. A conveying apparatus **100** moves the set of twelve bottles **12** in each conveying plate **94** sequentially through each station **92**.

Referring to FIGS. **3** and **4**, the bottles **12** are supplied from an infeed chamber **102** to station **2** of the filler apparatus **50** through the bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The infeed chamber **102** is enclosed to direct heated hydrogen peroxide laden air completely around the outer surface **34** of the bottles **12**. A mechanical scissors mechanism and a vacuum "pick and place" apparatus **104** position twelve bottles **12** at a time (in a two by six matrix, FIG. **8**) into one of the conveying plates **94**.

A plurality of conveying plates **94** are attached to a main conveyor **106**. The main conveyor **106** forms a continuous element around conveyor pulleys **108** and **110** as illustrated in FIG. **3**. A bottle support plate **107** supports a bottom **120** of each bottle **12** as the bottles **12** are conveyed from station to station through the filler apparatus **50**. Each conveying plate **94** passes through stations **1** through **41**, around pulley **108**, and returns around pulley **110** to repeat the process. The main conveyor **106**, conveying plates **94**, and pulleys **108** and **110** are enclosed in the sterilization tunnel **90**.

At station **4**, the bottles **12** in the conveying plate **94** enter a bottle detection apparatus **112**. The bottle detection apparatus **112** determines whether all twelve bottles **12** are actually present and correctly positioned in the conveying plate **94**. Proximity sensors **114** detect the presence and the alignment of each bottle **12**. In the present invention, a bottle **12** with correct alignment is in an upright position with the opening **16** of the bottle **12** located in an upward position. Information regarding the location of any misaligned or missing bottles **12** is relayed to the control system **550**. The control system **550** uses this location information to ensure that, at future stations **92**, bottle filling or sealing will not occur at the locations corresponding to the misaligned or missing bottles **12**.

At station **7**, as illustrated in FIGS. **3** and **10**, the bottles **12** in the conveying plate **94** enter an interior bottle sterilization apparatus **116**. A sterilant, such as hydrogen peroxide, oxonia, or any other suitable aseptic sterilant is applied as a heated vapor fog into the interior **118** of each bottle **12**. Preferably, hydrogen peroxide is used as the sterilant in the present invention. The application of sterilant is accomplished with the use of a plurality of sterilant measuring devices **121** and applicator spray nozzles **122**. A separate measuring device **121** and applicator spray nozzle **122** are used for each of the twelve bottle **12** locations in the conveying plate **94**. Each bottle **12** is supplied with the same measured quantity of sterilant, preferably in the form of a hot vapor fog. The measured quantity of sterilant may be drawn from a reservoir **124** of sterilant, heated, vaporized, etc., in a manner similar to that described above with regard to the sterilant application apparatus **36**.

The control system **550** monitors and controls a spray apparatus **126** that includes the applicator spray nozzles **122**. Each applicator spray nozzle **122** sprays the sterilant into the interior **118** of a corresponding bottle **12** as a hot vapor fog. The applicator spray nozzles **122** are designed to extend through the bottle openings **16**. The applicator spray nozzles **122** descends into the interior **118** and toward the bottom of the bottles **12**. This ensures the complete application of sterilant to the entire interior **118** and interior surface **119** of each bottle **12**. Alternately, the applicator spray nozzles **122** may be positioned immediately above the bottle openings **16** prior to the application of sterilant.

FIG. **9** illustrates a perspective view of a partition **130** that provides control of sterile air flow within the sterilization tunnel **90** of the filler apparatus **50**. The partition **130** includes a top baffle plate **132**, a middle baffle plate **134**, and a bottom baffle plate **136**. The top baffle plate **132** and the middle baffle plate **134** are provided with cut-outs **133** which

correspond to the outer shape of each bottle **12** and to the outer shape of the conveyor plate **94**. The cut-outs **133** allow each bottle **12** and each conveyor plate **94** to pass through the partition **130**. A space **138** between the middle baffle plate **134** and the bottom baffle plate **136** allows each empty conveyor plate **94** to pass through the partition **130** as it travels on its return trip from the pulley **108** toward the pulley **110**.

As illustrated in FIG. **3**, partitions **130**A, **130**B, and **130**C, are located within the sterilization tunnel **90**. FIG. **10** illustrates a cross-sectional view of partition **130**A including baffle plates **132**A, **134**A, and **136**A. The partition **130**A is located between stations **8** and **9**. FIG. **11** illustrates a cross-sectional view of partition **130**B including baffle plates **132**B, **134**B, and **136**B. The partition **130**B is located between stations **22** and **23**. FIG. **12** illustrates a cross-sectional view of partition **130**C including baffles **132**C, **134**C, and **136**C. The partition **130**C is located between stations **35** and **36**. As illustrated in FIG. **3**, sterile air is introduced through sterile air supply sources (e.g., conduits **140**, **142**, and **144**) into the sterilization tunnel **90**. The sterile air conduit **140** is located at station **23** (FIG. **11**), the sterile air conduit **142** is located at station **27** (FIG. **3**), and the sterile air conduit **144** is located at station **35** (FIG. **12**).

The partition **130**A separates an activation and drying apparatus **152** from the interior bottle sterilization apparatus **116**. The partition **130**B separates the activation and drying apparatus **152** from a main product filler apparatus **160** and a lid sterilization and heat sealing apparatus **162**. Thus, a first sterilization zone **164** is created that includes the activation and drying apparatus **152**. Partition **130**C separates the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** from a bottle discharge apparatus **280**. Thus, partitions **130**B and **130**C create a second sterilization zone **166** that includes the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162**. A third sterilization zone **172** includes the bottle discharge apparatus **280**. A fourth sterilization zone **165** includes the interior bottle sterilization apparatus **116**. The second sterilization zone **166** provides a highly sterile area where the bottles **12** are filled with a product and sealed. The second sterilization zone **166** is at a higher pressure than the first sterilization zone **164** and the third sterilization zone **172**. Therefore, any gas flow leakage is in the direction from the second sterilization zone **166** out to the first sterilization zone **164** and the third sterilization zone **172**. The first sterilization zone **164** is at a higher pressure than the fourth sterilization zone **165**. Therefore, gas flow is in the direction from the first sterilization zone **164** to the fourth sterilization zone **165**.

The partitions **130**A, **130**B, and **130**C create sterilization zones **164**, **165**, **166**, and **172** with different concentration levels of gas laden sterilant (e.g., hydrogen peroxide in air). The highest concentration level of sterilant is in the fourth sterilization zone **165**. For example, with the sterilant hydrogen peroxide, the concentration level of hydrogen peroxide is about 1000 ppm (parts per million) in the fourth sterilization zone **165**. The hydrogen peroxide sterilant level is about 3 ppm in the first sterilization zone **164**. The lowest concentration level of sterilant is in the second sterilization zone **166**. In the second sterilization zone **166**, the hydrogen peroxide sterilant concentration level is less than 0.5 ppm and typically about 0.1 ppm. Advantageously, this helps to maintain the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** at a low sterilant concentration level. This prevents unwanted high levels of sterilant to enter the food product during the filling and lidding process. The hydrogen peroxide sterilant concentration level is about 0.1 ppm in the third sterilization zone **172**.

As illustrated in FIG. **3**, a gas such as hot sterile air enters the first sterilization zone **164** at a rate of about 2400 cfm (cubic feet per minute). The temperature of the hot sterile air is about 230° F. The hot sterile air enters the first sterilization zone **164** through conduit **148**. Additional hot sterile air enters the second sterile zone through sterile air conduits **140**, **142**, and **144** at a total rate of about 1000 cfm (FIG. **3**). Also, hot sterile air enters at a rate of about 1800 cfm through ports **67** and **68** leading into the infeed and sterilization apparatus **60**. A portion of the hot sterile air exits the sterilization tunnel **90** at a rate of about 1500 cfm through a plurality of exhaust ports **153** located in the first sterilization zone **164** (FIG. **15**). A portion of the hot sterile air exits the sterilization tunnel **90** at a rate about 100 cfm through an opening **282** (FIG. **14**). The bottles **12** exit the sterilization tunnel **90** through the opening **282**. The continuous flow of sterile air flow out through the opening **282** prevents contaminants from entering the sterilization tunnel **90**.

As illustrated in FIG. **3**, the hot sterile air is drawn out of the fourth sterilization zone **165** of the sterilization tunnel **90** through the bottom opening **62** in the bottle infeed and sterilization apparatus **60**. Next, the hot sterile air from the infeed and sterilization apparatus together with the fourth sterilization zone **165** exits out of the exhaust conduit **70** of the infeed and sterilization apparatus at a rate of about 3600 cfm. This outflow of hot sterile air from the bottle infeed and sterilization apparatus **60** prevents contaminants from entering the bottle infeed sterilization apparatus **60** and the sterilization tunnel **90**.

Stations **10** through **21** include twelve stations for directing hot sterile air into each bottle **12** for the activation and removal of the sterilant from the interior of the bottle **12**. The sterile air supply system **146** supplies hot sterile air to a plurality of nozzles **150** in the activation and drying apparatus **152**. Hot sterile air is supplied to the sterile air supply system **146** through conduit **148**. The air is first passed through a filtration system to sterilize the air. The air is then heated in a heating system to about 230° F. The air temperature is regulated by the control system **550**. Also, the control system **550** monitors the air pressure and flow rate to ensure that an adequate flow of hot sterile air is maintained in the sterilization tunnel **90** of the application and drying apparatus **152**.

As shown in FIG. **8**, each bottle **12** generally has a small opening **16** compared to its height "H." A ratio of a diameter "D" of the bottle **12** to the height "H" of the bottle **12** is generally less than 1.0. The small bottle opening **16** combined with a larger height "H" restricts the flow of hot gas into the interior **118** of the bottle **12**. Also, PET and HDPE bottle materials have low heat resistance temperatures. These temperatures commonly are about 55° C. for PET and about 121° C. for HDPE. Typically, in the aseptic packaging industry, a low volume of air at a high temperature is applied to the packaging materials. This often results in deformation and softening of packaging materials formed of PET and HDPE. In order to prevent softening and deformation of the bottles **12**, when formed from these types of materials, the present invention applies high volumes of air at relatively low temperatures over an extended period of time in the activation and drying apparatus **152**. The plurality of nozzles **150** of the activation and drying apparatus **152** direct hot sterile air into the interior **118** of each bottle **12** (FIG. **11**). A long exposure time is predicated by the geometry of the bottle **12** and the softening temperature of the material used to form the bottle **12**. In the present invention, about 24

seconds are allowed for directing hot sterile air from the plurality of nozzles **150** into each bottle for the activation and removal of sterilant from the interior surface **119** of the bottle **12**. To achieve aseptic sterilization, a minimum bottle temperature of about 131° F. should be held for at least 5 seconds. To achieve this bottle temperature and time requirements, including the time required to heat the bottle, the sterilant is applied for about 1 second and the hot sterile air is introduced for about 24 seconds. The hot sterile air leaves the nozzles **150** at about 230° F. and cools to about 131° F. when it enters the bottle **12**. The hot sterile air is delivered at a high volume so that the bottle **12** is maintained at about 131° F. for at least 5 seconds. The about 24 seconds provides adequate time for the bottle **12** to heat up to about 131° F. and to maintain this temperature for at least 5 seconds. After bottle **12** has dried, the residual hydrogen peroxide remaining on the bottle **12** surface is less than 0.5 PPM.

A foodstuff product is first sterilized to eliminate bacteria in the product. An "Ultra High Temperature" (UHT) pasteurization process is required to meet the aseptic FDA standard. The time and temperature required to meet the aseptic FDA standard depends on the type of foodstuff. For example, milk must be heated to 282° F. for not less than 2 seconds in order to meet the aseptic standards.

After UHT pasteurization, the product is delivered to a main product filler apparatus **160**. The main product filler apparatus is illustrated in FIGS. **3** and **13**. The main product filler **160** can be sterilized and cleaned in place to maintain aseptic FDA and **3**A standards. A pressurized reservoir apparatus **180** that can be steam sterilized is included in the main product filler apparatus **160**. As illustrated in FIG. **13**, the pressurized reservoir apparatus **180** includes an enclosed product tank **182** with a large capacity (e.g., 15 gallons). The product tank **182** is able to withstand elevated pressures of about 60 psig or more. The pressurized reservoir apparatus **180** also includes a level sensor **184**, a pressure sensor **186**, a volumetric measuring device **188**, and a filling nozzle **190**. The product tank **182** includes a single inlet with a valve cluster including a sterile barrier to separate the product process system from aseptic surge tanks and the main product filler apparatus **160**. The product tank **182** has an outlet with twelve connections. At each connections is a volumetric measuring device **188** such as a mass or volumetric flow meter. A plurality of filling nozzles **190**A, **190**B are provided at stations **23**, **25**, respectively. In addition, there are a plurality of volumetric measuring devices **188**A and **188**B to measure the volume of product entering each bottle **12** at stations **23** and **25**, respectively. The control system **550** calculates the desired volume of product to be inserted into each bottle **12**, and controls the product volume by opening or closing a plurality of valves **194**A and **194**B. The activation mechanisms for valves **194**A and **194**B have a sterile barrier to prevent contamination of the product. The plurality of valves **194**A control the volume of product flowing through a corresponding plurality of nozzles **196**A into the bottles **12** at station **23**. The plurality of valves **194**B control the volume of product flowing through a corresponding plurality of nozzles **196**B into the bottles **12** at station **25**. The control system **550** uses the previously stored information provided by the bottle detection apparatus **112** to only allow filling to occur at the locations where bottles **12** are actually present and correctly aligned.

The initial sterilization process for the pressurized reservoir apparatus **180** includes the step of exposing all of the surfaces of the pressurized reservoir apparatus **180** that come in contact with the product to steam at temperatures above about 250° F. for a minimum of about 30 minutes. Elements such as cups **198**A and **198**B are used to block off nozzle outlets **196**A and **196**B respectively, to allow a build-up of steam pressure to about 50 psig inside the pressurized reservoir apparatus **180**. Condensate generated as the steam heats the interior surfaces of the pressurized reservoir apparatus **180** is collected in the cups **198**A and **198**B. This condensate is released when the cups **198**A and **198**B are removed from the nozzle outlets **196**A and **196**B. Once the interior surfaces of the pressurized reservoir apparatus **180** are sterilized, the steam is shut off, and sterile air is used to replace the steam. The sterile air reduces the interior temperature of the pressurized reservoir apparatus **180** to the temperature of the product before the product is allowed to enter the enclosed product tank **182**. Sterile air is directed through sterile air conduits **142** and **144** into the second sterilization zone **166** at a volume rate of about 800 scfm (FIG. **13**). The sterile air flow entering the second sterilization zone **166** provides sterile air to the main product filler apparatus **160** and to the lid sterilization and heat sealing apparatus **162**.

The main product filler apparatus **160** includes a separate filling position for each bottle. The bottle **12** filling operation is completed for six bottles at station **23** and for six bottles at station **25**.

FIGS. **3** and **13** illustrate the lid sterilization and heat sealing apparatus **162**. A lid **200** is applied to each of the twelve bottles **12** at station **31**. For a fully aseptic bottle filler, complete lid **200** sterilization is necessary, and therefore a sterilant such as hydrogen peroxide is typically used. In the present invention, the lids are formed of a material such as foil or plastic. The lids **200** are joined together by a small interconnecting band that holds them together to form a long connected chain of lids **200**, hereinafter referred to as a "daisy chain" **202**. A daisy chain **202** of lids **200** is placed on each of a plurality of reels **210**. For the twelve bottle configuration of the present invention, six of the reels **210**, each holding a daisy chain **202** of lids **200**, are located on each side of a heat sealing apparatus **214**. Each daisy chain **202** of lids **200** winds off of a corresponding reel **210** and is sterilized, preferably using a hydrogen peroxide bath **204**. A plurality of hot sterile air knives **208**, which are formed by jets of hot sterile air, activate the hydrogen peroxide to sterilize the lids **200** on the daisy chain **202**. The hot sterile air knives **208** also remove the hydrogen peroxide from the lids **200** so that the residual concentration of hydrogen peroxide is less than 0.5 PPM. The hydrogen peroxide bath **204** prevents any contaminants from entering the sterilization tunnel **90** via the lidding operation. Once sterilized, the lids **200** enter the sterilization tunnel **90** where they are separated from the daisy chain **202** and placed on a bottle **12**. Each lid is slightly larger in diameter then that of the opening **16** of a bottle **12**. During the placement of the lid **200** on the bottle **12**, a slight mechanical crimp of the lid **200** is formed to locate and hold the lid **200** on the bottle **12**. The crimp holds the lid **200** in place on the bottle **12** until the bottle **12** reaches a station **33** for sealing.

At station **33**, the lids **200** are applied to the bottles **12**. The heat sealing apparatus **214** includes a heated platen **216** that applies heat and pressure against each lid **200** for a predetermined length of time, to form a seal between the lid **200** and the bottle **12**. The heated platen **216** is in a two by six configuration to seal twelve of the bottles **12** at a time.

At station **37**, the lid **200** seal and bottle **12** integrity are checked in a known manner by a seal integrity apparatus (not shown) comprising, for example, a bottle squeezing mechanism and a proximity sensor. Each bottle **12** is

squeezed by the bottle squeezing mechanism which causes the lid **200** on the bottle **12** to extend upward. The proximity sensor detects if the lid **200** has extended upward, which indicates an acceptable seal, or whether the seal remains flat, which indicates a leaking seal or bottle **12**. The location of the defective bottles **12** are recorded by the control system **550** so that the defective bottles will not be packed.

Bottle discharge from the sterilization tunnel **90** of the filler apparatus **50** occurs at stations **38** and **40** as illustrated in FIGS. **3**, **13** and **14**. A bottle discharge apparatus **280** is located at stations **38** and **40**. At this point in the filler apparatus **50**, the filled and sealed bottles **12** are forced in an upward direction such that a top portion **284** of each bottle **12** protrudes through the opening **282** in the sterilization tunnel **90** (FIG. **14**). A rotating cam **290** or other suitable means (e.g., an inflatable diaphragm, etc.) may be used to apply a force against the bottom **120** of each bottle **12** to force the bottle **12** in an upward direction.

As illustrated in FIG. **14**, the bottle discharge apparatus **280** comprises a lifting apparatus **286** that includes a gripper **288** that grasps the top portion **284** of each bottle **12** and lifts the bottle **12** out through the opening **282** in the sterilization tunnel **90**. In order to ensure that contaminated air cannot enter the sterilization tunnel **90**, the sterile air in the sterilization tunnel **90** is maintained at a higher pressure than the air outside the sterilization tunnel **90**. Thus, sterile air is always flowing out of the sterilization tunnel **90** through the opening **282**. In addition, the gripper **288** never enters the sterilization tunnel **90**, because the top portion **284** of the bottle **12** is first lifted out of the sterilization tunnel **90** by the action of the rotating cam **290** before being grabbed by the gripper **288**.

FIG. **15** illustrates a top view of the filler apparatus **50** including the bottle infeed and sterilization apparatus **60**, the interior bottle sterilization apparatus **116**, and the activation and drying apparatus **152**. FIG. **15** additionally illustrates the main filler apparatus **160**, the lid sterilization and heat sealing apparatus **162**, and the bottle discharge apparatus **280**.

Referring again to FIGS. **1** and **14**, the lifting apparatus **286** lifts the bottles **12** at station **38** and places the bottles **12** in a first lane **292** that transports the bottles **12** to a first capping apparatus **410**. In addition, the lifting apparatus **286** lifts the bottles **12** at station **40** and places the bottles **12** in a second lane **294** that transports the bottles **12** to a second capping apparatus **400**.

The first capping apparatus **410** secures a cap (not shown) on the top of each bottle **12** in the first lane **292**. The second capping apparatus **400** secures a cap on the top of each bottle **12** in the second lane **294**. The caps are secured to the bottles **12** in a manner known in the art. It should be noted that the capping process may be performed outside of the sterilization tunnel **90** because each of the bottles **12** have previously been sealed within the sterilization tunnel **90** by the lid sterilization and heat sealing apparatus **162** using a sterile lid **200**.

After capping, the bottles **12** are transported via the first and second lanes **292**, **294** to labelers **460** and **470**. The first labeling apparatus **470** applies a label to each bottle **12** in the first lane **292**. The second labeling apparatus **460** applies a label to each bottle **12** in the second lane **294**.

From the first labeling apparatus **470**, the bottles **12** are transported along a first set of multiple lanes (e.g., 4) to a first case packing apparatus **490**. From the second labeling apparatus **460**, the bottles **12** are transported along a second set of multiple lanes to a second case packing apparatus **480**. Each case packing apparatus **480**, **490** gathers and packs a plurality of the bottles **12** (e.g., twelve) in each case in a suitable (e.g., three by four) matrix.

A first conveyor **296** transports the cases output by the first case packer **490** to a first palletizer **510**. A second conveyor **298** transports the cases output by the second case packer **480** to a second palletizer **500**. A vehicle, such as a fork lift truck, then transports the pallets loaded with the cases of bottles **12** to a storage warehouse.

Referring again to FIG. **3**, the main conveyor **106** and each conveying plate **94** are cleaned and sanitized once during each revolution of the main conveyor **106**. Specifically, after each empty conveying plate **94** passes around the pulley **108**, the conveying plate **94** is passed through a liquid sanitizing apparatus **300** and a drying apparatus **302**. The liquid sanitizing apparatus **300** sprays a mixture of a sterilizing agent (e.g., oxonia, (hydrogen peroxide and peroxyacetic acid)) over the entire surface of each conveying plate **94** and associated components of the main conveyor **106**. In the drying apparatus **302**, heated air with is used to dry the main conveyor **106** and conveying plates **94**.

Stations **1** through **40** are enclosed in the sterilization tunnel **90**. The sterilization tunnel **90** is supplied with air that is pressurized and sterilized. The interior of the sterilization tunnel **90** is maintained at a pressure higher than the outside environment in order to eliminate contamination during the bottle processing. In addition, to further ensure a sterile environment within the sterilization tunnel **90**, the sterile air supply provides a predetermined number of air changes (e.g., 2.5 changes of air per minute) in the sterilization tunnel **90**.

Before bottle production is initiated, the bottle infeed and sterilization apparatus **60** and the filler apparatus **50** are preferably sterilized with an aseptic sterilant. For example, a sterilant such as a hot hydrogen peroxide mist may be applied to all interior surfaces of the bottle infeed and sterilization apparatus **60** and the filler apparatus **50**. Then, hot sterile air is supplied to activate and remove the hydrogen peroxide, and to dry the interior surfaces of the bottle infeed and sterilization apparatus **60** and the filler apparatus **50**.

FIG. **16** is a side view of the aseptic processing apparatus **10** of the present invention indicating the location of the control and monitoring devices that are interfaced with the control system **550**. The control system **550** gathers information and controls process functions in the aseptic processing apparatus **10**. A preferred arrangement of the control and monitoring devices are indicated by encircled letters in FIG. **16**. A functional description of each of the control and monitoring devices is listed below. It should be noted that these control and monitoring devices are only representative of the types of devices that may be used in the aseptic processing apparatus **10** of the present invention. Other types and combinations of control and monitoring devices may be used without departing from the intended scope of the present invention. Further, control system **550** may respond in different ways to the outputs of the control and monitoring devices. For example, the control system **550** may automatically adjust the operational parameters of the various components of the aseptic processing apparatus **10**, may generate and/or log error messages, or may even shut down the entire aseptic processing apparatus **10**. In the preferred embodiment of the present invention, the control and monitoring devices include:

A. A bottle counter to ensure that a predetermined number of the bottles **12** (e.g., six bottles) on each upper

horizontal row **24**, **28** enter the loading area of the bottle infeed and sterilization apparatus **60**.

B. A proximity sensor to ensure that the first group of bottles **12** has dropped into the first bottle position in the bottle infeed and sterilization apparatus **60**.

C1. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus **36** is full.

C2. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus **36** is emptied in a predetermined time.

C3. A pressure sensor to ensure that the pressure of the air used by the sterilant application apparatus **36** is within predetermined atomization requirements.

C4. A temperature sensor to ensure that each heat heating element used by the sterilant application apparatus **36** is heated to the correct temperature.

D. A proximity sensor (e.g., proximity sensor **71**, FIG. **3**) to ensure that a bottle jam has not occurred within the bottle infeed and sterilization apparatus **60**.

E. A temperature sensor to ensure that the temperature of the heated sterile air entering the bottle infeed and sterilization apparatus **60** is correct.

F. A proximity sensor that to ensure that each conveying plate **94** is fully loaded with bottles **12**.

G1. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus **116** is full.

G2. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus **116** is emptied in a predetermined time.

G3. A pressure sensor to ensure that the pressure of the air used by the interior bottle sterilization apparatus **116** is within predetermined atomization requirements.

G4. A temperature sensor to ensure that each heat heating element used by the interior bottle sterilization apparatus **116** is heated to the correct temperature.

H. A temperature sensor to ensure that the air drying temperature within the activation and drying apparatus **152** is correct.

I. A plurality of flow sensors to ensure that the airflow rate of the sterile air entering the sterilization tunnel **90** is correct.

J. A pressure sensor to ensure that the pressure of the sterile air entering the activation and drying apparatus **152** is correct.

K. A measuring device (e.g., volumetric measuring device **188**, FIG. **3**) to ensure that each bottle **12** is filled to a predetermined level.

L. A pressure sensor to ensure that the pressure in the product tank **182** is above a predetermined level.

M. A level sensor to ensure that the level of product in the product tank **182** is maintained at a predetermined level.

N. Proximity sensors to ensure that the daisy chains **202** of lids **200** are present in the lid sterilization and heat sealing apparatus **162**

O. A level sensor to ensure that the hydrogen peroxide level in the hydrogen peroxide bath **204** in the lid sterilization and heat sealing apparatus **162** is above a predetermined level.

P. A temperature sensor to ensure that the temperature of the hot sterile air knives **208** of the lid sterilization and heat sealing apparatus **162** is correct.

Q. A temperature sensor to ensure that the heat sealing apparatus **214** is operating at the correct temperature.

R. Proximity sensors to ensure that the bottles **12** are discharged from the filler.

S. A speed sensor to measure the speed of the conveying apparatus **100**.

T. A concentration sensor to ensure that the concentration of oxonia is maintained at a predetermined level in the sanitizing apparatus **300**.

U. A pressure sensor to ensure that the pressure of the oxonia is maintained above a predetermined level in the sanitizing apparatus **300**.

V. A temperature sensor to ensure that the drying temperature of the drying apparatus **302** is correct.

The following steps are performed during the "Clean In Place" (CIP) process in the filler apparatus **50**;

23. Conductivity sensor to verify caustic and acid concentrations.

24. Temperature sensor to verify "Clean In Place" solution temperatures.

25. Flow meter to verify "Clean In Place" flow rates.

26. Time is monitored to ensure that adequate cleaning time is maintained.

The follow steps are performed during sterilization of the bottle filler apparatus **50**;

27. Temperature sensors for measuring steam temperatures.

28. Proximity sensors to ensure filler nozzle cleaning/sterilization cups are in position.

29. Temperature sensors for air heating and cooling.

30. Flow meter for hydrogen peroxide injection.

31. Time is monitored to ensure the minimum time periods are met (steam, hydrogen peroxide application and activation/drying).

The foregoing description of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and many modifications and variations are possible in light of the above teaching. Such modifications and variations that may be apparent to a person skilled in the art are intended to be included within the scope of this invention.

I claim:

1. Apparatus comprising:

a sterilization tunnel for surrounding a plurality of containers with pressurized gas; and

a plurality of zones within the sterilization tunnel having different sterilant concentration levels therein wherein the sterilant concentration levels in the plurality of zones are maintained at a ratio of at least about 5 to 1.

2. The apparatus of claim **1**, wherein said plurality of zones have different gas flow rates.

3. The apparatus of claim **1**, wherein the sterilant concentration levels of the plurality of sterilant concentration zones are maintained at a ratio of at least about 1,000 ppm to 0.1 ppm.

4. Apparatus comprising:

a sterilization tunnel for surrounding a plurality of containers with pressurized gas;

a sterilant supply source to supply sterilant into the sterilization tunnel;

a control system, operatively attached to a plurality of sterilant concentration zones within the sterilization tunnel, for automatically adjusting the operational

parameters of the tunnel, wherein the sterilant concentration levels in the plurality of sterilant concentration zones are maintained at a ratio of at least about 5 to 1;

at least one gas supply source to supply the pressurized gas into the sterilization tunnel; and

at least one gas exit to allow the pressurized gas to escape the sterilization tunnel.

5. The apparatus of claim **3**, further comprising at least one partition forming the plurality of sterilant concentration zones within the sterilization tunnel.

6. The apparatus of claim **3**, wherein the gas is sterile air.

7. The apparatus of claim **3**, wherein the sterilant is hydrogen peroxide.

8. The apparatus of claim **3**, further including a product filler and a lidding apparatus opening into a sterile zone of the sterilization tunnel.

9. The apparatus of claim **8**, wherein the concentration of the sterilant hydrogen peroxide is less than 0.5 ppm in the sterile zone.

10. The apparatus of claim **3**, further including an interior bottle sterilization apparatus opening into a sterile zone of the sterilization tunnel.

11. The apparatus of claim **10**, wherein the concentration of the sterilant hydrogen peroxide is about 1000 ppm in the sterile zone.

12. The apparatus of claim **3**, further including an activation and drying apparatus opening into the sterilization tunnel.

13. The apparatus of claim **12**, wherein the concentration of the sterilant hydrogen peroxide is about 3 ppm.

14. The apparatus of claim **3**, further including a bottle discharge apparatus opening into the sterilization tunnel.

15. The apparatus of claim **14**, wherein the concentration of the sterilant hydrogen peroxide is about 0.1 ppm.

16. The apparatus of claim **3**, wherein the containers are bottles.

17. Apparatus comprising:

a sterilization tunnel for surrounding a plurality of containers with pressurized gas;

a sterilant supply source to supply sterilant into the sterilization tunnel;

a plurality of zones having a plurality of gas nozzles within the sterilization tunnel;

at least one partition forming a plurality of sterilant concentration zones within the sterilization tunnel wherein the sterilant concentration levels of the plurality of sterilant concentration zones are maintained at a ratio of at least about 5 to 1;

at least one gas supply source to supply the pressurized gas into the sterilization tunnel; and

at least one gas exit to allow the pressurized gas to escape the sterilization tunnel.

18. The apparatus of claim **17**, further including at least one partition forming gas flow zones.

19. The apparatus of claim **18**, wherein each partition comprises openings for allowing objects to pass through each partition.

20. The apparatus of claim **17**, wherein the pressurized gas is sterile air.

21. The apparatus of claim **17**, wherein the sterilant is hydrogen peroxide.

22. The apparatus of claim **17**, further including an activation and drying apparatus opening into a first of said gas flow zones.

23. The apparatus of claim **22**, wherein sterile air enters the first gas flow zone at a rate of about 2400 cfm.

24. The apparatus of claim **23**, wherein sterile air exits the first gas flow zone at a rate of about 1500 cfm.

25. The apparatus of claim **17**, further including a product filler and a lidding apparatus opening into a second of said gas flow zones of the sterilization apparatus.

26. The apparatus of claim **25**, wherein sterile air enters the second gas flow zone at a rate of about 1000 cfm.

27. The apparatus of claim **17**, further including a bottle discharge apparatus opening into a third of said gas flow zones of the sterilization tunnel.

28. The apparatus of claim **27**, wherein sterile air exits the third gas flow zone at a rate of about 100 cfm.

29. The apparatus of claim **17**, further including a bottle infeed and sterilization apparatus with an opening into a fourth gas flow zone of the sterilization tunnel.

30. The apparatus of claim **29**, wherein sterile air enters the infeed and sterilization apparatus at a rate of about 1800 cfm.

31. The apparatus of claim **29**, wherein sterile air from the infeed and sterilization apparatus together with the fourth gas flow zone exits the infeed and sterilization apparatus at a rate of about 3600 cfm.

32. The apparatus of claim **17**, wherein the containers are bottles.

33. A method comprising:

providing a sterilization tunnel for surrounding a plurality of containers with pressurized gas;

introducing sterilant from a sterilant supply source into the sterilization tunnel;

providing a plurality of sterilant concentration zones within the sterilization tunnel wherein the sterilant concentration levels of the plurality of sterilant concentration zones are maintained at a ratio of at least about 5 to 1;

providing at least one partition for forming said sterilant concentration zones;

setting the level of sterilant concentration by a control system;

introducing pressurized gas from at least one gas supply source into the sterilization tunnel; and

allowing the pressurized gas to escape the sterilization tunnel.

34. The method of claim **33**, further comprising providing a control system operatively attached to the plurality of sterilant concentration zones within the sterilization tunnel.

35. The method of claim **33**, wherein the step of introducing gas further comprises introducing sterile air.

36. The method of claim **33**, wherein the sterilant is hydrogen peroxide.

37. Apparatus comprising:

means for providing a plurality of containers in a sterilization tunnel;

means for providing a plurality of sterilant concentration zones within the sterilization tunnel wherein the sterilant concentration levels of the plurality of sterilant concentration zones are maintained at a ratio of at least about 5 to 1; and

means for providing a plurality of gas flow rates within the sterilization tunnel.

* * * * *

Exhibit E

US006209591B1

(12) **United States Patent**
Taggart

(10) **Patent No.: US 6,209,591 B1**
(45) **Date of Patent: Apr. 3, 2001**

(54) **APPARATUS AND METHOD FOR PROVIDING CONTAINER FILLING IN AN ASEPTIC PROCESSING APPARATUS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/376,992**

(22) Filed: **Aug. 18, 1999**

Related U.S. Application Data

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(51) **Int. Cl.**[7] **B65B 1/04**
(52) **U.S. Cl.** **141/89**; 141/129; 141/48
(58) **Field of Search** 141/89–93, 97, 141/172, 129, 275–278, 48, 63

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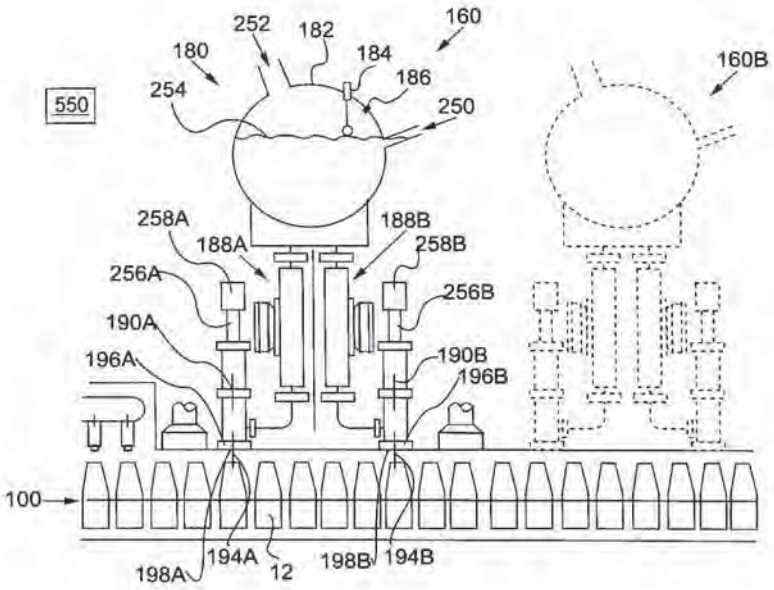
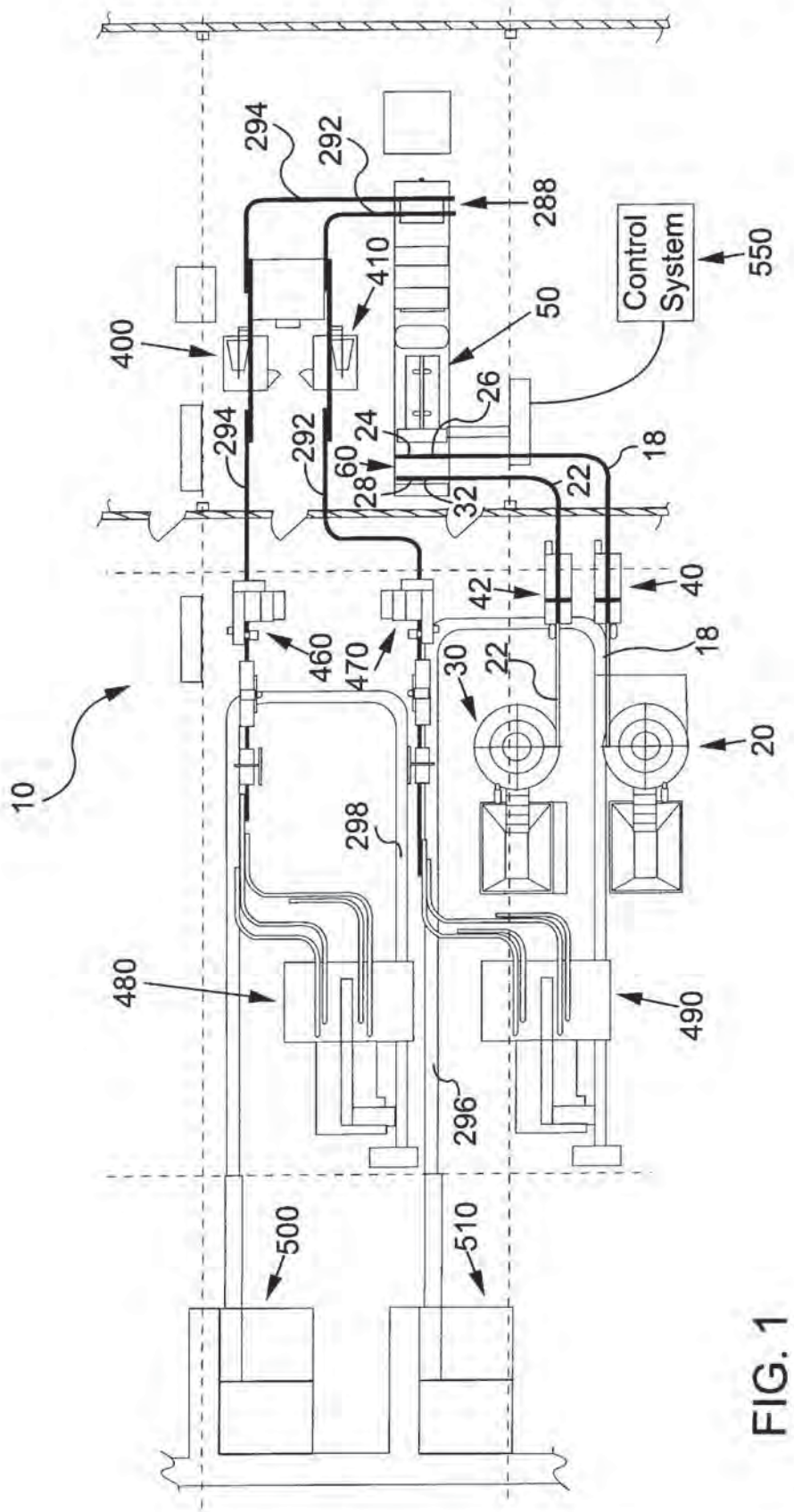
(74) *Attorney, Agent, or Firm*—Schmeiser, Olsen & Watts

(57) **ABSTRACT**

An apparatus and method for providing container product filling in an aseptic processing apparatus. An apparatus including a valve mechanism for controlling the opening or closing of a valve including extending a portion of the valve from a second sterile region into a first sterile region, thereby, preventing contaminants from being carried into the first sterile region.

28 Claims, 22 Drawing Sheets




294
292
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Control System
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510

FIG. 1

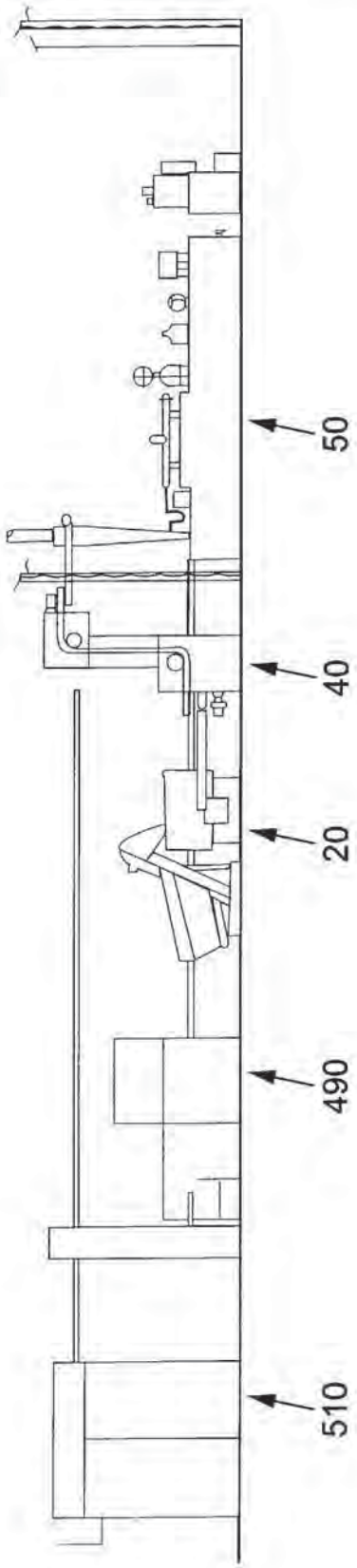
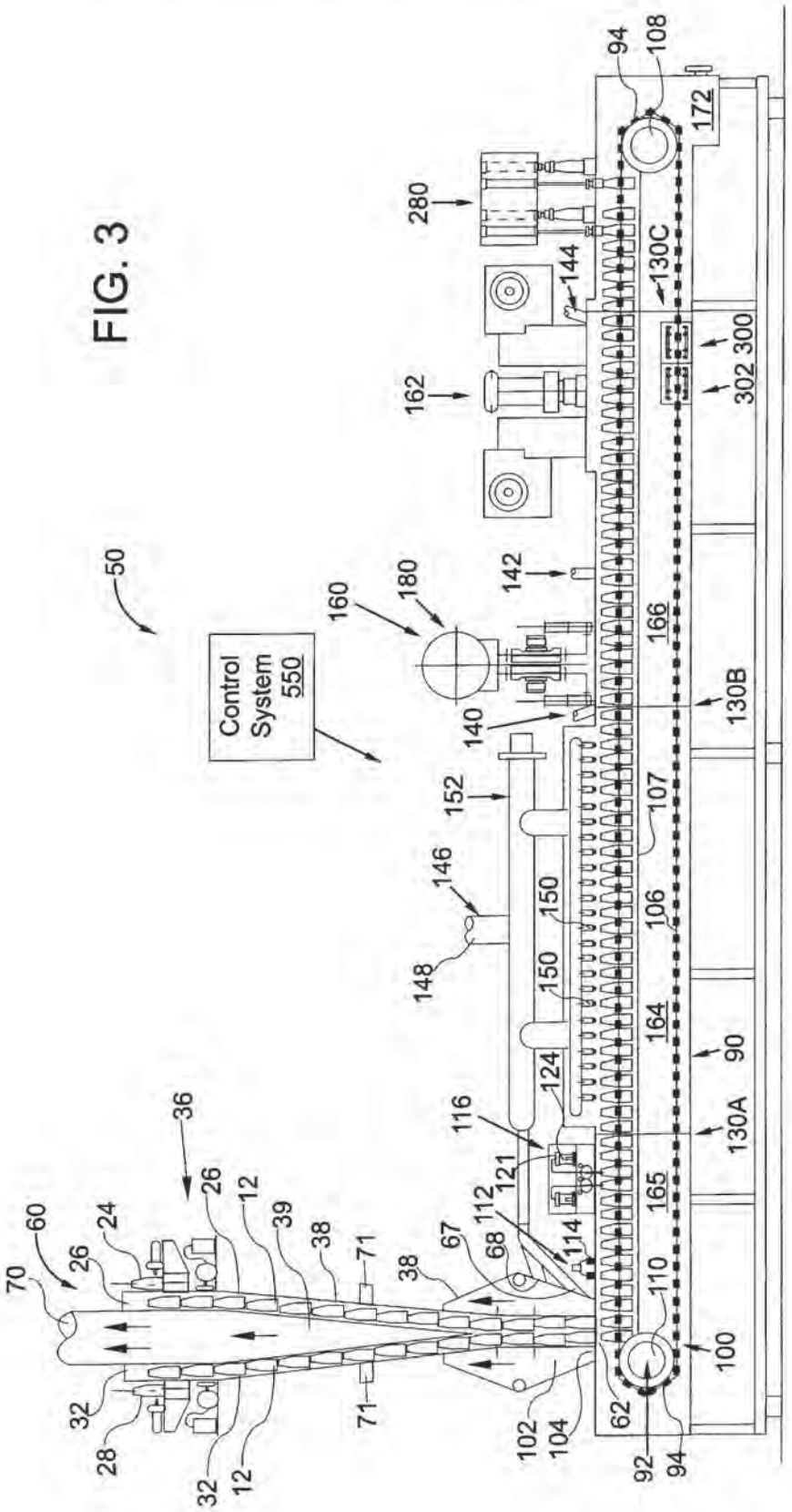


FIG. 2

FIG. 3


50
Control System 550
94
108
172
280
144
130C
162
302
300
160
180
142
166
140
130B
152
107
146
150
106
148
150
164
90
124
130A
116
121
36
26
12
39
38
71
67
68
112
114
165
110
100
60
24
70
32
28
62
92
94
102
104

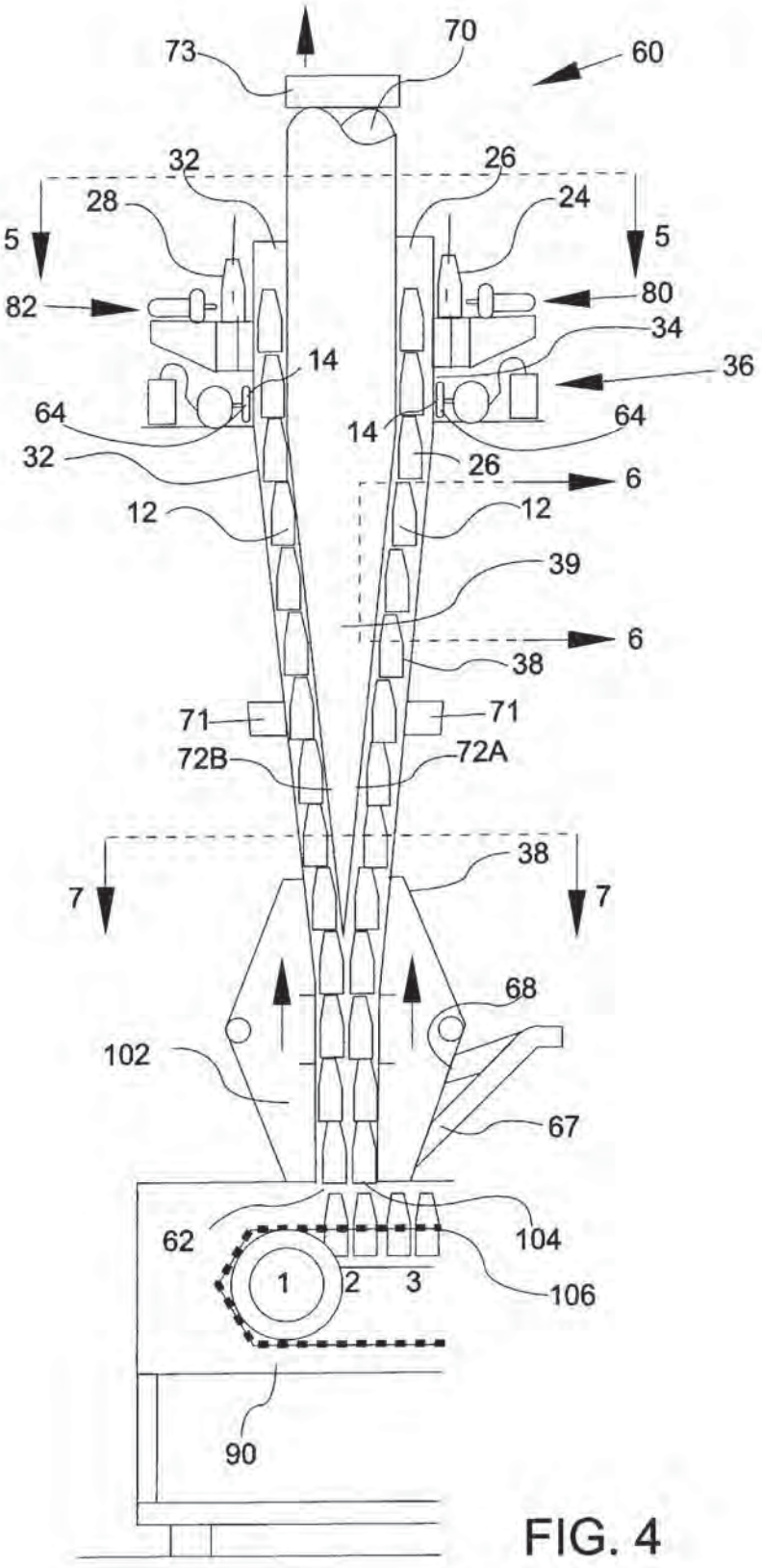

73
70
60
32
26
28
24
5
5
82
80
34
14
36
64
14
64
32
26
6
12
12
39
6
38
71
71
72B
72A
38
7
7
68
102
67
62
104
1
2
3
106
90

FIG. 4

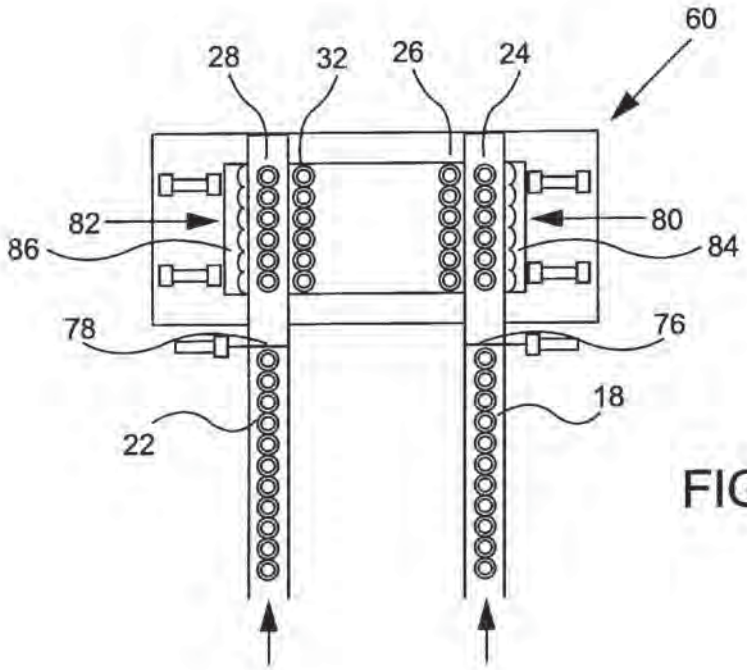


FIG. 5

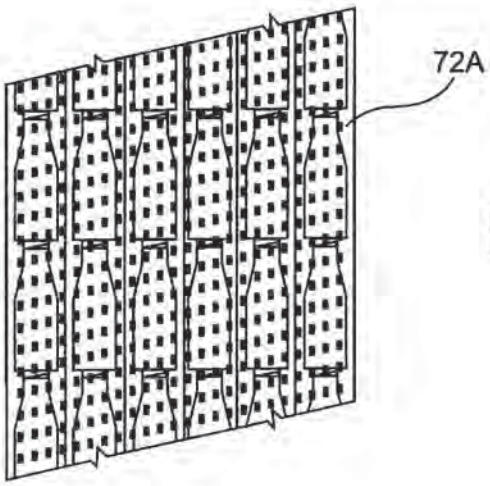


FIG. 6

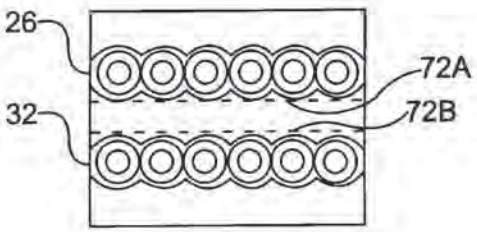


FIG. 7

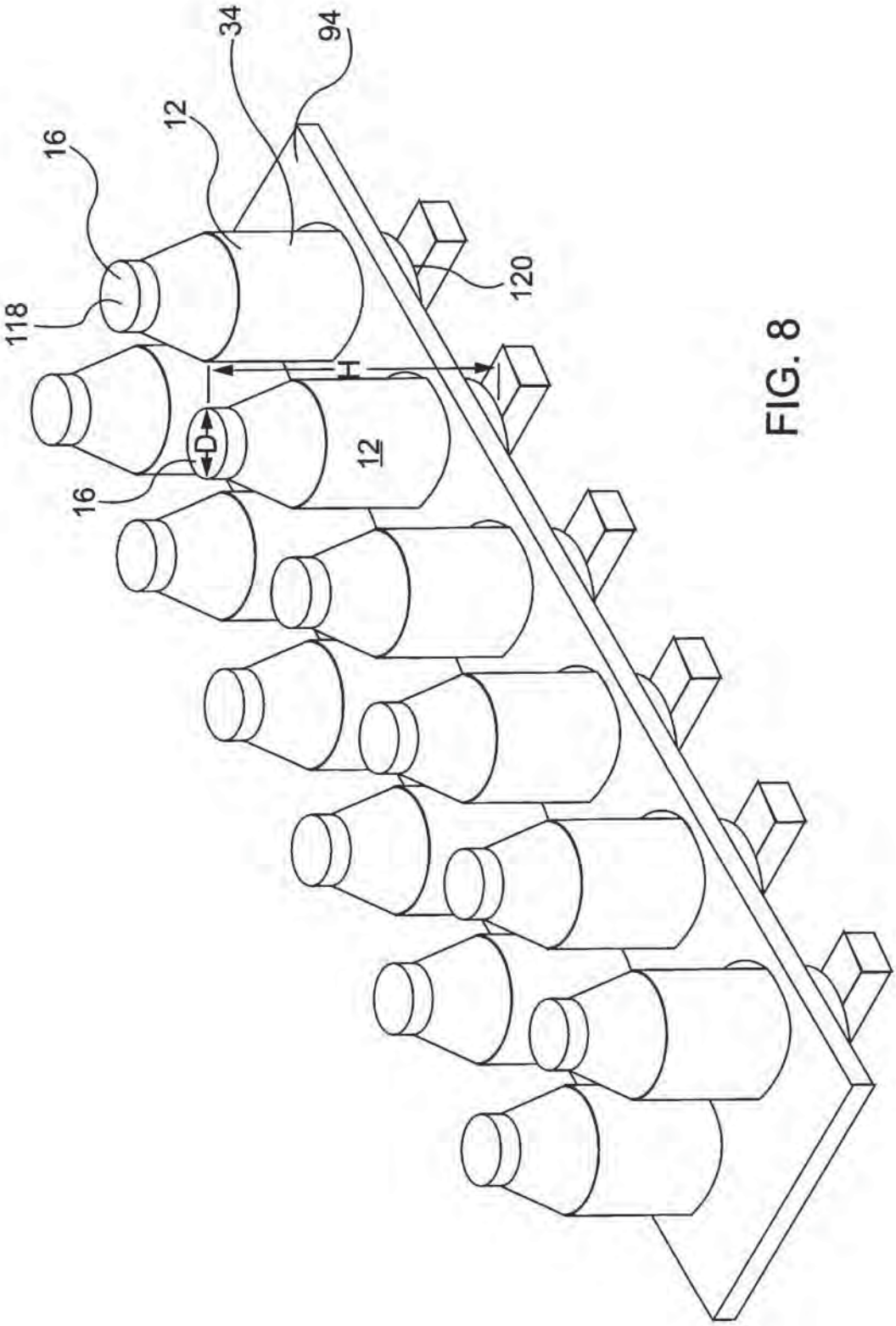


FIG. 8

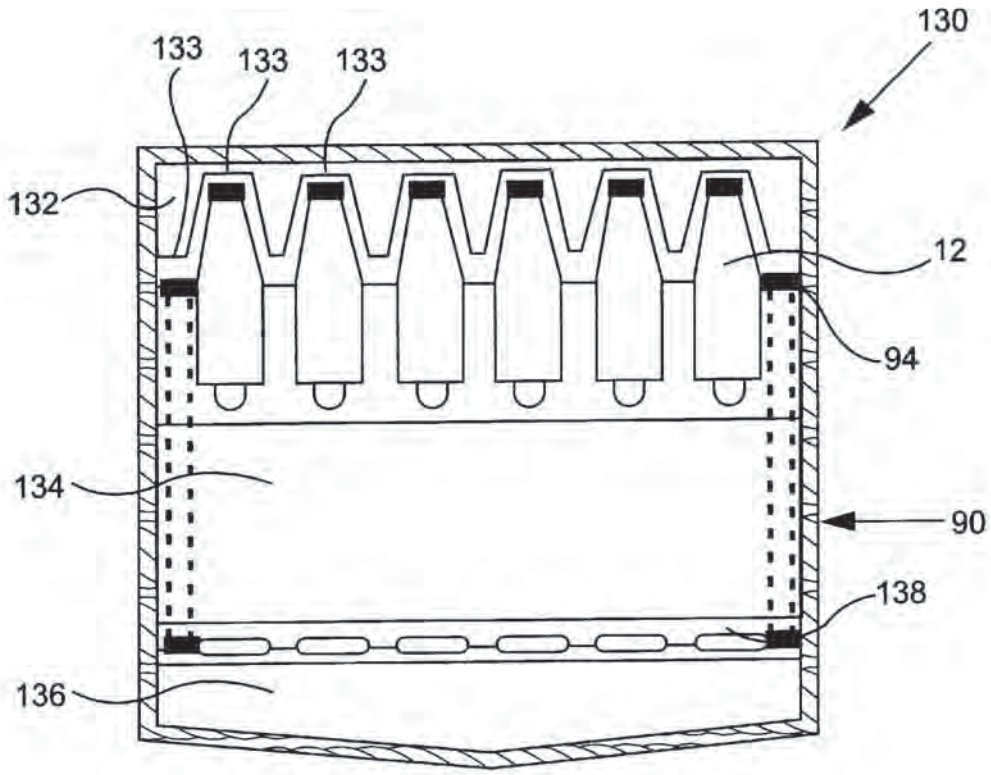


FIG. 9

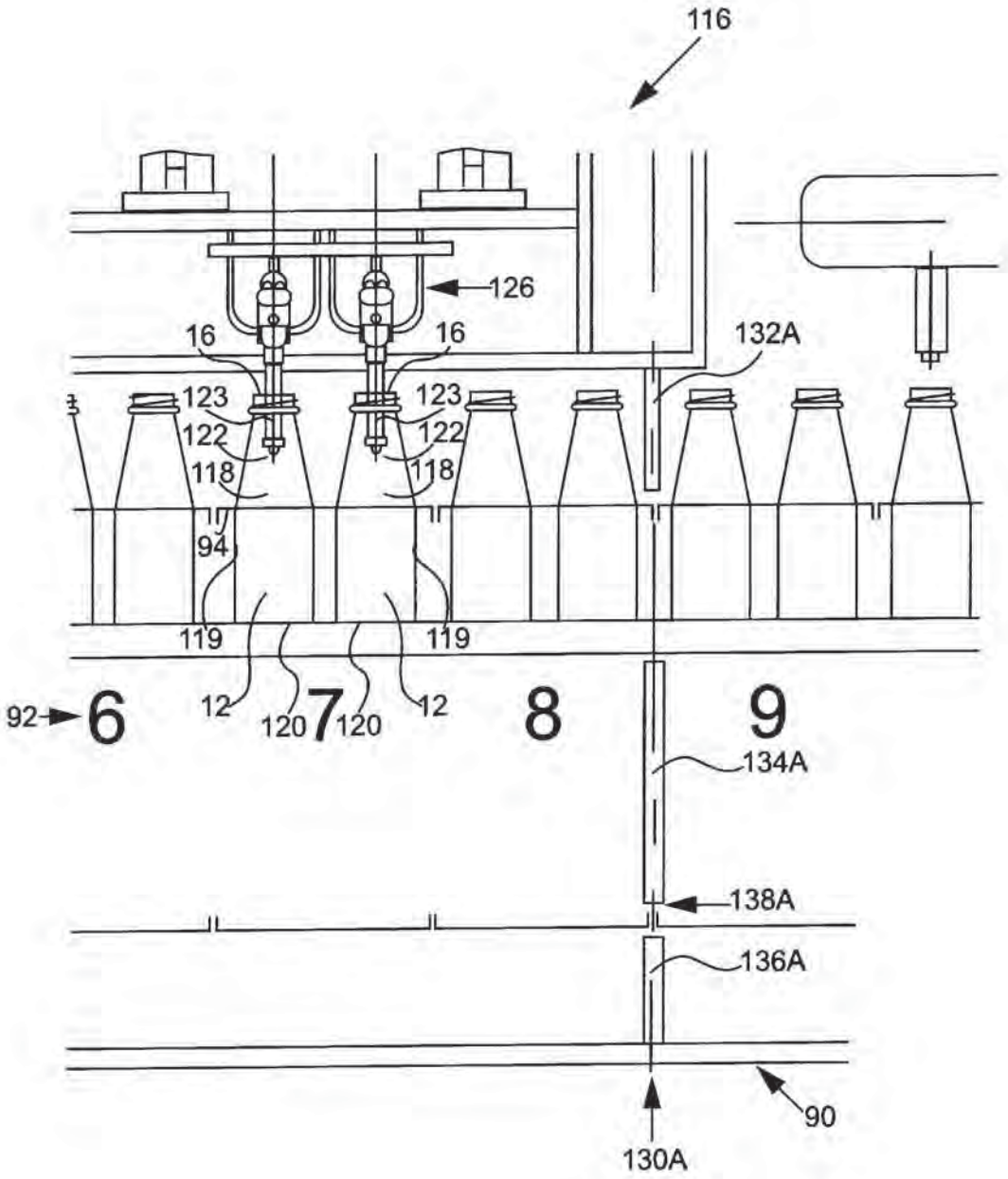

116
126
16
16
132A
123
123
122
122
118
118
94
119
119
92
6
12
120
7
120
12
8
9
134A
138A
136A
90
130A

FIG. 10

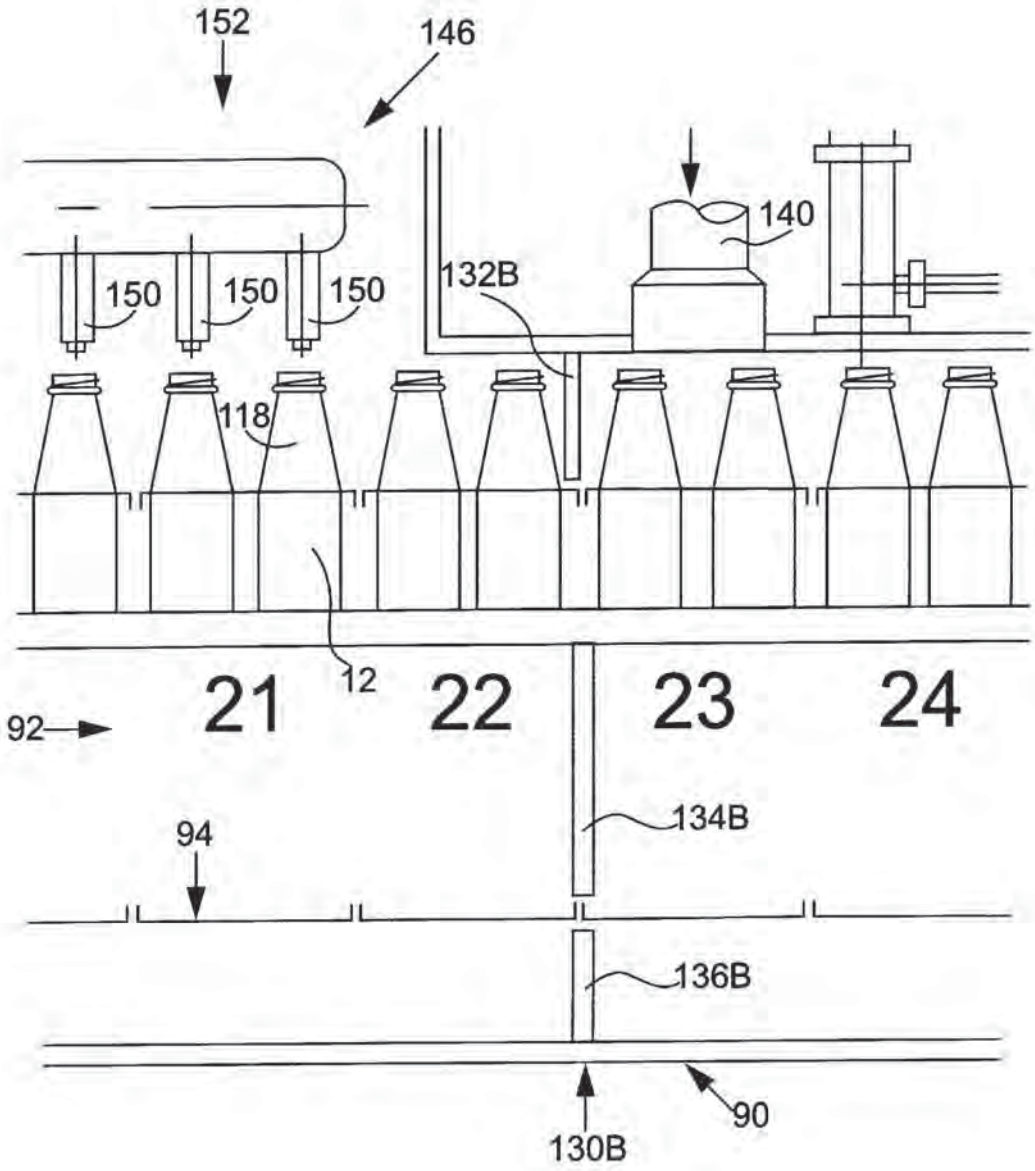

152
146
140
150
150
150
132B
118
12
92
21
22
23
24
94
134B
136B
90
130B

FIG. 11

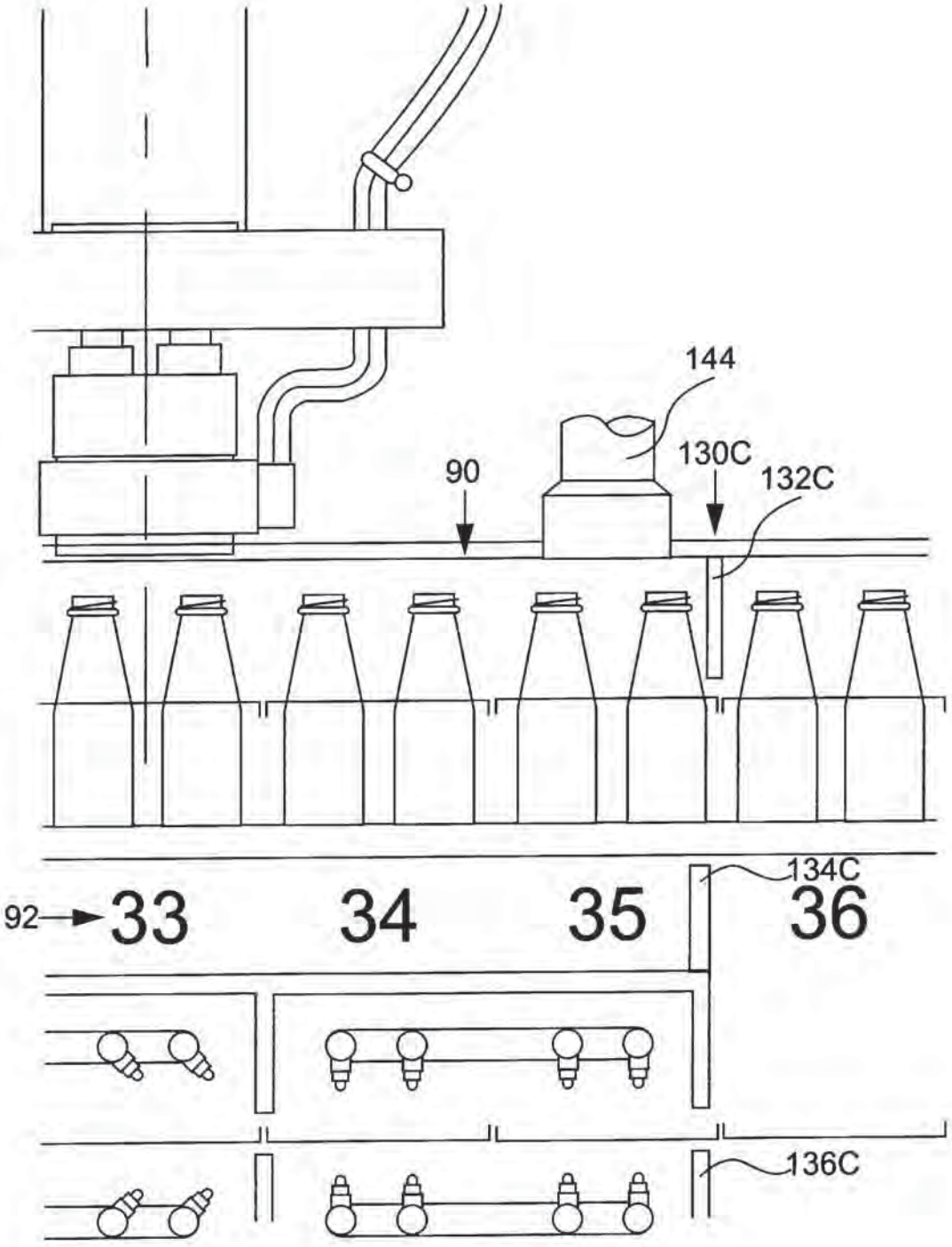


FIG. 12

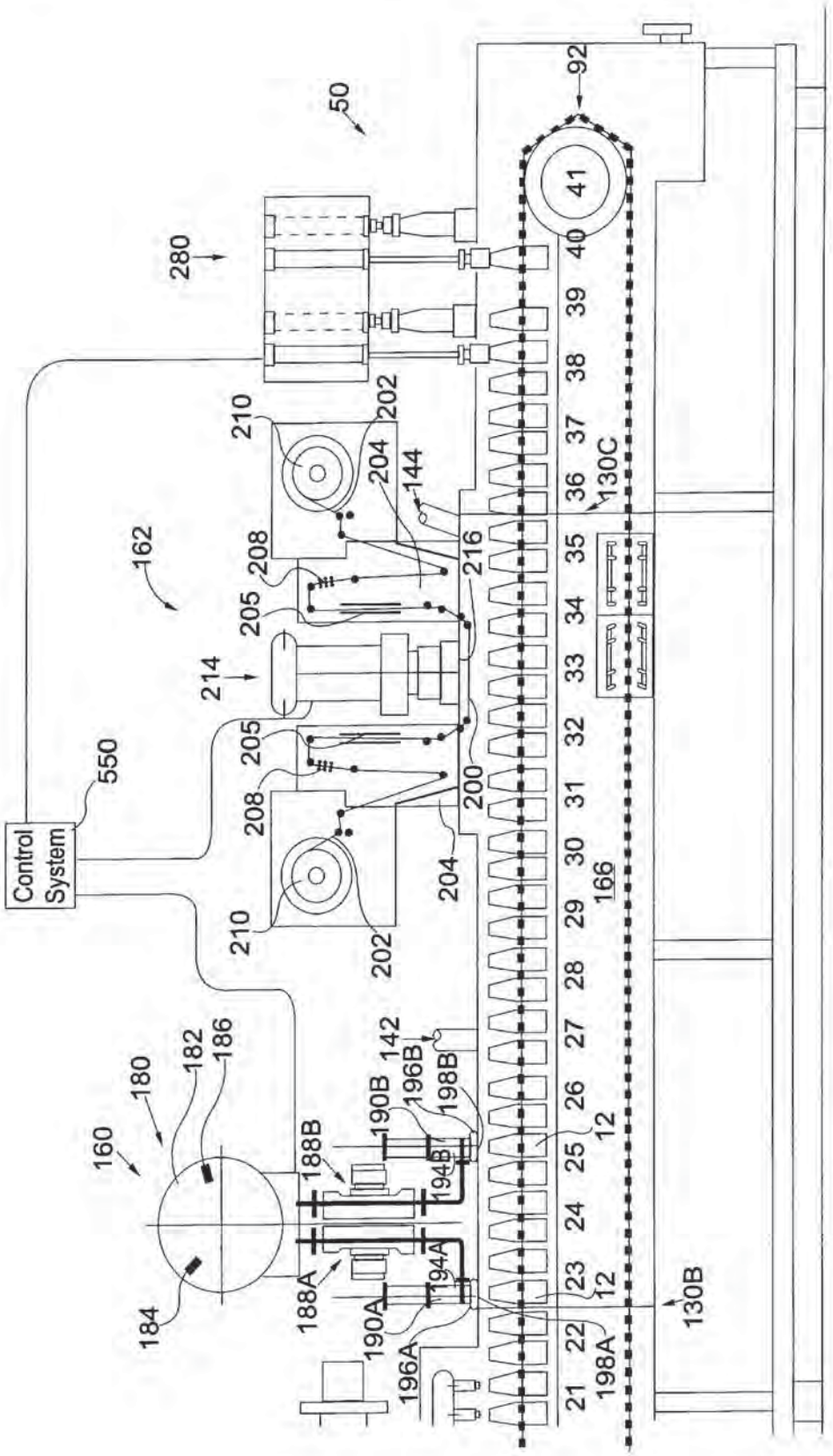

50
92
41
40
39
38
37
36
130C
35
34
33
32
31
30
166
29
28
27
26
12
25
24
23
12
22
21
130B
280
210
202
204
144
208
216
205
214
200
162
550
Control System
160
180
182
186
184
188A
188B
190A
190B
196A
196B
198A
198B
142
194A
194B

FIG. 13

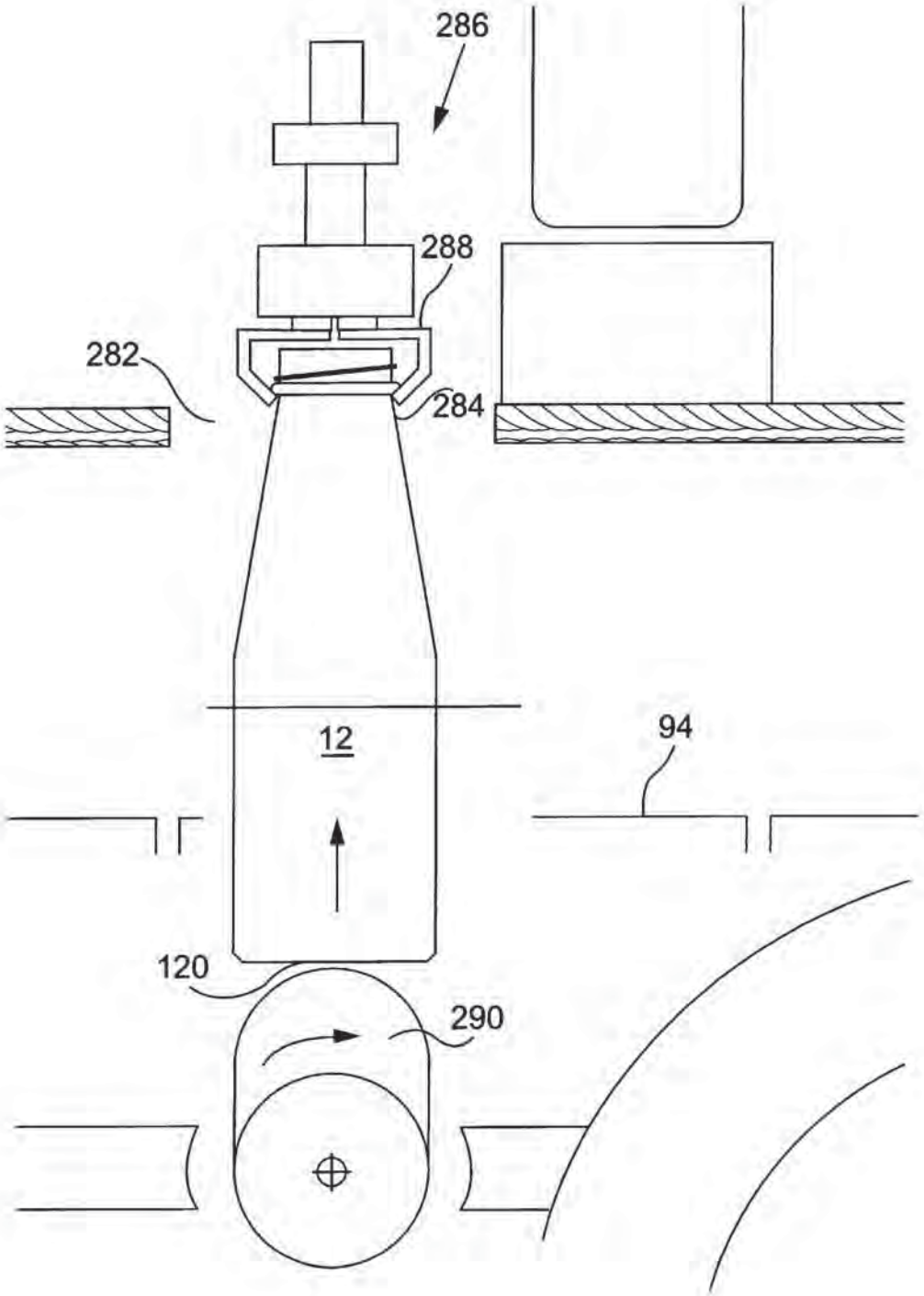


FIG. 14

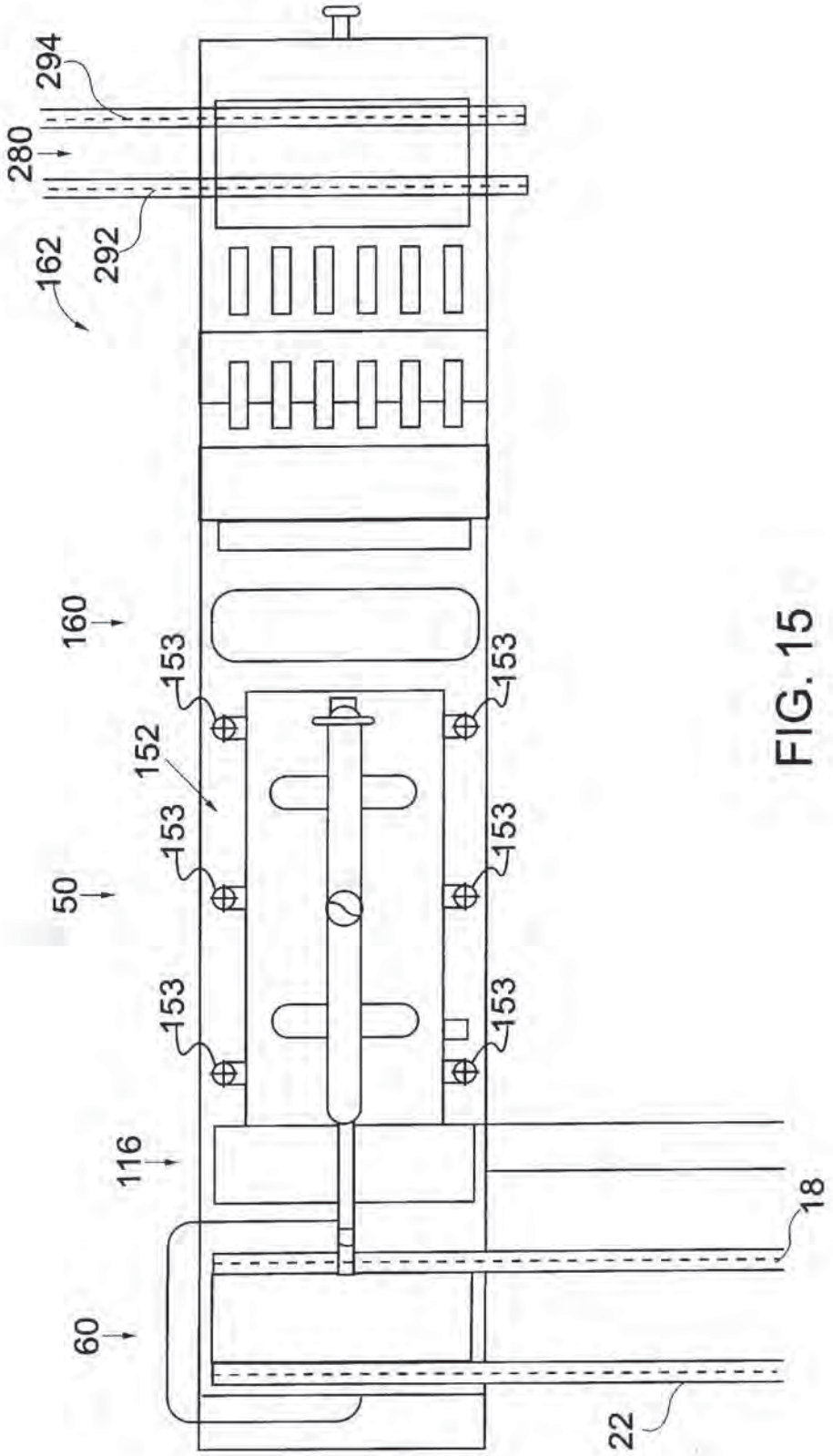


FIG. 15

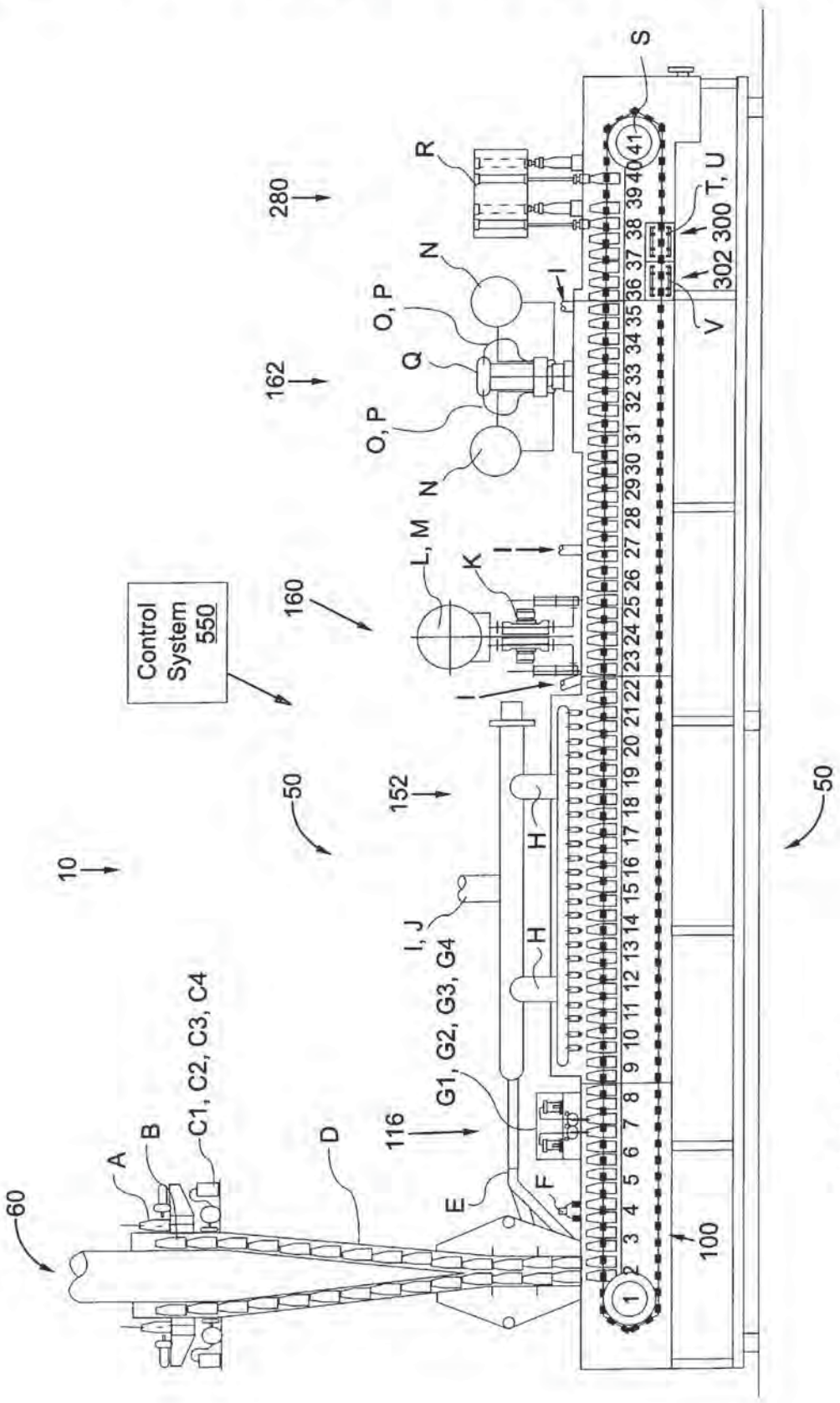

Control System 550
10
50
50
60
100
116
152
160
162
280
A
B
C1, C2, C3, C4
D
E
F
G1, G2, G3, G4
H
I, J
K
L, M
N
O, P
Q
R
S
T, U
V
300
302

FIG. 16

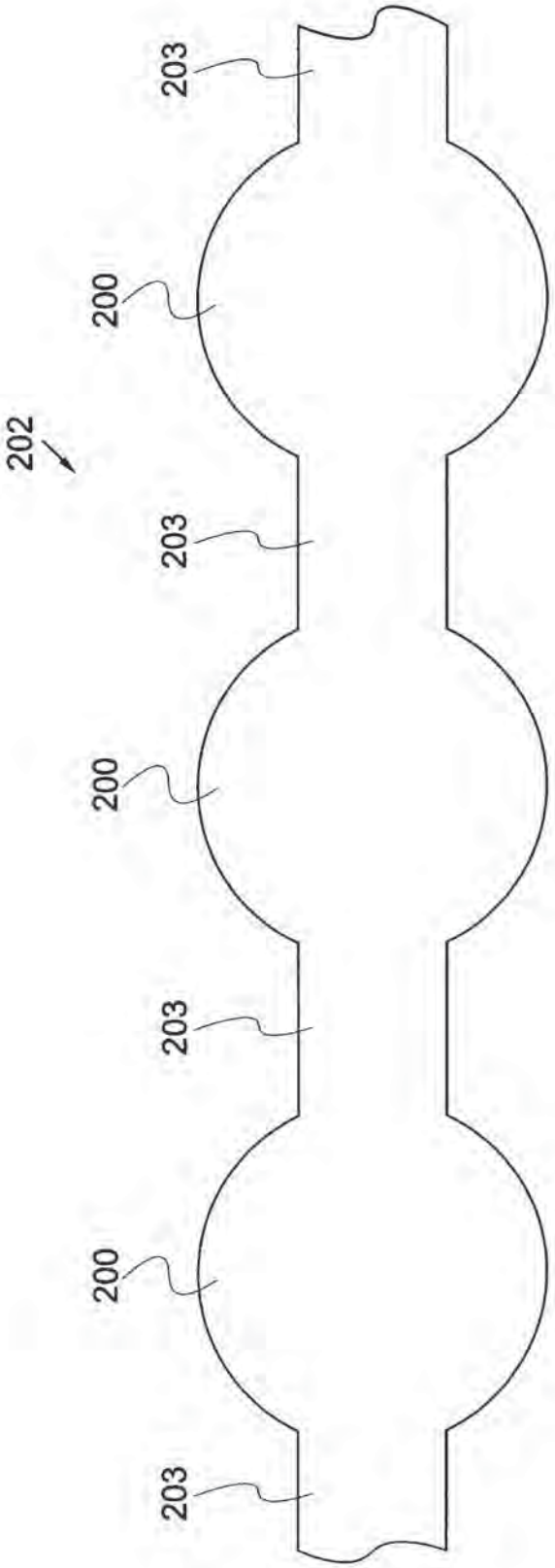


FIG. 17

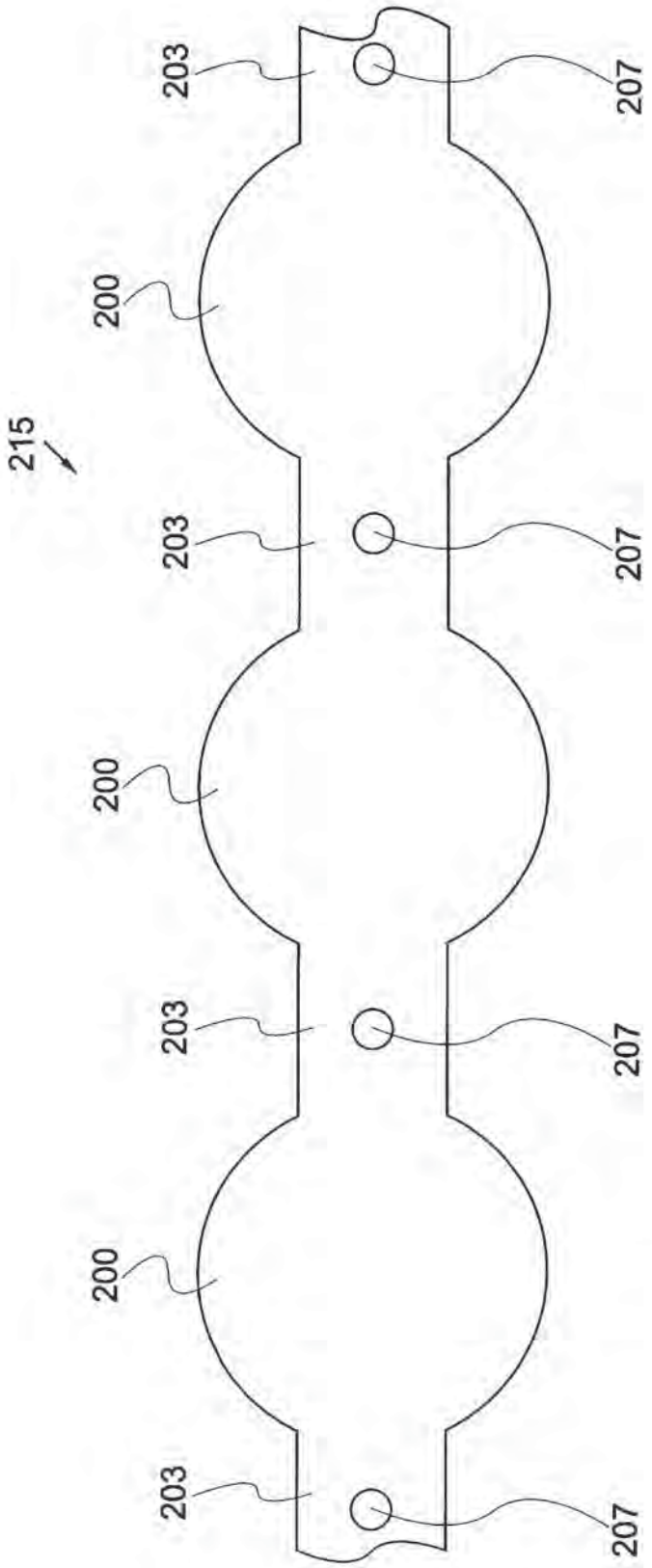


FIG. 18

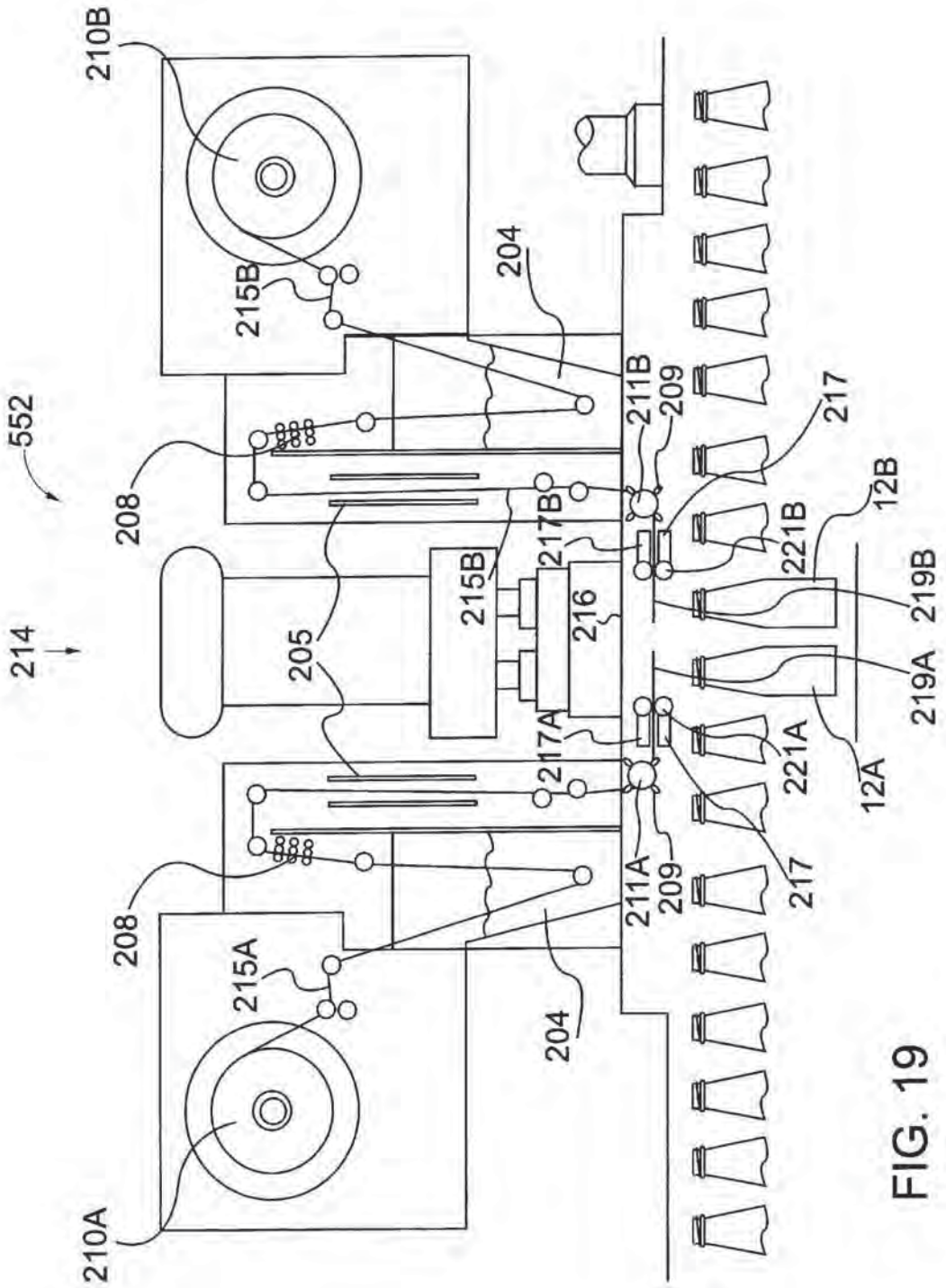

210B
215B
204
552
211B
209
217
208
217B
12B
221B
214
215B
216
219B
205
219A
217A
221A
12A
211A
209
217
208
215A
204
210A

FIG. 19

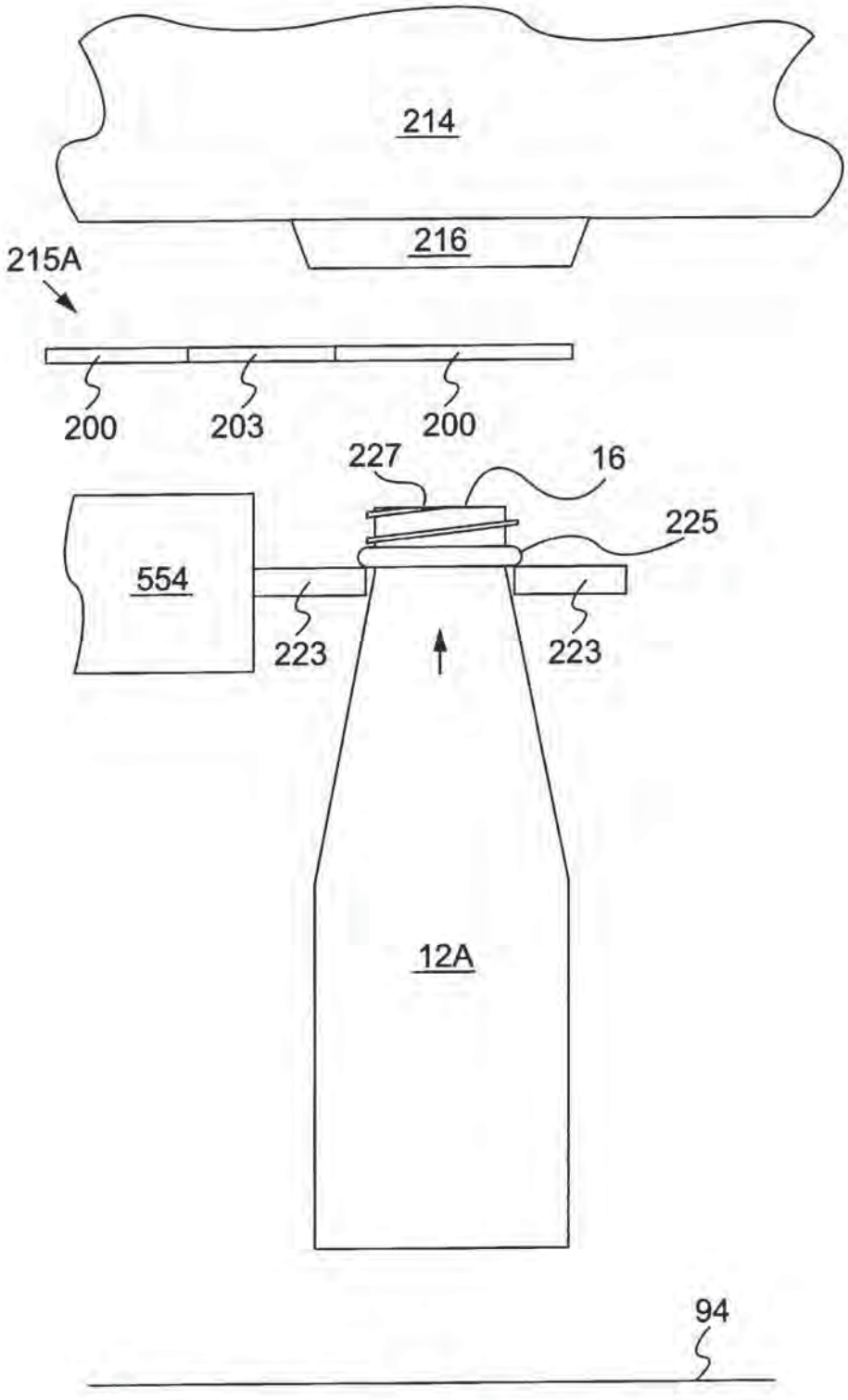
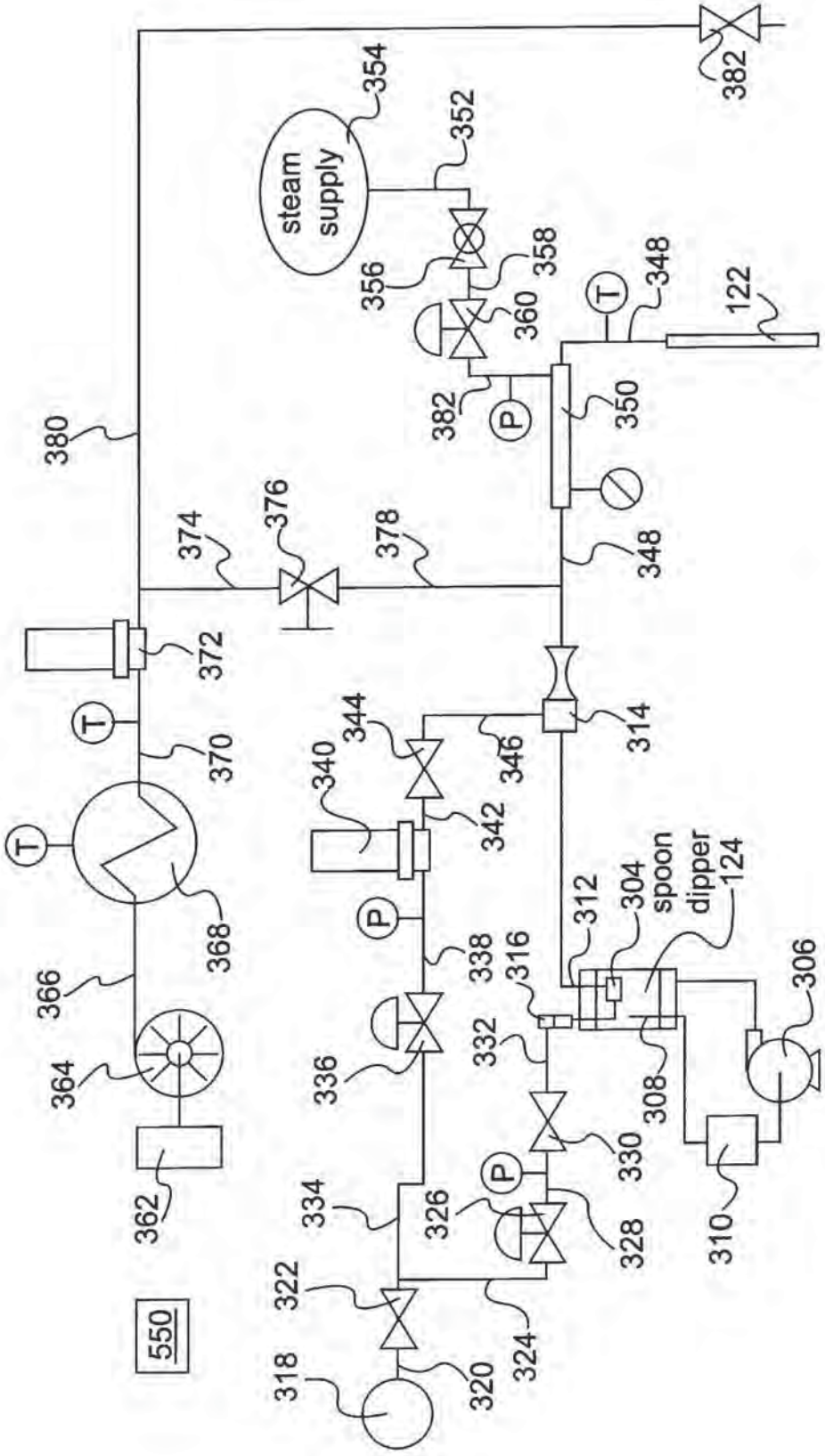


FIG. 20


steam supply
354
352
356
358
360
382
382
348
122
350
380
374
376
378
348
372
370
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340
342
346
314
368
366
364
362
338
316
312
304
spoon
dipper
124
306
336
332
308
330
334
326
328
310
322
324
318
320
550
T
P

FIG. 21

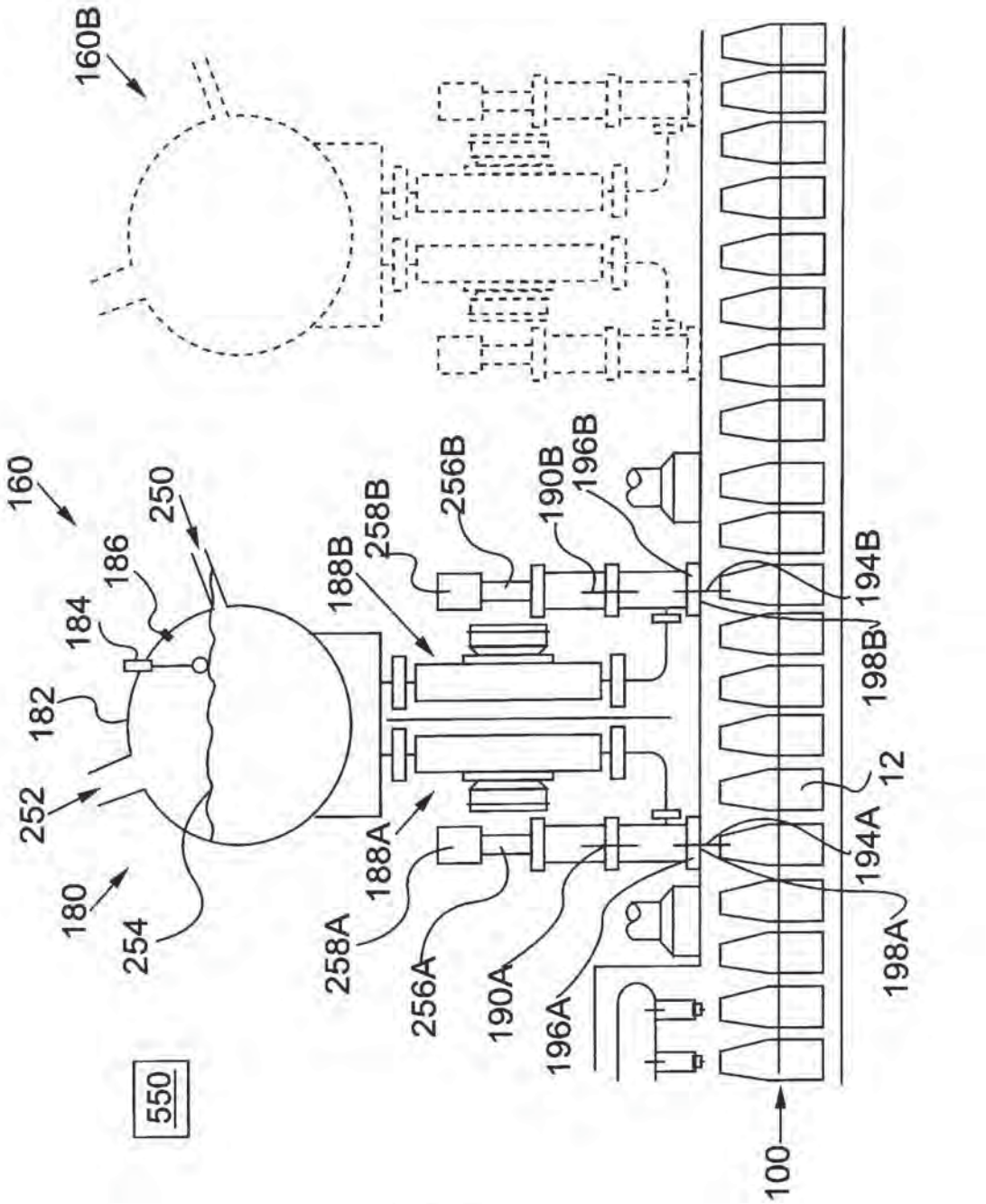

160B
160
250
186
184
182
252
180
254
550
188B
258B
256B
190B
196B
194B
198B
188A
258A
256A
190A
196A
194A
198A
12
100

FIG. 22

FIG. 24

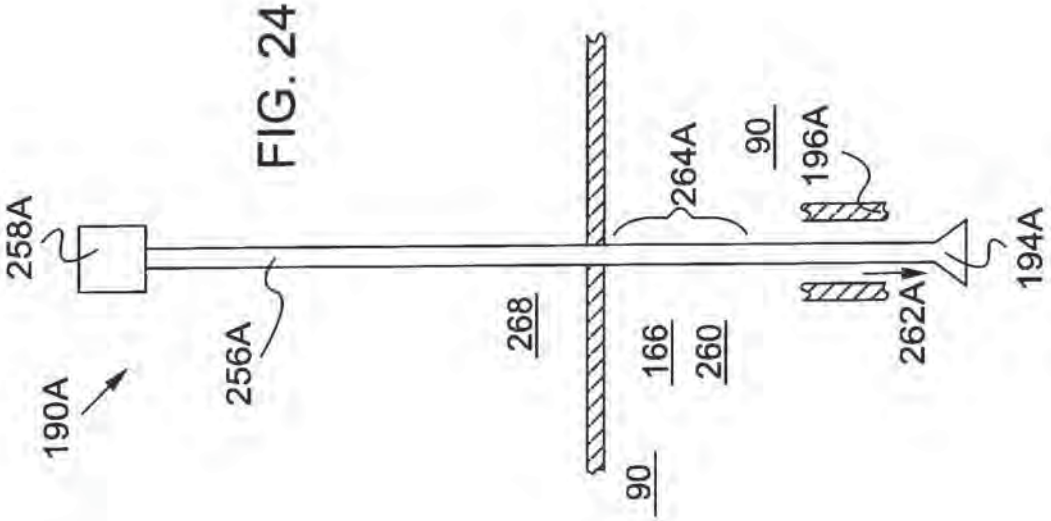

258A
190A
256A
268
90
166
260
264A
90
196A
194A
262A

FIG. 23

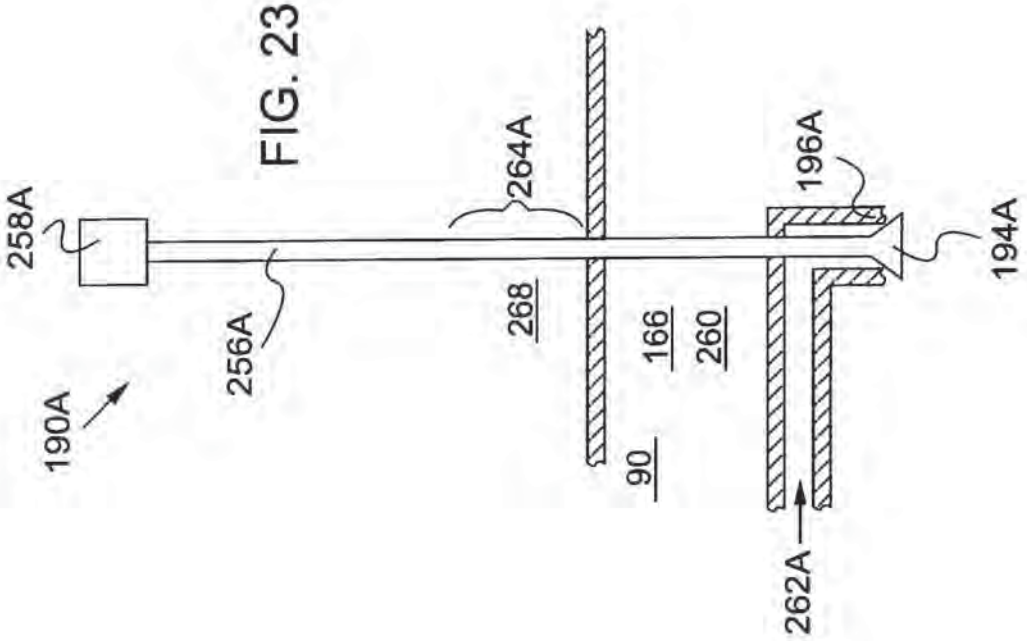

258A
190A
256A
268
90
166
260
264A
196A
194A
262A

FIG. 26

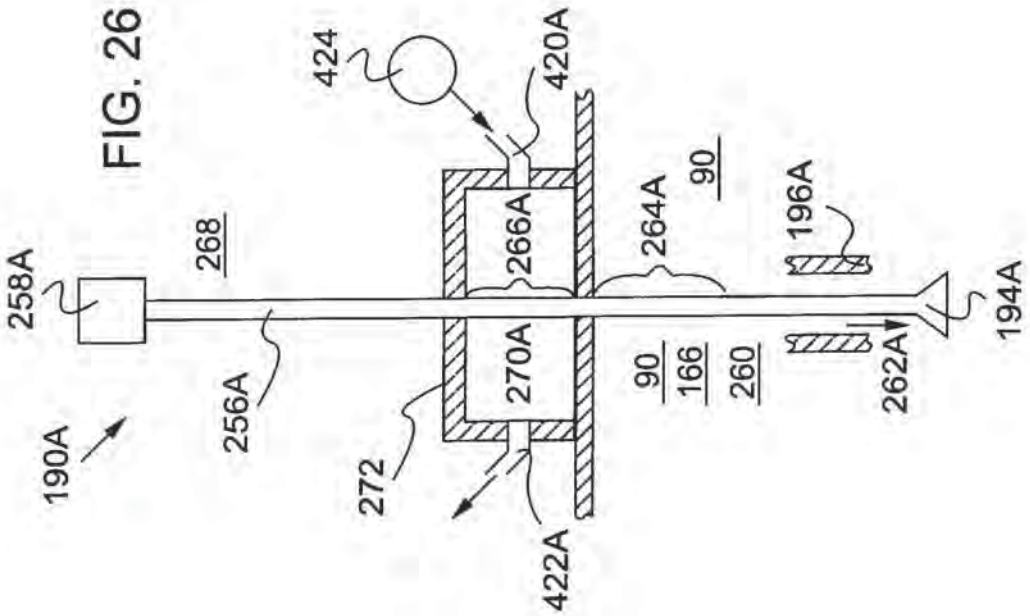
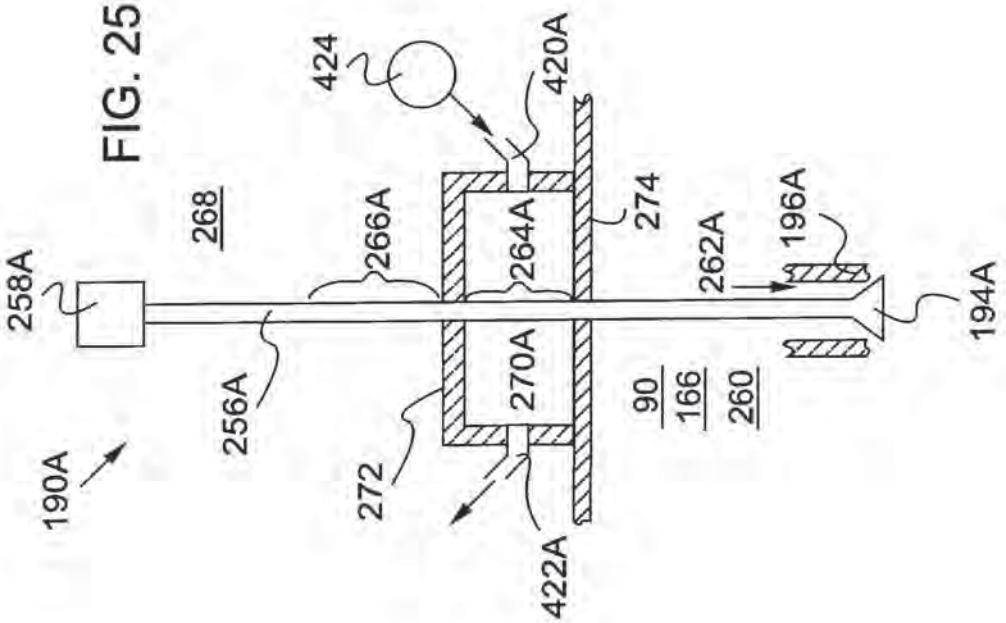

424
420A
90
196A
264A
266A
268
258A
194A
270A
90
166
260
262A
256A
272
190A
422A

FIG. 25


424
420A
274
196A
268
266A
264A
262A
258A
194A
270A
90
166
260
256A
272
190A
422A

APPARATUS AND METHOD FOR PROVIDING CONTAINER FILLING IN AN ASEPTIC PROCESSING APPARATUS

This application claims benefit to U.S. provisional application Serial No. 60/118,404, filed Feb. 2, 1999.

FIELD OF THE INVENTION

The present invention relates generally to systems for the aseptic packaging of food products. More particularly, the present invention relates to an apparatus and method for providing container product filling in an aseptic processing apparatus.

BACKGROUND OF THE INVENTION

Sterilized packaging systems in which a sterile food product is placed and sealed in a container to preserve the product for later use are well known in the art. Methods of sterilizing incoming containers, filling the containers with pasteurized product, and sealing the containers in an aseptic sterilization tunnel are also known.

Liquid product fillers are known in the art. Generally, a container is placed under a filler head. The filler head opens and dispenses the liquid product. When the container is filled to a desired level, the filler head closes and stops the flow of liquid product into the container. Commonly, in line aseptic fillers use completely mechanical devices for measuring and dosing product into containers. These devices include a first apparatus for measuring the amount of material to be dispensed, and a second apparatus which functions as a filling nozzle. Typically, the first apparatus includes a piston cylinder apparatus for measuring the amount of material. The amount of material measured by the piston cylinder apparatus is limited by the diameter and stroke of the piston. The first and second apparatus include complicated mechanical members which are difficult to sterilize, clean, and maintain.

Typically, rotary fillers include multiple filling stations and allow about 7 to 15 seconds for filling. Some of the rotary bottle filers use electronic measuring devices for dosing the desired amount of product into a bottle. In order to meet FDA (Food and Drug Administration) "aseptic" standards and 3A Sanitary Standards, all surfaces of the filler that come into contact with the liquid product must be sterilized. Before filling commences, a plurality of interior parts of the filler must be removed, sterilized, and replaced. This time consuming and expensive process is necessary in order to ensure the complete sterilization of all surfaces that come into contact with the liquid product.

Packaged food products can generally be categorized as high acid products (Ph below 4.5) or low acid products (Ph of 4.5 and above). The high acid content of a high acid product helps to reduce bacteria growth in the product, thereby increasing the shelf life of the product. The low acid content of a low acid product, however, necessitates the use of more stringent packaging techniques, and often requires refrigeration of the product at the point of sale.

Several packaging techniques, including extended shelf life (ESL) and aseptic packaging, have been developed to increase the shelf life of low acid products. During ESL packaging, for example, the packaging material is commonly sanitized and filled with a product in a presterilized tunnel under "ultra-clean" conditions. By using such ESL packaging techniques, the shelf life of an ESL packaged product is commonly extended from about 10 to 15 days to about 90 days. Aseptic packaging techniques, however, which require that the packaging take place in a sterile environment, using presterilized containers, etc., are capable of providing a packaged product having an even longer shelf life of 150 days or more. In fact, with aseptic packaging, the shelf life limitation is often determined by the quality of the taste of the packaged product, rather than by a limitation caused by bacterial growth.

For the aseptic packaging of food products, an aseptic filler must, for example, use an FDA (Food and Drug Administration) approved sterilant, meet FDA quality control standards, use a sterile tunnel or clean room, and must aseptically treat all packaging material. The food product must also be processed using an "Ultra High Temperature" (UHT) pasteurization process to meet FDA aseptic standards. The packaging material must remain in a sterile environment during filling, closure, and sealing operations.

Many attempts have been made, albeit unsuccessfully, to aseptically fill containers, such as bottles or jars having small openings, at a high output processing speed. In addition, previous attempts for aseptically packaging a low acid product in plastic bottles or jars (e.g., formed of polyethylene terepthalate (PET) or high density polyethylene (HDPE)), at a high output processing speed, have also failed. Furthermore, the prior art has not been successful in providing a high output aseptic filler that complies with the stringent United States FDA standards for labeling a packaged product as "aseptic." In the following description of the present invention, the term "aseptic" denotes the United States FDA level of aseptic.

SUMMARY OF THE INVENTION

In order to overcome the above deficiencies, the present invention provides an apparatus and method for providing container product filling in an aseptic processing apparatus. Additionally, the present invention provides both a "Clean In Place" (CIP) process for cleaning, and a "Sterilizing in Place" for sterilizing all of the interior surfaces of the filler without having to disassemble the filler. The filler apparatus includes a smooth filling tube which is easy to clean and sterilize. The filler apparatus is used in a system for providing aseptically processed low acid products in a container having a small opening, such as a glass or plastic bottle or jar, at a high output processing speed. Many features are incorporated into the filler apparatus in order to meet various FDA aseptic standards and 3A Sanitary Standards and Accepted Practices.

The present invention generally provides an apparatus comprising:

- a valve for controlling a flow of product;
- a first sterile region surrounding a region where the product exits the valve;
- a second sterile region positioned proximate said first sterile region;
- a valve activation mechanism for controlling the opening or closing of the valve by extending a portion of the valve from the second sterile region into the first sterile region and by retracting the portion of the valve from the first sterile region back into the second sterile region.

The present invention generally provides a method comprising the steps of:

- controlling a flow of product using a valve;
- surrounding a region where the product exits the valve with a sterile region;
- providing a second sterile region positioned proximate said first sterile region; and

controlling the opening or closing of the valve by extending a portion of the valve from the second sterile region into the first sterile region and by retracting the portion of the valve from the first sterile region back into the second sterile region.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention will best be understood from a detailed description of the invention and a preferred embodiment, thereof selected for the purposes of illustration, and shown in the accompanying drawings in which:

FIG. **1** is plan view of an aseptic processing apparatus in accordance with a preferred embodiment of the present invention;

FIG. **2** side view of the aseptic processing apparatus of FIG. **1**;

FIG. **3** is a partial cross-sectional side view of the aseptic processing apparatus of FIG. **1**;

FIG. **4** is a cross-sectional side view of a bottle infeed and sterilization apparatus;

FIG. **5** illustrates a cross-sectional top view of the bottle infeed and sterilization apparatus taken along line **5**—**5** of FIG. **4**;

FIG. **6** is an interior sectional view of an interior wall taken along line **6**—**6** of FIG. **4**;

FIG. **7** is a cross-sectional view of the bottle infeed and sterilization apparatus taken along line **7**—**7** of FIG. **4**;

FIG. **8** is a perspective view of a conveying plate for use in the aseptic processing apparatus of the present invention;

FIG. **9** is a perspective view of a partition in a sterilization tunnel;

FIG. **10** is a cross-sectional side view of an interior bottle sterilization apparatus and the partition located between stations **8** and **9**;

FIG. **11** is a cross-sectional side view of the partition located between stations **22** and **23**;

FIG. **12** is a cross-sectional side view of the partition located between stations **35** and **36**;

FIG. **13** is a cross-sectional side view of a lid sterilization and heat sealing apparatus;

FIG. **14** is a side view of a lifting apparatus with a gripper mechanism for lifting the bottles from the sterilization tunnel;

FIG. **15** is a top view of the aseptic processing apparatus;

FIG. **16** is a side view of the aseptic processing apparatus indicating the control and monitoring locations that are interfaced with a control system;

FIG. **17** is a plan view of a daisy chain of lids;

FIG. **18** is a plan view of another embodiment of a daisy chain of lids with holes for receiving pins of a drive wheel;

FIG. **19** is another embodiment of the lid sterilization and heat sealing apparatus including a pin drive apparatus;

FIG. **20** is perspective view of the heat sealing and gripper apparatus;

FIG. **21** is a schematic diagram of a sterilization control system for the interior bottle sterilization apparatus;

FIG. **22** is a side view of a main product filler apparatus;

FIG. **23** is a cross-sectional view of a valve in a closed position in a first sterile region;

FIG. **24** is a cross-sectional view with a portion of a valve stem displaced from a non-sterile region into the first sterile region;

FIG. **25** is a cross-sectional view of the valve in a closed position in a first sterile region, and with the portion of the valve stem located in a second sterile region; and

FIG. **26** is a cross-sectional view of the valve in an open position where the portion of the valve located in the second sterile region has been displaced into the first sterile region.

DETAILED DESCRIPTION OF THE INVENTION

Although certain preferred embodiments of the present invention will be shown and described in detail, it should be understood that various changes and modifications may be made without departing from the scope of the appended claims. The scope of the present invention will in no way be limited to the number of constituting components, the materials thereof, the shapes thereof, the relative arrangement thereof, etc., and are disclosed simply as an example of the preferred embodiment. The features and advantages of the present invention are illustrated in detail in the accompanying drawings, wherein like reference numerals refer to like elements throughout the drawings. Although the drawings are intended to illustrate the present invention, the drawings are not necessarily drawn to scale.

The present invention provides an aseptic processing apparatus **10** that will meet the stringent United States FDA (Food and Drug Administration) requirements and 3A Sanitary Standards and Accepted Practices required to label a food product (foodstuffs) as "aseptic." Hereafter, "aseptic" will refer to the FDA level of aseptic. The present invention provides an aseptic processing apparatus **10** for producing at least about a 12 log reduction of *Clostridium botulinum* in food products. In addition, the present invention produces packaging material with at least about a 6 log reduction of spores. Actual testing of the aseptic processing apparatus is accomplished with spore test organisms. These test organisms are selected on their resistance to the media selected used to achieve sterility. For example, when steam is the media, the test organism is *Bacillus stearothermophilus*. When hydrogen peroxide is the media, then the test organism is *Bacillus subtilis* var. *globigii*.

The present invention processes containers such as bottles or jars that have a small opening compared to its height and its greatest width (e.g., the ratio of the opening diameter to the height of the container is less than 1.0). In the preferred embodiment, a bottle **12** (see, e.g., FIG. **8**) is illustrated as the container. The container may alternately comprise a jar. The bottle **12** is preferably formed of a plastic such as polyethylene terepthalate (PET) or high density polyethylene (HDPE), although other materials such as glass may also be used. The present invention uses an aseptic sterilant such as hydrogen peroxide (H_2O_2) or oxonia (hydrogen peroxide and peroxyacetic acid) to sterilize the bottles **12**. In the preferred embodiment of the present invention, hydrogen peroxide is used as the sterilant. The present invention uses hydrogen peroxide with a concentration of less than about 35% and ensures that the bottles **12** have less than about 0.5 ppm of residual hydrogen peroxide after each bottle **12** is sterilized.

FIGS. **1**–**3** illustrate several views of an aseptic processing apparatus **10** in accordance with a preferred embodiment of the present invention. As shown, the aseptic processing apparatus **10** includes a first bottle unscrambler **20**, a second bottle unscrambler **30**, and a bottle lifter **40** for providing a supply of properly oriented empty bottles. The empty bottles are delivered to a filler apparatus **50** after passing through a bottle infeed and sterilization apparatus **60** for aseptic ster-

ilization. The filled bottles are sealed at a first capping apparatus **400** or a second capping apparatus **410**. A control system **550** monitors and controls the operation of the aseptic processing apparatus **10**. The filled and sealed bottles are packed and palletized using a first case packing apparatus **480**, a second case packing apparatus **490**, a first palletizer **500**, and a second palletizer **510**.

The bottles **12** arrive at a first bottle unscrambler **20** with a random orientation, such that an opening **16** (see FIG. **8**) of each bottle **12** can be oriented in any direction. The first bottle unscrambler **20** manipulates the bottles **12** until the opening **16** of each bottle **12** is in a top vertical position. The bottles **12** leave the first bottle unscrambler **20** in a series formation with the opening **16** of each bottle **12** oriented vertically. The bottles **12** travel in single file in a first lane **18** to a first bottle lifter **40**. The first bottle lifter **40** lifts and transports the bottles **12** to a bottle infeed and sterilization apparatus **60**. A second bottle unscrambler **30** may also used to provide a supply of vertically oriented bottles **12**. The bottles **12** output from the second bottle unscrambler **30** travel in single file in a second lane **22** to a second bottle lifter **42**, which lifts and transports the bottles **12** to the bottle infeed and sterilization apparatus **60**.

FIG. **3** illustrates the bottle infeed, sterilization, and conveying apparatus **60** attached to the filler apparatus **50**. FIG. **4** illustrates a cross-sectional side view of the bottle infeed, sterilization, and conveying apparatus **60**. FIG. **5** illustrates a cross-sectional top view of the bottle infeed, sterilization, and conveying apparatus **60** taken along line **5**—**5** of FIG. **4**. The bottle infeed and sterilization apparatus **60** preferably inputs six bottles **12** in a horizontal direction from the first lane **18** and six bottles in a horizontal direction from the second lane **22** (FIG. **5**). A gate **76** in the first lane **18** selectively groups six bottles **12** at a time in first horizontal row **24**. A gate **78** in the second lane **22** selectively groups six bottles **12** at a time in a second horizontal row **28**. An infeed apparatus **80** includes a pushing element **84** for pushing the bottles **12** in the first horizontal row **24** into a first vertical lane **26**. A corresponding infeed apparatus **80** includes a pushing element **86** for pushing the bottles **12** in the second horizontal row **28** into a second vertical lane **32**. The six bottles **12** in the first vertical lane **26** and the six bottles **12** in the second vertical lane **32** are directed downward into the bottle infeed and sterilization apparatus **60**.

Referring to FIG. **4**, as the bottles **12** move downward in the first vertical lane **26** and the second vertical lane **32**, a sterilant **14**, such as heated hydrogen peroxide, oxonia, or other aseptic sterilant, is applied to an outside surface **34** of each bottle **12** by a sterilant application apparatus **36**. The outside surface **34** of a bottle **12** is illustrated in greater detail in FIG. **8**. The bottles **12** may move downward in the first vertical lane **26** and the second vertical lane **32** by the force of gravity. Alternatively, controlled downward movement of the bottles **12** can be created by the use of a conveying device such as a moving conveying chain. A plurality of pins are attached to the conveying chain. Each bottle **12** rests on one of the pins attached to the conveying chain. Therefore, the motion of each bottle is controlled by the speed of the moving conveying chain.

A sterilant such as hydrogen peroxide may be provided to the sterilant application apparatus **36** in many ways. For example, liquid hydrogen peroxide may be provided in a reservoir at a level maintained by a pump and overflow pipe. A plurality of measuring cups (e.g., approximately 0.5 ml each) connected by an air cylinder are submerged into the reservoir and are lifted above the liquid level. Thus, a measured volume of liquid hydrogen peroxide is contained in each measuring cup.

Each measuring cup may include a conductivity probe that is configured to send a signal to the control system **550** indicating that the measuring cup is full. A tube (e.g., having a diameter of about 1/16") is positioned in the center of the measuring cup. A first end of the tube is positioned near the bottom of the measuring cup. A second end of the tube is connected to the sterilant application apparatus **36**. The sterilant application apparatus **36** includes a venturi and a heated double tube heat exchanger. When the measuring cup is full, and a signal is received from the control system **550**, a valve is opened allowing pressurized sterile air to enter the venturi. The pressurized air flow causes a vacuum to be generated in second end of the tube causing liquid hydrogen peroxide to be pulled out of the measuring cup. The liquid hydrogen peroxide is sprayed into a sterile air stream which atomizes the hydrogen peroxide into a spray. The atomized hydrogen peroxide enters the double tube heat exchanger in order to heat the atomized hydrogen peroxide above its vaporization phase. The double tube heat exchanger is heated with steam and the temperature is monitored and controlled by the control system **550**. In FIG. **4**, the application of the sterilant **14** by the sterilant application apparatus **36** is accomplished through the use of spray nozzles **64** that produce a sterilant fog which is directed to the entire outside surface **34** of each bottle **12**.

Alternatively, a direct spray of heated hydrogen peroxide may be continuously applied to the outside surface **34** of each bottle **12**. For producing the direct spray, a metering pump regulates the amount of hydrogen peroxide, a flow meter continuously measures and records the quantity of hydrogen peroxide being dispensed, a spray nozzle produces a fine mist, and a heat exchanger heats the hydrogen peroxide above the vaporization point.

FIGS. **3** and **4** illustrate the sterilization chamber **38** for activation and drying of bottles **12** which is included in the bottle infeed, sterilization, and conveying apparatus **60**. The sterilization chamber **38** sterilizes the outside surface **34** of each bottle **12**. The sterilization chamber **38** encloses a conduit **39**. Sterile heated air, which is generated by a sterile air supply system **146** (FIG. **3**), enters the conduit **39** of the sterilization chamber **38** through ports **67** and **68** located at the bottom of the sterilization chamber **38**. The sterile heated air also enters through a bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The sterile heated air travels up through the conduit **39** of the sterilization chamber **38**, and exits the top of the sterilization chamber **38** through an exhaust conduit **70**. The sterile heated air continuously flows in an upward direction through the sterilization chamber **38**, thus preventing any contaminants from entering the bottle infeed and sterilization apparatus **60**. To create the sterile heated air, the air is first passed through a filtering system (e.g., a group of double sterile air filters to sterilize the air. The air is then heated in a heating system (e.g., an electric heater) to about 230° F. The air temperature is regulated by the control system **550**. Other techniques for providing the sterile heated air may also be used. The control system **550** monitors the air pressure and flow rate of the sterile heated air to ensure that an adequate flow of the hot sterile air is maintained in the bottle sterilization chamber **38** of the bottle infeed and sterilization apparatus **60**.

As illustrated in FIGS. **4**, **6**, and **7**, the sterilization chamber **38** includes two opposing, interior, perforated walls **72**A, **72**B. The perforated walls **72**A and **72**B guide the bottles **12** downward in the first vertical lane **26** and the second vertical lane **32**, respectively. The perforated walls **72**A, **72**B also allow the complete circulation of hot sterile air around the outside surface **34** of each bottle **12** in the

sterilization chamber **38**. The sterilization chamber **38** supplies hot sterile air to the outside surface **34** of each bottle **12** between the sterilant application apparatus **36** and the bottom opening **62** of the bottle infeed and sterilization apparatus **60**. This sterilant may be hydrogen peroxide or oxonia (hydrogen peroxide and peroxyacetic acid).

In accordance with the preferred embodiment of the present invention, twelve drying positions are provided in the sterilization chamber **38**. Each bottle **12** is exposed to the hot sterile air in the sterilization chamber **38** for about at least 24 seconds. This provides time sufficient time for the hydrogen peroxide sterilant to break down into water and oxygen, to kill any bacteria on the bottles **12**, and to evaporate from the outside surface **34** of the bottles **12**.

An exhaust fan **73** is located at a top of the exhaust conduit **70** to provide an outlet from the sterilization tunnel **90**, and to control the sterile air flow rate through the sterilization chamber **38**. The exhaust fan **73** is controlled by the control system **550**. The control system **550** controls the sterile air temperature preferably to about 230° F., and controls the sterile air flow rate through the sterilization chamber **38**. The flow rate is preferably about 1800 scfm through the sterilization chamber **38**. The bottles **12** leave the sterilization chamber **38** with a hydrogen peroxide concentration of less than 0.5 PPM.

As shown in FIGS. **3** and **4**, a plurality of proximity sensors **71** located along the sides of the vertical lanes **26**, **32** detect any bottle **12** jams that occur within the sterilization chamber **38**. The proximity sensors **71** transmit an alarm signal to the control system **550**. The bottles **12** leave the bottle infeed and sterilization apparatus **60** through the bottom opening **62**, and enter a sterilization tunnel **90** of the filler apparatus **50**.

In the preferred embodiment of the present invention, the filler apparatus **50** includes forty-one (41) index stations **92**, hereafter referred to as "stations." Various index stations **92** are illustrated in FIGS. **3**, **4**, and **11–15**. The conveying motion of the bottles **12** to the various stations **92** through the filler apparatus **50** is based on an indexing motion. The filler apparatus **50** is designed to convey the bottles **12** through the various operations of the filler **50** in a two by six matrix. The twelve bottles **12** in the two by six matrix are positioned in, and displaced by, a conveying plate **94** as illustrated in FIG. **8**. Therefore, twelve bottles **12** are exposed to a particular station **92** at the same time. A conveying apparatus **100** moves the set of twelve bottles **12** in each conveying plate **94** sequentially through each station **92**.

Referring to FIGS. **3** and **4**, the bottles **12** are supplied from an infeed chamber **102** to station **2** of the filler apparatus **50** through the bottom opening **62** of the bottle infeed and sterilization apparatus **60**. The infeed chamber **102** is enclosed to direct heated hydrogen peroxide laden air completely around the outer surface **34** of the bottles **12**. A mechanical scissors mechanism and a vacuum "pick and place" apparatus **104** position twelve bottles **12** at a time (in a two by six matrix, FIG. **8**) into one of the conveying plates **94**.

A plurality of conveying plates **94** are attached to a main conveyor **106**. The main conveyor **106** forms a continuous element around conveyor pulleys **108** and **110** as illustrated in FIG. **3**. A bottle support plate **107** supports a bottom **120** of each bottle **12** as the bottles **12** are conveyed from station to station through the filler apparatus **50**. Each conveying plate **94** passes through stations **1** through **41**, around pulley **108**, and returns around pulley **110** to repeat the process. The main conveyor **106**, conveying plates **94**, and pulleys **108** and **110** are enclosed in the sterilization tunnel **90**.

At station **4**, the bottles **12** in the conveying plate **94** enter a bottle detection apparatus **112**. The bottle detection apparatus **112** determines whether all twelve bottles **12** are actually present and correctly positioned in the conveying plate **94**. Proximity sensors **114** detect the presence and the alignment of each bottle **12**. In the present invention, a bottle **12** with correct alignment is in an upright position with the opening **16** of the bottle **12** located in an upward position. Information regarding the location of any misaligned or missing bottles **12** is relayed to the control system **550**. The control system **550** uses this location information to ensure that, at future stations **92**, bottle filling or sealing will not occur at the locations corresponding to the misaligned or missing bottles **12**.

At station **7**, as illustrated in FIGS. **3** and **10**, the bottles **12** in the conveying plate **94** enter an interior bottle sterilization apparatus **116**. A sterilant, such as hydrogen peroxide, oxonia, or any other suitable aseptic sterilant is applied as a heated vapor fog into the interior **118** of each bottle **12**. Preferably, hydrogen peroxide is used as the sterilant in the present invention. The application of sterilant is accomplished with the use of a plurality of sterilant measuring devices **121** and a plurality of probes **123**. Each probe **123** includes any practical means for transferring the sterilant from the probe **123** to the interior surface **119** of the bottle **12**. For example, an opening or a plurality of openings may be used for ejecting the sterilant onto the interior surface **119**. Preferably, in the present invention, an applicator spray nozzle **122** is included in each probe **123**. The applicator spray nozzle **122** provides uniform sterilant application without droplet formation on the interior surface **119** of the bottle **12**. A separate measuring device **121** and the probe **123** are used for each of the twelve bottle **12** locations in the conveying plate **94**. Each sterilant measuring device **121** may include a spoon dipper **304** (e.g., approximately 0.5 ml each) as illustrated in FIG. **21**. Each bottle **12** is supplied with the same measured quantity of sterilant, preferably in the form of a hot vapor fog. A pump **306** provides a sterilant (e.g., hydrogen peroxide) from a sterilant supply tank **310** to a reservoir **124**. An overflow pipe **308** maintains the sterilant liquid level in the reservoir **124** by returning excess sterilant to the sterilant supply tank **310**. The spoon dipper **304** connected to an air cylinder **316** is submerged into the reservoir **124** and is lifted above the liquid level. Thus, a measured volume of liquid hydrogen peroxide (e.g., approximately 0.5 ml) is contained in each spoon dipper **304**.

Each spoon dipper **304** may include a conductivity probe that is configured to send a signal to the control system **550** indicating that the spoon dipper **304** is full. A tube **312** (e.g., having a diameter of about 1/16") is positioned in the center of the spoon dipper **304**. A first end of the tube **312** is positioned near the bottom of the spoon dipper **304**. A second end of the tube **312** is connected to an atomizing venturi **314**.

A pressurized air source **318** is connected by a conduit **320** to a flow adjust valve **322**. A conduit **324** connects the flow adjust valve **322** to a regulator valve **326**. A conduit **328** connects the regulator valve **326** with a solenoid actuated valve **330**. A conduit **332** connects the solenoid actuated valve **330** with the air cylinder **316**. The control system **550** controls the solenoid actuated valve **330** which controls the compressed air supplied to the air cylinder **316**. Compressed air supplied to the air cylinder **316** lowers or lifts the spoon dipper **304** into or out of the liquid sterilant.

A conduit **334** connects the flow adjust valve **322** with the regulator valve **336**. A conduit **338** connects the regulator valve **336** with a sterile air filter **340**. A conduit **342** connects the sterile air filter **340** with a solenoid actuated valve **344**. A conduit **346** connects the solenoid actuated valve **344** with the atomizing venturi **314**. When the spoon dipper **304** is full, and a signal is received from the control system **550**, the solenoid actuated valve **344** is opened allowing pressurized sterile air to enter the atomizing venturi **314** through the conduit **346**. The pressurized air flow causes a vacuum to be generated in the second end of the tube **312** causing liquid hydrogen peroxide to be pulled out of the spoon dipper **304**.

A first supply of sterile air is supplied through conduit **346**. The pressurized air supplied through conduit **346** is used to atomize the hydrogen peroxide sterilant in the atomizing venturi **314**. Atomization of the liquid hydrogen peroxide may be provided by other means such as by using ultrasonic frequencies to atomize the liquid hydrogen peroxide.

A conduit **348** connects with the atomizing venturi **314**, passes through a heat exchanger **350** (e.g., double tube heat exchanger), and connects with a probe **123** including the applicator spray nozzle **122**. A conduit **352** connects a steam supply **354** with a valve **356**. A conduit **358** connects the valve **356** with a regulator valve **360**. A conduit **382** connects the regulator valve **360** with the heat exchanger **350**.

A second supply of hot sterile air is supplied to the atomized sterilant through a conduit **378**. A humidity control apparatus **362** maintains the humidity level of the air entering a blower **364**. A conduit **366** connects the blower **364** with a heater **368**. A conduit **370** connects the heater **368** with a sterile filter **372**. A conduit **374** connects the sterile filter **372** with a flow adjust valve **376**. The conduit **378** connects the flow adjust valve **376** with the conduit **348**. A conduit **380** connects the sterile filter **372** with a bypass valve **382**. The blower **364** operates continuously supplying humidity controlled air to the heater **368**. The flow of heated sterile air is controlled with the flow adjust valve **376** and travels through conduit **378**.

Exiting conduit **378**, the second supply of hot sterile air enters the conduit **348** to mix with the atomized hydrogen peroxide from the atomizing venturi **314**. Excess flow of heated sterile air travels through conduit **380** and passes through the bypass valve **382**. The second supply of hot sterile air assists in obtaining a uniform concentration of hydrogen peroxide in the air stream in conduit **348** and provides enough momentum to ensure that all portions of the bottle **12** interior **118** are contacted by hydrogen peroxide. Furthermore, the second supply of hot sterile air is continuously blowing, whereas the first supply of sterile air and hydrogen peroxide in conduit **346** is intermittent corresponding to the movement of the bottles **12**. Since the second supply of hot sterile air is continuous, hydrogen peroxide does not have the ability to fall out of the air stream and deposit in the delivery conduit **348** in the form of drops. This ensures that the delivery of hydrogen peroxide is consistent from one bottle **12** application to the next and does not allow a drop to be directed into the bottle **12** interior **118**.

The mixture of heated sterile air and atomized hydrogen peroxide in conduit **348** passes through the double tube heat exchanger **350**. The double tube heat exchanger **350** adds additional heat to the atomized hydrogen peroxide. Heat is supplied to the double tube heat exchanger **350** from the steam supply **354** controlled by the regulator valve **360**. Generally, hydrogen peroxide has chemical stabilizers in it that may cause a white powder precipitate to form on the inner surfaces of the double tube heat exchanger **350**. This occurs when the temperature differential between the supplied steam heat and the gas to be heated is large. In the present invention, the temperature of the atomized hydrogen peroxide is typically about the same as the supplied steam heat so that a minimal amount of precipitate occurs. Another embodiment of the invention eliminates the need for the double tube heat exchanger **350** because the temperature of the atomized hydrogen peroxide is already at the desired temperature.

The temperature of the atomized gas entering the interior **118** of the bottle **12** is in the range of about 100° C. to 120° C. This temperature is limited to prevent the plastic bottles **12** from melting. The droplet size occurring on the interior surface **119** of the bottles **12** is in the range of about 300 to 500 micrometers. The initial concentration level of hydrogen peroxide on the interior surface **119** of the bottle **12** is about 35%.

As illustrated in FIG. **21**, the control system **550** monitors the temperatures at locations denoted as "T" in the interior bottle sterilization apparatus **116**. The temperartures "T" are measured in the conduit **348**, in the heater **368**, and in the conduit **370**. Additionally, the control system **550** monitors the pressures at locations denoted as "P" as illustrated in FIG. **21**. The pressures "p" are measured in the conduit **328**, conduit **338**, and in the conduit **382**.

The control system **550** monitors and controls a spray apparatus **126** that includes the probe **123** including the applicator spray nozzles **122** FIG. **10**. Each applicator spray nozzle **122** sprays the sterilant into the interior **118** of a corresponding bottle **12** as a hot vapor fog. The probe **123** including applicator spray nozzles **122** are designed to extend through the bottle openings **16**. The probe **123** including applicator spray nozzles **122** descends into the interior **118** and toward the bottom of the bottles **12**. This ensures the complete application of sterilant to the entire interior **118** and interior surface **119** of each bottle **12**. Alternately, the probe **123** including the applicator spray nozzles **122** may be positioned immediately above the bottle openings **16** prior to the application of sterilant.

FIG. **9** illustrates a perspective view of a partition **130** that provides control of sterile air flow within the sterilization tunnel **90** of the filler apparatus **50**. The partition **130** includes a top baffle plate **132**, a middle baffle plate **134**, and a bottom baffle plate **136**. The top baffle plate **132** and the middle baffle plate **134** are provided with cut-outs **133** which correspond to the outer shape of each bottle **12** and to the outer shape of the conveyor plate **94**. The cut-outs **133** allow each bottle **12** and each conveyor plate **94** to pass through the partition **130**. A space **138** between the middle baffle plate **134** and the bottom baffle plate **136** allows each empty conveyor plate **94** to pass through the partition **130** as it travels on its return trip from the pulley **108** toward the pulley **110**.

As illustrated in FIG. **3**, partitions **130**A, **130**B, and **130**C, are located within the sterilization tunnel **90**. FIG. **10** illustrates a cross-sectional view of partition **130**A including baffle plates **132**A, **134**A, and **136**A. The partition **130**A is located between stations **8** and **9**. FIG. **11** illustrates a cross-sectional view of partition **130**B including baffle plates **132**B, **134**B, and **136**B. The partition **130**B is located between stations **22** and **23**. FIG. **12** illustrates a cross-sectional view of partition **130**C including baffles **132**C, **134**C, and **136**C. The partition **130**C is located between stations **35** and **36**. As illustrated in FIG. **3**, sterile air is

introduced through sterile air supply sources (e.g., conduits **140**, **142**, and **144**) into the sterilization tunnel **90**. The sterile air conduit **140** is located at station **23** (FIG. **11**), the sterile air conduit **142** is located at station **27** (FIG. **3**), and the sterile air conduit **144** is located at station **35** (FIG. **12**).

The partition **130**A separates an activation and drying apparatus **152** from the interior bottle sterilization apparatus **116**. The partition **130**B separates the activation and drying apparatus **152** from a main product filler apparatus **160** and a lid sterilization and heat sealing apparatus **162**. Thus, a first sterilization zone **164** is created that includes the activation and drying apparatus **152**. Partition **130**C separates the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** from a bottle discharge apparatus **280**. Thus, partitions **130**B and **130**C create a second sterilization zone **166** that includes the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162**. A third sterilization zone **172** includes the bottle discharge apparatus **280**. A fourth sterilization zone **165** includes the interior bottle sterilization apparatus **116**. The second sterilization zone **166** provides a highly sterile area where the bottles **12** are filled with a product and sealed. The second sterilization zone **166** is at a higher pressure than the first sterilization zone **164** and the third sterilization zone **172**. Therefore, any gas flow leakage is in the direction from the second sterilization zone **166** out to the first sterilization zone **164** and the third sterilization zone **172**. The first sterilization zone **164** is at a higher pressure than the fourth sterilization zone **165**. Therefore, gas flow is in the direction from the first sterilization zone **164** to the fourth sterilization zone **165**.

The partitions **130**A, **130**B, and **130**C create sterilization zones **164**, **165**, **166**, and **172** with different concentration levels of gas laden sterilant (e.g., hydrogen peroxide in air). The highest concentration level of sterilant is in the fourth sterilization zone **165**. For example, with the sterilant hydrogen peroxide, the concentration level of hydrogen peroxide is about 1000 ppm (parts per million) in the fourth sterilization zone **165**. The hydrogen peroxide sterilant level is about 3 ppm in the first sterilization zone **164**. The lowest concentration level of sterilant is in the second sterilization zone **166**. In the second sterilization zone **166**, the hydrogen peroxide sterilant concentration level is less than 0.5 ppm and typically about 0.1 ppm. Advantageously, this helps to maintain the main product filler apparatus **160** and the lid sterilization and heat sealing apparatus **162** at a low sterilant concentration level. This prevents unwanted high levels of sterilant to enter the food product during the filling and lidding process. The hydrogen peroxide sterilant concentration level is about 0.1 ppm in the third sterilization zone **172**.

As illustrated in FIG. **3**, a gas such as hot sterile air enters the first sterilization zone **164** at a rate of about 2400 cfm (cubic feet per minute). The temperature of the hot sterile air is about 230° F. The hot sterile air enters the first sterilization zone **164** through conduit **148**. Additional hot sterile air enters the second sterile zone through sterile air conduits **140**, **142**, and **144** at a total rate of about 1000 cfm (FIG. **3**). Also, hot sterile air enters at a rate of about 1800 cfm through ports **67** and **68** leading into the infeed and sterilization apparatus **60**. A portion of the hot sterile air exits the sterilization tunnel **90** at a rate of about 1500 cfm through a plurality of exhaust ports **153** located in the first sterilization zone **164** (FIG. **15**). A portion of the hot sterile air exits the sterilization tunnel **90** at a rate about 100 cfm through an opening **282** (FIG. **14**). The bottles **12** exit the sterilization tunnel **90** through the opening **282**. The continuous flow of sterile air flow out through the opening **282** prevents contaminants from entering the sterilization tunnel **90**.

As illustrated in FIG. **3**, the hot sterile air is drawn out of the fourth sterilization zone **165** of the sterilization tunnel **90** through the bottom opening **62** in the bottle infeed and sterilization apparatus **60**. Next, the hot sterile air from the infeed and sterilization apparatus together with the fourth sterilization zone **165** exits out of the exhaust conduit **70** of the infeed and sterilization apparatus at a rate of about 3600 cfm. This outflow of hot sterile air from the bottle infeed and sterilization apparatus **60** prevents contaminants from entering the bottle infeed sterilization apparatus **60** and the sterilization tunnel **90**.

Stations **10** through **21** include twelve stations for directing hot sterile air into each bottle **12** for the activation and removal of the sterilant from the interior of the bottle **12**. In these twelve stations, a third supply of hot sterile air is provided through the sterile air supply system **146**. The sterile air supply system **146** supplies hot sterile air to a plurality of nozzles **150** in the activation and drying apparatus **152**. The hot sterile air flow in each bottle **12** is about 40 SCFM. Hot sterile air is supplied to the sterile air supply system **146** through conduit **148**. The air is first passed through a filtration system to sterilize the air. The air is then heated in a heating system to about 230° F. The air temperature is regulated by the control system **550**. Also, the control system **550** monitors the air pressure and flow rate to ensure that an adequate flow of hot sterile air is maintained in the sterilization tunnel **90** of the application and drying apparatus **152**.

As shown in FIG. **8**, each bottle **12** generally has a small opening **16** compared to its height "H." A ratio of a diameter "D" of the bottle **12** to the height "H" of the bottle **12** is generally less than 1.0. The small bottle opening **16** combined with a larger height "H" restricts the flow of hot gas into the interior **118** of the bottle **12**. Also, PET and HDPE bottle materials have low heat resistance temperatures. These temperatures commonly are about 55° C. for PET and about 121° C. for HDPE. Typically, in the aseptic packaging industry, a low volume of air at a high temperature is applied to the packaging materials. This often results in deformation and softening of packaging materials formed of PET and HDPE. In order to prevent softening and deformation of the bottles **12**, when formed from these types of materials, the present invention applies high volumes of air at relatively low temperatures over an extended period of time in the activation and drying apparatus **152**. The plurality of nozzles **150** of the activation and drying apparatus **152** direct hot sterile air into the interior **118** of each bottle **12** (FIG. **11**). A long exposure time is predicated by the geometry of the bottle **12** and the softening temperature of the material used to form the bottle **12**. In the present invention, about 24 seconds are allowed for directing hot sterile air from the plurality of nozzles **150** into each bottle for the activation and removal of sterilant from the interior surface **119** of the bottle **12**. To achieve aseptic sterilization, a minimum bottle temperature of about 131° F. should be held for at least 5 seconds. To achieve this bottle temperature and time requirements, including the time required to heat the bottle, the sterilant is applied for about 1 second and the hot sterile air is introduced for about 24 seconds. The hot sterile air leaves the nozzles **150** at about 230° F. and cools to about 131° F. when it enters the bottle **12**. The hot sterile air is delivered at a high volume so that the bottle **12** is maintained at about 131° F. for at least 5 seconds. The about 24 seconds provides adequate time for the bottle **12** to heat up to about 131° F. and to maintain this temperature for at least 5 seconds. After bottle **12** has dried, the residual hydrogen peroxide remaining on the bottle **12** surface is less than 0.5 PPM.

A foodstuff product is first sterilized to eliminate bacteria in the product. An "Ultra High Temperature" (UHT) pasteurization process is required to meet the aseptic FDA standard. The time and temperature required to meet the aseptic FDA standard depends on the type of foodstuff. For example, milk must be heated to 282° F. for not less than 2 seconds in order to meet the aseptic standards.

After UHT pasteurization, the product is delivered to a main product filler apparatus **160**. The main product filler apparatus is illustrated in FIGS. **3**, **13**, and **22**. The main product filler **160** can be sterilized and cleaned in place to maintain aseptic FDA and 3A standards. A pressurized reservoir apparatus **180** that can be steam sterilized is included in the main product filler apparatus **160**. As illustrated in FIG. **22**, the pressurized reservoir apparatus **180** includes an enclosed product tank **182** with a large capacity (e.g., 15 gallons). The product tank **182** is able to withstand elevated pressures of about 60 psig or more. The pressurized reservoir apparatus **180** also includes a level sensor **184**, a pressure sensor **186**, at least one volumetric measuring device **188** (two are shown as **188**A, **188**B), and at least one filling nozzle **190** (two are shown as **190**A, **190**B). The product tank **182** includes a single product inlet **250** with a valve cluster (not shown) including a sterile barrier to separate the product supply system (not shown) from the main product filler apparatus **160**. The product tank **182** has an outlet with twelve connections. At each connections is a volumetric measuring device **188** such as a mass or volumetric flow meter. Pressurized steam or sterile air is supplied into the product tank **182** through the inlet **252**. The product level **254** in the product tank **182** is measured by the level sensor **184**. The control system **550** maintains the product level and pressure in the product tank **182**. This supplies each filling nozzle **190** (e.g. **190**A, **190**B) with a constant pressure that ensures proper product delivery to the bottles **12**.

Filling nozzles **190**A, **190**B are provided at stations **23**, **25**, respectively. Additionally, there are a plurality of corresponding volumetric measuring devices **188**A and **188**B to measure the volume of product entering each bottle **12** at stations **23** and **25**, respectively. In accordance with the present invention, the volumetric measuring devices **188**A and **188**B are preferably electronic measuring devices such as a magnetic flow meter which measures the volume of product flow, or a mass flow meter which measures the weight of product flow. The electronic measuring devices provide filling accuracies of about 0.5%. The control system **550** calculates the desired volume of product to be inserted into each bottle **12**, and controls the product volume by opening or closing a plurality of valves **194**A and **194**B included in the filling nozzles **190**A and **190**B, respectively. The amount of product delivered to the bottles **12** is controlled by the duration of time that the plurality of valves **194**A and **194**B are open. The control system **550** controls the duration of time. Thus, any desired quantity of product may be selected by controlling the duration of time that the valves **194**A and **194**B are open.

The activation mechanisms for valves **194**A and **194**B include valve stems **256**A and **256**B attached to actuators **258**A and **258**B, respectively. Each actuator **258**A, **258**B may include any suitable actuating apparatus (e.g. hydraulic, pneumatic, electrical, etc.). Preferably, in the present invention, the actuators **258**A and **258**B include air cylinders controlled by the control system **550**. The actuators **258**A and **258**B are attached to the valve stems **256**A and **256**B, respectively. The actuators **258**A and **258**B displace the valve stems **256**A and **256**B in an upward and downward direction.

FIG. **23** illustrates the valve stem **256**A attached to the valve **194**A. A first sterile region **260** surrounds the nozzle **196**A through which product **262**A exits. The first sterile region **260** is connected to, and is at the same sterilization level as, the second sterilization zone **166** (FIG. **3**) of the sterile tunnel **90**. The valve **194**A is in a closed position against nozzle **196**A blocking the flow of product **262**A into a bottle **12** (not shown) located in the first sterile region **260**. A first portion **264**A of the valve stem **256**A is surrounded by a non-sterile region **268**, for example, the area located outside of the sterile tunnel **90**. Thus, the first portion **264**A of the valve stem **256**A is exposed with contaminants.

As illustrated in FIG. **24**, the actuator **258**A has displaced the valve stem **256**A in a downward direction. The valve **194**A is removed from the nozzle **196**A allowing product **262**A to flow into a bottle **12** (not shown). The first portion **264**A of the valve stem **256**A has entered the first sterile region **260**. This may create a problem because the first portion **264**A of the valve stem **256**A may carry contaminants from the non-sterile region **268** into the first sterile region **260**. In order to overcome this difficulty, the present invention has introduced a second sterile region **270** as illustrated in FIG. **25**.

The second sterile region **270**A is enclosed by a housing **272** and by a wall **274**. The wall **274** separates the second sterile region **270**A from the first sterile region **260**. The first sterile region **260** is connected to, and is at the same sterilization level, as the second sterilization zone **166** of the sterile tunnel **90**. A sterilizing media **424** is supplied to the second sterile region **270**A through the inlet conduit **420**A. An outlet conduit **422**A may be added to allow the sterilizing media **424** to leave the second sterile region **270**A. The sterilizing media **424** may include any suitable sterilant (e.g. steam, hydrogen peroxide, oxonia, etc.). The non-sterile region **268** lies outside of the housing **272**. A second portion **266**A of the valve stem lies in the non-sterile region **268**. As illustrated in FIG. **25**, the valve **194**A is in a closed position against the nozzle **196**A blocking the flow of product **262**A into a bottle **12** (not shown) in the first sterile region **260**. The first portion **264**A of the valve stem **256**A is surrounded by the second sterile region **270**A. Thus, the first portion **266**A of the valve stem **256**A is maintained in a sterile condition.

As illustrated in FIG. **26**, the actuator **258**A has displaced the valve stem **256**A in a downward direction. The valve **194**A is removed from the nozzle **196**A allowing product **262**A to flow into a bottle **12** (not shown). The first portion **264**A of the valve stem **256**A has entered the first sterile region **260**. In the present invention, the first portion **264**A of the valve stem **256**A has not introduced contaminants into the first sterile region **260** because the first portion **264**A of the valve stem **256**A was pre-sterilized in the second sterile region **270**A before entering the first sterile region **260**. The second portion **266**A of the valve stem **256**A has entered the second sterile region **270**A from the non-sterile region **268**. The second portion **266**A of the valve stem **256**A is sterilized in the second sterile region **270**A removing any contaminants. Therefore, the second sterile region **270**A removes any contaminants from the valve stem **256**A before any portion of the valve stem **256**A enters the first sterile region **260**. Thus, contaminants are prevented from entering the sterile tunnel **90** through the filling nozzles **190**A and **190**B, and the valves **194**A and **194**B, respectively.

The plurality of valves **194**A control the volume of product flowing through a corresponding plurality of nozzles **196**A into the bottles **12** at station **23**. The plurality of valves **194**B control the volume of product flowing through a

corresponding plurality of nozzles **196**B into the bottles **12** at station **25**. The control system **550** uses previously stored information provided by the bottle detection apparatus **112** to only allow filling to occur at the locations where bottles **12** are actually present and correctly aligned.

The initial sterilization process for the pressurized reservoir apparatus **180** includes the step of exposing all of the surfaces of the pressurized reservoir apparatus **180** that come in contact with the product to steam at temperatures above about 250° F. for a minimum of about 30 minutes. Elements such as cups **198**A and **198**B (FIG. **22**) are used to block off nozzle outlets **196**A and **196**B, respectively, to allow a build-up of steam pressure to about 50 psig inside the pressurized reservoir apparatus **180**. Condensate generated as the steam heats the interior surfaces of the pressurized reservoir apparatus **180** is collected in the cups **198**A and **198**B. This condensate is released when the cups **198**A and **198**B are removed from the nozzle outlets **196**A and **196**B. Once the interior surfaces of the pressurized reservoir apparatus **180** are sterilized, the steam is shut off, and sterile air is used to replace the steam. The sterile air reduces the interior temperature of the pressurized reservoir apparatus **180** to the temperature of the product before the product is allowed to enter the enclosed product tank **182**. As shown in FIG. **13**, sterile air is directed through sterile air conduits **142** and **144** into the second sterilization zone **166** at a volume rate of about 800 scfm. The sterile air flow entering the second sterilization zone **166** provides sterile air to the main product filler apparatus **160** and to the lid sterilization and heat sealing apparatus **162**.

The main product filler apparatus **160** includes a separate filling position for each bottle. A bottle **12** moves into position under a nozzle **196**. The bottle stops and the valve **194** opens allowing product **262** to enter the bottle **12**. The volumetric measuring device **188** measure the amount of product entering the bottle **12**. Next, when the desired bottle **12** fill level is achieved, the valve **194** is closed. The control system **550** controls the valve opening and closing. Additionally, the control system **550** does not allow product **262** to flow if a bottle **12** is not present. The bottle **12** filling operation is completed for six bottles at station **23** and for six bottles at station **25**. The filling cycle is repeated for each cycle of the aseptic processing apparatus **10**. In the present invention the bottle filling time is about 1.5 seconds. Another embodiment of the present invention adds a second main product filler apparatus **160**B located at, for example, stations **27** and **29** (FIG. **22**). In this embodiment, the bottles **12** are partially filled by the first main product filler apparatus **160** at stations **23** and **25**. Next, the bottles are moved to the second main product filler apparatus **160**B where the filling of each bottle is completed at stations **27** and **29**. For example, in filling each **16** fluid ounce bottle **12**, the first main product filler apparatus **160** would fill the first 8 ounces in about 1.5 seconds. Next, the second main product filler apparatus **160** would fill the remaining 8 ounces in each bottle **12** in another about 1.5 seconds. The second main product filler **160**B allows the operation to be kept to about 1.5 seconds at each main product filler apparatus **160**, **160**B. This allows the conveying apparatus **100** to move the bottles through the aseptic processing apparatus **10** at speeds greater than about 350 bottles **12** per minute.

FIGS. **3**, **13**, **16** and **19** illustrate the lid sterilization and heat sealing apparatus **162**. A lid **200** is applied to each of the twelve bottles **12** at station **33**. For a fully aseptic bottle filler, complete lid **200** sterilization is necessary, and therefore a sterilant such as hydrogen peroxide is typically used. In the present invention, the lids are formed of a material such as foil or plastic. The lids **200** are joined together by a small interconnecting band **203** that holds them together to form a long continuous chain of lids **200**, hereinafter referred to as a "daisy chain" **202**. The daisy chain **202** of lids is illustrated in FIGS. **17**. A daisy chain **202** of lids **200** is placed on each of a plurality of reels **210**. For the twelve bottle configuration of the present invention, six of the reels **210**, each holding a daisy chain **202** of lids **200**, are located on each side of a heat sealing apparatus **214**. Each daisy chain **202** of lids **200** winds off of a corresponding reel **210** and is sterilized, preferably using a hydrogen peroxide bath **204**. The concentration of hydrogen peroxide can range from about 30 to 40%, however, preferably the concentration is about 35%. Each lid **200** remains in the hydrogen peroxide bath **204** for at least about 6 seconds. A plurality of hot sterile air knives **208**, which are formed by jets of hot sterile air, activate the hydrogen peroxide to sterilize the lids **200** on the daisy chain **202**. The hot sterile air temperature is about 135° C. The hot air knives **208** also remove excess hydrogen peroxide from the lids **200**. A plurality of heated platens **205** further dry the lids **200** so that the residual concentration of hydrogen peroxide is less than 0.5 PPM. The hydrogen peroxide bath **204** prevents any contaminants from entering the sterilization tunnel **90** via the lidding operation.

Once sterilized, the lids **200** enter the sterilization tunnel **90** where they are separated from the daisy chain **202** and placed on a bottle **12**. Each lid is slightly larger in diameter then that of the opening **16** of a bottle **12**. During the placement of the lid **200** on the bottle **12**, a slight mechanical crimp of the lid **200** is formed to locate and hold the lid **200** on the bottle **12**. The crimp holds the lid **200** in place on the bottle **12** until the bottle **12** reaches a station **33** for sealing. Sealing may also be accomplished without having to provide the mechanical crimp on the lid **200**.

Another embodiment of a lid sterilization and heat sealing apparatus **552** is illustrated in FIG. **19**. As illustrated in FIG. **18**, the daisy chain **215** of lids **200** includes a hole **207** located in each interconnecting band **203**. Each hole **207** receives a pin **209** of a drive sprocket **211**.

The daisy chain **215**A, **215**B of lids **200** is placed on each of a plurality of reels **210** (e.g. **210**A and **210**B). For the twelve bottle configuration of the present invention, six of the reels **210**, each holding a daisy chain **215**A, **215**B of lids **200**, are located on each side of a heat sealing apparatus **214**. Each daisy chain **215**A, **215**B of lids **200** winds off of a corresponding reel **210** and is sterilized preferably using a hydrogen peroxide bath **204**. The concentration of hydrogen peroxide can range from about 30 to 40%, however, preferably the concentration is about 35%. The lids **200** remain in the hydrogen peroxide bath **204** for at least about 6 seconds. A plurality of hot sterile air knives **208**, which are formed by jets of hot sterile air, activate the hydrogen peroxide to sterilize the lids **200** on the daisy chain **215**A, **215**B. The hot sterile air temperature is about 135° C. The hot air knives **208** also remove excess hydrogen peroxide form the lids **200**. A plurality of heated platens **205** further dry the lids **200** so that the residual concentration of hydrogen peroxide is less than 0.5 PPM. The hydrogen peroxide bath **204** prevents any contaminants from entering the sterilization tunnel **90** via the lidding operation. The drive sprocket **211**A includes a plurality of pins **209** that engage with the holes **207** of the daisy chain **215**A. The drive sprocket **211**A rotates in a counterclockwise direction and indexes and directs the daisy chain **215**A, through a plurality of guides **217**A. The guides **217**A may include a plurality of rollers **221**A to further guide and direct an end **219**A of the daisy chain **215**A over the bottle **12**A. The drive sprocket

211B includes a plurality of pins **209** that engage with the holes **207** of the daisy chain **215B**. The drive sprocket **211B** rotates in a clockwise direction and indexes and directs the daisy chain **215B** through a plurality of guides **217B**. The guides **217B** may include a plurality of rollers **221B** to further guide and direct an end **219B** of the daisy chain **215B** over the bottle **12B**.

Once sterilized, the lids **200** enter the sterilization tunnel **90** where they are separated from the daisy chain **215A, 217B** and placed on the bottle **12A, 12B**. At station **33**, the lids **200** are applied to the bottles **12**. As illustrated in FIGS. **13** and **20**, the heat sealing apparatus **214** includes a heated platen **216** that applies heat and pressure against each lid **200** for a predetermined length of time, to form a seal between the lid **200** and the bottle **12A, 12B**. Although lidding for a bottle has been described, it should be appreciated that lidding of other containers (e.g. jars) can be provided by the present invention. FIG. **20** illustrates a perspective view of the heat sealing apparatus **214**, the daisy chain **215A**, the gripper apparatus **554**, the bottle **12A**, and the conveying plate **94**. The lid **200** is located above the bottle opening **16**. The gripper apparatus **554** includes a grip **223** for capturing the bottle **12A** by a bottle lip **225**. The gripper apparatus **554** lifts the bottle **12A** in an upward direction so that the lid **200** is pressed between a bottle top lip **227** and the heated platen **216**. The interconnecting band **203** severs and separates the lid **200** on the bottle **12** from the next lid on the daisy chain **215A**. The heated platen **216** is in a two by six configuration to seal twelve of the bottles **12** at a time. There is a separate gripper apparatus **554** for each of the twelve bottles **12**. After each bottle **12** is sealed, its gripper apparatus **554** lowers and releases the bottle **12** and each bottle **12** continues to station **37**.

At station **37**, the lid **200** seal and bottle **12** integrity are checked in a known manner by a seal integrity apparatus (not shown) comprising, for example, a bottle squeezing mechanism and a proximity sensor. Each bottle **12** is squeezed by the bottle squeezing mechanism which causes the lid **200** on the bottle **12** to extend upward. The proximity sensor detects if the lid **200** has extended upward, which indicates an acceptable seal, or whether the seal remains flat, which indicates a leaking seal or bottle **12**. The location of the defective bottles **12** are recorded by the control system **550** so that the defective bottles will not be packed.

Bottle discharge from the sterilization tunnel **90** of the filler apparatus **50** occurs at stations **38** and **40** as illustrated in FIGS. **3, 13** and **14**. A bottle discharge apparatus **280** is located at stations **38** and **40**. At this point in the filler apparatus **50**, the filled and sealed bottles **12** are forced in an upward direction such that a top portion **284** of each bottle **12** protrudes through the opening **282** in the sterilization tunnel **90** (FIG. **14**). A rotating cam **290** or other suitable means (e.g., an inflatable diaphragm, etc.) may be used to apply a force against the bottom **120** of each bottle **12** to force the bottle **12** in an upward direction.

As illustrated in FIG. **14**, the bottle discharge apparatus **280** comprises a lifting apparatus **286** that includes a gripper **288** that grasps the top portion **284** of each bottle **12** and lifts the bottle **12** out through the opening **282** in the sterilization tunnel **90**. In order to ensure that contaminated air cannot enter the sterilization tunnel **90**, the sterile air in the sterilization tunnel **90** is maintained at a higher pressure than the air outside the sterilization tunnel **90**. Thus, sterile air is always flowing out of the sterilization tunnel **90** through the opening **282**. In addition, the gripper **288** never enters the sterilization tunnel **90**, because the top portion **284** of the bottle **12** is first lifted out of the sterilization tunnel **90** by the action of the rotating cam **290** before being grabbed by the gripper **288**.

FIG. **15** illustrates a top view of the filler apparatus **50** including the bottle infeed and sterilization apparatus **60**, the interior bottle sterilization apparatus **116**, and the activation and drying apparatus **152**. FIG. **15** additionally illustrates the main filler apparatus **160**, the lid sterilization and heat sealing apparatus **162**, and the bottle discharge apparatus **280**.

Referring again to FIGS. **1** and **14**, the lifting apparatus **286** lifts the bottles **12** at station **38** and places the bottles **12** in a first lane **292** that transports the bottles **12** to a first capping apparatus **410**. In addition, the lifting apparatus **286** lifts the bottles **12** at station **40** and places the bottles **12** in a second lane **294** that transports the bottles **12** to a second capping apparatus **400**.

The first capping apparatus **410** secures a cap (not shown) on the top of each bottle **12** in the first lane **292**. The second capping apparatus **400** secures a cap on the top of each bottle **12** in the second lane **294**. The caps are secured to the bottles **12** in a manner known in the art. It should be noted that the capping process may be performed outside of the sterilization tunnel **90** because each of the bottles **12** have previously been sealed within the sterilization tunnel **90** by the lid sterilization and heat sealing apparatus **162** using a sterile lid **200**.

After capping, the bottles **12** are transported via the first and second lanes **292, 294** to labelers **460** and **470**. The first labeling apparatus **470** applies a label to each bottle **12** in the first lane **292**. The second labeling apparatus **460** applies a label to each bottle **12** in the second lane **294**.

From the first labeling apparatus **470**, the bottles **12** are transported along a first set of multiple lanes (e.g., **4**) to a first case packing apparatus **490**. From the second labeling apparatus **460**, the bottles **12** are transported along a second set of multiple lanes to a second case packing apparatus **480**. Each case packing apparatus **480, 490** gathers and packs a plurality of the bottles **12** (e.g., twelve) in each case in a suitable (e.g., three by four) matrix.

A first conveyor **296** transports the cases output by the first case packer **490** to a first palletizer **510**. A second conveyor **298** transports the cases output by the second case packer **480** to a second palletizer **500**. A vehicle, such as a fork lift truck, then transports the pallets loaded with the cases of bottles **12** to a storage warehouse.

Referring again to FIG. **3**, the main conveyor **106** and each conveying plate **94** are cleaned and sanitized once during each revolution of the main conveyor **106**. Specifically, after each empty conveying plate **94** passes around the pulley **108**, the conveying plate **94** is passed through a liquid sanitizing apparatus **300** and a drying apparatus **302**. The liquid sanitizing apparatus **300** sprays a mixture of a sterilizing agent (e.g., oxonia, (hydrogen peroxide and peroxyacetic acid)) over the entire surface of each conveying plate **94** and associated components of the main conveyor **106**. In the drying apparatus **302**, heated air with is used to dry the main conveyor **106** and conveying plates **94**.

Stations **1** through **40** are enclosed in the sterilization tunnel **90**. The sterilization tunnel **90** is supplied with air that is pressurized and sterilized. The interior of the sterilization tunnel **90** is maintained at a pressure higher than the outside environment in order to eliminate contamination during the bottle processing. In addition, to further ensure a sterile environment within the sterilization tunnel **90**, the sterile air supply provides a predetermined number of air changes (e.g., 2.5 changes of air per minute) in the sterilization tunnel **90**.

Before bottle production is initiated, the bottle infeed and sterilization apparatus **60** and the filler apparatus **50** are preferably sterilized with an aseptic sterilant. For example, a sterilant such as a hot hydrogen peroxide mist may be applied to all interior surfaces of the bottle infeed and sterilization apparatus **60** and the filler apparatus **50**. Then, hot sterile air is supplied to activate and remove the hydrogen peroxide, and to dry the interior surfaces of the bottle infeed and sterilization apparatus **60** and the filler apparatus **50**.

FIG. **16** is a side view of the aseptic processing apparatus **10** of the present invention indicating the location of the control and monitoring devices that are interfaced with the control system **550**. The control system **550** gathers information and controls process functions in the aseptic processing apparatus **10**. A preferred arrangement of the control and monitoring devices are indicated by encircled letters in FIG. **16**. A functional description of each of the control and monitoring devices is listed below. It should be noted that these control and monitoring devices are only representative of the types of devices that may be used in the aseptic processing apparatus **10** of the present invention. Other types and combinations of control and monitoring devices may be used without departing from the intended scope of the present invention. Further, control system **550** may respond in different ways to the outputs of the control and monitoring devices. For example, the control system **550** may automatically adjust the operational parameters of the various components of the aseptic processing apparatus **10**, may generate and/or log error messages, or may even shut down the entire aseptic processing apparatus **10**. In the preferred embodiment of the present invention, the control and monitoring devices include:

A. A bottle counter to ensure that a predetermined number of the bottles **12** (e.g., six bottles) on each upper horizontal row **24**, **28** enter the loading area of the bottle infeed and sterilization apparatus **60**.

B. A proximity sensor to ensure that the first group of bottles **12** has dropped into the first bottle position in the bottle infeed and sterilization apparatus **60**.

C1. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus **36** is full.

C2. A conductivity sensor to ensure that the measuring cup used by the sterilant application apparatus **36** is emptied in a predetermined time.

C3. A pressure sensor to ensure that the pressure of the air used by the sterilant application apparatus **36** is within predetermined atomization requirements.

C4. A temperature sensor to ensure that each heat heating element used by the sterilant application apparatus **36** is heated to the correct temperature.

D. A proximity sensor (e.g., proximity sensor **71**, FIG. **3**) to ensure that a bottle jam has not occurred within the bottle infeed and sterilization apparatus **60**.

E. A temperature sensor to ensure that the temperature of the heated sterile air entering the bottle infeed and sterilization apparatus **60** is correct.

F. A proximity sensor that to ensure that each conveying plate **94** is fully loaded with bottles **12**.

G1. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus **116** is full.

G2. A conductivity sensor to ensure that the measuring cup used by the interior bottle sterilization apparatus **116** is emptied in a predetermined time.

G3. A pressure sensor to ensure that the pressure of the air used by the interior bottle sterilization apparatus **116** is within predetermined atomization requirements.

G4. A temperature sensor to ensure that each heat heating element used by the interior bottle sterilization apparatus **116** is heated to the correct temperature.

H. A temperature sensor to ensure that the air drying temperature within the activation and drying apparatus **152** is correct.

I. A plurality of flow sensors to ensure that the airflow rate of the sterile air entering the sterilization tunnel **90** is correct.

J. A pressure sensor to ensure that the pressure of the sterile air entering the activation and drying apparatus **152** is correct.

K. A measuring device (e.g., volumetric measuring device **188**, FIG. **3**) to ensure that each bottle **12** is filled to a predetermined level.

L. A pressure sensor to ensure that the pressure in the product tank **182** is above a predetermined level.

M. A level sensor to ensure that the level of product in the product tank **182** is maintained at a predetermined level.

N. Proximity sensors to ensure that the daisy chains **202** of lids **200** are present in the lid sterilization and heat sealing apparatus **162**

O. A level sensor to ensure that the hydrogen peroxide level in the hydrogen peroxide bath **204** in the lid sterilization and heat sealing apparatus **162** is above a predetermined level.

P. A temperature sensor to ensure that the temperature of the hot sterile air knives **208** of the lid sterilization and heat sealing apparatus **162** is correct.

Q. A temperature sensor to ensure that the heat sealing apparatus **214** is operating at the correct temperature.

R. Proximity sensors to ensure that the bottles **12** are discharged from the filler.

S. A speed sensor to measure the speed of the conveying apparatus **100**.

T. A concentration sensor to ensure that the concentration of oxonia is maintained at a predetermined level in the sanitizing apparatus **300**.

U. A pressure sensor to ensure that the pressure of the oxonia is maintained above a predetermined level in the sanitizing apparatus **300**.

V. A temperature sensor to ensure that the drying temperature of the drying apparatus **302** is correct. The following steps are performed during the "Clean In Place" (CIP) process in the filler apparatus **50**;

23. Conductivity sensor to verify caustic and acid concentrations.

24. Temperature sensor to verify "Clean In Place" solution temperatures.

25. Flow meter to verify "Clean In Place" flow rates.

26. Time is monitored to ensure that adequate cleaning time is maintained.

The follow steps are performed during sterilization of the bottle filler apparatus **50**;

27. Temperature sensors for measuring steam temperatures.

28. Proximity sensors to ensure filler nozzle cleaning/sterilization cups are in position.

29. Temperature sensors for air heating and cooling.

30. Flow meter for hydrogen peroxide injection.

31. Time is monitored to ensure the minimum time periods are met (steam, hydrogen peroxide application and activation/drying).

The foregoing description of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and many modifications and variations are possible in light of the above teaching. Such modifications and variations that may be apparent to a person skilled in the art are intended to be included within the scope of this invention.

I claim:

1. Apparatus comprising:

a valve for controlling a flow of product;

a first sterile region surrounding a region where the product exits the valve;

a continuously sterilized second sterile region positioned proximate said first sterile region whereby said second sterile region is continuously sterilized during operation;

a valve activation mechanism for controlling the opening or closing of the valve by extending a portion of the valve from the continuously sterilized second sterile region into the first sterile region and by retracting the portion of the valve from the first sterile region back into the continuously sterilized second sterile region.

2. The apparatus of claim **1**, further including:

a tank for containing a pressurized supply of the product; and

a measuring device connected to the tank for measuring an amount of the product flowing from the tank to the valve.

3. Apparatus comprising:

a tank for containing a supply of a pressurized product;

a measuring device connected to the tank for measuring an amount of the product flowing from the tank to a container;

a filling nozzle connected to the measuring device for directing product flow into the container;

a valve located within the filling nozzle for controlling the flow of product;

a first sterile region surrounding a region where the product exits the valve;

a valve stem attached to the valve for controlling the opening or closing of the valve;

a sterilization chamber surrounding a first portion of the valve stem; and

a valve activation mechanism for controlling the opening or closing of the valve by extending the first portion of the valve stem from the sterilization chamber into the first sterile region and by retracting the first portion of the valve stem from the first sterile region back into the sterilization chamber.

4. The apparatus of claim **3**, wherein the container is a bottle.

5. The apparatus of claim **3**, wherein the tank is pressurized with sterile air.

6. The apparatus of claim **3**, further including a level measuring device for measuring the level of the product in the tank.

7. The apparatus of claim **6**, wherein the measuring device is a volume flow meter.

8. The apparatus of claim **7**, wherein the volume flow meter is a magnetic flow meter.

9. The apparatus of claim **6**, wherein the measuring device is a mass flow meter.

10. The apparatus of claim **3**, wherein the valve activation mechanism includes an air cylinder.

11. The apparatus of claim **3**, wherein the sterilization chamber includes a sterilant flowing through the sterilization chamber to provide sterilization and cleaning of the first portion of the valve stem.

12. The apparatus of claim **11**, wherein the sterilant is steam.

13. The apparatus of claim **11**, wherein the sterilant is hydrogen peroxide.

14. The apparatus of claim **3**, further including a removable device for blocking off an exit of the valve to allow a build-up of steam pressure inside the tank during an initial apparatus sterilization.

15. The apparatus of claim **3**, wherein the container is filled to a first level with the product exiting from the filling nozzle and wherein the container is filled to a second level with product exiting from a second filling nozzle.

16. A method comprising the steps of:

controlling a flow of product using a valve;

surrounding a region where the product exits the valve with a sterile region;

providing a continuously sterilized second sterile region positioned proximate said first sterile region whereby said second sterile region is continuously sterilized during operation; and

controlling the opening or closing of the valve by extending a portion of the valve from the continuously sterilized second sterile region into the first sterile region and by retracting the portion of the valve from the first sterile region back into the continuously sterilized second sterile region.

17. The method of claim **16**, further including the step of providing a tank for containing a supply of pressurized product flowing to the valve.

18. The method of claim **17**, further including the step of providing a measuring device for measuring the amount of pressurized product flowing from the tank to the valve.

19. The method of claim **18** further including the steps of:

exposing the valve, an interior surface of the tank, and an interior surface of the measuring device with steam;

covering an exit of the valve; and

allowing a build-up of steam pressure inside the tank to above a temperature of about 250° F., a steam pressure of about 50 psig, for about 30 minutes.

20. The method of claim **16**, further including the step of providing a second apparatus wherein the container is filled to a first level with the product exiting from the first apparatus, and the container is filled to a second level with the product exiting from the second apparatus.

21. The method of claim **20** further including the steps of:

uncovering the exit of the valve; and

providing sterile air to reduce the temperature of the valve, the interior surface of the tank, and the interior surface of the measuring device to the temperature of the product.

22. A method comprising the steps of:

controlling a flow of product using a valve;

surrounding a region where the product exits the valve with a sterile region;

providing a second sterile region positioned proximate said first sterile region;

controlling the opening or closing of the valve by extending a portion of the valve from the second sterile region

into the first sterile region and by retracting the portion of the valve from the first sterile region back into the second sterile region;

providing a tank for containing a supply of pressurized product flowing to the valve;

providing a measuring device for measuring the amount of pressurized product flowing from the tank to the valve;

exposing the valve, an interior surface of the tank, and an interior surface of the measuring device with steam;

covering an exit of the valve; and

allowing a build-up of steam pressure inside the tank to above a temperature of about 250° F., a steam pressure of about 50 psig, for about 30 minutes.

23. A method comprising the steps of:

controlling a flow of product using a valve;

surrounding a region where the product exits the valve with a sterile region;

providing a second sterile region positioned proximate said first sterile region;

controlling the opening or closing of the valve by extending a portion of the valve from the second sterile region into the first sterile region and by retracting the portion of the valve from the first sterile region back into the second sterile region;

providing a second apparatus wherein the container is filled to a first level with the product exiting from the first apparatus, and the container is filled to a second level with the product exiting from the second apparatus;

uncovering the exit of the valve; and

providing sterile air to reduce the temperature of the valve, the interior surface of the tank, and the interior surface of the measuring device to the temperature of the product.

24. Apparatus comprising:

an inline bottle filing apparatus including:

a valve for controlling a flow of product;

a first sterile region surrounding a region where the product exits the valve;

a second sterile region positioned proximate said first sterile region;

a valve activation mechanism for controlling the opening or closing of the valve by extending a portion of the valve from the second sterile region into the first sterile region and by retracting the portion of the valve from the first sterile region back into the second sterile region.

25. The apparatus of claim **24**, further comprising a sterile tunnel.

26. Apparatus comprising:

a valve for controlling a flow of product into a bottle;

a first sterile region surrounding a region where the product exits the valve;

a second sterile region positioned proximate said first sterile region;

a valve activation mechanism for controlling the opening or closing of the valve by extending a portion of the valve from the second sterile region into the first sterile region, such that the valve does not contact the bottle, and by retracting the portion of the valve from the first sterile region back into the second sterile region.

27. The apparatus of claim **26**, further comprising a sterile tunnel.

28. The apparatus of claim **27**, wherein the valve mechanism fills the bottle such that the atmospheric pressure of the interior of the bottle is the same atmospheric pressure of the sterile tunnel.

* * * * *

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF NEW YORK

STEUBEN FOODS, INC.,

Plaintiff,

-*vs*-

JASPER PRODUCTS, LLC

Defendant.

CORPORATE DISCLOSURE STATEMENT

Civil Action No. _____

Pursuant to Rule 5.1(e) of the Local Rules of the United States District Court for the Western District of New York, the plaintiff, Steuben Foods, Inc. ("Steuben Foods"), by its attorneys, Hiscock & Barclay LLP and Oblon, Spivak, McClelland, Maier & Neustadt, LLP, states as follows:

1. All parent companies of corporation: Steuben Foods has no parent companies.

2. Any publicly held company that owns 10% or more of corporation: None.

DATED: November 14, 2013

HISCOCK & BARCLAY LLP

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AO 120 (Rev. 08/10)

TO:	**Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Western District of New York on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT Western District of New York
PLAINTIFF STEUBEN FOODS, INC.		DEFENDANT JASPER PRODUCTS, LLC

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	6,945,013	9/20/2005	Steuben Foods Incorporated
2	6,536,188	3/25/2003	Steuben Foods, Inc.
3	6,481,468	11/19/2002	Steuben Foods Incorporated
4	6,475,435	11/5/2002	Steuben Foods Incorporated
5	6,209,591	4/3/2001	Steuben Foods Inc.

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

AO 440 (Rev. 06/12) Summons in a Civil Action

UNITED STATES DISTRICT COURT

for the

Western District of New York

STEUBEN FOODS, INC. *Plaintiff(s)* v. JASPER PRODUCTS, LLC *Defendant(s)*	)	Civil Action No.

SUMMONS IN A CIVIL ACTION

To: *(Defendant's name and address)* JASPER PRODUCTS, LLC.
3877 E. 27th Street
Joplin, Missouri 64804

A lawsuit has been filed against you.

Within 21 days after service of this summons on you (not counting the day you received it) — or 60 days if you are the United States or a United States agency, or an officer or employee of the United States described in Fed. R. Civ. P. 12 (a)(2) or (3) — you must serve on the plaintiff an answer to the attached complaint or a motion under Rule 12 of the Federal Rules of Civil Procedure. The answer or motion must be served on the plaintiff or plaintiff's attorney, whose name and address are:

Thomas B. Cronmiller, Esq.
Hiscock & Barclay, LLP
2000 HSBC Plaza
100 Chestnut Street
Rochester, New York 14604

If you fail to respond, judgment by default will be entered against you for the relief demanded in the complaint. You also must file your answer or motion with the court.

CLERK OF COURT

Date: _____

_____
Signature of Clerk or Deputy Clerk

Civil Action No.

PROOF OF SERVICE

(This section should not be filed with the court unless required by Fed. R. Civ. P. 4 (l))

This summons for *(name of individual and title, if any)* _____
was received by me on *(date)* _____ .

❒ I personally served the summons on the individual at *(place)* _____
_____ on *(date)* _____ ; or

❒ I left the summons at the individual's residence or usual place of abode with *(name)* _____
_____ , a person of suitable age and discretion who resides there,
on *(date)* _____ , and mailed a copy to the individual's last known address; or

❒ I served the summons on *(name of individual)* _____ , who is
designated by law to accept service of process on behalf of *(name of organization)* _____
_____ on *(date)* _____ ; or

❒ I returned the summons unexecuted because _____ ; or

❒ Other *(specify):*

My fees are $ _____ for travel and $ _____ for services, for a total of $ 0.00 .

I declare under penalty of perjury that this information is true.

Date: _____ _____
Server's signature

_____
Printed name and title

_____
Server's address

Additional information regarding attempted service, etc: