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(12) **United States Patent**
Klein et al.

(10) **Patent No.: US 10,837,914 B2**
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(54) **IMPLEMENT ANALYZING DEVICE AND METHOD FOR UTILIZING THE SAME**

(71) Applicant: **Neogen Corporation**, Lansing, MI (US)

(72) Inventors: **Frank Eric Klein**, Howell, MI (US); **Andrew John Wheeler**, Hollis Center, ME (US); **Andrew John DenHartigh**, Lansing, MI (US); **William Hoerner**, Lansing, MI (US); **Nathaniel Banner**, Lansing, MI (US); **Damon Borich**, Austin, TX (US); **Andrea Grbavac**, Austin, TX (US); **Alejandro Silveyra**, Austin, TX (US); **Michelle Silveyra**, Austin, TX (US); **Zwckxally Obregon**, Cedar Creek, TX (US)

(73) Assignee: **NEOGEN CORPORATION**, Lansing, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 66 days.

(21) Appl. No.: **15/488,793**

(22) Filed: **Apr. 17, 2017**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**
G01N 21/78 (2006.01)
G01N 35/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G01N 21/78*** (2013.01); ***B01L 3/5023*** (2013.01); ***G01N 1/38*** (2013.01);
(Continued)

(58) **Field of Classification Search**
None
See application file for complete search history.

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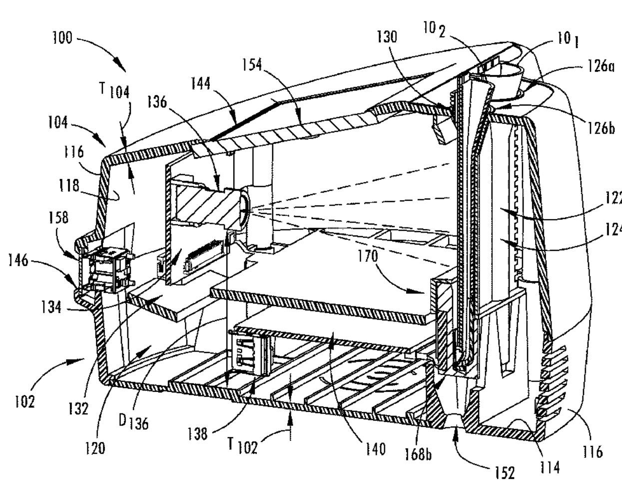
Primary Examiner — Kathryn Wright
(74) *Attorney, Agent, or Firm* — Honigman LLP; Douglas H. Siegel; Jonathan P. O'Brien

(57) **ABSTRACT**

An implement analyzing device that is sized for receiving more than one fluid retainer cartridge assembly is disclosed. The implement analyzing device includes a support member, a housing, a cartridge receiver, at least one cartridge heater, an imaging device and an implement analyzing device integrated circuit. The cartridge receiver is disposed within a cavity in the implement analyzing device and defines at least one cartridge viewing window. At least one cartridge heater disposed within the cavity and connected to the cartridge receiver. The imaging device is disposed within the cavity and arranged opposite the at least one cartridge viewing window. The implement analyzing device integrated circuit is communicatively coupled to the at least one cartridge heater and the imaging device.

27 Claims, 26 Drawing Sheets



(51) **Int. Cl.**

G01N 1/38	(2006.01)
B01L 3/00	(2006.01)
G01N 21/84	(2006.01)
G01N 21/77	(2006.01)

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

CPC ***G01N 35/00584*** (2013.01); *B01L 2200/0621* (2013.01); *B01L 2200/0689* (2013.01); *B01L 2300/042* (2013.01); *B01L 2300/0681* (2013.01); *B01L 2300/087* (2013.01); *B01L 2300/0825* (2013.01); *G01N 21/8483* (2013.01); *G01N 2021/7759* (2013.01); *G01N 2035/00346* (2013.01)

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2013/0309778	A1	11/2013	Lowe et al.	
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2016/0103075	A1	4/2016	Borich et al.	
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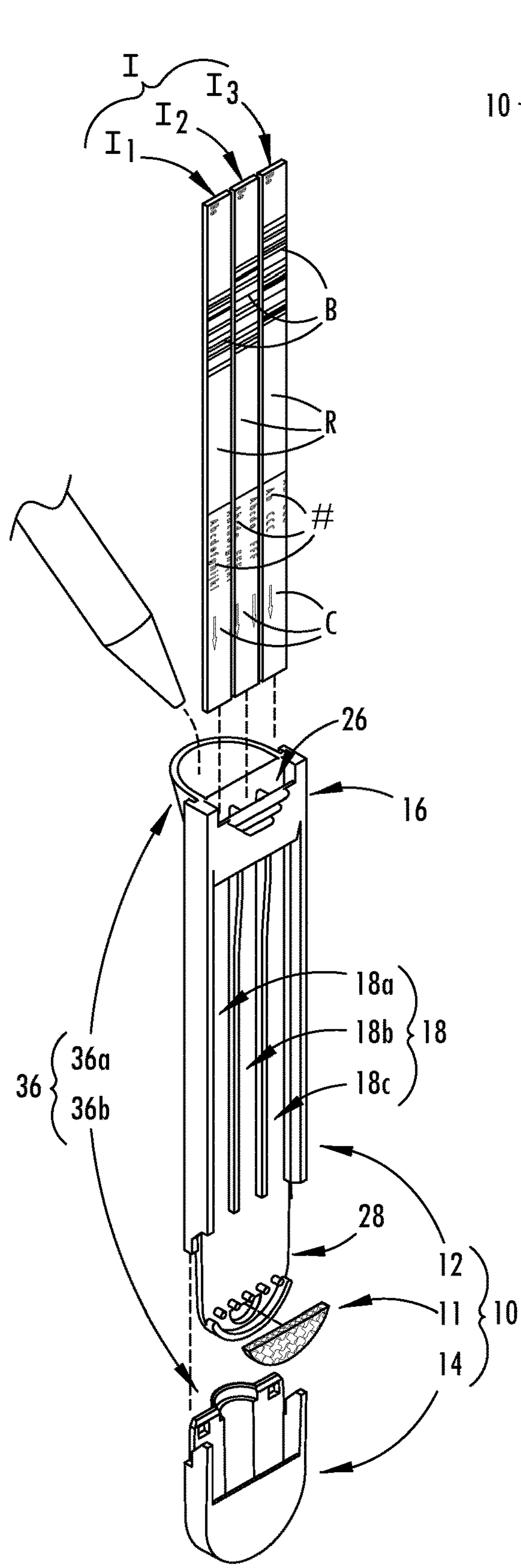

I
I3
I2
I1
B
R
#
C
26
16
18a
18b
18
18c
36
36a
36b
28
12
11
10
14

FIG. 1A

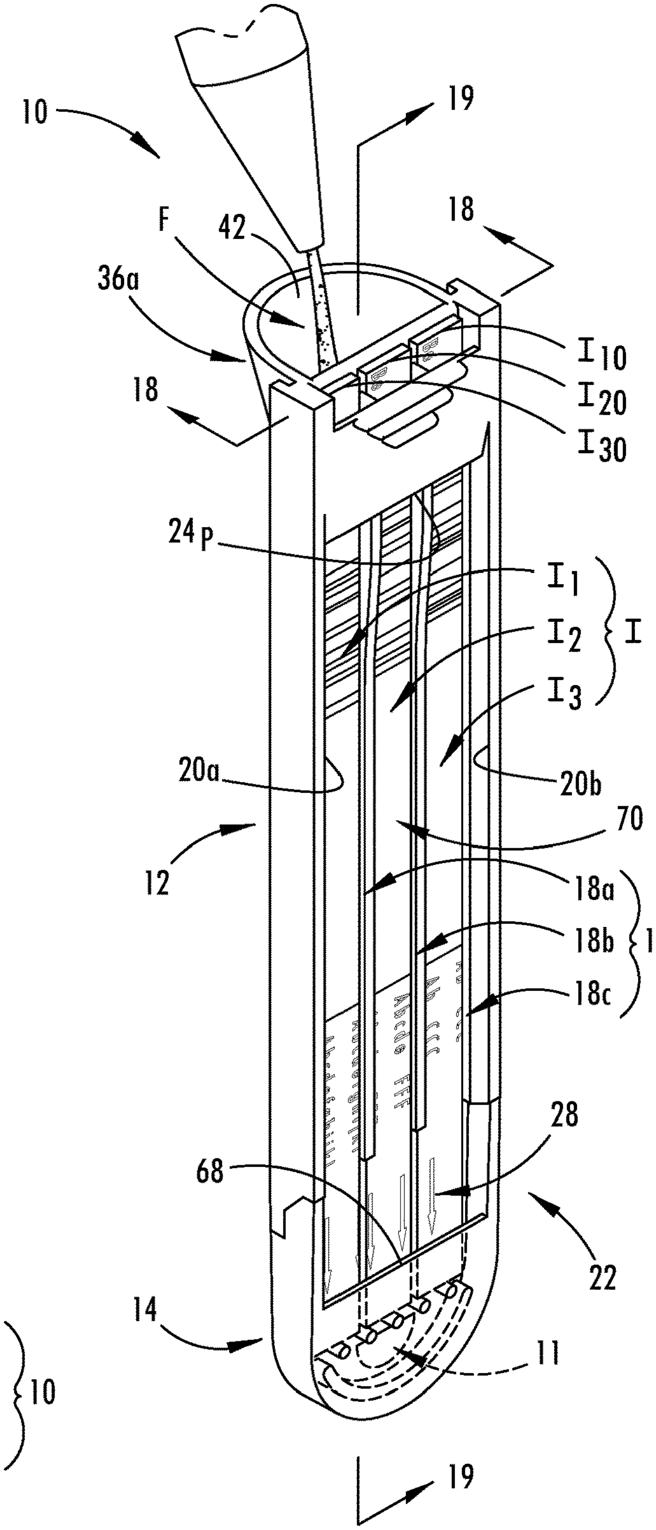

10
19
F
42
18
36a
I10
I20
18
I30
24p
I1
I2
I
I3
20a
20b
70
12
18a
18b
18
18c
28
68
22
14
11
19

FIG. 1B

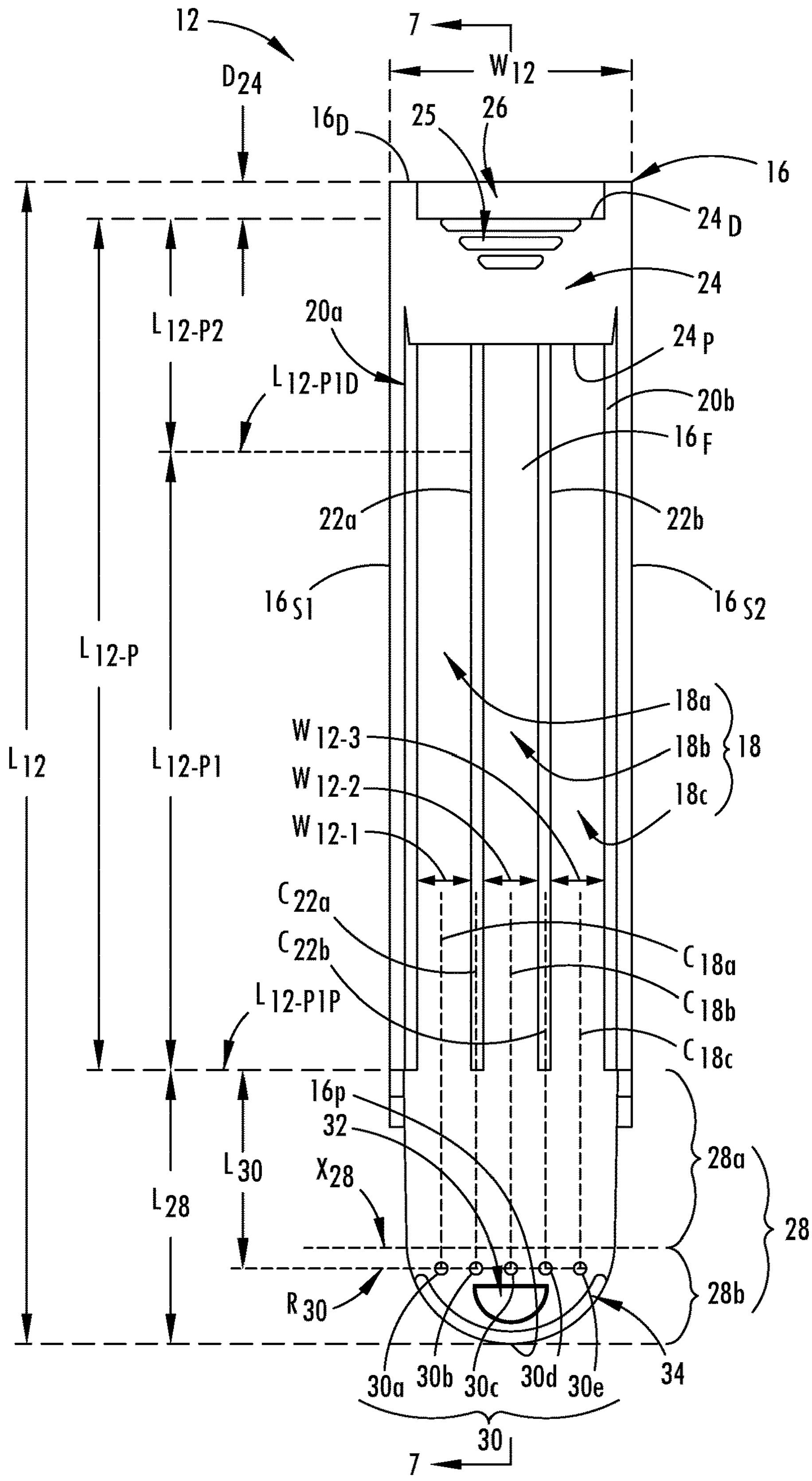
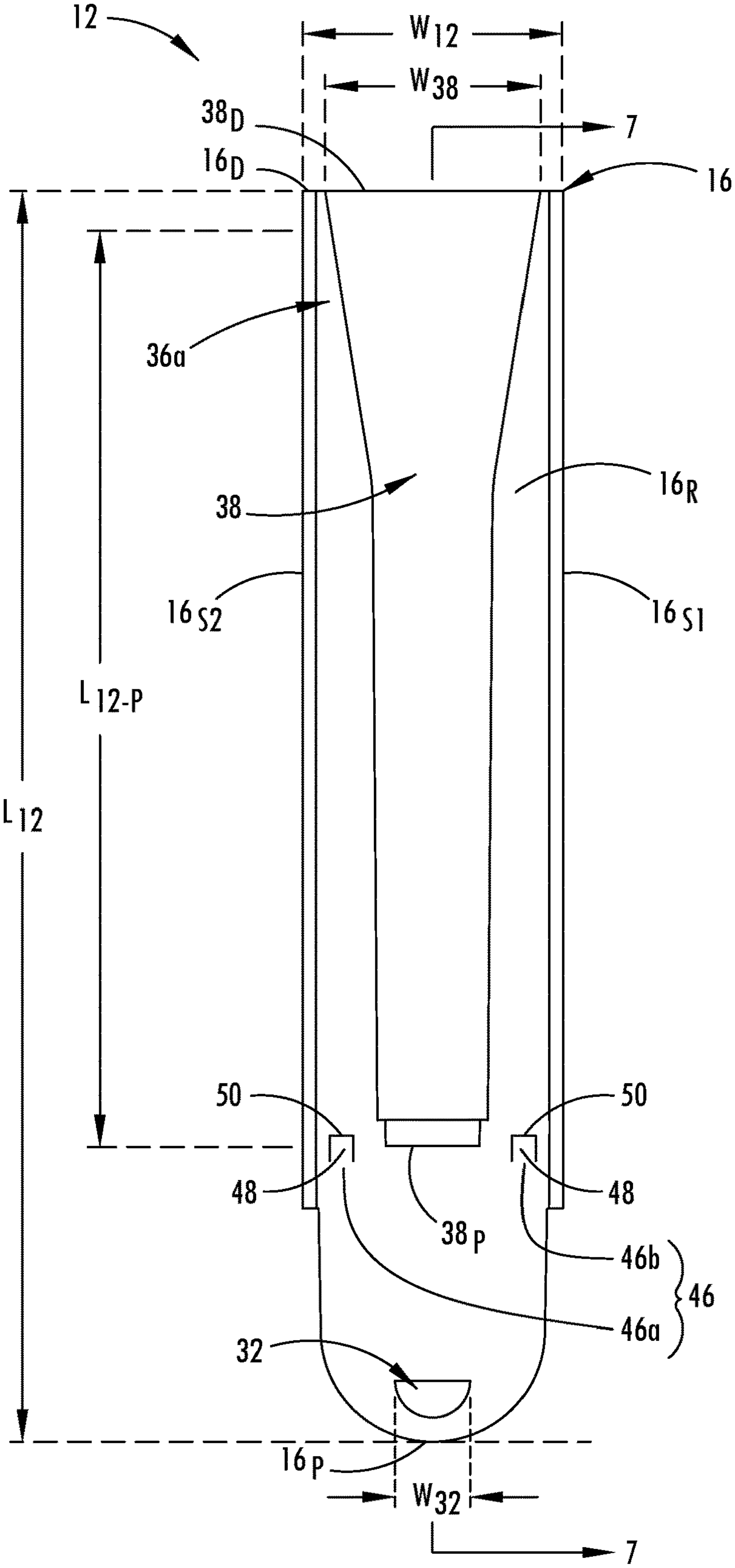
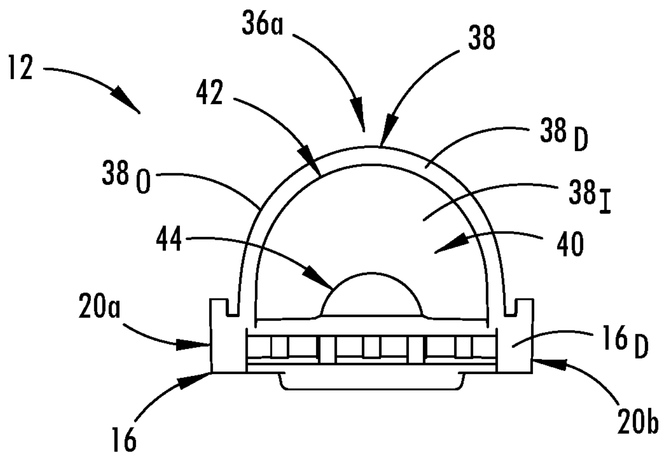

12
7
W12
D24
16D
25
26
16
24D
24
20a
24P
L12-P2
20b
L12-P1D
16F
22a
22b
16S1
16S2
L12-P
18a
W12-3
18b
18
18c
W12-2
W12-1
L12
L12-P1
C22a
C18a
C22b
C18b
L12-P1P
C18c
16p
32
28a
L30
X28
28
L28
28b
R30
34
30a
30b
30c
30d
30e
30
7

FIG. 2



12
W12
W38
38D
16D
7
16
36a
38
16R
16S2
16S1
L12-P
L12
50
50
48
48
38P
46b
46
46a
32
16P
W32
7

FIG. 3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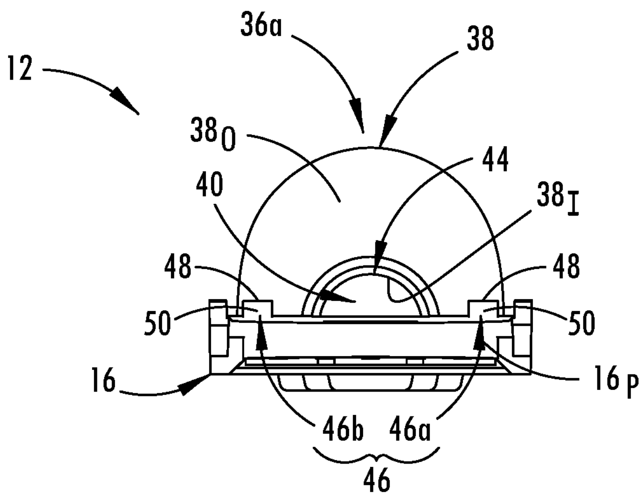
38
12
42
38 D
38 O
38 I
44
40
20a
16 D
16
20b

FIG. 4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38 O
44
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38 I
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48
50
50
16
16 P
46b
46a
46

FIG. 5

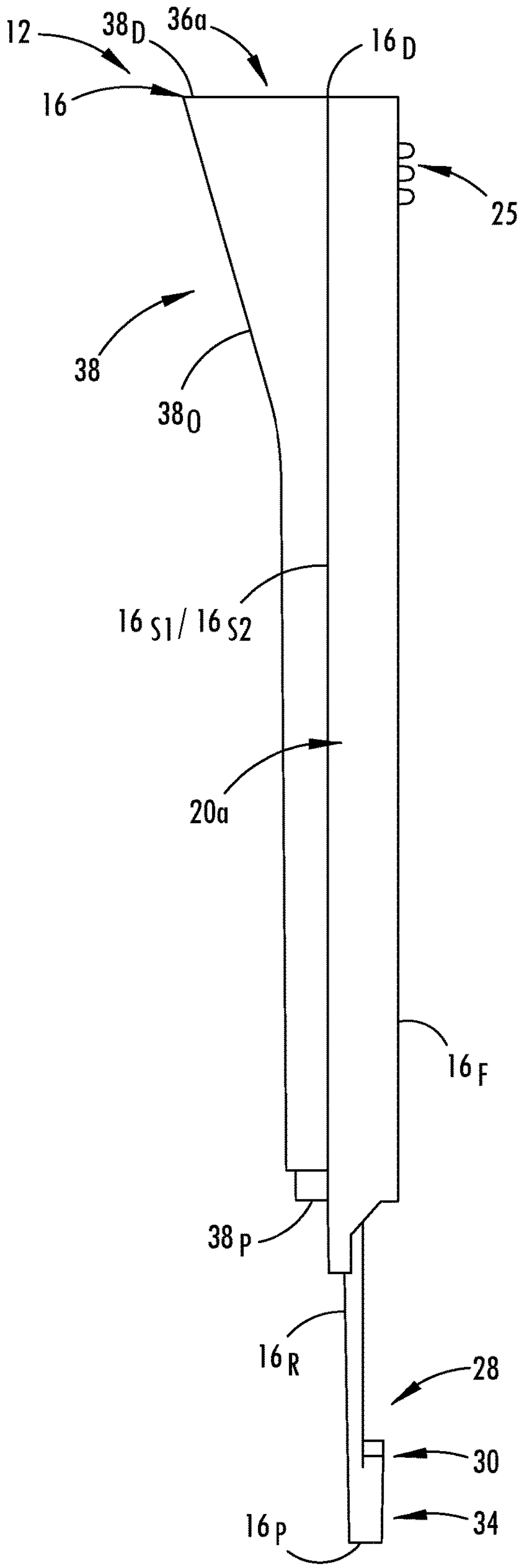

12
38D
36a
16D
16
25
38
38O
16S1/16S2
20a
16F
38P
16R
28
30
34
16P

FIG. 6

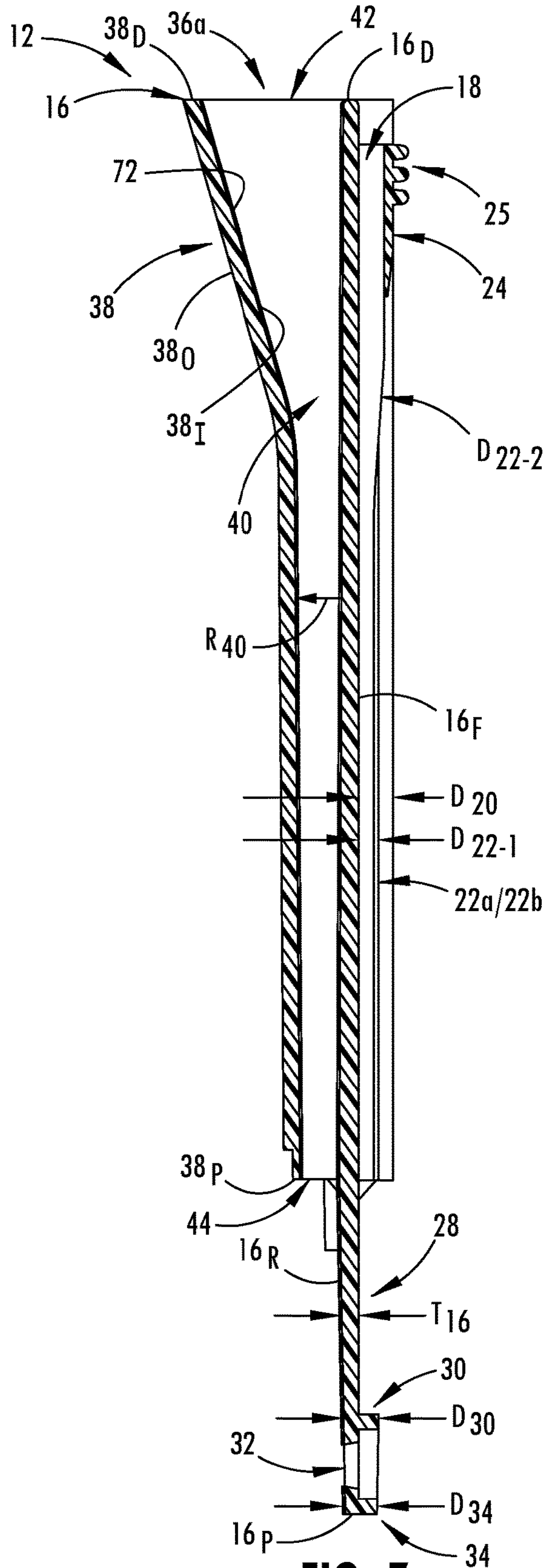

12
38D
36a
42
16D
18
16
72
25
24
38
38O
38I
40
D22-2
R40
16F
D20
D22-1
22a/22b
38P
44
16R
28
T16
30
D30
32
D34
16P
34

FIG. 7

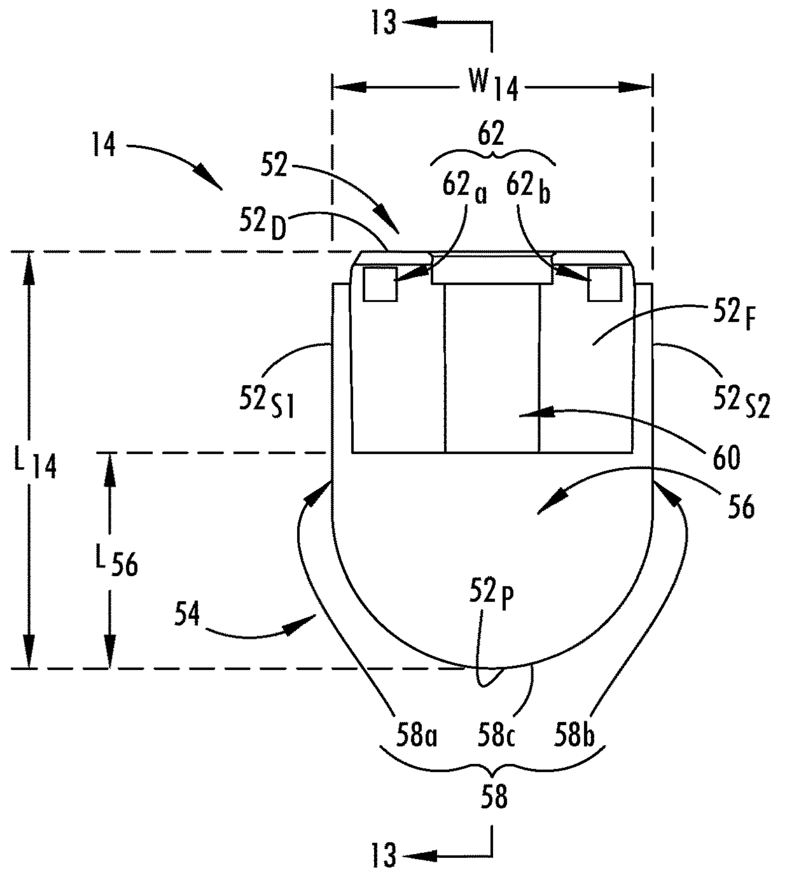

13
W14
62
62a
62b
14
52
52D
52F
52S1
52S2
60
L14
L56
56
54
52P
58a
58c
58b
58
13

FIG. 8

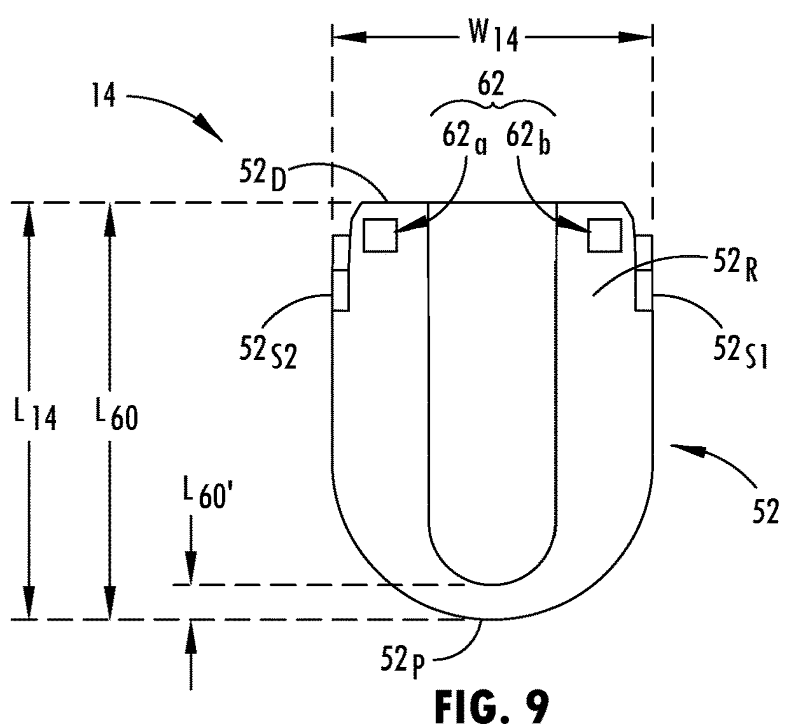

W14
62
62a
62b
14
52D
52R
52S2
52S1
L14
L60
L60'
52
52P

FIG. 9

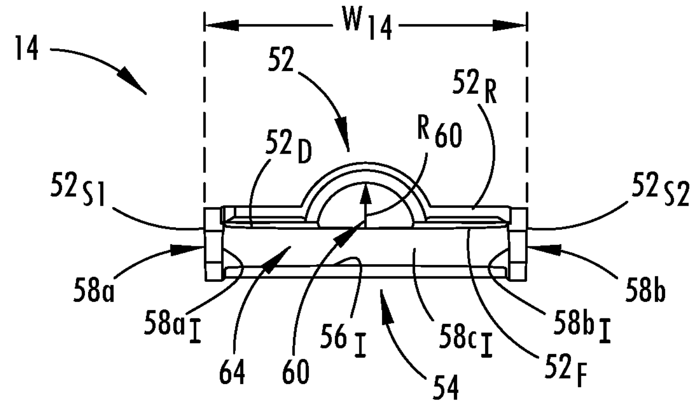

W14
14
52
52R
R60
52D
52S1
52S2
58a
58b
58aI
58bI
56I
58cI
64
60
52F
54

FIG. 10

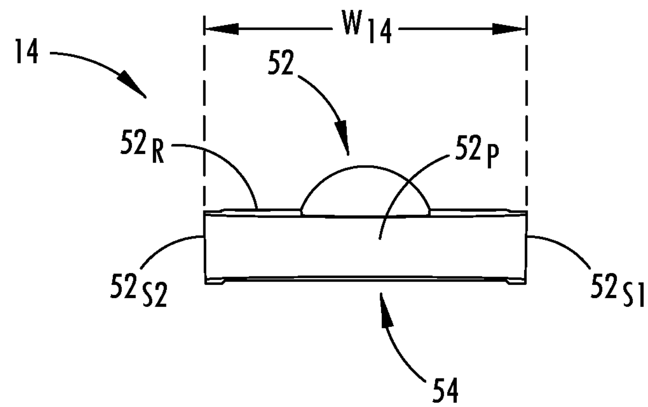
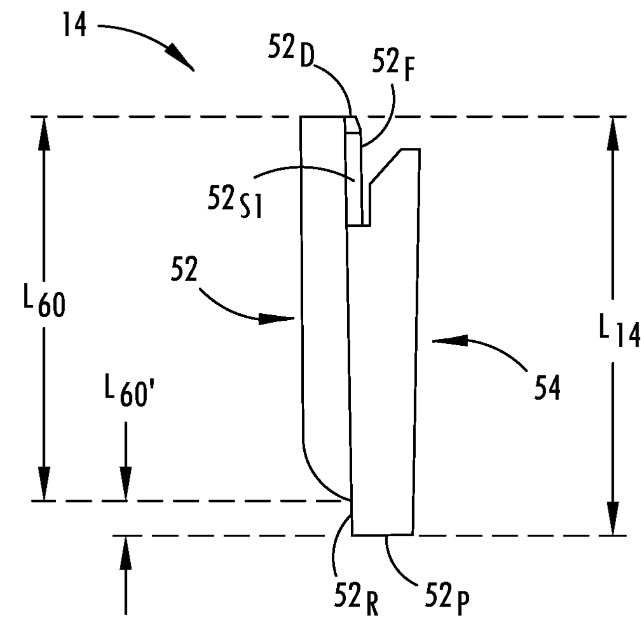
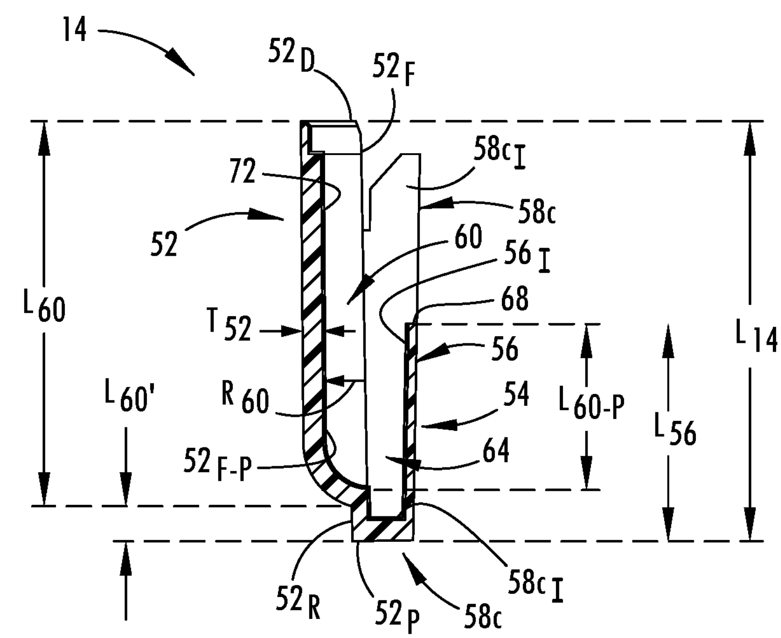

W14
14
52
52R
52P
52S2
52S1
54

FIG. 11



14
52D
52F
52S1
52
L60
L60'
L14
54
52R
52P

FIG. 12



14
52D
52F
72
58cI
58c
52
60
56I
68
T52
L60
L60'
R60
56
54
L60-P
L56
L14
52F-P
64
52R
52P
58c
58cI

FIG. 13

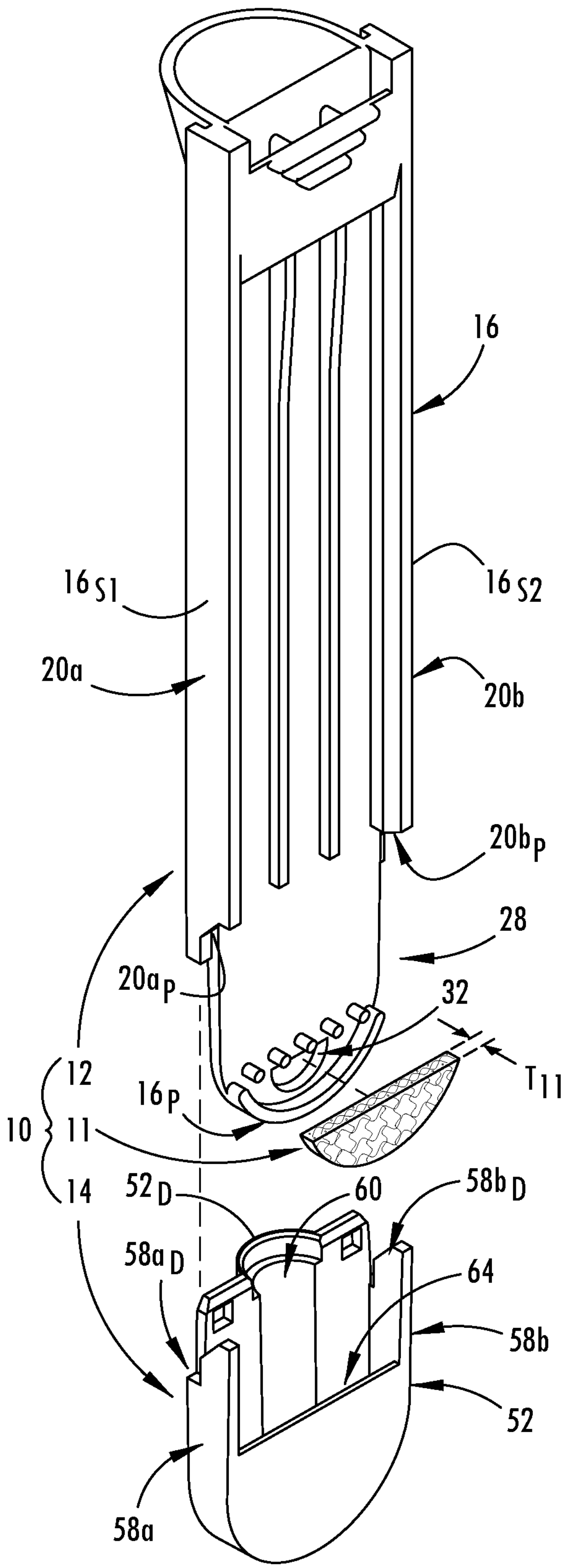


FIG. 14A

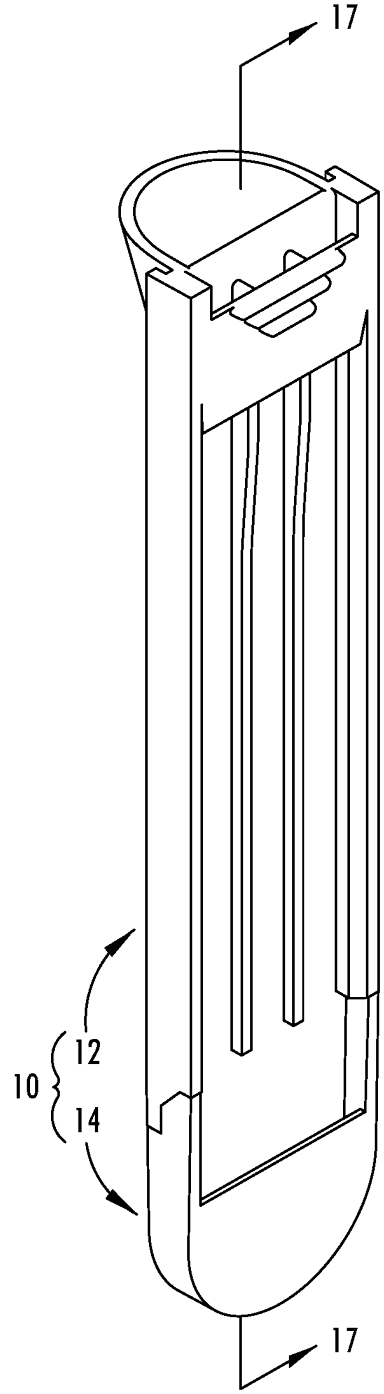


FIG. 14B

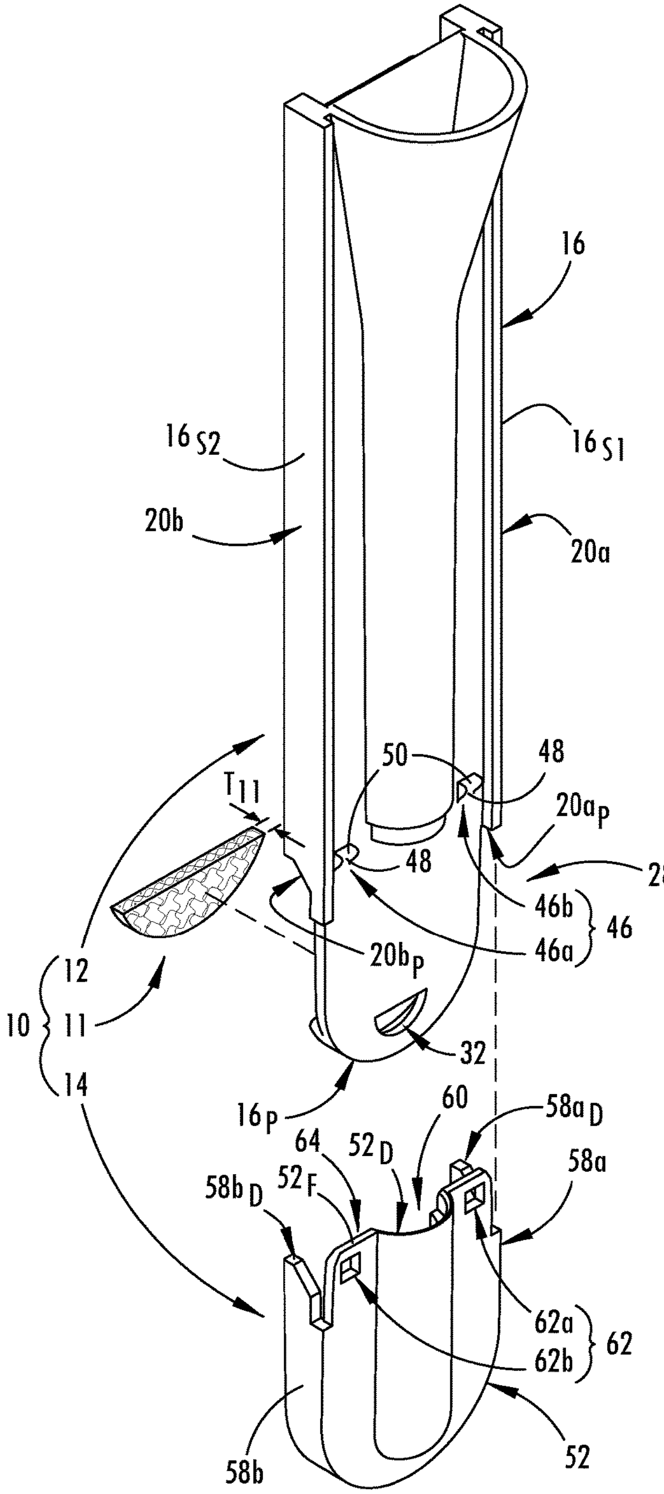


FIG. 15A

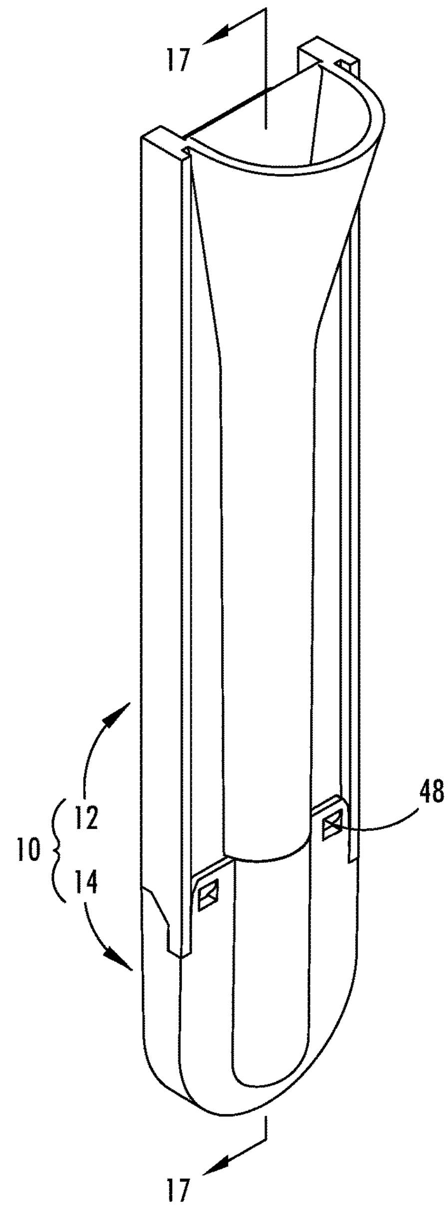


FIG. 15B

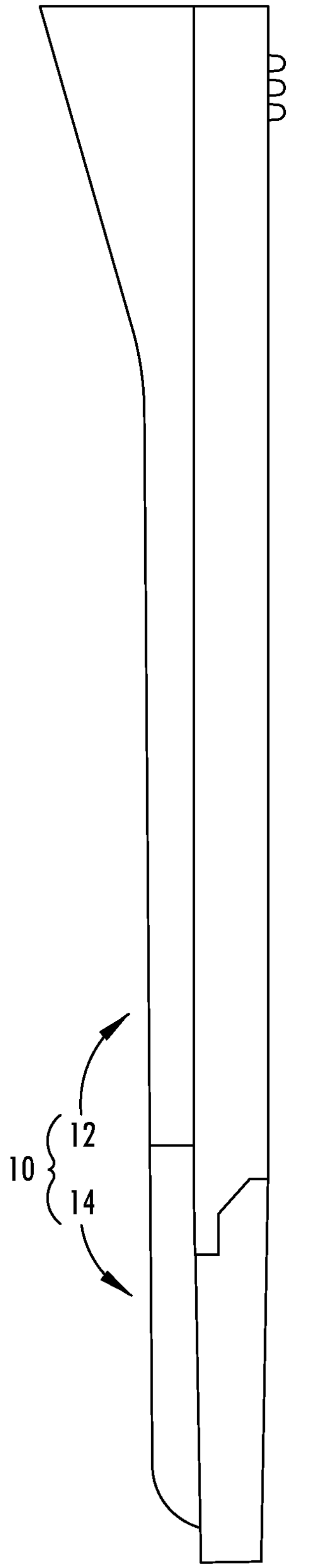


FIG. 16

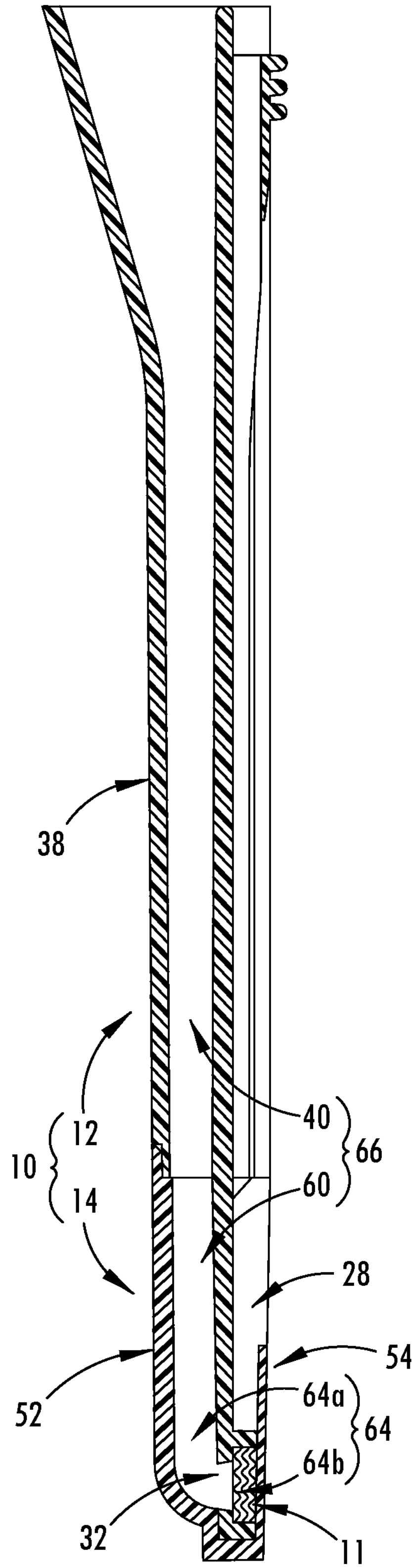
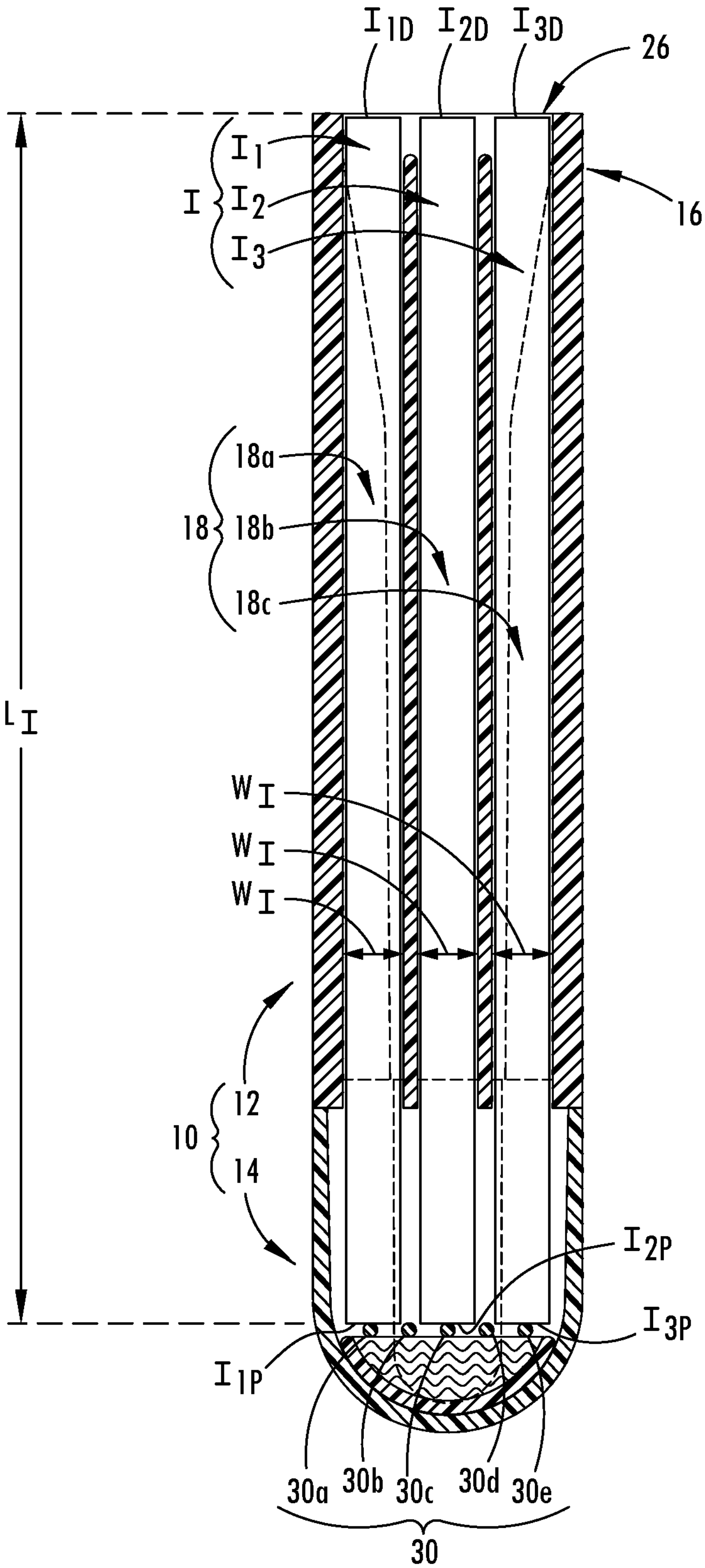


FIG. 17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I2D
I3D
26
I1
I
I2
I3
16
18a
18
18b
18c
LI
WI
WI
WI
12
10
14
I2P
I3P
I1P
30a
30b
30c
30d
30e
30

FIG. 18

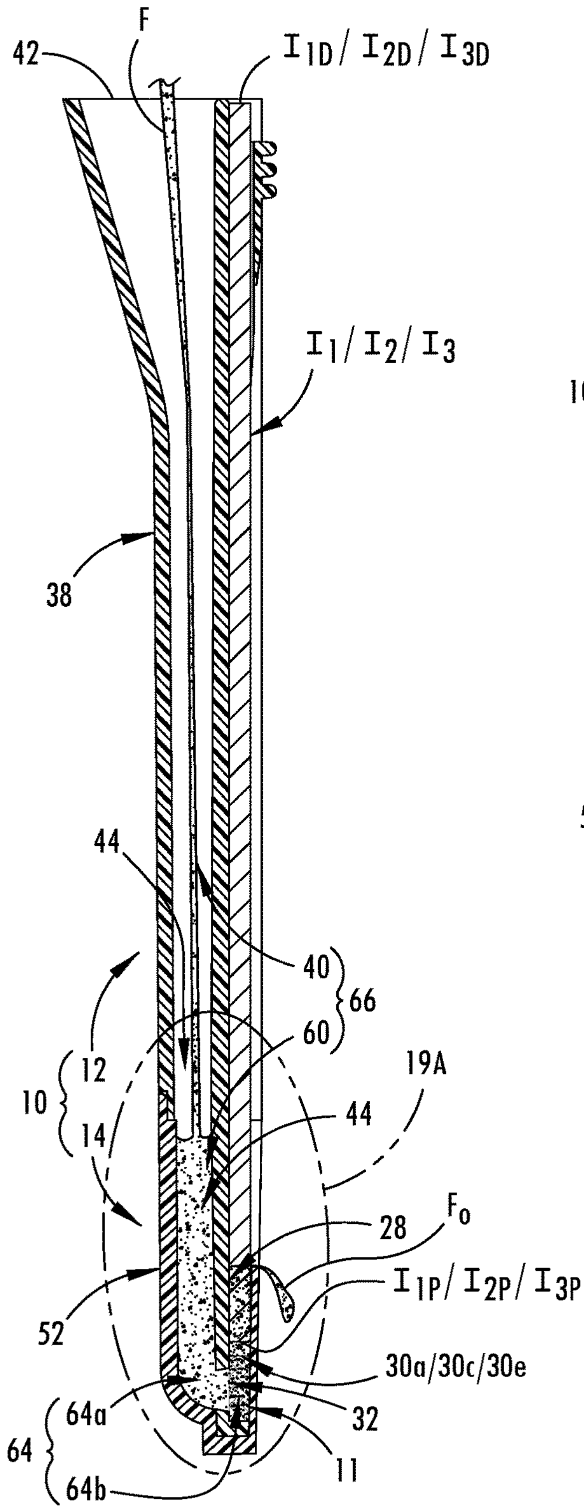


FIG. 19

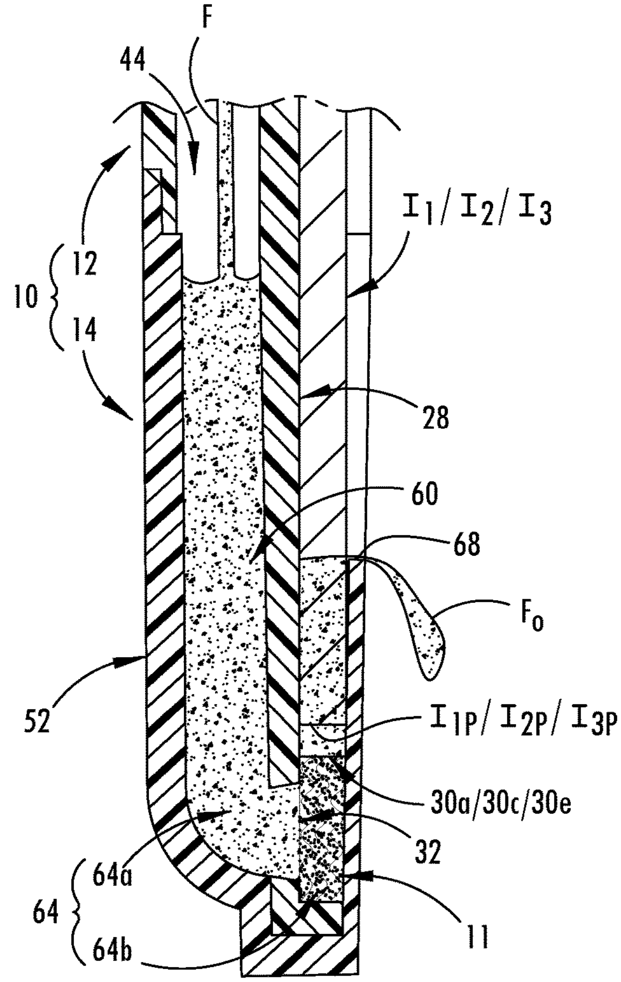


FIG. 19A

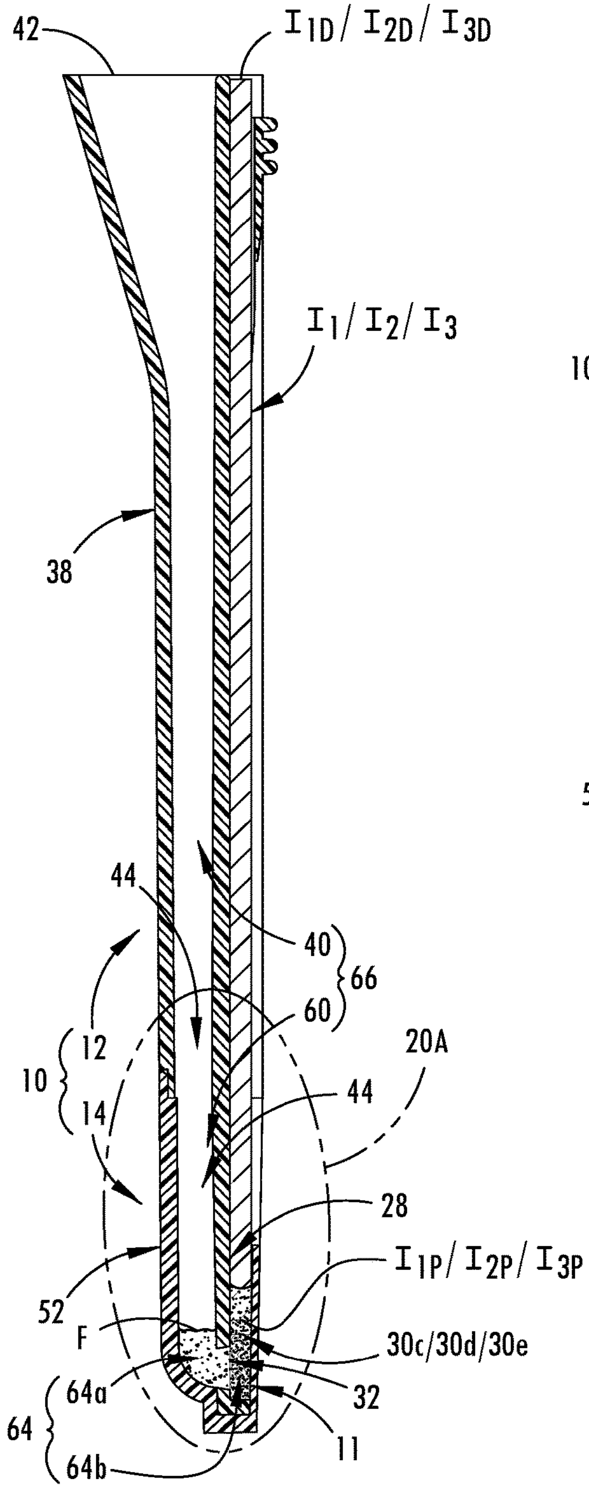


FIG. 20

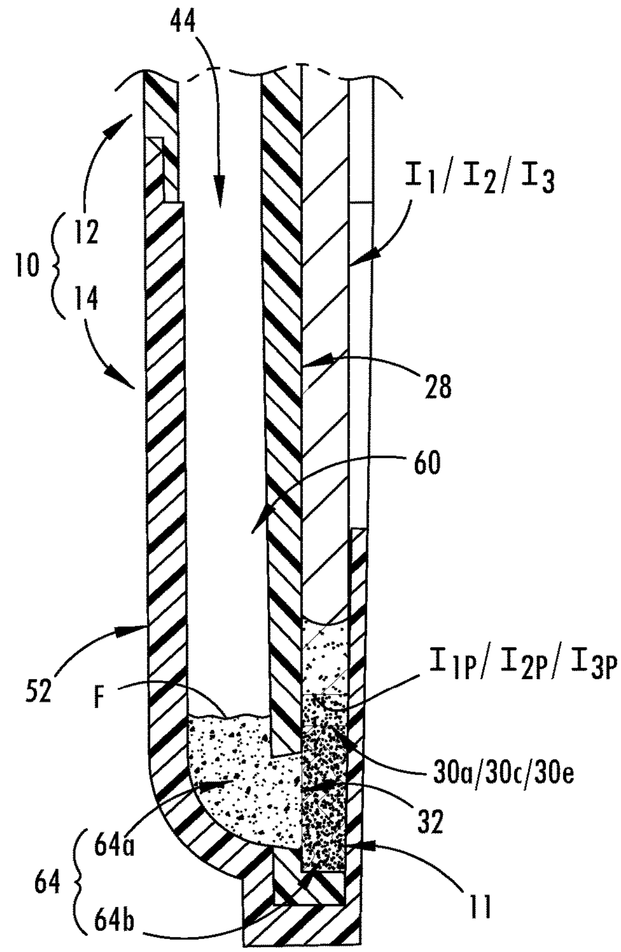


FIG. 20A

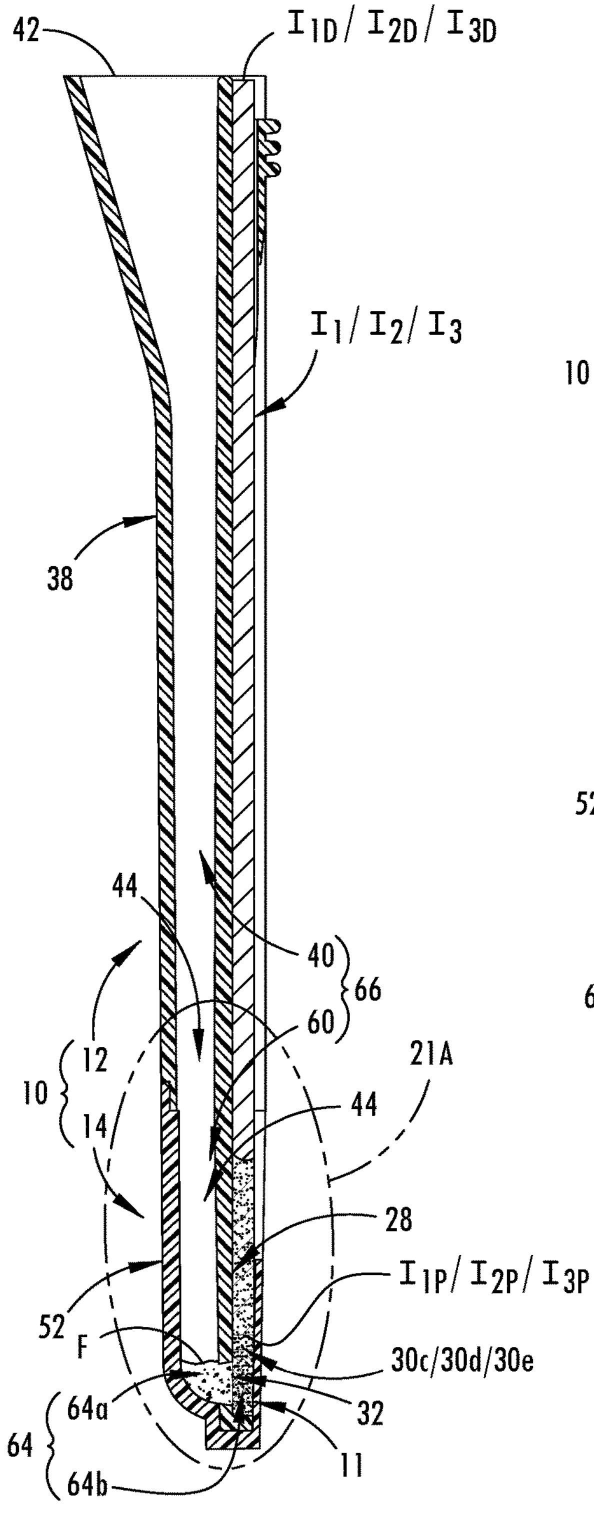


FIG. 21

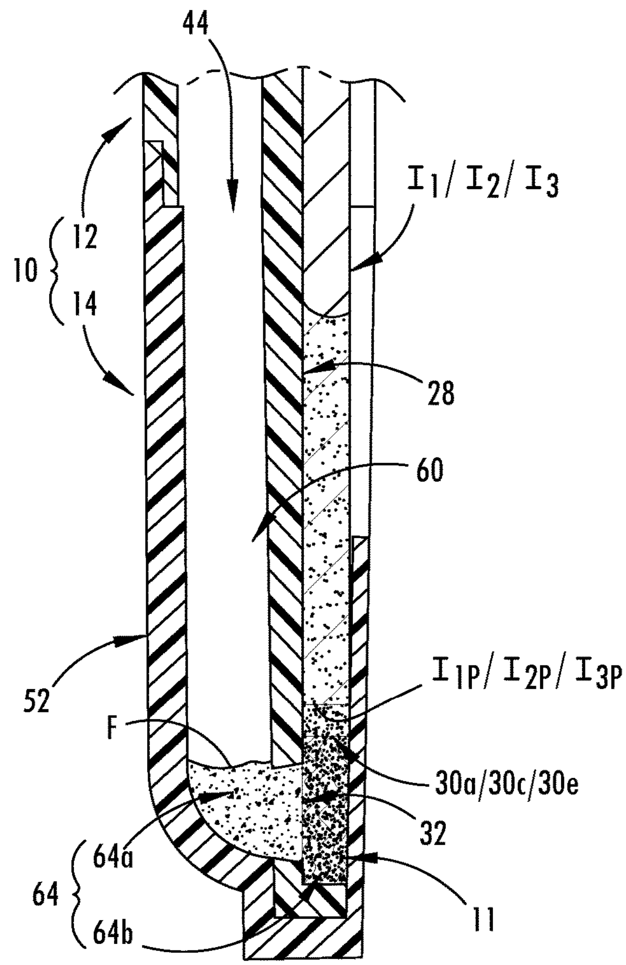


FIG. 21A

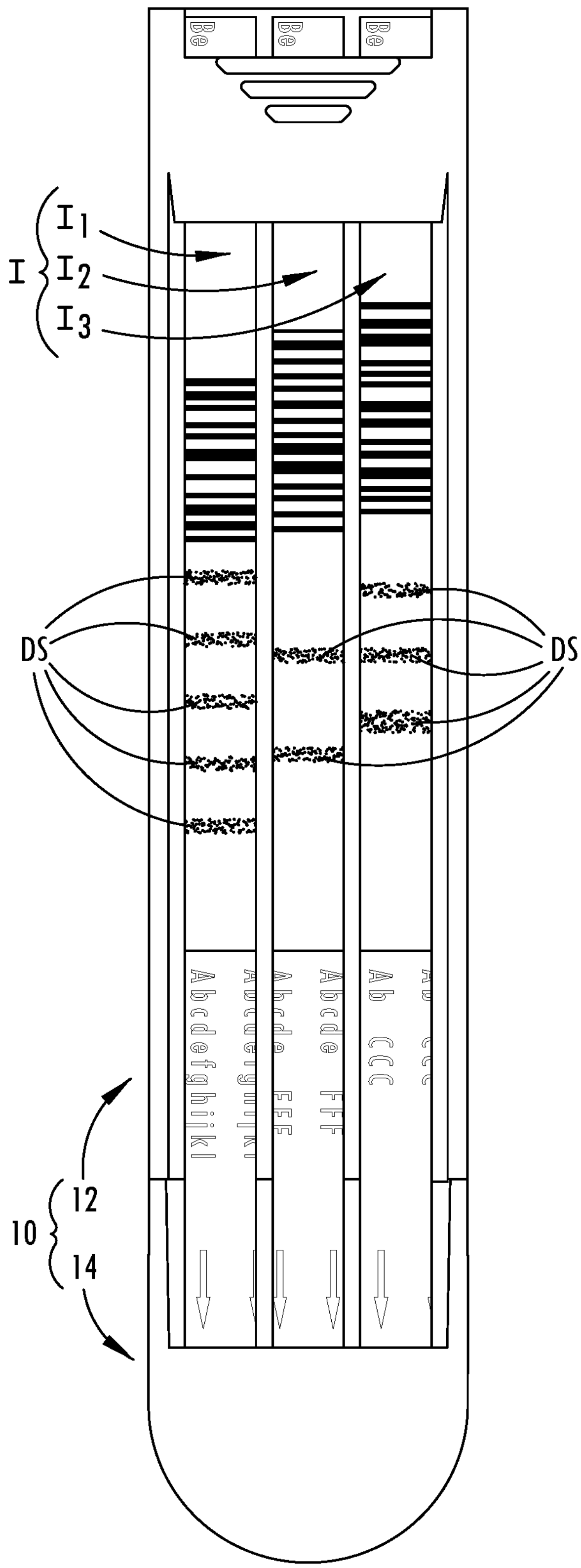


FIG. 22

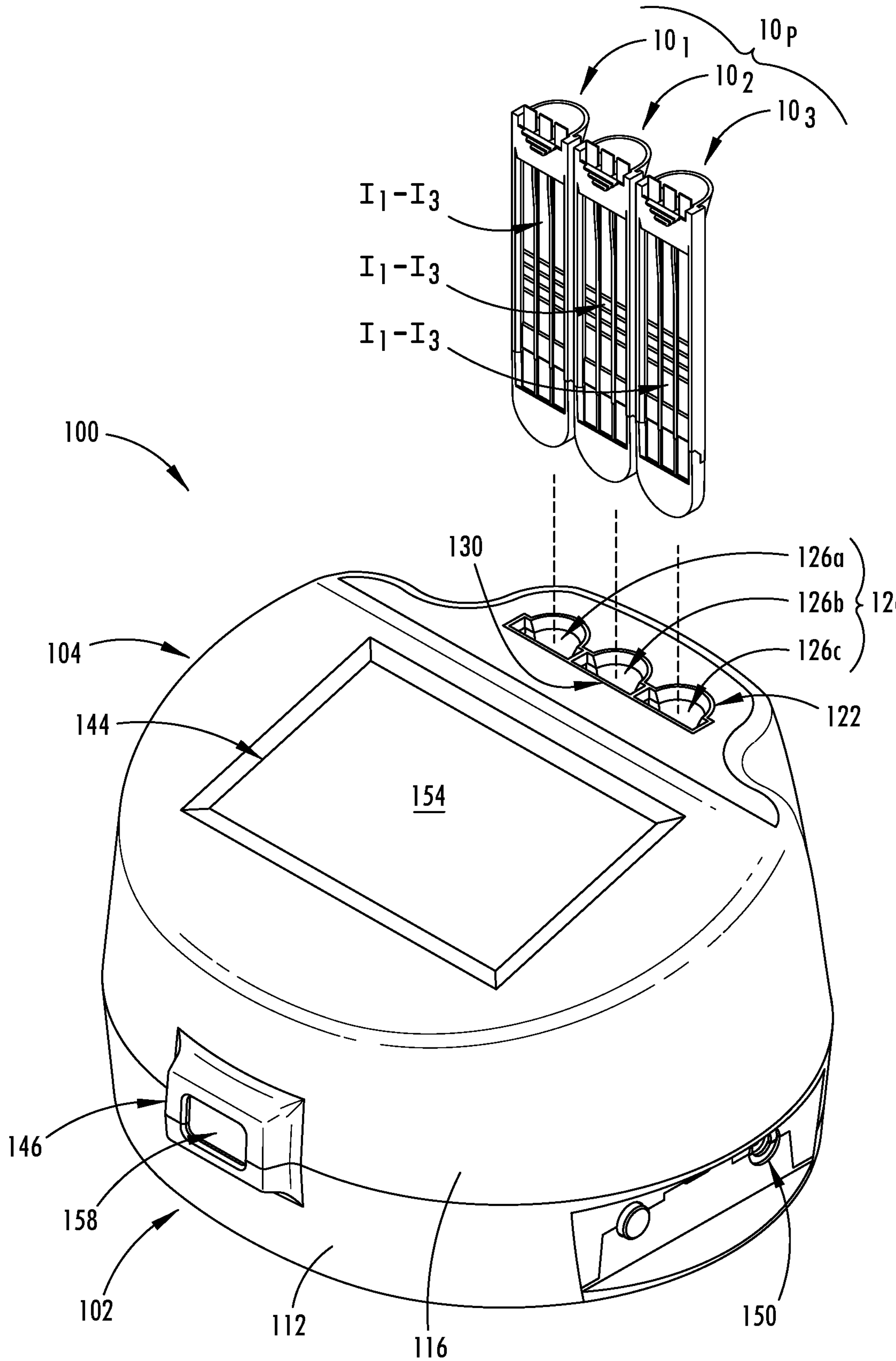

10p
10 1
10 2
10 3
I1-I3
I1-I3
I1-I3
100
130
126a
126b
126
126c
104
122
144
154
146
158
102
112
116
150

FIG. 23

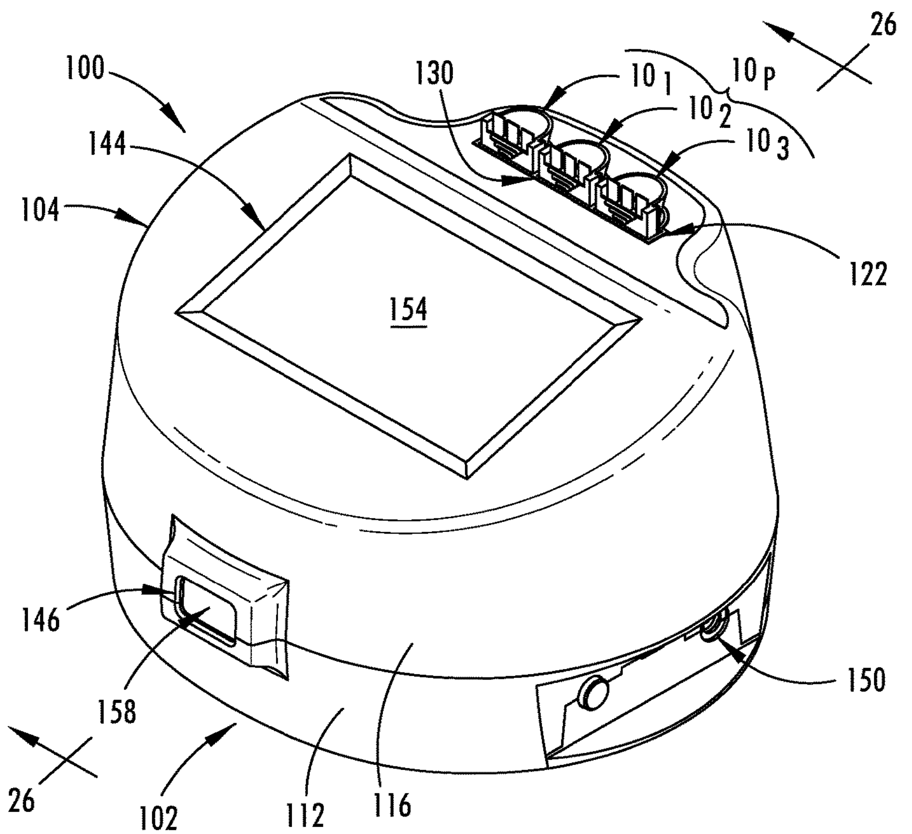


FIG. 24A

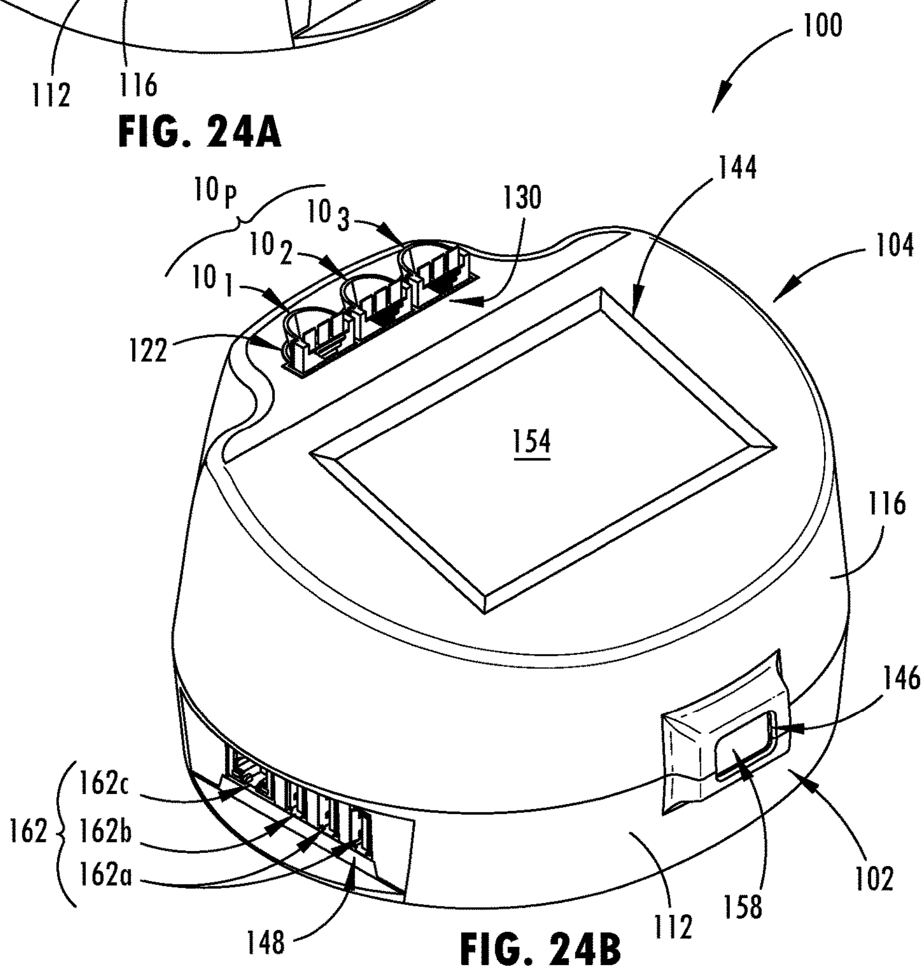


FIG. 24B

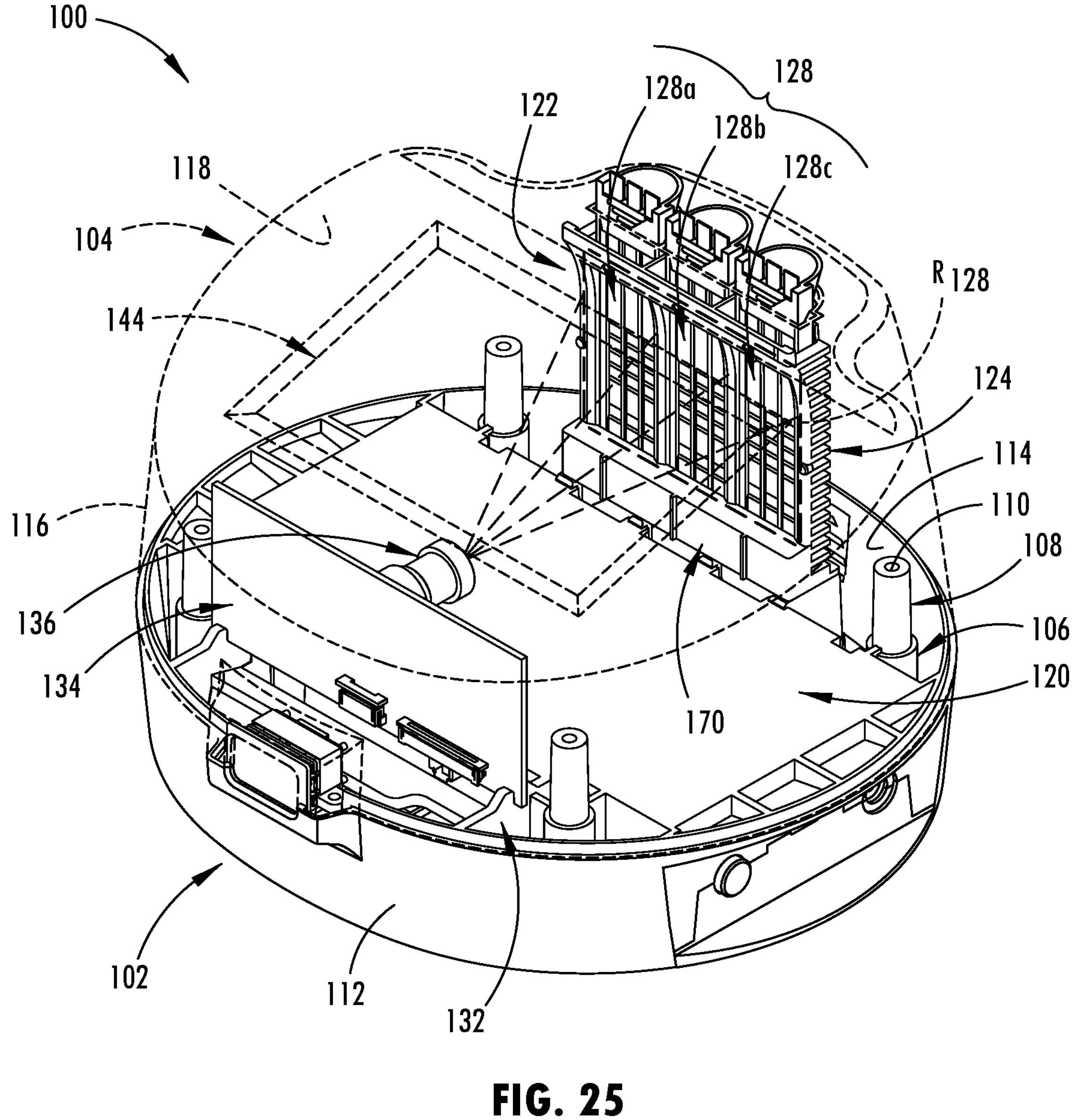

100
128
128a
122
128b
118
128c
104
R 128
144
124
114
110
116
108
136
106
134
120
170
102
112
132

FIG. 25

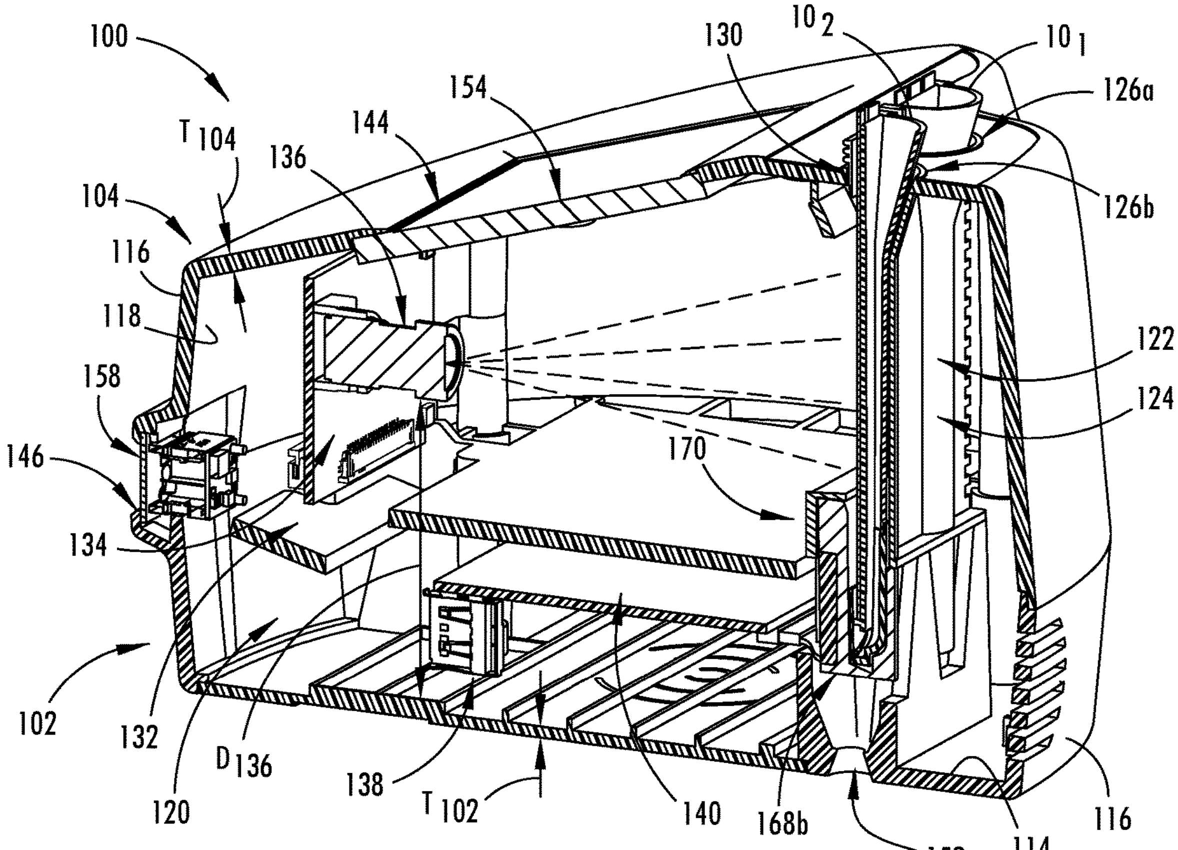

100
130
10 2
10 1
126a
154
144
T 104
136
126b
104
116
118
122
158
124
146
170
134
102
132
D 136
120
138
T 102
140
168b
152
114
116

FIG. 26

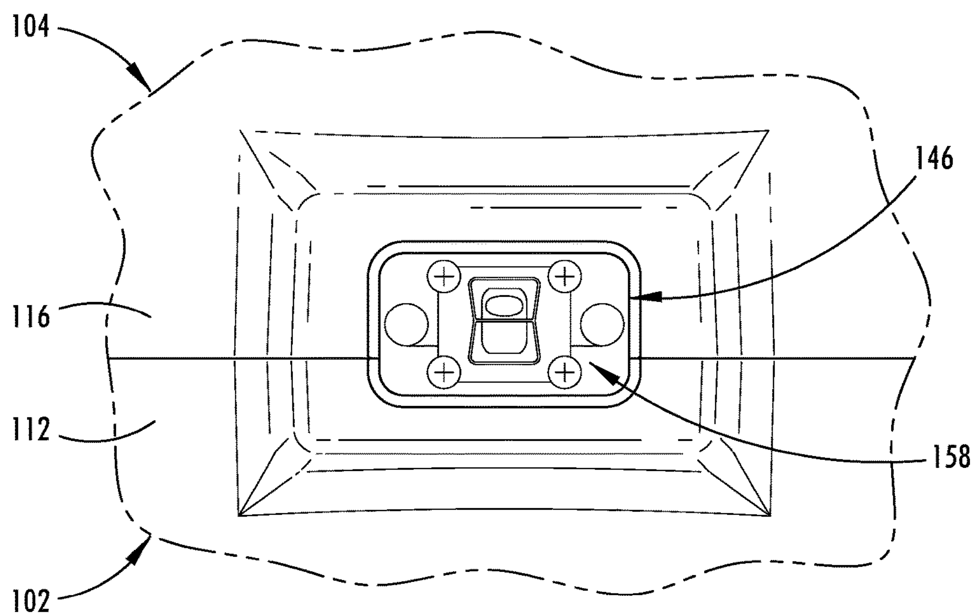

104
146
116
112
158
102

FIG. 27

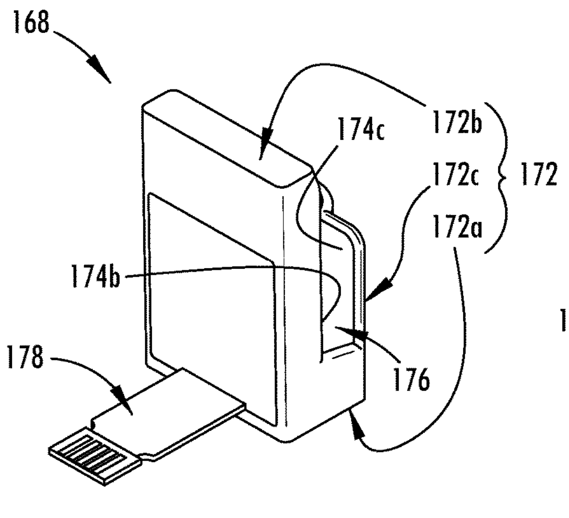


FIG. 28

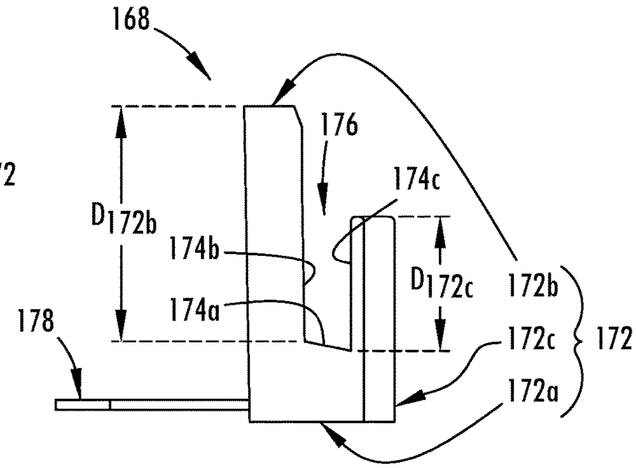


FIG. 29

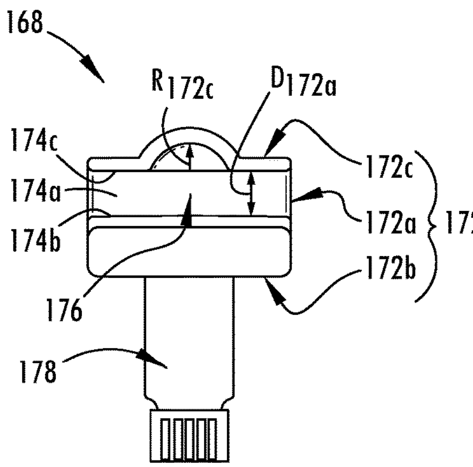


FIG. 30

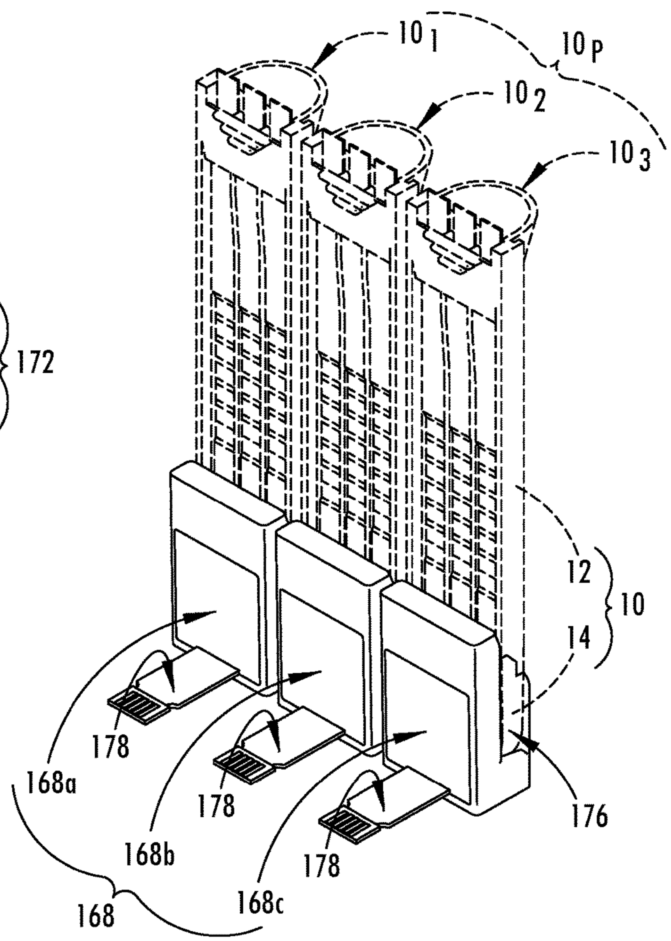
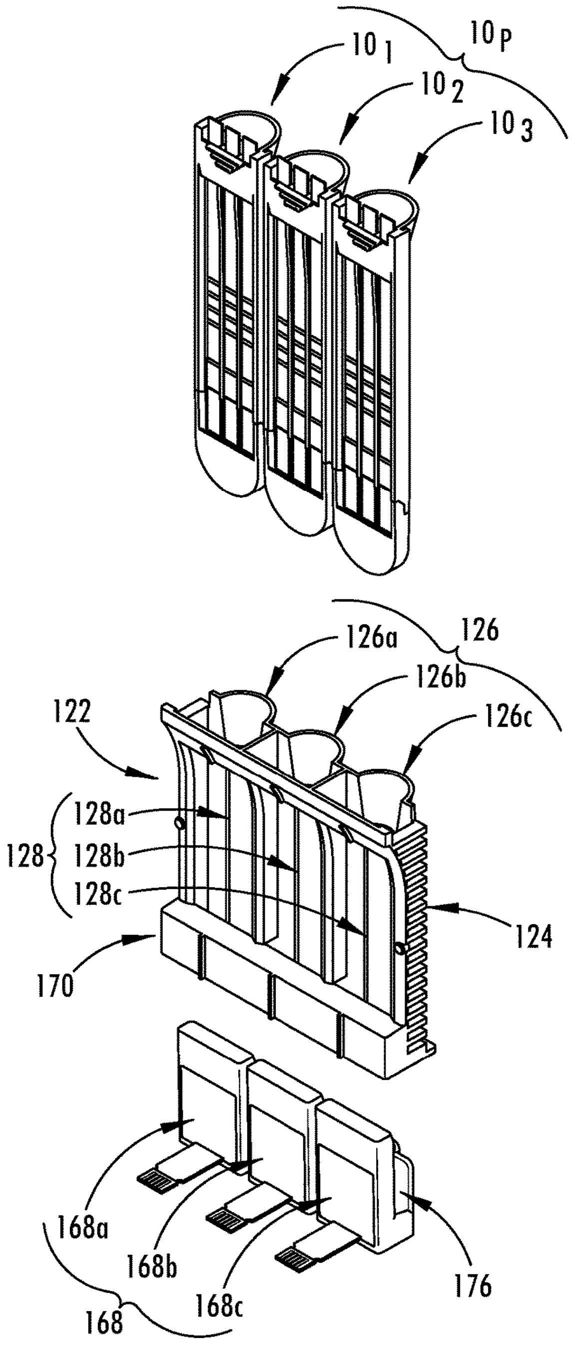
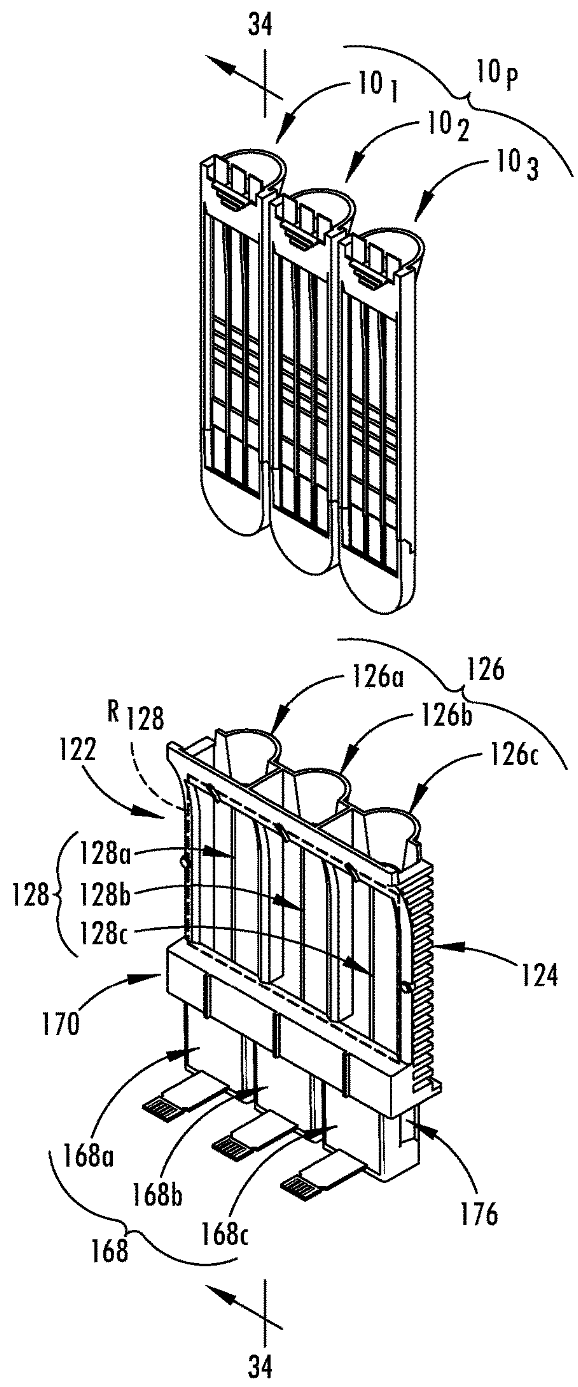


FIG. 31



10_1
10_P
10_2
10_3
126a
126
126b
122
126c
128a
128
128b
128c
124
170
168a
168b
176
168c
168

FIG. 32



34
10_1
10_P
10_2
10_3
126a
126
R 128
126b
122
126c
128a
128
128b
128c
124
170
168a
168b
176
168c
168
34

FIG. 33

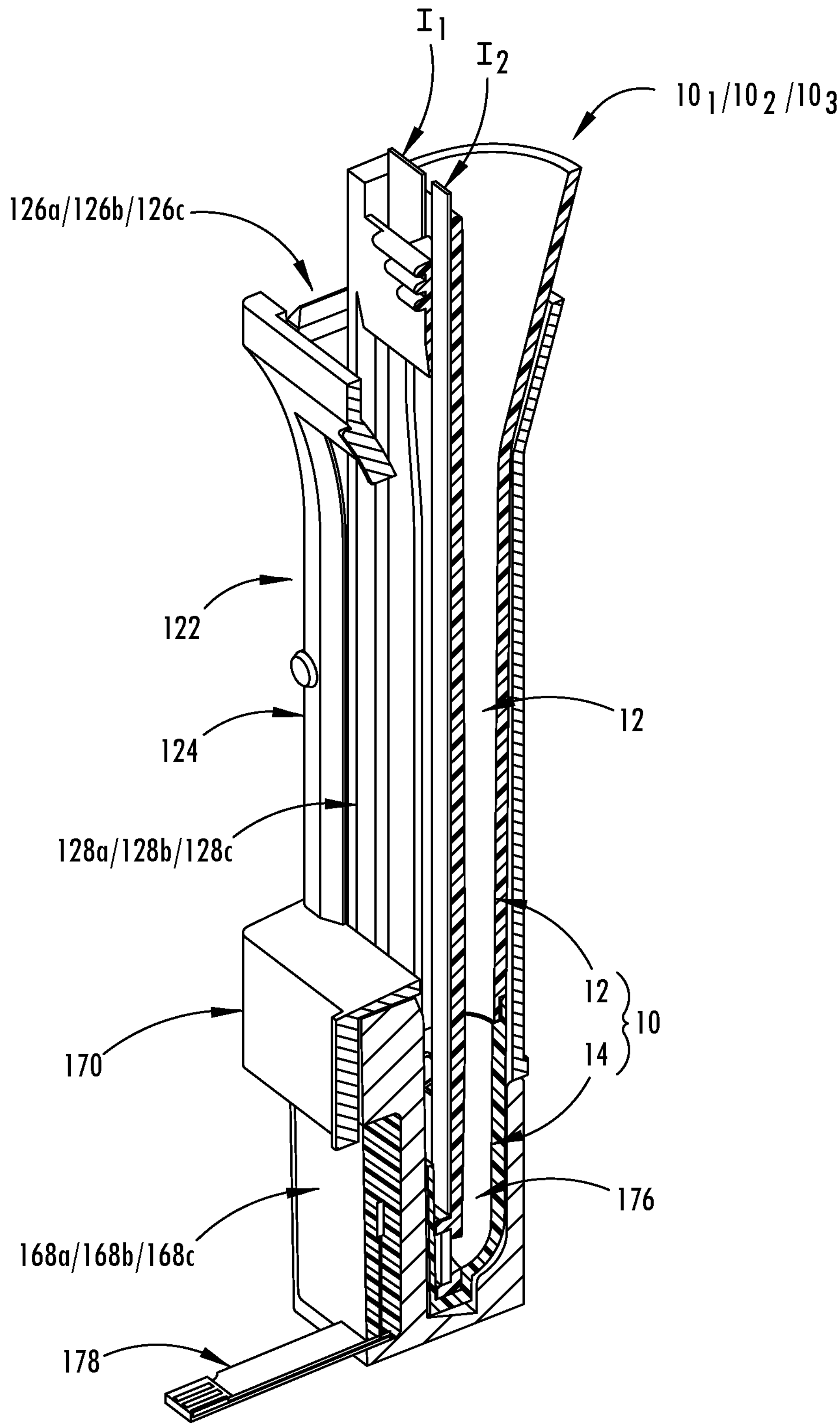

I1
I2
10 1/10 2 /10 3
126a/126b/126c
122
124
128a/128b/128c
12
12
10
14
14
170
176
168a/168b/168c
178

FIG. 34

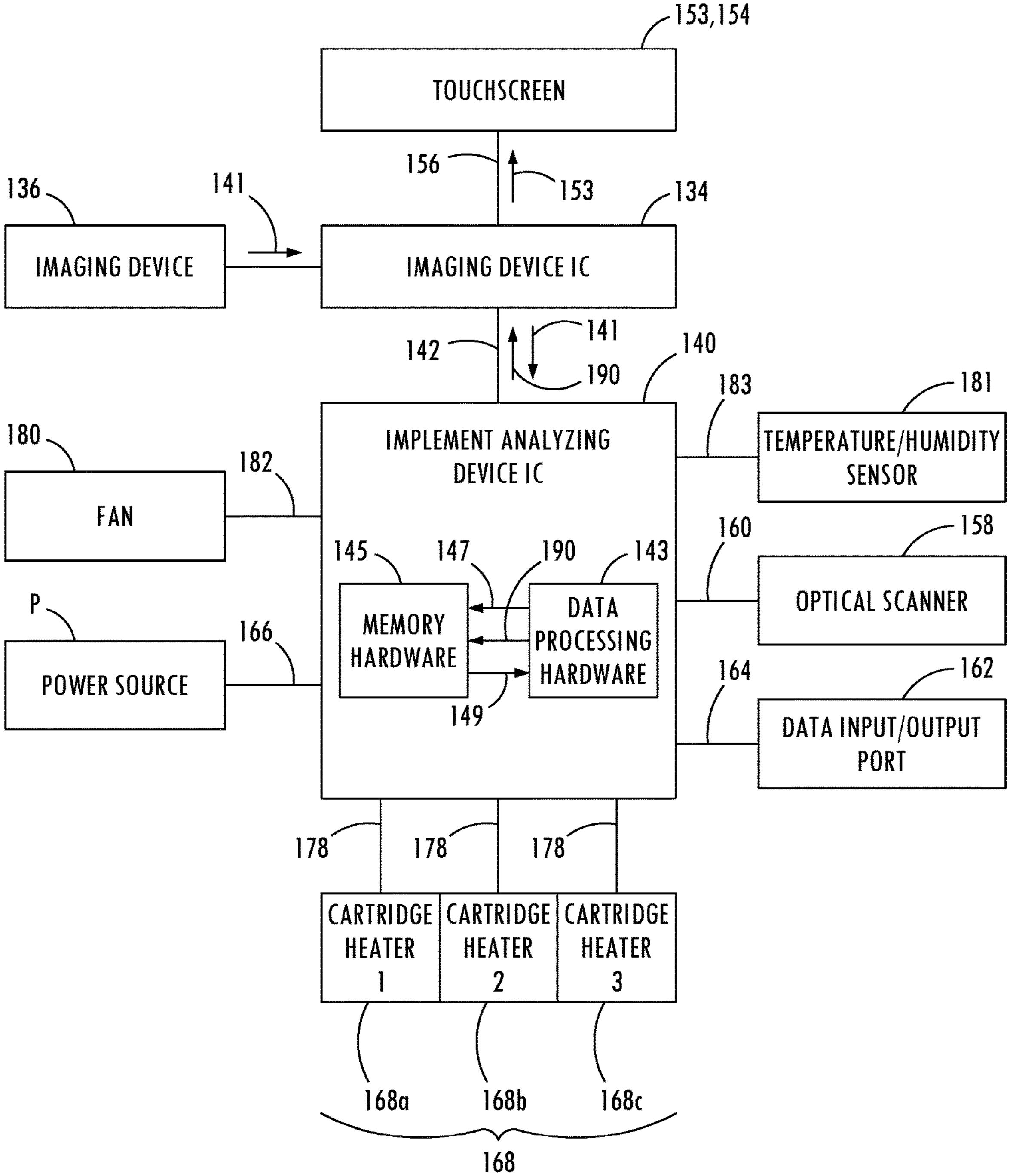

153,154
TOUCHSCREEN
156
153
134
136
141
IMAGING DEVICE
IMAGING DEVICE IC
142
141
190
140
183
181
180
IMPLEMENT ANALYZING DEVICE IC
TEMPERATURE/HUMIDITY SENSOR
182
FAN
145
147
190
143
160
158
MEMORY HARDWARE
DATA PROCESSING HARDWARE
OPTICAL SCANNER
P
POWER SOURCE
166
149
164
162
DATA INPUT/OUTPUT PORT
178
178
178
CARTRIDGE HEATER 1
CARTRIDGE HEATER 2
CARTRIDGE HEATER 3
168a
168b
168c
168

FIG. 35

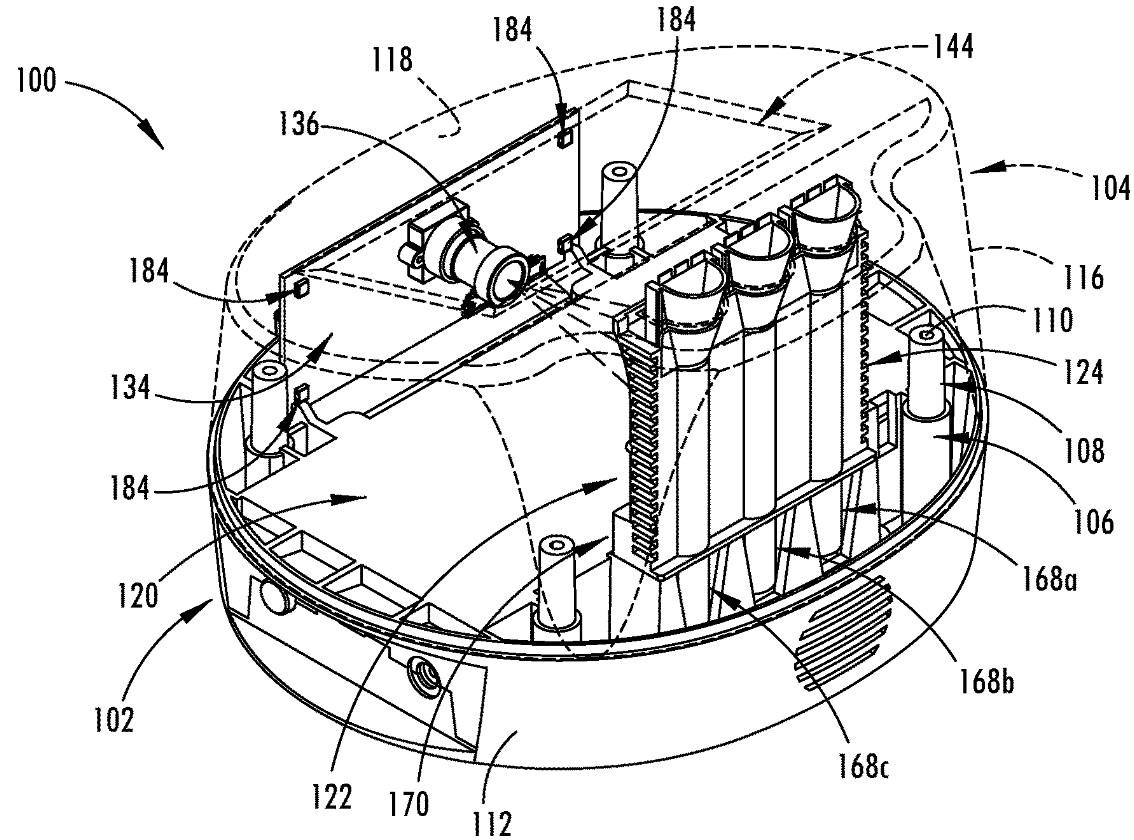


FIG. 36

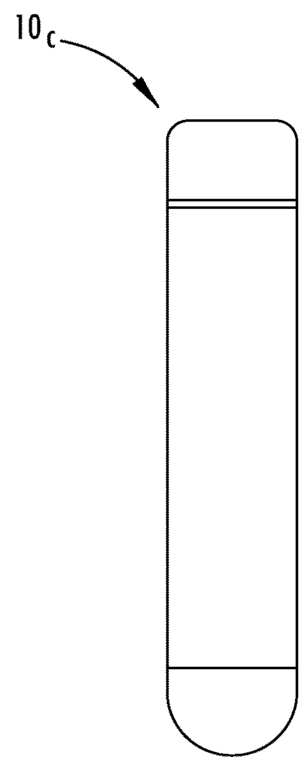


FIG. 37

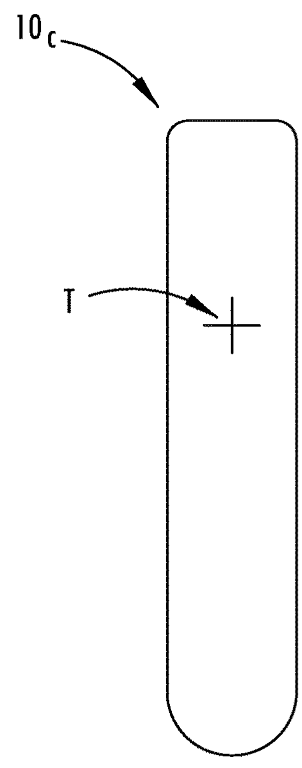


FIG. 38

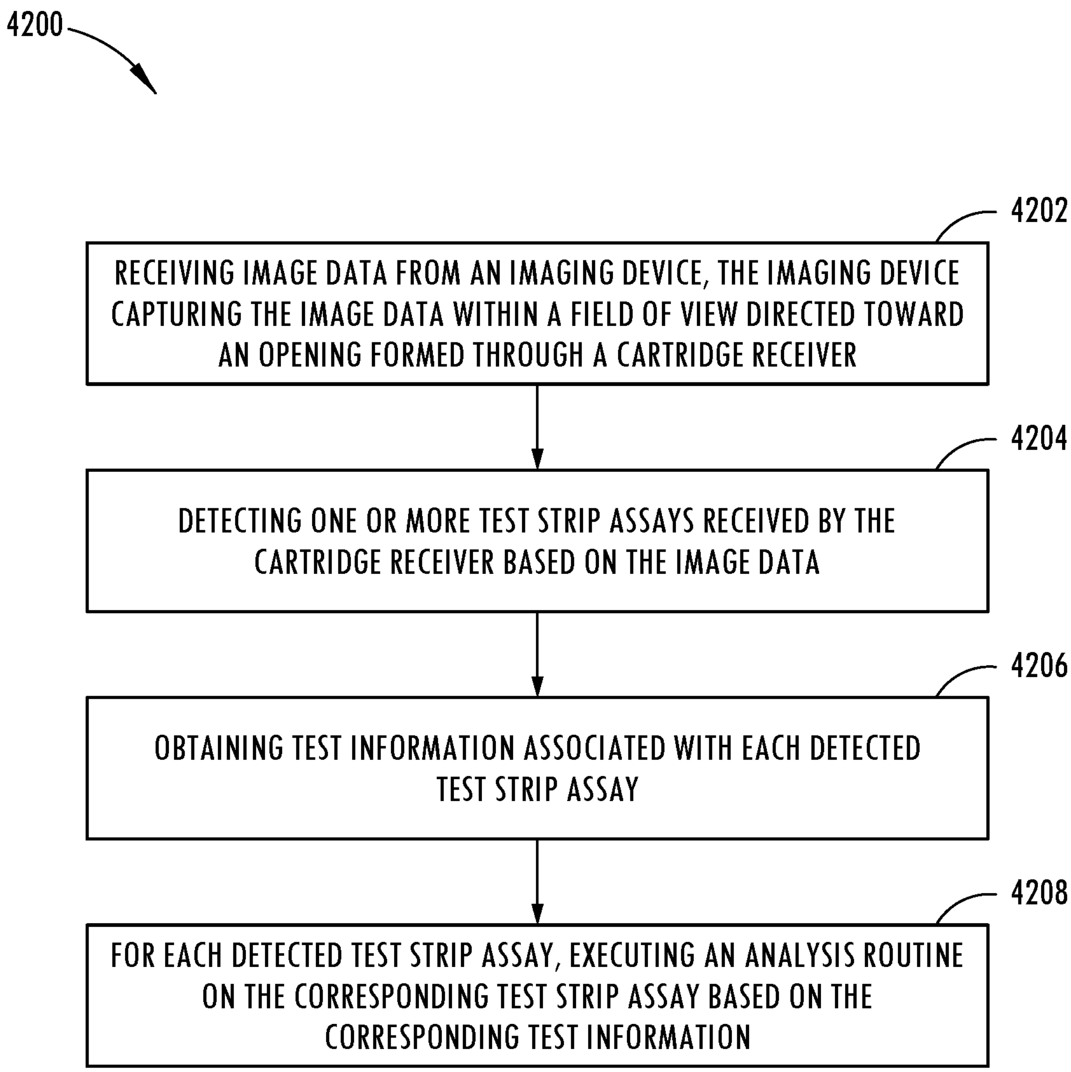

4200
4202
RECEIVING IMAGE DATA FROM AN IMAGING DEVICE, THE IMAGING DEVICE CAPTURING THE IMAGE DATA WITHIN A FIELD OF VIEW DIRECTED TOWARD AN OPENING FORMED THROUGH A CARTRIDGE RECEIVER
4204
DETECTING ONE OR MORE TEST STRIP ASSAYS RECEIVED BY THE CARTRIDGE RECEIVER BASED ON THE IMAGE DATA
4206
OBTAINING TEST INFORMATION ASSOCIATED WITH EACH DETECTED TEST STRIP ASSAY
4208
FOR EACH DETECTED TEST STRIP ASSAY, EXECUTING AN ANALYSIS ROUTINE ON THE CORRESPONDING TEST STRIP ASSAY BASED ON THE CORRESPONDING TEST INFORMATION

FIG. 39

IMPLEMENT ANALYZING DEVICE AND METHOD FOR UTILIZING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This U.S. patent application claims priority to U.S. Provisional Application 62/439,568 filed on Dec. 28, 2016, the disclosure of which is considered part of the disclosure of this application and is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

This disclosure relates to devices and methods for assaying test samples.

BACKGROUND

Implement analyzing device are known. While existing implement analyzing devices perform adequately for their intended purpose, improvements to implement analyzing devices are continuously being sought in order to advance the arts.

SUMMARY

This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

One aspect of the disclosure provides an implement analyzing device that is sized for receiving more than one fluid retainer cartridge assembly. The implement analyzing device includes a support member, a housing, a cartridge receiver, at least one cartridge heater, an imaging device and an implement analyzing device integrated circuit. The housing is connected to the support member. Each of the support member and the housing defines an outer surface and an inner surface. The inner surface of each of the support member and the housing form a cavity. The cartridge receiver is disposed within the cavity and connected to the inner surface of one or both of the support member and the housing. The cartridge receiver defines at least one cartridge viewing window. The at least one cartridge heater is disposed within the cavity and connected to the cartridge receiver. The imaging device is disposed within the cavity and arranged opposite the at least one cartridge viewing window. The implement analyzing device integrated circuit communicatively coupled to the at least one cartridge heater and the imaging device. The implement analyzing device integrated circuit includes data processing hardware that executes instructions stored on memory hardware for operating the at least one cartridge heater and the imaging device.

Implementations of the disclosure may include one or more of the following optional features. For example, the cartridge receiver includes a body defining at least one first opening and at least one second opening. The at least one first opening formed by the body of the cartridge receiver is aligned with a cartridge receiver passage extending through the housing.

In some examples, the at least one cartridge heater is defined by a body that includes: a base portion; a front portion; and a rear portion. Each of the base portion, the front portion and the rear portion is defined by a cartridge supporting surface. The cartridge supporting surface of each of the base portion and the front portion are defined by a

substantially flat surface. The cartridge supporting surface of the rear portion includes a substantially flat surface that is interrupted by a curved or arcuate surface portion.

In some instances, the at least one first opening is defined by: a first cartridge receiving opening; a second cartridge receiving opening; and a third cartridge receiving opening.

In some implementations, the at least one cartridge heater may include: a first cartridge heater; a second cartridge heater; and a third cartridge heater. The first cartridge heater corresponds to, is located opposite and axially aligned with the first cartridge receiving opening of the at least one first opening. The second cartridge heater corresponds to, is located opposite and axially aligned with the second cartridge receiving opening of the at least one first opening. The third cartridge heater corresponds to, is located opposite and axially aligned with the third cartridge receiving opening of the at least one first opening.

In some examples, each of the first cartridge heater, the second cartridge heater and the third cartridge heater are connected to the implement analyzing device integrated circuit. The implement analyzing device integrated circuit selectively activates each of the first cartridge heater, the second cartridge heater and the third cartridge heater.

In some implementations, the front portion and the rear portion of the body are not connected by side portions.

In some configurations, the implement analyzing device further includes: a fan or a temperature sensor. The fan may be located within the cavity and is connected to the implement analyzing device integrated circuit. The temperature sensor is located within the cavity and is connected to the implement analyzing device integrated circuit.

In other configurations, the implement analyzing device further includes: an imaging device integrated circuit connected to the imaging device. The imaging device integrated circuit is communicatively-coupled to the implement analyzing device integrated circuit.

In yet other configurations, the implement analyzing device further includes: a plurality of light sources arranged within the cavity and connected to the imaging device integrated circuit. The plurality of light sources are directed toward the at least one cartridge viewing window.

In some examples, the imaging device integrated circuit independently operates each light source of the plurality of light sources. In other examples, the plurality of light sources are light emitting diode light sources.

In some instances, the imaging device is aligned with a region of the at least one cartridge viewing window.

In some implementations, the imaging device is a complementary metal oxide semiconductor (CMOS) sensor.

In some examples, one or both of the support member and the housing define a plurality of passages extending through the support member or the housing. The plurality of passages may include a user interface passage that is sized for permitting access to a user interface. The user interface is communicatively-coupled to the implement analyzing device integrated circuit.

In some instances, the user interface is a capacitive touch touchscreen.

In some implementations, the plurality of passages include a data input passage that is sized for permitting access to an optical scanner. The optical scanner is communicatively-coupled to the implement analyzing device integrated circuit. In other examples, the plurality of passages includes one or more data input/output passages that is sized for permitting access to one or more universal serial bus ports, one or more secure digital card ports, or an Ethernet port. In yet other examples, the one or more universal serial bus ports, the one or more secure digital card ports, or the Ethernet port is communicatively-coupled to the implement analyzing device integrated circuit. In some instances, the plurality of passages includes one or more power passages for permitting insertion of a power cord to communicatively couple the implement analyzing device integrated circuit to a power source.

In an example, the implement analyzing device integrated circuit includes data processing hardware and memory hardware.

Another aspect of the disclosure provides a method. The method includes the step of obtaining an implement analyzing device that includes: an opening formed through a cartridge receiver; data processing hardware; and an imaging device in communication with the data processing hardware. The method also includes the step of obtaining one or more test strip assays. The test strip assays are configured to chemically react with a chemical analyte after contact with a fluid. The method also includes the step of inserting the one or more test strip assays into the cartridge receiver and receiving at the data processing hardware: image data from the imaging device. The imaging device captures the image data within a field of view directed toward the opening formed through the cartridge receiver. The method also includes the step of detecting, by the data processing hardware, the one or more test strip assays received by the cartridge receiver based on the image data and obtaining by the data processing hardware: test information associated with each detected test strip assay. For each detected test strip assay, the method includes executing by the data processing hardware an analysis routine on the corresponding test strip assay based on the corresponding test information. The analysis routine is configured to: analyze color and/or intensity information within a result region located on the corresponding test strip assay based on the image data received from the imaging device. The method also includes determining a test result indicating a presence and/or concentration of the chemical analyte within the fluid based on the analyzed color and/or intensity information.

Implementations of the disclosure may include one or more of the following optional features. For example, the method may further include the step of: providing one or more fluid retainer cartridge assemblies. The one or more fluid retainer cartridge assemblies is configured to retain the fluid and fluid retainer cartridge assemblies. The method also includes the step of: inserting one or more test strip assays in the one or more fluid retainer cartridge assemblies. The method also includes the step of: inserting the one or more fluid retainer cartridge assemblies into the cartridge receiver.

In some implementations, the one or more fluid retainer cartridge assemblies include two fluid retainer cartridge assemblies and the one or more test strip assays include two test strip assays. The inserting step includes inserting one strip assay into one of the two fluid retainer cartridge assemblies and inserting the other strip assay into the other of the fluid retainer cartridge assemblies.

In some examples, the method further includes the steps of: after obtaining the test information associated with the one or more test strip assays inserted in the one or more fluid retainer cartridge assemblies, measuring, by the data processing hardware, a level of the fluid retained by the corresponding inserted fluid retainer cartridge assembly; and determining, by the data processing hardware, whether the measured level of the fluid is at least a threshold fluid level. The threshold fluid level is specified by the test information.

The method also includes: in response to determining that the measured level of the fluid is at least the threshold fluid level, executing the analysis routine on each detected test strip assay retained by the corresponding inserted fluid retainer cartridge assembly.

In some instances, the method further includes the step of: after obtaining the test information associated with the one or more test strip assays inserted in the one or more fluid retainer cartridge assemblies, initiating, by the data processing hardware, a timer in response to determining that the measured level of the fluid is at least the threshold fluid level. The analysis routine determines the test result associated with each detected test strip assay retained by the corresponding inserted fluid retainer cartridge assembly when the timer satisfies an analysis duration, the analysis duration specified by the test information.

In some examples, the method further includes the steps of: after obtaining the test information associated with the one or more test strip assays inserted in the one or more fluid retainer cartridge assemblies, selectively activating, by the data processing hardware, at least one heating device in communication with the data processing hardware and thermally coupled to a corresponding inserted fluid retainer cartridge assembly based on a desired temperature of the retained fluid, the desired temperature specified by the test information associated with at least one detected test strip assay retained by the corresponding inserted fluid retainer cartridge assembly; and selectively deactivating, by the data processing hardware, the corresponding heating device after a prescribed period of time specified by the test information.

In some instances, selectively activating at least one heating device includes selectively activating at least two heating devices independently from one another, one heating device thermally coupled to inserted fluid retainer cartridge assembly, the other heating device thermally coupled to the other inserted fluid retainer cartridge assembly.

In some implementations, obtaining test information associated with each detected test strip essay includes: analyzing the image data received from the imaging device to identify one or more indicia markings disposed on each detected test strip assay; determining a unique test strip identifier associated with each detected test strip assay based on identified indicia markings; retrieving from memory hardware in communication with the data processing hardware, the test information associated with each detected test strip essay using the corresponding unique test strip identifier.

In some instances, the one or more indicia markings is selected from barcode data, alphanumerical data, and color data.

In some implementations, obtaining the test information associated with each detected test strip essay includes: receiving barcode data from an optical scanner in communication with the data processing hardware, the optical scanner configured to scan the barcode data from each detected test strip assay; determining a unique test strip identifier associated with each detected test strip assay based on the scanned barcode data; and retrieving from memory hardware in communication with the data processing hardware, the test information associated with each detected test strip essay using the corresponding unique test strip identifier.

In some examples, the analysis routine analyzes intensity information includes line intensity of one or more result lines superimposed in the result region of the corresponding test strip assay.

In some instances, the analysis routine is further configured to: determine a rate of change in line intensity of the one or more result lines; and predict the test result indicating the presence and/or concentration of the chemical analyte within the fluid based on the rate of change in line intensity.

In some examples, executing the analysis routine on the corresponding test strip assay includes: executing a result line centering routine on the corresponding test strip assay to center one or more result lines superimposed in the result region of the corresponding test strip assay, the result line centering routine configured to: identify the one or more result lines superimposed in the result region based on the image data received from the imaging device; and adjust a position of the one or more result lines to align with result line centering information specified, the line centering information specified by the test information associated with the corresponding test strip assay.

In some implementations, the method further includes: executing, by the data processing hardware, a graphical user interface on a screen in communication with the data processing hardware. The graphical user interface is configured to display the test result for each detected test strip assay.

In some instances, executing the analysis routine includes: executing a first analysis routine on a first detected test strip assay and a second analysis routine on a second detected test strip assay.

In some examples, the first and second detected test strip assays are retained by a single fluid retainer cartridge assembly inserted into the cartridge receiver.

In some implementations, the first detected test strip assay is retained by a first fluid retainer cartridge assembly inserted into the cartridge receiver and the second detected test strip assay is retained by a second fluid retainer cartridge assembly inserted into the cartridge receiver.

In some instances, the method further includes executing a third analysis routine on a third detected test strip assay simultaneously with the first and second analysis routines.

In some examples, the first, second and third detected test strip assays are all retained by a single fluid retainer cartridge assembly inserted into the cartridge receiver.

In some implementations, the first detected test strip assay is retained by a first fluid retainer cartridge assembly inserted into the cartridge receiver, the second detected test strip assay is retained by a second fluid retainer cartridge assembly inserted into the cartridge receiver, and the third detected test strip assay is retained by a third fluid retainer cartridge assembly inserted into the cartridge receiver.

Yet another aspect of the disclosure provides a method. The method includes: receiving, at data processing hardware, image data from an imaging device in communication with the data processing hardware. The imaging device captures the image data within a field of view directed toward an opening formed through a cartridge receiver. The method also includes detecting, by the data processing hardware, one or more test strip assays received by the cartridge receiver based on the image data. The test strip assays configured to chemically react with a chemical analyte after contact with a fluid. The method also includes obtaining, by the data processing hardware, test information associated with each detected test strip assay. For each detected test strip assay, the method includes executing, by the data processing hardware, an analysis routine on the corresponding test strip assay based on the corresponding test information. The analysis routine configured to: analyze color and/or intensity information within a result region located on the corresponding test strip assay based on the image data received from the imaging device; and determine a test result indicating a presence and/or concentration of the chemical analyte within the fluid based on the analyzed color and/or intensity information.

Implementations of the disclosure may include one or more of the following optional features. For example, the detecting the one or more test strip assays received by the cartridge receiver includes detecting the one or more test strip assays retained by one or more fluid retainer cartridge assemblies removably-inserted into the cartridge receiver. Each fluid retainer assembly is configured to retain the fluid and two or more test strip assays.

In some examples, detecting the one or more test strip assays received by the cartridge receiver includes detecting a plurality of test strip assays retained by two or more fluid retainer cartridge assemblies removably-inserted into the cartridge receiver. Each of the two or more fluid retainer cartridge assemblies removably-inserted into the cartridge receiver retaining at least one of the detected plurality of test strip assays.

In some instances, after obtaining the test information associated with each detected test strip assay, the method further includes: for each removably-inserted fluid retainer cartridge assembly: measuring, by the data processing hardware, a level of the fluid retained by the corresponding removably-inserted fluid retainer cartridge assembly; determining, by the data processing hardware, whether the measured level of the fluid is at least a threshold fluid level, the threshold fluid level specified by the test information; and in response to determining the measured level of the fluid is at least the threshold fluid level, executing the analysis routine on each detected test strip assay retained by the corresponding removably-inserted fluid retainer cartridge assembly.

In some implementations, the method further includes: initiating, by the data processing hardware, a timer in response to determining the measured level of the fluid is at least the threshold fluid level. The analysis routine determines the test result associated with each detected test strip assay retained by the corresponding removably-inserted fluid retainer cartridge assembly when the timer satisfies an analysis duration, the analysis duration specified by the test information.

In some examples, after obtaining the test information associated with each detected test strip assay, the method further includes: for each removably-inserted fluid retainer cartridge assembly: selectively activating, by the data processing hardware, at least one heating device in communication with the data processing hardware and thermally coupled to a corresponding removably-inserted fluid retainer cartridge assembly based on a desired temperature of the retained fluid, the desired temperature specified by the test information associated with at least one detected test strip assay retained by the corresponding removably-inserted fluid retainer cartridge assembly; and selectively deactivating, by the data processing hardware, the corresponding heating device after a prescribed period of time specified by the test information.

In some instances, selectively activating at least one heating device includes selectively activating at least two heating devices independently from one another when at least two fluid retainer cartridge assemblies are removably-inserted into the cartridge receiver. Each heating device is thermally coupled to a corresponding removably-inserted fluid retainer cartridge assembly and thermally isolated from the one or more other fluid retainer cartridge assemblies.

In some implementations, obtaining test information associated with each detected test strip essay includes: analyzing the image data received from the imaging device to identify one or more indicia markings disposed on each detected test strip assay; determining a unique test strip identifier associated with each detected test strip assay based on identified indicia markings; and retrieving from memory hardware in communication with the data processing hardware, the test information associated with each detected test strip essay using the corresponding unique test strip identifier.

In some examples, the one or more indicia markings include at least one of barcode data, alphanumerical data, or color data.

In some instances, obtaining the test information associated with each detected test strip essay includes: receiving barcode data from an optical scanning device in communication with the data processing hardware, the optical scanning device configured to scan the barcode data from each detected test strip assay; determining a unique test strip identifier associated with each detected test strip assay based on the scanned barcode data; and retrieving from memory hardware in communication with the data processing hardware, the test information associated with each detected test strip essay using the corresponding unique test strip identifier.

In some implementations, the analysis routine analyzes intensity information includes line intensity of one or more result lines superimposed in the result region of the corresponding test strip assay.

In some examples, the analysis routine is further configured to: determine a rate of change in line intensity of the one or more result lines; and predict the test result indicating the presence and/or concentration of the chemical analyte within the fluid based on the rate of change in line intensity.

In some instances, executing the analysis routine on the corresponding test strip assay includes executing a result line centering routine on the corresponding test strip assay to center one or more result lines superimposed in the result region of the corresponding test strip assay. The result line centering routine configured to: identify the one or more result lines superimposed in the result region based on the image data received from the imaging device; and adjust a position of the one or more result lines to align with result line centering information specified, the line centering information specified by the test information associated with the corresponding test strip assay.

In some examples, after executing the analysis routine on the corresponding test strip assay, the method further includes storing the test result for the corresponding test strip assay in memory hardware in communication with the data processing hardware.

In some implementations, the method further includes executing, by the data processing hardware, a graphical user interface on a screen in communication with the data processing hardware. The graphical user interface is configured to display the test result for each detected test strip assay.

In some instances, executing the analysis routine includes simultaneously executing a first analysis routine on a first detected test strip assay and a second analysis routine on a second detected test strip assay.

In some examples, the first and second detected test strip assays are retained by a single fluid retainer cartridge assembly removably-inserted into the cartridge receiver.

In some implementations, the first detected test strip assay is retained by a first fluid retainer cartridge assembly removably-inserted into the cartridge receiver, and the second detected test strip assay is retained by a second fluid retainer cartridge assembly removably-inserted into the cartridge receiver.

In some instances, the method further includes executing a third analysis routine on a third detected test strip assay simultaneously with the first and second analysis routines.

In some examples, the first, second and third detected test strip assays are all retained by a single fluid retainer cartridge assembly removably-inserted into the cartridge receiver.

In some implementations, the first detected test strip assay is retained by a first fluid retainer cartridge assembly removably-inserted into the cartridge receiver, the second detected test strip assay is retained by a second fluid retainer cartridge assembly removably-inserted into the cartridge receiver, and the third detected test strip assay is retained by a third fluid retainer cartridge assembly removably-inserted into the cartridge receiver.

The details of one or more implementations of the disclosure are set forth in the accompanying drawings and the description below. Other aspects, features, and advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

The drawings described herein are for illustrative purposes only of selected configurations and not all possible implementations, and are not intended to limit the scope of the present disclosure.

FIG. **1**A is an exploded perspective view of a fluid retainer cartridge assembly and a plurality of implements positioned relative to the fluid retainer cartridge assembly.

FIG. **1**B is an assembled perspective view of the fluid retainer cartridge assembly of FIG. **1**A and the plurality of implements positioned within the fluid retainer cartridge assembly.

FIG. **2** is a front view of a base portion of the fluid retainer cartridge assembly of FIG. **1**A.

FIG. **3** is a rear view of the base portion of FIG. **2**.

FIG. **4** is a top view of the base portion of FIG. **2**.

FIG. **5** is a bottom view of the base portion of FIG. **2**.

FIG. **6** is a side view of the base portion of FIG. **2**.

FIG. **7** is a cross-sectional view of the base portion according to line **7**-**7** of FIG. **2**.

FIG. **8** is a front view of a cap portion of the fluid retainer cartridge assembly of FIG. **1**A.

FIG. **9** is a rear view of the cap portion of FIG. **6**.

FIG. **10** is a top view of the cap portion of FIG. **6**.

FIG. **11** is a bottom view of the cap portion of FIG. **6**.

FIG. **12** is a side view of the cap portion of FIG. **6**.

FIG. **13** is a cross-sectional view of the base portion according to line **13**-**13** of FIG. **8**.

FIG. **14**A is a front exploded view of the fluid retainer cartridge assembly of FIG. **1**A.

FIG. **14**B is a front assembled view of the fluid retainer cartridge assembly of FIG. **14**A.

FIG. **15**A is a rear exploded view of the fluid retainer cartridge assembly of FIG. **1**A.

FIG. **15**B is a rear assembled view of the fluid retainer cartridge assembly of FIG. **15**A.

FIG. **16** is a side view of the fluid retainer cartridge assembly of FIG. **14**B or FIG. **15**B.

FIG. **17** is a cross-sectional view of the fluid retainer cartridge assembly according to line **17**-**17** of FIG. **14**B or FIG. **15**B.

FIG. **18** is a cross-sectional view of the fluid retainer cartridge assembly according to line **18**-**18** of FIG. **1**B.

FIG. **19** is a cross-sectional view of the fluid retainer cartridge assembly according to line **19**-**19** of FIG. **1**B.

FIG. **19**A is an enlarged view according to line **19**A of FIG. **19**.

FIG. **20** is another cross-sectional view of the fluid retainer cartridge assembly according to FIG. **19**.

FIG. **20**A is an enlarged view according to line **20**A of FIG. **20**.

FIG. **21** is another cross-sectional view of the fluid retainer cartridge assembly according to FIG. **20**.

FIG. **21**A is an enlarged view according to line **21**A of FIG. **21**.

FIG. **22** is a front view of the fluid retainer cartridge assembly according to line **22** of FIG. **1**B.

FIG. **23** is an exploded perspective view of an implement analyzing device and a plurality of fluid retainer cartridge assemblies containing a plurality of implements positioned located within the plurality of fluid retainer cartridge assemblies.

FIG. **24**A is a right side perspective view of FIG. **23** illustrating the plurality of fluid retainer cartridge assemblies disposed within the implement analyzing device.

FIG. **24**B is a left side perspective view of FIG. **23** illustrating the plurality of fluid retainer cartridge assemblies disposed within the implement analyzing device.

FIG. **25** is a right side perspective view of the plurality of fluid retainer cartridge assemblies disposed within the implement analyzing device that corresponds to FIG. **24**A, illustrating a housing of the implement analyzing device in phantom in order to reveal components located within a cavity of the implement analyzing device.

FIG. **26** is a cross-sectional view of the implement analyzing device according to line **26-26** of FIG. **24**A.

FIG. **27** a front view of a portion of the implement analyzing device, illustrating an exemplary data input passage and an exemplary optical scanner,

FIG. **28** is a perspective view of an exemplary cartridge heater of the implement analyzing device.

FIG. **29** is a side view of the cartridge heater of FIG. **28**.

FIG. **30** is a top view of the cartridge heater of FIG. **28**.

FIG. **31** is a perspective view of a plurality of cartridge heaters interfaced with a plurality of fluid retainer cartridge assemblies.

FIG. **32** is an exploded view of a subassembly of the implement analyzing device including the plurality of cartridge heaters of FIG. **31** and a cartridge receiver.

FIG. **33** is an assembled view of the subassembly of FIG. **32**.

FIG. **34** is a cross-sectional view of the subassembly according to line **34-34** of FIG. **33**.

FIG. **35** is a block diagram illustrating a connection of components of the implement analyzing device.

FIG. **36** is a partial perspective of the implement analyzing device with the housing removed from a support member of the implement analyzing device.

FIG. **37** is a rear view of a calibration cartridge that is interfacably-connectable to the implement analyzing device.

FIG. **38** is a front view of the calibration cartridge of FIG. **37**.

FIG. **39** is a flow chart of an example method for determining a test result indicating a presence and/or concentration of a chemical analyte within a fluid in contact with a test strip assay.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

Example configurations will now be described more fully with reference to the accompanying drawings. Example configurations are provided so that this disclosure will be thorough, and will fully convey the scope of the disclosure to those of ordinary skill in the art. Specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of configurations of the present disclosure. It will be apparent to those of ordinary skill in the art that specific details need not be employed, that example configurations may be embodied in many different forms, and that the specific details and the example configurations should not be construed to limit the scope of the disclosure.

The terminology used herein is for the purpose of describing particular exemplary configurations only and is not intended to be limiting. As used herein, the singular articles "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. Additional or alternative steps may be employed.

When an element or layer is referred to as being "on," "engaged to," "connected to," "attached to," or "coupled to" another element or layer, it may be directly on, engaged, connected, attached, or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly engaged to," "directly connected to," "directly attached to," or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.). As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

The terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections. These elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as "first," "second," and other numerical terms do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the example configurations.

Referring to FIGS. **1**A and **1**B, a fluid retainer cartridge assembly is shown generally at **10**. The fluid retainer cartridge assembly **10** includes a base portion **12** and a cap portion **14** that is fluidly-connected to the base portion **12**. The fluid retainer cartridge assembly **10** may optionally include a fluid filter **11** that may be connected to the base portion **12**.

As will be explained in greater detail in the following disclosure (at FIGS. **18-22**), the base portion **12** and the cap portion **14** collectively retain at least one (e.g., three) implement I (see, e.g., FIGS. **1A-1B**) while the base portion **12** guides an amount of fluid F, for example, raw milk (see, e.g., FIG. **1**B) into a fluid-receiving void defined by the cap portion **14**. If optionally included, the fluid filter **11** may filter the fluid F. Once the fluid F arrives in the fluid-receiving void of the cap portion **14**, the fluid F contacts the at least one implement I. In an example, the at least one implement I may be a test strip assay and the fluid F may include a chemical analyte (e.g., a veterinary antibiotic, such as a beta-lactam or tetracycline) that chemically reacts with the at least one test strip assay I. In an example as seen in FIG. **1**A, each implement I_1, I_2, I_3 of the plurality of implements I may include indicia markings, such as, for example, one or more of barcode data B, alphanumerical data # (e.g., letters and/or numbers), color data C or the like that may be read by an imaging device **136** (see, e.g., FIGS. **25**-**26**) of an implement analyzing device **100** (see, e.g., FIG. **23**) that can monitor, read and analyze the one or more implements I before, during or after being contacted with the fluid F. Preloaded cartridge assemblies **10** may include an identification marker on the cartridge itself that can be interpreted and used to identify the set of tests present. Barcode data B may include one-dimensional or multi-dimensional barcodes.

Although an exemplary fluid F may include, for example, raw milk as described above, other fluids F may be interfaced with the fluid retainer cartridge assembly **10**. For example, other exemplary fluids F may include, but is not limited to: blood, saliva, corn fluid or the like. Furthermore, the fluid F may be interfaced with the fluid retainer cartridge assembly **10** at any desirable temperature, such as, for example, room temperature, a temperature that is lower than room temperature (as a result of, for example, cooling or chilling the fluid F) or a temperature that is higher than room temperature (as a result of, for example, warming or heating the fluid F).

Each of the base portion **12** and the cap portion **14** may be formed from a thermoplastic or other material suitable for injection molding, such as, acrylonitrile butadiene styrene (ABS plastic). Other exemplary materials may include polypropylene, polystyrene, nylon, polycarbonate, and thermoplastics infused with polymers (e.g., graphite, carbon fibers, glass-reinforced) to enhance thermal conductivity. The thermoplastic material may promote, for example, sufficient heat transfer of heat from an external heating source in order to warm or heat the fluid F that is disposed within the fluid retainer cartridge assembly **10**.

Referring to FIGS. **2**-**7**, the base portion **12** includes a body **16** that is generally defined by a front surface $\mathbf{16}_F$ (see, e.g., FIG. **2**), a rear surface $\mathbf{16}_R$, (see, e.g., FIG. **3**) a distal end surface $\mathbf{16}_D$ (see, e.g., FIG. **4**), a proximal end surface $\mathbf{16}_P$ (see, e.g., FIG. **5**), a first side surface $\mathbf{16}_{S1}$ (see, e.g., FIG. **6**) and a second side surface $\mathbf{16}_{S2}$ (see, e.g., FIGS. **3** and **6**). As seen in FIGS. **2**-**3**, the base portion **12** is further generally defined by a length L_{12} extending between the distal end surface $\mathbf{16}_D$ and the proximal end surface $\mathbf{16}_P$. The base portion **12** is yet even further generally defined by a width W_{12} extending between the first side surface $\mathbf{16}_{S1}$ and the second side surface $\mathbf{16}_{S2}$.

Referring to FIG. **2**, the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** generally defines more than one implement-receiving channel **18** (e.g., three implement-receiving channels **18***a*-**18***c*) extending along a portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12**. The more than one implement-receiving channel **18** may be defined by a first sidewall flange **20***a*, a second sidewall flange **20***b*, a first rib **22***a* and a second rib **22***b*.

The first sidewall flange **20***a* extends away from the front surface $\mathbf{16}_F$ and is arranged proximate the first side surface $\mathbf{16}_{S1}$. The second sidewall flange **20***b* extends away from the front surface $\mathbf{16}_F$ and is arranged proximate the second side surface $\mathbf{16}_{S2}$. The first rib **22***a* extends away from the front surface $\mathbf{16}_F$ and is arranged proximate the first sidewall flange **20***a*. The second rib **22***b* extends away from the front surface $\mathbf{16}_F$ and is arranged proximate but spaced-apart from second sidewall flange **20***b*.

The first sidewall flange **20***a* is spaced apart from the first rib **22***a* at a distance equal to a first portion $W_{12\text{-}1}$ of the width W_{12} of the base portion **12** for defining a first implement-receiving channel **18***a* of the more than one implement-receiving channels **18**. The first rib **22***a* is spaced apart from the second rib **18***b* at a distance equal to a second portion $W_{12\text{-}2}$ of the width W_{12} of the base portion **12** for defining a second implement-receiving channel **18***b* of the more than one implement-receiving channels **18**. The second rib **22***b* is spaced apart from the second sidewall flange **20***b* at a distance equal to a third portion $W_{12\text{-}3}$ of the width W_{12} of the base portion **12** for defining a third implement-receiving channel **18***c* of the more than one implement-receiving channels **18**.

With continued reference to FIG. **2**, the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** further defines an implement distal end retainer portion **24**. The implement distal end retainer portion **24** extends across the width W_{12} of the base portion **12** and connects the first sidewall flange **20***a* to the second sidewall flange **20***b*. Furthermore, the implement distal end retainer portion **24** may be further defined by a distal end $\mathbf{24}_D$ and a proximal end $\mathbf{24}_P$; the distal end $\mathbf{24}_D$ may be arranged at a distance D_{24} away from the distal end surface $\mathbf{16}_D$ of the body **16** of the base portion **12** for defining an access port **26** that is sized for permitting insertion of, for example, a user's finger therein for grasping any of the one or more implements I for inserting or removing the one or more implements I from the more than one implement-receiving channels **18**. The implement distal end retainer portion **24** may also include a series of friction ribs **25** that may assist a user in grasping the fluid retainer cartridge assembly **10** when inserting or removing the fluid retainer cartridge assembly **10** into/from an implement analyzing device **100** (see, e.g., FIG. **23**) that can monitor, read and analyze the one or more implements I before, during or after being contacted with the fluid F.

With reference to FIGS. **2** and **7**, each of the first sidewall flange **20***a* and the second sidewall flange **20***b* may extend away from the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** at a substantially constant distance D_{20} (see, e.g., FIG. **7**) along the portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12**. Each of the first rib **22***a* and the second rib **22***b* may extend away from the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** at a substantially constant distance $D_{22\text{-}1}$ (see, e.g., FIG. **7**) along a first segment $L_{12\text{-}P1}$ (see, e.g., FIG. **2**) of the portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12**. The first segment $L_{12\text{-}P1}$ of the portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12** may be bound by a proximal end $L_{12\text{-}P1P}$ and a distal end $L_{12\text{-}P1D}$. In some examples, each of the first rib **22***a* and the second rib **22***b* may extend away from the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** at a progressively-increasing distance $D_{22\text{-}2}$ (see, e.g., FIG. **7**) from the distal end $L_{12\text{-}P1D}$ of the first segment $L_{12\text{-}P1}$ of the portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12** along a second segment $L_{12\text{-}P2}$ (see, e.g., FIG. **2**) of the portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12** toward the proximal end $\mathbf{24}_P$ of the implement distal end retainer portion **24**.

As seen in FIG. **2**, a portion (i.e., a tongue portion **28**) of the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** does not include any of the first sidewall flange **20***a*, the second sidewall flange **20**b, the first rib **22**a and the second rib **22**b. In an example as seen in FIG. **1**B, when the one or more implements I are interfaced with the fluid retainer cartridge assembly **10**, the one or more implements I may extend out of the more than one implement-receiving channels **18** and over the tongue portion **28**.

Referring to FIG. **2**, the tongue portion **28** may be defined by a length L_{28} extending between the proximal end $L_{12\text{-}P1P}$ of the first segment $L_{12\text{-}P1}$ of the portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12** and proximal-most/lower-most portion of the proximal end surface $\mathbf{16}_P$ of the body **16** of the base portion **12**. In some instances, the proximal end surface $\mathbf{16}_P$ may include an arcuate shape that partially defines the tongue portion **28**. Furthermore, proximal end surface $\mathbf{16}_P$ connects (see, e.g., dashed line X_{28} extending across the tongue portion **28**) the first side surface $\mathbf{16}_{S1}$ to the second side surface $\mathbf{16}_{S2}$. Yet even further, as see in FIG. **2**, the first side surface $\mathbf{16}_{S1}$ is substantially parallel to the second side surface $\mathbf{16}_{S2}$ along the length L_{28} of the tongue portion **28**. Therefore, in an example, the tongue portion **28** may be generally defined by: (1) a substantially square or rectangular portion **28**a defined in part by the first side surface $\mathbf{16}_{S1}$ and the second side surface $\mathbf{16}_{S2}$ and (2) a substantially 'half moon' portion **28**b defined by the proximal end surface $\mathbf{16}_P$, which is demarcated from the substantially square or rectangular portion **28**a by the dashed line X_{28}.

Although the first sidewall flange **20**a, the second sidewall flange **20**b, the first rib **22**a and the second rib **22**b do not extend away from the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** defined by the tongue portion **28**, a plurality of projections **30** extend away from the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** defined by the tongue portion **28** at a distance D_{30} (see, e.g., FIG. **7**). In some implementations, the plurality of projections **30** may be substantially cylindrical (or they may have another shape for evenly distributing and selectively flowing the fluid F, as described below), and may be linearly-arranged in a row (see, e.g., dashed line R_{30} extending across the 'half moon' portion **28**b, which is substantially parallel to the dashed line X_{28}). Furthermore, the row R_{30} of the plurality of projections **30** may extend from the 'half moon' portion **28**b of the tongue portion and may be arranged at a length L_{30} (see, e.g., FIG. **2**) away from the proximal end $L_{12\text{-}P1P}$ of the first segment $L_{12\text{-}P1}$ of the portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12**.

In an example, as seen in FIG. **2**, the plurality of projections **30** may be defined by a first projection **30**a, a second projection **30**b, a third projection **30**c, a fourth projection **30**d and a fifth projection **30**e. In some implementations, the plurality of projections **30** including the first-through-fifth projections **30**a-**30**e may be arranged relative to the first-through-third implement-receiving channels **18**a-**18**c as follows: (1) the first projection **30**a may be aligned with a center (see, e.g., dashed line C_{18a}) of the first portion $W_{12\text{-}1}$ of the width W_{12} defining the first implement-receiving channel **18**a, (2) the second projection **30**b may be aligned with a center (see, e.g., dashed line C_{22a}) of the first rib **22**a that partially defines each of the first and second implement-receiving channels **18**a, **18**b, (3) the third projection **30**c may be aligned with a center (see, e.g., dashed line C_{18b}) of the second portion $W_{12\text{-}2}$ of the width W_{12} defining the second implement-receiving channel **18**b, (4) the fourth projection **30**d may be aligned with a center (see, e.g., dashed line C_{22b}) of the second rib **22**b that partially defines each of the second and third implement-receiving channels **18**b, **18**c and (5) the fifth projection **30**e may be aligned with a center (see, e.g., dashed line C_m) of the third portion $W_{12\text{-}3}$ of the width W_{12} defining the third implement-receiving channel **18**c.

In an example, the tongue portion **28** may further define a fluid-flow passage **32** extending through a thickness T_{16} (see, e.g., FIG. **7**) of the body **16** of the base portion **12**. The thickness T_{16} of the body **16** of the base portion **12** (as defined by the tongue portion **28**) is bound by the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** and the rear surface $\mathbf{16}_R$ of the body **16** of the base portion **12**. Furthermore, as seen in FIGS. **2**-**3**, the fluid-flow passage **32** may be defined by the substantially 'half moon' portion **28**b of the tongue portion **28**. In some instances, the fluid-flow passage **32** may include a smaller, but substantially proportional 'half-moon' geometry compared to the 'half moon' portion **28**b of the tongue portion **28** and includes a maximum width W_{32} (see, e.g., FIG. **3**) that extends between an laterally-outward-most portion of each of the second projection **30**b and the fourth projection **30**d.

In yet another example, the tongue portion **28** may further define a fluid-flow guide rib **34**. The fluid-flow guide rib **34** may extend away from the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** defined by the substantially 'half moon' portion **28**b of the tongue portion **28** at a distance D_{34} (see, e.g., FIG. **7**). Furthermore, as seen in FIG. **2**, the fluid-flow guide rib **34** may include an arcuate shape and extend away from the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** defined by the substantially 'half moon' portion **28**b of the tongue portion **28** proximate the proximal end surface **16**p of the body **16** of the base portion **12**.

Referring to FIG. **1**A, the fluid retainer cartridge assembly **10** may further define a fluid guide portion **36**. In an example, the fluid guide portion **36** may be defined by a funnel portion **36**a formed by the base portion **12** and a fluid conduit portion **36**b formed by the cap portion **14**.

Referring to FIGS. **3**-**7**, the funnel portion **36**a is generally defined by a funnel body **38** that extends away from the rear surface $\mathbf{16}_R$ of the base portion **12**. As seen in FIG. **3**, the funnel body **38** may be defined by a distal surface $\mathbf{38}_D$, which may be defined, in part, by the distal surface $\mathbf{16}_D$ of the body **16** of the base portion **12**, and a proximal surface $\mathbf{38}_P$. With continued reference to FIG. **3**, the funnel body **38** may include a length defined approximately by the portion $L_{12\text{-}P}$ of the length L_{12} of the base portion **12**. The funnel body **38** may be defined by a width W_{38} that narrows for at least a portion of the length $L_{12\text{-}P}$ of the funnel body **38** as the funnel body **38** extends from the distal surface $\mathbf{38}_D$ to the proximal surface $\mathbf{38}_P$.

Referring to FIG. **7**, the funnel body **38** is generally defined by an inner surface $\mathbf{38}_I$ and an outer surface $\mathbf{38}_O$. The inner surface $\mathbf{38}_I$ is arranged in an opposing relationship with respect to the rear surface $\mathbf{16}_R$ of the body **16** of the base portion **12** and forms a fluid-flow passage **40** extending through the funnel body **38**. Access to the fluid-flow passage **40** is formed by an upstream opening **42** (see, e.g., FIGS. **4** and **7**) that permits entry of the fluid F into the funnel body **38** and a downstream opening **44** (see, e.g., FIGS. **4** and **5**) that permits the fluid F to exit the funnel body **38**.

The fluid-flow passage **40** may be defined by an arcuate channel having a radius R_{40} or radial geometric component. Furthermore, as seen in FIG. **7**, the radius R_{40} may be greater near the distal surface $\mathbf{38}_D$ of the funnel body **38** such that the upstream opening **42** forms a larger opening or mouth portion of the fluid-flow passage **40** of the funnel body **38** than that of the downstream opening **44**, which may form a relatively smaller opening or throat portion of the fluid-flow passage **40** of the funnel body **38**.

Referring to FIGS. **3** and **5**, the rear surface $\mathbf{16}_R$ of the base portion **12** may also define a cap-retainer portion **46**. The cap-retainer portion **46** may defined by a pair of protrusions including a first protrusion **46***a* and a second protrusion **46***b* that extend away from the rear surface $\mathbf{16}_R$ of the base portion **12**. The first protrusion **46***a* and the second protrusion **46***b* may be respectively arranged near opposite sides of the funnel body **38** and near the proximal surface $\mathbf{38}_P$ of the funnel body **38**. Each of the first protrusion **46***a* and the second protrusion **46***b* may be defined by a ramp surface **48** and latch surface **50** (FIG. **15**A).

Referring to FIGS. **8**-**13**, the cap portion **14** of the fluid retainer cartridge assembly **10** includes a body **52** and a tongue-receiving housing **54** connected to the body **52**. The body **52** is generally defined by a front surface $\mathbf{52}_F$, a rear surface $\mathbf{52}_R$, a distal end surface $\mathbf{52}_D$, a proximal end surface $\mathbf{52}_P$, a first side surface $\mathbf{52}_{S1}$ and a second side surface $\mathbf{52}_{S2}$. The cap portion **14** is further generally defined by a length L_{14} (see, e.g., FIGS. **8**-**9** and **12**-**13**) extending between the distal end surface $\mathbf{52}_D$ and the proximal end surface $\mathbf{52}_P$. The cap portion **14** is yet even further generally defined by a width W_{14} (see, e.g., FIGS. **8**-**11**) extending between the first side surface $\mathbf{52}_{S1}$ and the second side surface $\mathbf{52}_{S2}$.

As seen in FIG. **8**, the tongue-receiving housing **54** may be defined by an implement proximal end retainer portion **56** and a flange portion **58** defined by a first sidewall flange segment **58***a*, a second sidewall flange segment **58***b* and an arcuate flange segment **58***c*. The implement proximal end retainer portion **56** extends across a width W_{14} of the base portion **14** and is connected to each of the first sidewall flange segment **58***a*, the second sidewall flange segment **58***b* and the arcuate flange segment **58***c*. The implement proximal end retainer portion **56** extends away from the arcuate flange segment **58***c* toward the distal end surface $\mathbf{52}_D$ of the body **52** at a length L_{56}; the length L_{56} of the implement proximal end retainer portion **56** may be equal to approximately half of the length L_{14} of the cap portion **14**.

With continued reference to FIG. **8**, the first sidewall flange segment **58***a* extends away from the front surface $\mathbf{52}_F$ and is arranged proximate the first side surface $\mathbf{52}_{S1}$. The second sidewall flange segment **58***b* extends away from the front surface $\mathbf{52}_F$ and is arranged proximate the second side surface $\mathbf{52}_{S2}$. The arcuate flange segment **58***c* extends away from the front surface $\mathbf{52}_F$ and is arranged proximate the proximal surface $\mathbf{52}_P$.

Referring to FIG. **13**, the body **52** of the cap portion **14** may include a substantially constant thickness T_{52}. As seen in FIGS. **8**-**13**, the body **52** defined by the substantially constant thickness T_{52} is not substantially planar, and, as a result, the body **52** may form an arcuate-shaped channel **60** (see, e.g., FIGS. **8**, **10**, **13**) defined by a radius R_{60} (see, e.g., FIGS. **10**, **13**) or radial geometric component extending into the front surface $\mathbf{52}_F$ of the body **52**, which results in the rear surface $\mathbf{52}_R$ of the body **52** defining an arcuate projection.

Referring to FIGS. **9** and **12**-**13**, the arcuate-shaped channel **60** may be defined by a length L_{60} that extends along a portion of the length L_{14} of the cap portion **14** from the distal end surface $\mathbf{52}_D$ of the body **52** toward the proximal end surface $\mathbf{52}_P$ of the body **52**. Furthermore, a remainder of the length L_{14} of the cap portion **14** where the arcuate-shaped channel **60** is not formed is shown generally at L_{60}'. Yet even further, as seen in FIG. **13**, a portion $L_{60\text{-}P}$ of the length L_{60} of the arcuate-shaped channel **60** extends along a portion of the length L_{56} of the implement proximal end retainer portion **56**.

Referring to FIGS. **8**-**9**, a pair of protrusion-receiving passages **62** extend through the thickness T_{52} of the body **52**. The pair of protrusion-receiving passages **62** may defined by a first protrusion-receiving passage **62***a* and a second protrusion-receiving passage **62***b*. The first protrusion-receiving passage **62***a* and the second protrusion-receiving passage **62***b* may be respectively arranged near opposite sides of the arcuate-shaped channel **60**.

As seen in FIGS. **10** and **13**, the cap portion **14** forms a fluid-receiving void **64**. The fluid-receiving void **64** is generally defined by an inner surface $\mathbf{56}_I$ of the implement proximal end retainer portion **56**, an inner surface $\mathbf{58}_I$ of the arcuate flange segment **58***c*, a portion of an inner surface $\mathbf{58}a_I$, $\mathbf{58}b_I$ of each of the first sidewall flange segment **58***a* and the second sidewall flange segment **58***b* that extends along the length L_{56} of the implement proximal end retainer portion **56**, and a portion $\mathbf{52}_{F\text{-}P}$ of the front surface $\mathbf{52}_F$ that extends along the length L_{56} of the implement proximal end retainer portion **56**.

Referring to FIGS. **14**A-**15**B, a method for forming the fluid retainer cartridge assembly **10** is described. In a first optional step, as seen at FIGS. **14**A and **15**A, the fluid filter **11** may be inserted on the front surface $\mathbf{16}_F$ in the substantially half-moon portion **28***b* of the tongue portion **28** and between projections **30** and fluid-flow guide rib **34** (i.e., as described herein-below, the fluid filter **11** may be inserted in a downstream fluid-receiving void **64***b*). The fluid filter **11** may be sized and configured to be arranged in this location in a friction-fit relationship. Furthermore, the fluid filter **11** may be sized to have a thickness T_{11} that is similar to the height of the projections **30** and/or fluid-flow guide rib **34** above the front surface $\mathbf{16}_F$, e.g., the distance D_{30} less the thickness T_{16}, or the distance D_{34} less the thickness T_{16} (FIG. **7**). Although an implementation of the fluid retainer cartridge assembly **10** may include the fluid filter **11**, the fluid filter **11** may be omitted from the design of the fluid retainer cartridge assembly **10**.

Although an implementation of the fluid retainer cartridge assembly **10** may include one fluid filter **11** as described above, the fluid retainer cartridge assembly **10** may include one or more second filters. In an example, a second filter or pre-filter **11***a* may be connected to the base portion **12**. Because the pre-filter **11***a* is located upstream of the filter **11**, the pre-filter **11***a* may be referred to as an upstream filter and the filter **11** may be referred to as a downstream filter. In an implementation, the pre-filter **11***a* may be disposed within the fluid-flow passage **40** extending through the funnel body **38** proximate or near the distal surface $\mathbf{38}_D$ of the funnel body **38**. Therefore, the pre-filter **11***a* may filter a 'dirty' fluid F prior to the fluid F being passed through the fluid filter **11**.

As seen in FIGS. **14**A and **15**A, the distal end surface $\mathbf{52}_D$ of the body **52** of the cap portion **14** is axially aligned with the proximal end surface **16***p* of the body **16** of the base portion **12**. Furthermore, as seen in FIGS. **14**A and **15**A, the tongue portion **28** of the base portion **12** is axially aligned with the fluid-receiving void **64** formed by the tongue-receiving housing **54** of the cap portion **14**. When the base portion **12** and the cap portion **14** are axially aligned as described above, the fluid-flow passage **40** extending through the funnel body **38** of the base portion **12** is axially aligned with the arcuate-shaped channel **60** formed by the body **52** of the cap portion **14**.

With reference to FIG. **14**A, the first side surface **16***si* defining a proximal end $\mathbf{20}a_P$ of the first sidewall flange **20***a* of the base portion **12** may define a recess that corresponds to a projection defined by a distal end $\mathbf{58}a_D$ of the first sidewall flange segment **58***a* of the cap portion **14**. Similarly, as seen in FIG. **15**A, the second side surface $\mathbf{16}_{S2}$ defining a proximal end $\mathbf{20}b_P$ of the second sidewall flange **20***b* of the base portion **12** may define a recess that corresponds to a projection defined by a distal end **58**b_D of the second sidewall flange segment **58**b of the cap portion **14**.

Furthermore, as seen in FIG. **15**A, when the base portion **12** and cap portion **14** are axially aligned as described above, the cap-retainer portion **46** (of the base portion **12**) defined by the first protrusion **46***a* and the second protrusion **46***b* are axially aligned with the pair of protrusion-receiving passages **62** (of the cap portion **14**) defined by the first protrusion-receiving passage **62***a* and the second protrusion-receiving passage **62***b*. As the tongue portion **28** of the base portion **12** is inserted into the fluid-receiving void **64** of the cap portion **14**, the ramp surface **48** of each of the first protrusion **46***a* and the second protrusion **46***b* contacts and rides adjacent the front surface **52**$_F$ (proximate the distal end surface **52**$_D$) of the body **52** for respectively advancing each of the first protrusion **46***a* and the second protrusion **46***b* into the first protrusion-receiving passage **62***a* and the second protrusion-receiving passage **62***b*. Just after the ramp surface **48** of each of the first protrusion **46***a* and the second protrusion **46***b* has been respectively aligned with the first protrusion-receiving passage **62***a* and the second protrusion-receiving passage **62***b*, the body **52** (proximate the distal end surface **52**$_D$) of the cap portion **14** flexes over the latch surface **50** of each of the first protrusion **46***a* and the second protrusion **46***b* for removably-attaching the cap portion **14** to the base portion **12** as seen in FIGS. **14**B and **15**B.

Referring to FIGS. **16-17**, the base portion **12** and the cap portion **14** are shown in a removably-attached configuration after the first protrusion **46***a* and the second protrusion **46***b* are arranged within the first protrusion-receiving passage **62***a* and the second protrusion-receiving passage **62***b*. With reference to FIG. **17**, the fluid-flow passage **40** extending through the funnel body **38** of the base portion **12** is fluidly-connected to the arcuate-shaped channel **60** formed by the body **52** of the cap portion **14** for forming an axial fluid conduit **66** of the fluid retainer cartridge assembly **10**. Furthermore, as seen in FIG. **17**, after the first protrusion **46***a* and the second protrusion **46***b* are arranged within the first protrusion-receiving passage **62***a* and the second protrusion-receiving passage **62***b* for removably-attaching the base portion **12** to the cap portion **14**, the tongue portion **28** of the base portion **12** is fully axially disposed within the fluid-receiving void **64** formed by the tongue-receiving housing **54** of the cap portion **14** such that the tongue portion **28** fluidly-divides the fluid-receiving void **64** into an upstream fluid-receiving void **64***a* and the downstream fluid-receiving void **64***b*. The upstream fluid-receiving void **64***a* is in fluid communication with the downstream fluid-receiving void **64***b* by way of the fluid-flow passage **32** of the tongue portion **28**.

If the fluid filter **11** is disposed within the downstream fluid-receiving void **64***b*, any fluid F that passes from the upstream fluid-receiving void **64***a* to the downstream fluid-receiving void **64***b* by way of the fluid-flow passage **32** will be filtered by the fluid filter **11**; in such an implementation, the upstream fluid-receiving void **64***a* may be referred to as an unfiltered reservoir portion of the fluid-receiving void **64** and the downstream fluid-receiving void **64***b* may be referred to as a filtered reservoir portion of the fluid-receiving void **64**. However, if the fluid filter **11** is not disposed within the downstream fluid-receiving void **64***b*, any fluid F that enters the downstream fluid-receiving void **64***b* from the upstream fluid-receiving void **64***a* by way of the fluid-flow passage **32** of the tongue portion **28** is not filtered.

Referring to FIGS. **1**A-**1**B and **18**, a plurality of implements I (e.g., a plurality of test strip assays) are interfaced with the fluid retainer cartridge assembly **10**. The plurality of test strip assays I includes three test strip assays, being: a first test strip assay I_1, a second test strip assay I_2 and a third test strip assay I_3.

As seen in FIGS. **1**A and **18**, the plurality of test strip assays I are disposed into the fluid retainer cartridge assembly **10** by way of the access port **26** formed by the body **16** of the base portion **12** such that the plurality of test strip assays I are arranged within the plurality of implement-receiving channels **18**. In an example, the plurality of test strip assays I may be arranged within the plurality of implement-receiving channels **18** as follows: (1) the first test strip assay I_1 is arranged within the first implement-receiving channel **18***a*, (2) the second test strip assay I_2 is arranged within the second implement-receiving channel **18***b* and (3) the third test strip assay I_3 is arranged within the third implement-receiving channel **18***c*.

Referring to FIG. **18**, insertion of the plurality of test strip assays I into the fluid retainer cartridge assembly **10** ceases once a proximal end I_{1P}, I_{2P}, I_{3P} of each test strip assay I_1, I_2, I_3 engages a corresponding projection **30***a*, **30***c*, **30***e* of the plurality of projections **30**. For example, as seen in FIG. **18**: (1) the proximal end I_{1P} of the first test strip assay I_1 engages the first projection **30***a* that is aligned with the center C_{18a} (see, e.g., FIG. **2**) of the first portion $W_{12\text{-}1}$ of the width W_{12} of the base portion **12** that defines the first implement-receiving channel **18***a*, (2) the proximal end I_{2P} of the second test strip assay **12** engages the third projection **30***c* that is aligned with the center C_{18b} (see, e.g., FIG. **2**) of the second portion $W_{12\text{-}2}$ of the width W_{12} of the base portion **12** that defines the second implement-receiving channel **18***b* and (3) the proximal end I_{3P} of the third test strip assay I_3 engages the fifth projection **30***e* that is aligned with the center C_{18c} (see, e.g., FIG. **2**) of the third portion $W_{12\text{-}3}$ of the width W_{12} of the base portion **12** that defines the third implement-receiving channel **18***c*.

As seen in FIG. **18**, each test strip assay I_1, I_2, I_3 of the plurality of test strip assays I includes a width W_I and a length L_I. The width W_I of each test strip assay I_1, I_2, I_3 is respectively approximately equal to the width portion $W_{12\text{-}1}$, $W_{12\text{-}2}$, $W_{12\text{-}3}$ (see, e.g., FIG. **2**) of the width W_{12} of the base portion **12** that defines each implement-receiving channel **18***a*, **18***b*, **18***c* of the plurality of implement-receiving channels **18**. With reference to FIGS. **1**B and **18**, the length L_I of each test strip assay I_1, I_2, I_3 is selectively sized such that when the proximal end I_{1P}, I_{2P}, I_{3P} of each test strip assay I_1, I_2, I_3 engages a corresponding projection **30***a*, **30***c*, **30***e* of the plurality of projections **30**, a distal end I_{1D}, I_{2D}, I_{3D} of each test strip assay I_1, I_2, I_3 is accessible at the access port **26** for permitting, for example, insertion of a user's finger therein for grasping any of the first, second or third test strip assays I_1, I_2, I_3 for inserting or removing any of the first, second or third test strip assays I_1, I_2, I_3 from any of the first, second or third implement-receiving channels **18***a*, **18***b*, **18***c*.

Referring to FIGS. **1**B and **19-21**A, fluid F is poured into the fluid retainer cartridge assembly **10**. As seen in FIGS. **1**B, **19** and **19**A, the fluid F initially enters the axial fluid conduit **66** of the fluid retainer cartridge assembly **10** by way of the upstream opening **42** of the funnel body **38** formed by the base portion **12**. The fluid F passes through the fluid-flow passage **40** of the funnel body **38** of the base portion **12** and subsequently exits the fluid-flow passage **40** of the funnel body **38** of the base portion **12** at the downstream opening **44**. The fluid F then enters the arcuate-shaped channel **60** formed by the body **52** of the cap portion **14** that is in fluid communication with the fluid-flow passage **40** of the funnel body **38** of the base portion **12** at the downstream opening **44** such that the fluid F ultimately arrives at the upstream fluid-receiving void **64***a* of the fluid-receiving void **64**. In an example, as seen in FIG. **19**A, fluid F_O (which is an amount of the fluid F that exceeds the volume of the fluid-receiving void **64**) exits the fluid retainer cartridge assembly **10** by spilling over a fluid overflow edge **68**, which may be a portion of the distal end surface $\mathbf{52}_D$, formed by the front surface $\mathbf{52}_F$ of the body **52** of the cap portion **14**.

As seen in FIGS. **20** and **20**A, the fluid F may radially pass from the upstream fluid-receiving void **64***a* of the fluid-receiving void **64** and into the downstream fluid-receiving void **64***b* of the fluid-receiving void **64**. As seen in FIGS. **20** and **20**A, the fluid filter **11** is shown optionally inserted into the downstream fluid-receiving void **64***b* for filtering the fluid F as the fluid F migrates radially through the fluid filter **11** from the upstream fluid-receiving void **64***a* into the downstream fluid-receiving void **64***b*.

As seen in FIGS. **21** and **21**A, after the fluid F arrives in the downstream fluid-receiving void **64***b* of the fluid-receiving void **64** and moves around projections **30**, the fluid F comes into contact with the proximal end I_{1P}, I_{2P}, I_{3P} of each test strip assay I_1, I_2, I_3 and fluid F is drawn up each test strip assay I_1, I_2, I_3, for example, by capillary action. The shape, quantity and arrangement (e.g., centering along the dashed lines C_{18a}, C_{18b}, C_{18c}, C_{22a}, C_{22b} of FIG. **2**) of the plurality of projections **30** may assist in evenly distributing and selectively flowing the fluid F about the proximal end I_{1P}, I_{2P}, I_{3P} of each test strip assay I_1, I_2, I_3 for adequately dosing each test strip assay I_1, I_2, I_3 with a sufficient amount of fluid F.

Referring to FIG. **22**, in one use of the fluid retainer cartridge assembly **10**, after being contacted with the fluid F, each test strip assay I_1, I_2, I_3 may include a result region R configured to provide a detectable signal DS (e.g., a color change or intensity information) indicating the presence and/or concentration of a chemical analyte within the fluid (F) when the fluid (F) is in contact with the result region R; and the detectable signal DS may be determined by exposing each test strip assay I_1, I_2, I_3 to an imaging device **136** (see, e.g., FIGS. **25**-**26**) of an implement analyzing device **100** (see, e.g., FIG. **23**) that can monitor, read and analyze the one or more test strip assays I_1, I_2, I_3 during or after being contacted with the fluid F. As used herein, the detectable signal DS is associated with color and/or intensity information within the result region R (FIGS. **1**A and **22**) located on each of the one or more test strip assays I_1, I_2, I_3. Exposure of each test strip assay I_1, I_2, I_3 to an imaging device **136** of an implement analyzing device **100** may be permitted by a viewing window or viewing port **70** of the fluid retainer cartridge assembly **10**. With reference to FIG. **1**B, the viewing window or viewing port **70** is defined by an absence of material of one or both of the base portion **12** and the cap portion **14**. In an example, the viewing window or viewing port **70** is generally bound by: (1) the first sidewall flange **20***a* of the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12**, (2) the second sidewall flange **20***b* of the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12**, (3) the proximal end $\mathbf{24}_P$ of the implement distal end retainer portion **24** the front surface $\mathbf{16}_F$ of the body **16** of the base portion **12** and (4) the fluid overflow edge **68** formed by the front surface $\mathbf{52}_F$ of the body **52** of the cap portion **14**.

In other examples (as shown in FIGS. **7** and **13**), the inner surface $\mathbf{38}_I$ of the funnel body **38** formed by the base portion **12**, the portion $\mathbf{52}_{F\text{-}P}$ of the front surface $\mathbf{52}_F$ that extends along the length L_{56} of the implement proximal end retainer portion **56**, and/or the inner surface $\mathbf{56}_I$ of the implement proximal end retainer portion **56** may include an optional dried reagent **72** disposed thereon. Such reagents may include acids, bases, buffers, surfactants, dyes, colorometric signaling agents, fluorometric signaling agents, antibodies, enzymes, receptors, antigens, cofactors, chemical filtration agents, anticoagulants, blocking agents, chelating agents, and leaching agents.

In yet another implementation, the fluid retainer cartridge assembly **10** may include a seal **74** (not shown), which may be formed from, for example, a foil material. The seal **74** may be disposed over, adjacent, proximate or near the distal surface $\mathbf{38}_D$ of the funnel body **38**. The seal **74** may serve one or more purposes, for example, to prevent contamination of the inner surface $\mathbf{38}_I$ of the funnel body **38** and/or for retention of dried reagent **72** on the inner surface $\mathbf{38}_I$ of the funnel body **38** of base portion **12**.

Referring to FIG. **23**, an implement analyzing device **100** is shown generally at **100**. The implement analyzing device **100** is sized for receiving more than one fluid retainer cartridge assembly **10**, which has been described above at FIGS. **1**A-**22**. As seen in FIG. **23**, the more than one fluid retainer cartridge assembly **10** may be, for example: a first fluid retainer cartridge assembly $\mathbf{10}_1$; a second fluid retainer cartridge assembly $\mathbf{10}_2$; and a third fluid retainer cartridge assembly $\mathbf{10}_3$. The first fluid retainer cartridge assembly $\mathbf{10}_1$, the second fluid retainer cartridge assembly $\mathbf{10}_2$ and the third fluid retainer cartridge assembly $\mathbf{10}_3$ may be collectively referred to as a plurality of fluid retainer cartridge assemblies $\mathbf{10}_P$.

The exemplary first fluid retainer cartridge assembly $\mathbf{10}_1$, the exemplary second fluid retainer cartridge assembly $\mathbf{10}_2$ and the exemplary third fluid retainer cartridge assembly $\mathbf{10}_3$ that may be interfaced with the implement analyzing device **100** may be substantially similar to the fluid retainer cartridge assembly **10** described above at FIGS. **1**A-**22**. Although the following disclosure is directed to the exemplary fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ being interfaced with the implement analyzing device **100**, the implement analyzing device **100** is not limited to being interfaced with the exemplary fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$; as such, the functionality of the implement analyzing device **100** may remain the same when other fluid retainer cartridge assemblies having different shapes or sizes are interfaced with the implement analyzing device **100**.

In association with what has been described above at FIGS. **1**A-**22**, the exemplary fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ are each sized for containing a plurality of implements I, such as, for example, a first test strip assay I_1, a second test strip assay I_2 and a third test strip assay I_3. Furthermore, because the implement analyzing device **100** is sized for receiving more than one fluid retainer cartridge assembly (e.g., three fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$), and, if each of the first fluid retainer cartridge assembly $\mathbf{10}_1$, the second fluid retainer cartridge assembly $\mathbf{10}_2$ and the third fluid retainer cartridge assembly $\mathbf{10}_3$ are respectively loaded with a plurality of implements I such as, for example, a first test strip assay I_1, a second test strip assay I_2 and a third test strip assay I_3, each of the first fluid retainer cartridge assembly $\mathbf{10}_1$, the second fluid retainer cartridge assembly $\mathbf{10}_2$, and the third fluid retainer cartridge assembly $\mathbf{10}_3$ may be said to contain a plurality of test strip assays I_1-I_3 (defined respectively, for example, by: a first plurality of test strip assays I_1-I_3 contained by the first fluid retainer cartridge assembly $\mathbf{10}_1$; a second plurality of test strip assays I_1-I_3 contained by the second fluid retainer cartridge assembly 10_2; and a third plurality of test strip assays I_1-I_3 contained by the third fluid retainer cartridge assembly 10_3). Therefore, in use, the implement analyzing device **100** may simultaneously, sequentially, selectively or randomly analyze all or any test strip assay I_1, I_2, I_3 that is secured by all or any of the first fluid retainer cartridge assembly 10_1, the second fluid retainer cartridge assembly 10_2 and the third fluid retainer cartridge assembly 10_3.

In an example, simultaneous analysis of the first plurality of test strip assays I_1-I_3, the second plurality of test strip assays I_1-I_3 and the third plurality of test strip assays I_1-I_3 by the implement analyzing device **100** may expedite an analysis of what may otherwise be one analysis of one plurality of test strip assays I_1-I_3 (if the implement analyzing device **100** was configured to only receive one fluid cartridge retainer assembly). In an example, the implement analyzing device **100** may conduct simultaneous analysis of one implement (e.g., the first test strip assay I_1) of the first plurality of test strip assays I_1-I_3, the second plurality of test strip assays I_1-I_3 and the third plurality of test strip assays I_1-I_3; therefore, if desired, a user may comparatively study three unique species studies (e.g., that is associated with a unique sample associated with each first test strip assay I_1 of: the first plurality of test strip assays I_1-I_3; the second plurality of test strip assays I_1-I_3; and the third plurality of test strip assays I_1-I_3) of a genus study (e.g., a genus test associated with a common sample type related to the each first test strip assay I_1 and not each of the second test strip assay I_2 and each of the third test strip assay I_3) in one instance.

Referring to FIGS. **23** and **24**A-**24**B, the implement analyzing device **100** includes a support member **102** and a housing **104** connected to the support member **102**. As seen in FIG. **25**, each of the support member **102** and the housing **104** may respectively form one or more fastener passages **106**, **108** that correspond to one another that are sized for receiving one or more fasteners **110**. The one or fasteners **110** permit selective attachment of the housing **104** to the support member **102**.

With reference to FIGS. **23**, **24**A-**24**B, **25** and **26**, the support member **102** may define an outer surface **112** and an inner surface **114** (see, e.g., FIGS. **25**-**26**). Similarly, the housing **104** may define an outer surface **116** and an inner surface **118** (see, e.g., FIGS. **25**-**26**). The inner surface **114** of the support member **102** and the inner surface **118** of the housing **104** cooperate to form a cavity **120** (see, e.g., FIGS. **25**-**26**).

As seen in FIGS. **23**, **24**A-**24**B, **25**, **26** and **32**-**34**, the implement analyzing device **100** may further include a cartridge receiver **122** disposed within the cavity **120**. In an example, the cartridge receiver **122** is secured to the inner surface **114** of the support member **102**.

Referring to FIGS. **23**, **26** and **32**, the cartridge receiver **122** includes a body **124** defining at least one first opening **126** and at least one second opening **128** (see, e.g., FIG. **32**). The at least one first opening **126** formed by the body **124** of the cartridge receiver **122** is aligned with a cartridge receiver passage **130** (see, e.g., FIG. **23**) extending through a thickness T_{104} (see, e.g., FIG. **26**) of the housing **104** that is bound by the outer surface **116** of the housing **104** and an inner surface **118** of the housing **104**. As seen in FIG. **26**, the cartridge receiver passage **130** formed by the housing **104** permits access to the cartridge receiver **122** that is substantially contained within the cavity **120**.

With reference to FIG. **23**, the at least one first opening **126** of the body **124** of the cartridge receiver **122** may be defined by: a first cartridge receiving opening **126***a*; a second cartridge receiving opening **126***b*; and a third cartridge receiving opening **126***c*. The first cartridge receiving opening **126***a* may be sized for removable-insertion of the first fluid retainer cartridge assembly 10_1 within the body **124** of the cartridge receiver **122**. The second cartridge receiving opening **126***b* may be sized for removable-insertion of the second fluid retainer cartridge assembly 10_2 within the body **124** of the cartridge receiver **122**. The third cartridge receiving opening **126***c* may be sized for removable-insertion of the third fluid retainer cartridge assembly 10_3 within the body **124** of the cartridge receiver **122**.

With reference to FIG. **25**, in one embodiment, the at least one second opening **128** formed by the body **124** of the cartridge receiver **122** is contained within the cavity **120** and not accessible from any opening or passage formed by the housing **104**. As seen in FIGS. **25** and **32**, the at least one second opening **128** may be defined by a first cartridge viewing window **128***a*, a second cartridge viewing window **128***b* and a third cartridge viewing window **128***c*. In one embodiment, each of the first cartridge viewing window **128***a*, the second cartridge viewing window **128***b* and the third cartridge viewing window **128***c* may include a shape corresponding to the viewing window **70** (see, e.g., FIG. **1**B) of each of the first fluid retainer cartridge assembly 10_1, the second fluid retainer cartridge assembly 10_2 and the third fluid retainer cartridge assembly 10_3.

With reference to FIGS. **25**-**26**, the implement analyzing device **100** may further include an imaging device support member **132** disposed within the cavity **120**. In an example, the imaging device support member **132** is secured to or integrally extends from the inner surface **114** of the support member **102**.

In an example, the imaging device support member **132** supports an imaging device integrated circuit (IC) **134** that includes an imaging device **136**. With reference to FIG. **26**, the imaging device support member **132** is deliberately sized for arranging the imaging device **136** (and, correspondingly, the imaging device IC **134**) away from the inner surface **114** of the support member **102** at a distance D_{136}. With reference to FIGS. **25**-**26**, the resulting distance D_{136} is sufficient for arranging imaging device **136** in alignment with a region (see, e.g., dashed line box R_{128} in FIGS. **25** and **33**) of the at least one second openings **128***a*, **128***b*, and **128***c* formed by the body **124** of the cartridge receiver **122**. To put it another away, the imaging device **136** is arranged to capture image data **141** (FIG. **35**) within a field of view directed toward the second openings **128***a*, **128***b*, and **128***c* formed through the body **124** of the cartridge receiver **122**.

By aligning the imaging device **136** with the region R_{128} of the at least one second opening **128** formed by the body **124** of the cartridge receiver **122**, an imaging device **136** of the imaging device IC **134** is able to see/view/image/read the detectable signal DS (see, e.g., FIG. **22**) formed by one or more of the test strip assays I_1, I_2, I_3 after the one or more test strip assays I_1, I_2, I_3 is/are contacted with the fluid F. And with the field of view (dashed line box R_{128}), the imaging device **136** may capture image data **141** from any and all test strip assays I loaded into a cartridge assembly **10** in the cartridge receiver **122**. For instance, the image data **141** captured by imaging device **136** may include detectable signal DS (e.g., color and/or intensity information) from result region R located on the one or more test strip assays I_1, I_2, I_3 in contact with the fluid F. In an example, the imaging device **136** may be a complementary metal oxide semiconductor (CMOS) sensor. In other examples, a lens (not shown) may be mounted to or arranged over the CMOS sensor **136**.

Referring to FIG. **26**, the implement analyzing device **100** may further include an integrated circuit support member **138** disposed within the cavity **120**. In an example, the integrated circuit support member **138** is secured to or is integral with the inner surface **114** of the support member $\mathbf{10}_2$. The integrated circuit support member **138** may secure or support an implement analyzing device integrated circuit (IC) **140**. In an example, the implement analyzing device IC **140** may include embedded Linux software and a 1-GHz Sitara processor.

Referring to FIG. **35**, the implement analyzing device IC **140** is coupled to the imaging device IC **134** by a communication link **142** (e.g., a flex cable) for communicating one or more readings (e.g., any of the detectable signals DS, barcodes B, and the like) in the image data **141** captured by the imaging device **136** to the implement analyzing device IC **140**. Once the one or more readings (e.g., any of the detectable signals DS, barcodes B and the like) in the image data **141** is received by the implement analyzing device IC **140**, the implement analyzing device IC **140** may analyze and subsequently interpret the one or more readings (e.g., any of the detectable signals DS, barcodes B and the like) for a user.

Referring back to FIGS. **23** and **24**A-**24**B, in addition to the cartridge receiver passage **130**, one or both of the support member **102** and the housing **104** may further defined a plurality of other passages **144**-**150** extending through a thickness T_{102} (see, e.g., FIG. **26**) of the support member **102** or the thickness T_{104} of the housing **104**. Like the cartridge receiver passage **130**, the plurality of other passages **144**-**150** may extend through the thickness T_{102} of the support member **102** or the thickness T_{104} of the housing **104**. The plurality of other passages **144**-**150** may include, but is not limited to: a user interface passage **144**; one or more data input passages **146**; one or more data input/output passages **148**; one or more power passages **150** and the like. Furthermore, one or both of the support member **102** and the housing **104** may form a fluid overflow passage **152** (see, FIG. **26**).

As seen in FIGS. **23** and **24**A-**24**B, the user interface passage **144** may be sized for permitting access to a user interface **153** displayed on a screen **154**. The screen **154** may be a touchscreen, which may be disposed within the cavity **120**. At least a portion of a perimeter of the touchscreen **154** may be disposed adjacent or otherwise secured to the inner surface **118** of the housing **104** such that a user may access and read the touchscreen **154** by way of the user interface passage **144**. Referring to FIG. **35**, the touchscreen **154** may be communicatively coupled to one or more of the imaging device IC **134** and the implement analyzing device IC **140** by a communication link **156**. In some examples, data processing hardware **143** at the implement analyzing device IC **140** executes the user interface **153** on the screen **154** for displaying a test result **190** associated with one or more test strip assays I.

In an example, the touchscreen **154** may be a capacitive touch touchscreen. The user interface may be a graphical user interface **153** displayed on the touchscreen **154** for conveying status of a test step being conducted, the test result **190** or the like. Furthermore, a user may interact with the graphical user interface **153** by touching the touchscreen **154**. For instance, the user may provide data input or selections to software being executed by the data processing hardware **143** of the implement analyzing device IC **140**.

As seen in FIGS. **23**, **24**A-**24**B and **27**, the one or more data input passages **146** may be sized for permitting access to an optical scanner **158**. In an example, the optical scanner **158** may be permitted to scan features or barcode data (e.g., one or more barcodes B) of items (e.g., one or more of the test strip assays I_1, I_2, I_3) arranged externally of the cavity **120**. Referring to FIG. **35**, the optical scanner **158** may be communicatively coupled to one or more of the imaging device IC **134** and the implement analyzing device IC **140** by a communication link **160**. In some examples, the data processing hardware **143** receives barcode data B scanned by the optical scanner **158** that is associated with one or more of the test strip assays I_1, I_2, I_3; determines a unique test strip identifier **147** for each test strip assay I_1, I_2, I_3 based on the scanned barcode data; and retrieves from memory hardware **145** (which is in communication with the data processing hardware **143**), test information **149** associated with each of the one or more of the test strip assays I_1, I_2, I_3. The test information **149** may include at least one of a test strip assay type, a test/analysis type, a desired temperature of the fluid F, an analysis duration, and any other information that may be pertinent. As used herein, the analysis duration may correspond to a time threshold or prescribed period of time indicating a minimum duration required for the fluid F to be in contact with the result region R of the test strip assay I associated with the obtained test information **149** before obtaining a corresponding test result **19** (e.g., a presence and/or concentration of the chemical analyte within the fluid F).

Additional uses for the optical scanner **158** may include scanning sample IDs and Lot ID data. Sample IDs are generated by a user to identify a sample fluid F being used. Additional uses for the optical scanner **158** may include scanning testing location information, user information, and any additional information that can be used for testing. The optical scanner **158** may also be used to change the mode of the reader (i.e., Demo mode), to unlock new features, or as a security feature to unlock the reader or specific reader functionality when the user scans a specific barcode.

As seen FIG. **24**B, passages **148** may be sized for housing any type of data input/output port **162** such as, for example, one or more universal serial bus (USB) ports **162***a*. Furthermore, the implement analyzing device IC **140** may also include an on-board USB port; in an implementation, the on-board USB port may be connected to a Wi-Fi dongle (not shown) to permit wireless communication with the implement analyzing device IC **140** (in order to, e.g., permit wireless uploading of a test result or downloading software updates). Referring to FIG. **35**, the one or more data input/output ports **162** may be communicatively coupled to one or more of the imaging device IC **134** and the implement analyzing device IC **140** by a communication link **164**.

Although the data input/output passages **148** may be sized for housing one or more USB ports **162***a*, the data input/output passages **148** may be sized for housing other types of data ports **162**. In an example, the data input/output passages **148** may be sized for housing one or more secure digital (SD) card ports **162***b*. Thus, the data port **162** may include memory hardware **151** external to the implement analyzing device IC **140**, in addition to, or in lieu of, the memory hardware **151** located at the implement analyzing device IC **140**. In another example, the data input/output passages **148** may be sized for housing an Ethernet port **162***c* for hardwire-connecting the implement analyzing device IC **140** to, for example, a router/wireless router for Internet access in the event that Wi-Fi is not available.

Referring to FIGS. **23** and **24**A, the one or more power passages **150** may be sized for permitting insertion of a power cord **166** (see, e.g., FIG. **35**). The power cord **166** may couple a power source P (e.g., a wall outlet, battery or the like) to one or more of the imaging device IC **134** and the implement analyzing device IC **140**. Although a power cord **166** may provide a source of power to one or more of the imaging device IC **134** and the implement analyzing device IC **140**, in some examples, one or more of the imaging device IC **134** and the implement analyzing device IC **140** may include a battery (not shown) for powering one or more the imaging device IC **134** and the implement analyzing device IC **140**.

Referring to FIG. **26**, the fluid overflow passage **152** may be formed proximate or substantially below the cartridge receiver **122** to permit excess fluid F_O to evacuate the implement analyzing device **100**. In one embodiment, the fluid F_O evacuates the implement analyzing device **100** with the assistance of gravity. The excess fluid F_O may flow: (1) over the over the fluid overflow edge **68** (see, e.g., FIG. **1**B) of each of the first fluid retainer cartridge assembly $\mathbf{10}_1$, the second fluid retainer cartridge assembly $\mathbf{10}_2$ and the third fluid retainer cartridge assembly $\mathbf{10}_3$, (2) out of the cartridge receiver **122** and then (3) out of the fluid overflow passage **152**.

Referring to FIGS. **28**-**30**, the implement analyzing device **100** may further include at least one cartridge heater **168**. The at least one cartridge heater **168** may be disposed within or secured to a base portion **170** (see, e.g., FIGS. **25**-**26**) of the body **124** of the cartridge receiver **122**. The base portion **170** of the body **124** of the cartridge receiver **122** may be located opposite the at least one first opening **126** formed by the body **124** of the cartridge receiver **122**.

The at least one cartridge heater **168** is defined by a body **172** having a base portion **172***a*, a front portion **172***b* and a rear portion **172***c*. The body **172** may be an aluminum die cast cube containing heater tape with a thermistor embedded in thermal epoxy. Optionally, the aluminum die cast cube may also house a small vibration motor (not shown) that may impart vibrations to the exemplary fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ for mixing and agitating the fluid F contained by the exemplary fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$.

Each of the base portion **172***a*, the front portion **172***b* and the rear portion **172***c* is defined by a cartridge supporting surface **174***a*, **174***b*, **174***c*. In an example, the cartridge supporting surface **174***a*, **174***b* of each of the base portion **172***a* and the front portion **172***b* may be defined by a substantially flat or planar surface. In another example, the cartridge supporting surface **174***c* of the rear portion **172***c* may include a substantially flat or planar surface that is interrupted by a curved or arcuate surface portion defined by a radius R_{172c} (see, e.g., FIG. **30**).

The cartridge supporting surface **174***a*, **174***b*, **174***c* of each of the base portion **172***a*, the front portion **172***b* and the rear portion **172***c* defines a cartridge-receiving gap **176**. As seen in FIG. **29**, the cartridge-receiving gap **176** is partially defined by the cartridge supporting surface **174***b* of the front portion **172***b* extending away from the cartridge supporting surface **174***a* of the base portion **172***a* at a distance D_{172b}. With further reference to FIG. **29**, the cartridge-receiving gap **176** is further partially defined by the cartridge supporting surface **174***c* of the rear portion **172***c* extending away from the cartridge supporting surface **174***a* of the base portion **172***a* at a distance D_{172c}. The distance D_{172b} may be greater than the distance D_{172c}. Furthermore, as seen in FIG. **30**, the cartridge-receiving gap **176** is further partially defined by the cartridge supporting surface **174***b* of the front portion **172***b* being spaced apart from the cartridge supporting surface **174***c* of the rear portion **172***c* at a distance D_{172a}.

As seen in FIG. **31**, the cartridge-receiving gap **176** defined by the cartridge supporting surface **174***a*, **174***b*, **174***c* of each of the base portion **172***a*, the front portion **172***b* and the rear portion **172***c* may be sized for receiving at least the cap portion **14** of the exemplary fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$. In an example, the distance D_{172b}, defining the cartridge supporting surface **174***b* of the front portion **172***b* may be sized for extending across at least the length L_{56} (see, e.g., FIG. **8**) of the implement proximal end retainer portion **56** of the tongue-receiving housing **54** of the cap portion **14**. In an example, the distance D_{172c} defining the cartridge supporting surface **174***c* of the rear portion **172***c* may be sized for extending across at least a portion the length L_{60} (see, e.g., FIG. **9**) of at least the arcuate-shaped channel **60** of the body **52** of the cap portion **14**. Furthermore, the radius R_{172c} defining the curved or arcuate surface portion of the cartridge supporting surface **174***c* of the rear portion **172***c* may be sized for receiving and corresponding to the radius R_{60} (see, e.g., FIGS. **10**, **13**) or radial geometric component extending into the front surface $\mathbf{52}_F$ of the body **52** of the cap portion **14** that defines the arcuate-shaped channel **60**.

Once the cap portion **14** is disposed within the cartridge-receiving gap **176** of the body **172** of the at least one cartridge heater **168**, portions of the outer surface of the body **52** of the cap portion **14** may be disposed adjacent the cartridge supporting surface **174***a*, **174***b*, **174***c* of each of the base portion **172***a*, the front portion **172***b* and the rear portion **172***c* of the body **172** of the at least one cartridge heater **168** for thermally transferring heat from the at least one cartridge heater **168** to the body **52** of the cap portion **14** (and, ultimately, to the fluid F contained within the body **52** of the cap portion **14**). In an example, the proximal end surface $\mathbf{52}_P$ of the body **52** of the cap portion **14** may be disposed adjacent or proximate the cartridge supporting surface **174***a* of the base portion **172***a* of the body **172** of the at least one cartridge heater **168**. Further, in an example, the front surface $\mathbf{52}_F$ defined the by implement proximal end retainer portion **56** of the tongue-receiving housing **54** of the cap portion **14** may be disposed adjacent or proximate the cartridge supporting surface **174***b* of the front portion **172***b* of the body **172** of the at least one cartridge heater **168**. Yet even further, in an example, the rear surface $\mathbf{52}_R$ defined by the body **52** of the cap portion **14** may be disposed adjacent or proximate the cartridge supporting surface **174***c* of the rear portion **172***c* of the body **172** of the at least one cartridge heater **168**.

After the cap portion **14** is disposed within the cartridge-receiving gap **176** of the body **172** of the at least one cartridge heater **168** as described above and the body **52** of the cap portion **14** makes contact with the at least one cartridge heater **168** as described above, the corresponding contact there-between acts as thermal transfer regions, to thereby thermally couple a test strip assay I at the cap portion with the at least one cartridge heater **168**. The rear and front surfaces $\mathbf{52}_R$ and $\mathbf{52}_F$ defined by the body **52** of the cap portion **14** preheats the fluid F before the fluid F flows through the fluid-flow passage **32** formed by the flange **28** of the base portion **12**. Thereafter, the implement proximal end retainer portion **56** of the tongue-receiving housing **54** of the cap portion **14** heats the fluid F prior to and after the fluid F comes into contact with the test strip assays I_1, I_2, I_3. The ability to provide heat to both of the rear and front surfaces $\mathbf{52}_R$ and $\mathbf{52}_F$ of the body **52** of the cap portion **14** and to the implement proximal end retainer portion **56** of the tongue-receiving housing **54** of the cap portion **14** may ensure a more consistent testing temperature of the fluid F.

With reference to FIGS. **32-34** and as described above, the base portion **170** (that receives or houses the at least one cartridge heater **168**) of the body **124** of the cartridge receiver **122** is located axially opposite the at least one first opening **126** formed by the body **124** of the cartridge receiver **122**. Furthermore, as seen in FIGS. **31-32**, the at least one cartridge heater **168** may include: a first cartridge heater **168*a***; a second cartridge heater **168*b***; and a third cartridge heater **168*c***. In an example, the first cartridge heater **168*a*** corresponds to, is located opposite and axially aligned with the first cartridge receiving opening **126*a*** of the at least one first opening **126**. In another example, the second cartridge heater **168*b*** corresponds to, is located opposite and axially aligned with the second cartridge receiving opening **126*b*** of the at least one first opening **126**. In yet another example, the third cartridge heater **168*c*** corresponds to, is located opposite and axially aligned with the third cartridge receiving opening **126*c*** of the at least one first opening **126**.

Referring to FIGS. **28-31** and **35**, each of the first cartridge heater **168*a***, the second cartridge heater **168*b*** and the third cartridge heater **168*c*** may be connected to the implement analyzing device IC **140** by one or more communication links **178**. The one or more communication conduits **178** may permit the implement analyzing device IC **140** to selectively activate any of the first cartridge heater **168*a***, the second cartridge heater **168*b*** and the third cartridge heater **168*c***. Selective activation of any of the first cartridge heater **168*a***, the second cartridge heater **168*b*** and the third cartridge heater **168*c*** may result from software/instructions stored in the memory hardware **145** and executed by the data processing hardware **143** of the implement analyzing device IC **140**.

In an example, selective activation of any of the first cartridge heater **168*a***, the second cartridge heater **168*b*** and the third cartridge heater **168*c*** may arise from different test types (e.g., specified by the test information **149**) to be conducted on the first plurality of test strip assays I_1-I_3 contained by the first fluid retainer cartridge assembly $\mathbf{10}_1$, the second plurality of test strip assays I_1-I_3 contained by the second fluid retainer cartridge assembly $\mathbf{10}_2$ and the third plurality of test strip assays I_1-I_3 contained by the third fluid retainer cartridge assembly $\mathbf{10}_3$, which may each require different testing temperatures. For instance, the test information **149** associated with each test strip assay I_1-I_3 retained within one of the fluid retainer cartridge assemblies $\mathbf{10}_1$-$\mathbf{10}_3$ may specify a desired temperature of the fluid (F) retained therein. Accordingly, each of the first cartridge heater **168*a***, the second cartridge heater **168*b*** and the third cartridge heater **168*c*** that is associated with each of the first, second and third cartridge receiving openings **126*a***, **126*b***, **126*c*** may be controlled independently to carry out such non-similar temperature tests.

Referring back to FIGS. **28-30**, the front portion **172*b*** and the rear portion **172*c*** of the body **172** are not connected by corresponding side portions. The lack of side portions reduces an amount of heat transfer between neighboring cartridge heaters **168*a*-168*b*** and **168*b*-168*c***, and, thus, between neighboring fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ contained therein. By reducing heat transfer between neighboring fluid retainer cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$, independent heating of each fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ may be more accurately controlled. Accordingly, cartridge heaters **168*a-c*** may be selectively activated independently from one another such that each heating device **168*a-c*** is thermally coupled to a corresponding removably-inserted fluid retainer cartridge assembly **10** (e.g., assembly $\mathbf{10}_1$) and thermally isolated from the one or more other fluid retainer cartridge assemblies **10** (e.g., assemblies $\mathbf{10}_2$ and $\mathbf{10}_3$). Moreover, each heating device (e.g., each cartridge heater **168*a-c***) may be selectively deactivated after a prescribed period of time specified by the test information **149**. Here, the prescribed period of time may refer to the analysis duration during which the fluid (F) is in contact with the result region R on the one or more test strip assays I_1-I_3, or the prescribed period of time may refer to a time duration required to heat the fluid (F) to the desired temperature.

Activation of any of the first cartridge heater **168*a***, the second cartridge heater **168*b*** and the third cartridge heater **168*c*** results in any of the first cartridge heater **168*a***, the second cartridge heater **168*b*** and the third cartridge heater **168*c*** generating heat. The generated heat by any of the first cartridge heater **168*a***, the second cartridge heater **168*b*** and the third cartridge heater **168*c*** may be directed to any portion (e.g., the cap portion **14**) of the fluid retainer cartridge assembly **10** that is disposed within the cartridge-receiving gap **176** defined by the cartridge supporting surface **174*a***, **174*b***, **174*c*** of each of the base portion **172*a***, the front portion **172*b*** and the rear portion **172*c*** of the body **172** of the at least one cartridge heater **168**.

Referring to FIG. **35**, the implement analyzing device **100** may also include a fan **180** that is located within the cavity **120**. The fan **180** may be secured to one or more of the inner surface **114** of the support member **102** and the inner surface **118** of the housing **104**. The fan **180** may include a motor (not shown) that is connected to the implement analyzing device IC **140** by a communication link **182**. The motor associated with the fan **180** may be activated or deactivated upon the implement analyzing device IC **140** sending an activation or deactivation signal to the fan **180** by way of the communication link **182**.

Activation of the fan **180** may occur in order to cool one or more components that are located within the cavity **120** of the implement analyzing device **100**. The one or more components within the cavity **120** that may need to be cooled may include, but is not limited to one or more of the: the imaging device IC **134**, the implement analyzing device IC **140** and the at least one cartridge heater **168**. In some implementations, the fan **180** may be automatically activated if, for example, the implement analyzing device IC **140** determines (e.g., senses) that the at least one cartridge heater **168** exceeds a predetermined test temperature (i.e., the desired temperature specified by the test information **149**) for the purpose of reducing or maintaining the at least one cartridge heater **168** at or a below the predetermined test temperature. Such a determination made by the implement analyzing device IC **140**, may occur in response to a temperature and/or humidity sensor **181** positioned within the cavity **120** and communicatively-coupled to the implement analyzing device IC **140** by a communication link **183**.

The implement analyzing device **100** may include other components not shown in the Figures. For example, the implement analyzing device **100** may also include a vibration motor that provides haptic feedback during a test or for agitating the fluid F within any fluid retainer cartridge assembly **10**. In another example, the implement analyzing device **100** may also include an onboard three axis accelerometer for indicating to a user if the implement analyzing device **100** is not level in order to mitigate an adverse condition that may negatively impact fluid flow within any fluid retainer cartridge assembly **10**. In yet another example, the implement analyzing device **100** may also include antennas or sensors for a variety of functions relating to global positioning systems (GPS), radio frequency identification

(RFID) recognition, barometer readings and the like; such additional antennas or sensors may provide additional information about testing conditions that may be considered during analysis.

A method for utilizing the implement analyzing device **100** is now described. Firstly, as seen in FIG. **23**, at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of a plurality of fluid retainer cartridge assemblies $\mathbf{10}_P$ may be loaded with one or more of the test strip assays I_1, I_2, I_3. As seen in FIGS. **24**A-**24**B, **25**, **26**, the at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of the plurality of fluid retainer cartridge assemblies **10***p* that have been loaded with the test strip assays I_1, I_2, I_3 then may be interfaced with the implement analyzing device **100**, e.g., by inserting the at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of the plurality of fluid retainer cartridge assemblies **10***p* through the at least one first opening **126** (e.g., **126***a*, **126***b*, and **126***c*) of the body **124** of the cartridge receiver **122**. Alternatively, test strip assays I_1, I_2, I_3 may be loaded into the at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of a plurality of fluid retainer cartridge assemblies $\mathbf{10}_P$ after the at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of a plurality of fluid retainer cartridge assemblies $\mathbf{10}_P$ have been interfaced with the implement analyzing device **100**. In one embodiment, as seen in FIG. **1**B, each loaded at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of a plurality of fluid retainer cartridge assemblies $\mathbf{10}_P$ may be dosed with an amount of fluid F while, if desired, each loaded at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of a plurality of fluid retainer cartridge assemblies $\mathbf{10}_P$ is disposed within the implement analyzing device **100**. Alternatively, the plurality of fluid retainer cartridge assemblies **10***p* may be dosed with an amount of fluid F before test strip assays I_1, I_2, I_3 are loaded into the at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of a plurality of fluid retainer cartridge assemblies $\mathbf{10}_P$.

The implement analyzing device **100** may be actuated before, during or after dosing each loaded at least one fluid retainer cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ of a plurality of fluid retainer cartridge assemblies $\mathbf{10}_P$ with the amount of fluid F such that the implement analyzing device **100** can monitor, read, and analyze the one or more of the test strip assays I_1, I_2, I_3 before, during, and after dosing. Actuation of the implement analyzing device **100** may include one or more of the imaging device **136** obtaining one or more images I (see, e.g., FIGS. **25-26**) of the of the one or more of the test strip assays I_1, I_2, I_3 and may include activating the at least one cartridge heater **168**.

In an example, as seen in FIGS. **25-26**, the imaging device **136** of the imaging device IC **134** may continuously capture image data **141** of the one or more of the test strip assays I_1, I_2, I_3. The image data **141** captured by the imaging device **136** are communicated from the imaging device IC **134** to the implement analyzing device IC **140** by way of the communication link **142**.

Referring back to FIG. **35**, the data processing hardware **143** of the implement analyzing device IC **140** may execute a test strip assay recognition algorithm to detect one or more test strip assays I received by the cartridge receiver **122** based on the image data **141** received by the imaging device **136**. For instance, the test strip assay recognition algorithm may determine when a test strip assay I_1, I_2, I_3 is arranged within the region R_{128} of the at least one second opening **128** formed by the body **124** of the cartridge receiver **122** for the purpose of executing an analysis routine on each detected corresponding test strip assay I_1, I_2, I_3 based on the corresponding test information **149**. In one embodiment, the test strip assay recognition algorithm may continuously determine whether a test strip assay I_1, I_2, I_3 is arranged within the region R_{128} of the at least one second opening **128** formed by the body **124** of the cartridge receiver **122** for the purpose of executing an analysis routine on each detected corresponding test strip assay I_1, I_2, I_3.

In some scenarios, the test strip assay recognition algorithm analyzes multiple cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ through corresponding second openings **128***a*, **128***b*, **128***c* independently from one another to detect whether one or more test strip assays I are arranged in each independent cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$. For instance, the data processing hardware **143** may select any cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ and use the image data **141** to detect whether one or more test strip assays I are arranged within the selected port/cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ independently from the other cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$. Thus, the imaging device **136** may capture image data **141** directed toward the region R_{128} of the at least one second opening **128** formed by the body **124** of the cartridge receiver **122** and the data processing hardware **143** of the implement analyzing device IC **140** may use the image data **141** to individually monitor each cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ for the presence of one or more test strip assays I arranged therein. Accordingly, each cartridge assembly **10** that has been inserted into the cartridge receiver **122** may be monitored separately for the presence of test strip assays I, or two or more cartridge assemblies **10** may be monitored simultaneously for the presence of test strip assays I. Similarly, each cartridge assembly **10** that has been inserted into the cartridge receiver **122** may be independently heated and/or the capture image data **141** independently analyzed (for the test strip assays I_1, I_2, I_3 in that cartridge assembly **10**) separate from any other cartridge assembly **10**; or two or more cartridge assemblies **10** may be simultaneously heated and/or the capture image data **141** simultaneously analyzed (for the test strip assays I_1, I_2, I_3 in those cartridge assemblies **10**). Furthermore, the test strip assay recognition algorithm may analyze the image data **141** received from the imaging device **136** to identify one or more indicia markings disposed on each detected test strip assay I_1, I_2, I_3. The indicia markings may include at least one of the barcode data B, the alphanumerical data #, or the color data (see, FIG. **1**A). Thereafter, the data processing hardware **143** may determine the unique test strip identifier **147** associated with each detected test strip assay I_1, I_2, I_3 based on the identified indicia markings, and retrieve the test information **149** associated with each detected test strip assay I_1, I_2, I_3 using the corresponding unique test strip identifier **147**. Here, the memory hardware **145** contains a database/data store linking unique test strip identifiers **147** with corresponding test information **149**. Manufacturers of the test strip assays may provide the test strip information **149**. The memory hardware **145** may be internal (e.g., associated with the implement analyzing device IC **140**) or externally connected as one of the data input/output devices **162**. Additionally or alternatively, the optical scanner **158** may scan the barcode data B and provide the scanned barcode data B to the data processing hardware **143** for determining the unique test strip identifier **147**. Here, the unique test strip identifier **147** may be obtained for test strip assays I_1, I_2, I_3 prior to being inserted into the implement analyzing device **100**.

With continued reference to FIG. **35**, the data processing hardware **143** may execute, for each detected test strip assay I_1, I_2, I_3, the analysis routine on the corresponding test strip assay I after being contacted with the fluid F based on the corresponding test information **149**. The analysis routine is configured to analyze the detectable signal DS (e.g., a color change or intensity information) within the result region R located on the corresponding test strip assay I based on the image data **141**, and determine the test result **190** indicating the presence and/or concentration of the chemical analyte within the fluid F. Each test result **190** may be tagged with the corresponding unique test strip identifier **147** and stored in the memory hardware **145**. In some examples, the data processing hardware **143** displays the test result **190** for each detected test strip assay I on the graphical user interface **153** executing on the touchscreen **154**.

In some implementations, the data processing hardware **143** automatically executes an analysis routine on a corresponding detected test strip assay I in response to obtaining the test information **149** associated therewith. In other implementations, after obtaining the test information **149**, the data processing hardware **143** analyzes the image data **141** received from the imaging device **136** to measure a level of the fluid (F) retained by the corresponding removably-inserted fluid retainer cartridge assembly **10**, and determines whether the measured level of the fluid F is at least a threshold fluid level. The test information **149** may specify the threshold fluid level, whereby the threshold fluid level is a volume of fluid F sufficient for contacting the results region R on each detected test strip assay I retained by the corresponding fluid retainer cartridge assembly **10** to initiate the chemical reaction (if any) with a chemical analyte. Thereafter, the data processing hardware **143** may execute the analysis routine on each detected test strip assay I retained by the corresponding fluid retainer cartridge assembly **10** in response to determining the measured level of the fluid is at least the threshold fluid level. In some examples, the data processing hardware **143** initiates a timer responsive to the measured level of the fluid F being at least the threshold fluid level. In these examples, the analysis routine determines the test result **190** associated with each detected test strip assay I retained by the corresponding fluid retainer cartridge assembly **10** when the timer satisfies the analysis duration specified by the test information **149**. In some configurations, the cap portion **14** of the fluid retainer cartridge assembly **10** is translucent so that the fluid F is visible through the second opening **126** of the cartridge **122** and, thus, measurable from the image data **141** captured by the imaging device **136**.

Similar to how the test strip assay recognition algorithm analyzes multiple cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ independently from one another for detecting the presence of test strip assays I, the data processing hardware **143** may execute the analysis routine on each detected test strip assay I retained by a corresponding selected fluid retainer cartridge assembly **10** independently from other detected test strip assays I retained by other corresponding fluid retainer cartridge assemblies **10**. Thus, while cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_2$, $\mathbf{10}_3$ may each retain at least one test strip assay I detected by the recognition algorithm, the analysis routine may analyze the at least one test strip assay I retained by the cartridge assembly $\mathbf{10}_2$ independently from the at least one test strip assay I retained by the other cartridge assembly $\mathbf{10}_1$, $\mathbf{10}_3$. For instance, the analysis routine may analyze assays I within cartridge assembly $\mathbf{10}_2$ while waiting for the measured fluid level of the fluid within at least one of the other cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_3$ to reach the threshold fluid level. In another scenario, the analysis routine may analyze assays I retained within cartridge assembly $\mathbf{10}_2$ the recognition algorithm is continuously monitoring the other cartridge assemblies $\mathbf{10}_1$, $\mathbf{10}_3$ for the presence of test strip assays I. In some implementations, the analysis routine analyzes test strip assays I retained by at least two different cartridge assemblies **10** simultaneously.

In an example, activation of the at least one cartridge heater **168** during, for example, a period of time results in the at least one cartridge heater **168** imparting heat to at least, for example, the cap portion **14** of the fluid retainer cartridge assembly **10**, which may also contain the fluid F. The imparted heat serves to incubate at least, for example, the cap portion **14** of the fluid retainer cartridge assembly **10** if a particular test requires the fluid F contained therein to be heated to a desired temperature specified by the test information **149**.

In some implementations, the color and/or intensity information associated with the detectable signal DS includes line intensity of one or more result lines (e.g. control lines) superimposed in the result region R of the corresponding test strip assay I_1, I_2, I_3. The line intensity of the one or more result lines is analyzed by the analysis routine. In some examples, to expedite the analysis routine, the analysis routine may be further configured to determine a rate of change in the line intensity of the one or more result lines, and predict the test result **190** indicating the presence and/or concentration of the chemical analyte before result lines are fully developed, i.e., before the end of the analysis duration.

Before or after the image data **141** is ready to be analyzed, the data processing hardware **143** (i.e., processor) of the implement analyzing device IC **140** may also execute a series of result line centering routines each used to ensure that the region of interest (i.e. result region R) for each test and result line is centered. Line centering information specified by the testing information **149** associated with each test strip assay I_1, I_2, I_3 may vary by the lot in which each test strip assay I_1, I_2, I_3 was manufactured. In some instances, the series of line centering algorithms may auto-detect and position the center using the line centering information, even with the inherent positional variation. The line intensity of each line on each test strip assay I_1, I_2, I_3 is read and the quantified results are calculated, displayed and saved in the memory hardware **145**. Accordingly, execution of the analysis routine may include execution of the result line centering routine on the corresponding test strip assay (I) to center one or more result lines superimposed in the result region R. Here, the result line centering routine is configured to identify the one or more result lines superimposed in the result region R based on the image data **141** received from the imaging device **136**, and adjust a position of the one or more result lines to align with result line centering information specified by the test information **149**.

Referring to FIG. **36**, the implement analyzing device **100** may further include a plurality of light sources **184** arranged within the cavity **120** and directed toward the region **8128** of the at least one second opening **128** formed by the body **124** of the cartridge receiver **122** for the purpose of illuminating regions of each test strip assay I_1, I_2, I_3 that is to be imaged by the imaging device **136** as described above.

In an example, the plurality of light sources **184** are secured to the imaging device IC **134**. In an implementation, the plurality of light sources **184** include light emitting diode (LED) light sources. In some instances, the plurality of light sources **184** include eight LED light sources. The plurality of LED light sources may emit any desired type of color light (that is defined, e.g., by wavelength) including but not limited to: visible light; white light; colored light; and infrared light.

In an example, the imaging device IC **134** may include two sets of four LED light sources **184**. In an example, the imaging device IC **134** may independently operate each

LED light source **184** of the two sets of four LED light sources **184**. Furthermore, in an example, the imaging device IC **134** may include two independent lighting circuits that allow for different illumination conditions within the cavity **120** that may increase the potential of test types that may be conducted by the implement analyzing device **100**.

The method may also include one or more calibration steps for ensuring that the inter-unit variability is low. Many of the calibration steps may be performed a single time before the implement analyzing device **100** is utilized for a first time. Calibration may occur at the manufacturer or by a user in the field.

In an example, illumination calibration may set an illumination percentage of all the plurality of light sources **184** associated with the imaging device IC **134**. A target brightness may be determined through testing and the goal of the illumination calibration routine is to match actual brightness to a target brightness. Referring to FIGS. **37-38**, illumination calibration may be conducted by inserting a calibration cartridge **10***c* into a central port (e.g., the second cartridge receiving opening **126***b*) of the at least one first opening **126** formed by the body **124** of the cartridge receiver **122**. The imaging device **136** may obtain an image of the calibration cartridge **10***c*, which is subsequently provided to the implement analyzing device IC **140** for conducting the calibration process. An average brightness value is determined for the region of interest of the calibration cartridge **10***c* with all settings of the imaging device **136** set to default values. The illumination value is then adjusted so that the average brightness value is within a set tolerance of the target brightness value.

In another example, white balance calibration may be used for setting one or more color balance settings on the imaging device IC **134**; calibrating these values reduces a color variance between different implement analyzing devices **100** due to any inherent differences of the imaging devices **136** and plurality of light sources **184** installed therein. The same calibrator cartridge $\mathbf{10}_C$ and region of interest described above may be used for achieving white balance calibration as was used for brightness calibration. The imaging device **136** may obtain an image of the calibration cartridge $\mathbf{10}_C$, which is subsequently provided to the implement analyzing device IC **140** for conducting the calibration process. In some instances, the red balance value and the blue balance value are determined through an iterative process aimed at reducing the chrominance values to zero.

In yet another example, a lens calibration routine (for calibrating a lens associated with/attached to the imaging device **136**) may be used for post-processing correction of a vignetting effect that is inherent in the imaging device/lens setup. The lens calibration routine (that is conducted in response to the imaging device **136** obtaining an image of the calibration cartridge $\mathbf{10}_C$, which is subsequently provided to the implement analyzing device IC **140** for conducting the calibration process) may determine the intensity throughout the calibrator cartridge $\mathbf{10}_C$ and fits a curve to the white region; this curve can then be used to correct the image, reducing the color variance between ports within the implement analyzing device **100**.

In another example, port calibration may be used for locating each of the first, second and third cartridge receiving openings **126***a*, **126***b*, **126***c* to make the identification of each test strip assay I_1, I_2, I_3 easier and more accurate. The first, second and third cartridge receiving openings **126***a*, **126***b*, **126***c* are found by inserting a calibrator cartridge $\mathbf{10}_C$ into each of the first, second and third cartridge receiving openings **126***a*, **126***b*, **126***c*. The imaging device **136** may obtain an image of the calibration cartridge $\mathbf{10}_C$, which is subsequently provided to the implement analyzing device IC **140** for conducting the calibration process. The black regions of the calibrator cartridge $\mathbf{10}_C$ are used as fiducial markers, allowing for accurate determination of the cartridge boundaries. Techniques such as edge detection may additionally or alternatively be used to locate the boundary of each port within the captured image data **141**.

The data processing hardware **143** of the implement analyzing device IC **140** may execute a test strip assay recognition algorithm to detect one or more test strip assays I received by the cartridge receiver **122** based on the image data **141** received by the imaging device **136**. A third test strip assay **13** may be detected and includes a location within the first fluid retainer cartridge assembly $\mathbf{10}_1$, while first, second, and third test strip assays I_1, I_2, I_3 may be detected and include locations within the second fluid retainer cartridge assembly $\mathbf{10}_2$. Both the port calibration and test strip recognition algorithm may use a dynamic threshold to more accurately identify the bounds. When a strip is found, its specific position within in the cartridge receiver **122** can be saved for testing purposes. The data processing hardware **143** may execute the recognition algorithm to continuously look for the presence of test strips to automatically trigger the analysis. This feature can also be used to monitor the test and ensure the strip has not been removed during analysis.

In yet another example, crosshair calibration is an additional positional calibration of the internal components of the implement analyzing device **100**. In an example, a t-shaped crosshair T (see, e.g., FIG. **38**) of the calibrator cartridge $\mathbf{10}_C$ allows for both X and Y positional calibration offsets to be generated; the offsets are determined as the distance, both in X and in Y, from the expected location. The imaging device **136** may obtain an image of the calibration cartridge **10***c*, which is subsequently provided to the implement analyzing device IC **140** for conducting the calibration process. Using the offsets, the implement analyzing device **100** can more accurately locate specific characteristics on the cartridges or inserted test strip assays I_1, I_2, I_3.

In another example, a cartridge track may include white circular markers on either side that are imaged by the imaging device **136**, which is subsequently provided to the implement analyzing device IC **140** for conducting the calibration process for validating both position of internal components as well as illumination. The position and illumination values of these spots are saved during the overall calibration routine. These values are then checked every time the implement analyzing device **100** is turned on. If the position or illumination of the regions of interest are outside of the set threshold, the validation will not pass. This can indicate to the user that there is an issue with the implement analyzing device **100** that could cause invalid results. If the illumination values are not within tolerance for the predetermined regions of interest, this could indicate that the alignment of the internal components has been compromised or that the plurality of light sources **184** associated with the imaging device IC **134** are not functioning how they did during calibration.

FIG. **39** is a flow chart of an example method **4200** for determining a test result **190** indicating a presence and/or concentration of a chemical analyte within a fluid F in contact with a test strip assay I. The method includes, at block **4202**, receiving image data **141** from an imaging device **136**. The imaging device **136** captures the image data **141** within a field of view directed toward an opening **128** formed through a cartridge receiver **122**. At block **4204**, the method **4200** includes detecting, by the data processing hardware **143**, one or more test strip assays I received by the cartridge receiver **122** based on the image data **141**. Here, the test strip assays I are configured to chemically react with the chemical analyte after contact with a fluid F. At block **4206**, the method **4200** includes obtaining, by the data processing hardware **143**, test information **149** associated with each detected test strip essay I. For instance, the test information **149** may be retrieved from memory hardware **145** using a unique test strip identifier **147** linked to the test information **149**. For each detected test strip assay I, the method **4200** includes, at block **4408**, executing, by the data processing hardware **143**, an analysis routine on the corresponding test strip assay I based on the corresponding test information **149**. The analysis routine is configured to analyze a detectable signal DS (e.g., color and/or intensity information) within a result region R located on the corresponding test strip assay (I) based on the image data **141** received from the imaging device **136**, and determine the test result **190** indicating the presence and/or concentration of the chemical analyte within the fluid (F) based on the analyzed color and/or intensity information.

A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the disclosure. Accordingly, other implementations are within the scope of the following claims.

What is claimed is:

1. An implement analyzing system, comprising:

at least one fluid retainer cartridge assembly that is sized to receive at least one implement for indicating one or both of a presence and a concentration of an analyte; and

an implement analyzing device that is configured to receive the at least one fluid retainer cartridge assembly, wherein the implement analyzing device includes

a support member,

a housing connected to the support member, wherein each of the support member and the housing defines an outer surface and an inner surface, wherein the inner surface of each of the support member and the housing form a cavity,

a vertically-oriented cartridge receiver disposed within the cavity and connected to the inner surface of one or both of the support member and the housing, wherein the cartridge receiver includes a proximal end and a distal end, and wherein the cartridge receiver defines at least one cartridge viewing window and at least one first opening adjacent the proximal end of the cartridge receiver,

at least one cartridge heater disposed within the cavity and located at the distal end of the cartridge receiver,

an imaging device disposed within the cavity and arranged opposite the at least one cartridge viewing window, and

an implement analyzing device integrated circuit communicatively coupled to the at least one cartridge heater and the imaging device, wherein the implement analyzing device integrated circuit includes data processing hardware that executes instructions stored on memory hardware for operating the at least one cartridge heater and the imaging device.

2. The implement analyzing system of claim **1**, wherein the at least one first opening of the cartridge receiver is aligned with a cartridge receiver passage extending through the housing.

3. The implement analyzing system of claim **2**, wherein the at least one cartridge heater is defined by a body that includes:

a base portion, a front portion, and a rear portion;

wherein each of the base portion, the front portion and the rear portion is defined by a cartridge supporting surface;

wherein the cartridge supporting surface of each of the base portion and the front portion are defined by a substantially flat surface; and wherein the cartridge supporting surface of the rear portion includes a substantially flat surface that is interrupted by a curved or arcuate surface portion.

4. The implement analyzing system of claim **2**, wherein the at least one first opening is defined by:

a first cartridge receiving opening;

a second cartridge receiving opening; and

a third cartridge receiving opening.

5. The implement analyzing system of claim **4**, wherein the at least one cartridge heater includes:

a first cartridge heater;

a second cartridge heater; and

a third cartridge heater, wherein the first cartridge heater corresponds to, is located opposite and axially aligned with the first cartridge receiving opening of the at least one first opening, wherein the second cartridge heater corresponds to, is located opposite and axially aligned with the second cartridge receiving opening of the at least one first opening, wherein the third cartridge heater corresponds to, is located opposite and axially aligned with the third cartridge receiving opening of the at least one first opening.

6. The implement analyzing system of claim **5**, wherein each of the first cartridge heater, the second cartridge heater and the third cartridge heater are connected to the implement analyzing device integrated circuit.

7. The implement analyzing system of claim **6**, wherein the implement analyzing device integrated circuit selectively activates each of the first cartridge heater, the second cartridge heater and the third cartridge heater.

8. The implement analyzing system of claim **3**, wherein the front portion and the rear portion of the body are not connected by side portions.

9. The implement analyzing system of claim **1** further comprising:

a fan located within the cavity, wherein the fan is connected to the implement analyzing device integrated circuit; or

a temperature sensor located within the cavity, wherein the temperature sensor is connected to the implement analyzing device integrated circuit.

10. The implement analyzing system of claim **1** further comprising:

an imaging device integrated circuit connected to the imaging device, wherein the imaging device integrated circuit is communicatively-coupled to the implement analyzing device integrated circuit.

11. The implement analyzing system of claim **10**, further comprising:

a plurality of light sources arranged within the cavity and connected to the imaging device integrated circuit, wherein the plurality of light sources are directed toward the at least one cartridge viewing window.

12. The implement analyzing system of claim **11**, wherein the imaging device integrated circuit independently operates each light source of the plurality of light sources.

13. The implement analyzing system of claim **12**, wherein the plurality of light sources are light emitting diode light sources.

14. The implement analyzing system of claim **1**, wherein the imaging device is aligned with a region of the at least one cartridge viewing window.

15. The implement analyzing system of claim **1**, wherein the cartridge receiver is sized to receive more than one fluid retainer cartridge assembly.

16. The implement analyzing system of claim **15**, wherein the at least one cartridge viewing window of the cartridge receiver is sized to permit the imaging device to capture image data from more than one fluid retainer cartridge assembly.

17. The implement analyzing system of claim **1**, wherein one or both of the support member and the housing forms a fluid overflow passage.

18. The implement analyzing system of claim **1**, wherein the cartridge receiver is formed from a first material and at least one cartridge heater is formed from a second material, and wherein the first material is different from the second material.

19. A method comprising:

obtaining the implement analyzing system according to claim **1**,

obtaining at least one implement;

obtaining a test sample;

inserting the at least one implement into the cartridge receiver;

pouring the test sample into the cartridge receiver;

receiving, at the data processing hardware, image data from the imaging device, the imaging device capturing the image data within a field of view directed toward the at least one cartridge viewing window of the cartridge receiver;

obtaining, by the data processing hardware, test information associated with the at least one implement;

executing, by the data processing hardware, an analysis routine on the test information; and

determining a test result indicating one or both of the presence and the concentration of the analyte.

20. The method of claim **19**, wherein the at least one fluid retainer cartridge assembly includes two fluid retainer cartridge assemblies and the at least one implement includes two implements; and

wherein the inserting step includes inserting one implement into one of the two fluid retainer cartridge assemblies and inserting the other implement into the other of the fluid retainer cartridge assemblies.

21. The method of claim **19**, wherein executing the analysis routine comprises executing a first analysis routine on a first implement and a second analysis routine on a second implement.

22. The method of claim **21**, wherein the first and second implements are retained by a single fluid retainer cartridge assembly inserted into the cartridge receiver.

23. An implement analyzing device that is sized for receiving more than one fluid retainer cartridge assembly, comprising:

a support member;

a housing connected to the support member, wherein each of the support member and the housing defines an outer surface and an inner surface, wherein the inner surface of each of the support member and the housing form a cavity;

a vertically-oriented cartridge receiver disposed within the cavity and connected to the inner surface of one or both of the support member and the housing, wherein the cartridge receiver includes a proximal end and a distal end, and wherein the cartridge receiver defines at least one cartridge viewing window and at least one first opening adjacent the proximal end of the cartridge receiver;

at least one cartridge heater disposed within the cavity and located at the distal end of the cartridge receiver;

an imaging device disposed within the cavity; and

an implement analyzing device integrated circuit communicatively coupled to the at least one cartridge heater and the imaging device, wherein the implement analyzing device integrated circuit includes data processing hardware that executes instructions stored on memory hardware for operating the at least one cartridge heater and the imaging device,

wherein the cartridge receiver includes a lower surface portion,

wherein the at least one cartridge heater includes a front portion having a first upper surface portion and a rear portion having a second upper surface portion, and the first upper surface portion is offset from the second upper surface portion,

wherein the lower surface portion of the cartridge receiver is disposed adjacent the first and second upper surface portions of the at least one cartridge heater, and

wherein the cartridge receiver is connected to the at least one cartridge heater.

24. The implement analyzing device of claim **23**, wherein the at least one first opening of the cartridge receiver is aligned with a cartridge receiver passage extending through the housing.

25. The implement analyzing device of claim **23**, wherein the imaging device is aligned with a region of the at least one cartridge viewing window.

26. The implement analyzing device of claim **23**, wherein the cartridge receiver is sized to receive more than one fluid retainer cartridge assembly.

27. The implement analyzing device of claim **26**, wherein the at least one cartridge viewing window of the cartridge receiver is sized to permit the imaging device to capture image data from more than one fluid retainer cartridge assembly.

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