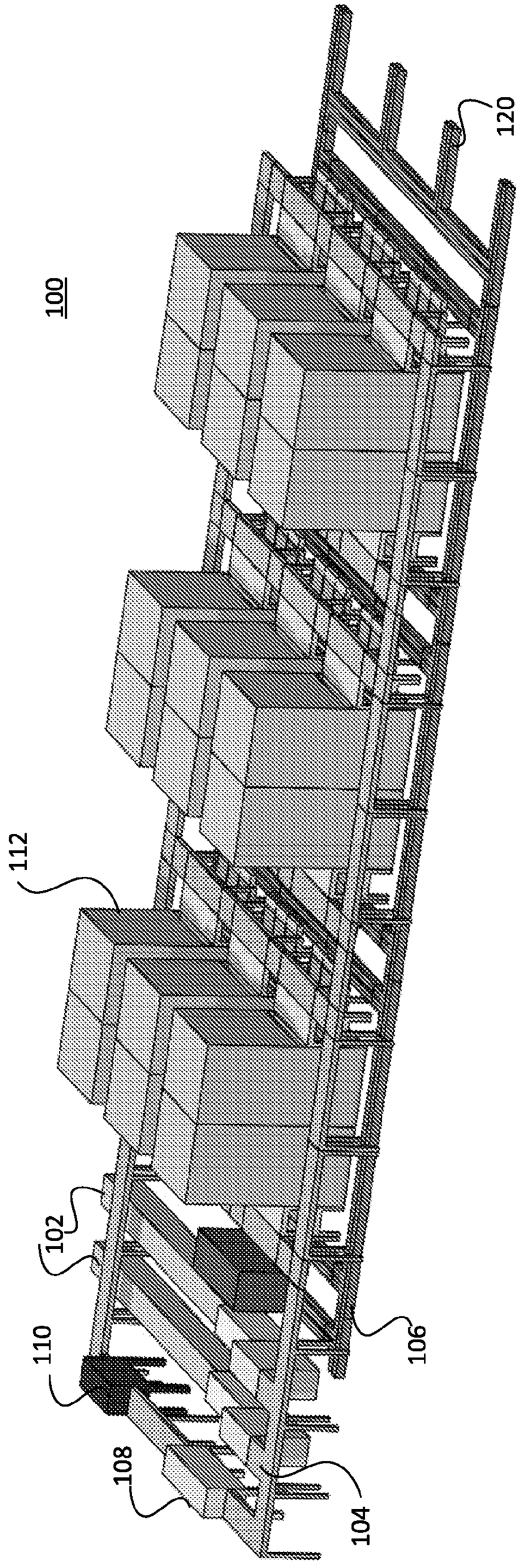


FIG. 1

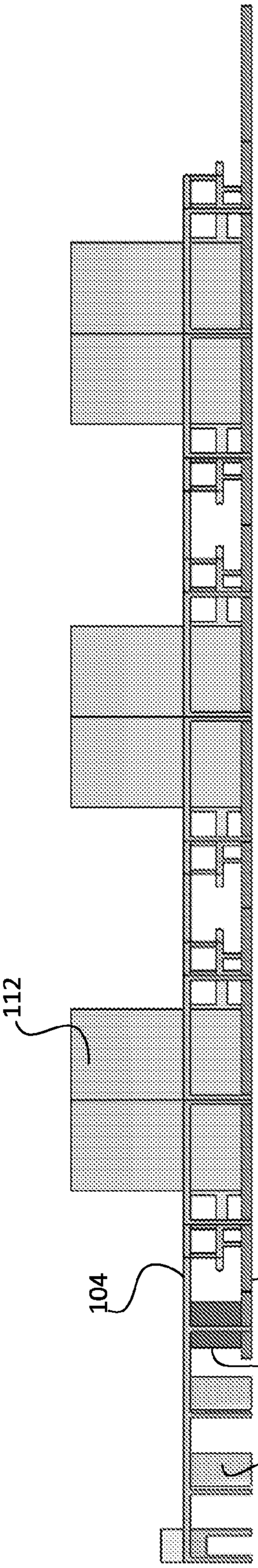


FIG. 1A

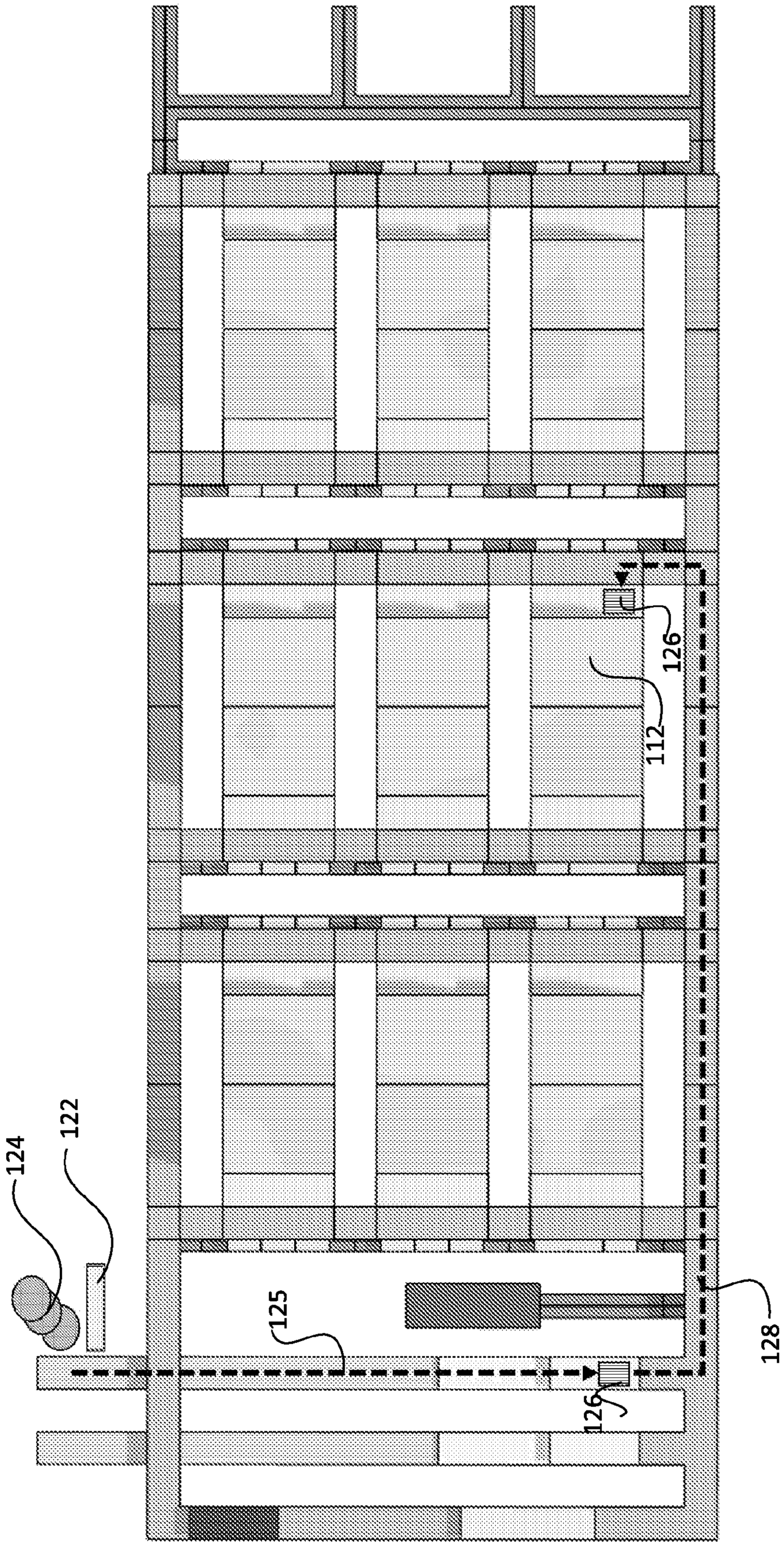


FIG. 1B

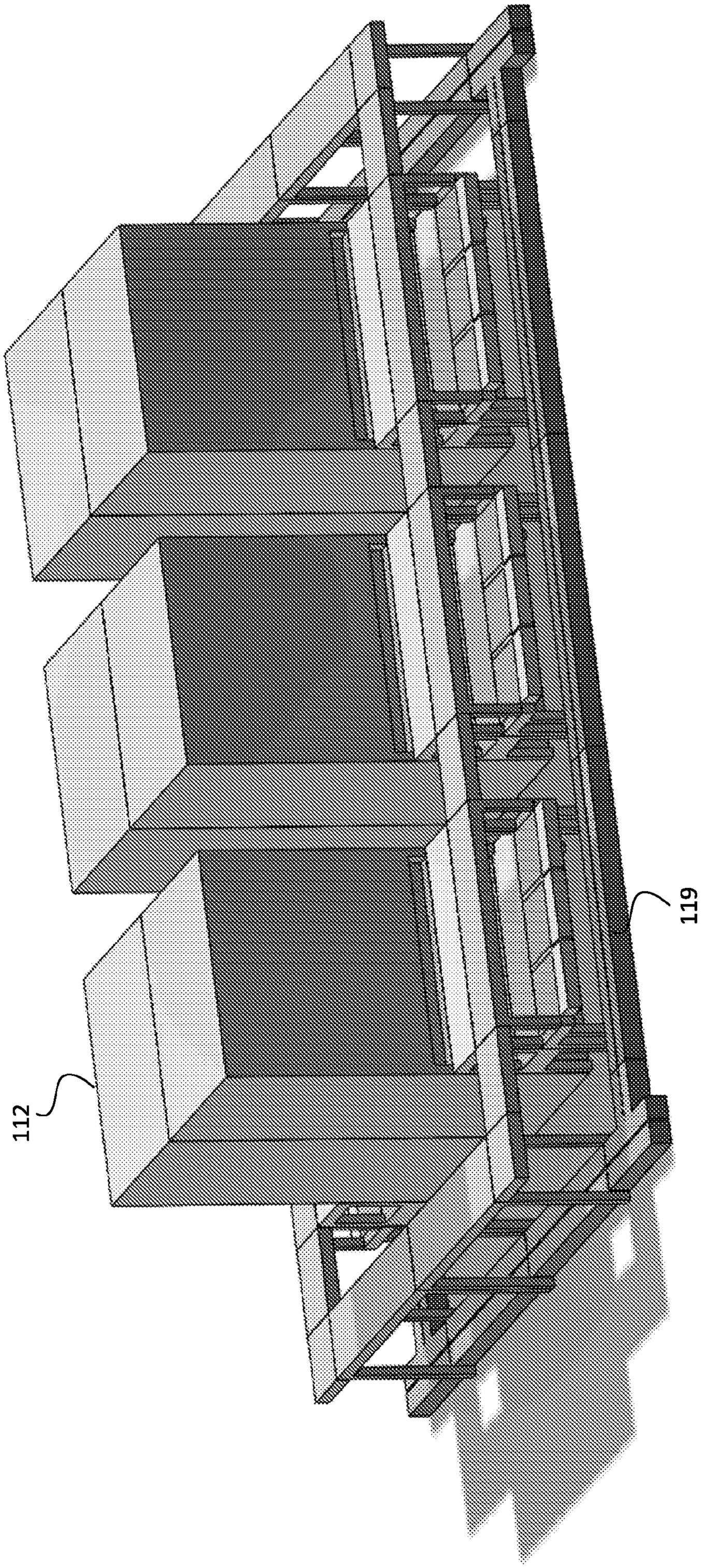


FIG. 1C

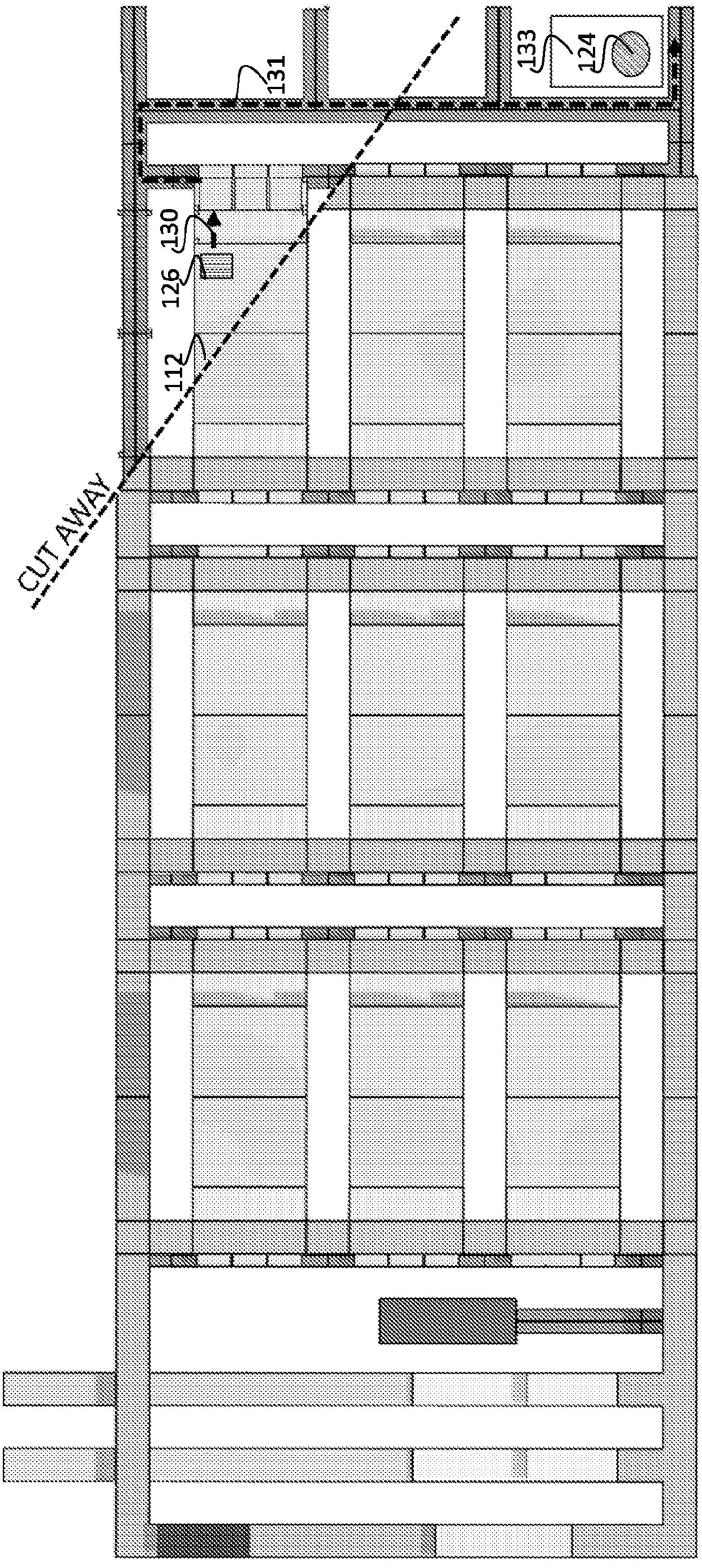


FIG. 1D

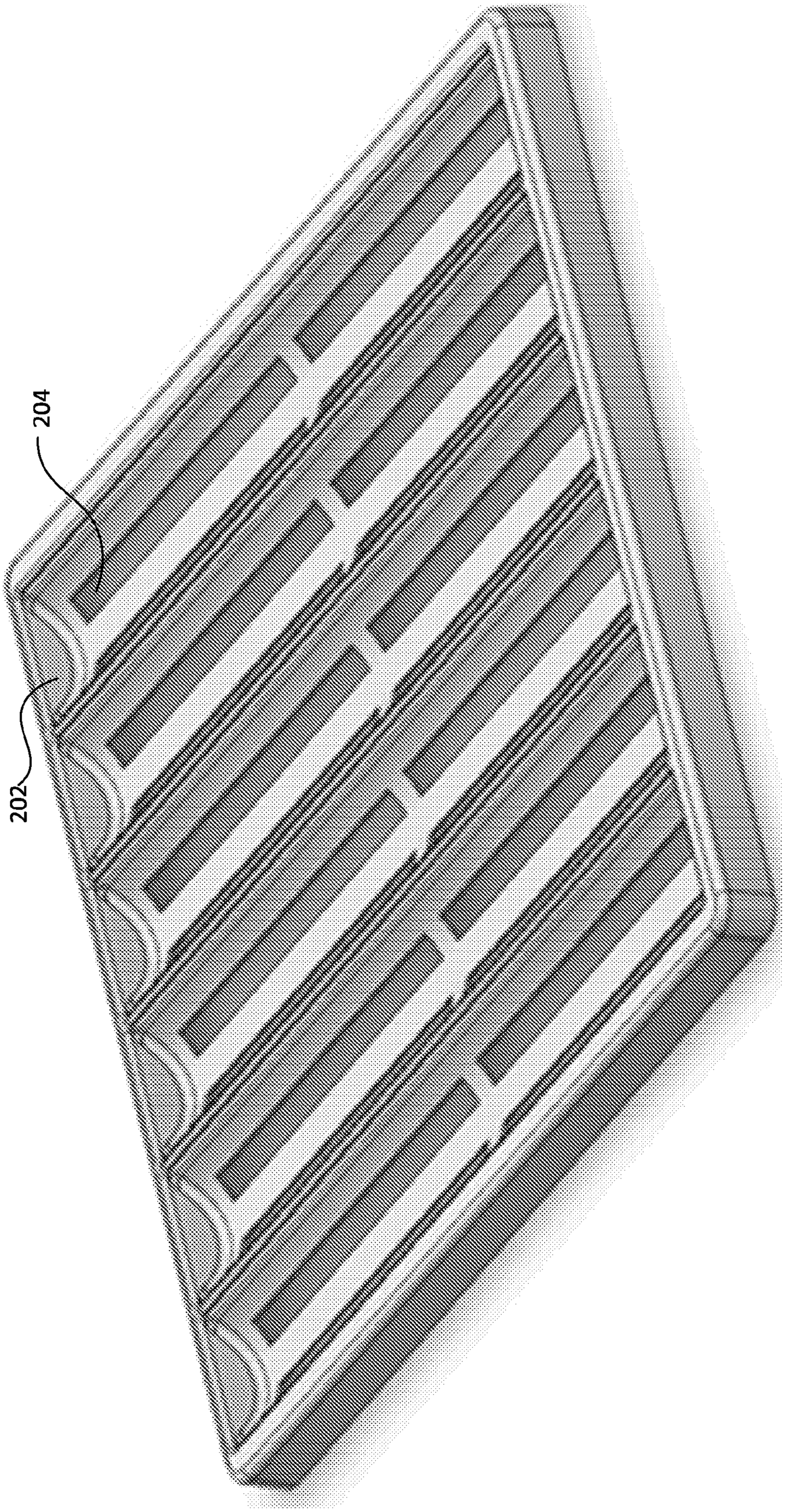


FIG. 2

FIG. 2A

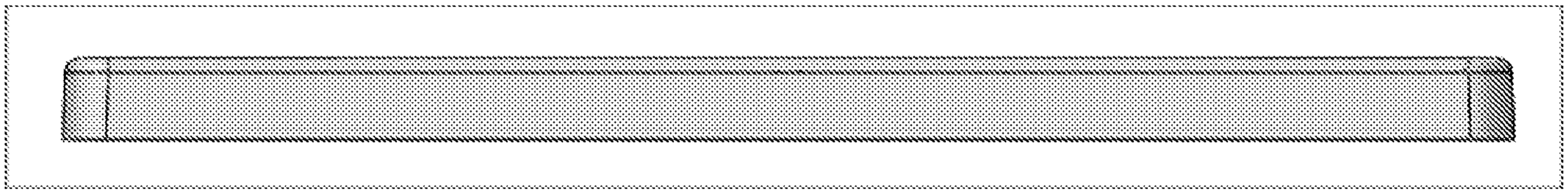
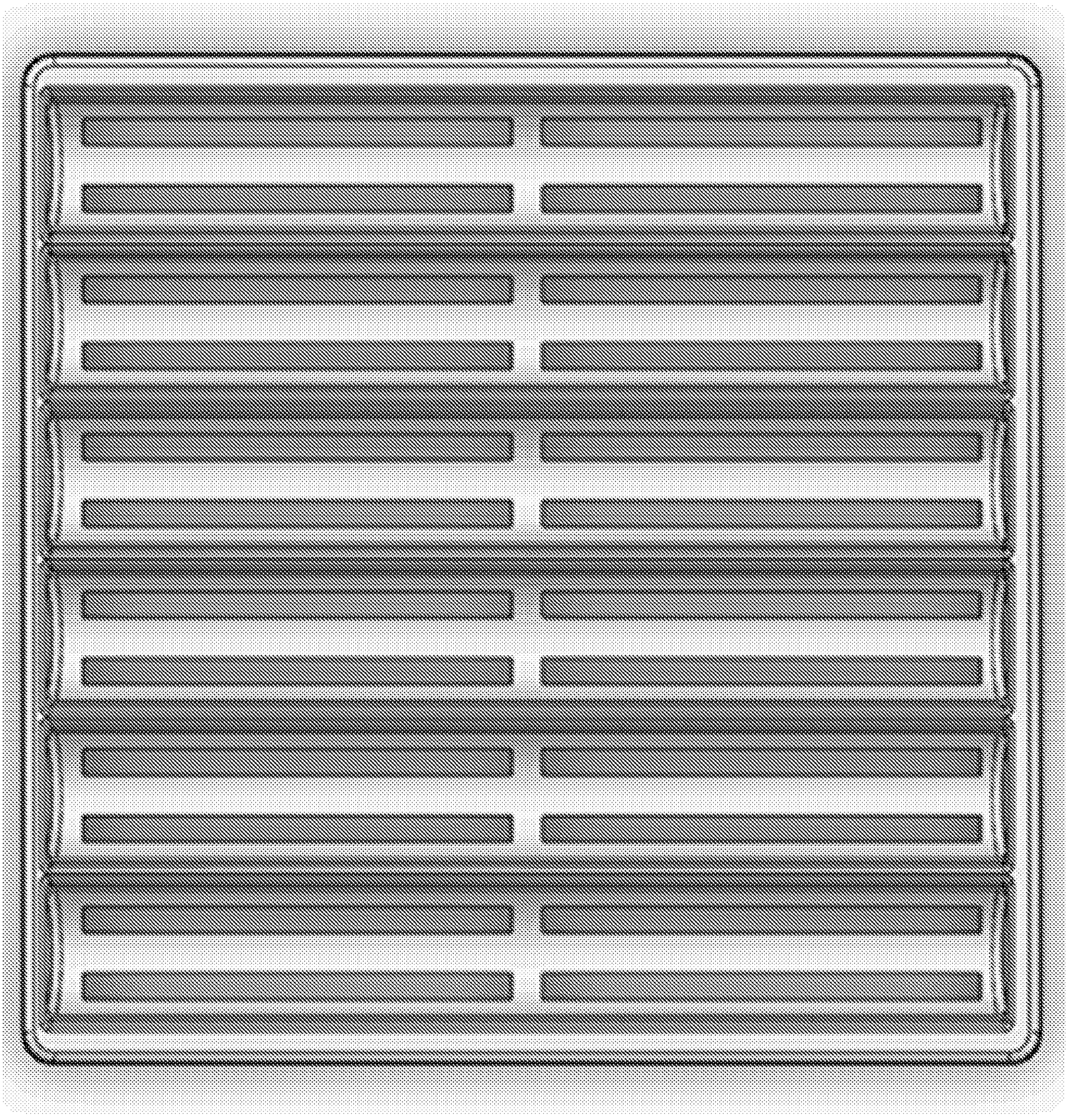


FIG. 2B



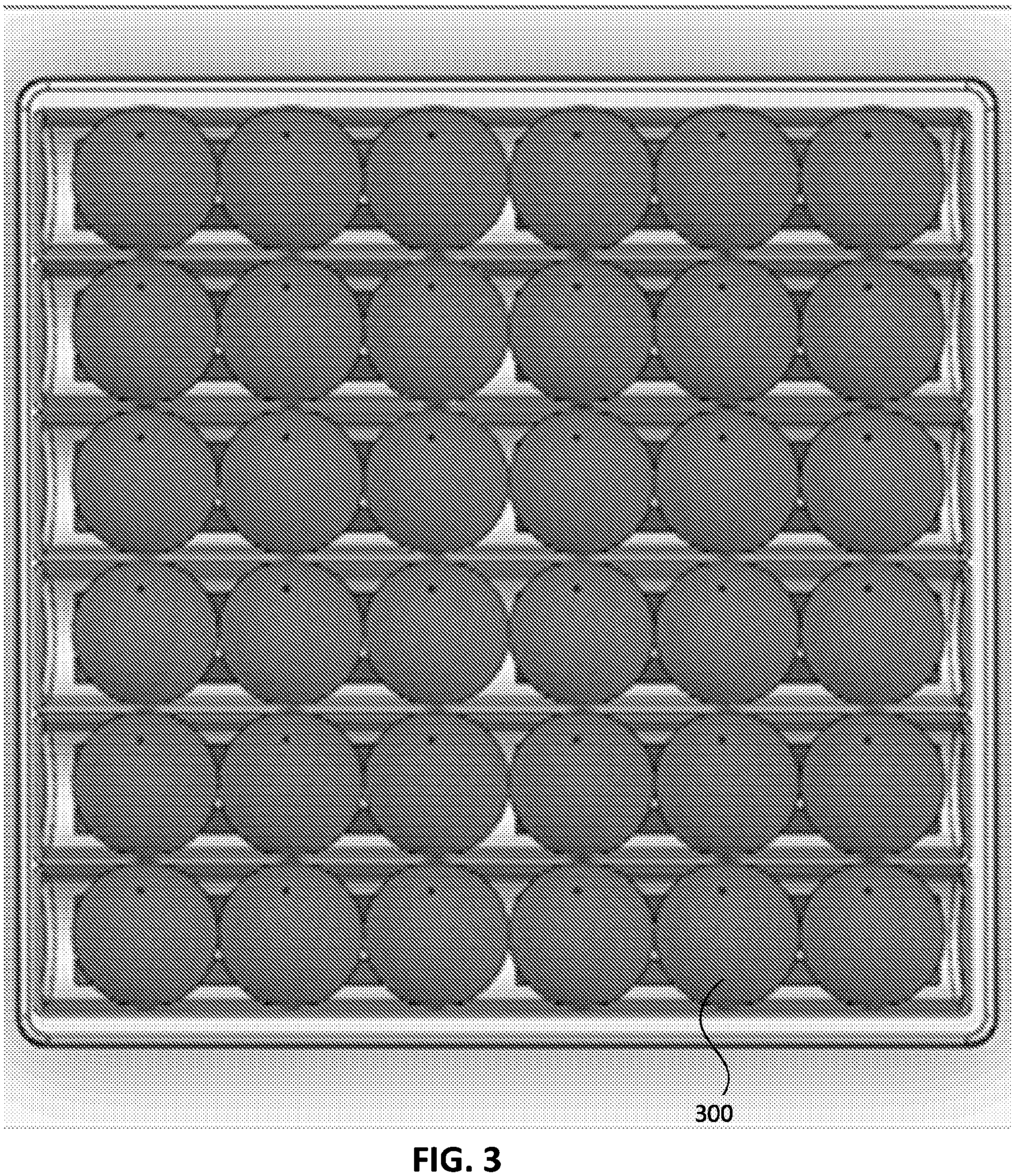
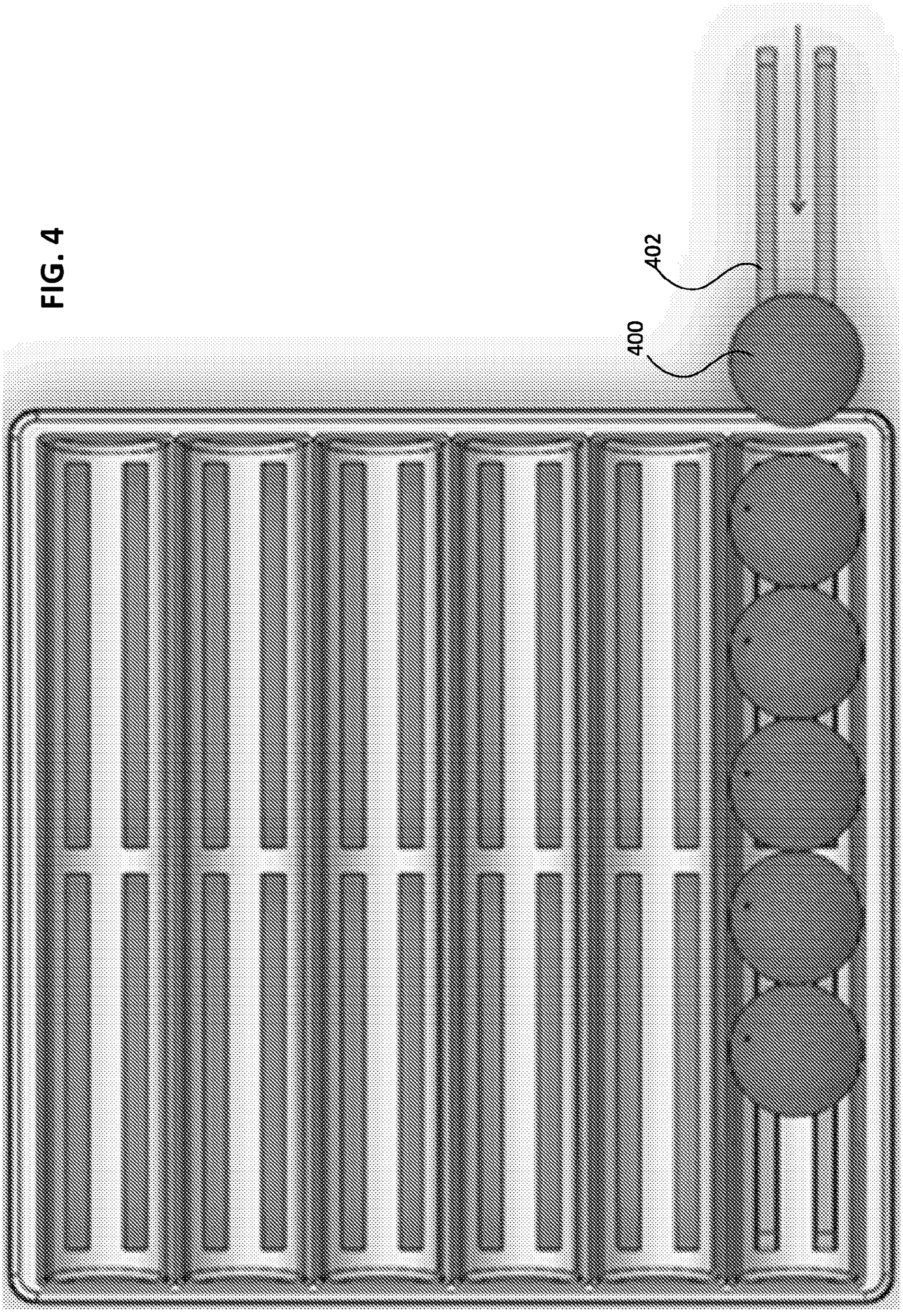


FIG. 3

FIG. 4



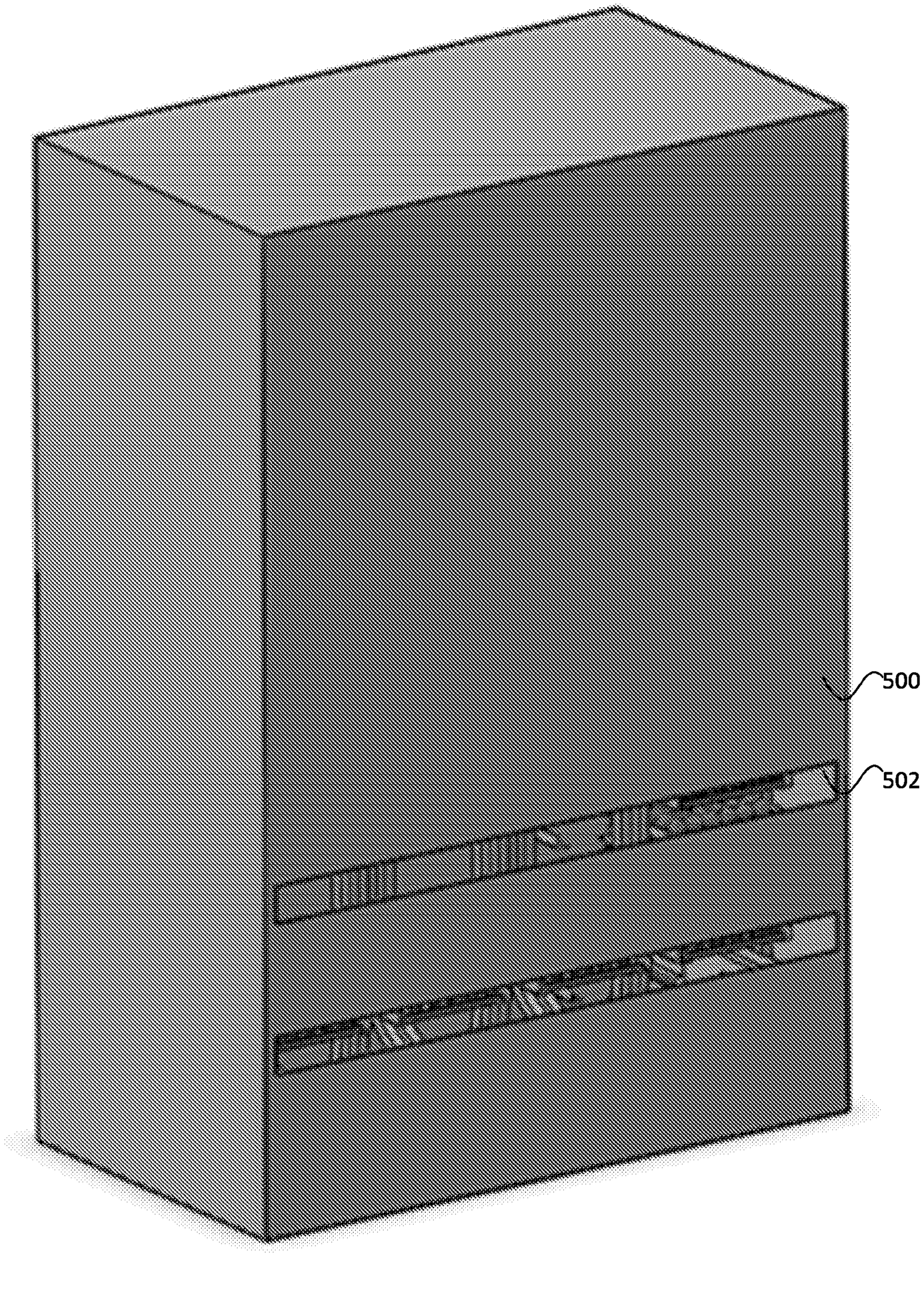


FIG. 5A

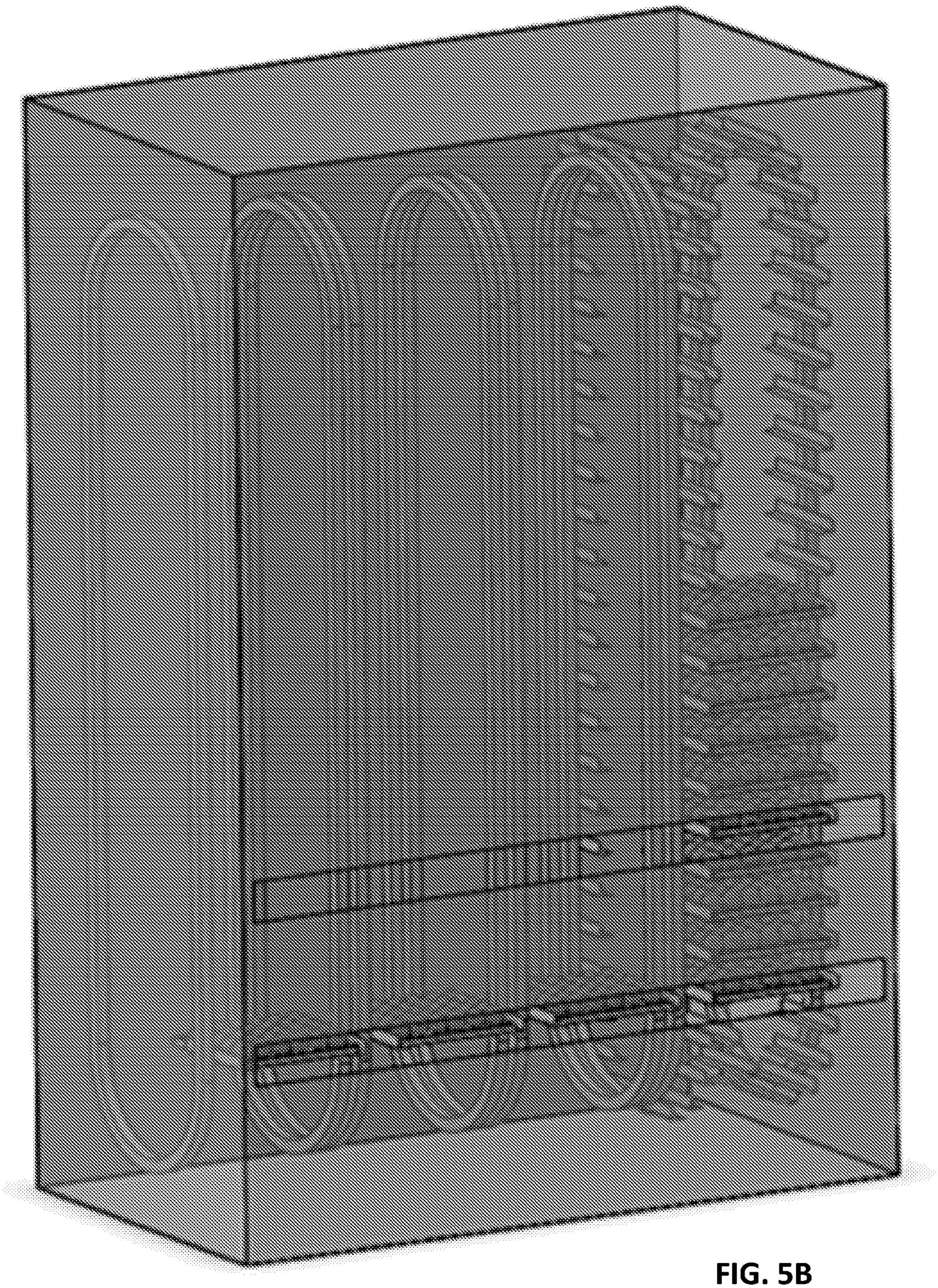


FIG. 5B

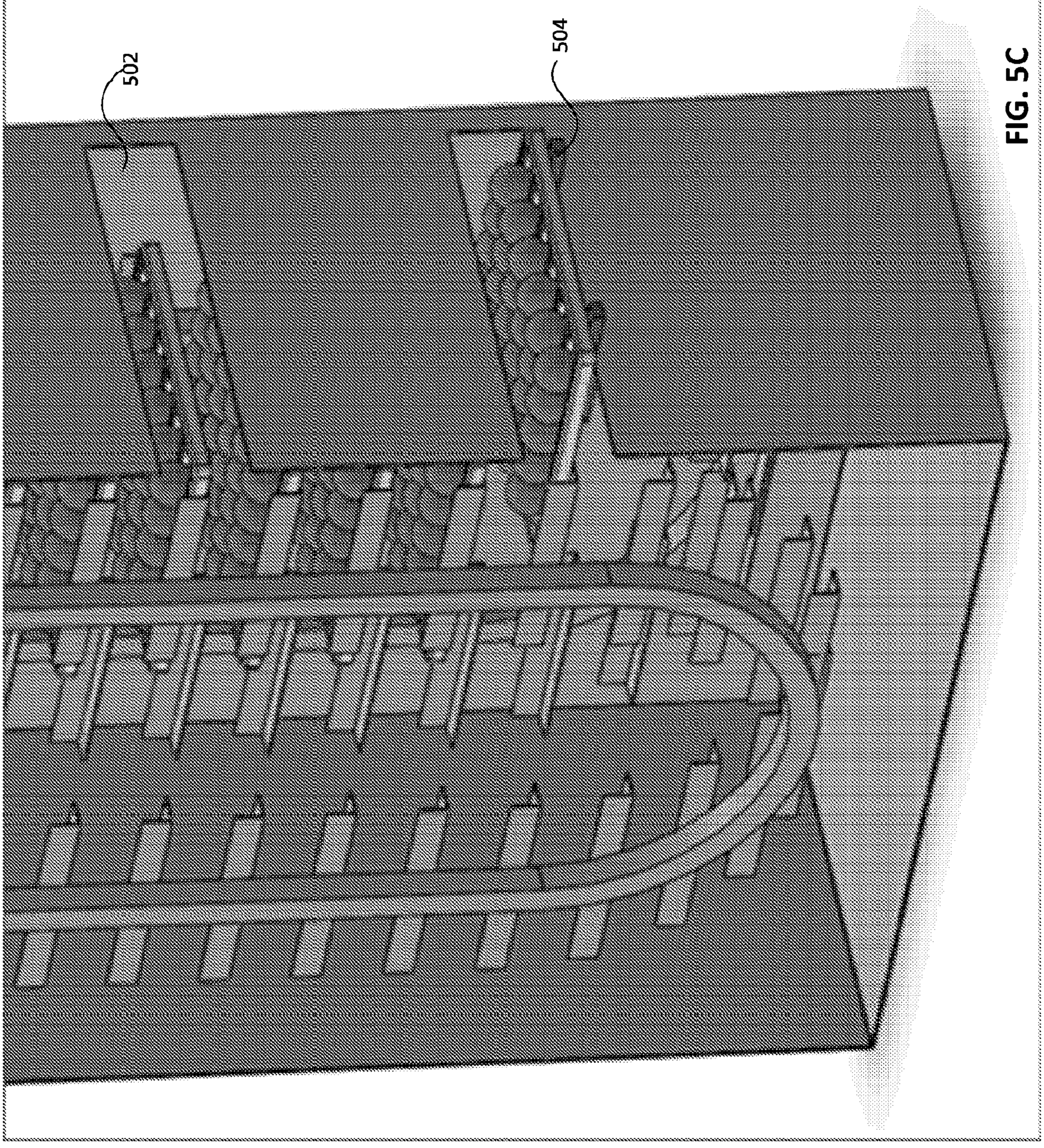


FIG. 5C

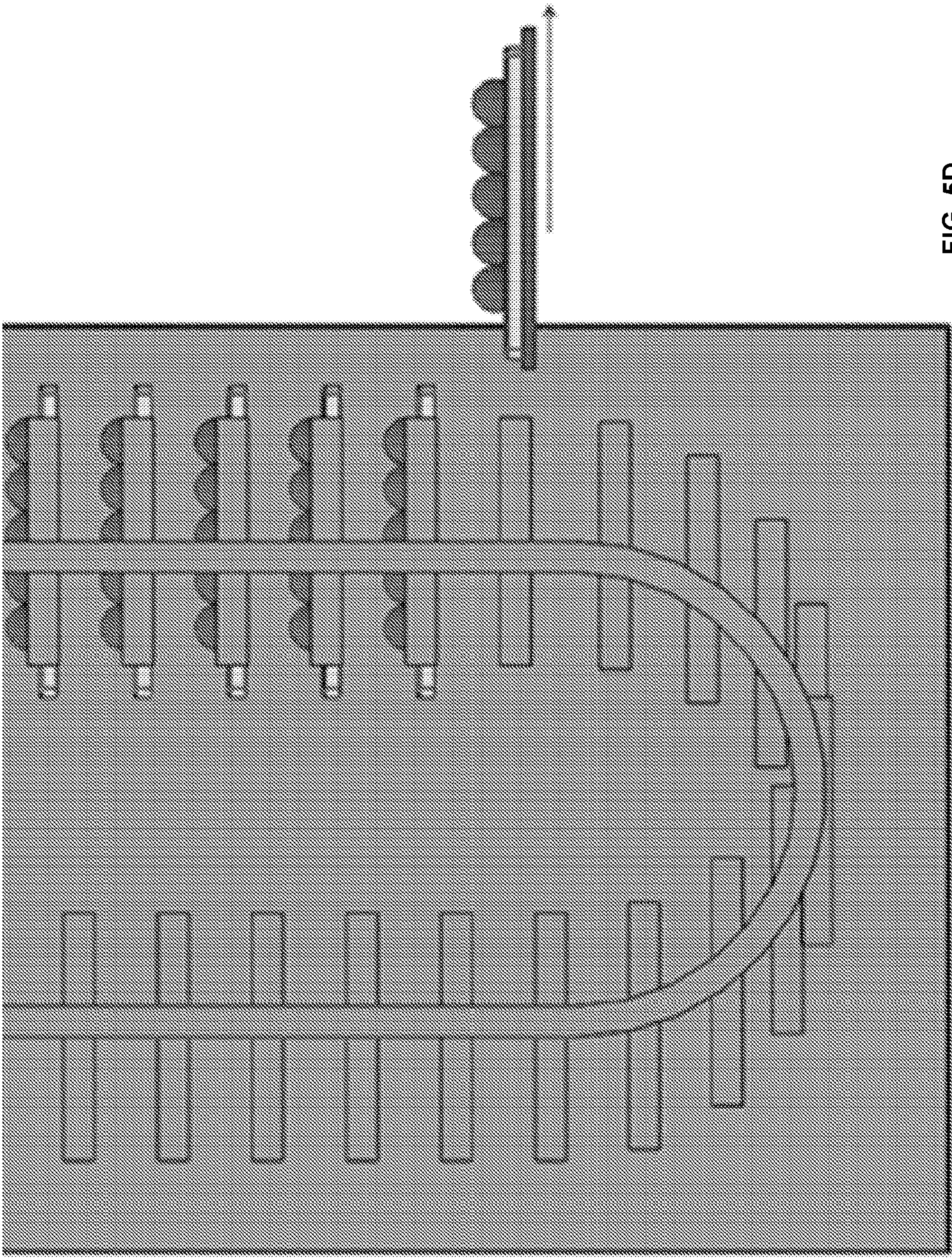


FIG. 5D

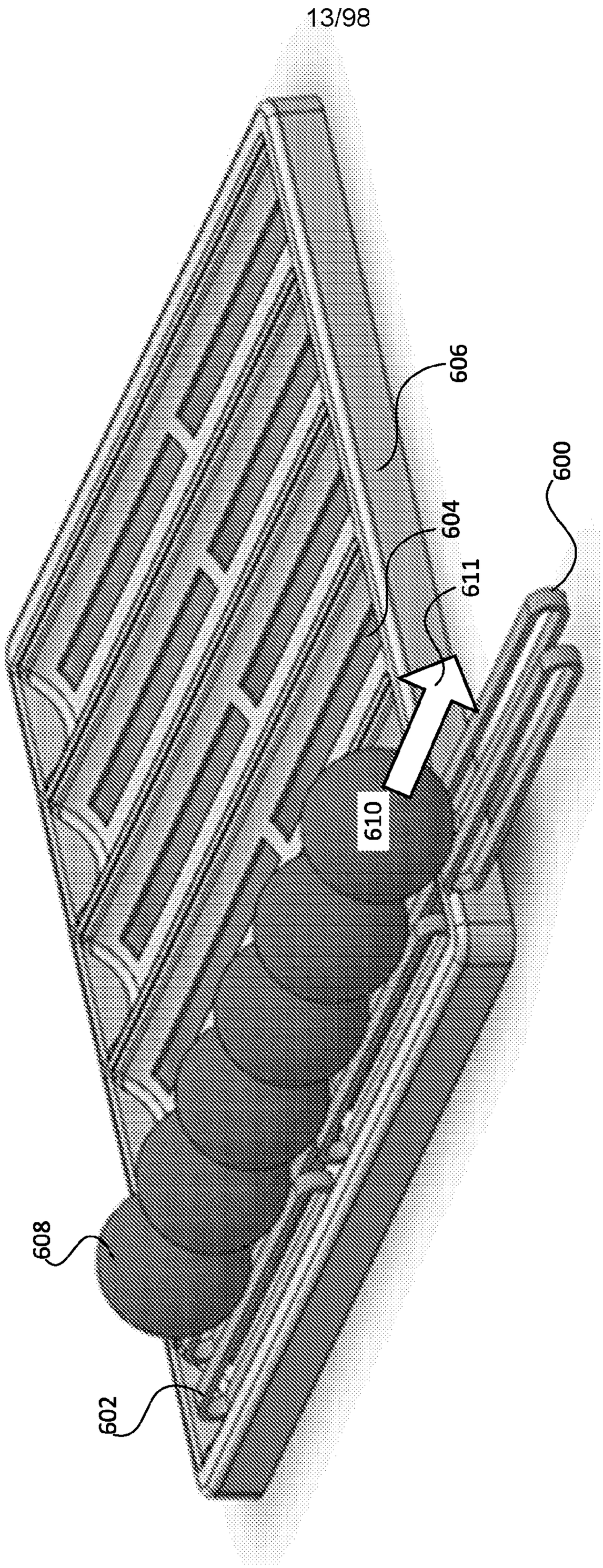


FIG. 6

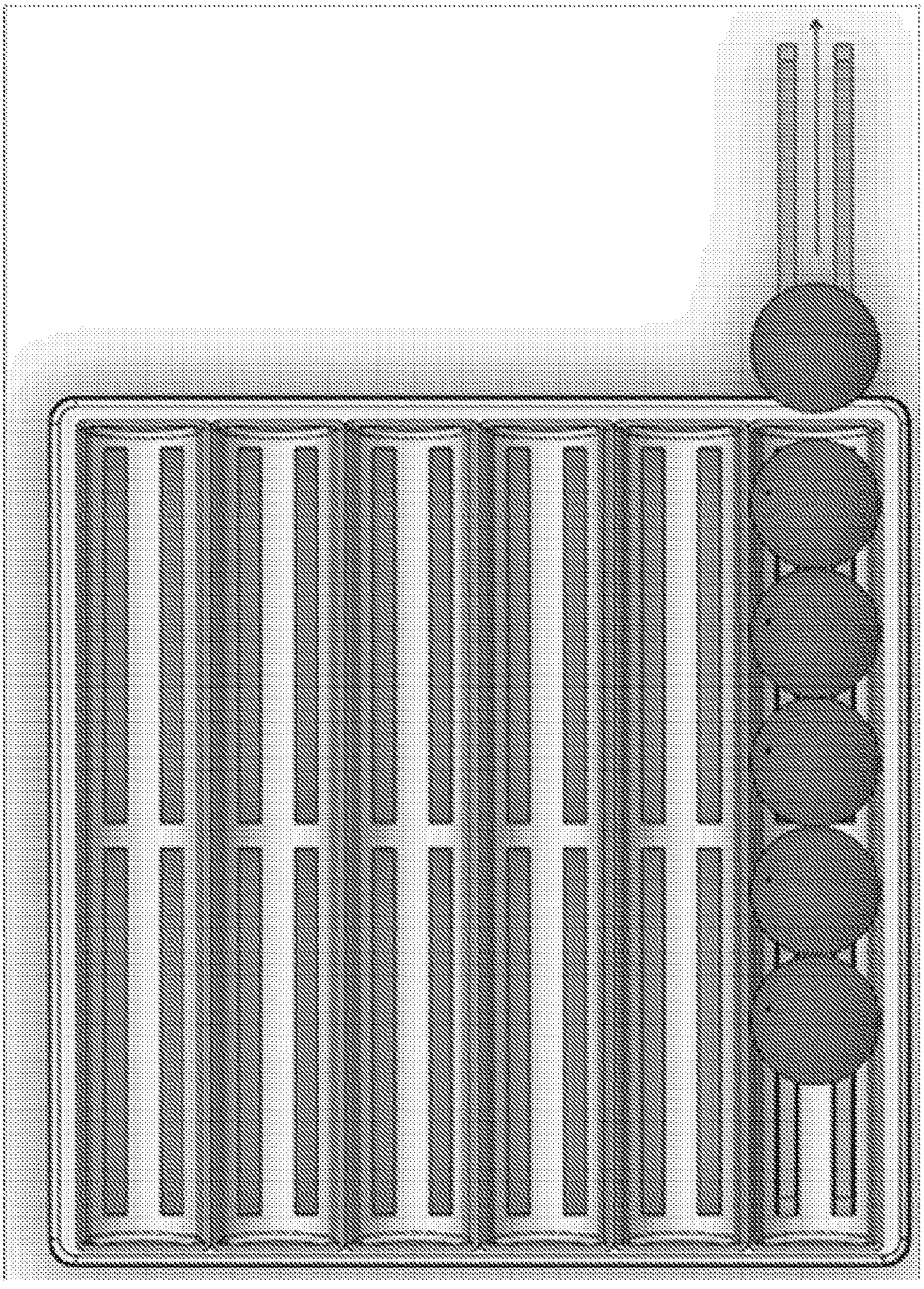


FIG. 6A

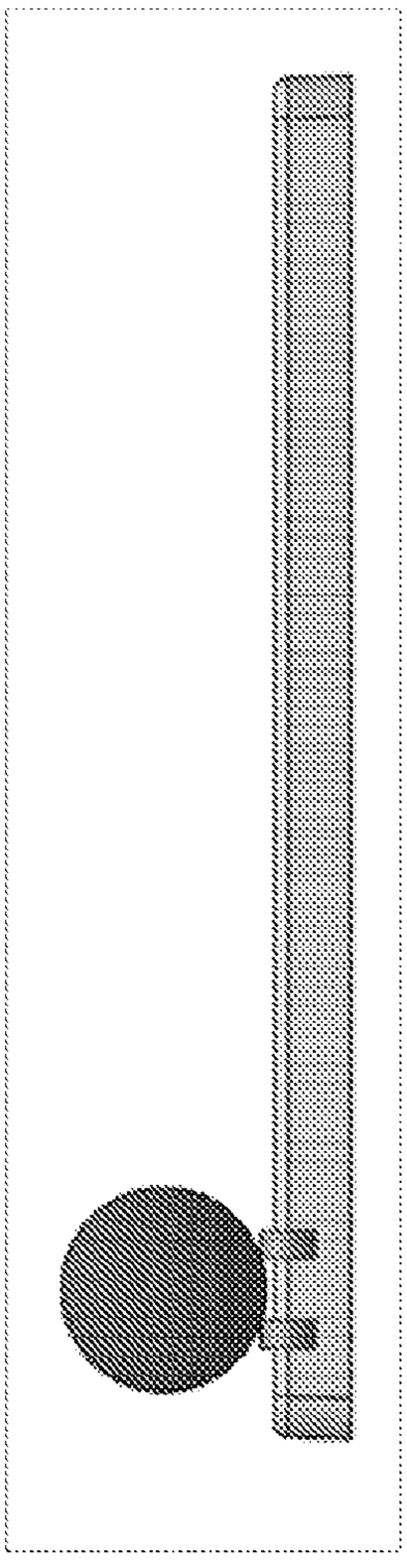


FIG. 6B

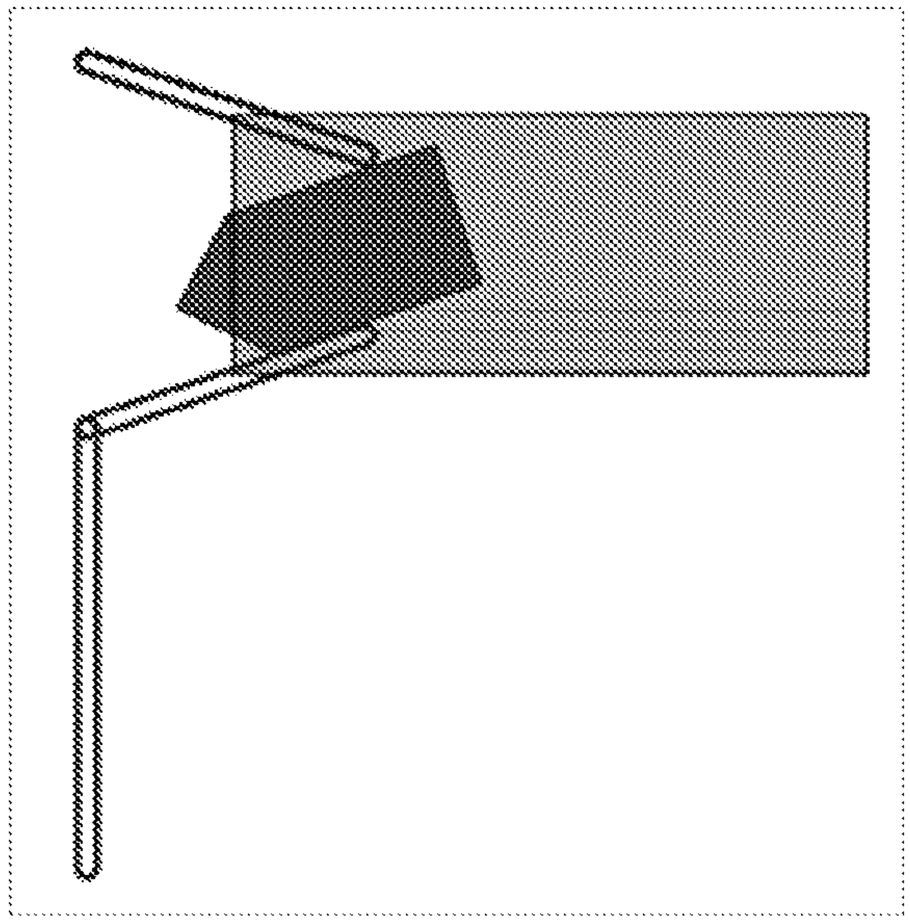


FIG. 7C

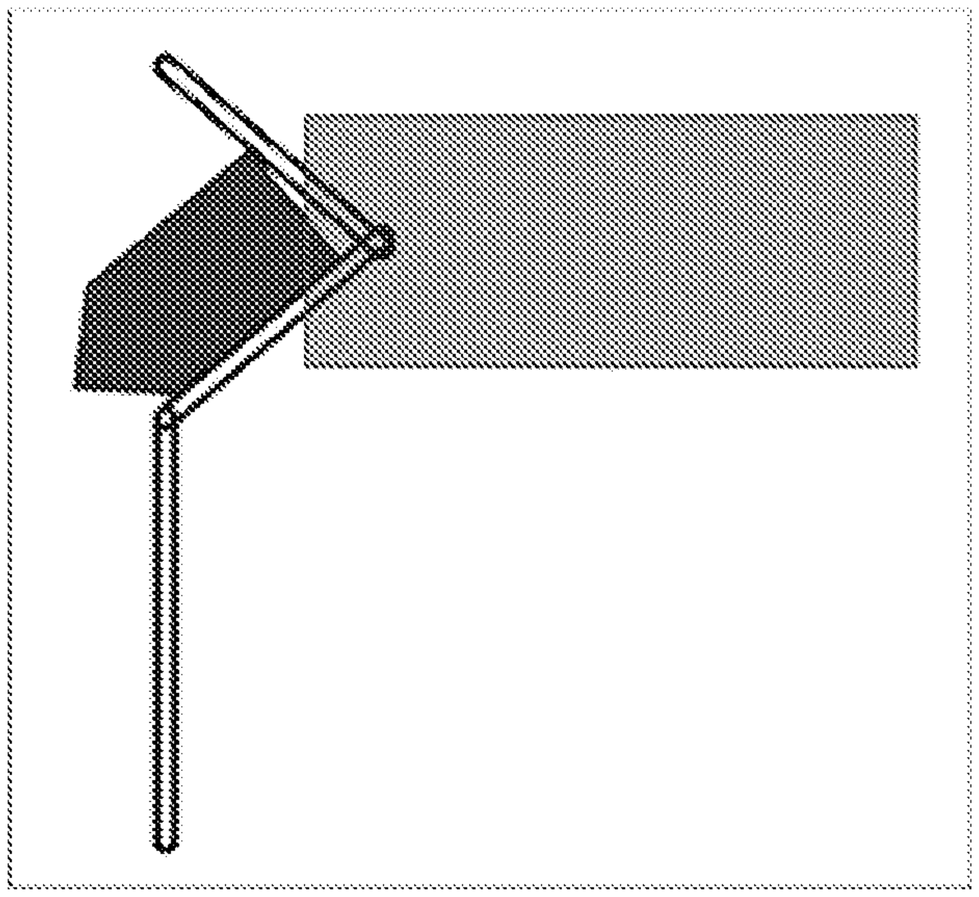


FIG. 7B

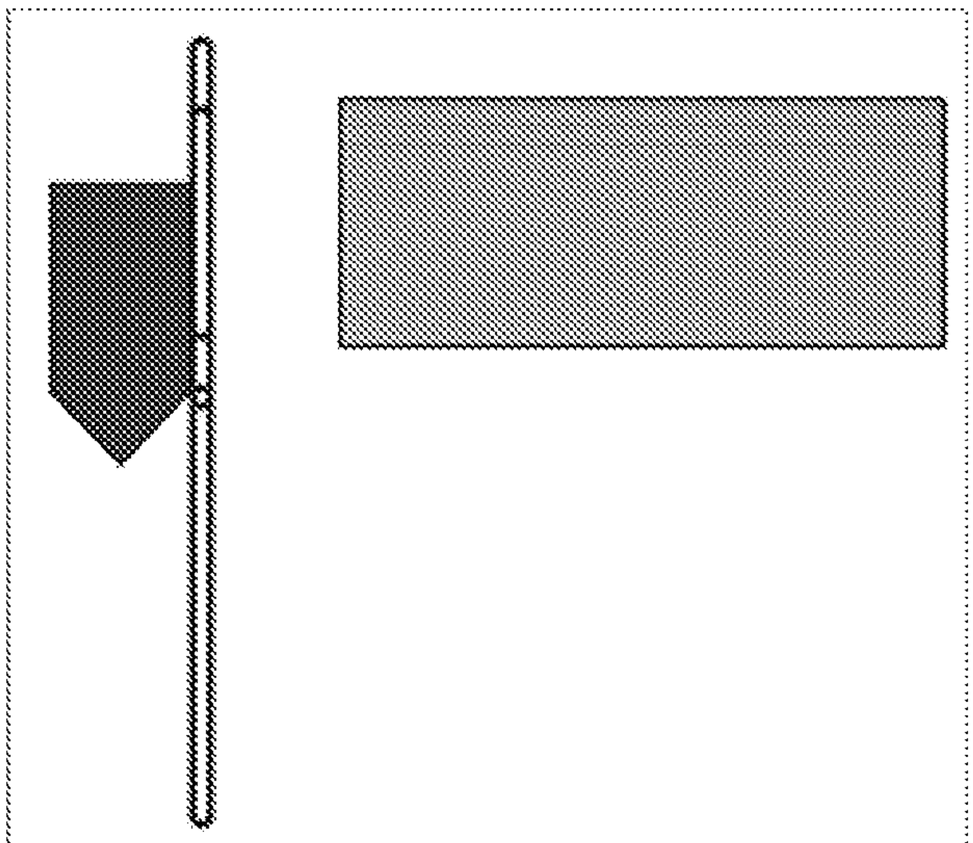


FIG. 7A

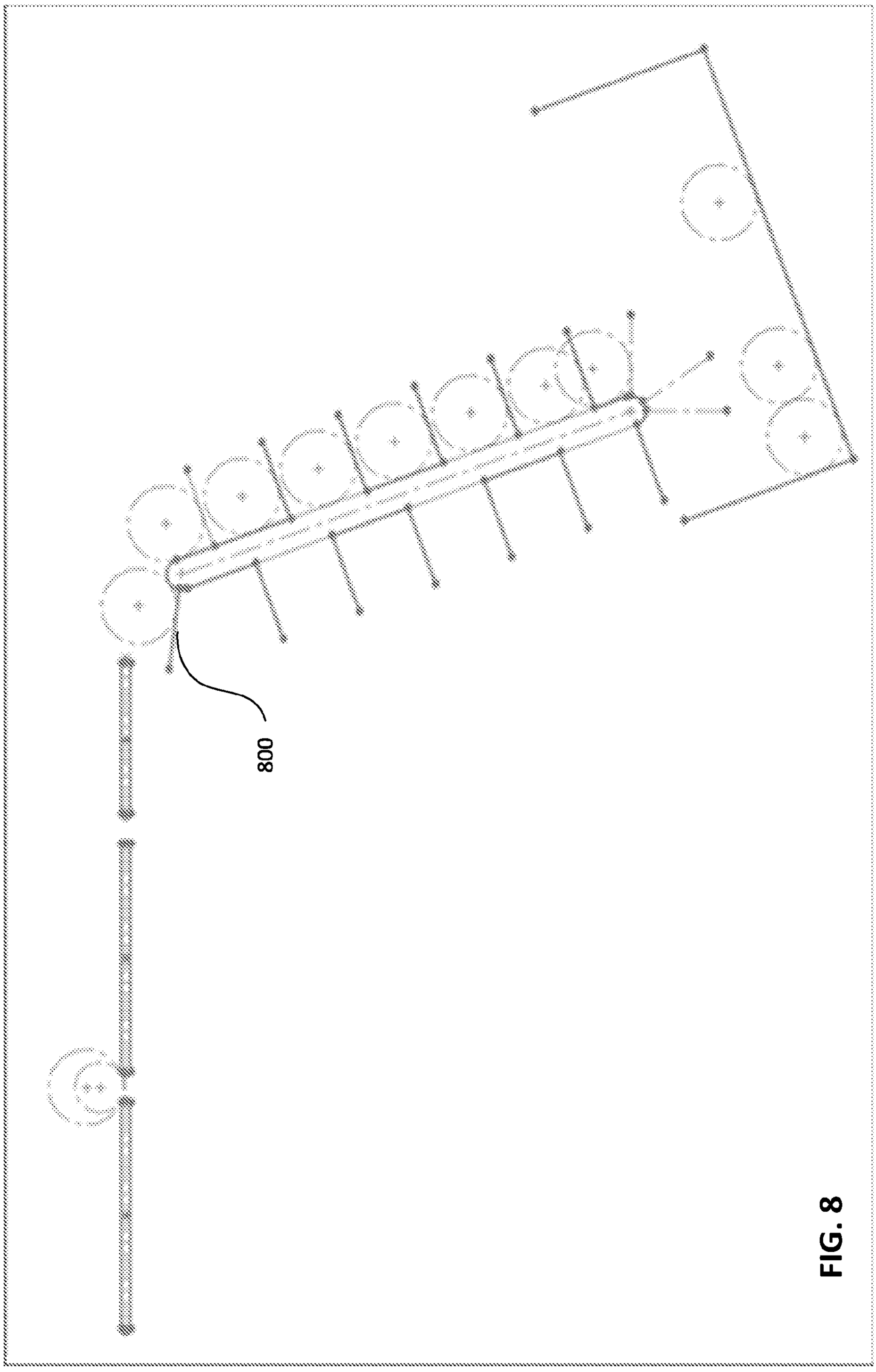


FIG. 8

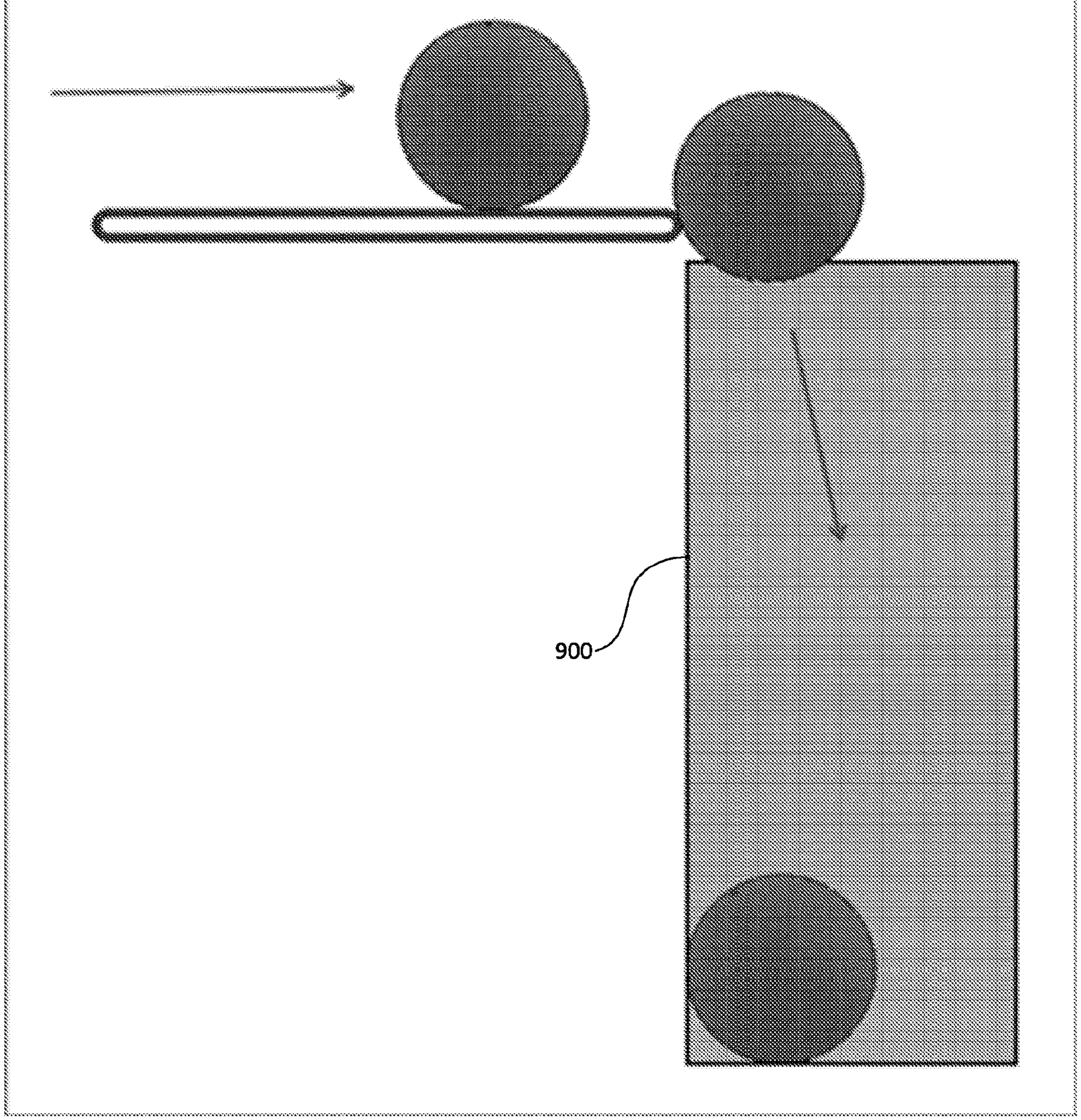
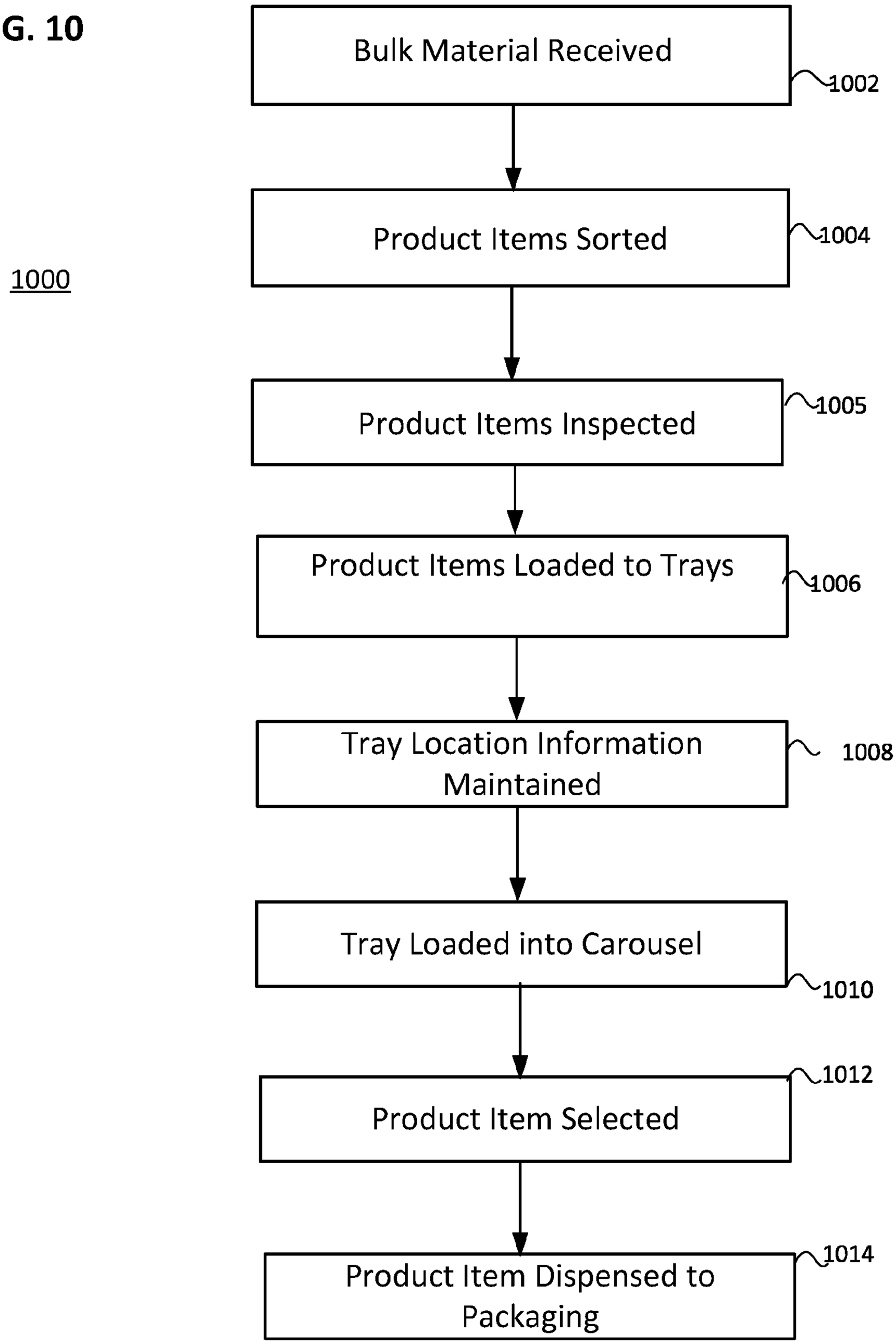


FIG. 9

FIG. 10


1000
Bulk Material Received
1002
Product Items Sorted
1004
Product Items Inspected
1005
Product Items Loaded to Trays
1006
Tray Location Information Maintained
1008
Tray Loaded into Carousel
1010
Product Item Selected
1012
Product Item Dispensed to Packaging
1014

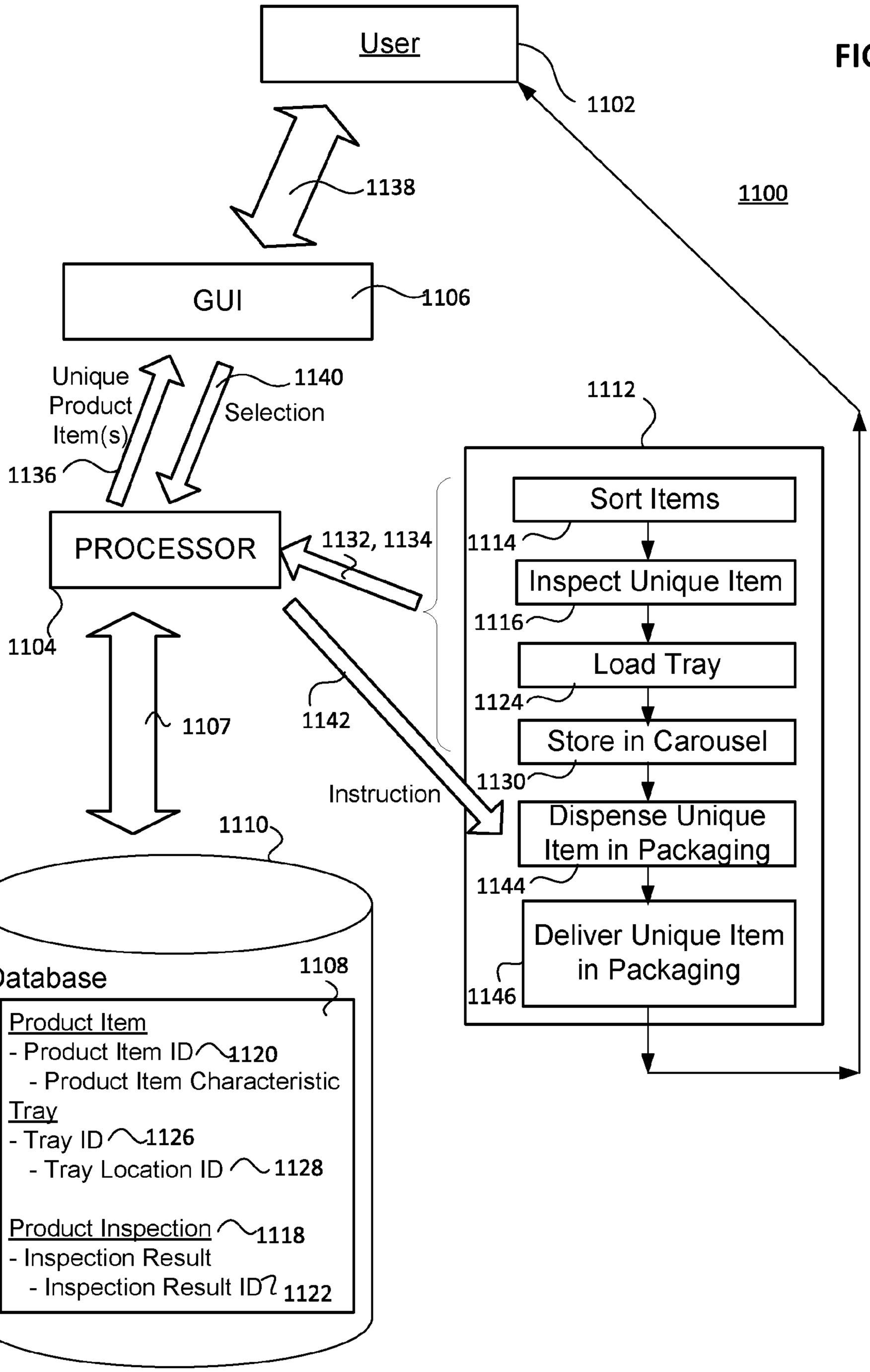

User
1102
1100
1138
GUI
1106
Unique Product Item(s)
1140
Selection
1136
PROCESSOR
1132, 1134
1104
1107
1142
Instruction
1112
Sort Items
1114
Inspect Unique Item
1116
Load Tray
1124
Store in Carousel
1130
Dispense Unique Item in Packaging
1144
Deliver Unique Item in Packaging
1146
1110
Database
1108
Product Item
- Product Item ID 1120
- Product Item Characteristic
Tray
- Tray ID 1126
- Tray Location ID 1128
Product Inspection 1118
- Inspection Result
- Inspection Result ID 1122

FIG. 11

1200
1202
1204
Barrier
Stone Fruit
Root Vegetables
Leafy Greens
Dry Boxes
Bread
Barrier
Dry Boxes
Dry Boxes
Apple, Pear, Banana
Dry Boxes
Root Vegetables
Seasonal Produce
Dairy
Frozen
Deli
Frozen Meat
Poultry
Beef and Pork
Other Meat

FIG. 12

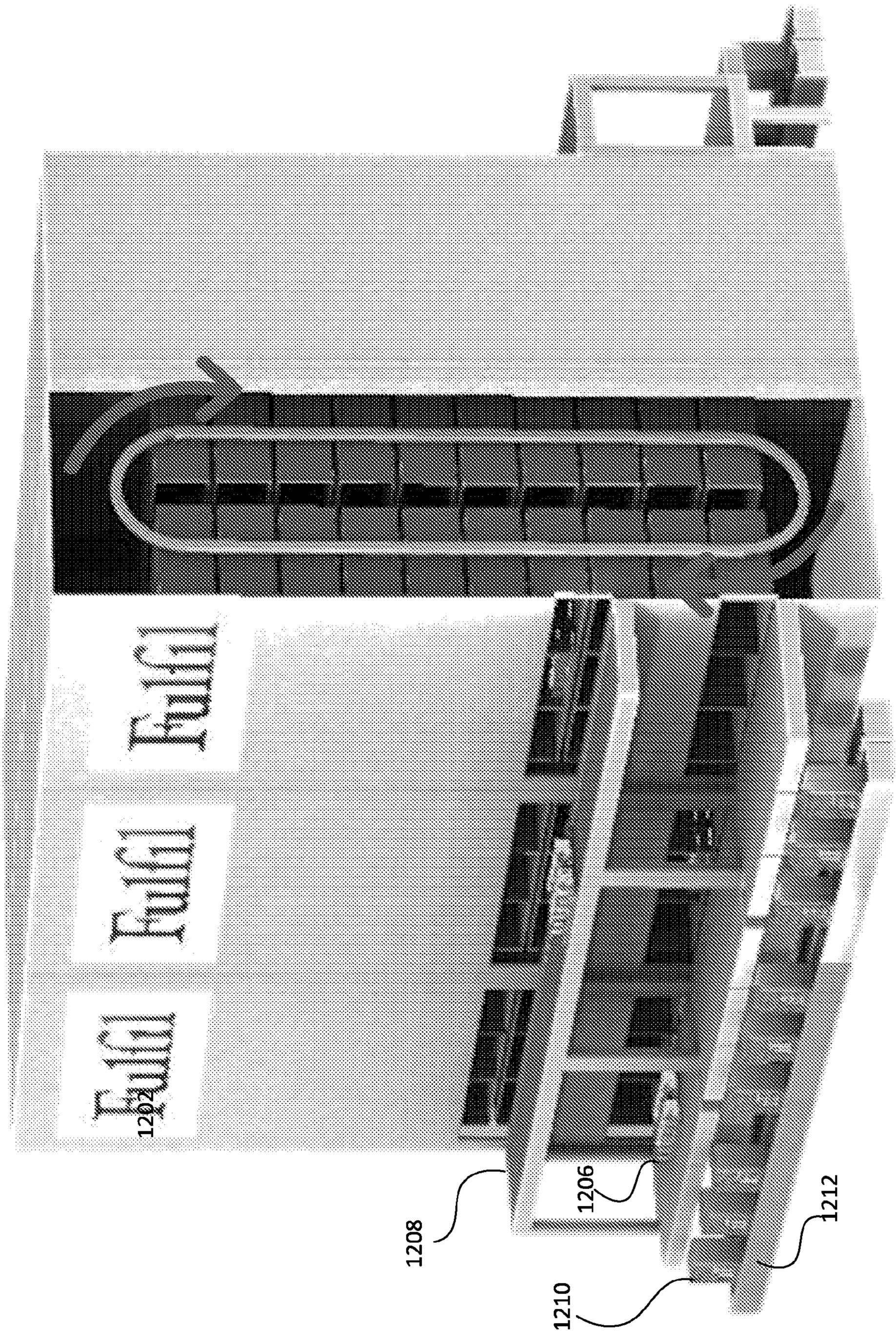


FIG. 13

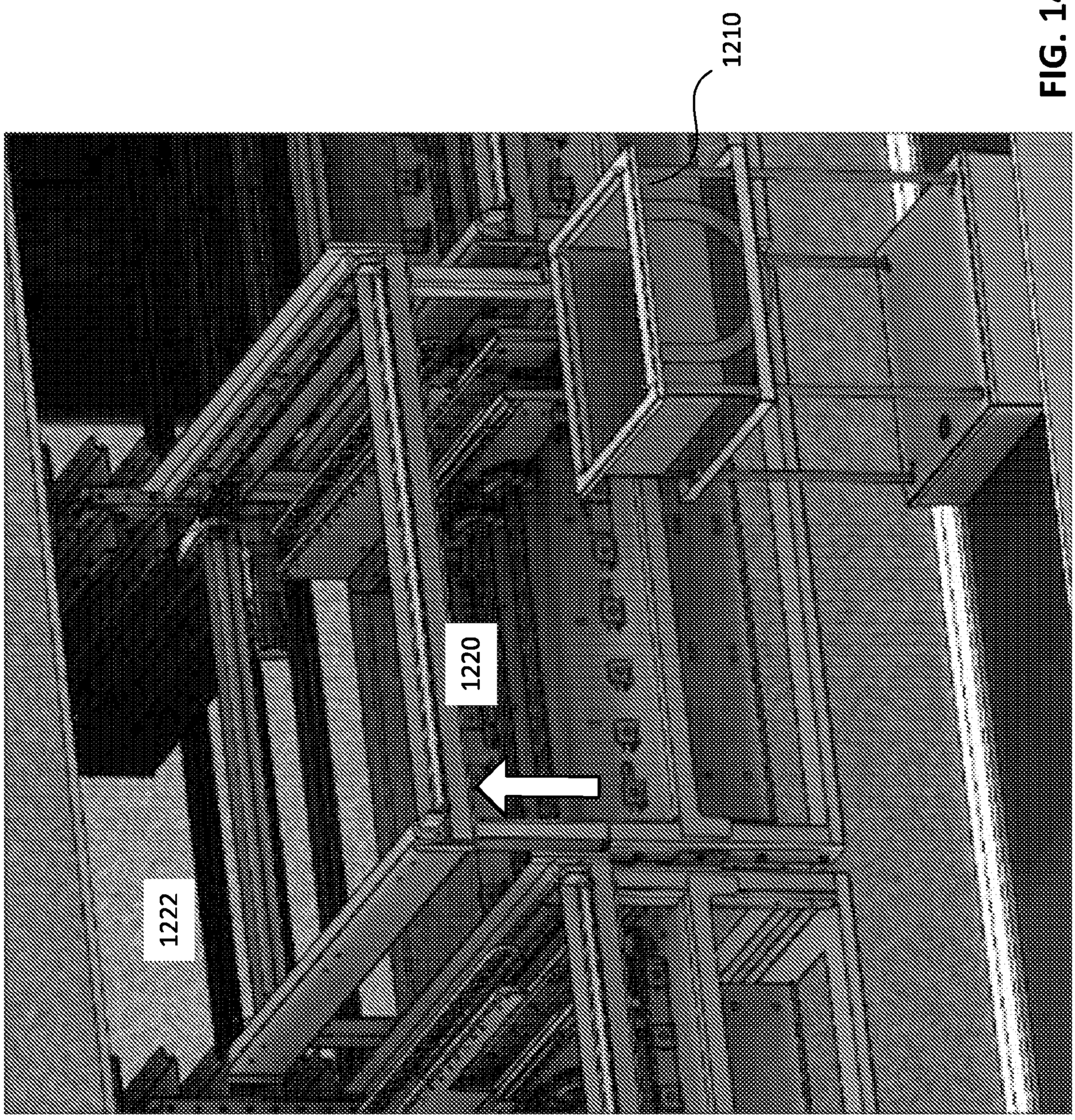


FIG. 14

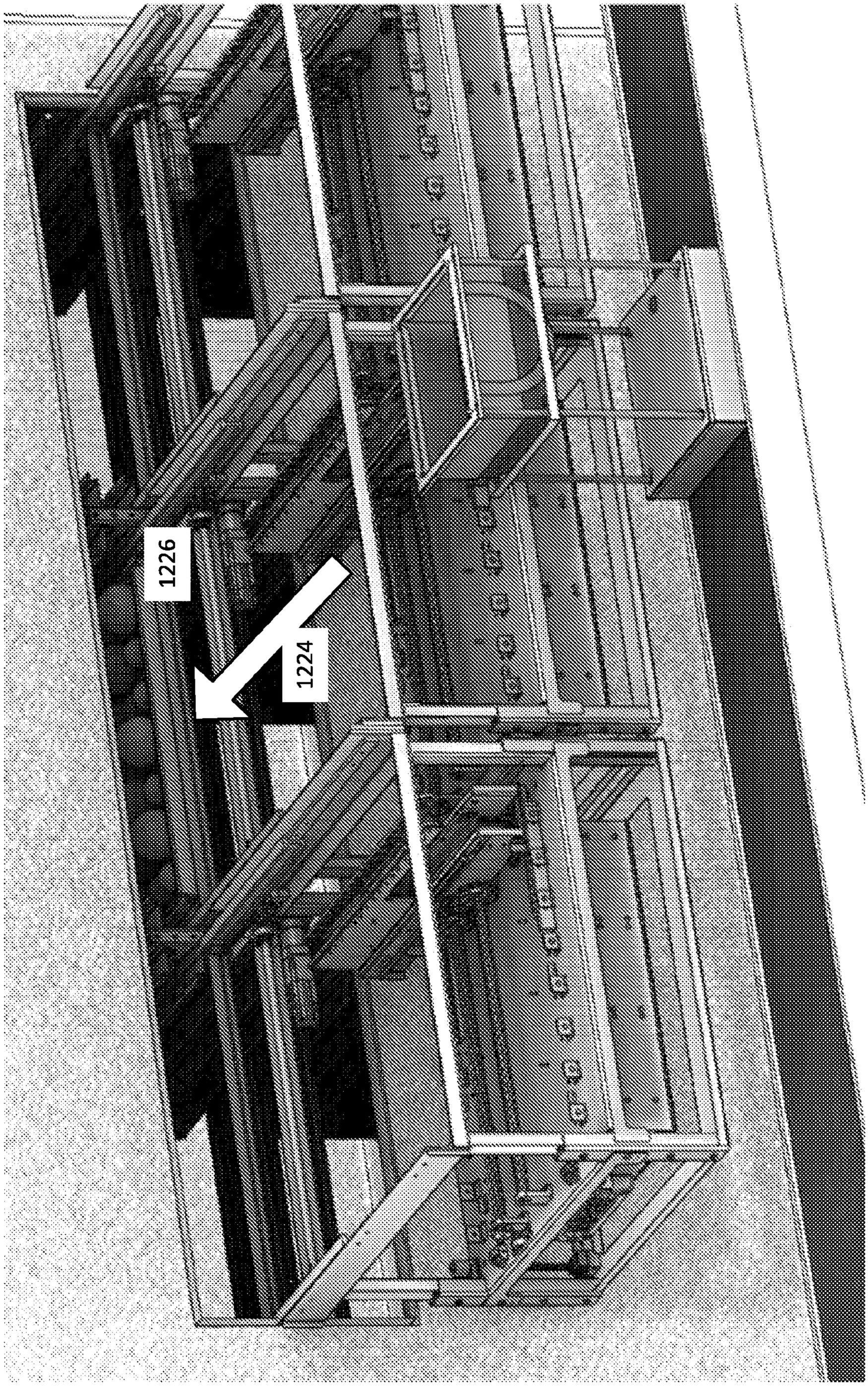


FIG. 15

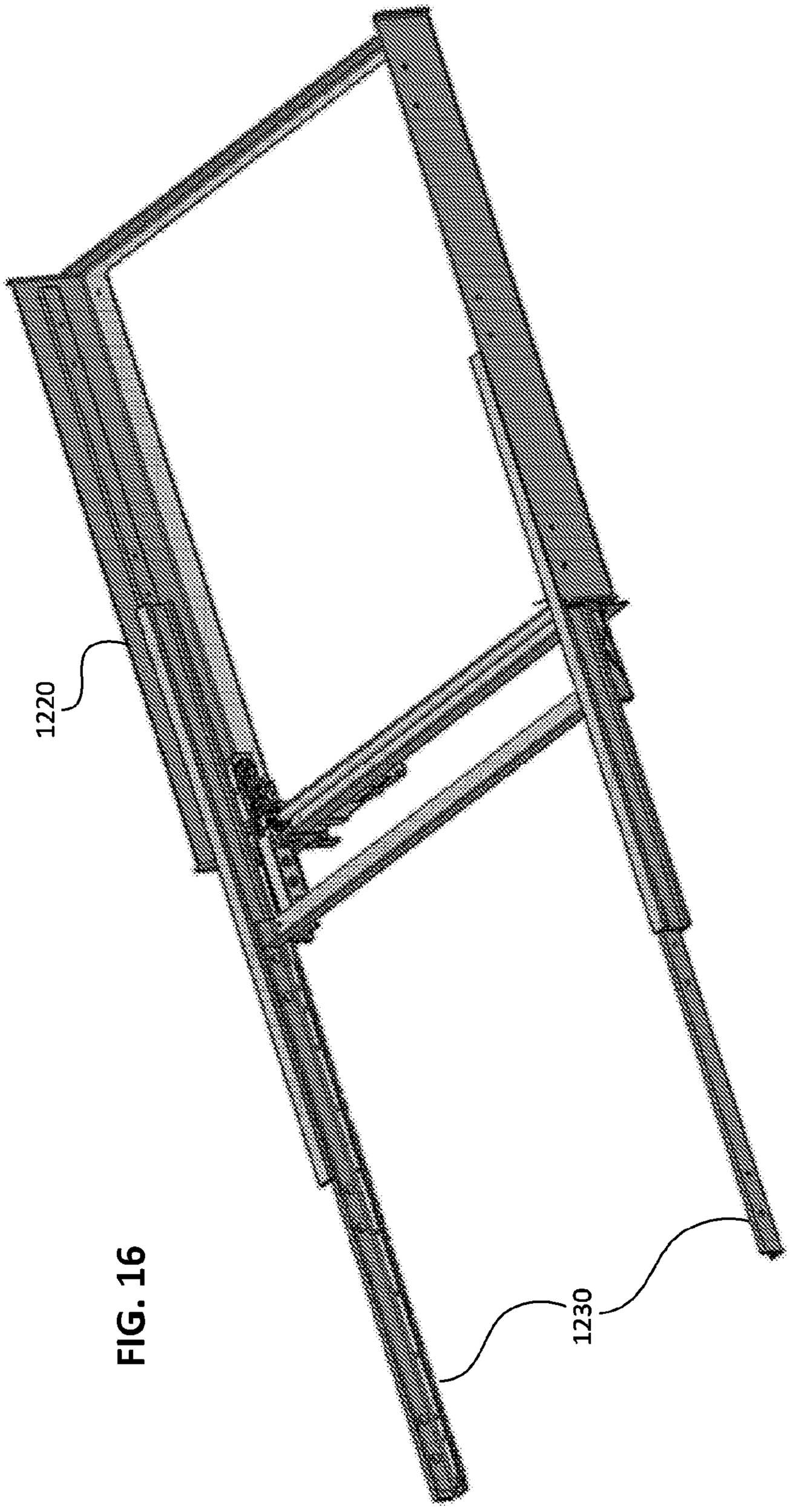


FIG. 16

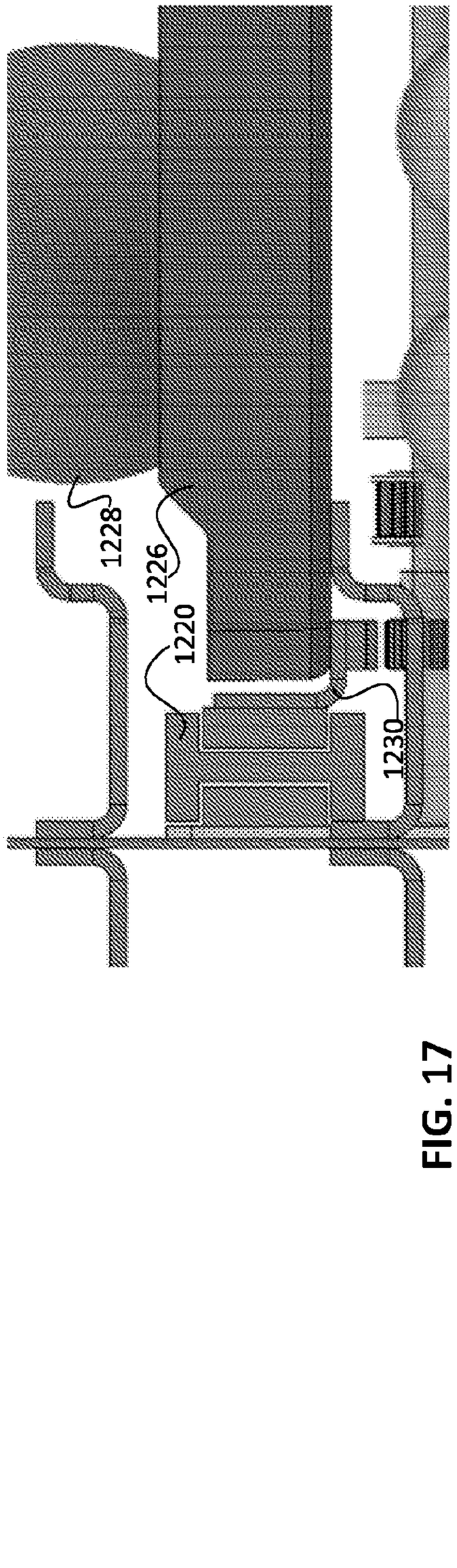


FIG. 17

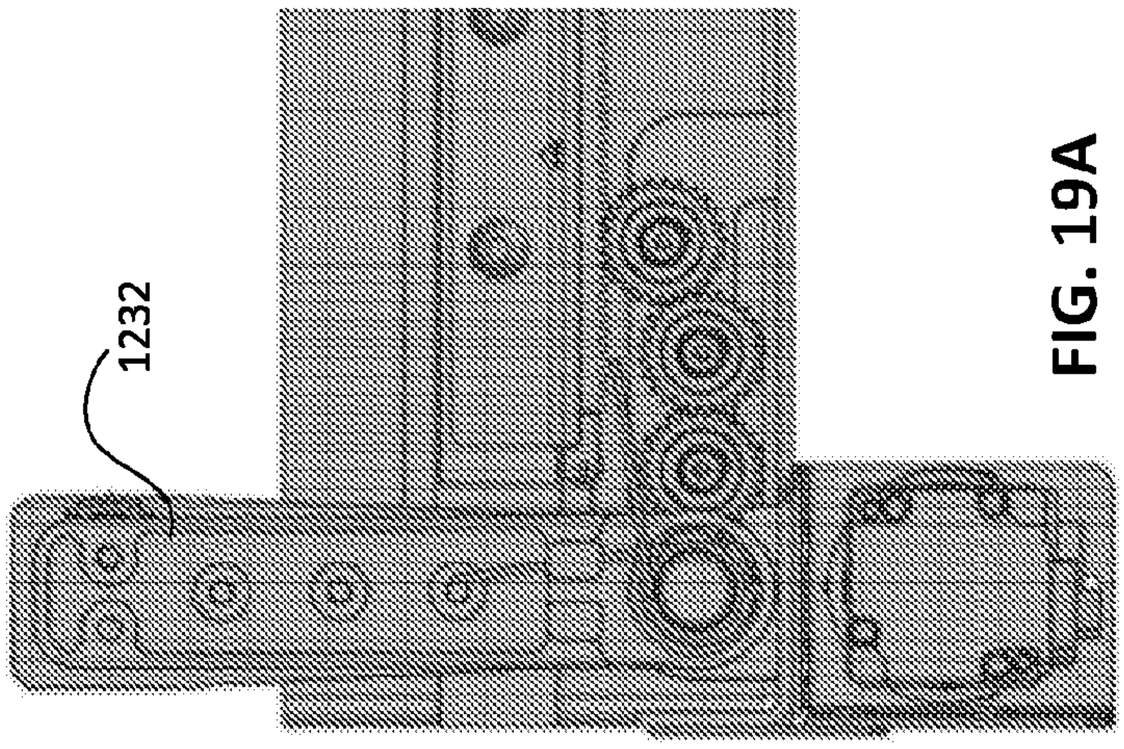


FIG. 19A

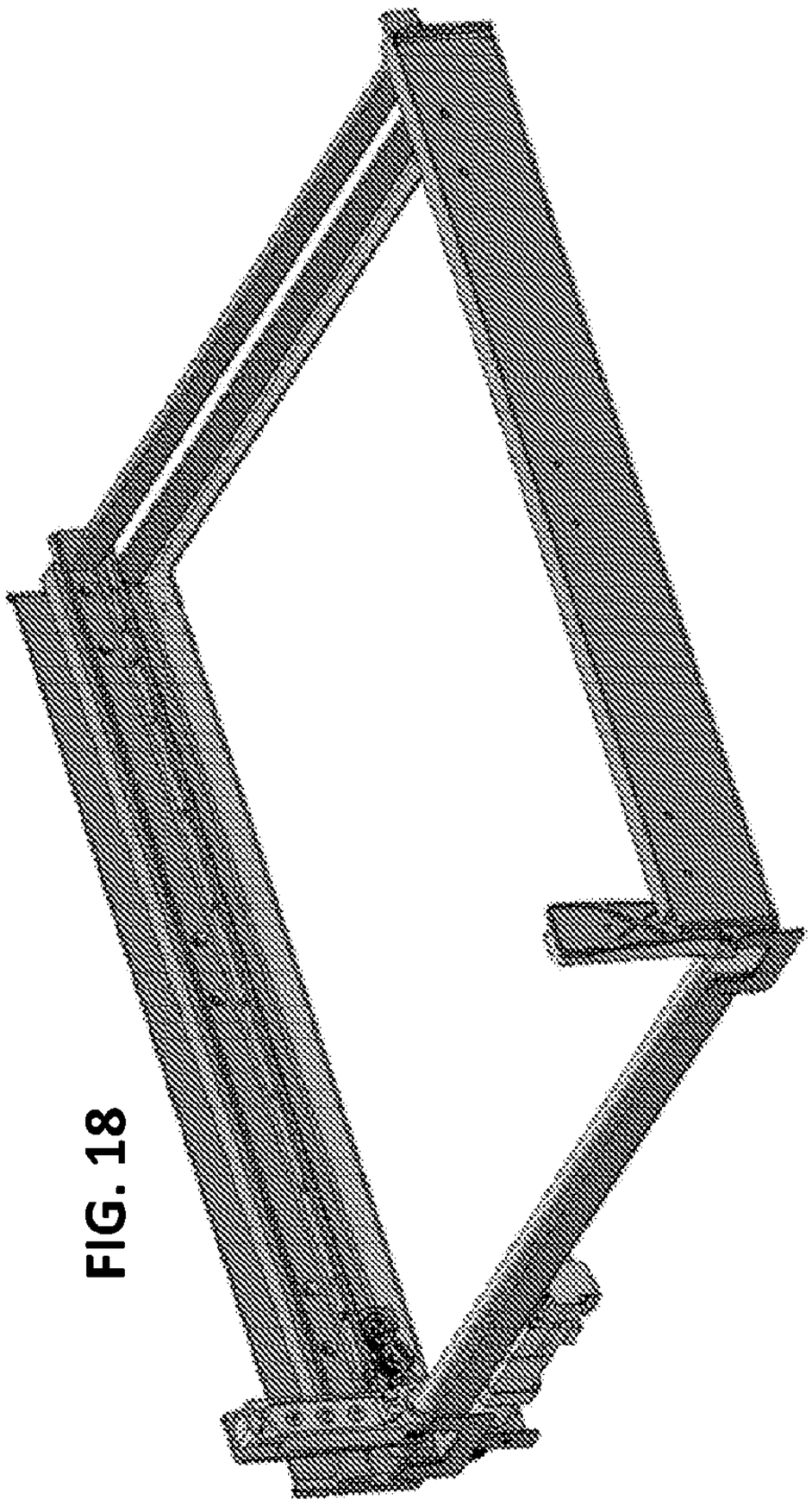


FIG. 18

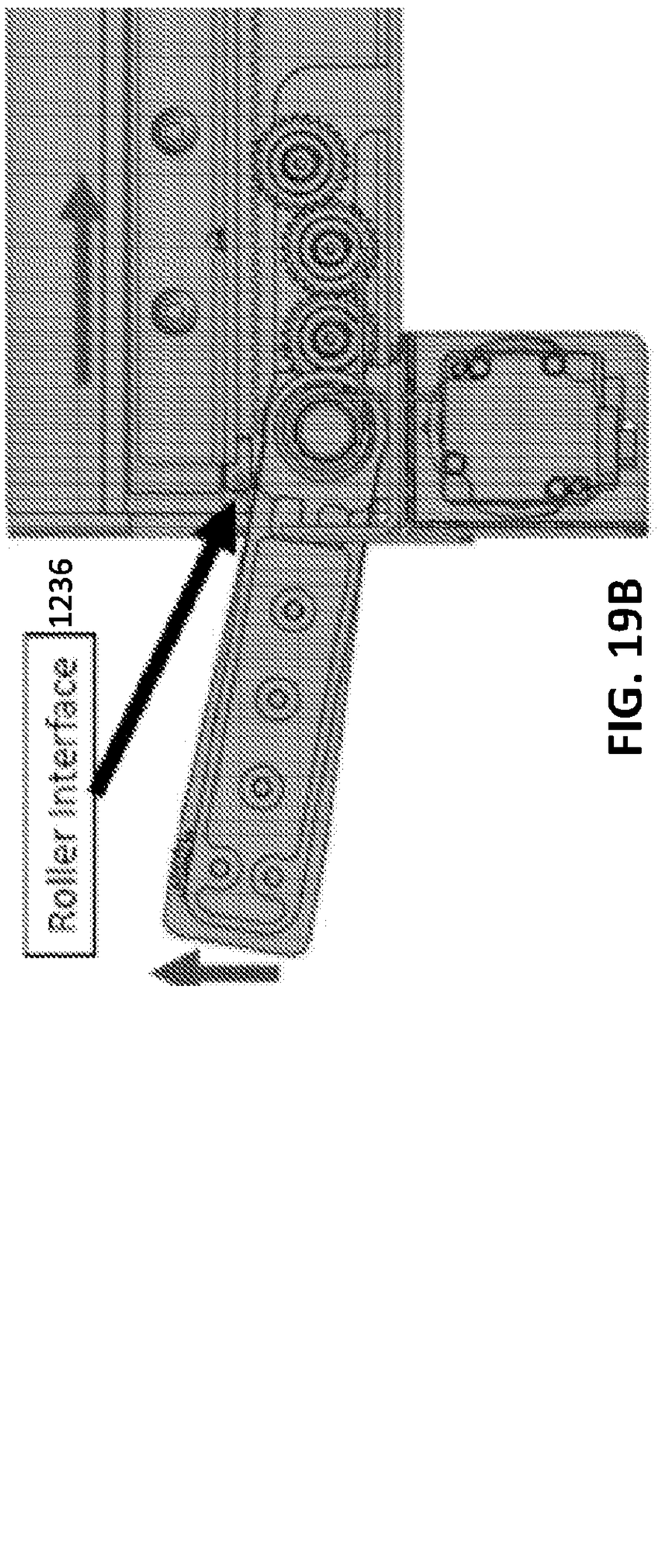


FIG. 19B

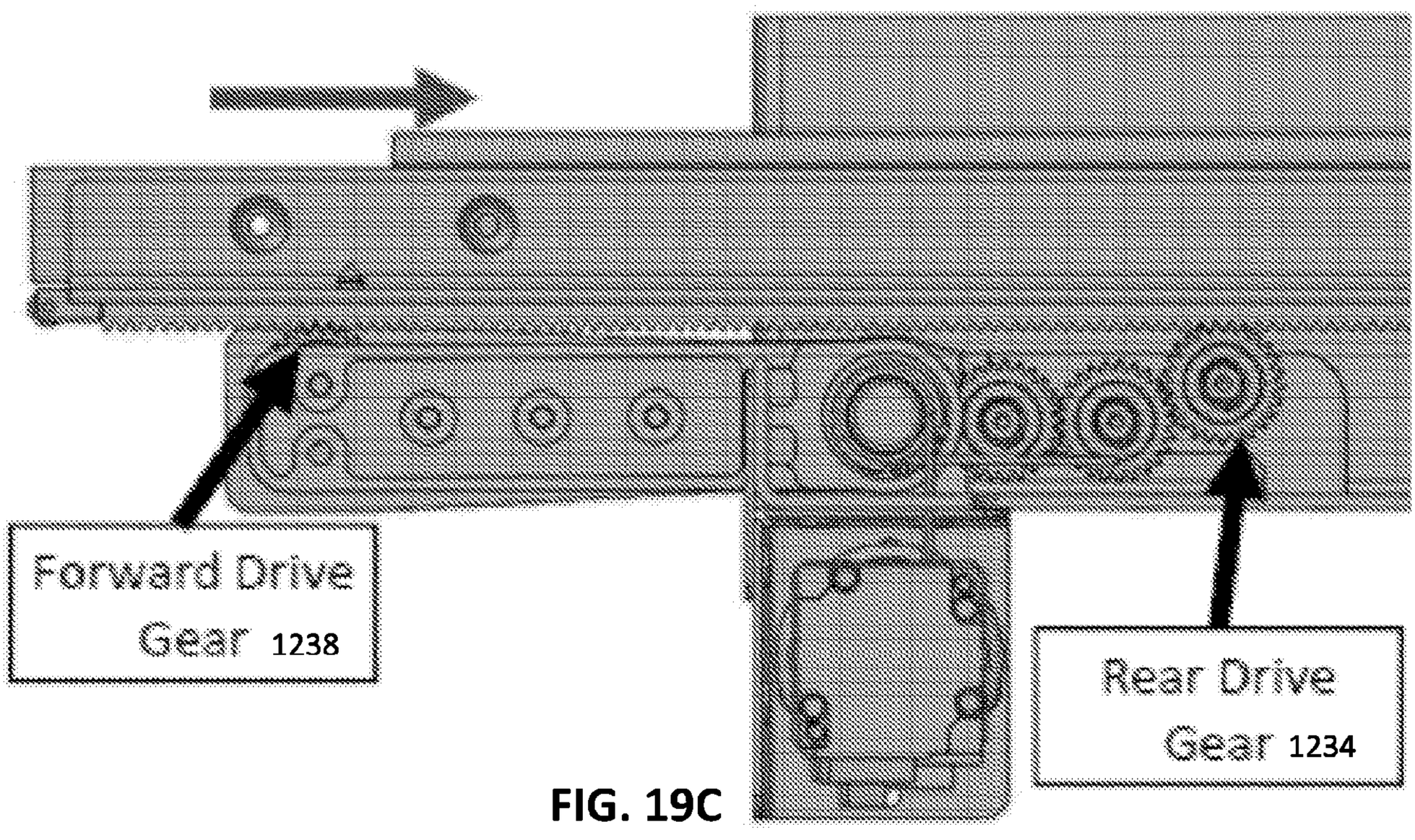


FIG. 19C

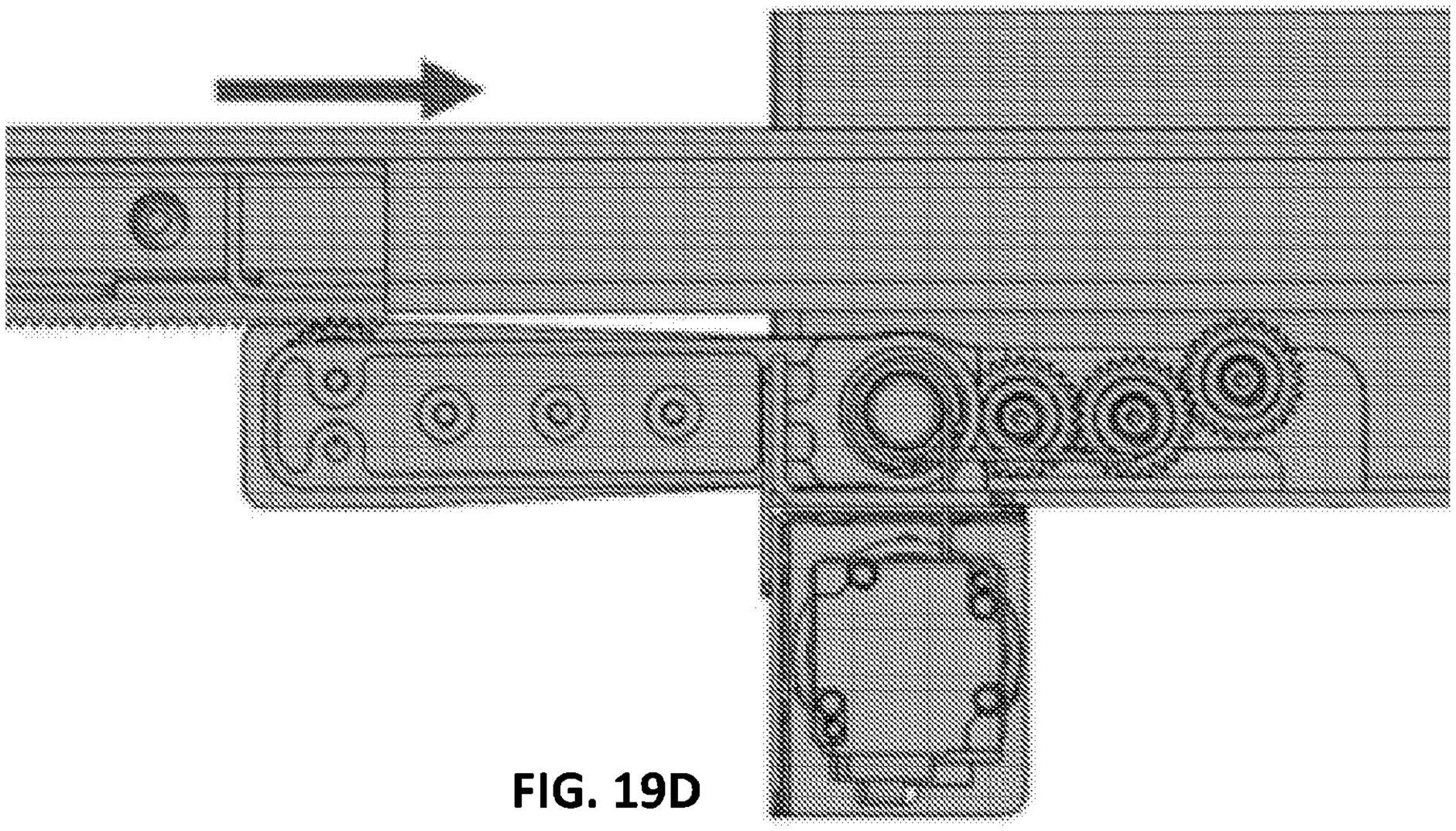


FIG. 19D

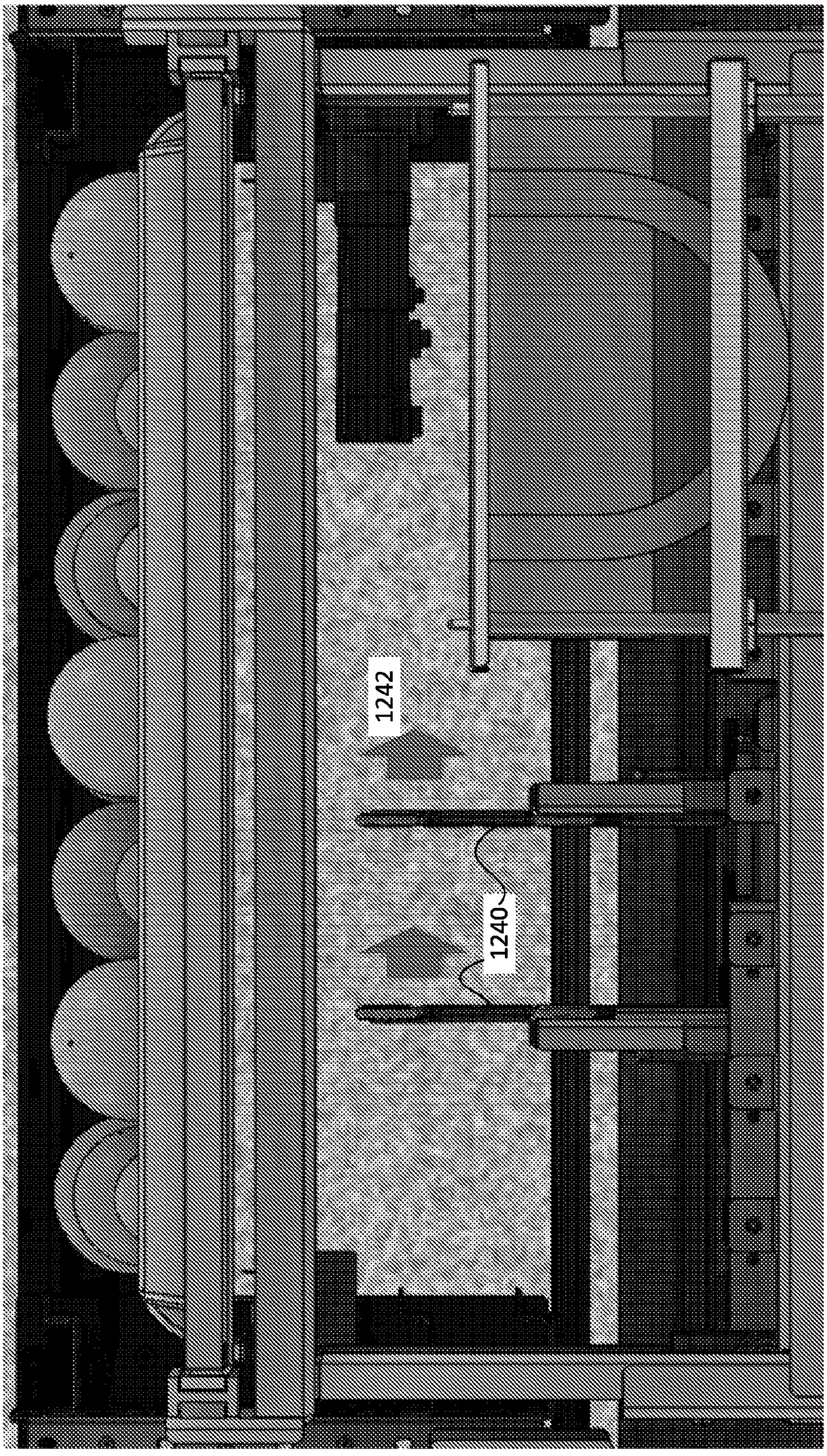


FIG. 20

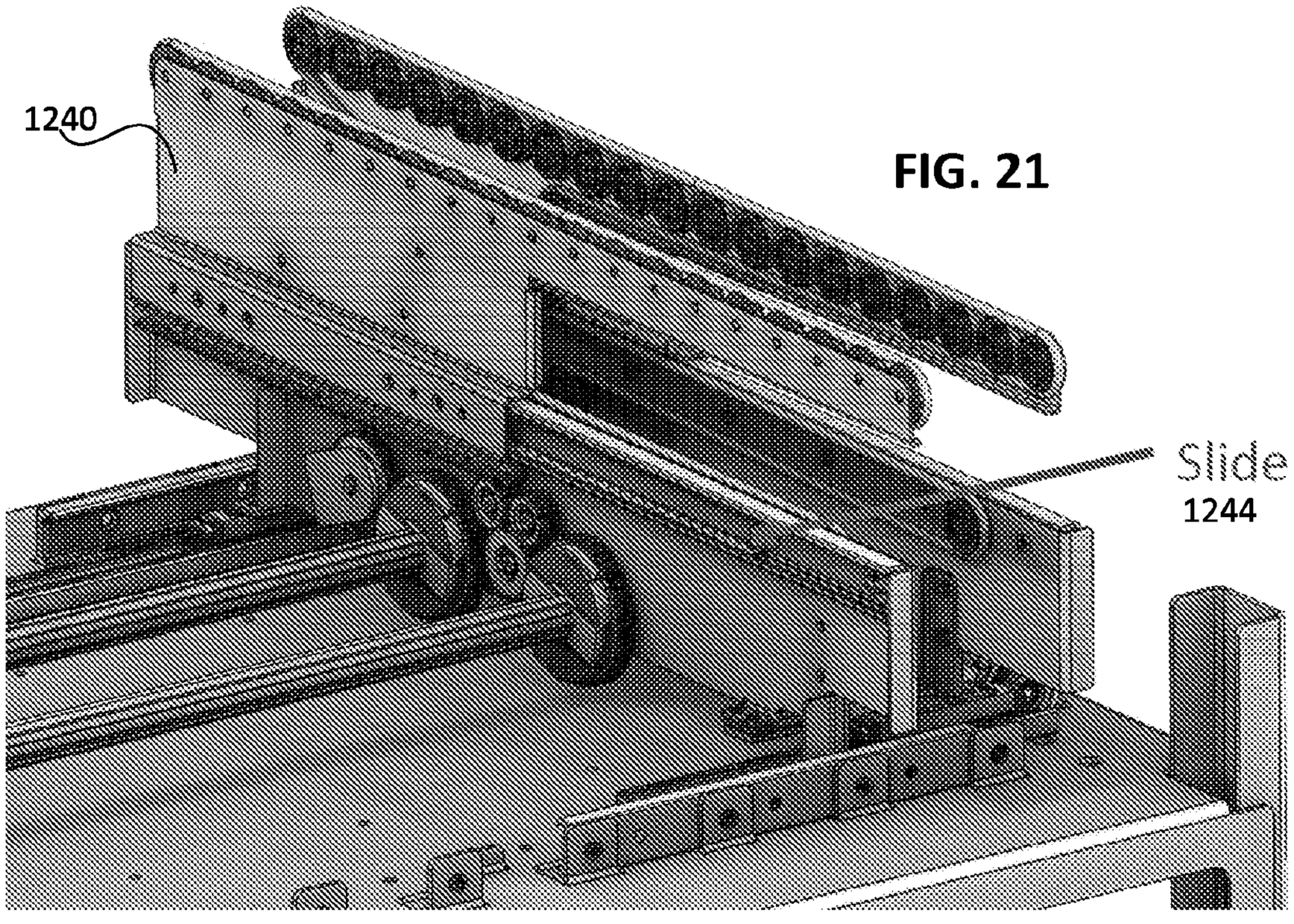
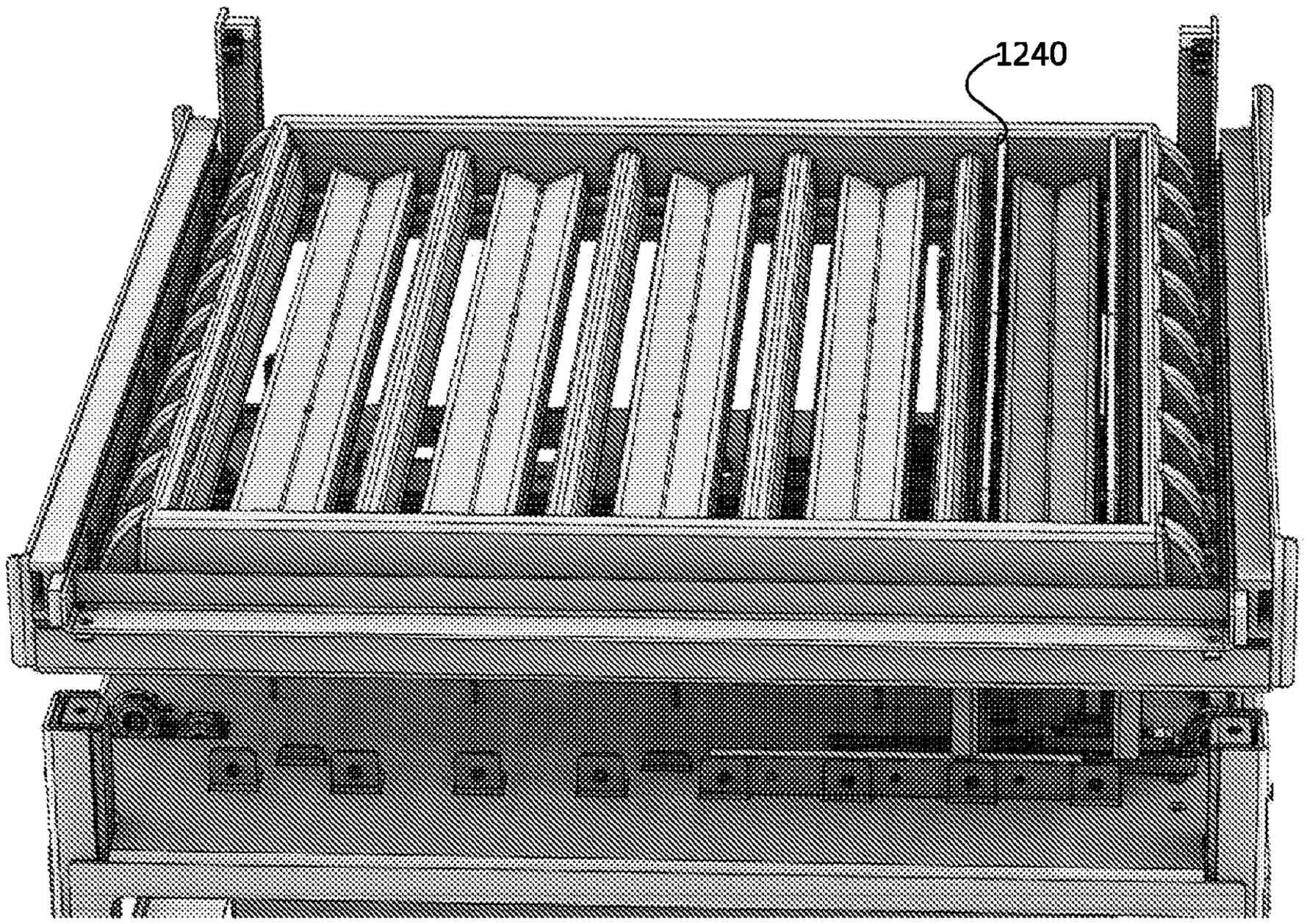


FIG. 21

FIG. 22



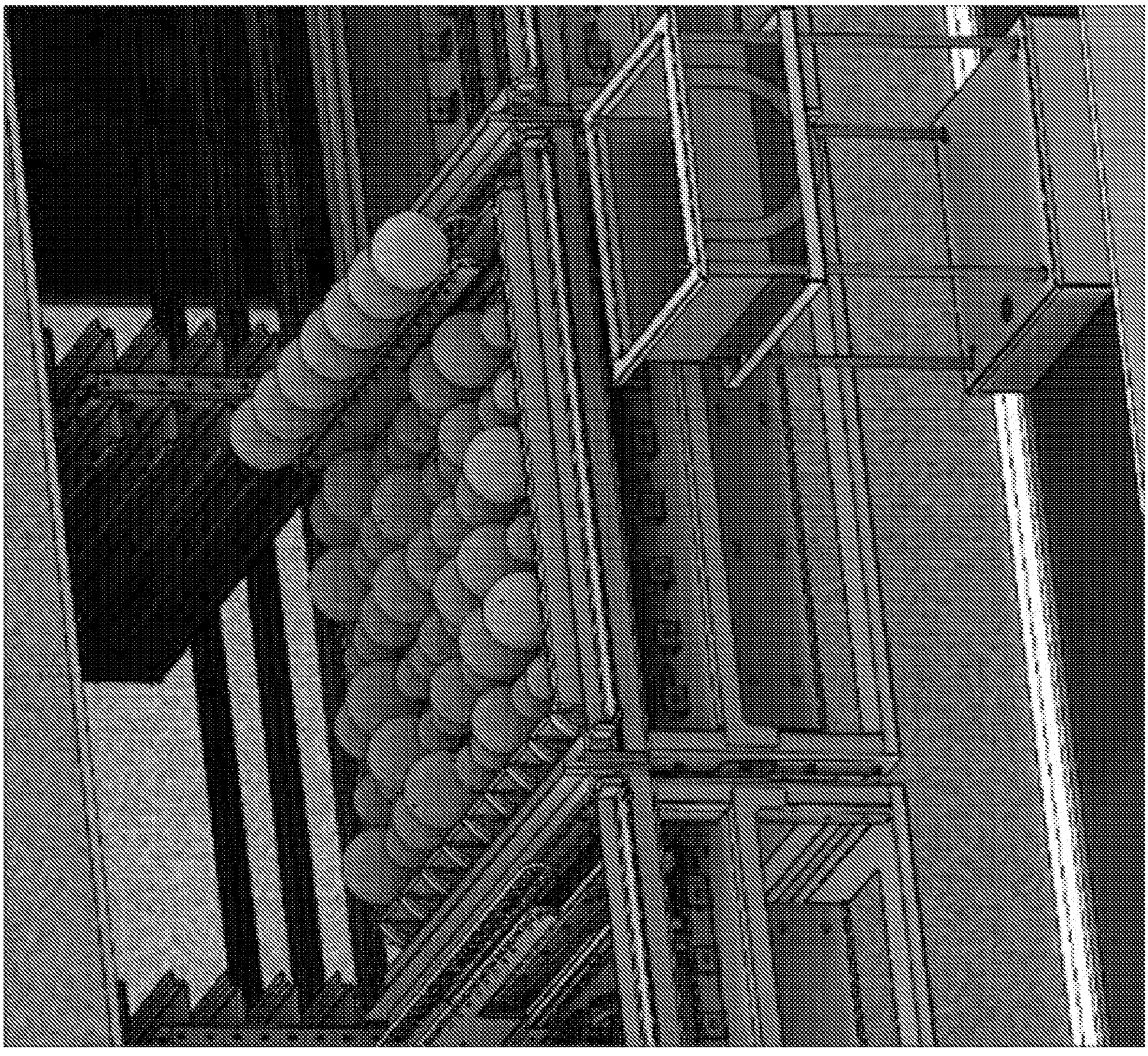


FIG. 23

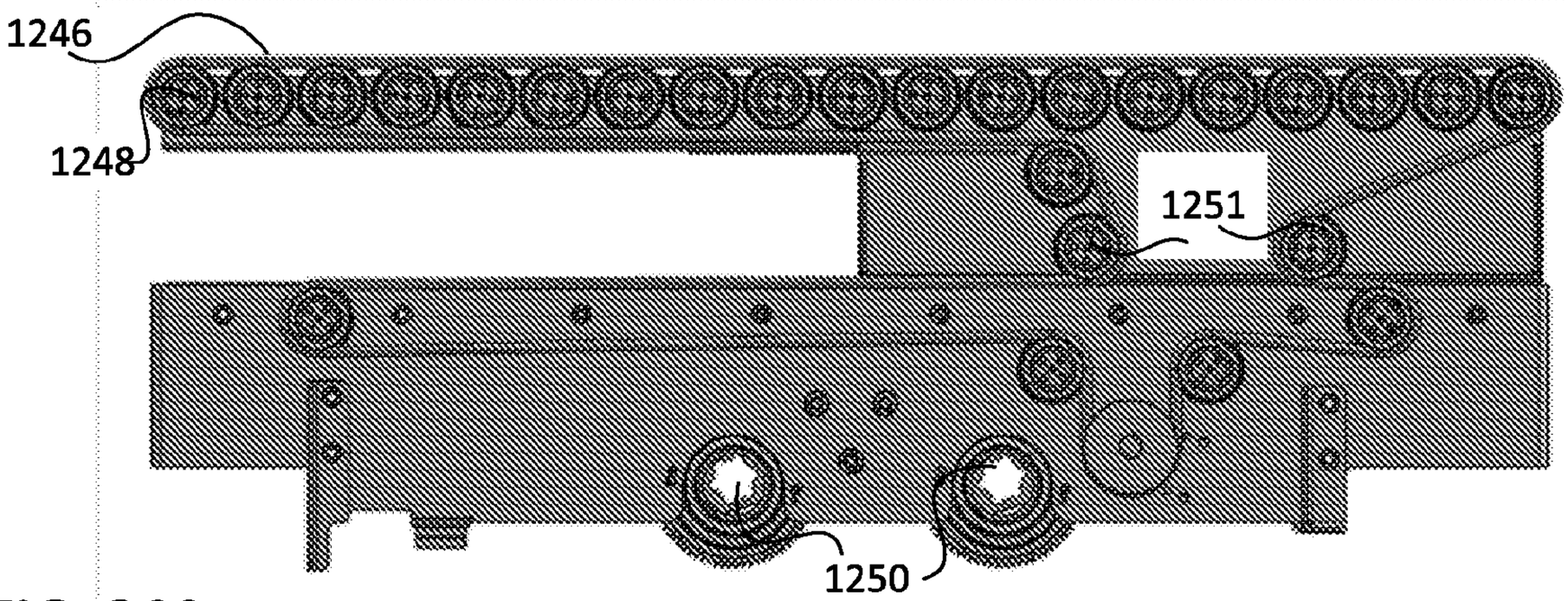


FIG. 24A

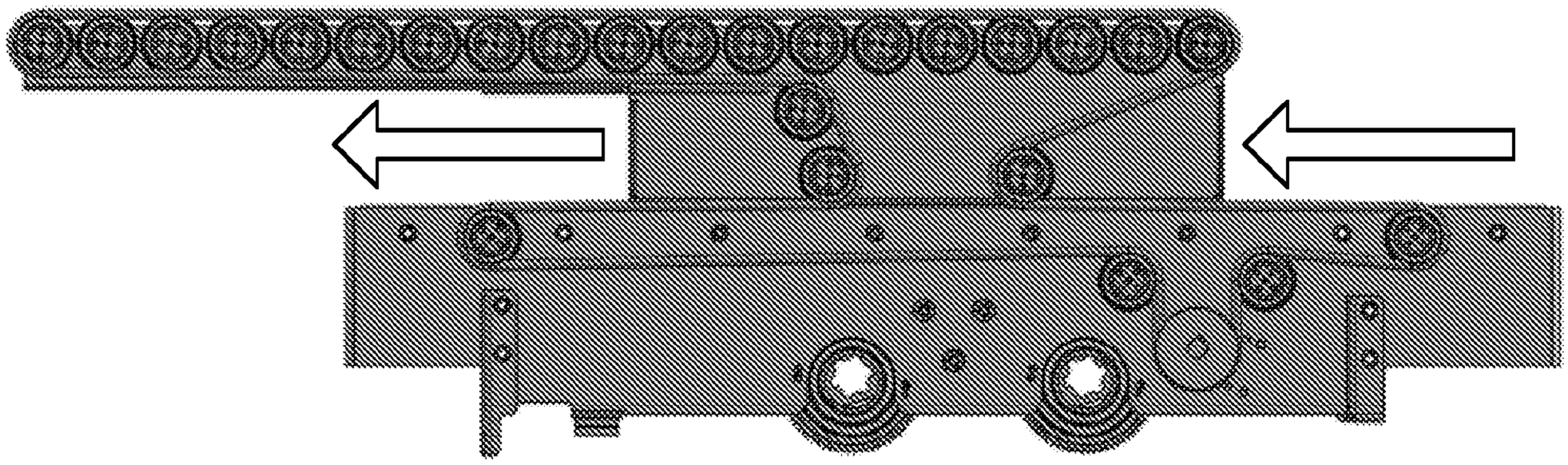
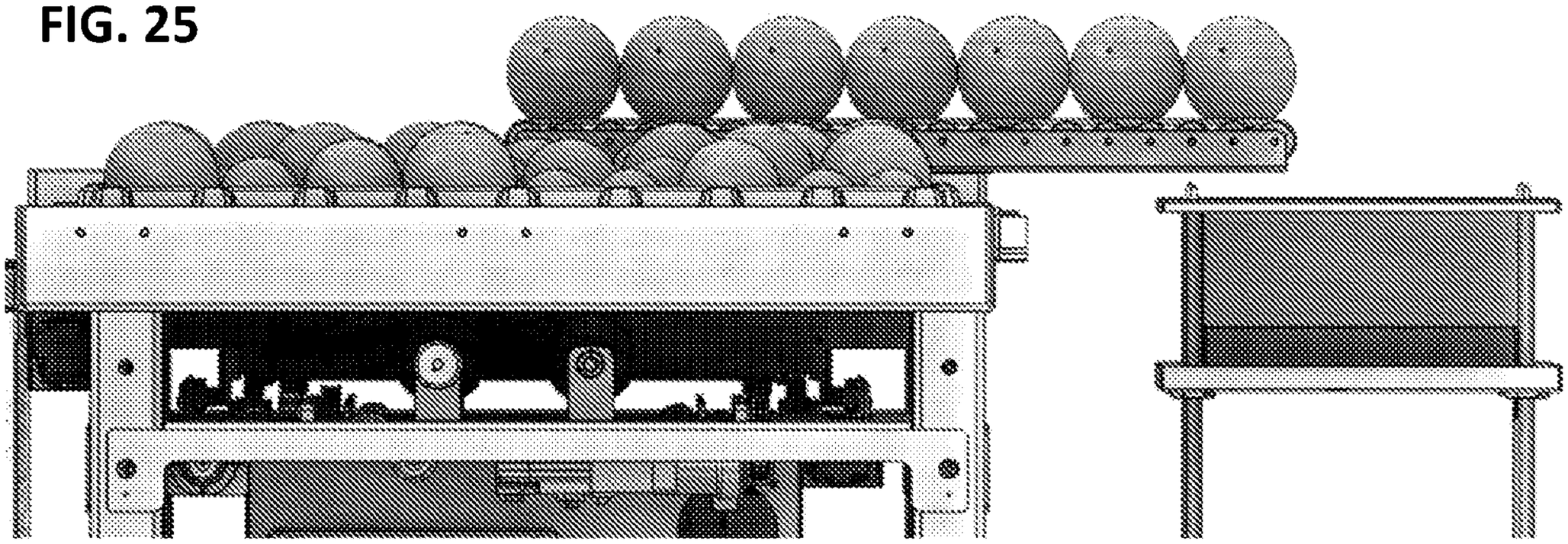


FIG. 24B

FIG. 25



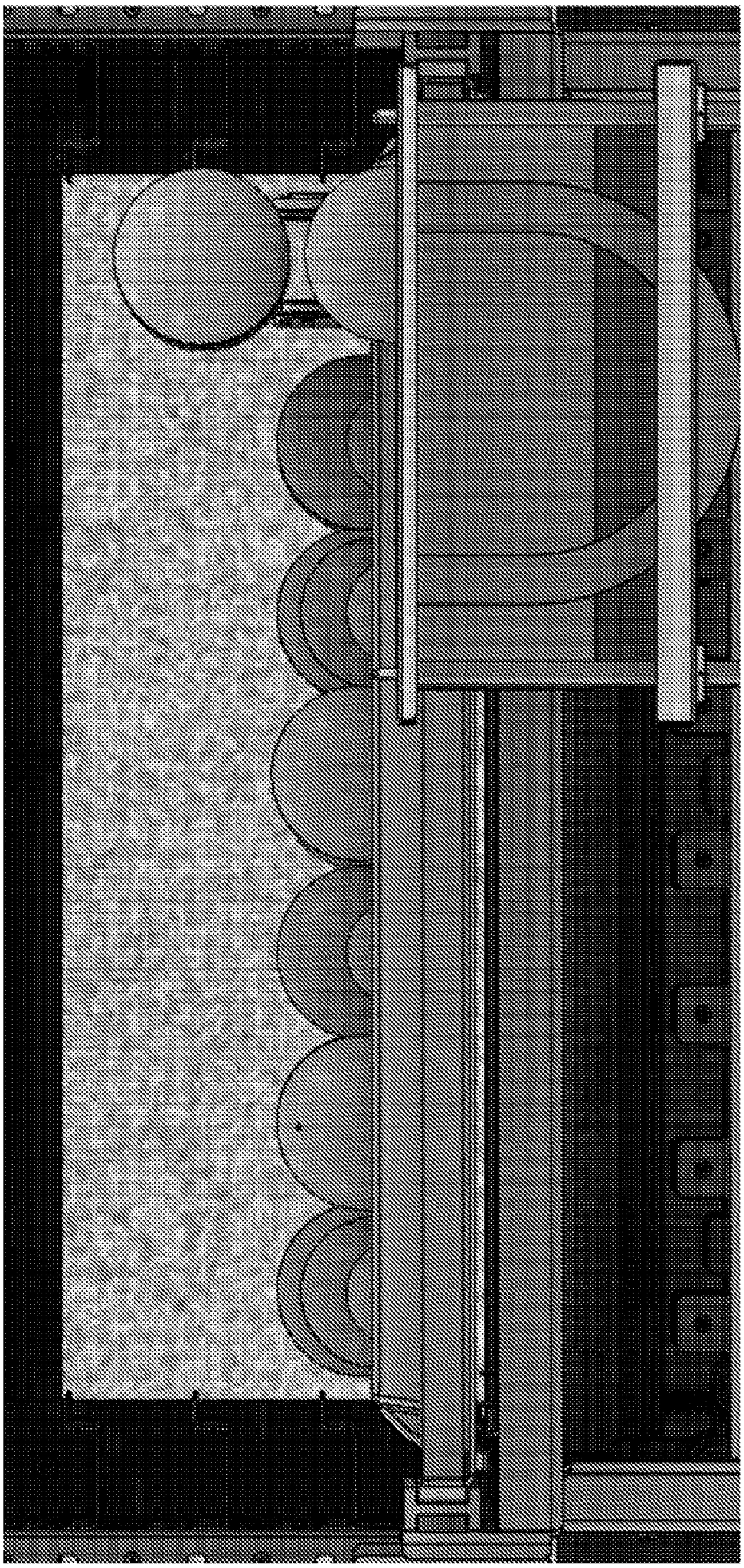


FIG. 26

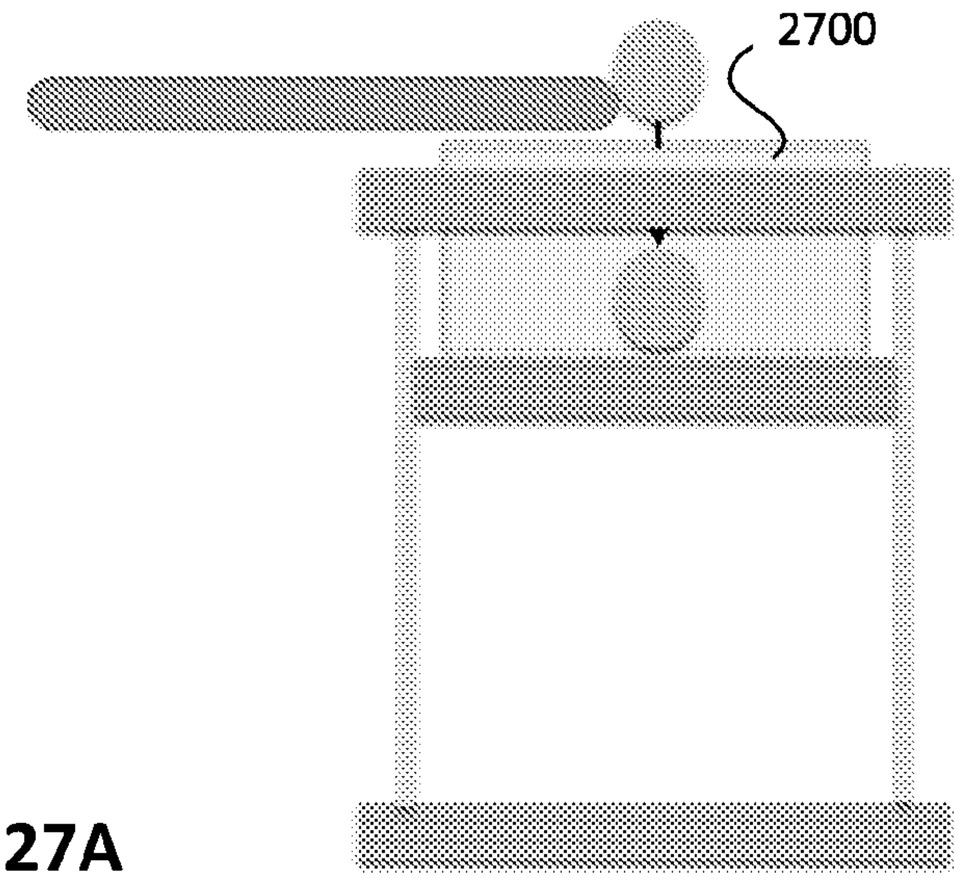


FIG. 27A

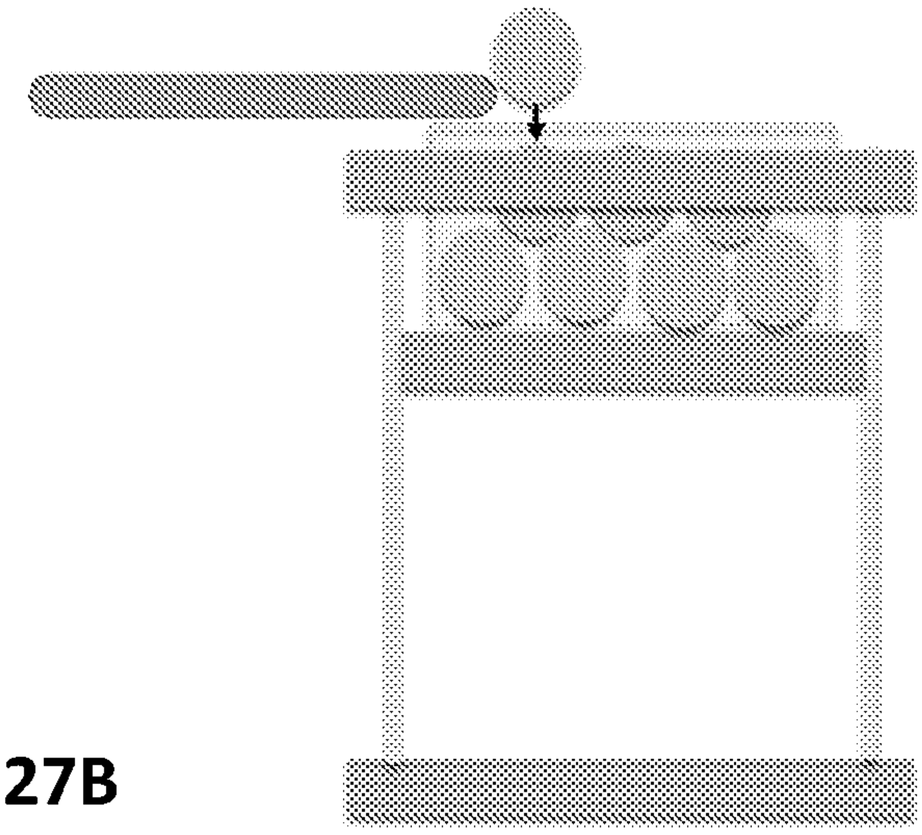


FIG. 27B

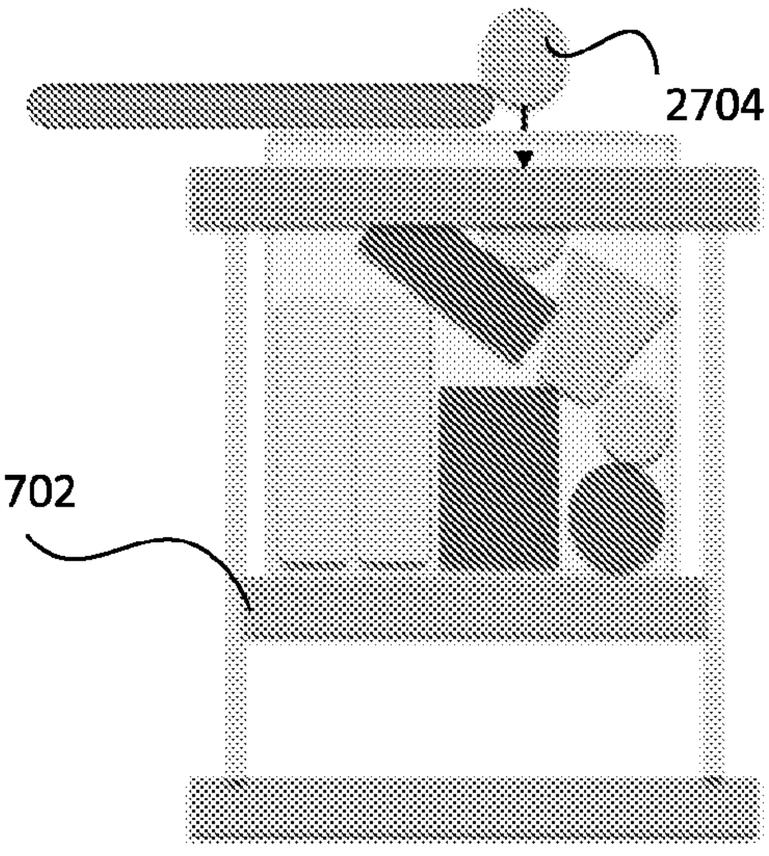


FIG. 27C

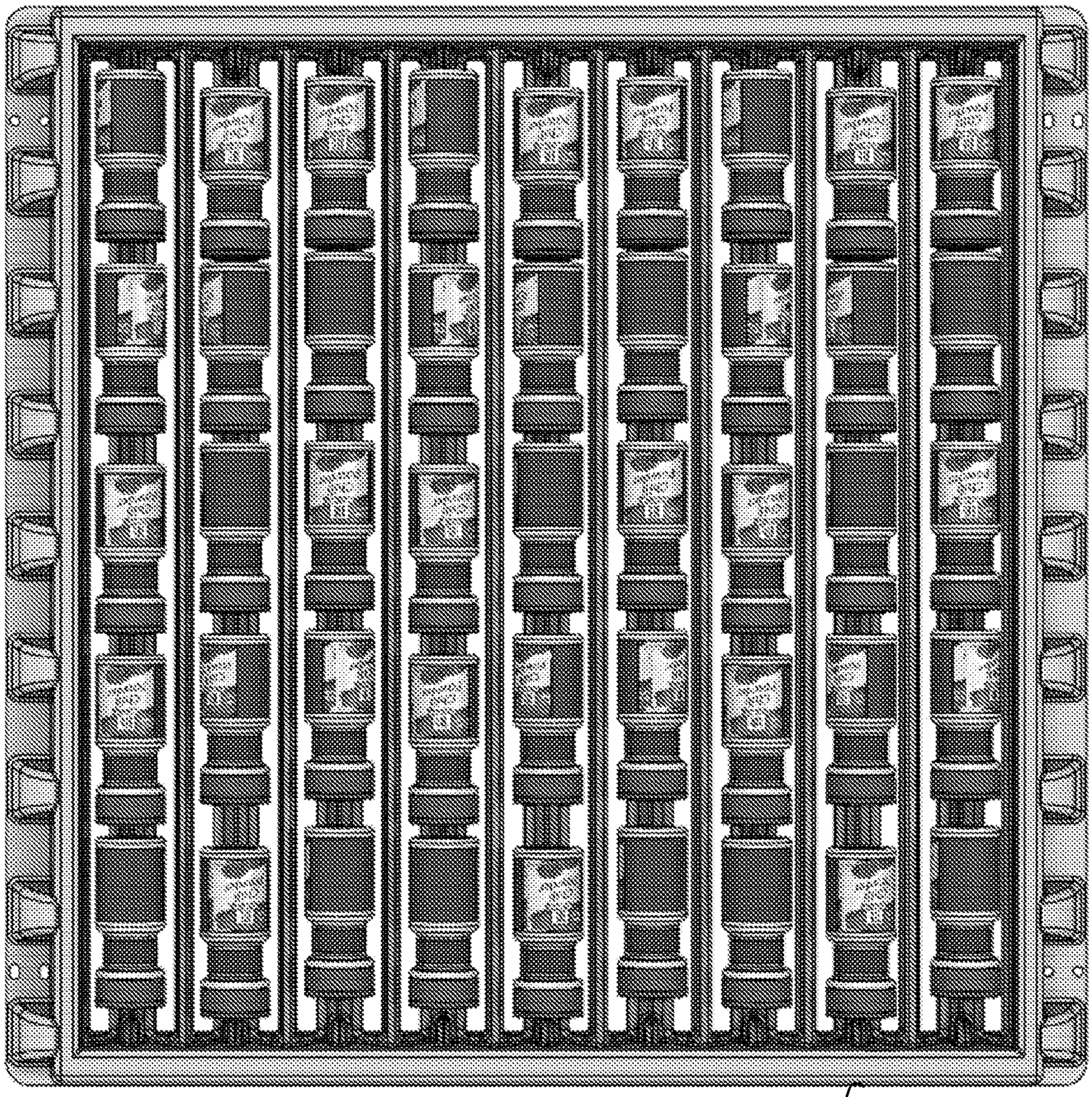
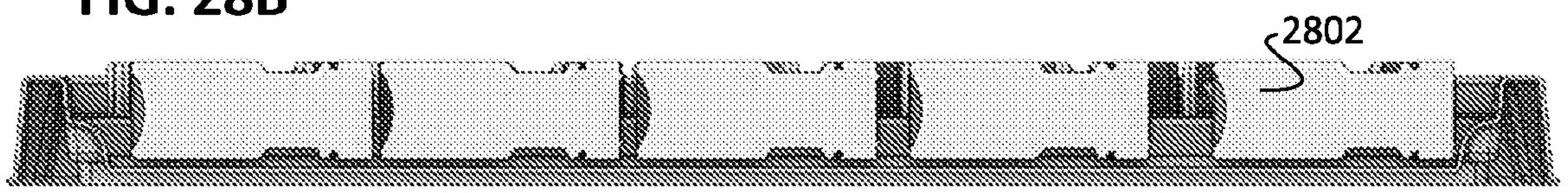


FIG. 28

FIG. 28A



FIG. 28B



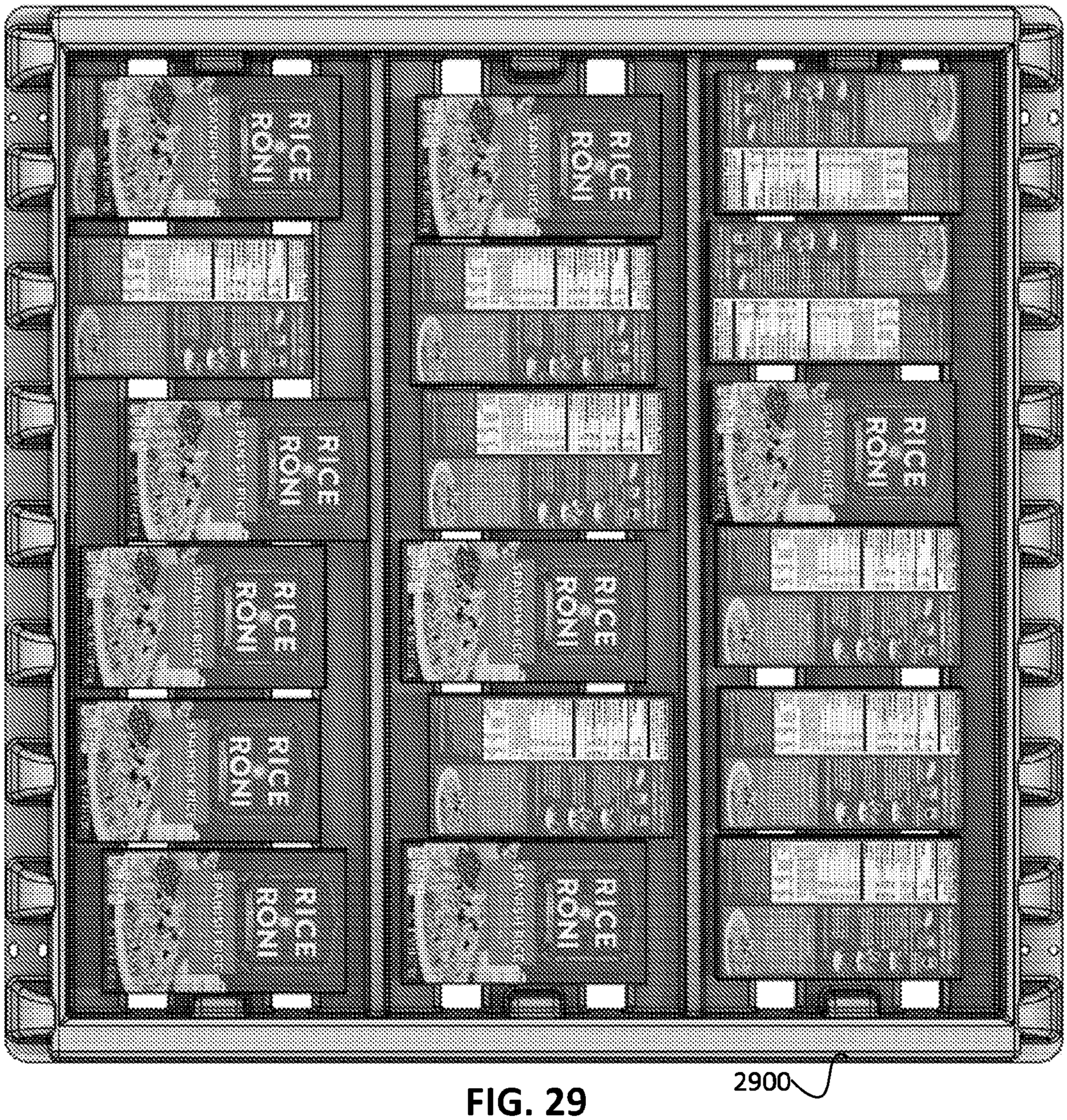


FIG. 29

FIG. 29A

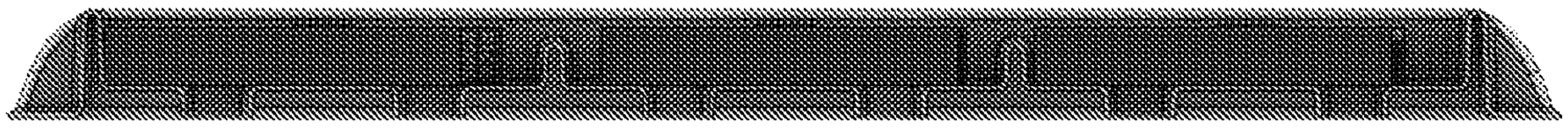
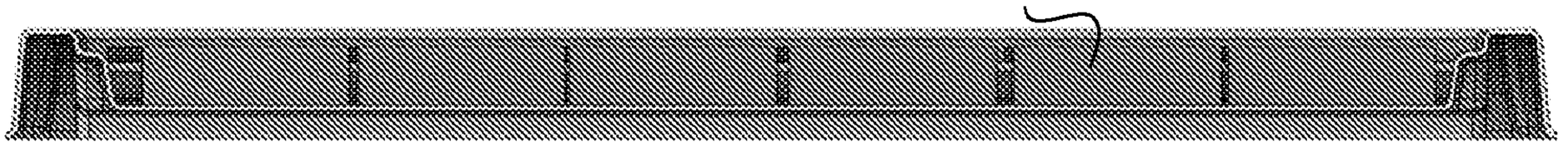


FIG. 29B



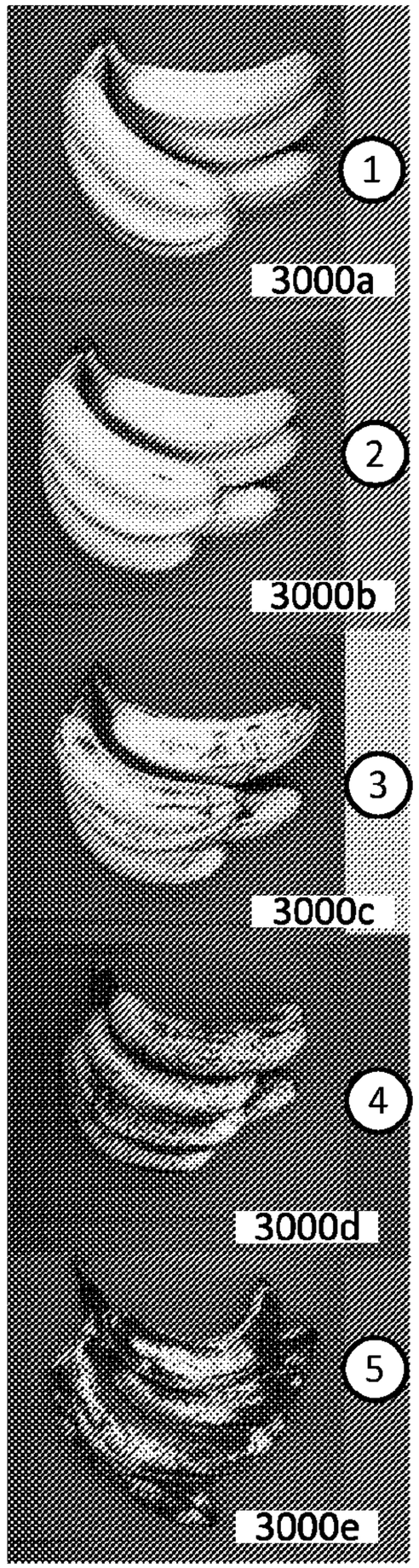

1
3000a
2
3000b
3
3000c
4
3000d
5
3000e

FIG. 30

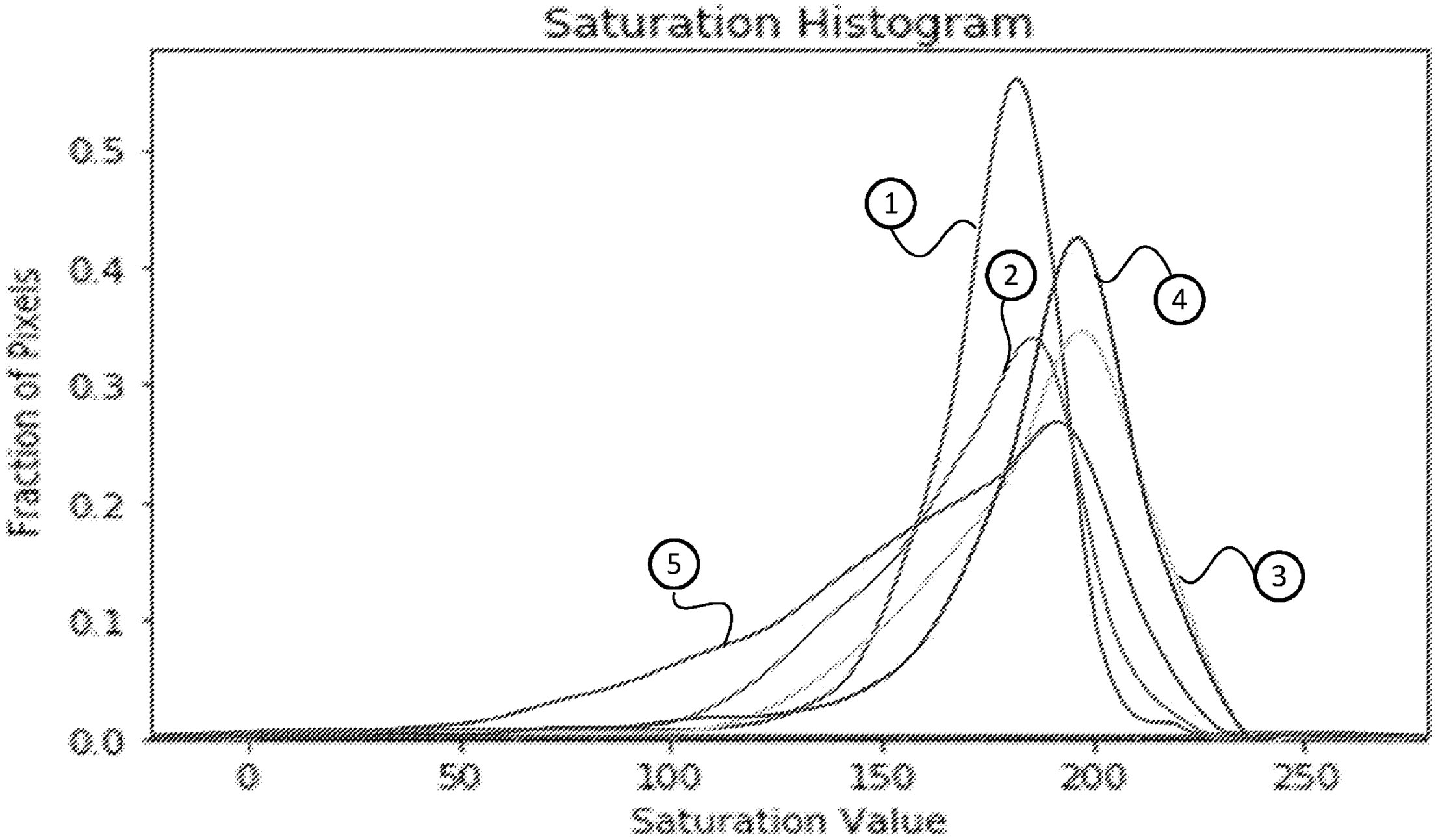

Saturation Histogram
Fraction of Pixels
0.0
0.1
0.2
0.3
0.4
0.5
0
50
100
150
200
250
Saturation Value
1
2
3
4
5

FIG. 31

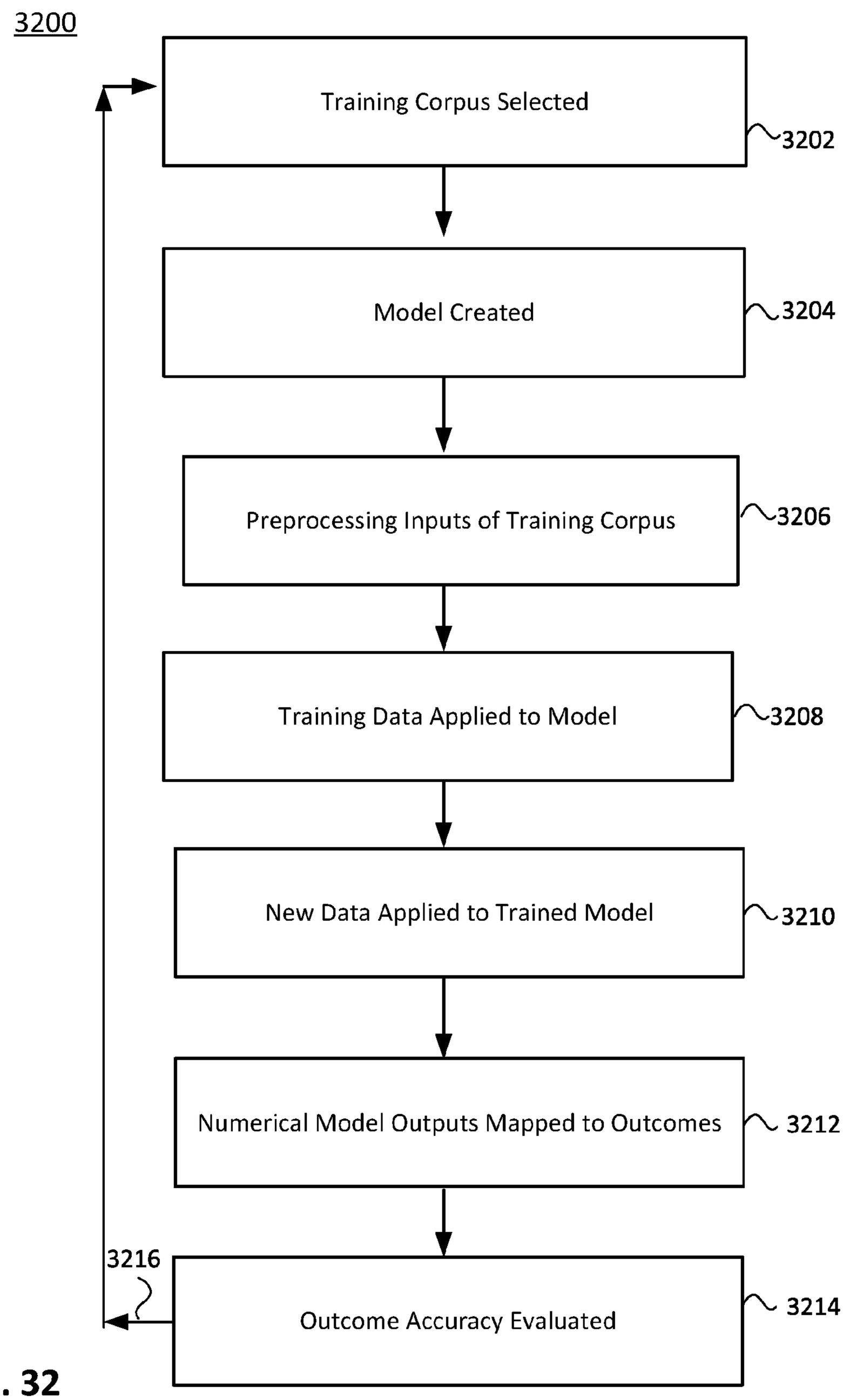

3200
Training Corpus Selected
3202
Model Created
3204
Preprocessing Inputs of Training Corpus
3206
Training Data Applied to Model
3208
New Data Applied to Trained Model
3210
Numerical Model Outputs Mapped to Outcomes
3212
3216
Outcome Accuracy Evaluated
3214

FIG. 32

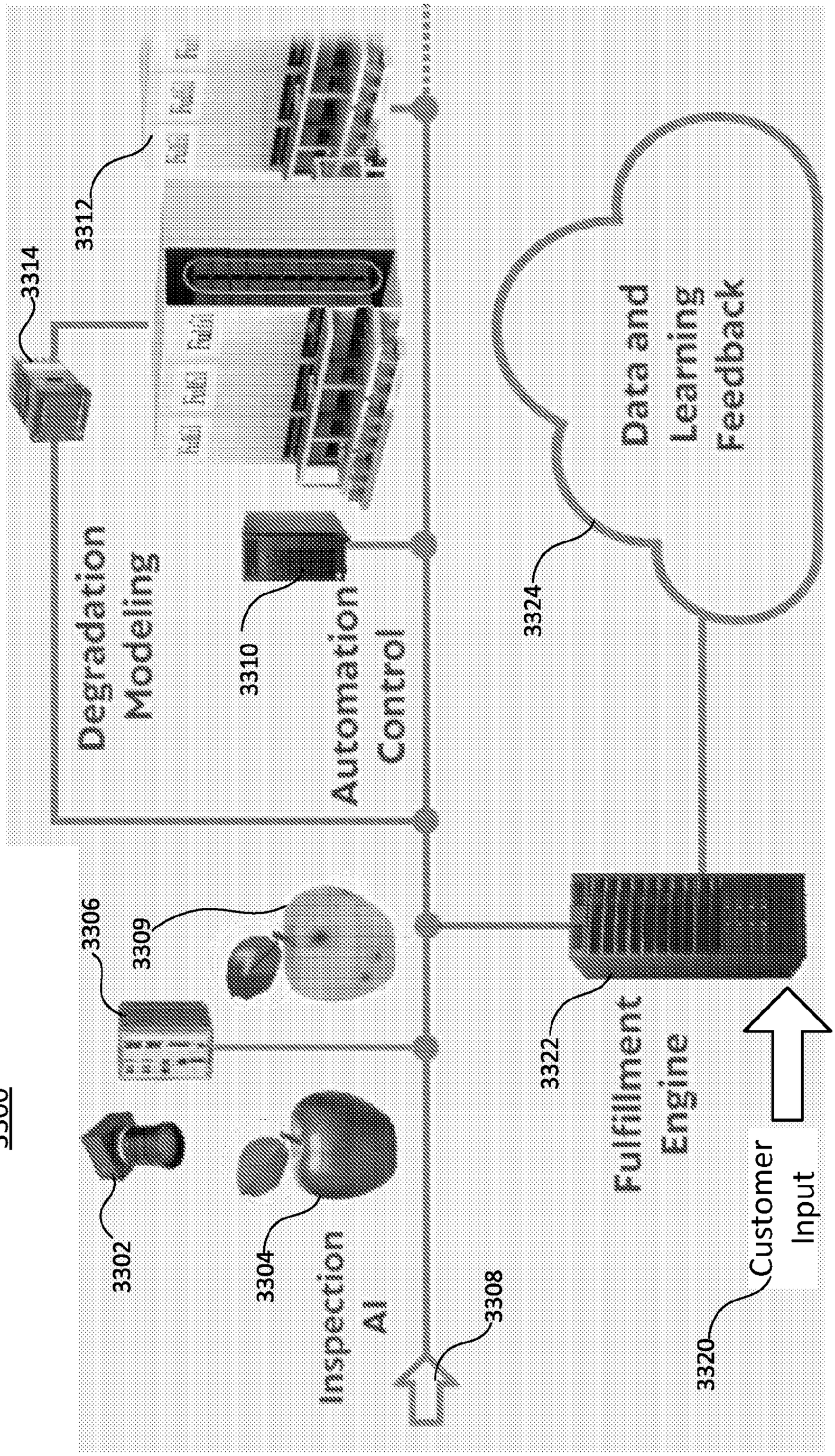

3300
3302
3304
Inspection
AI
3306
3308
3309
3310
Automation
Control
3312
3314
Degradation
Modeling
3320
Customer
Input
3322
Fulfillment
Engine
3324
Data and
Learning
Feedback

FIG. 33

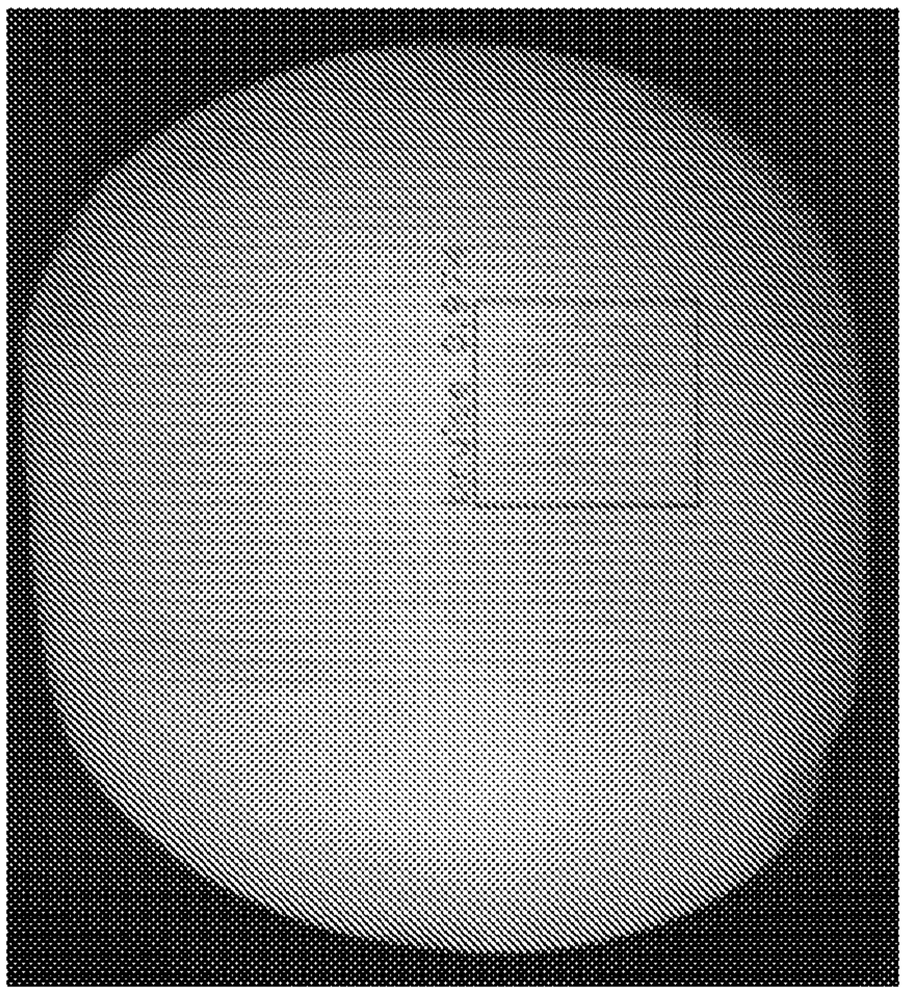


FIG. 34B

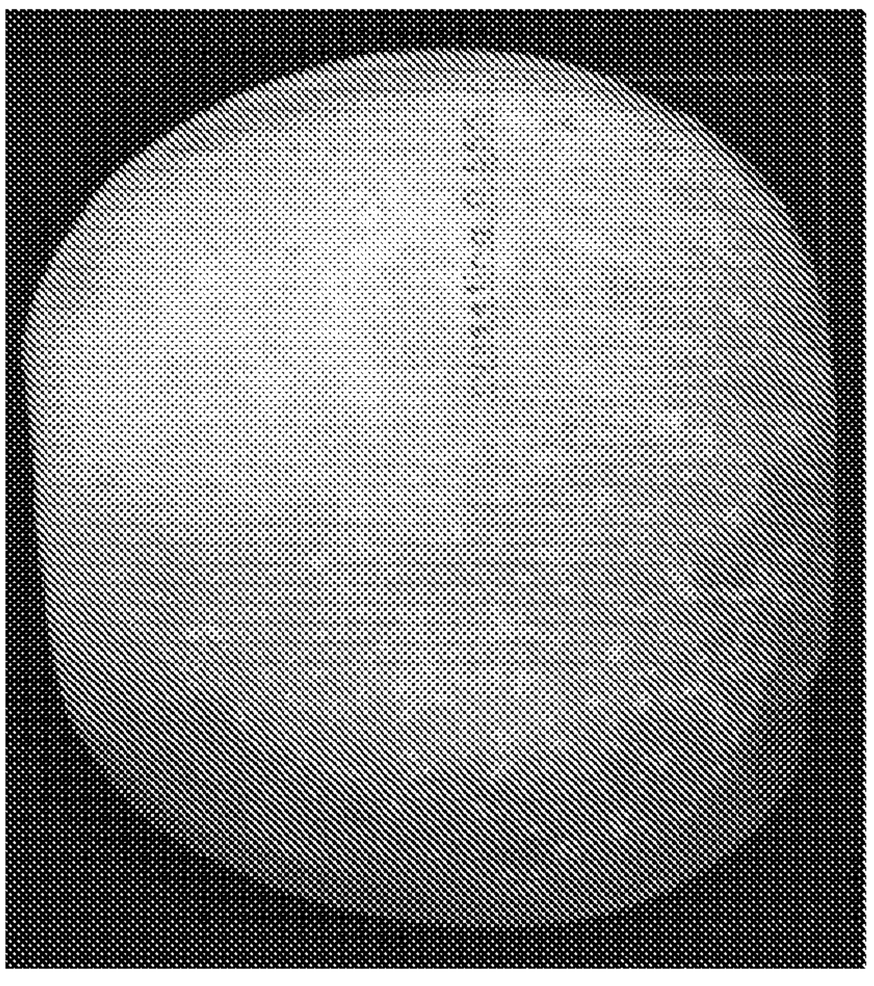


FIG. 34D

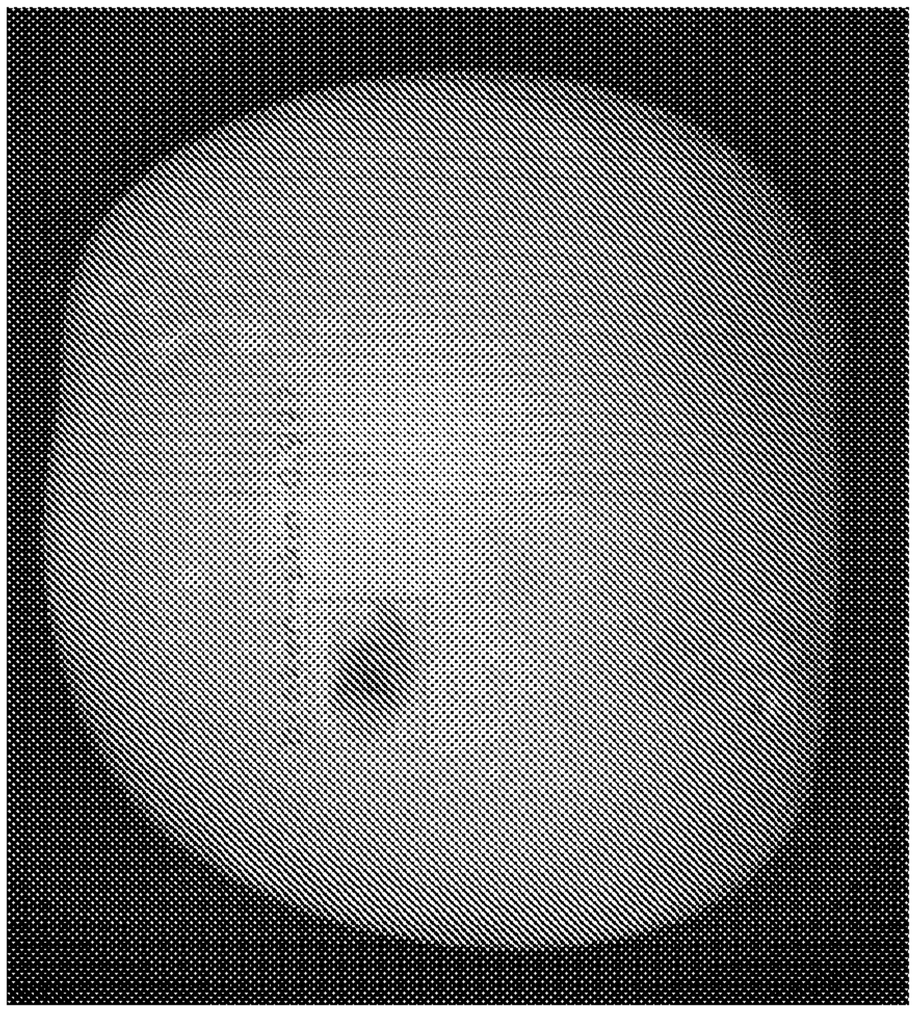


FIG. 34A

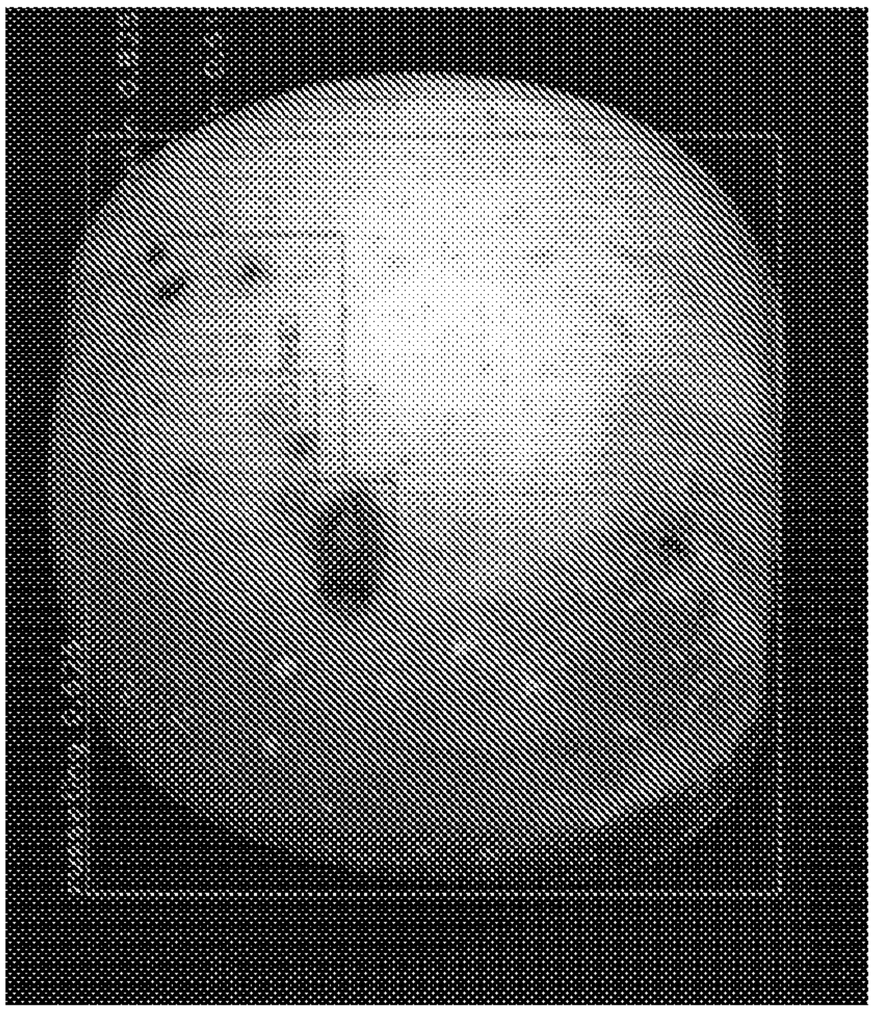


FIG. 34C

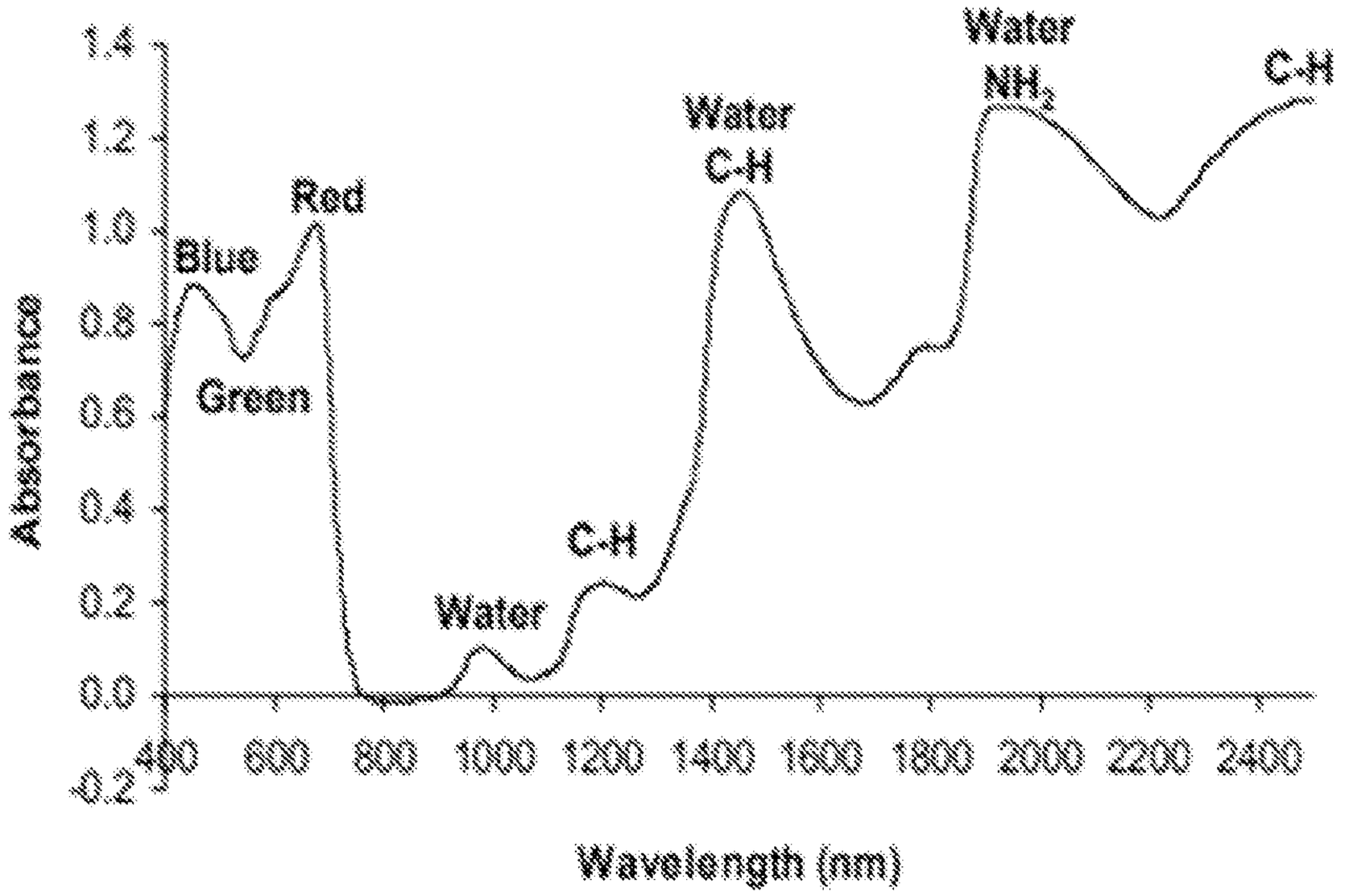


FIG. 35

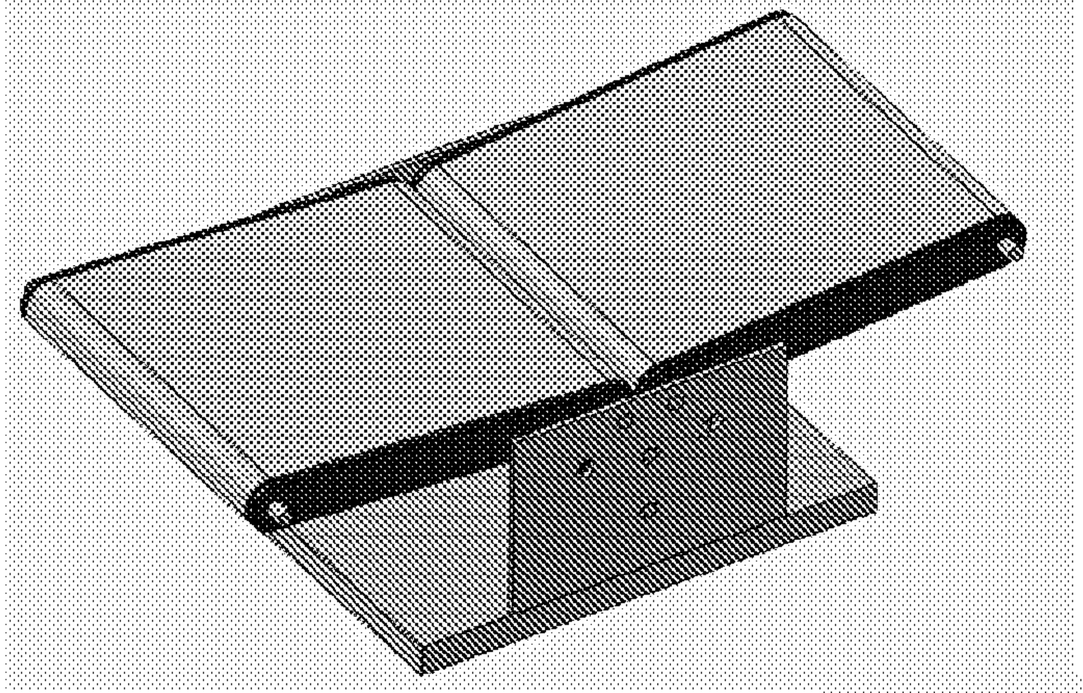


FIG. 36A

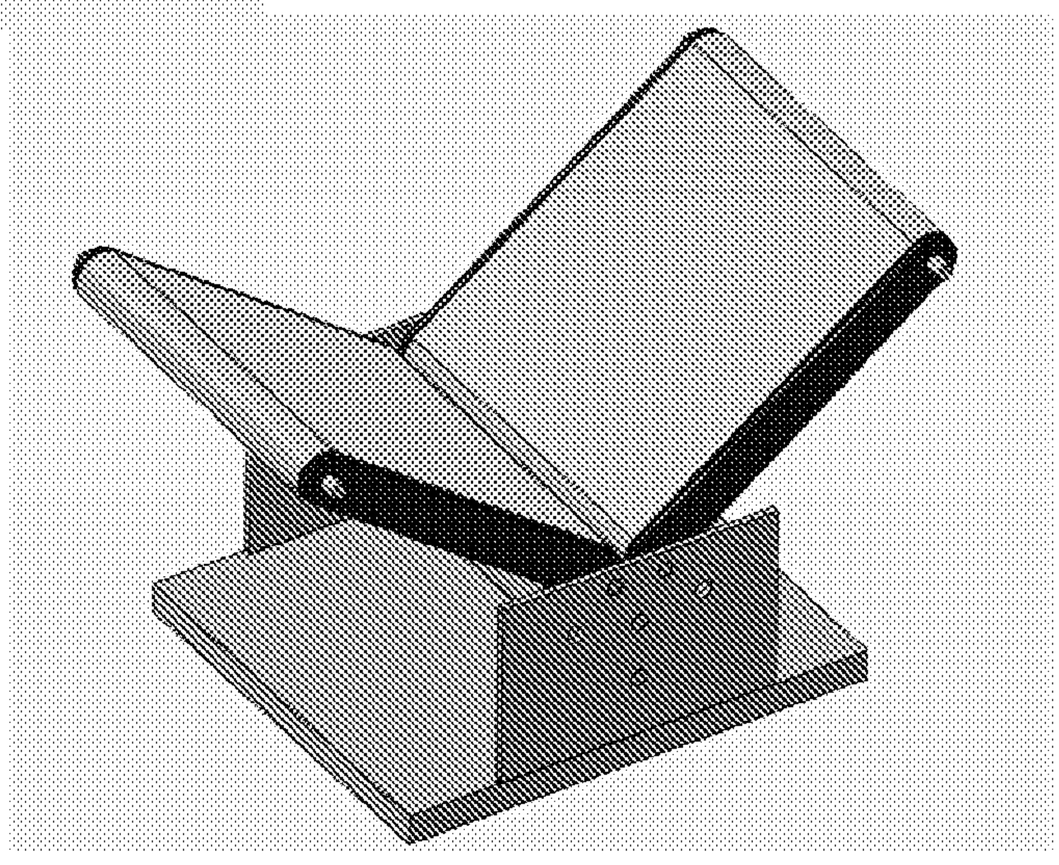


FIG. 36B

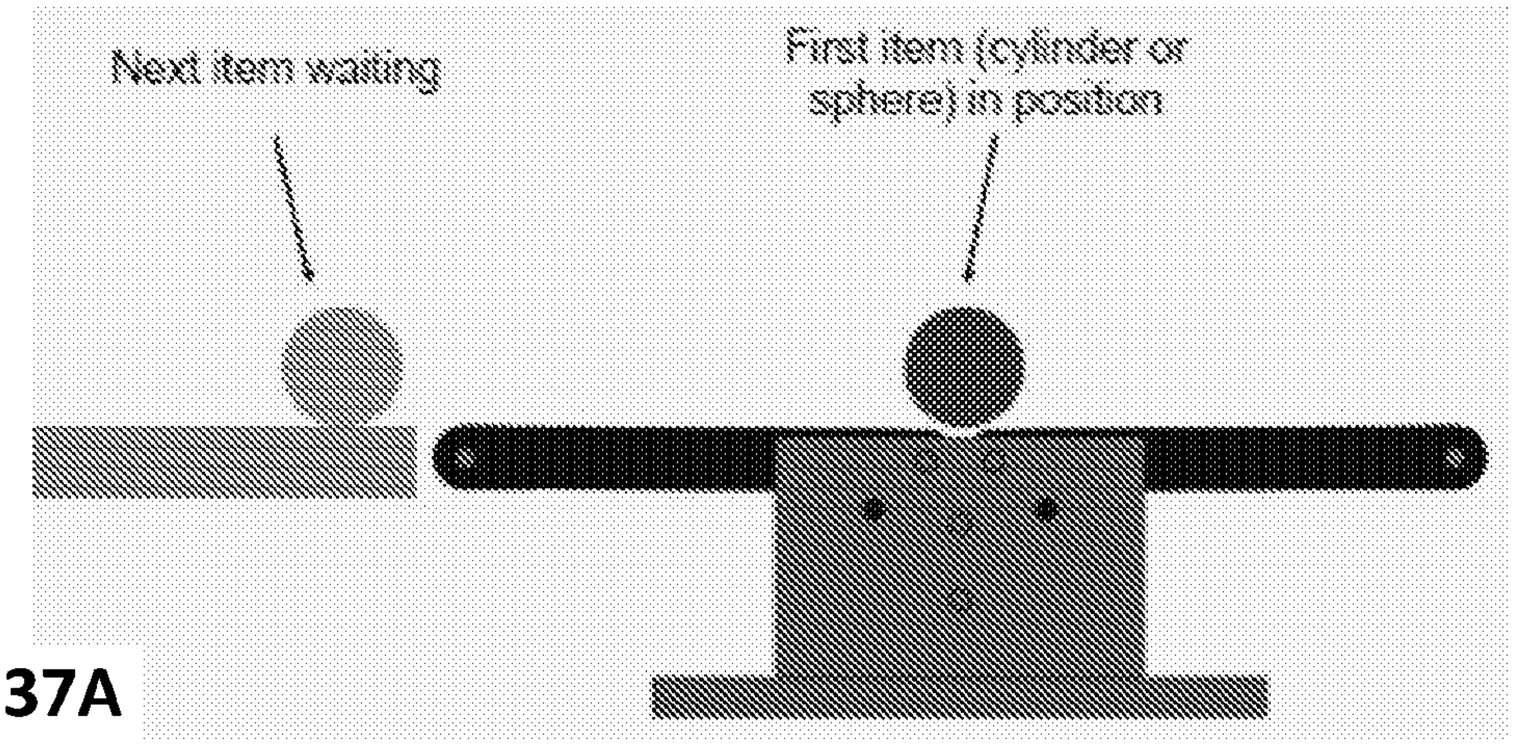


FIG. 37A

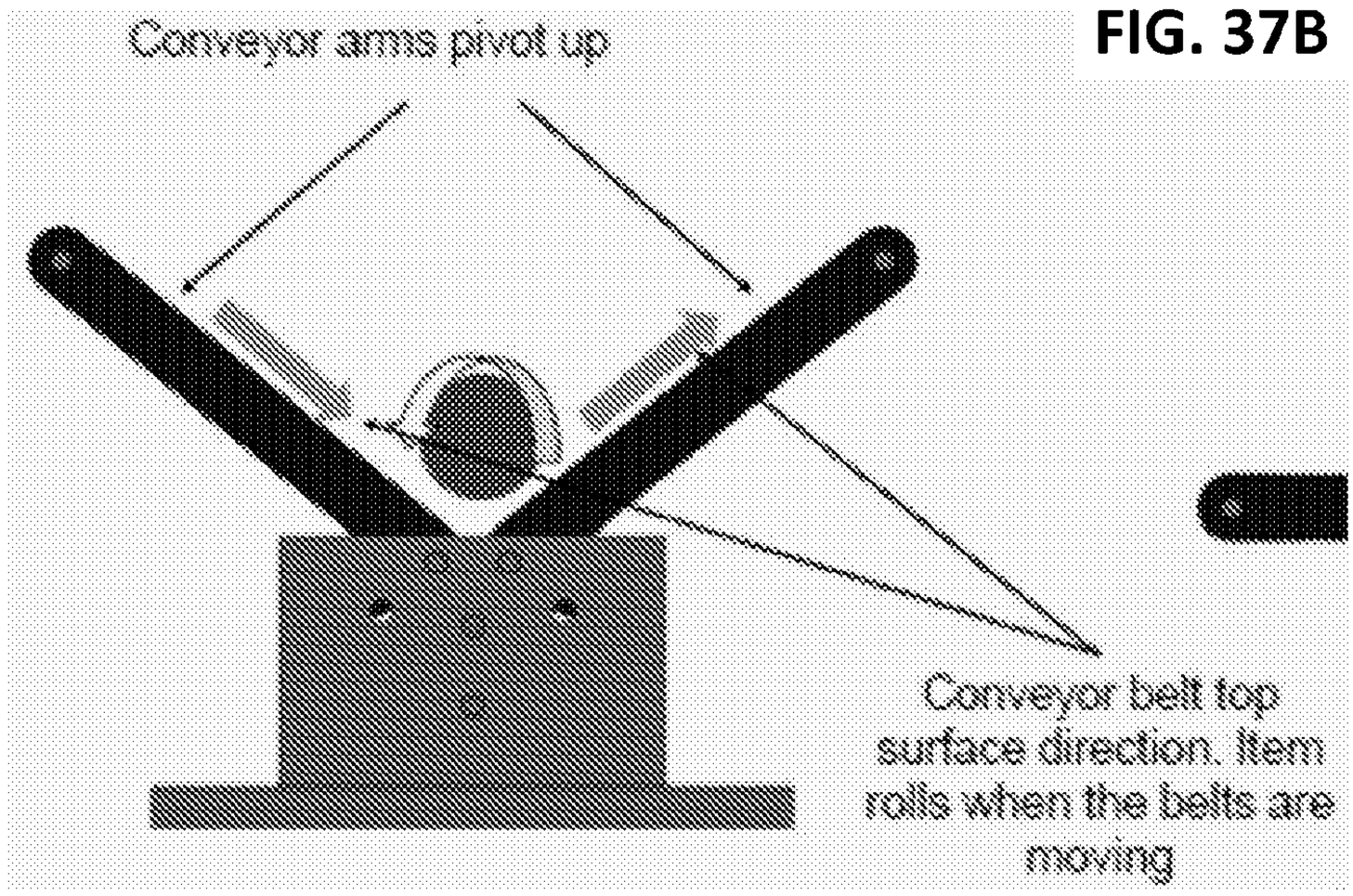


FIG. 37B

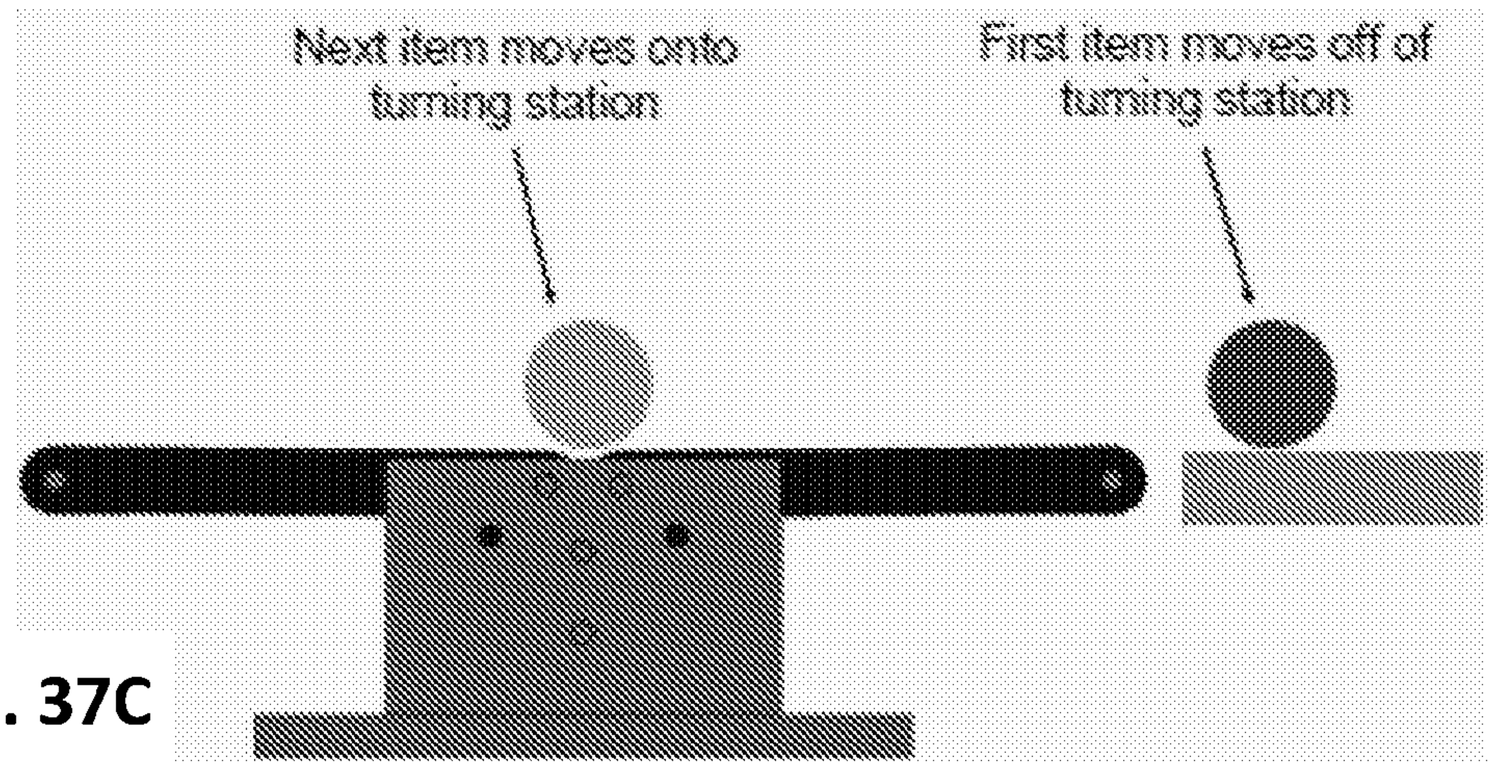


FIG. 37C

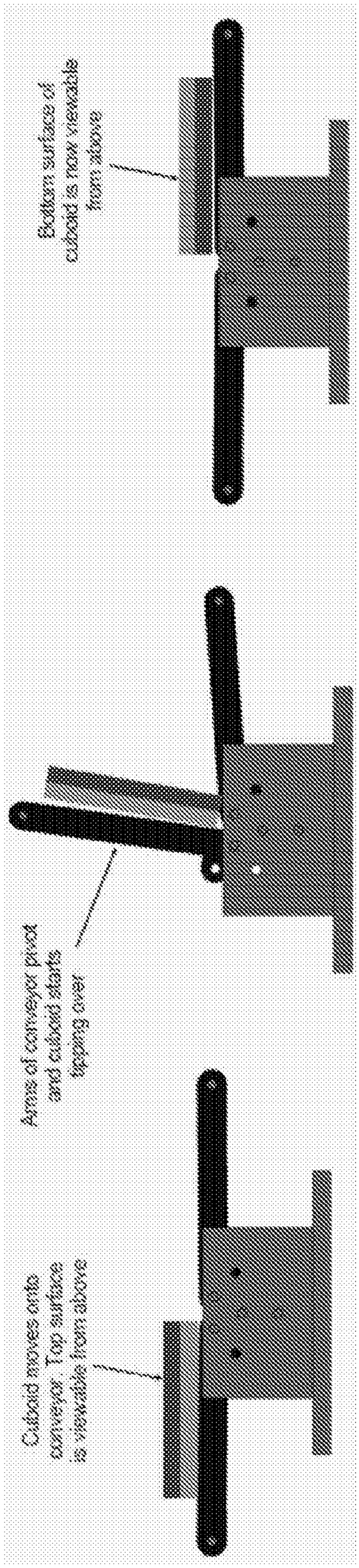


FIG. 37F

FIG. 37E

FIG. 37D

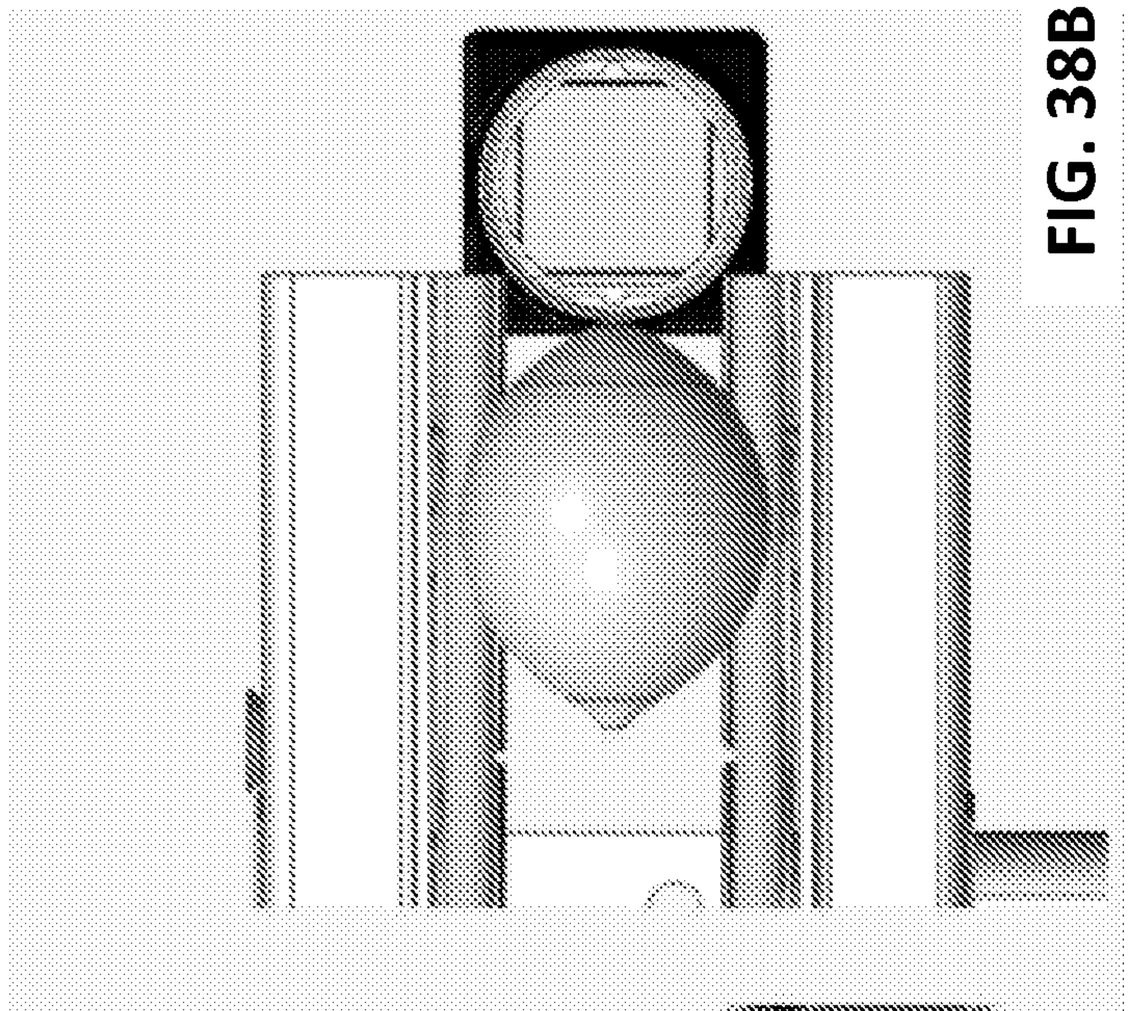


FIG. 38B

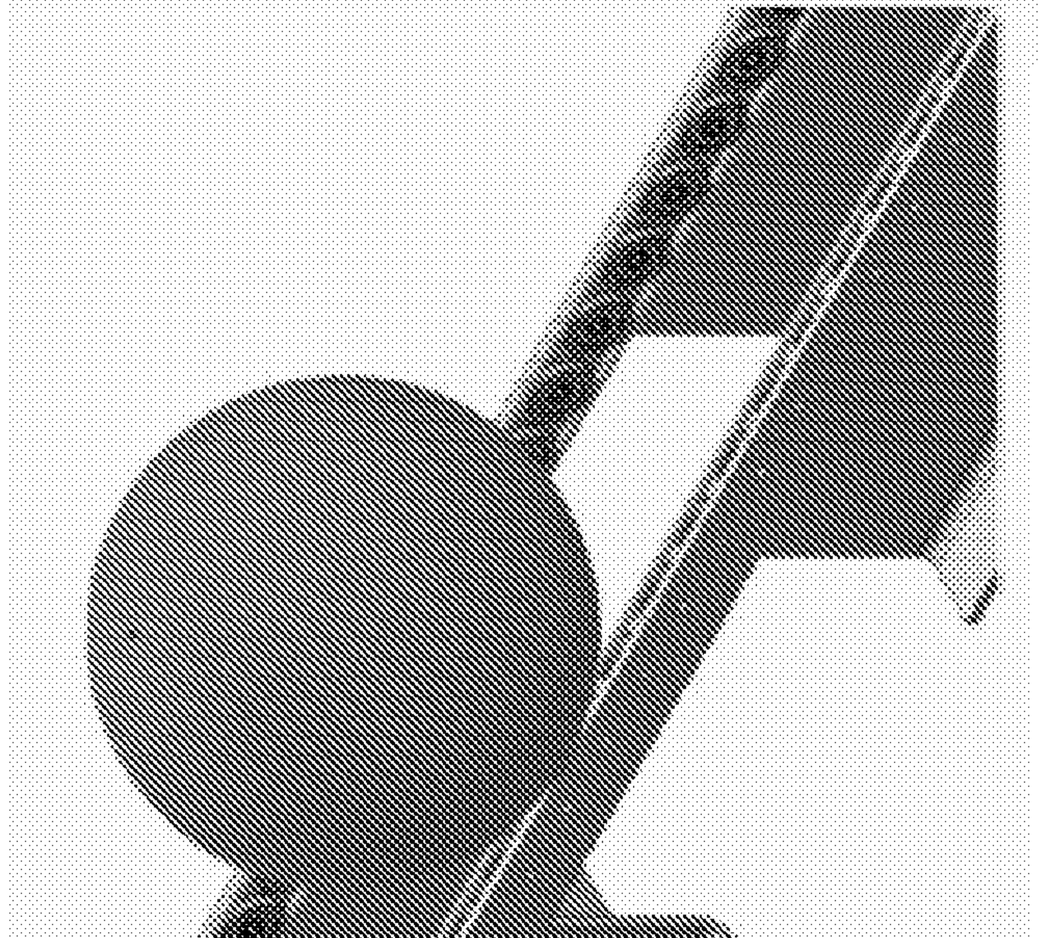


FIG. 38A

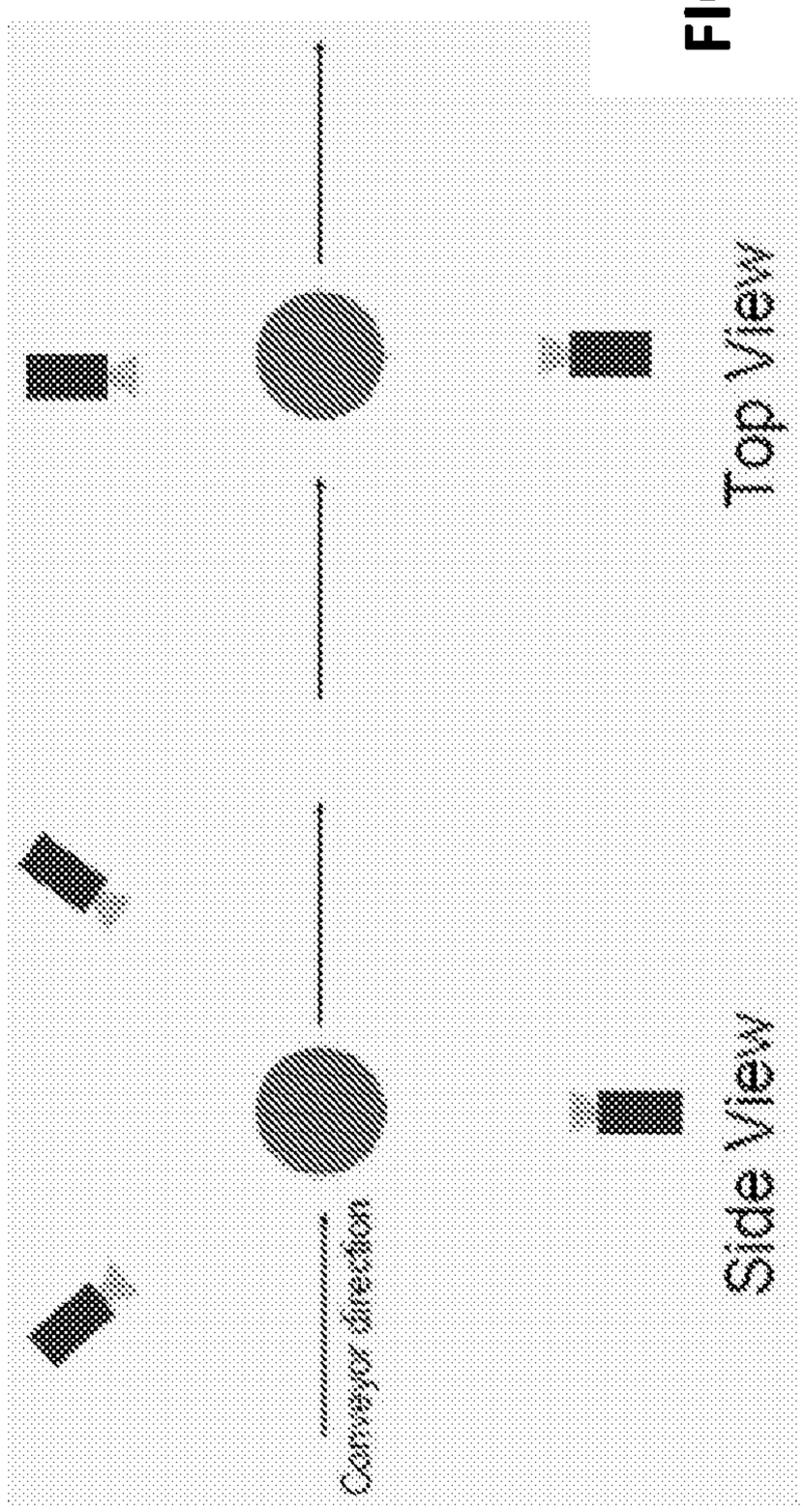


FIG. 38C

FIG. 38D

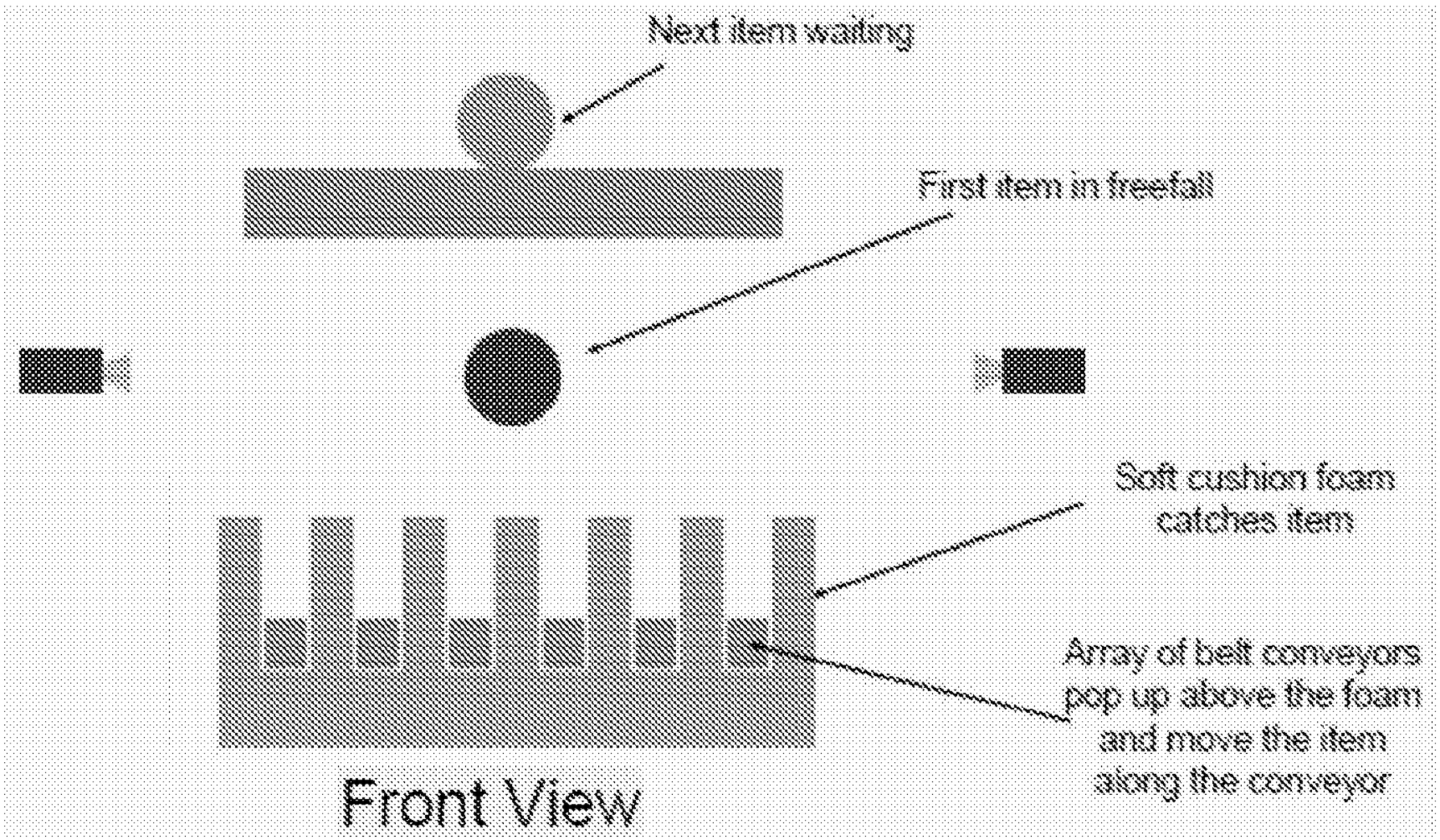


FIG. 39A

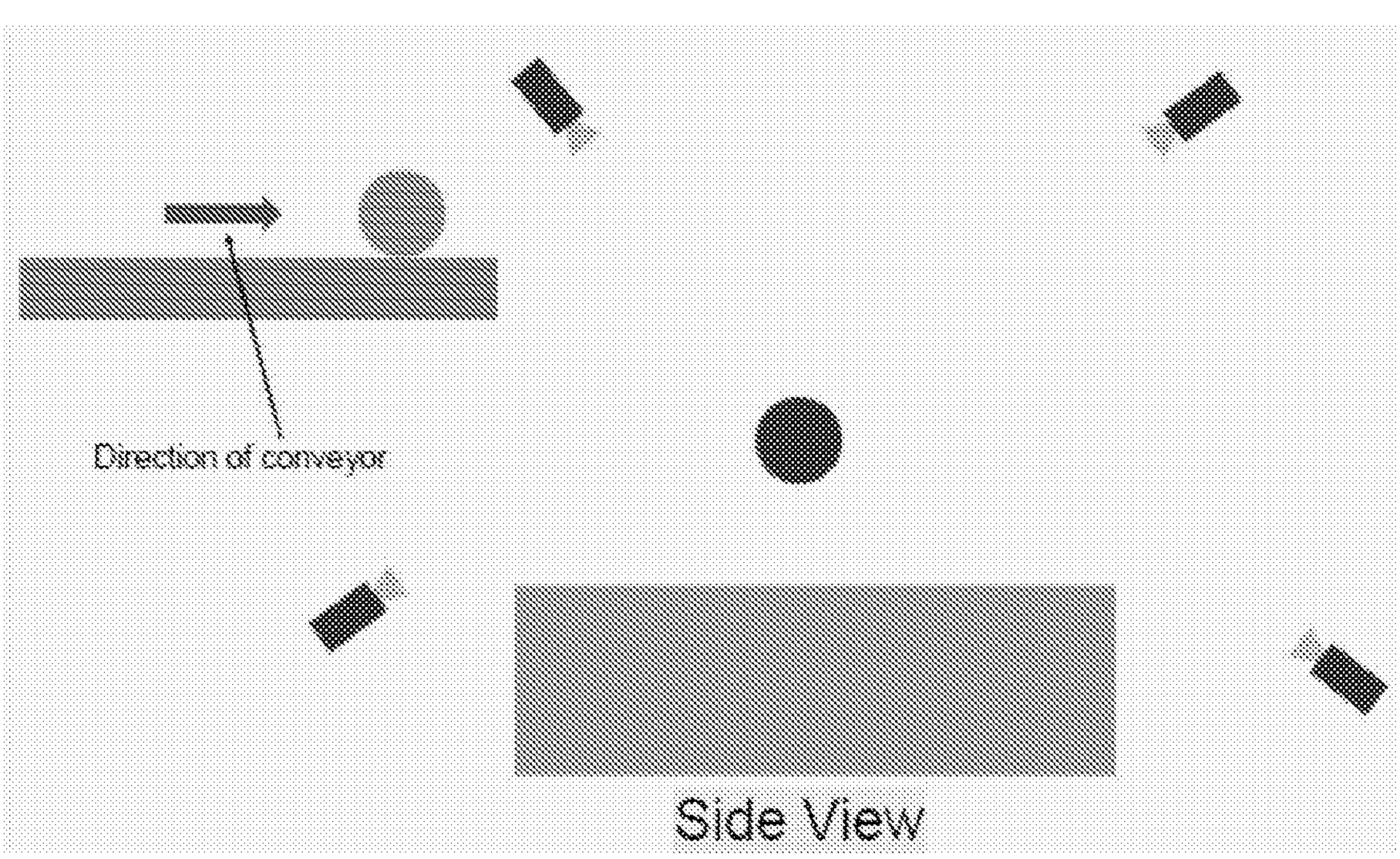


FIG. 39B

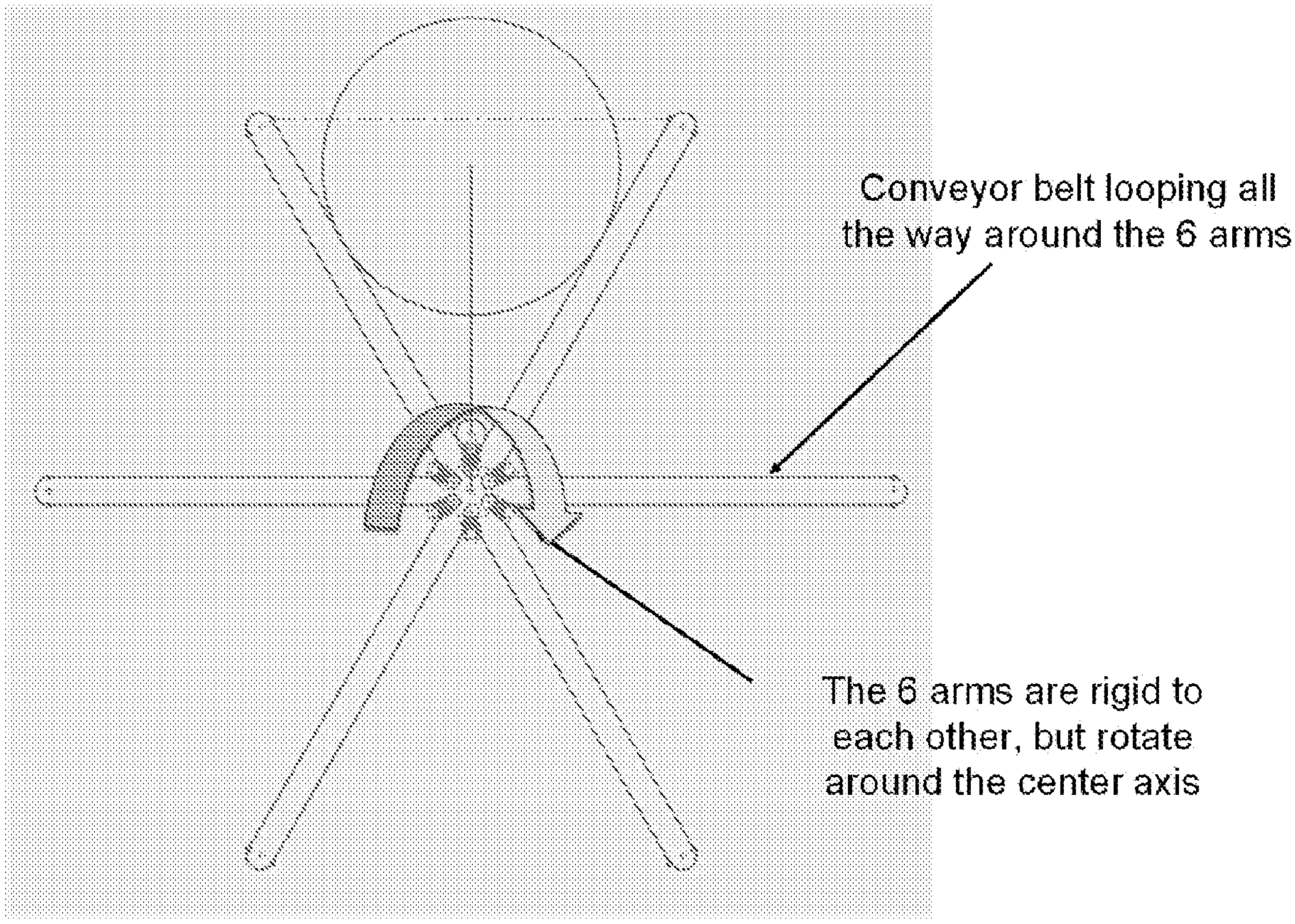

Conveyor belt looping all the way around the 6 arms
The 6 arms are rigid to each other, but rotate around the center axis

FIG. 40

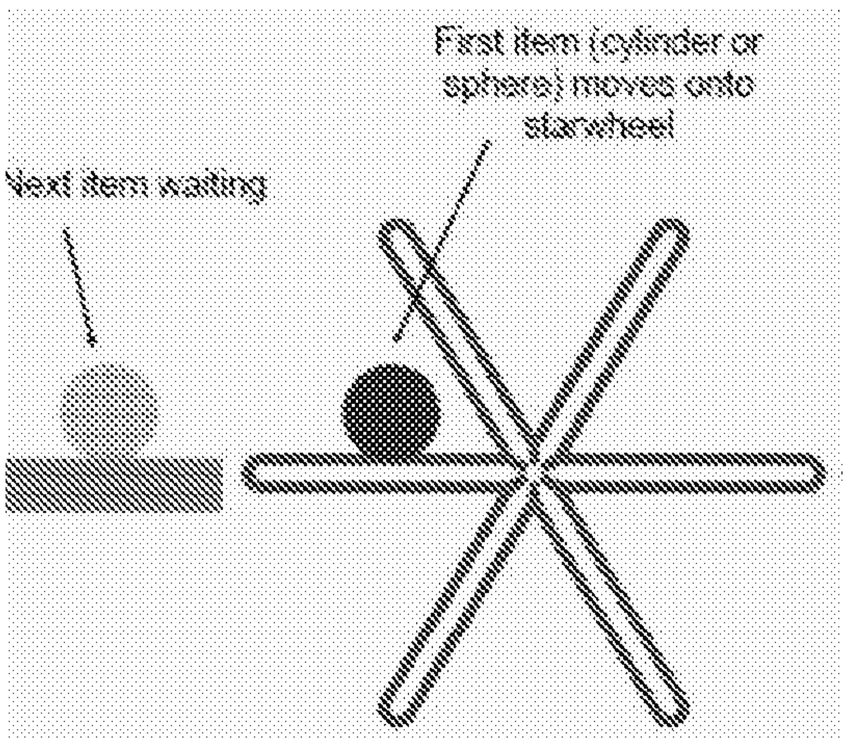
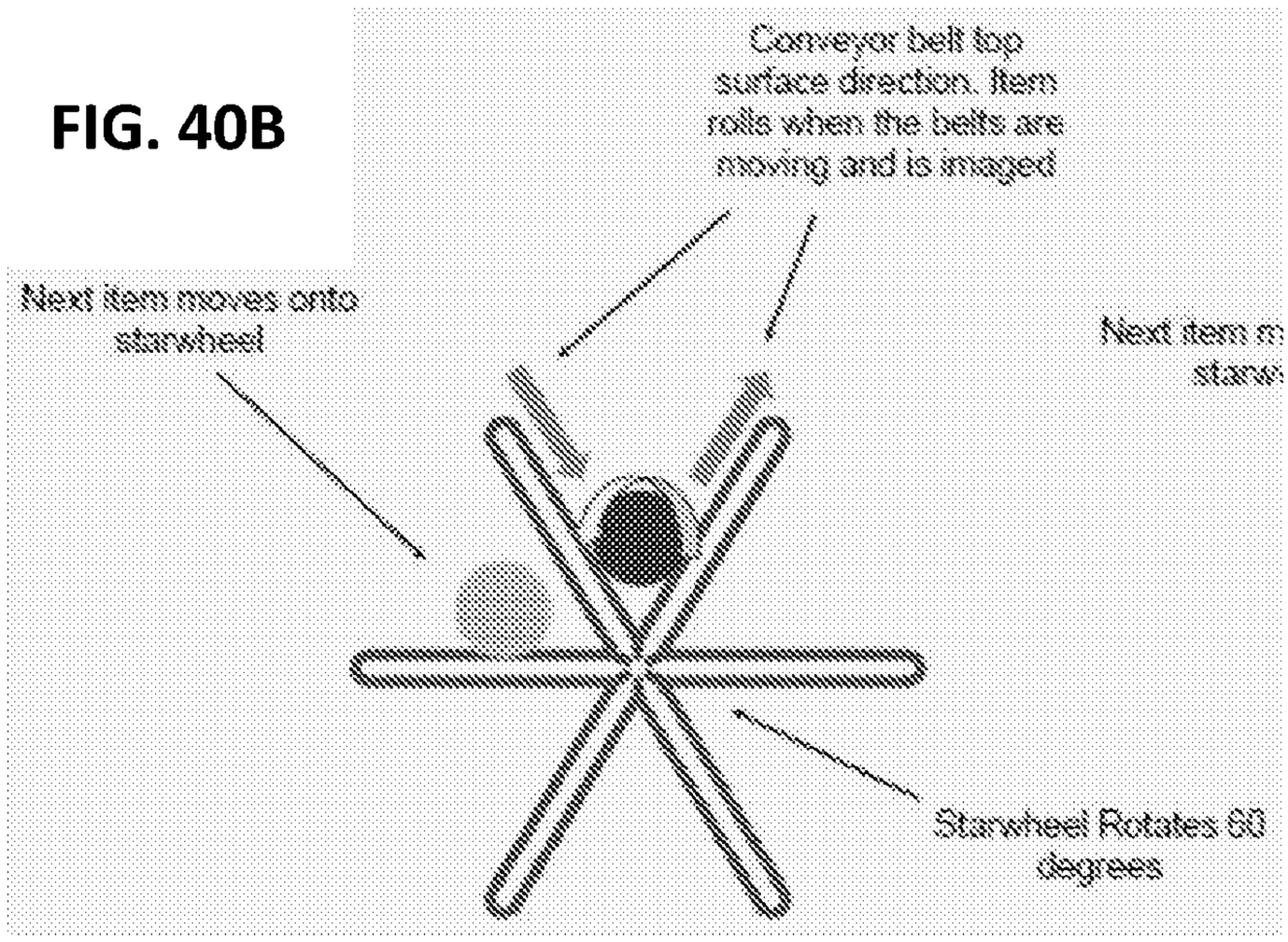


FIG. 40A

FIG. 40B



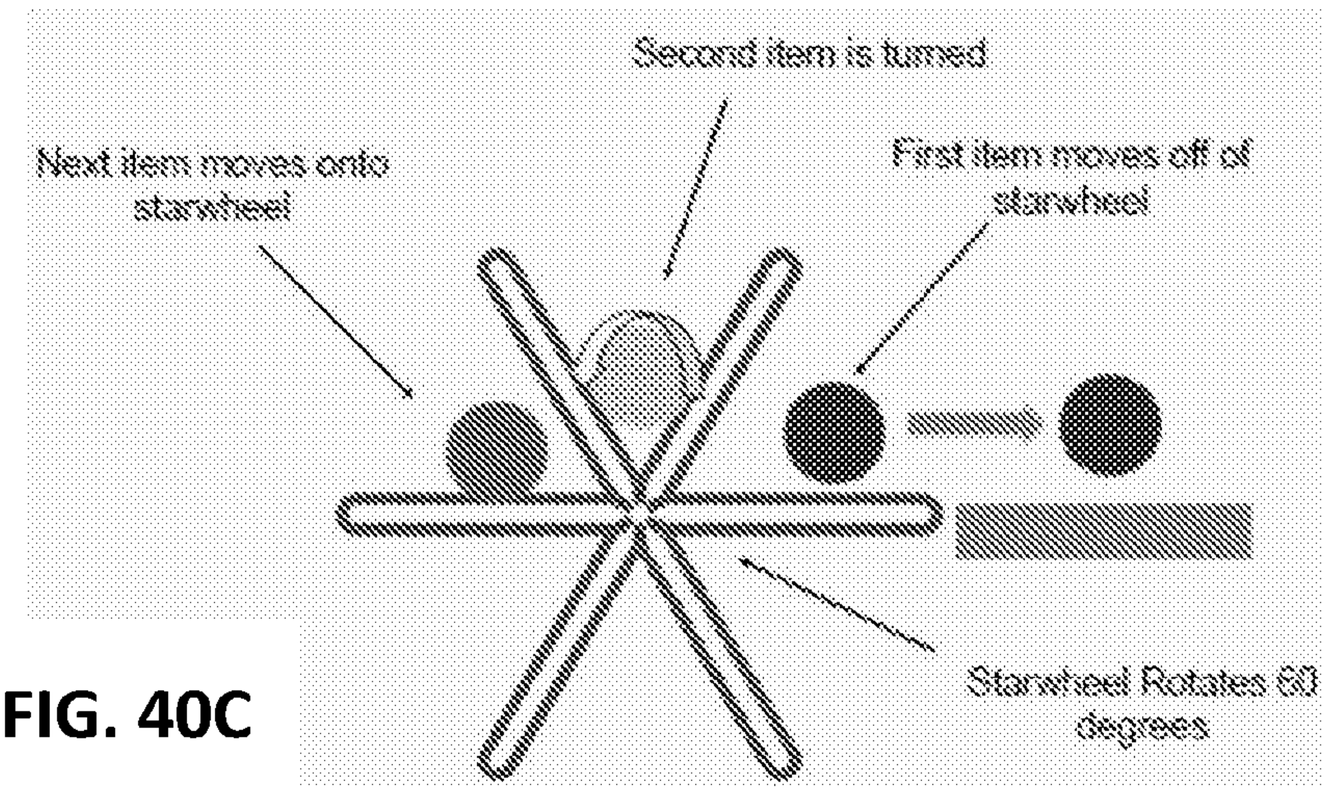


FIG. 40C

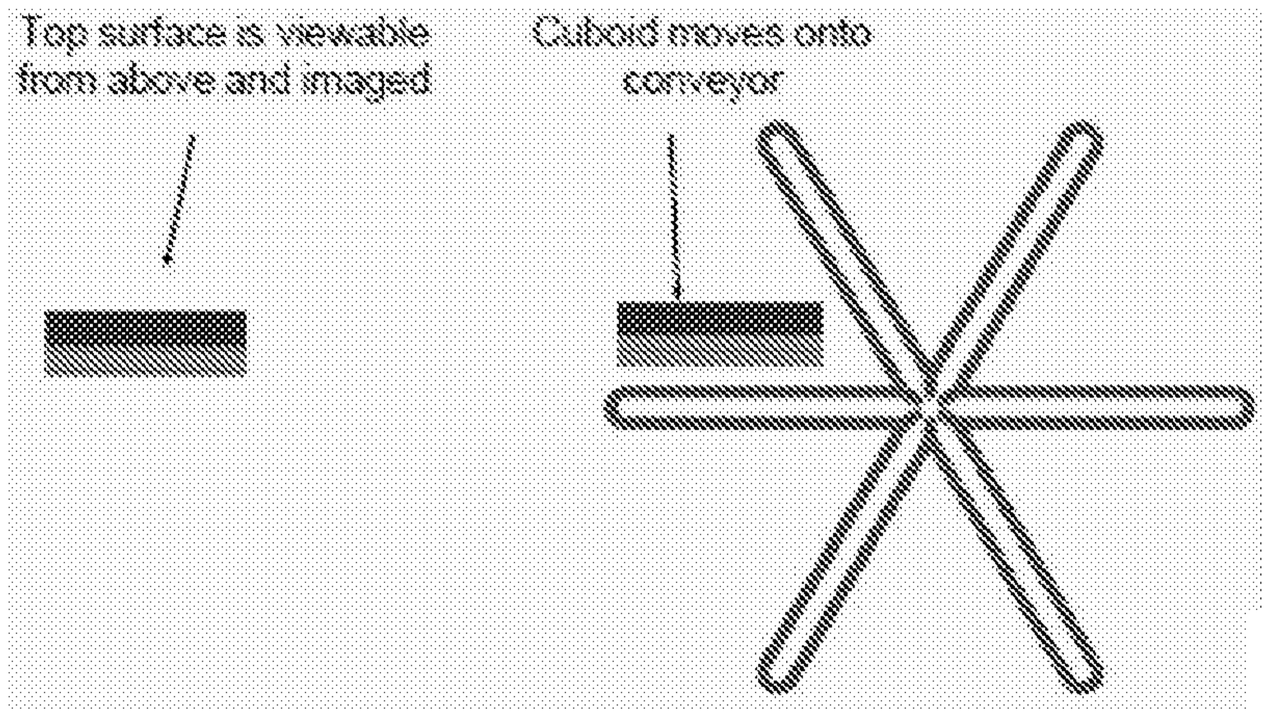


FIG. 40D

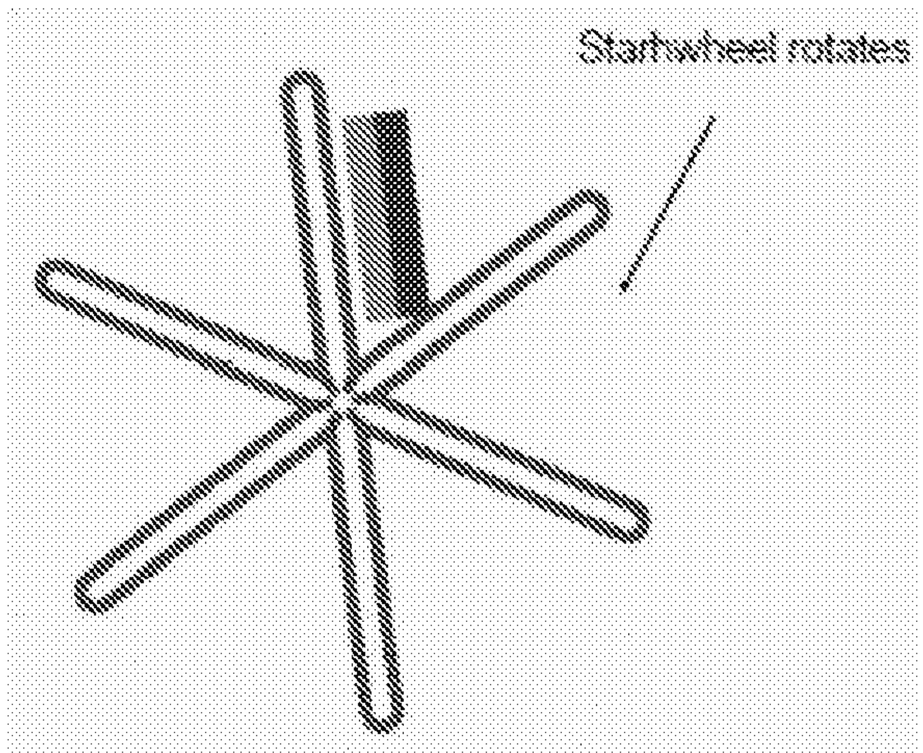


FIG. 40E

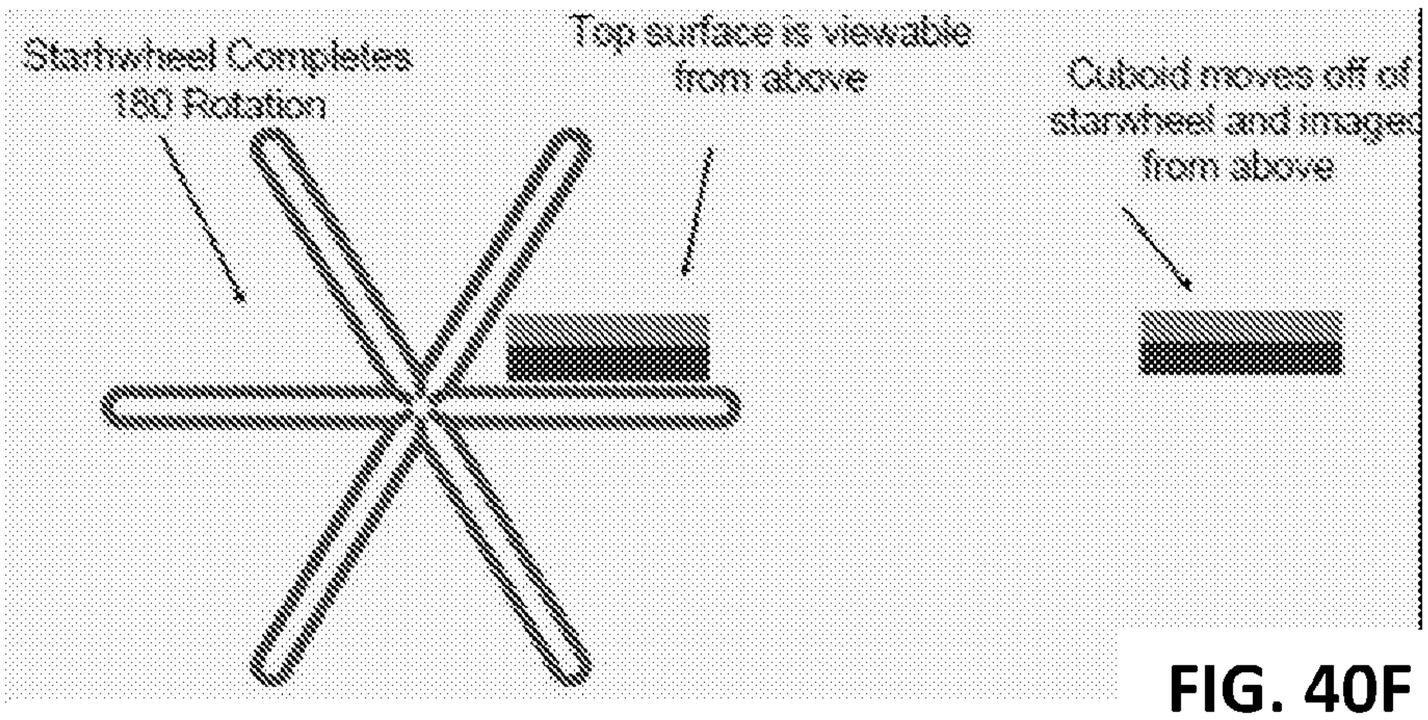


FIG. 40F

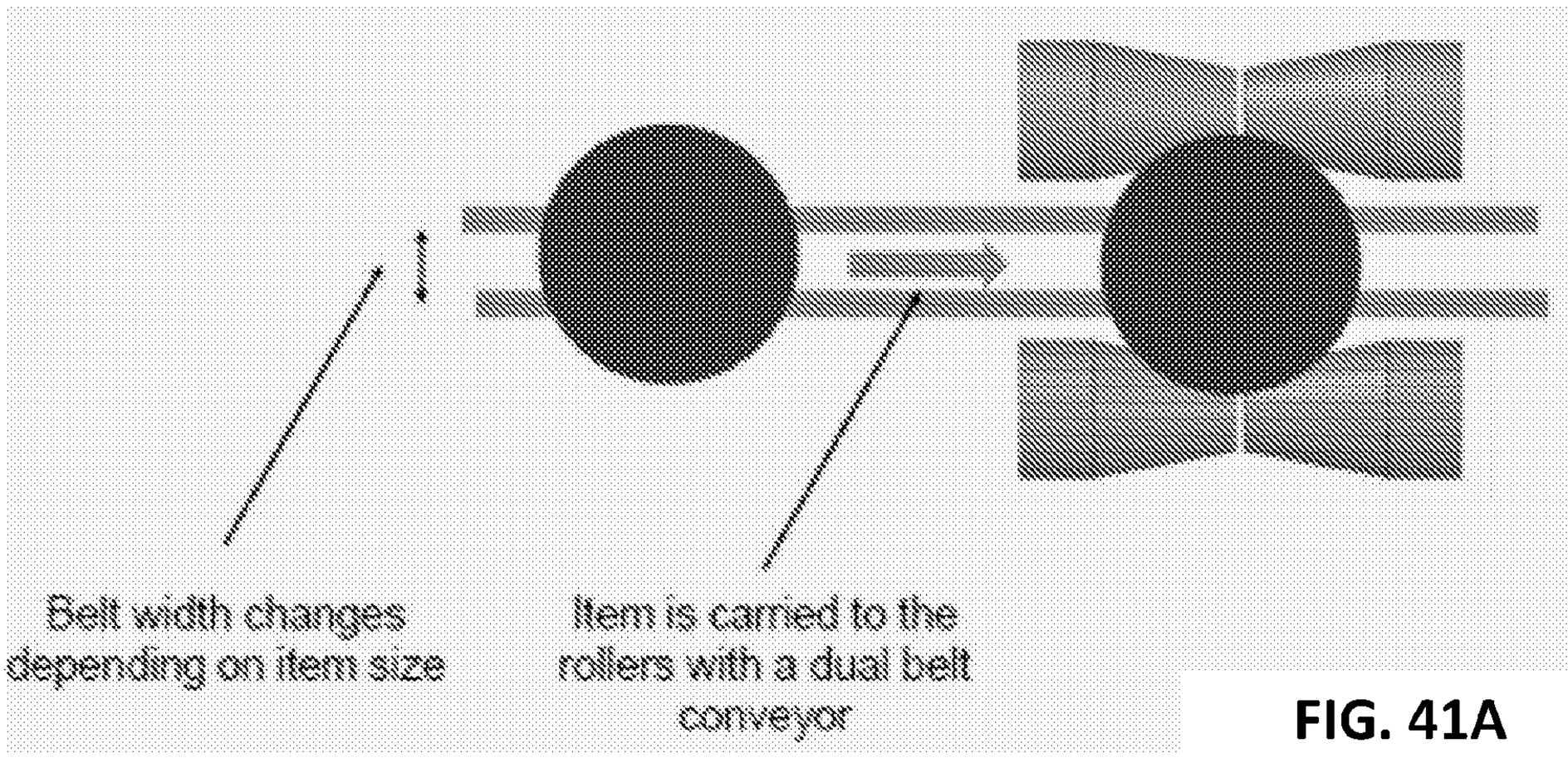


FIG. 41A

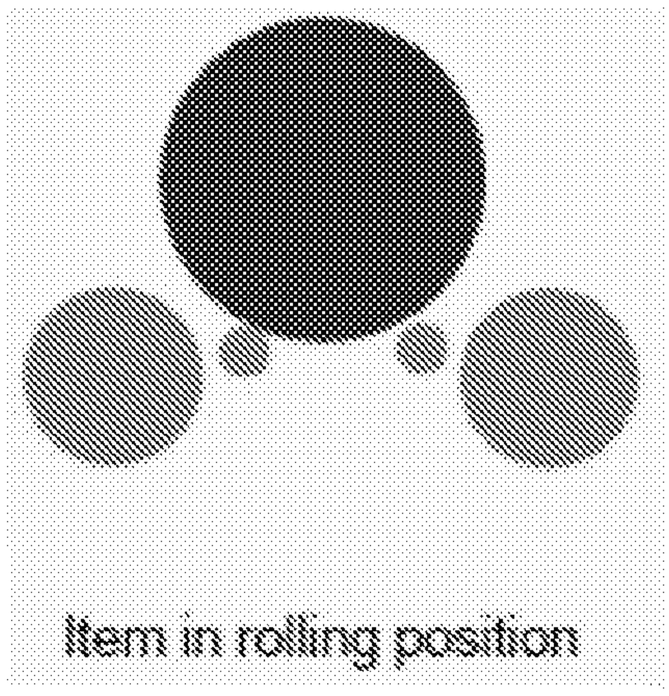


FIG. 41B

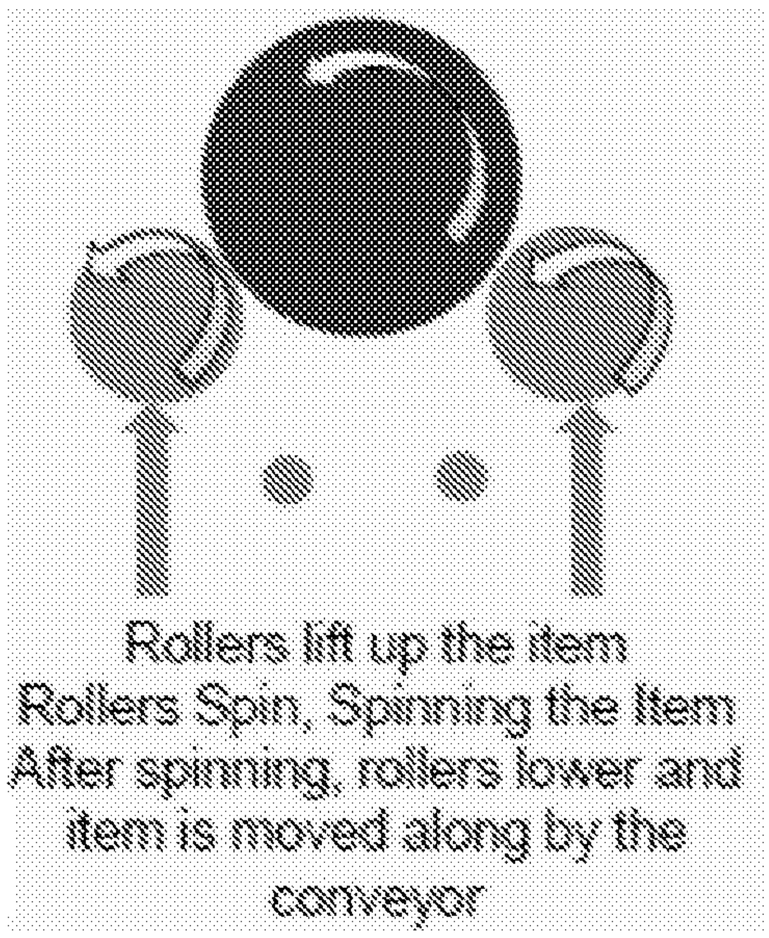


FIG. 41C

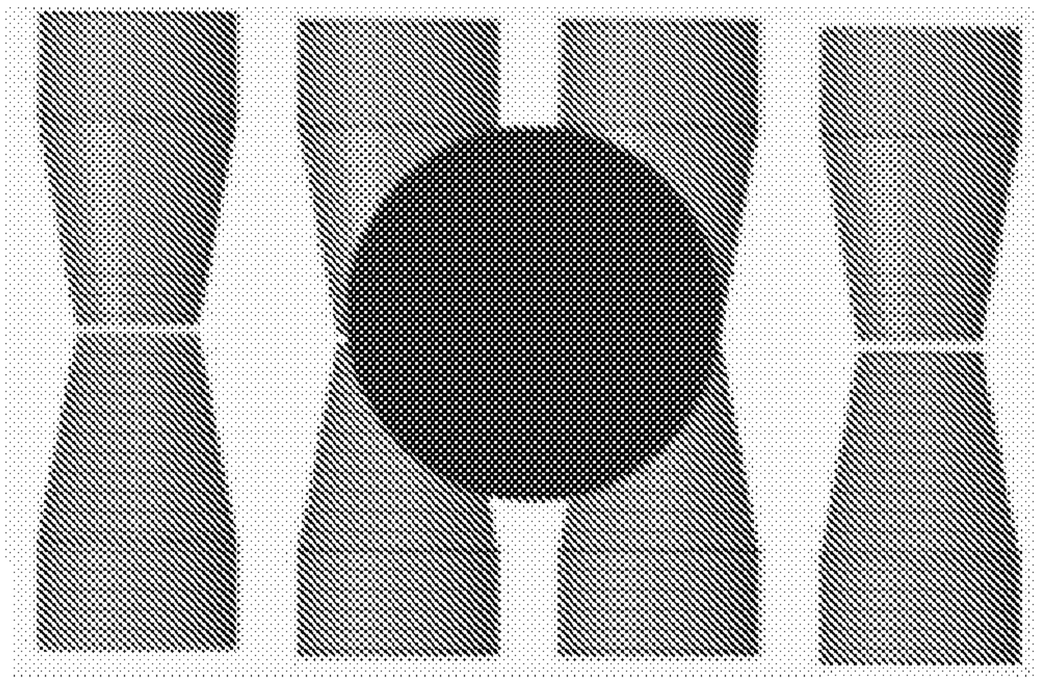
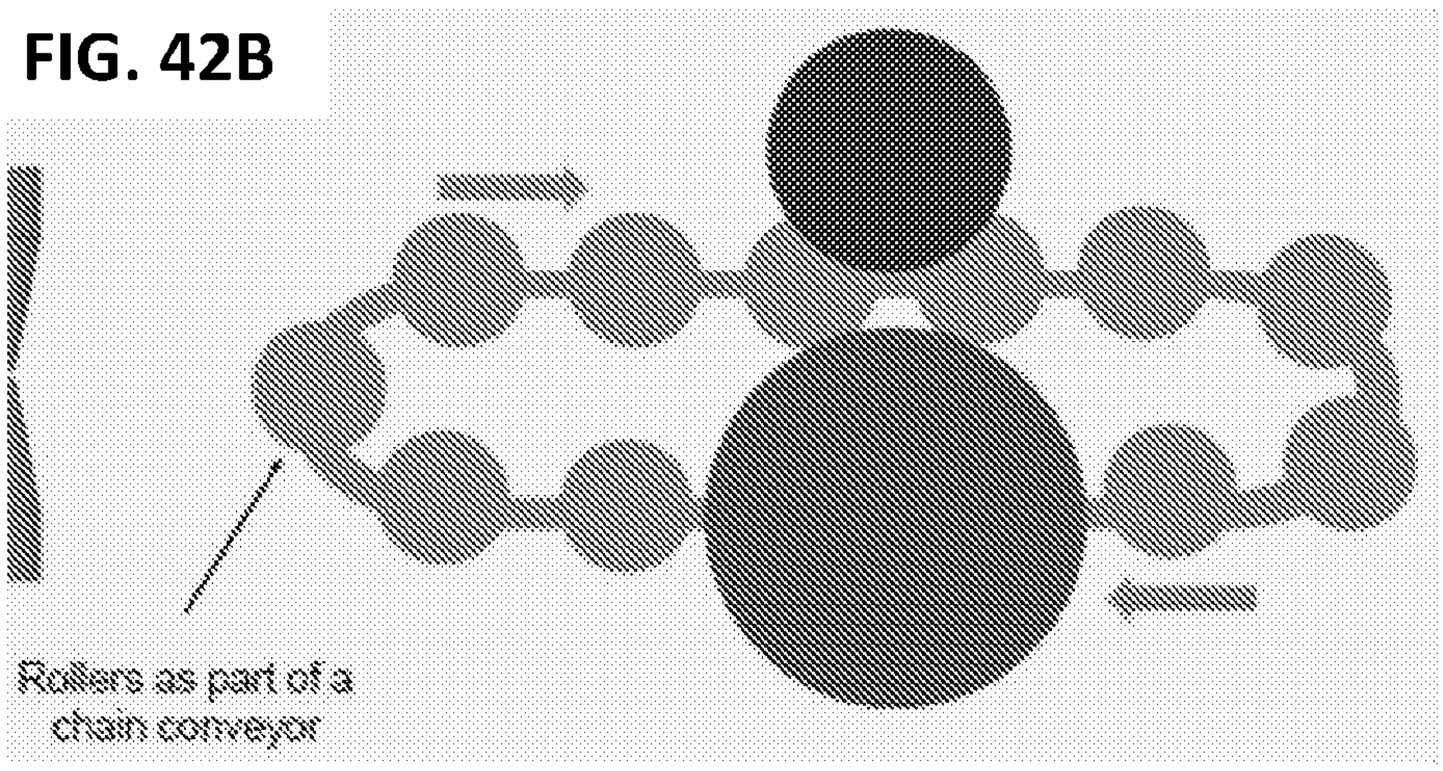


FIG. 42A

FIG. 42B



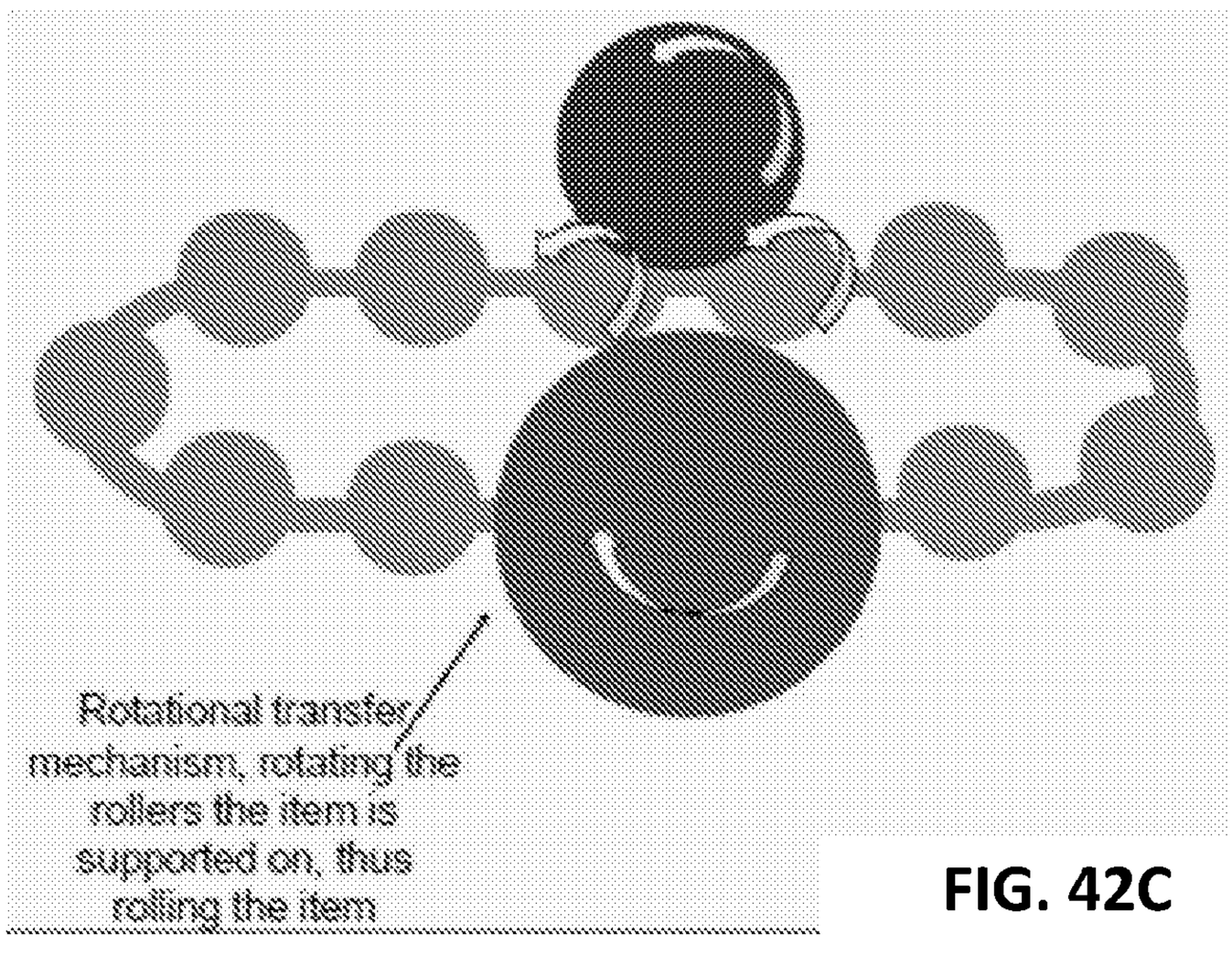


FIG. 42C

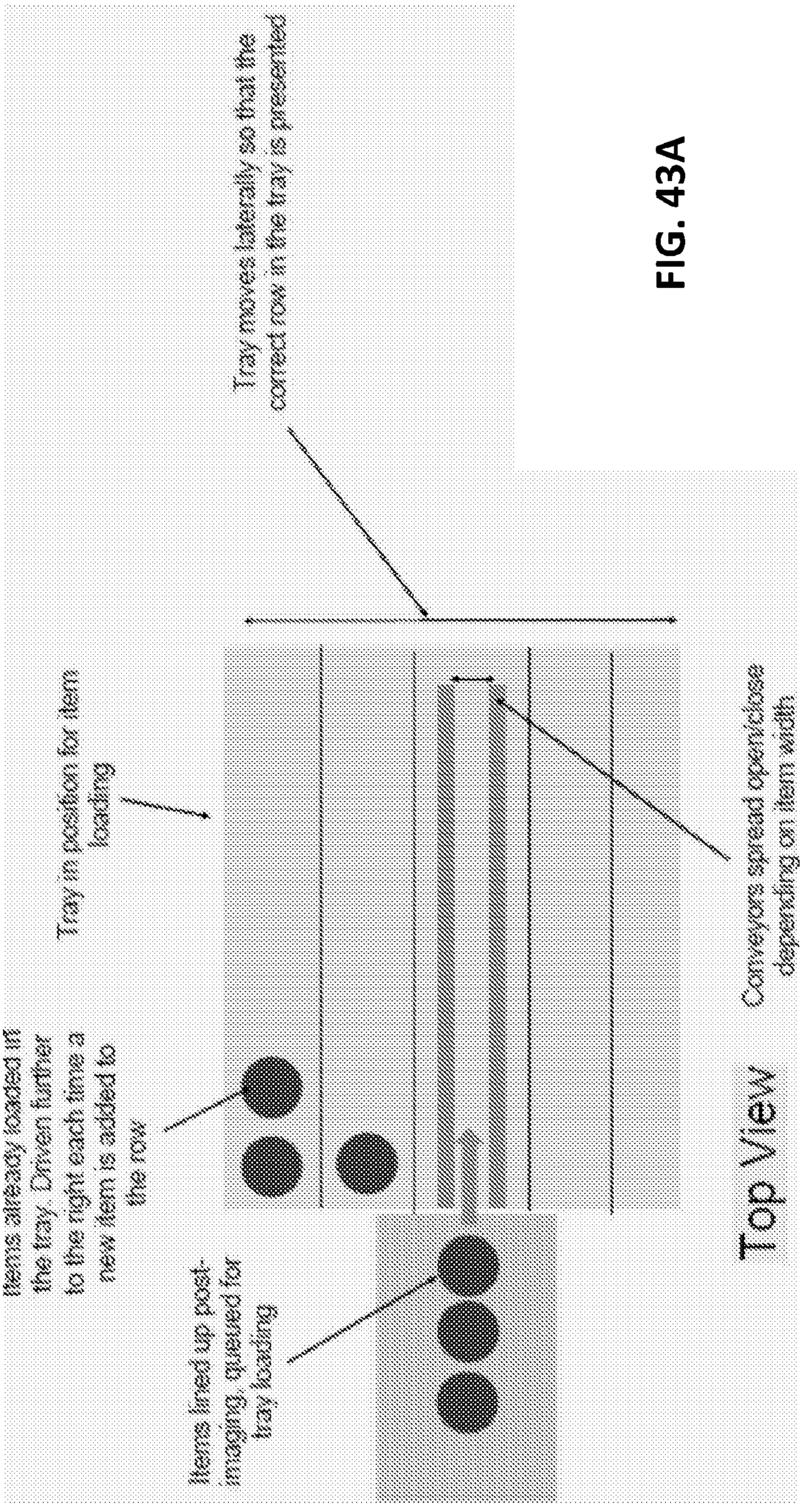


FIG. 43A

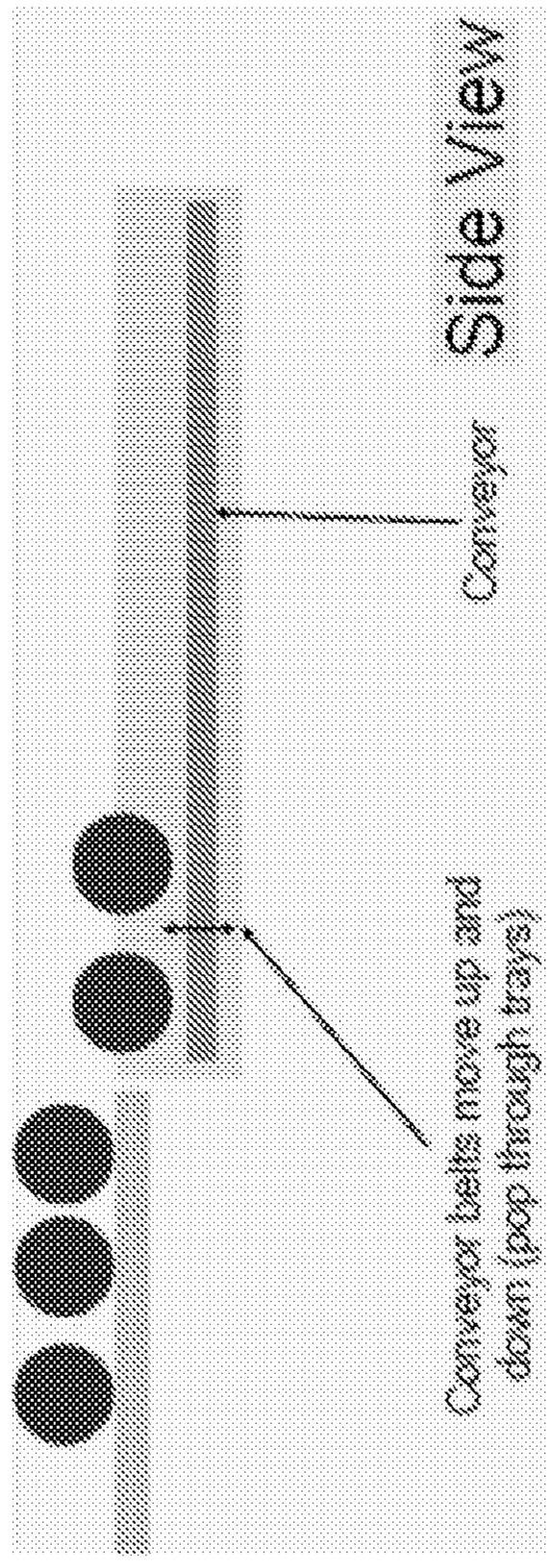


FIG. 43B

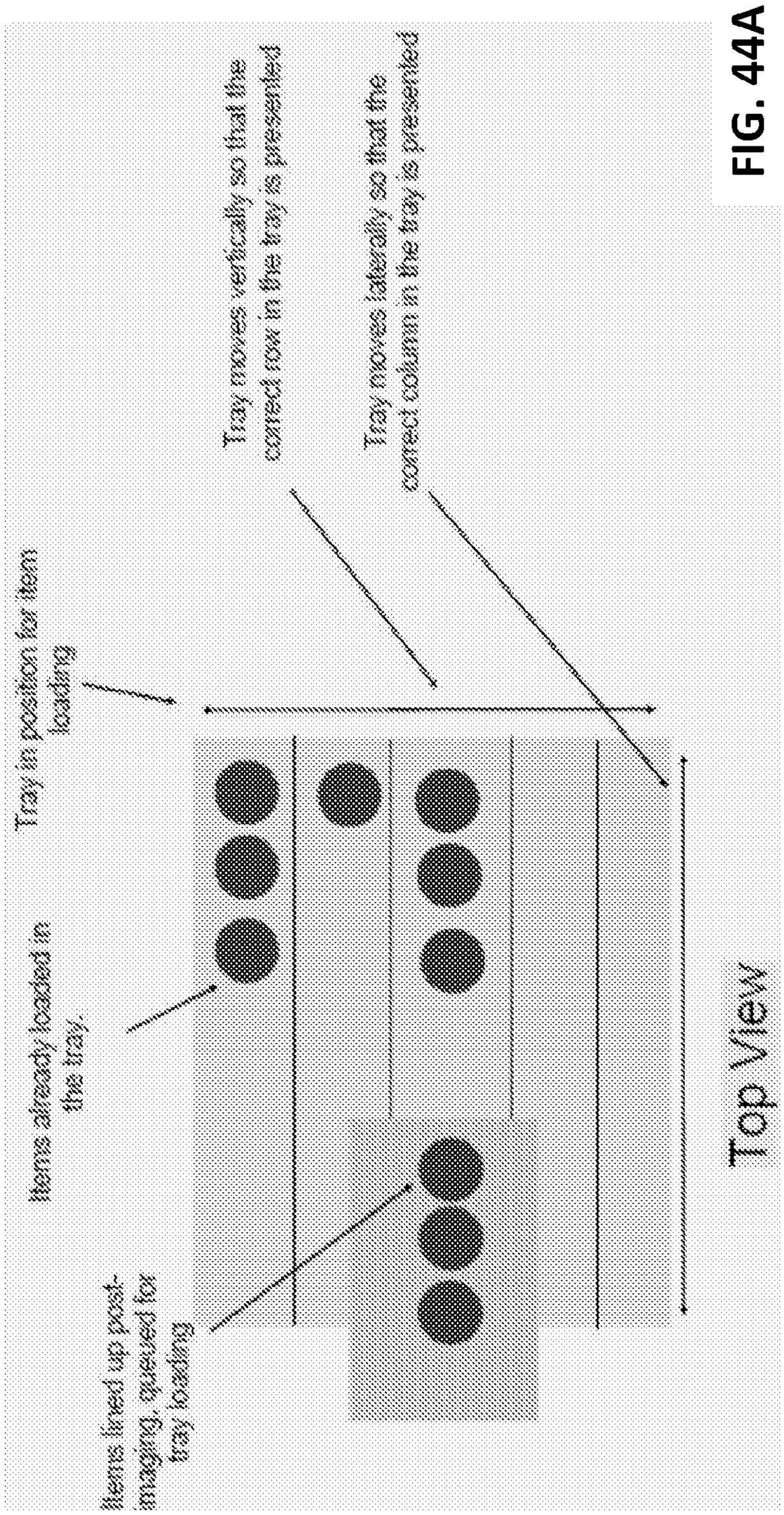


FIG. 44A

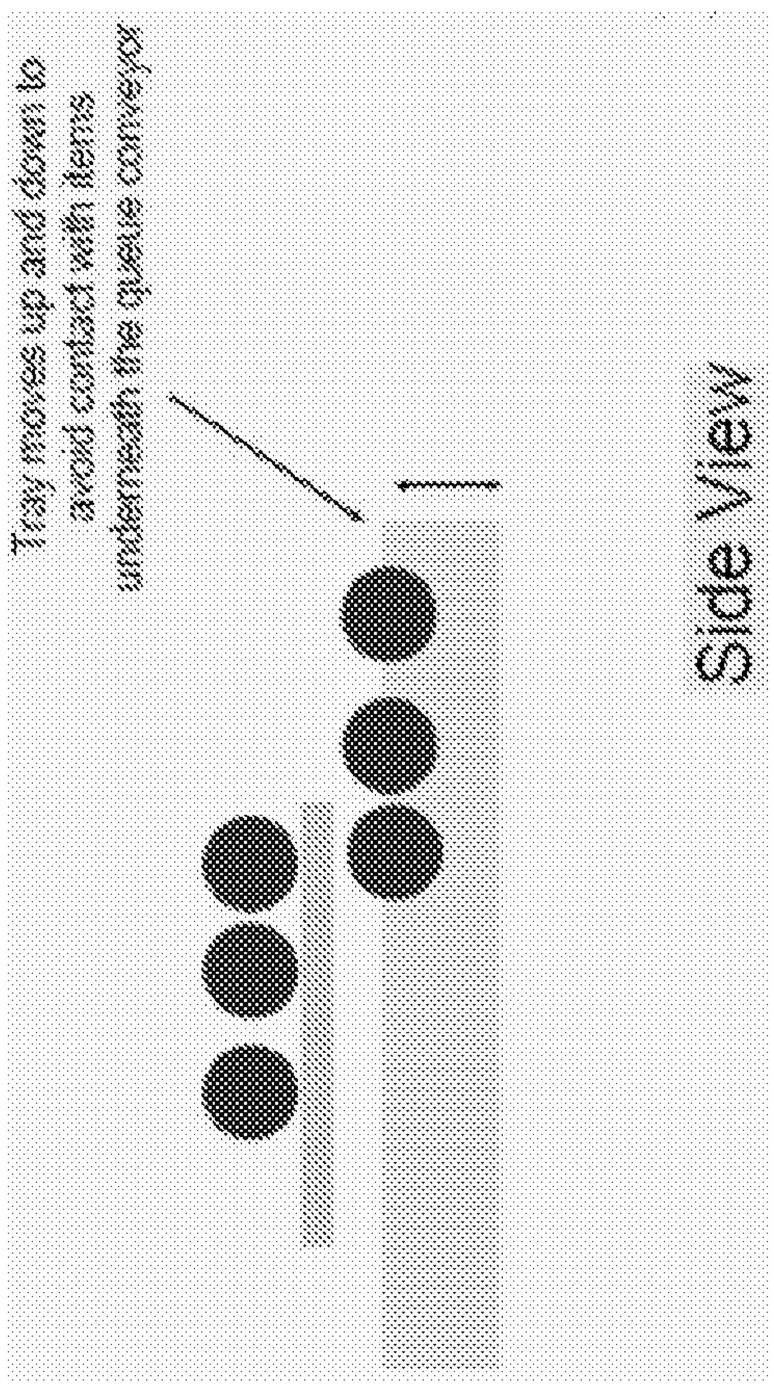


FIG. 44B

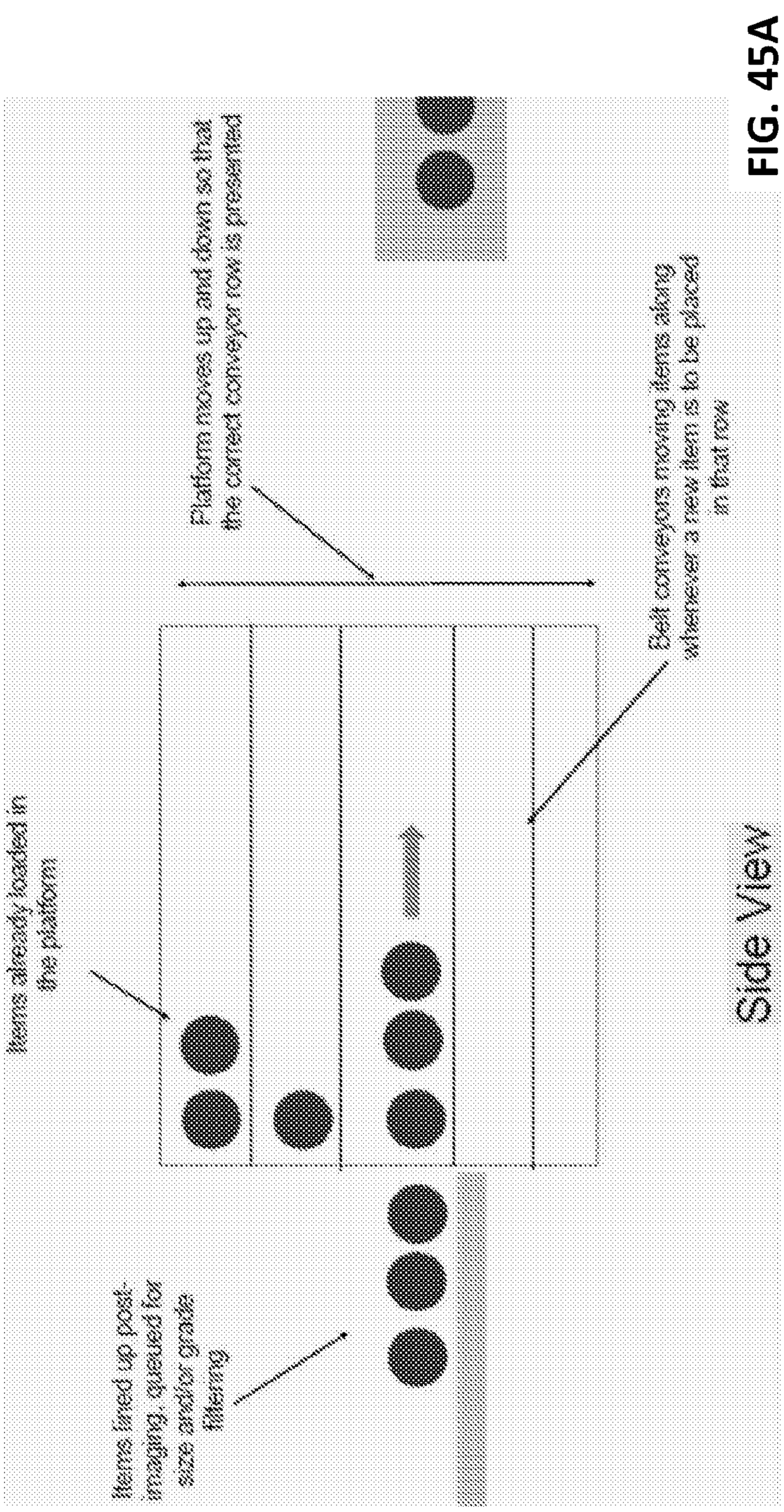


FIG. 45A

FIG. 45B

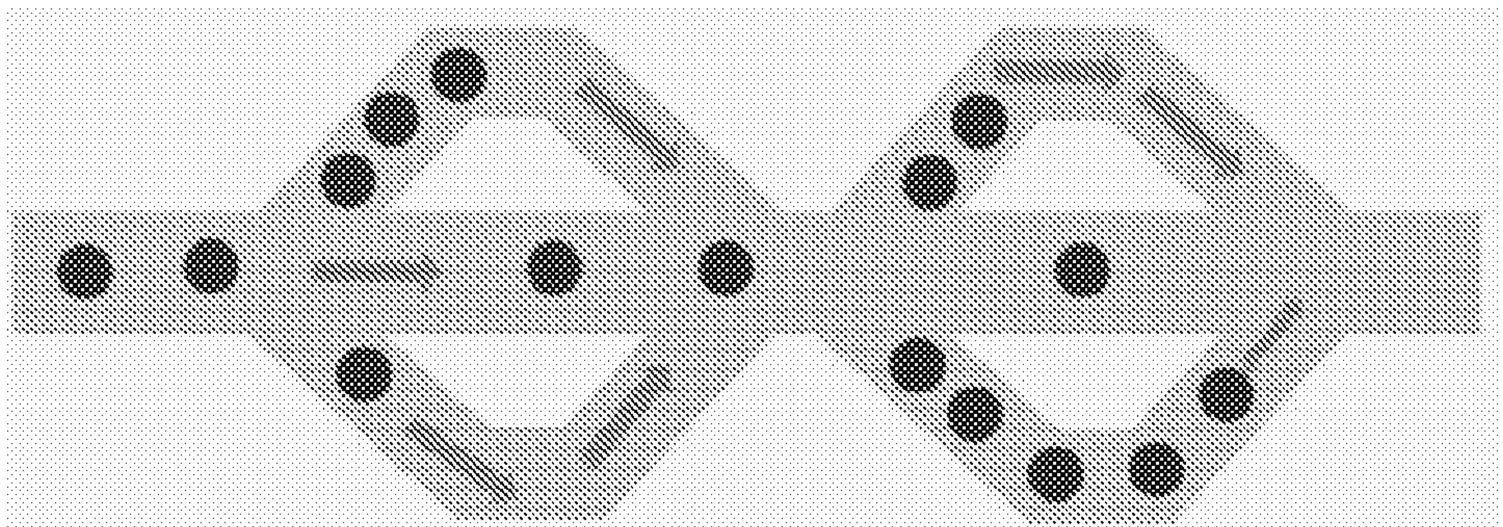


FIG. 45C

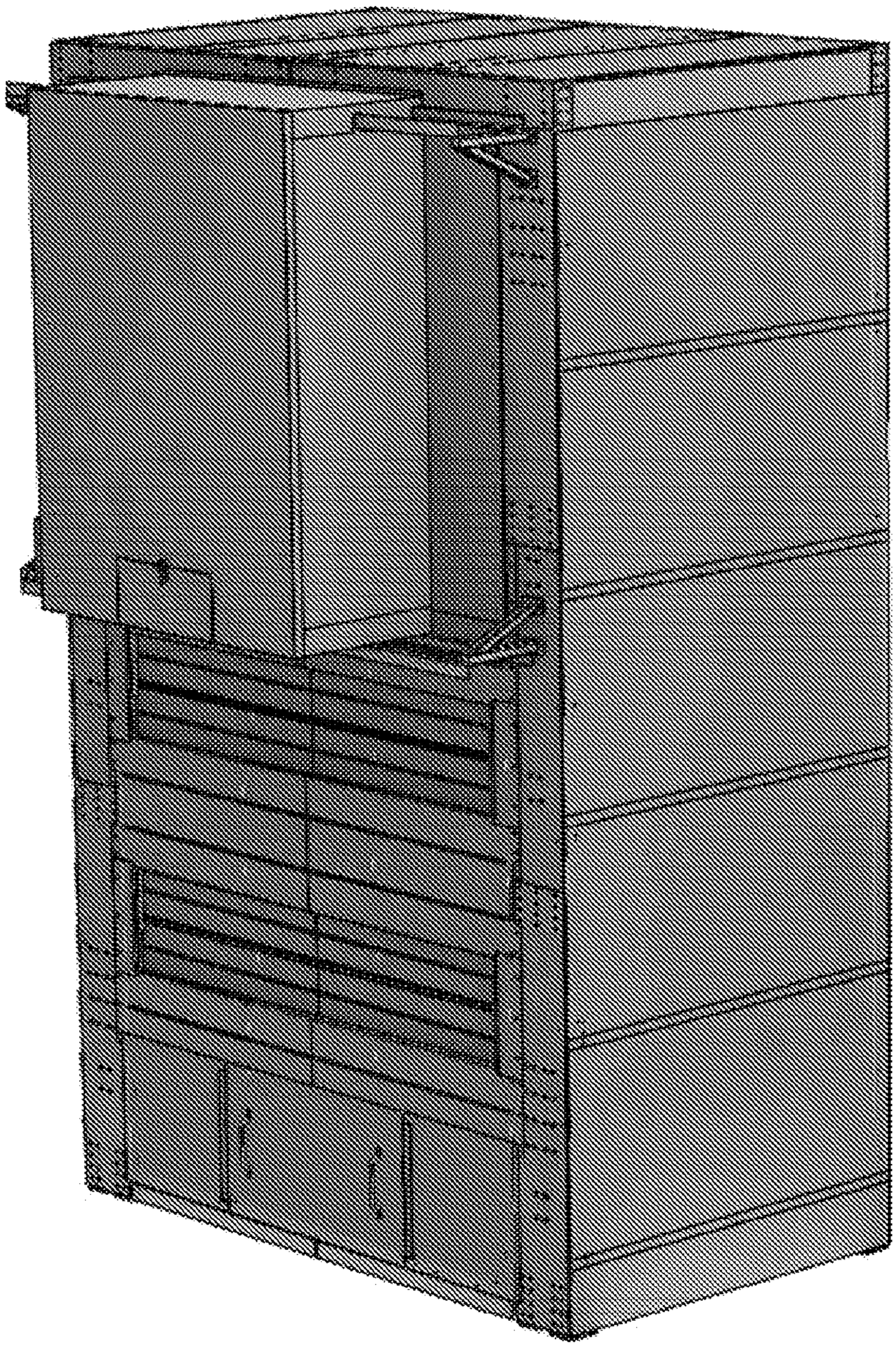


FIG. 46

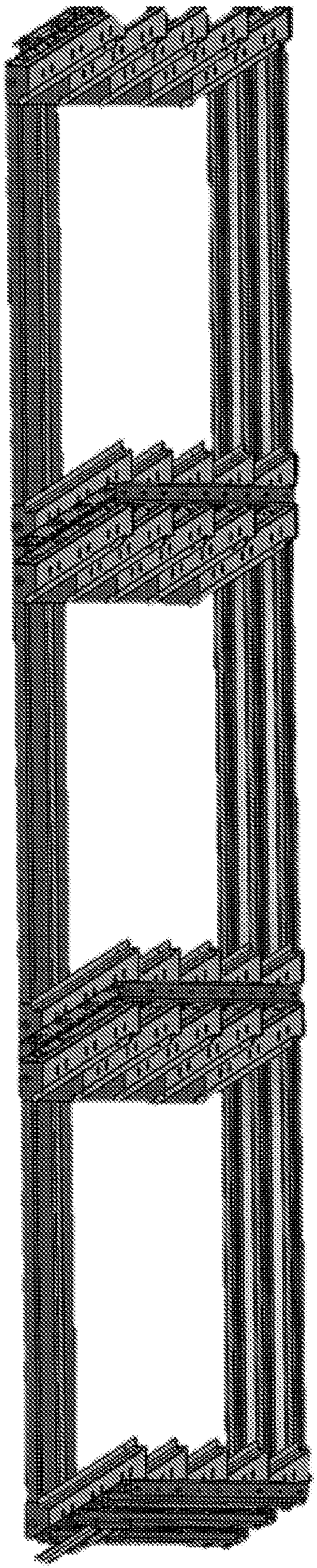


FIG. 46A

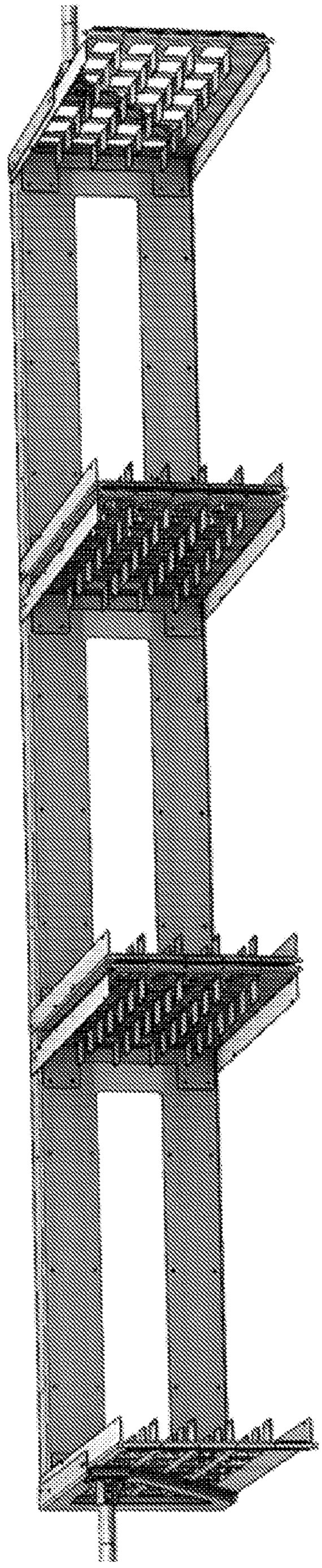


FIG. 46B

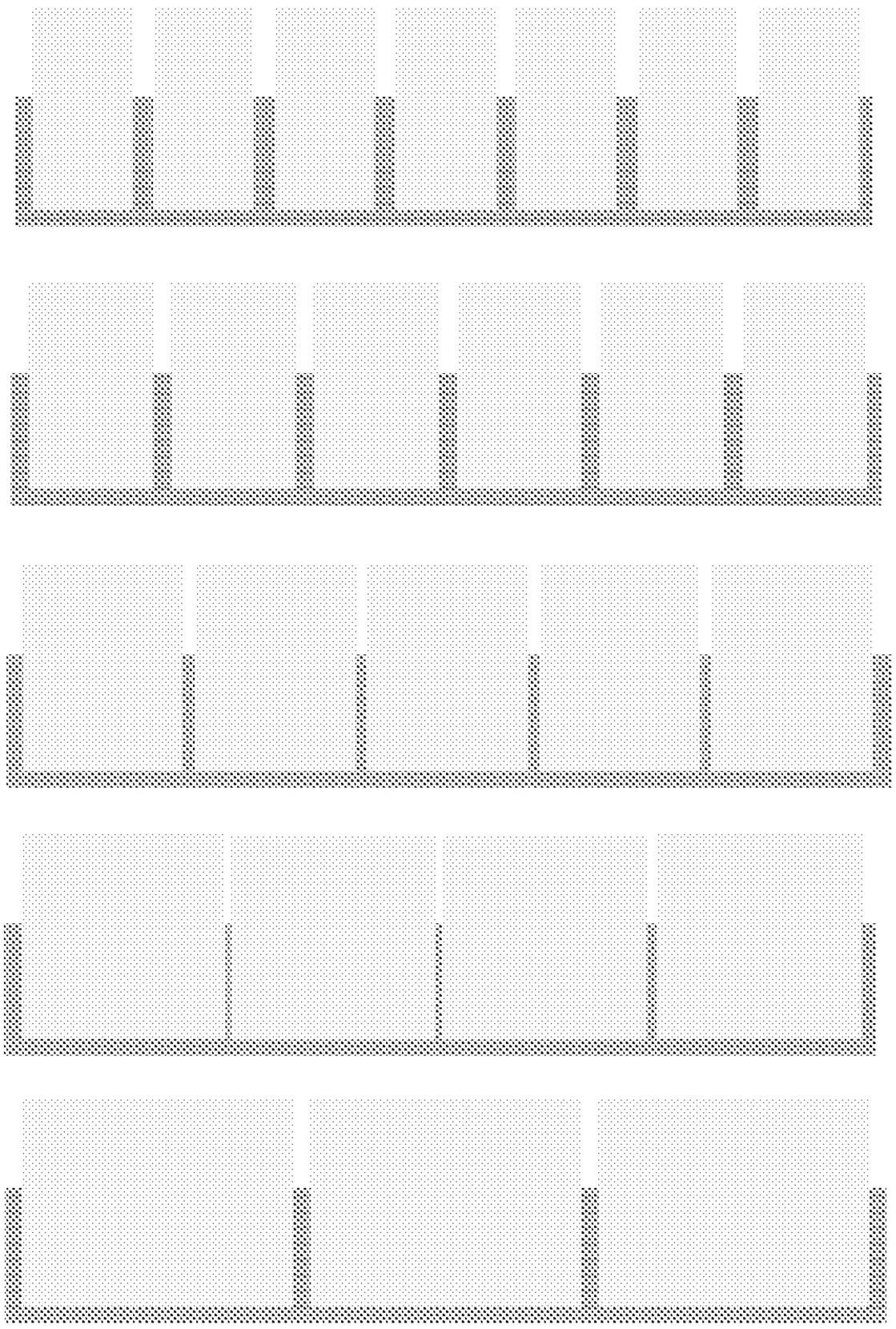


FIG. 46D

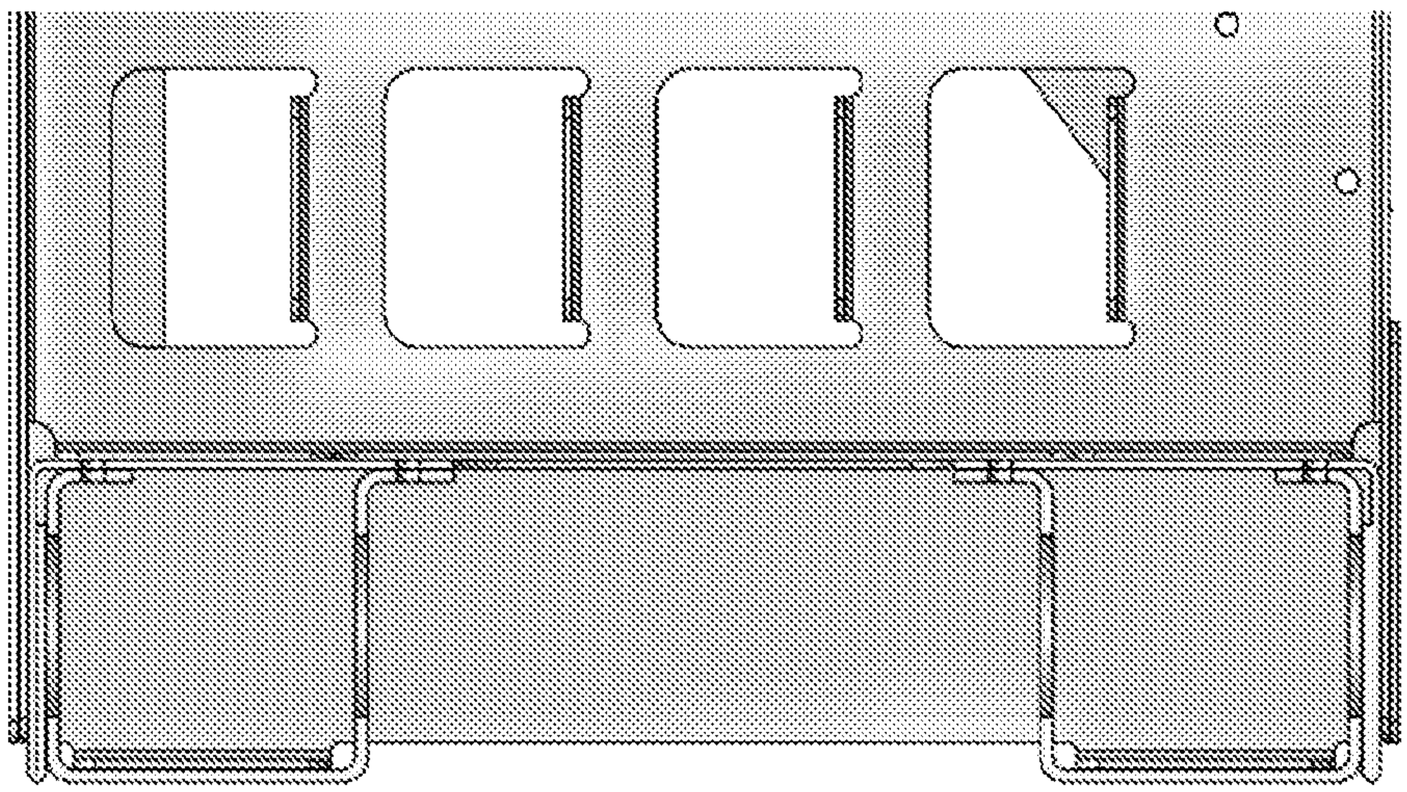


FIG. 46C

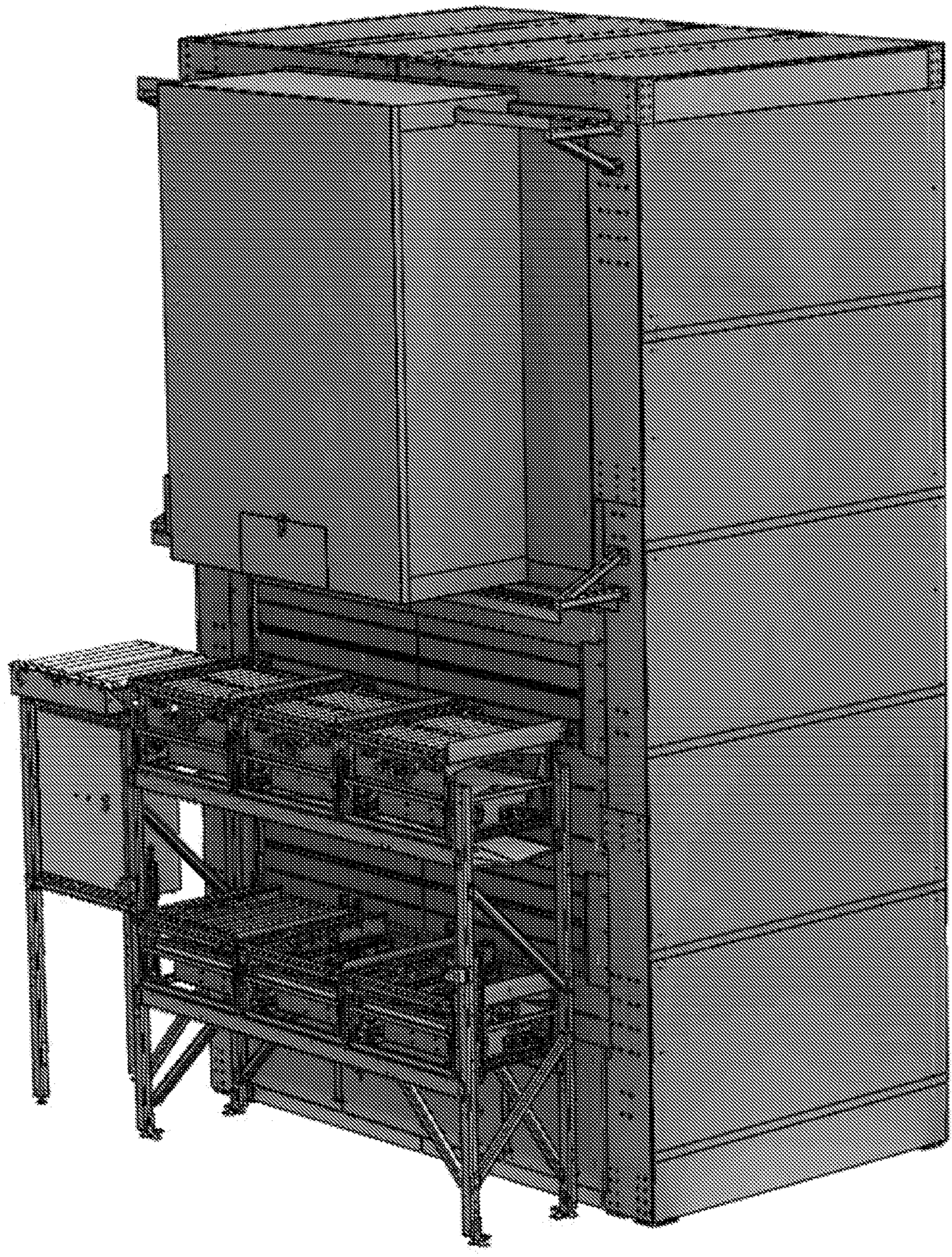


FIG. 47

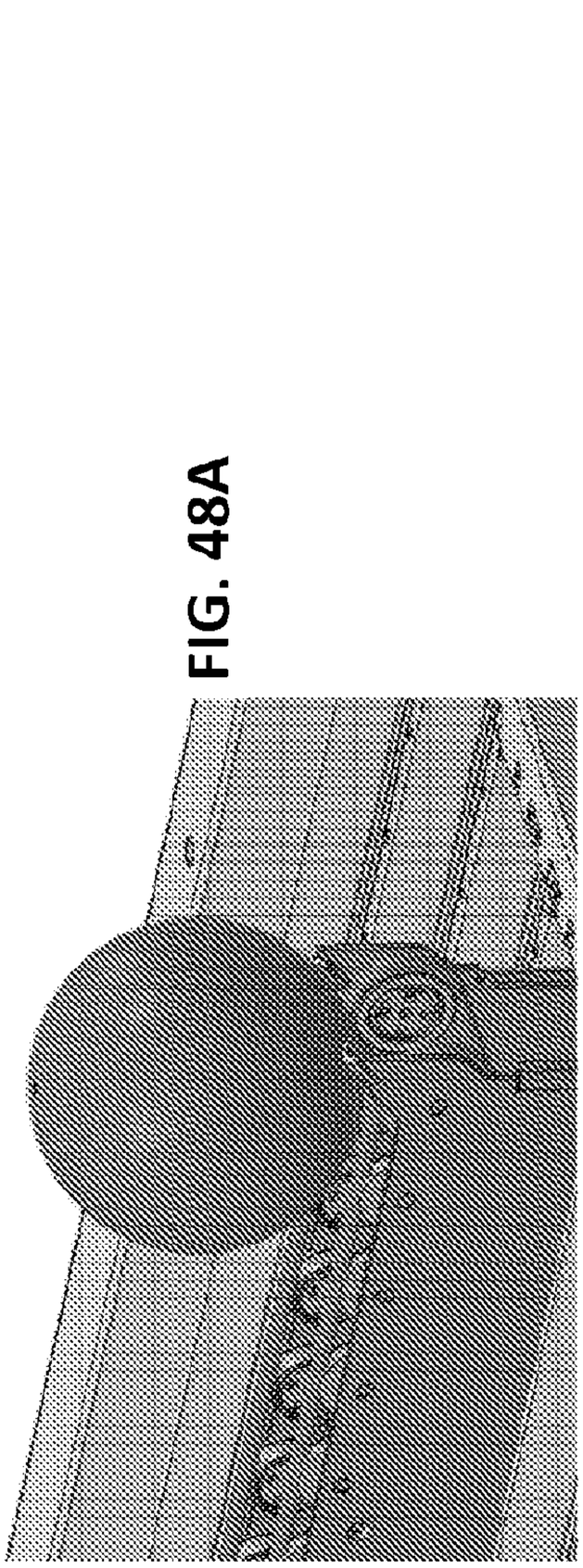


FIG. 48A

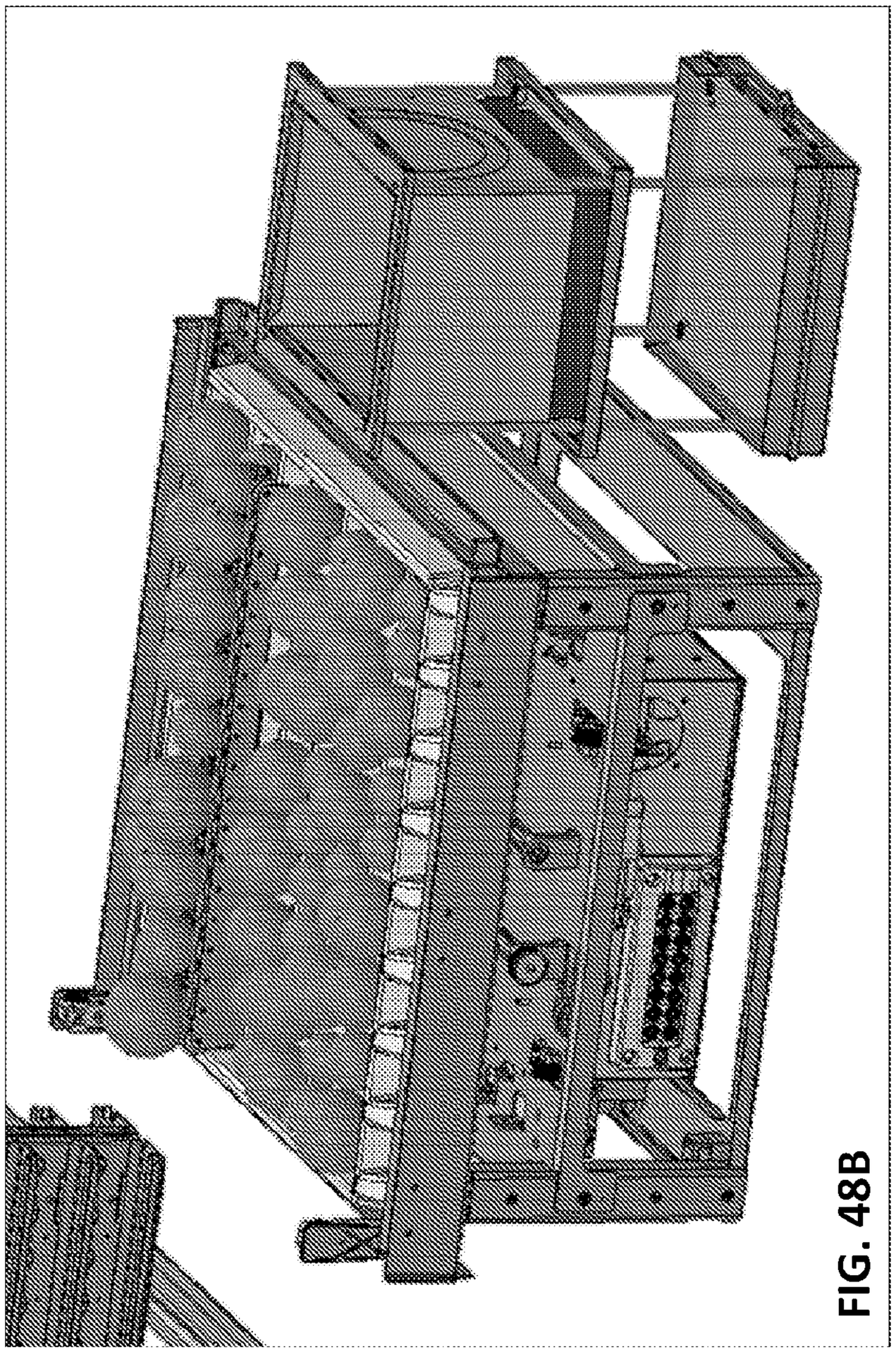


FIG. 48B

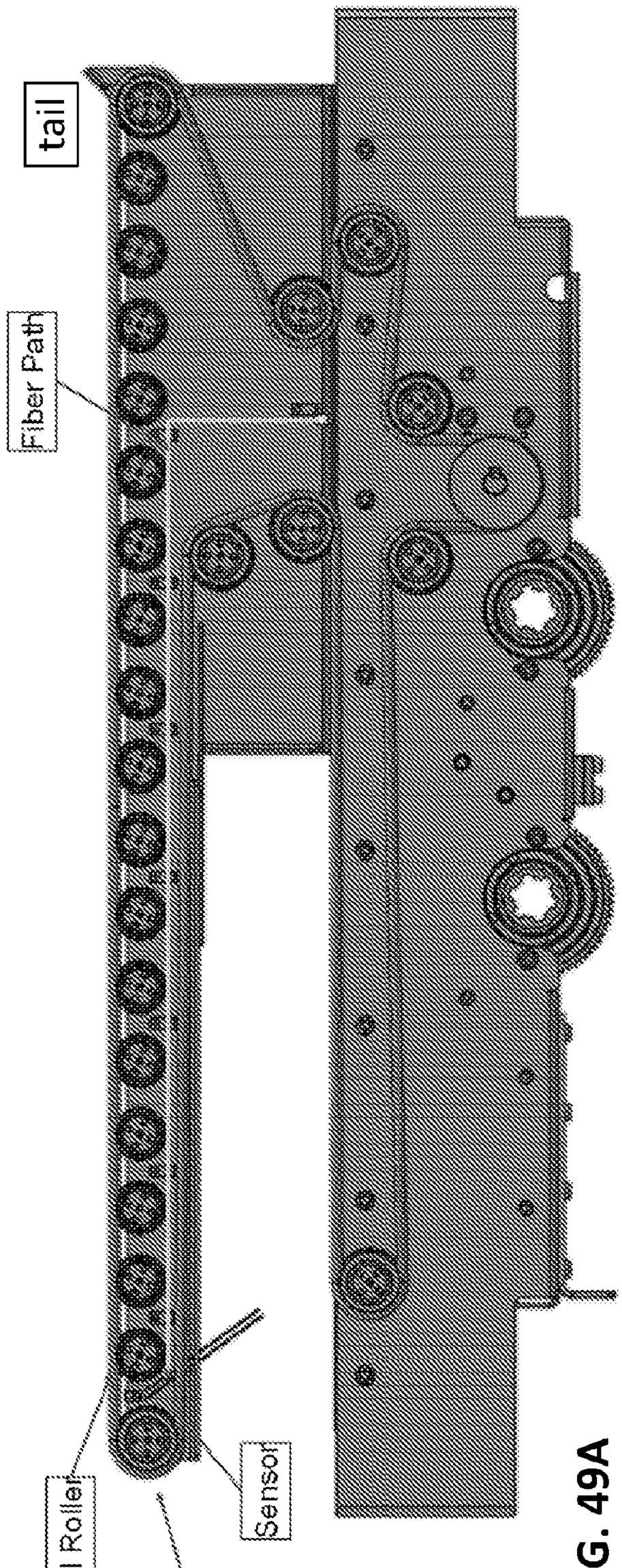


FIG. 49A

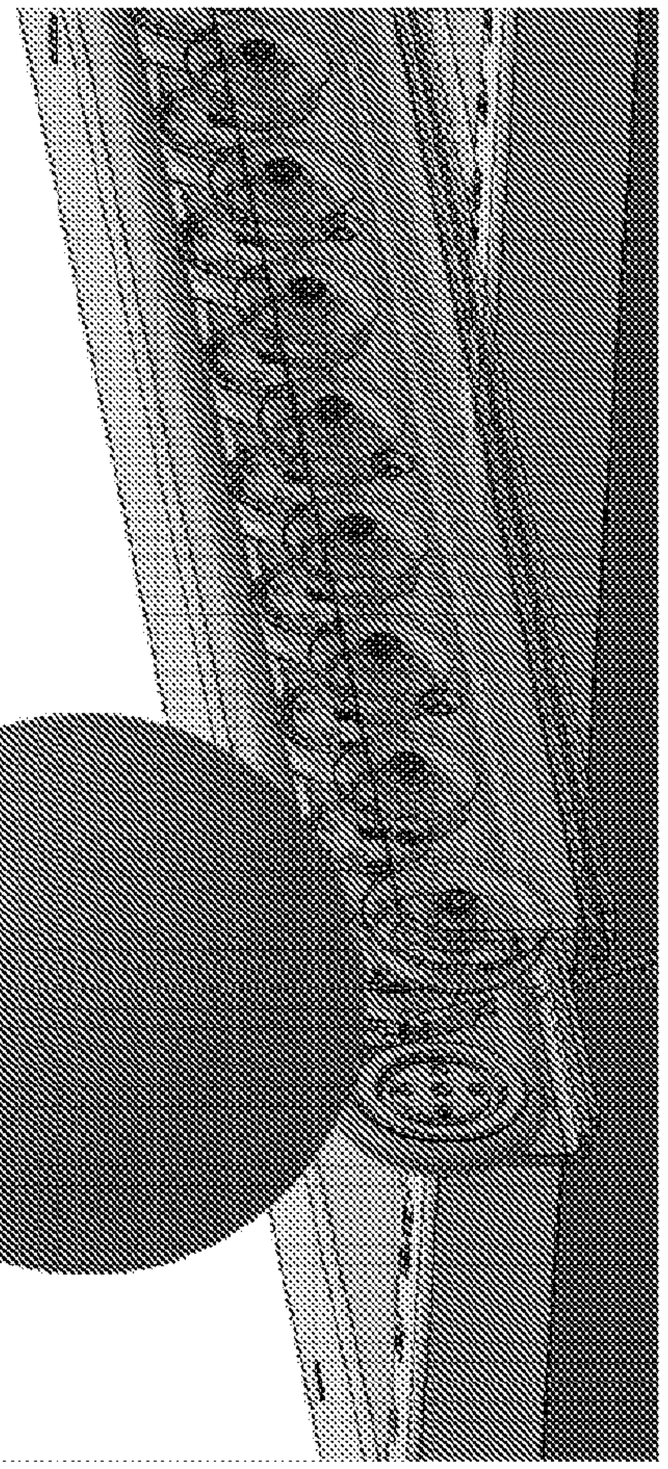


FIG. 49B

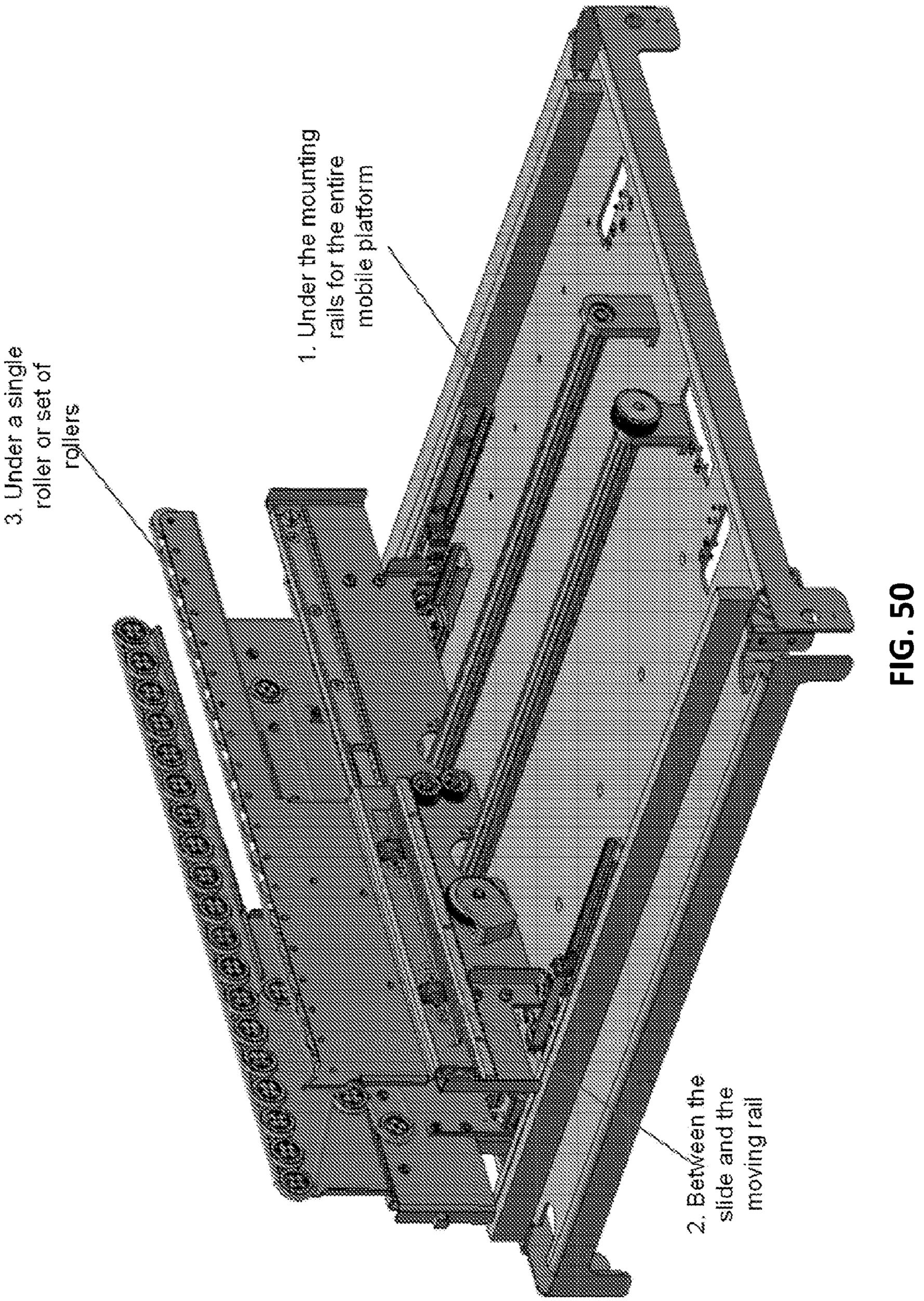

1. Under the mounting rails for the entire mobile platform
2. Between the slide and the moving rail
3. Under a single roller or set of rollers

FIG. 50

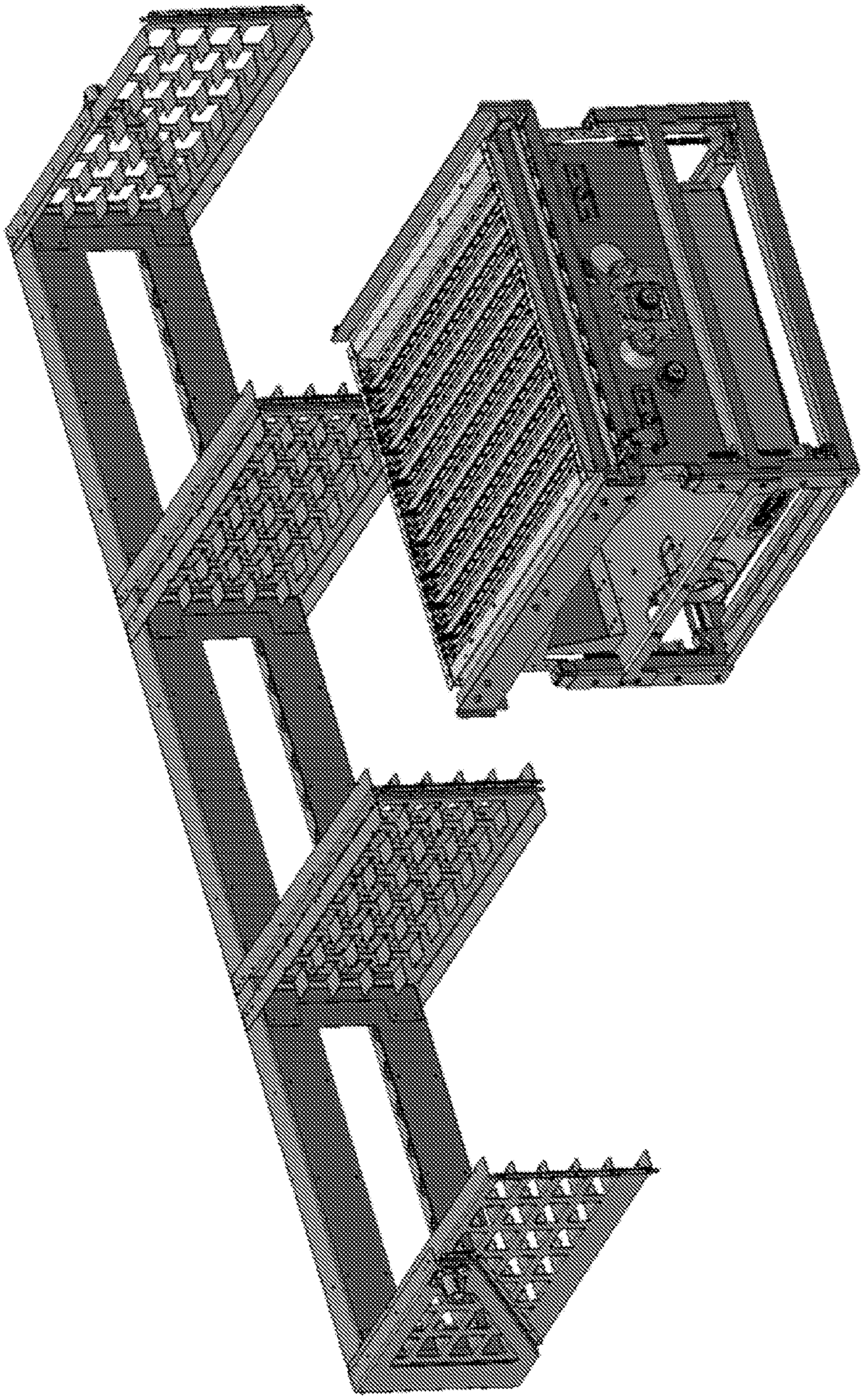


FIG. 51A

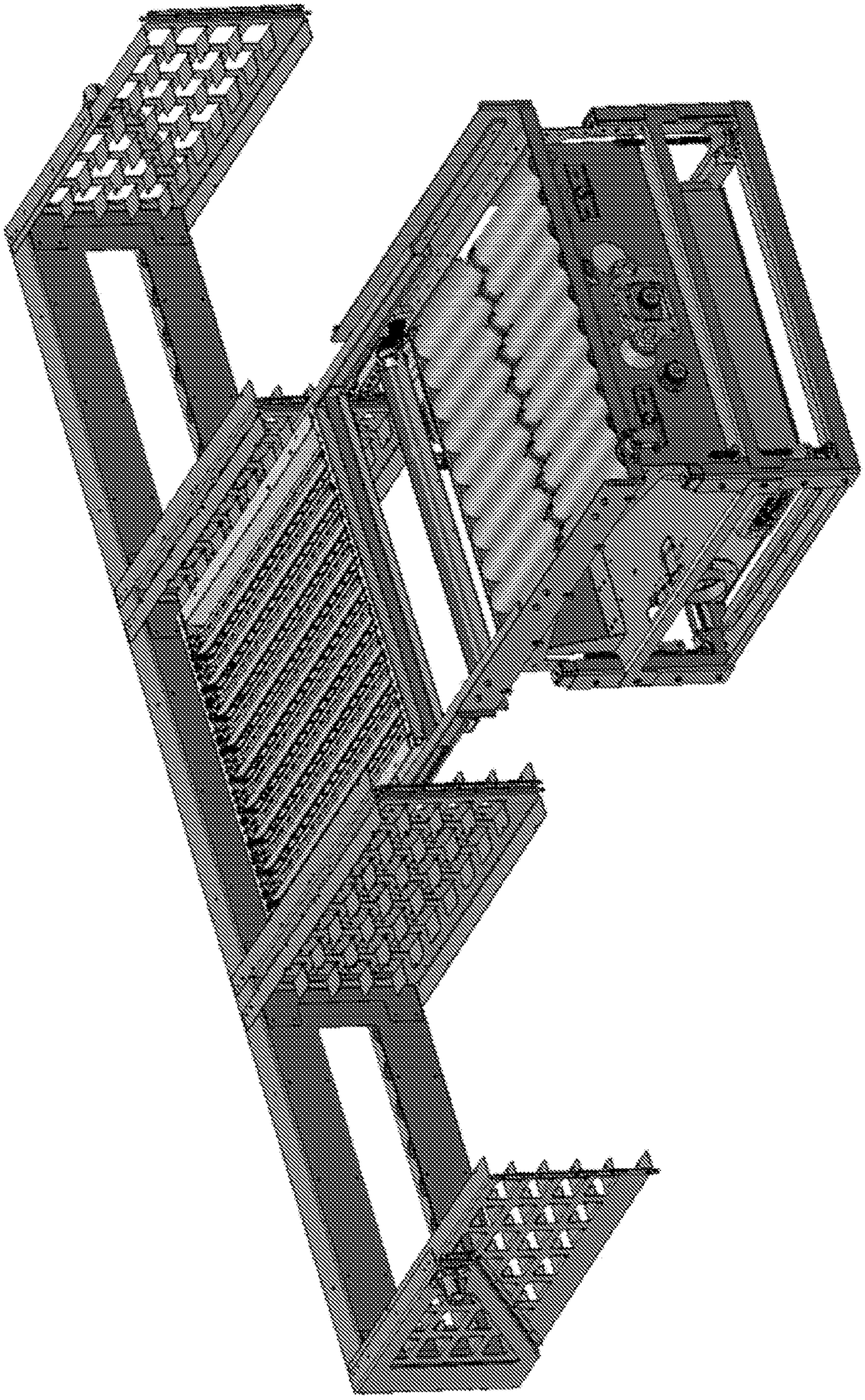


FIG. 51B

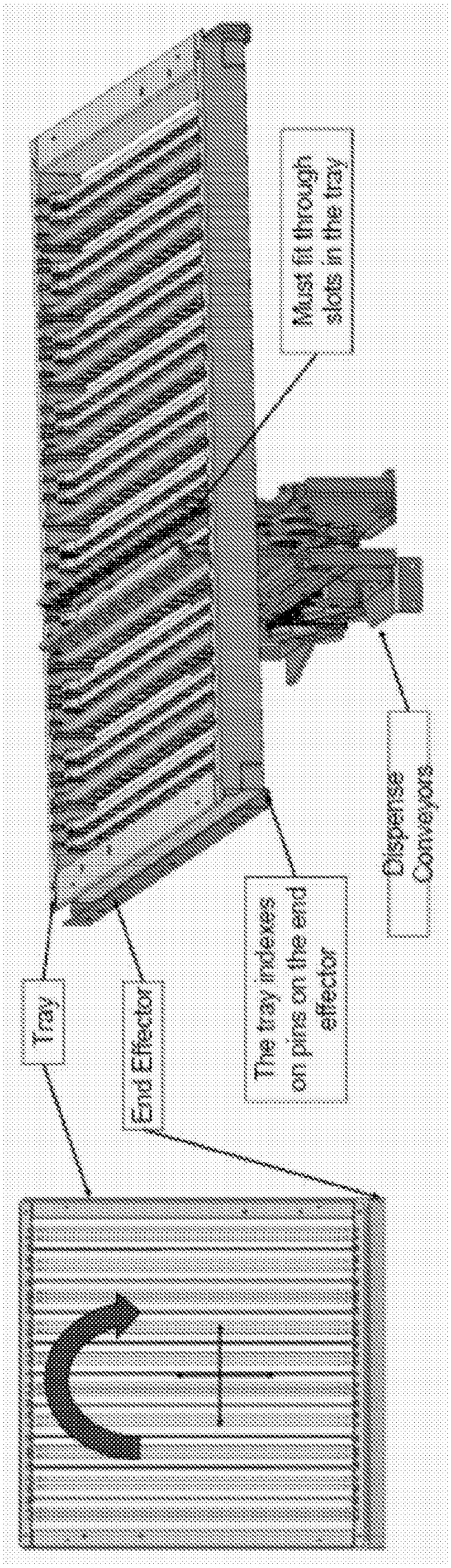

Must fit through slots in the tray
Crisp-rise Conveyors
The tray indexes on pins on the end effector
End Effector
Tray

FIG. 51C

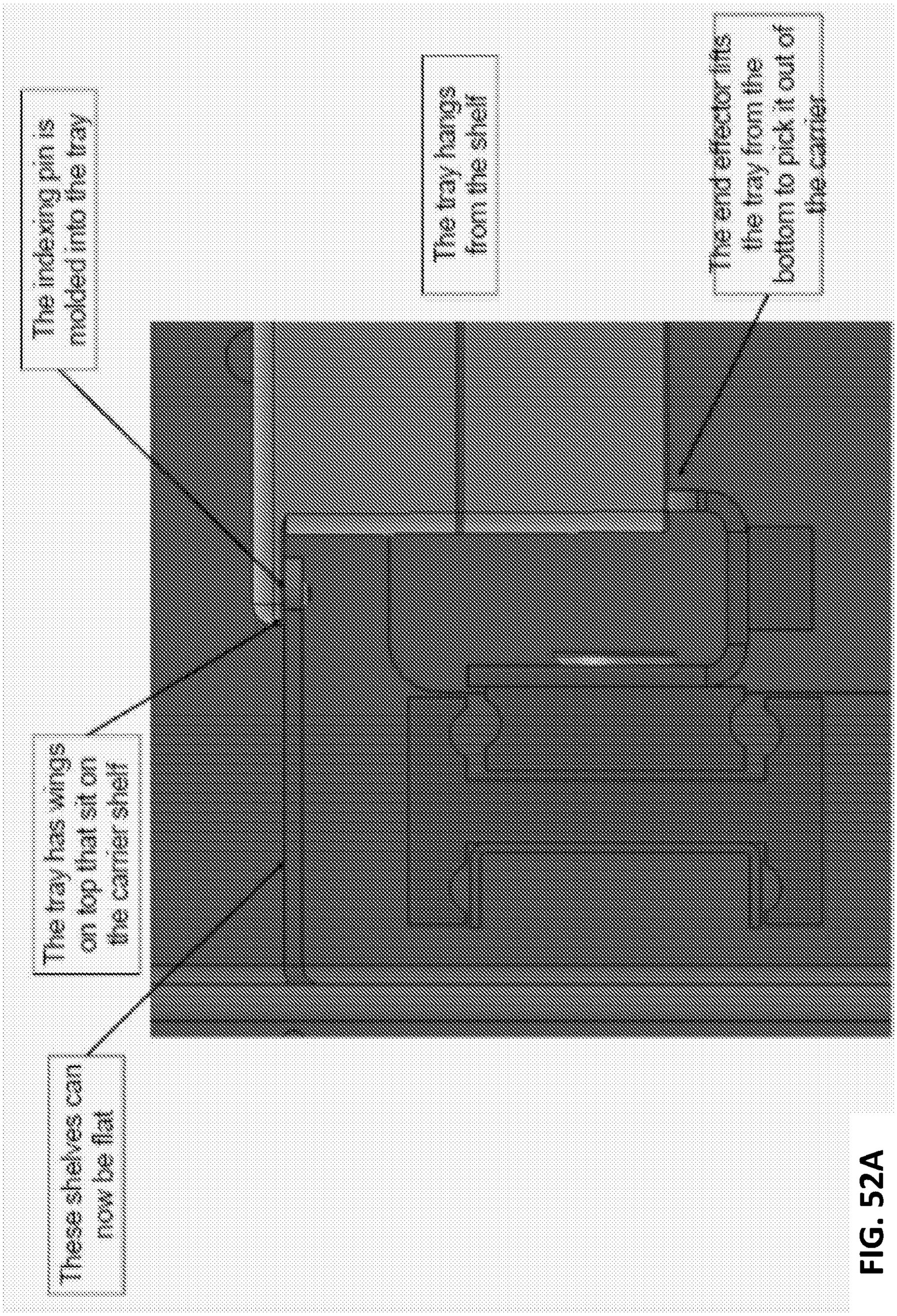

The tray has wings on top that sit on the carrier shelf
The tray hangs from the shelf
The end effector tilts the tray from the bottom to pick it out of the carrier
These shelves can now be flat

FIG. 52A

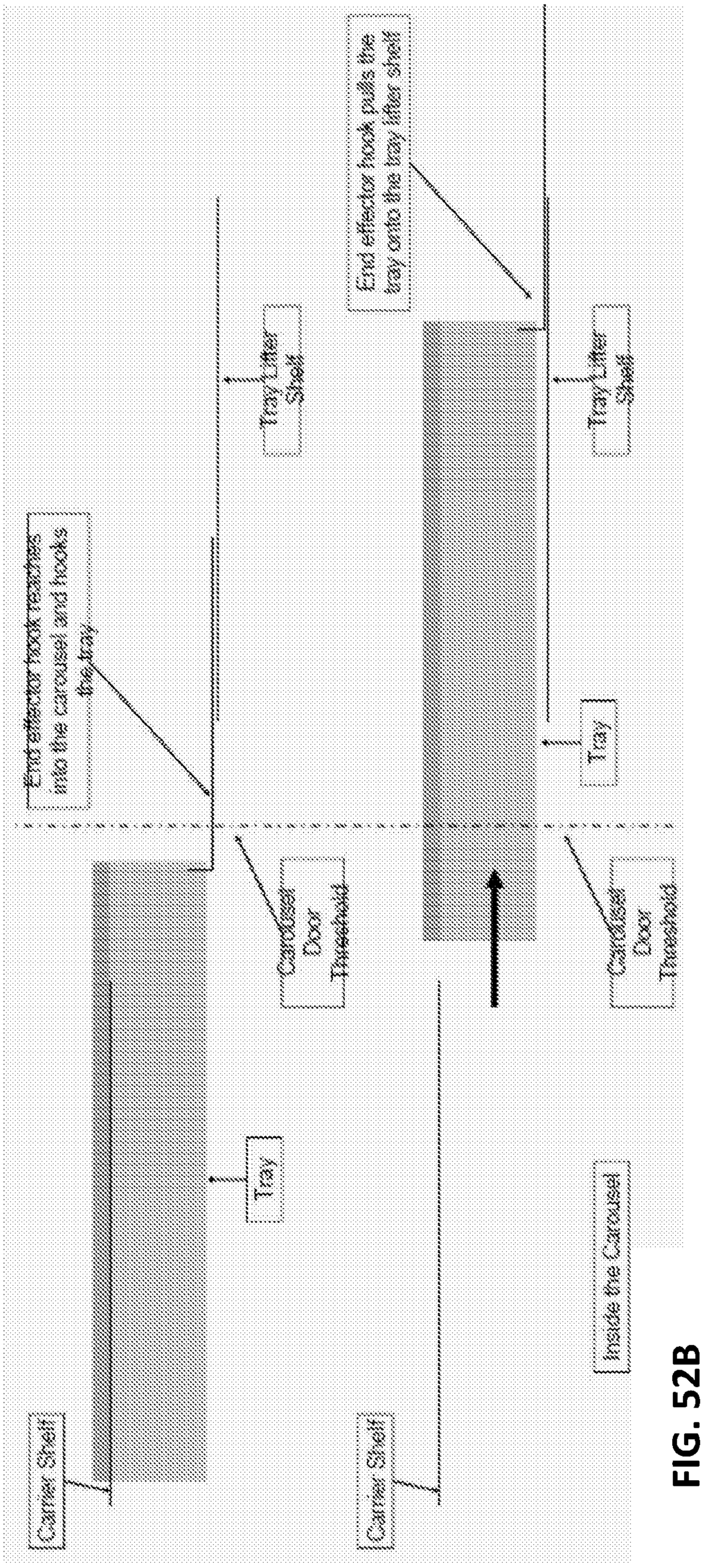

End effector hook pulls the tray onto the tray lifter shelf
Tray Lifter Shelf
End effector hook retracts into the carousel and hooks the tray
Carousel Door Treadmill
Tray
Tray
Tray Lifter Shelf
Carousel Door Treadmill
Tray
Carousel Door Treadmill
Inside the Carousel
Carrier Shelf
Carrier Shelf

FIG. 52B

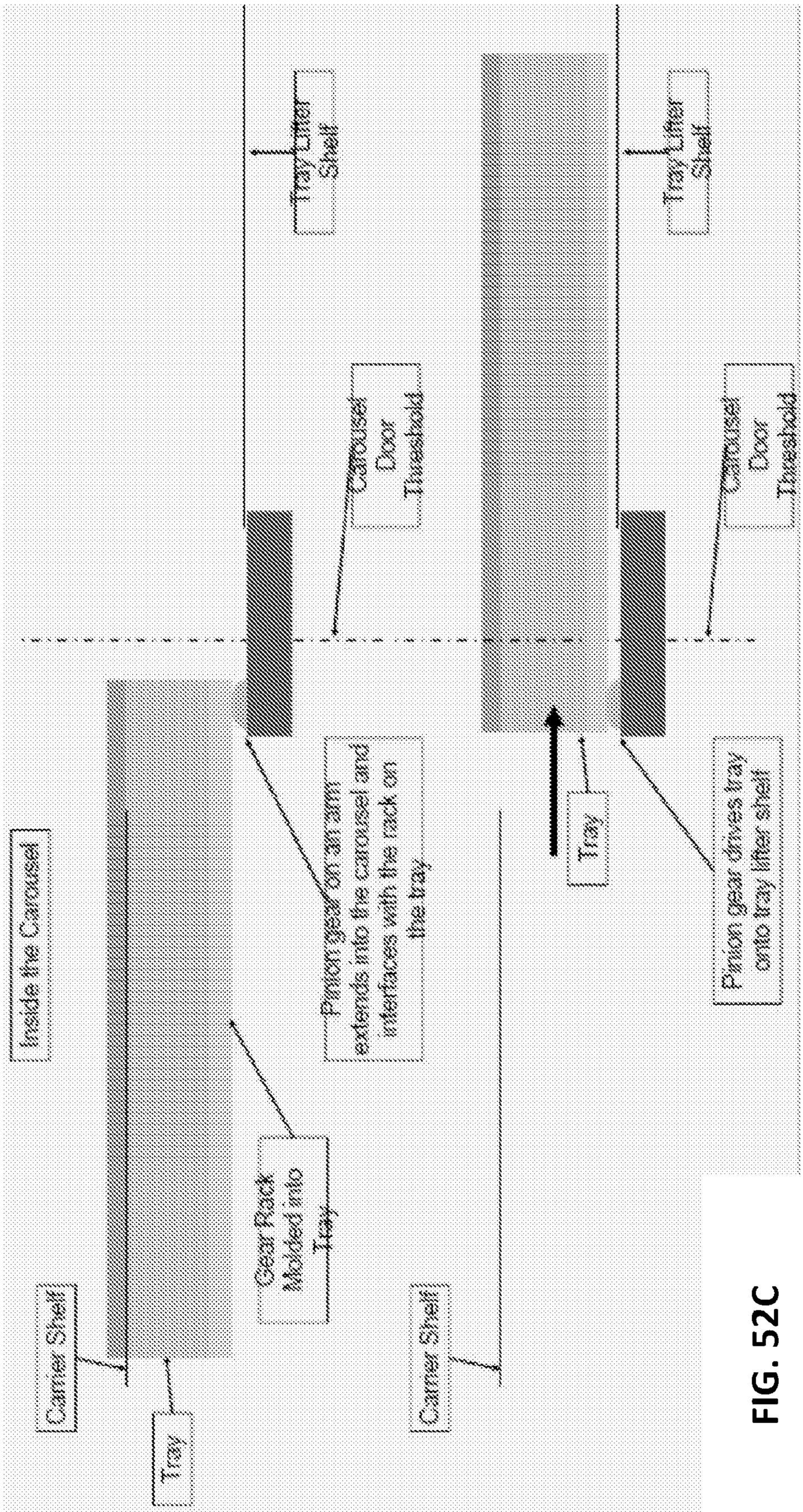

Tray Lifter Shelf
Carousel Door Threshold
Tray Lifter Shelf
Carousel Door Threshold
Pinion gear on an arm extends into the carousel and interfaces with the rack on the tray
Pinion gear drives tray onto tray lifter shelf
Tray
Inside the Carousel
Gear Rack embedded into Tray
Carrier Shelf
Tray
Carrier Shelf

FIG. 52C

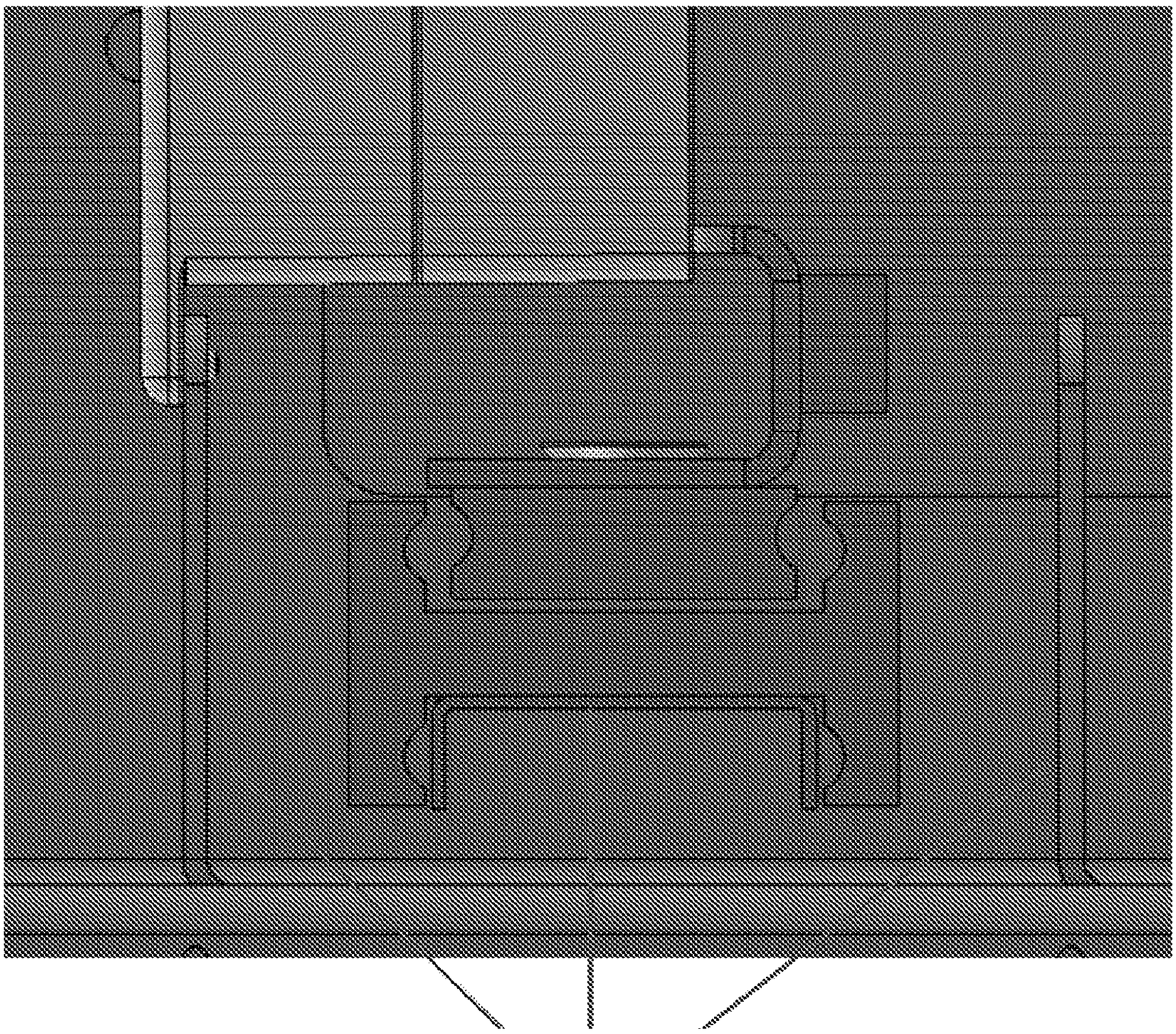


FIG. 53B

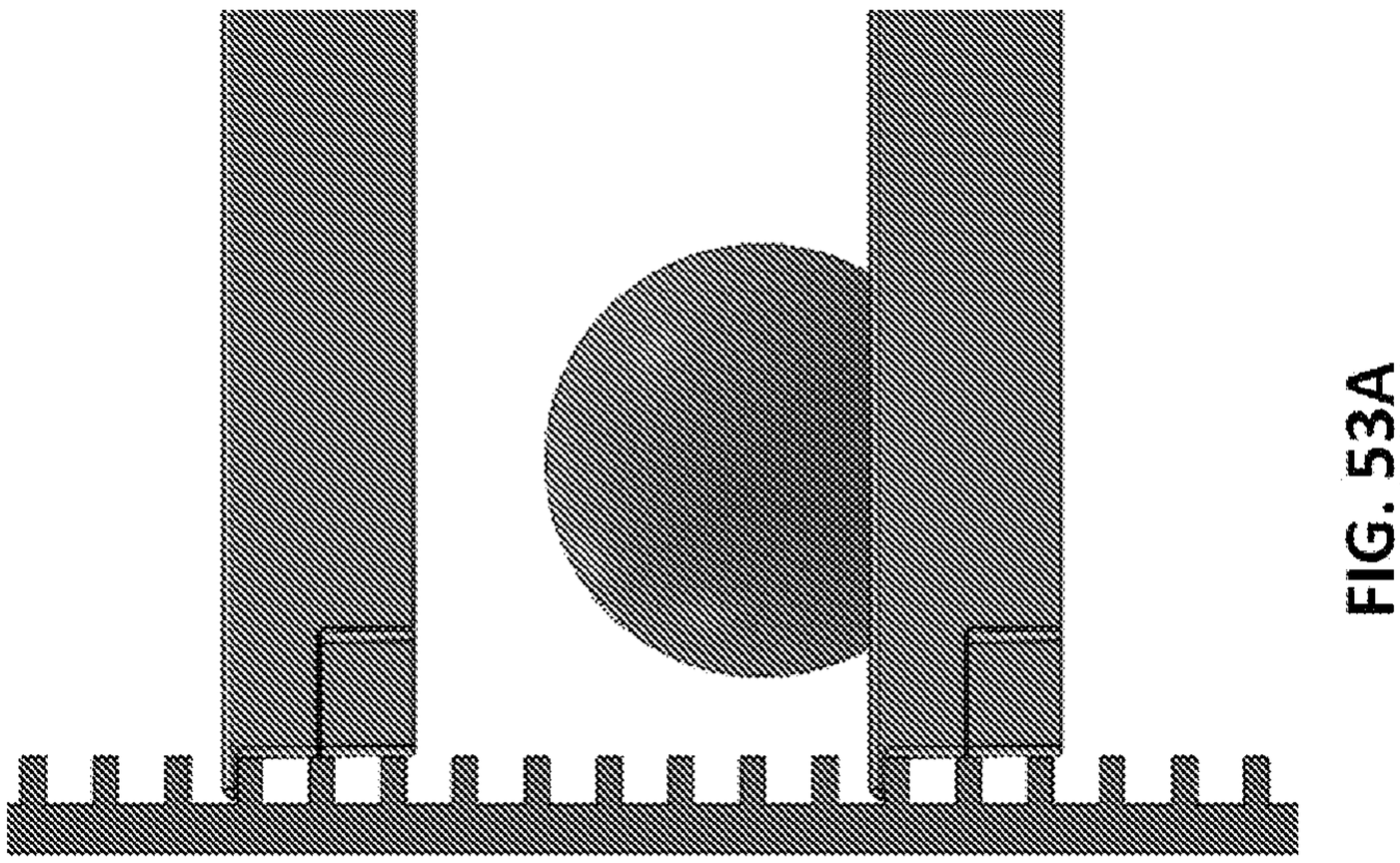


FIG. 53A

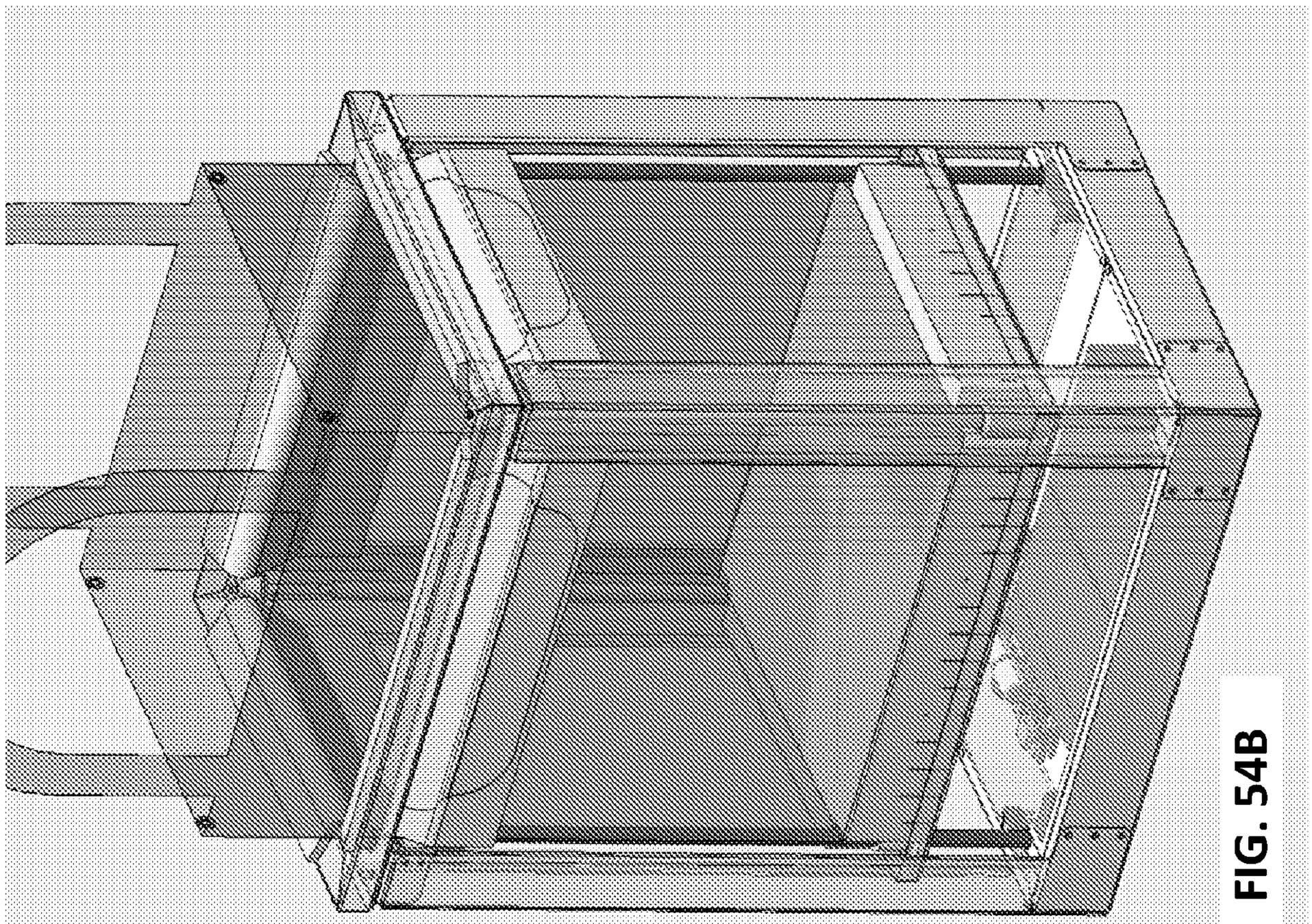


FIG. 54B

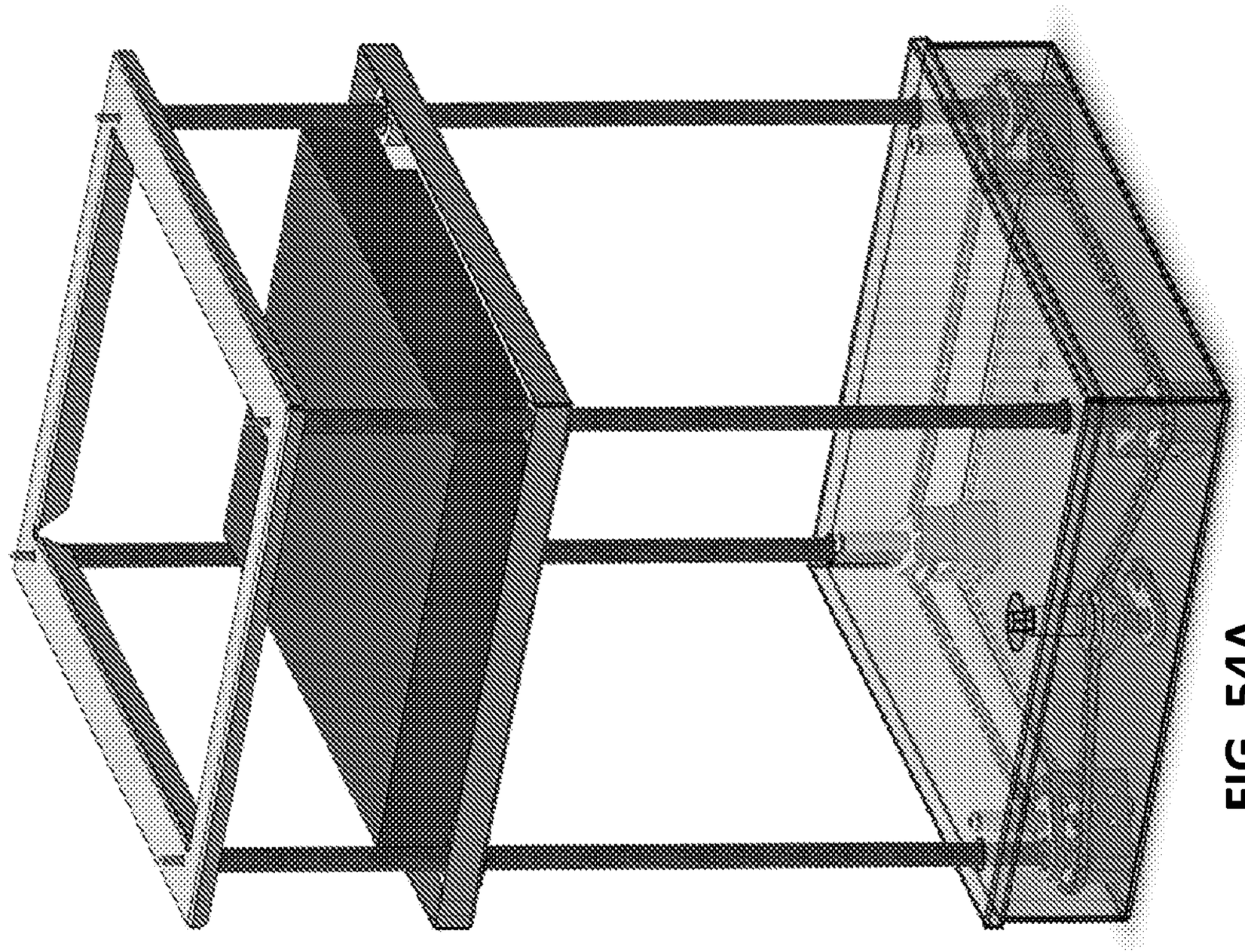


FIG. 54A

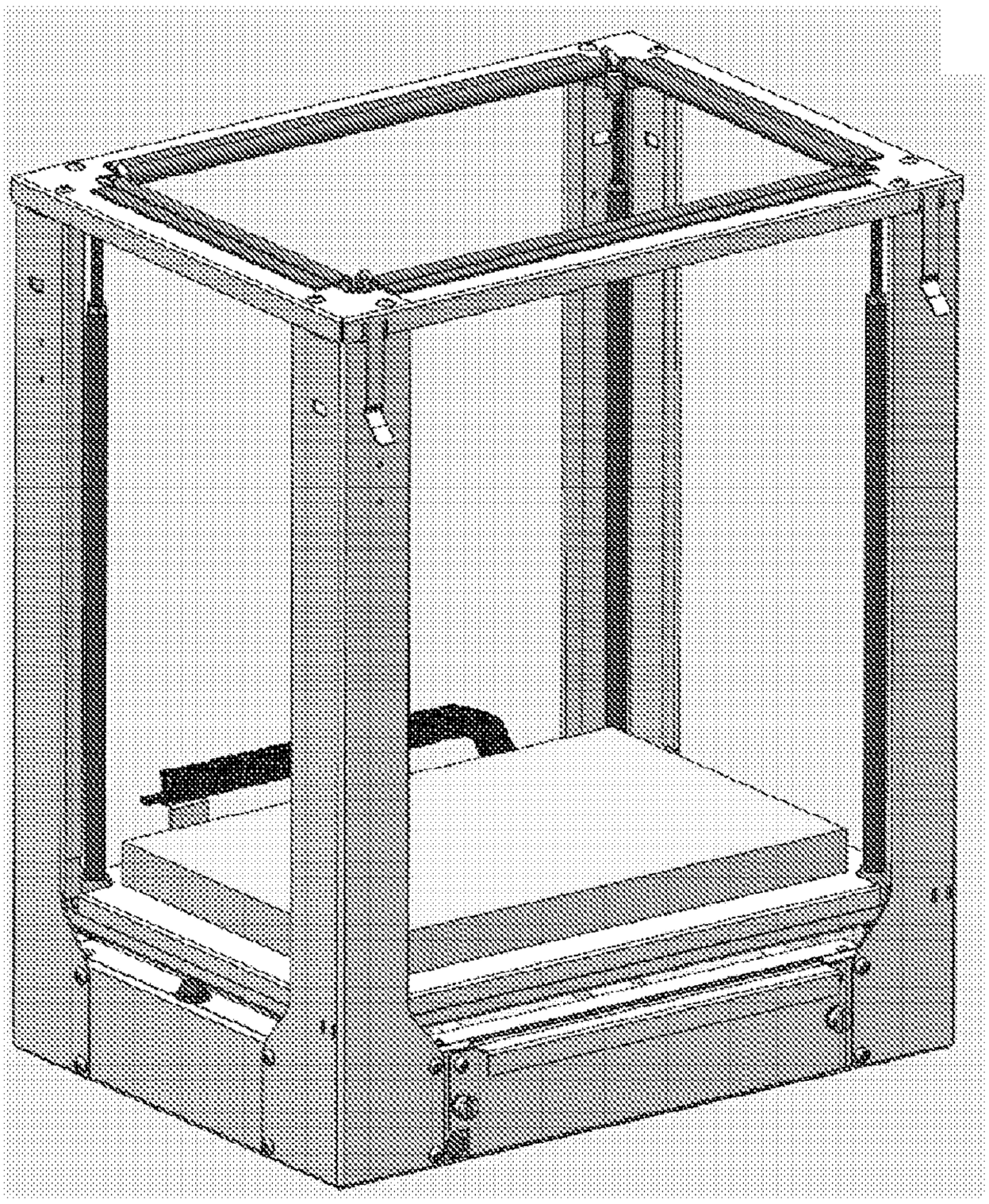


FIG. 55A

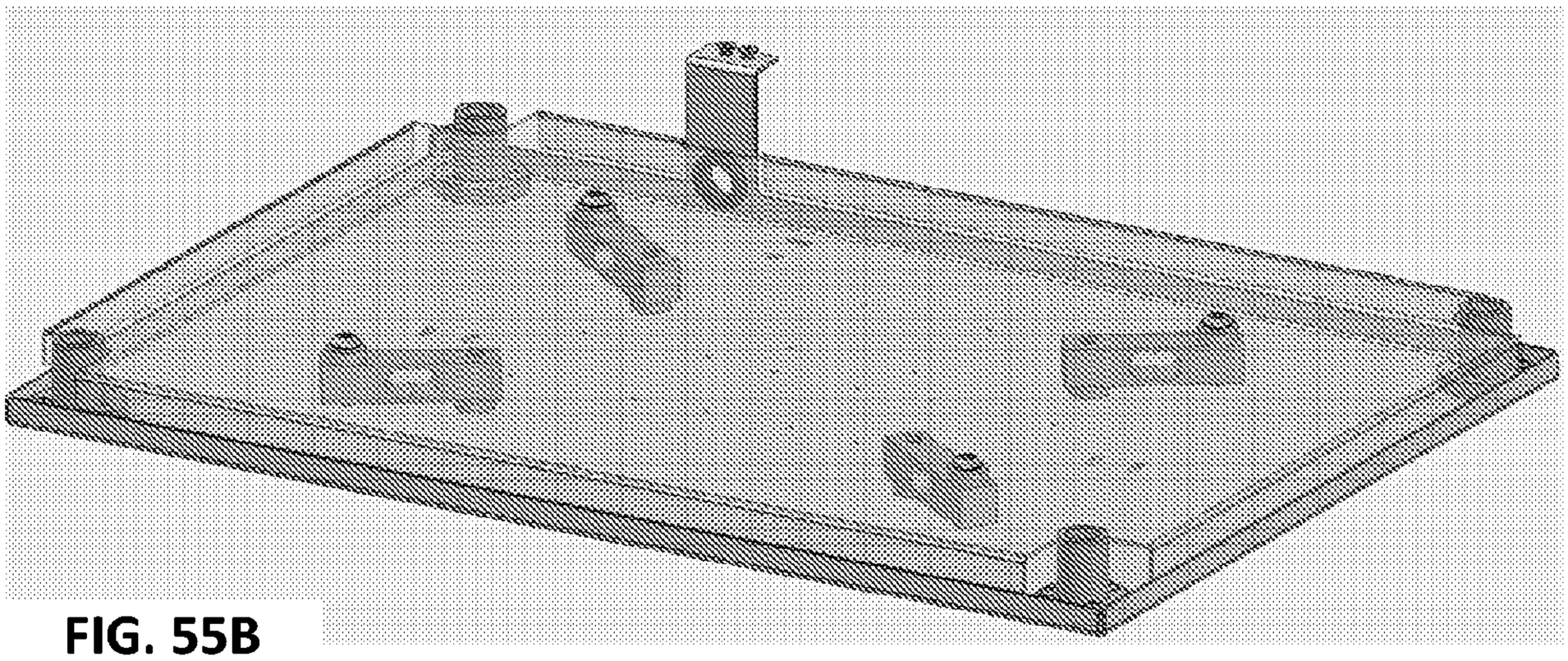


FIG. 55B

FIG. 56A

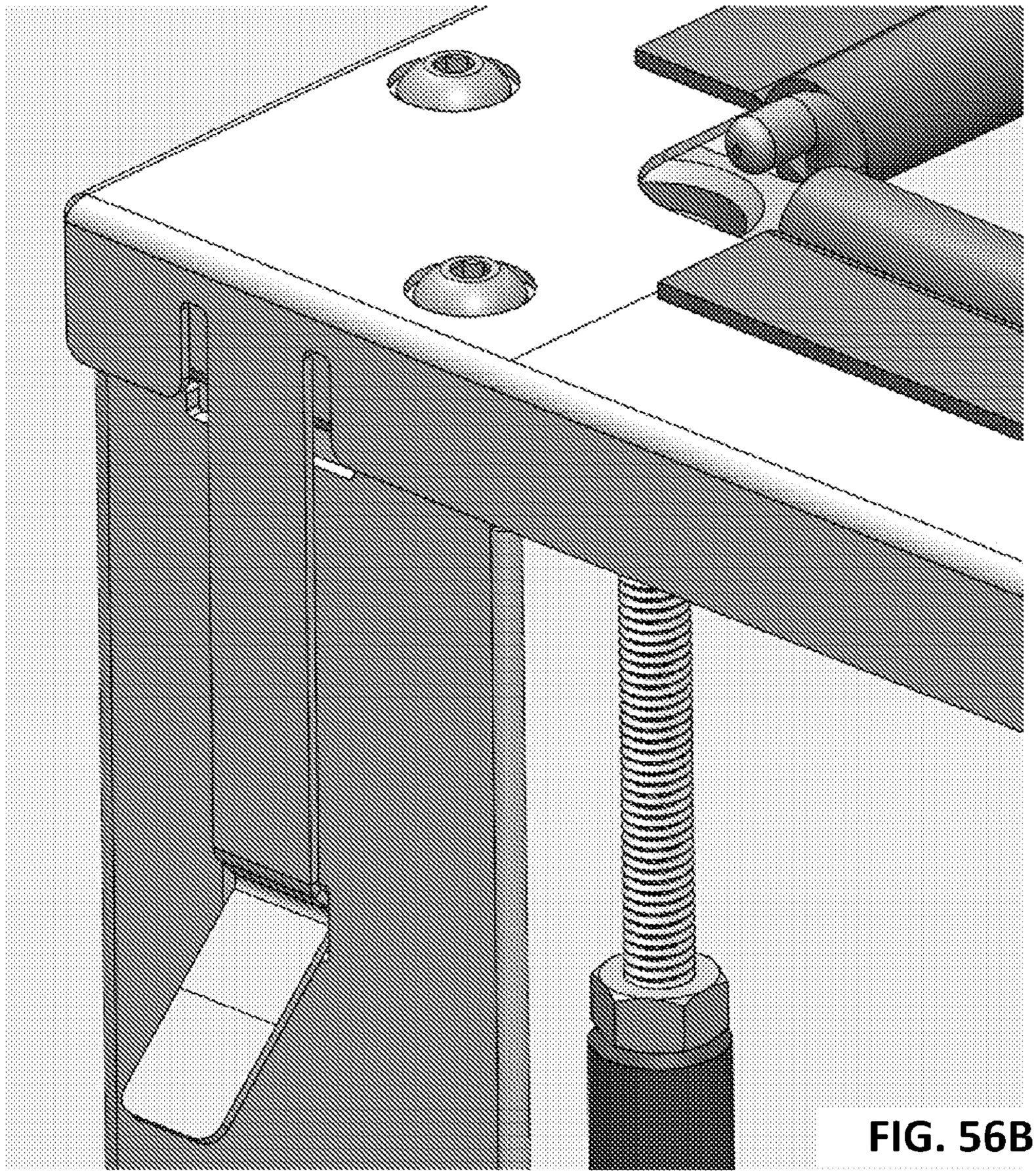


FIG. 56B

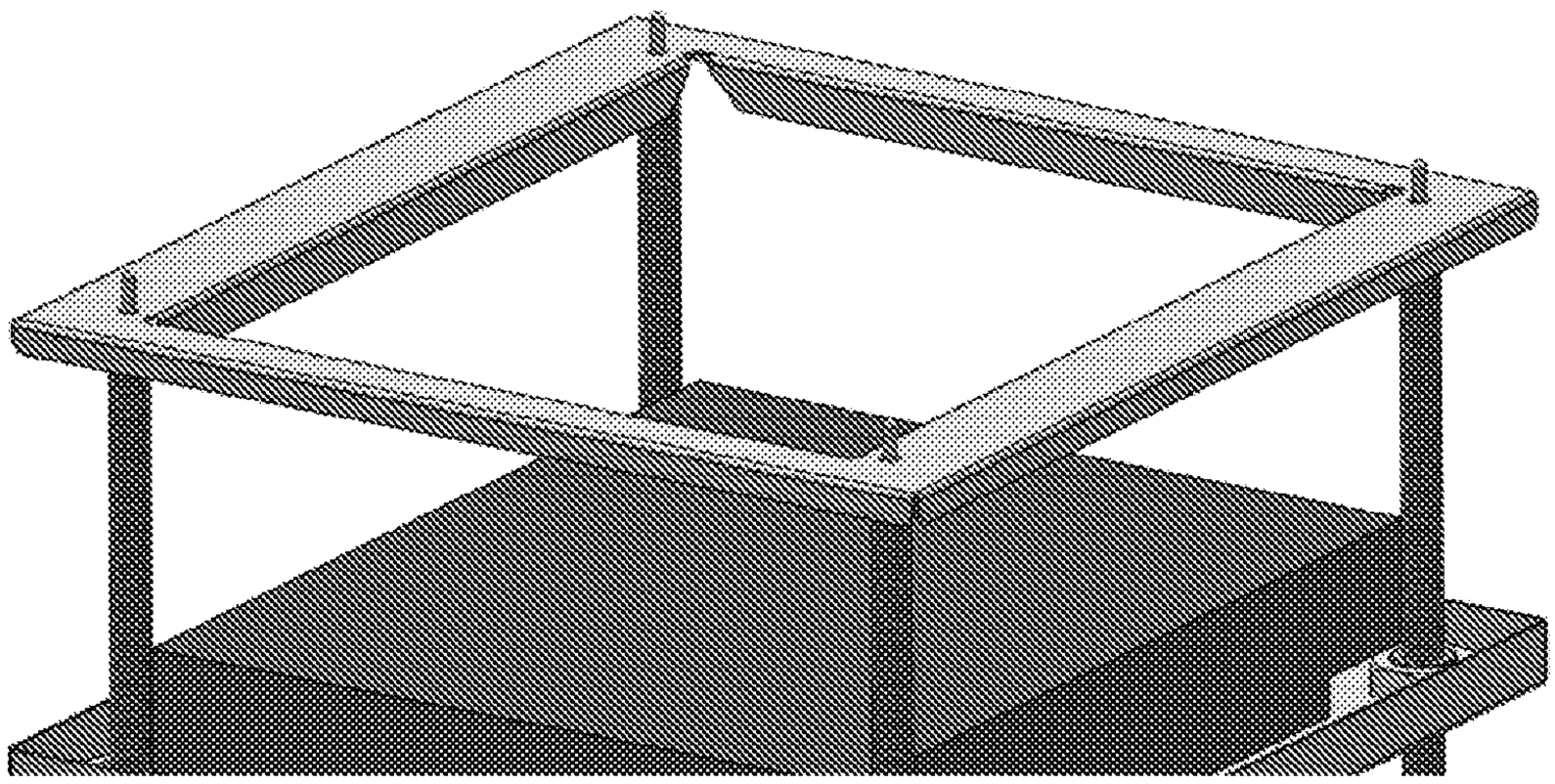
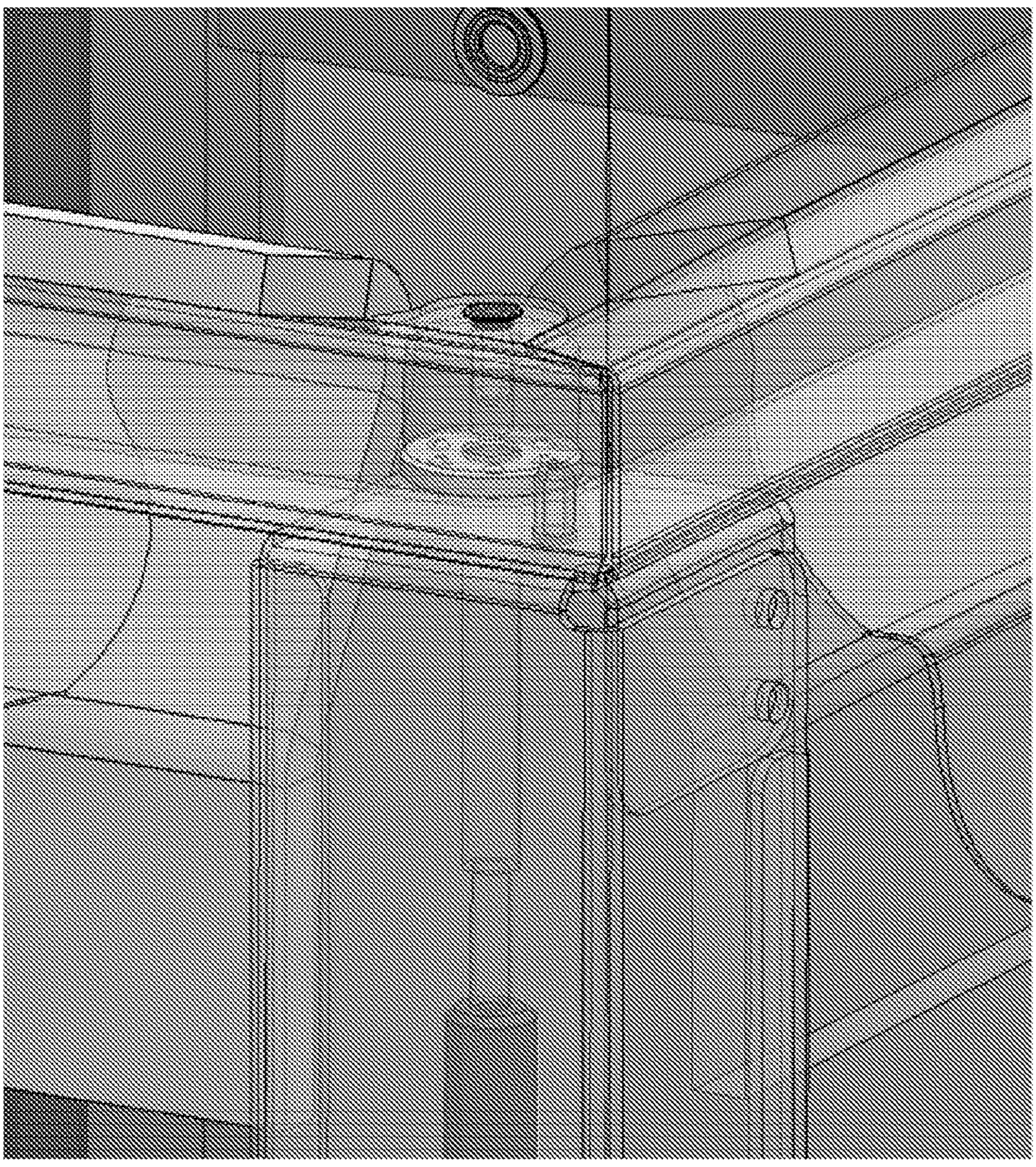


FIG. 57A

FIG. 57B



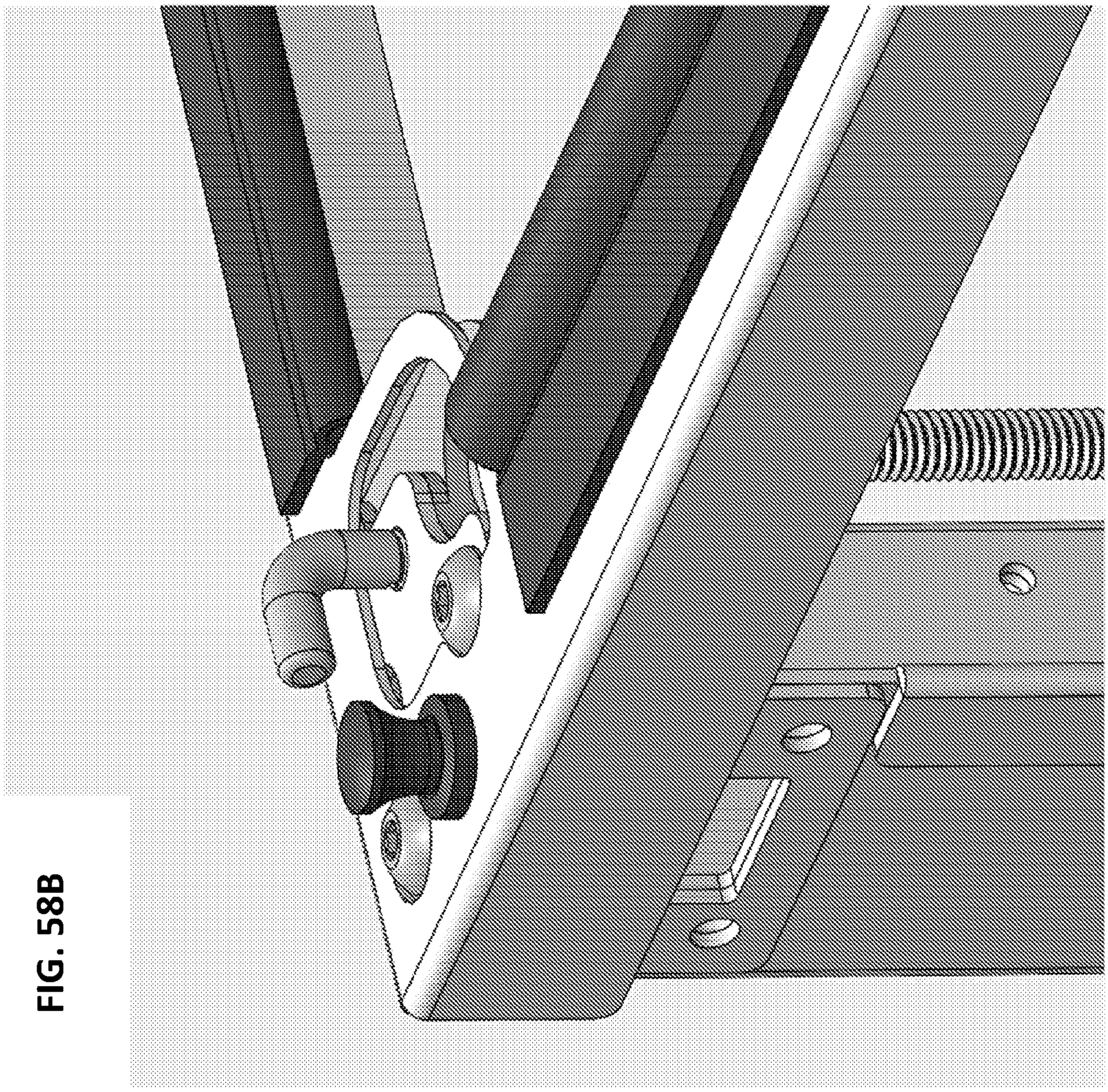


FIG. 58B

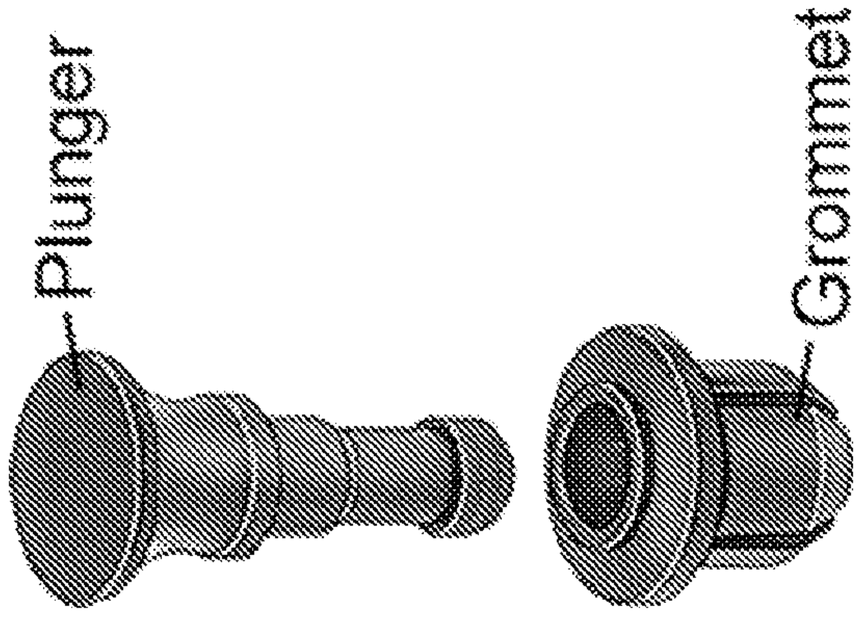


FIG. 58A

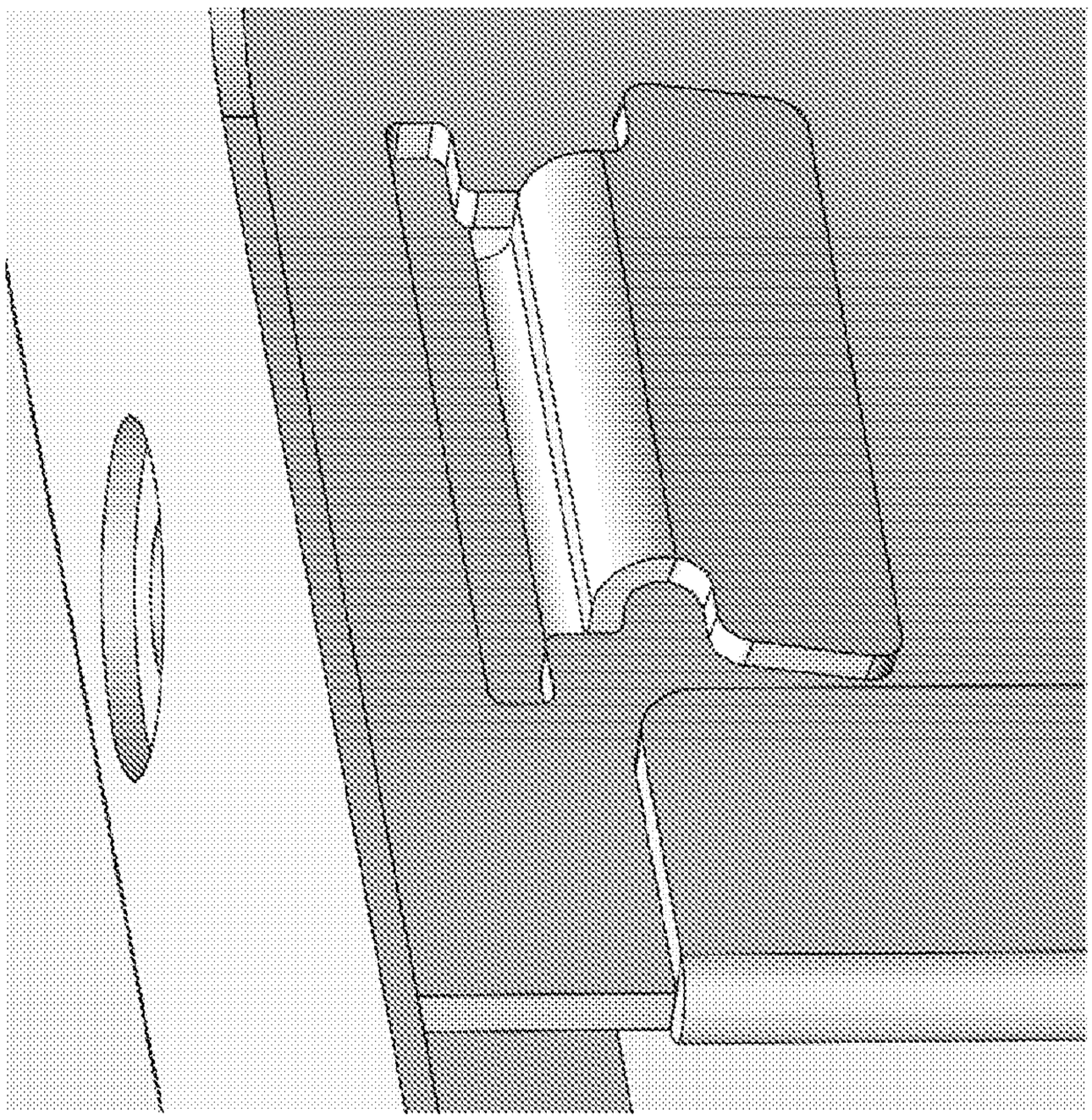


FIG. 59C

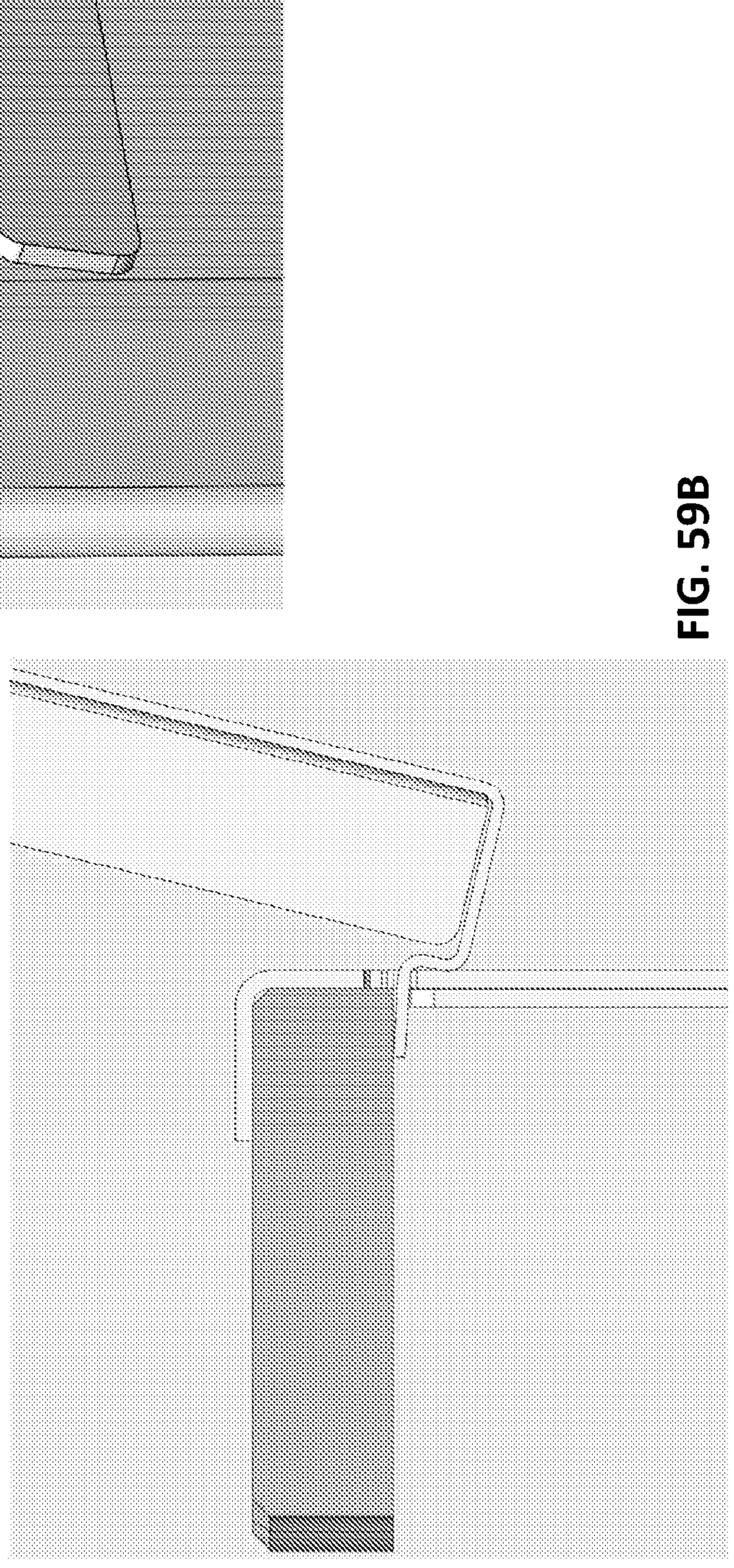


FIG. 59B

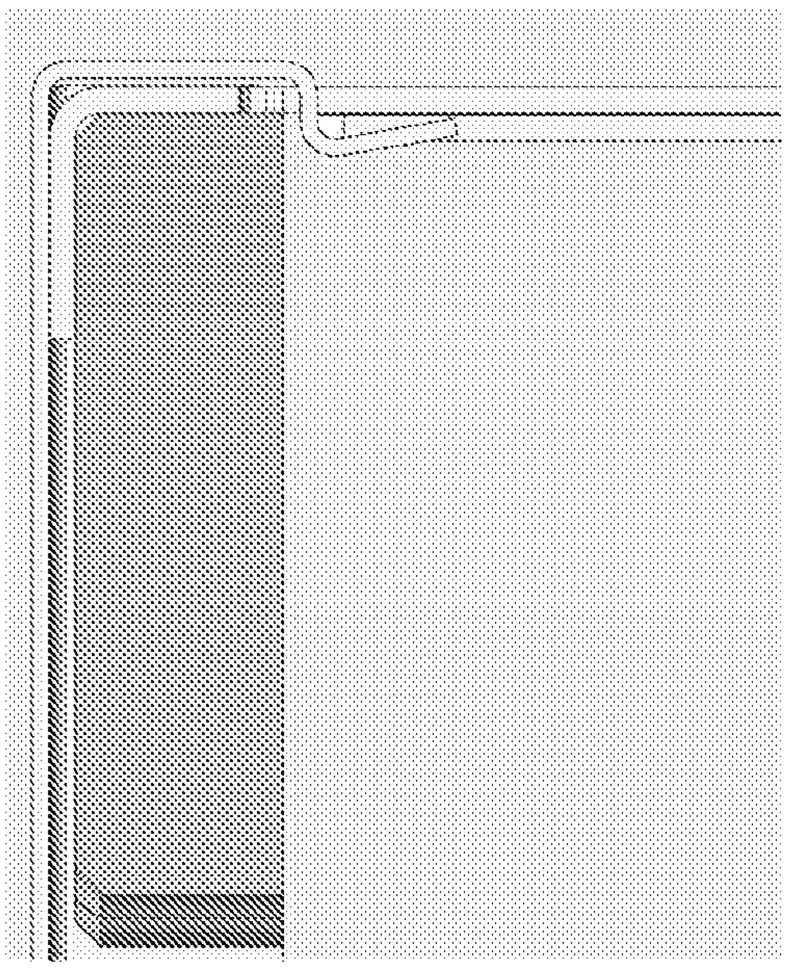


FIG. 59A

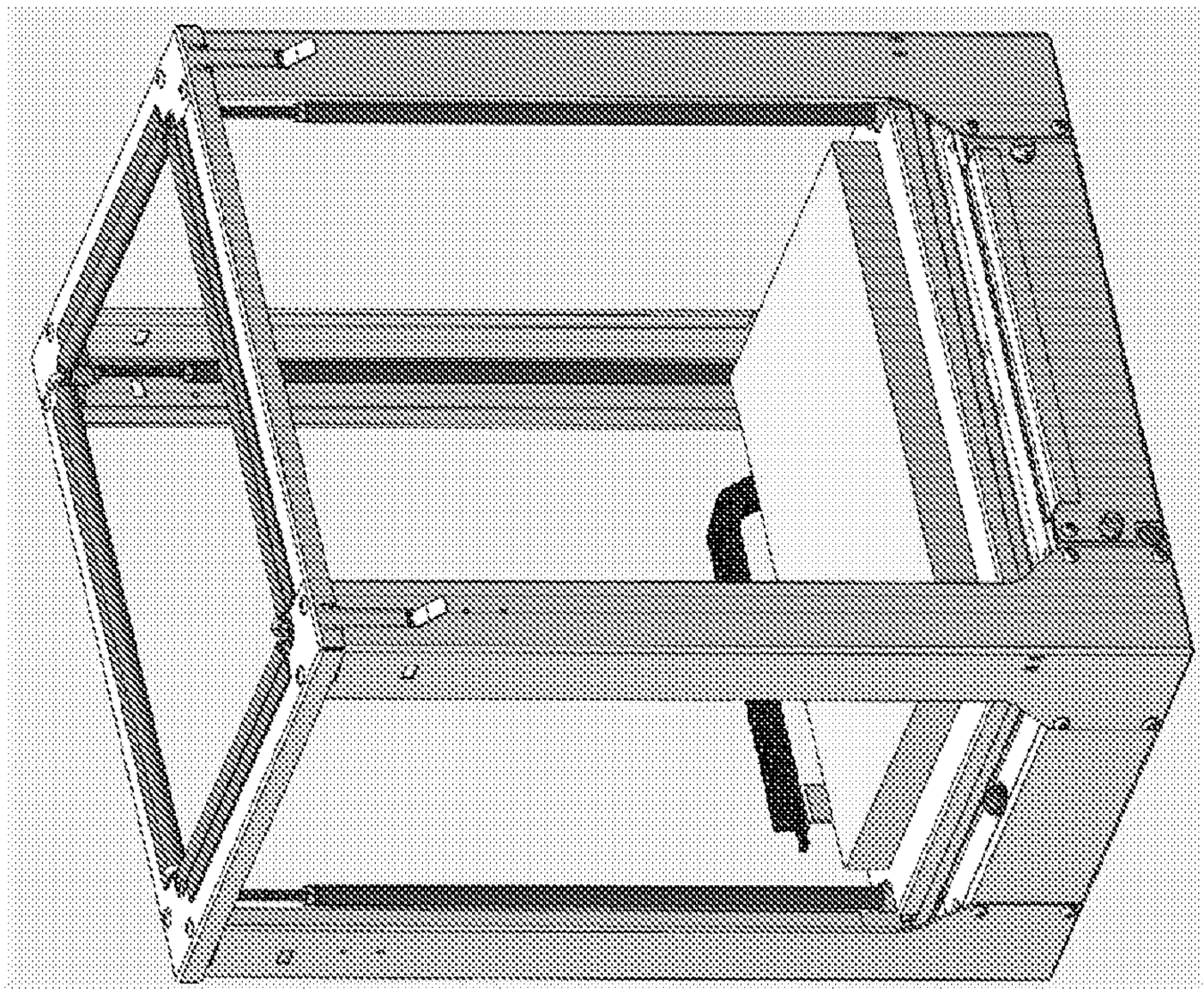


FIG. 60B

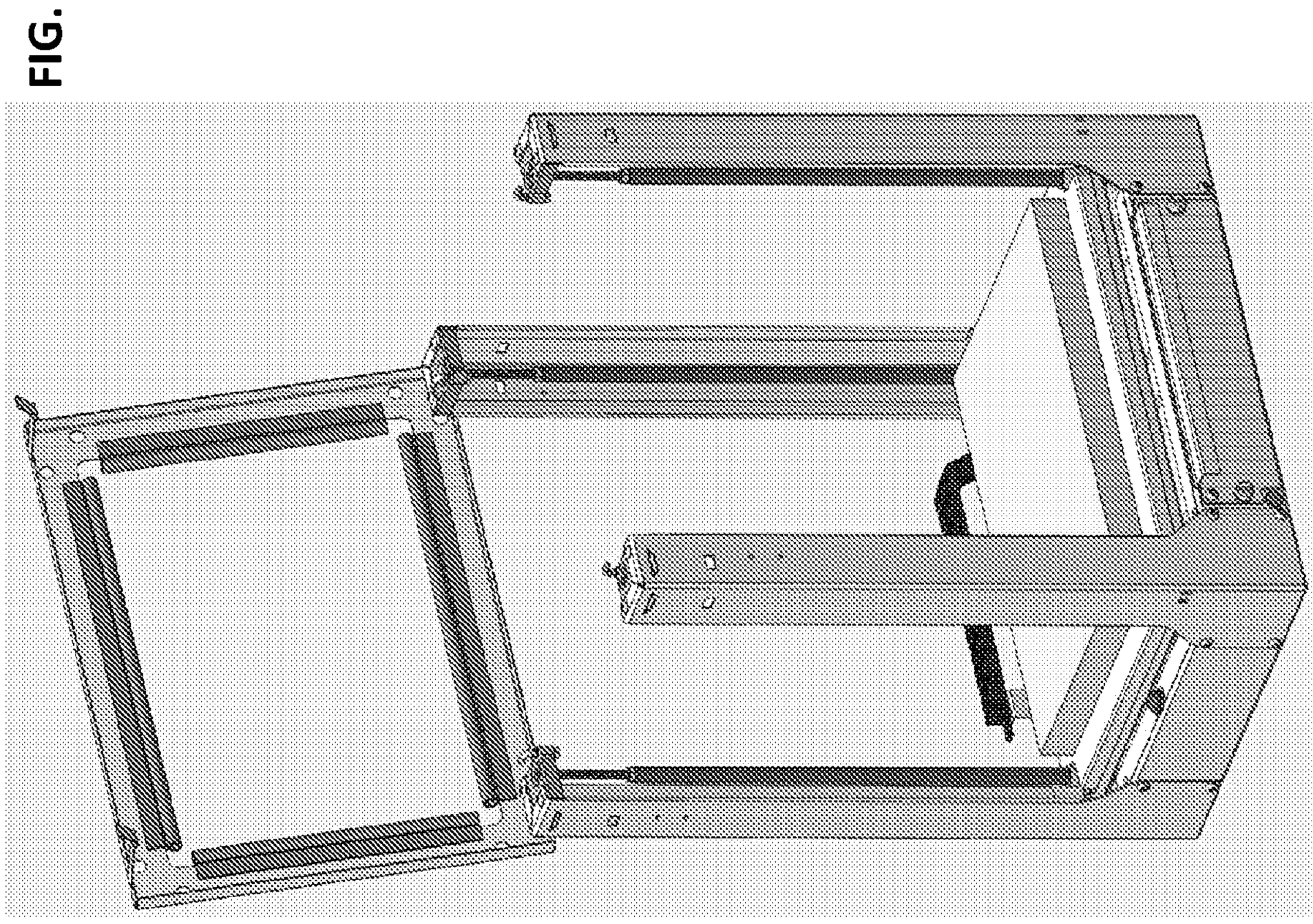


FIG. 60A

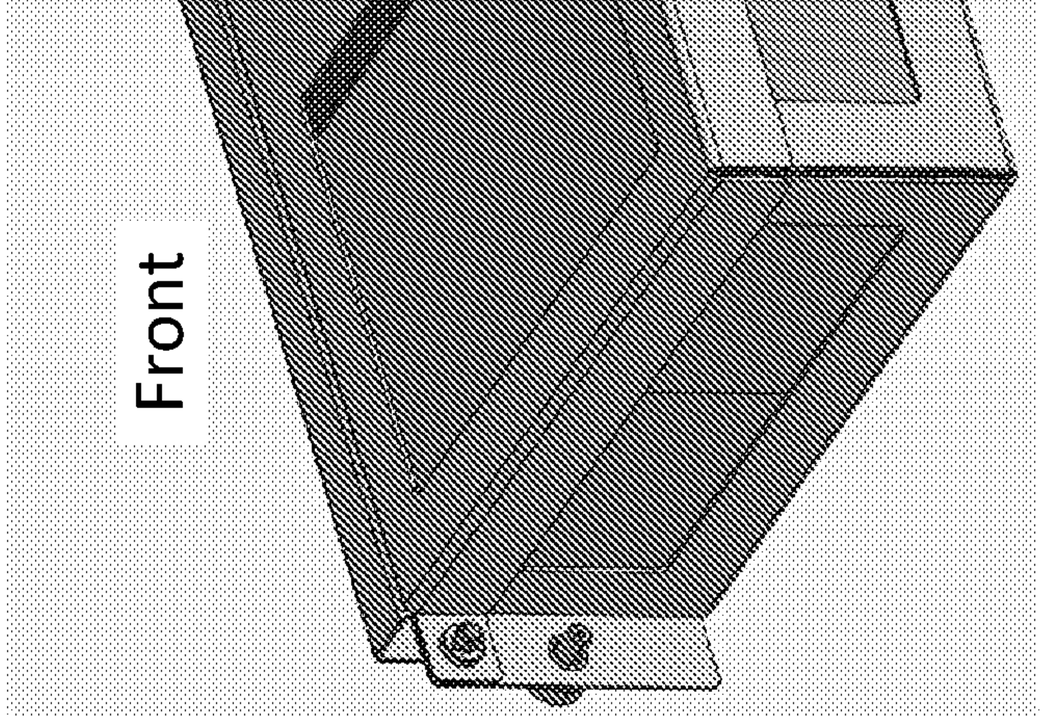


FIG. 61A

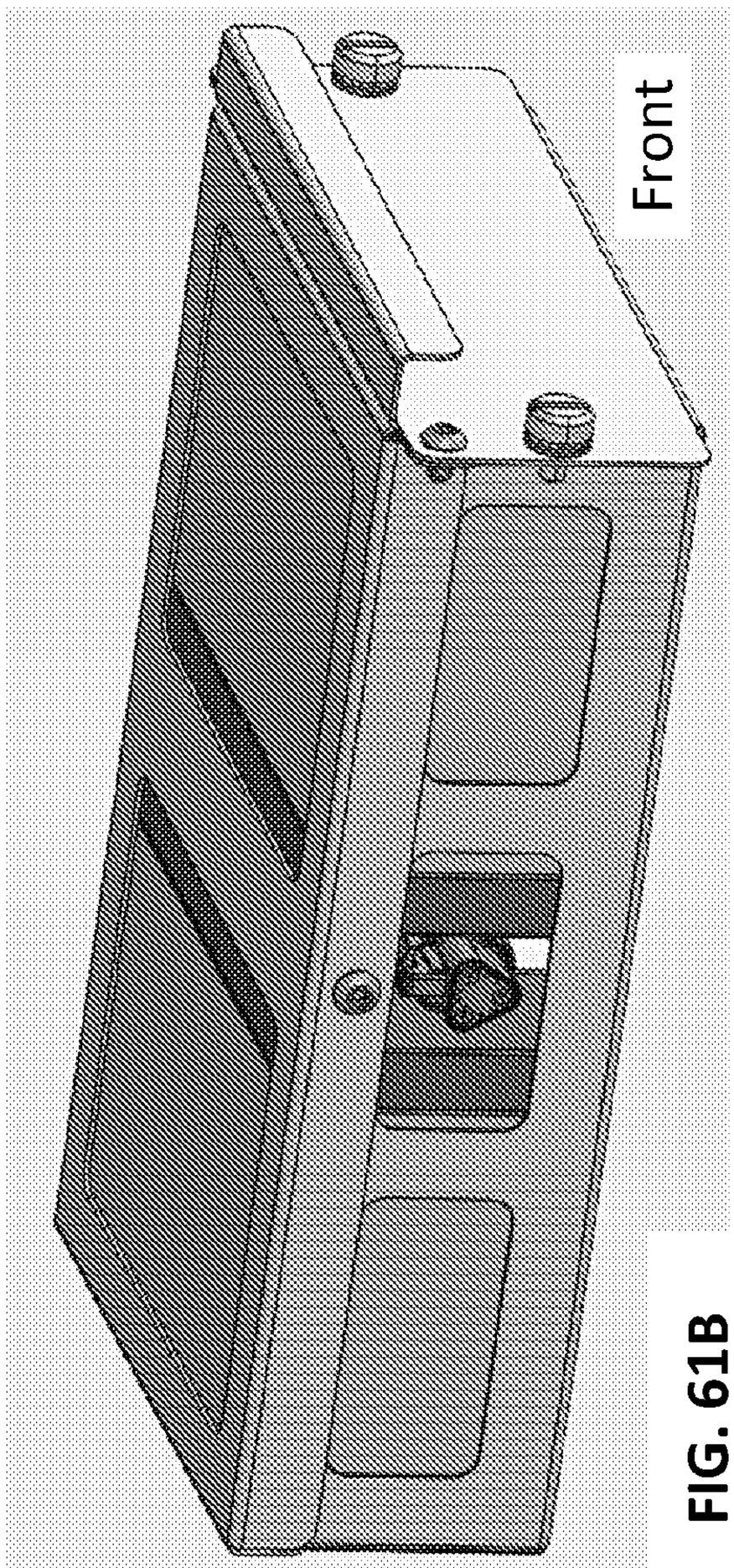


FIG. 61B

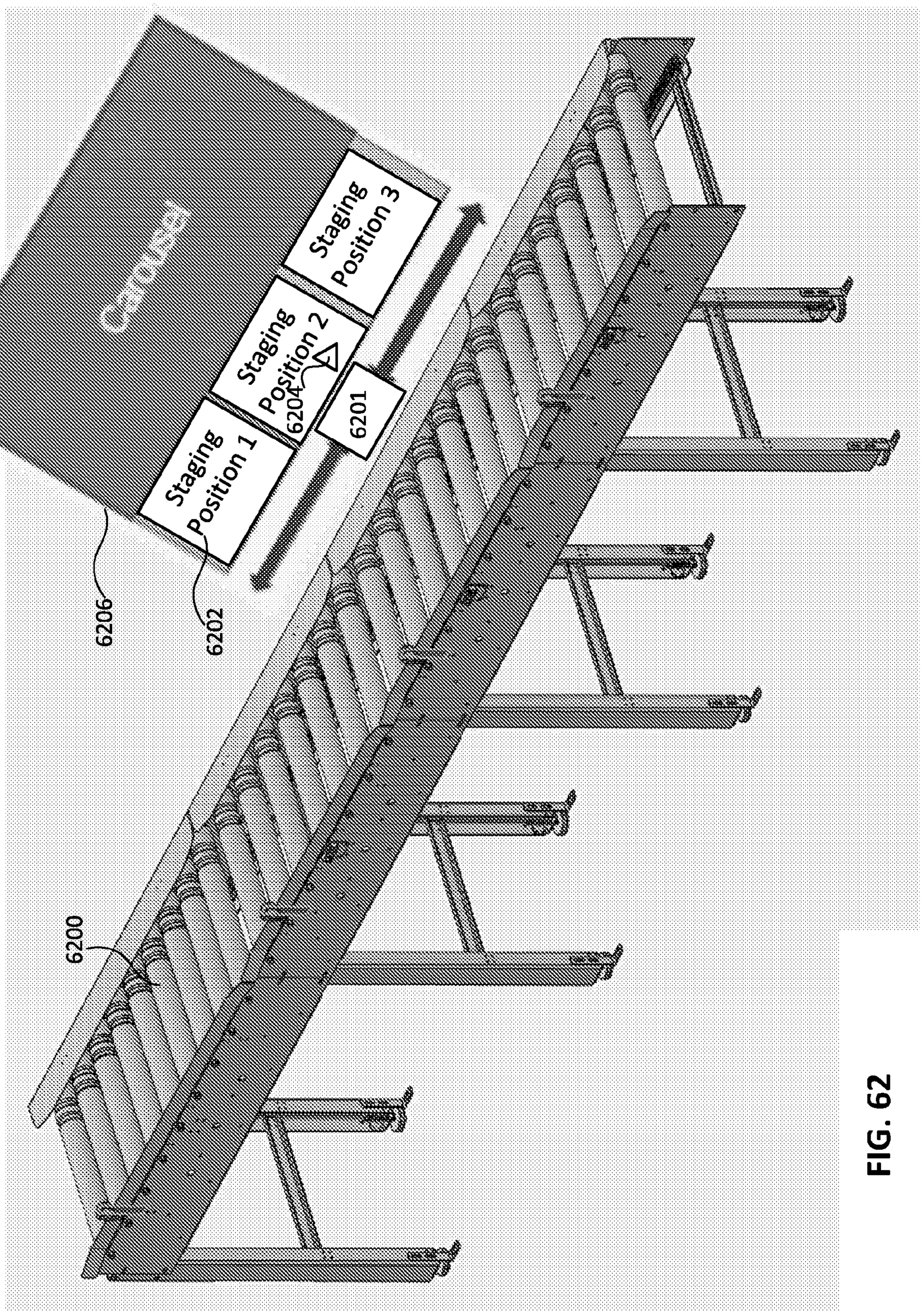

Staging Position 1
Staging Position 2
Staging Position 3
6201
6204
6206
6202
6200

FIG. 62

FIG. 63A

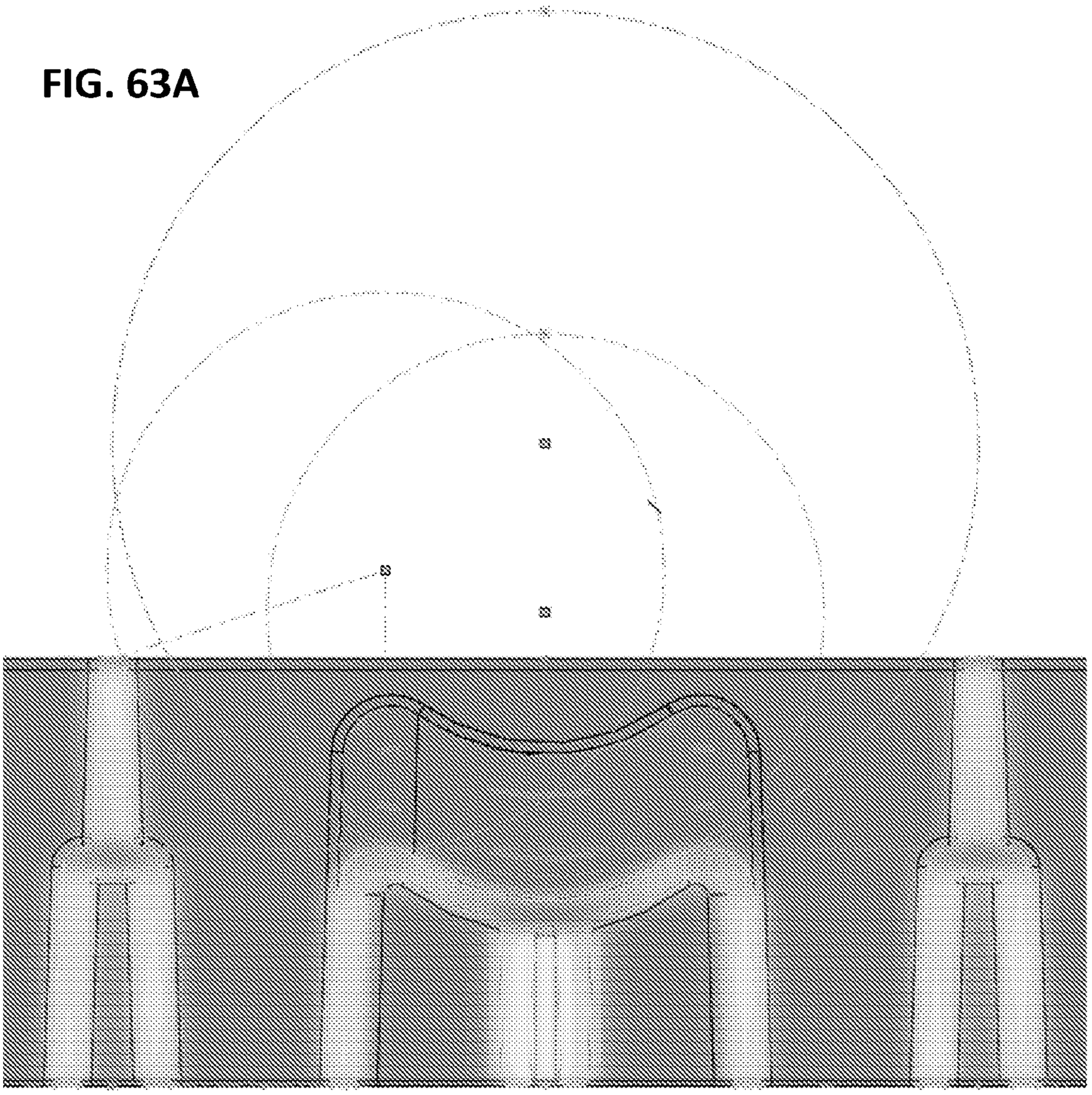
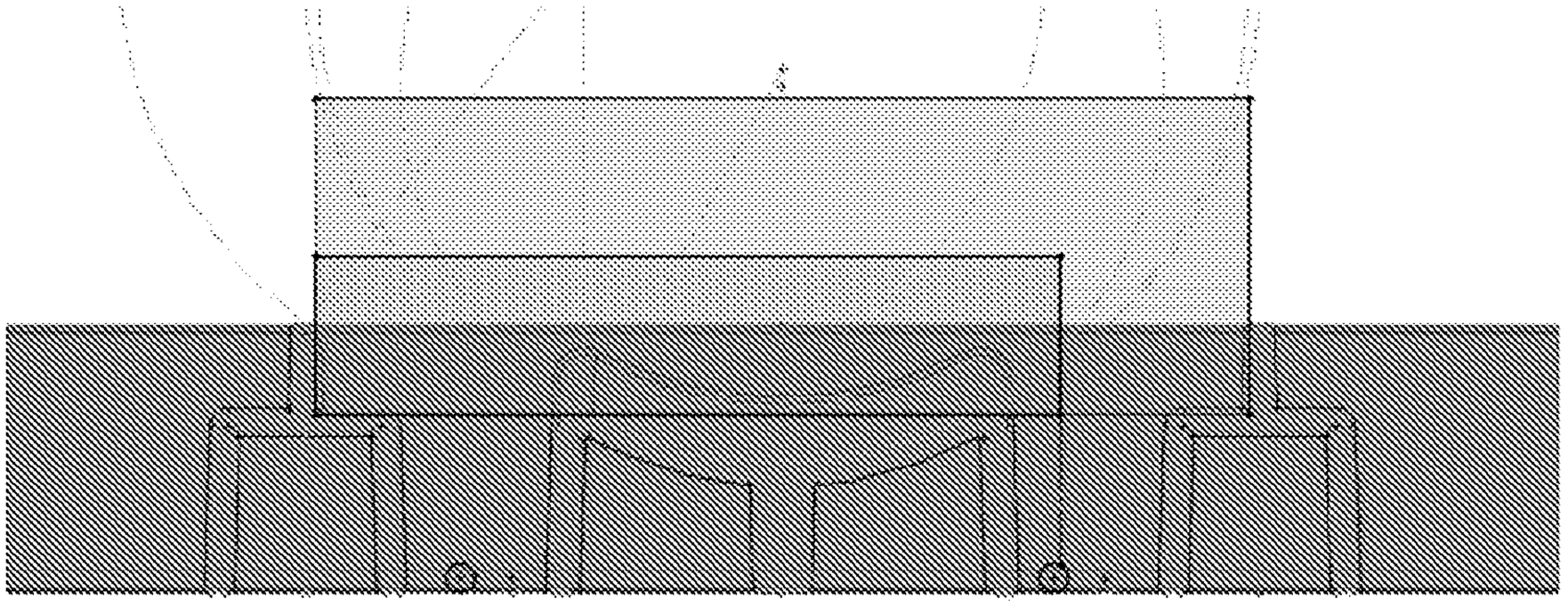


FIG. 63B



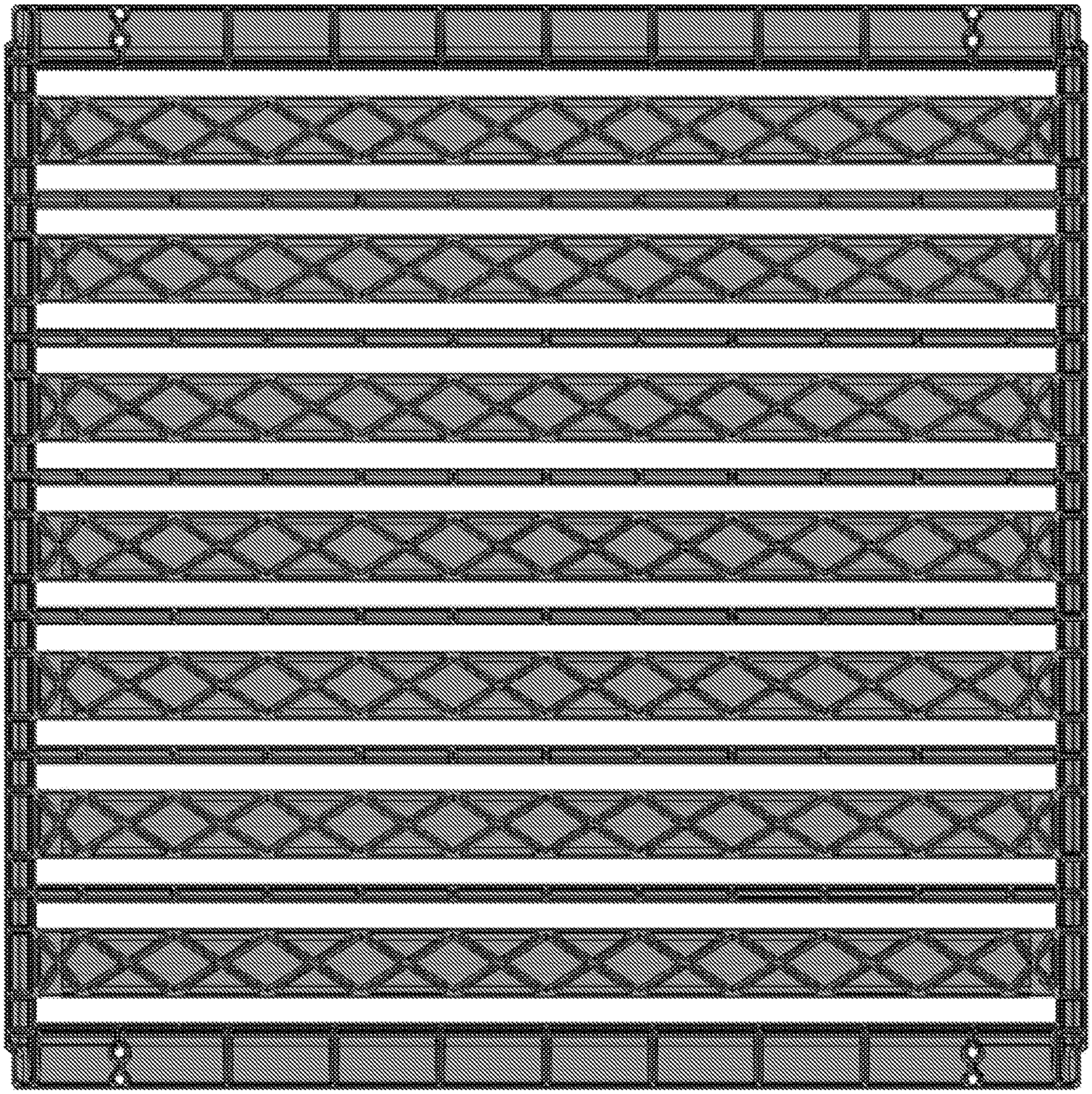


FIG. 64

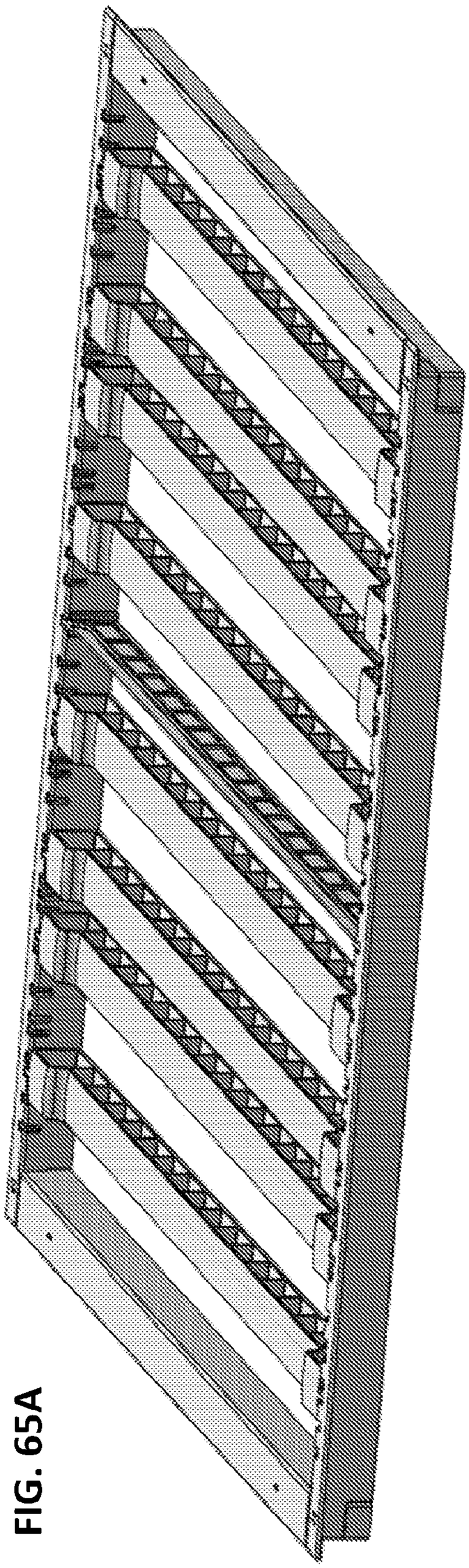


FIG. 65A

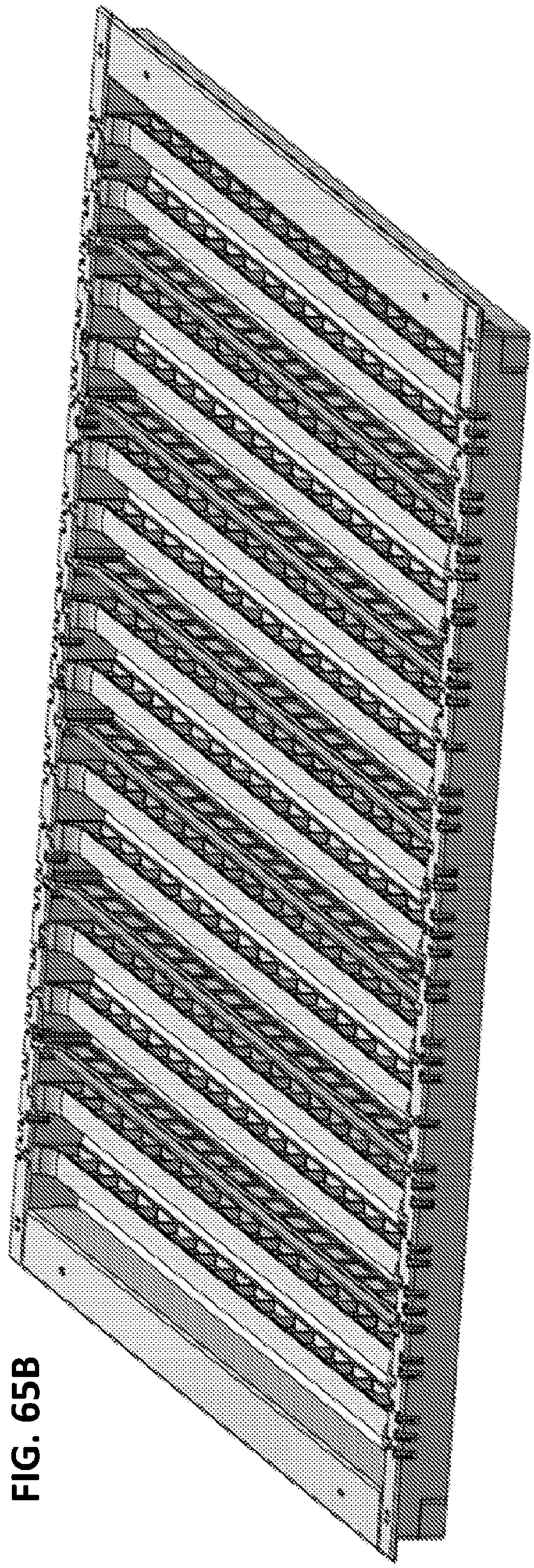


FIG. 65B

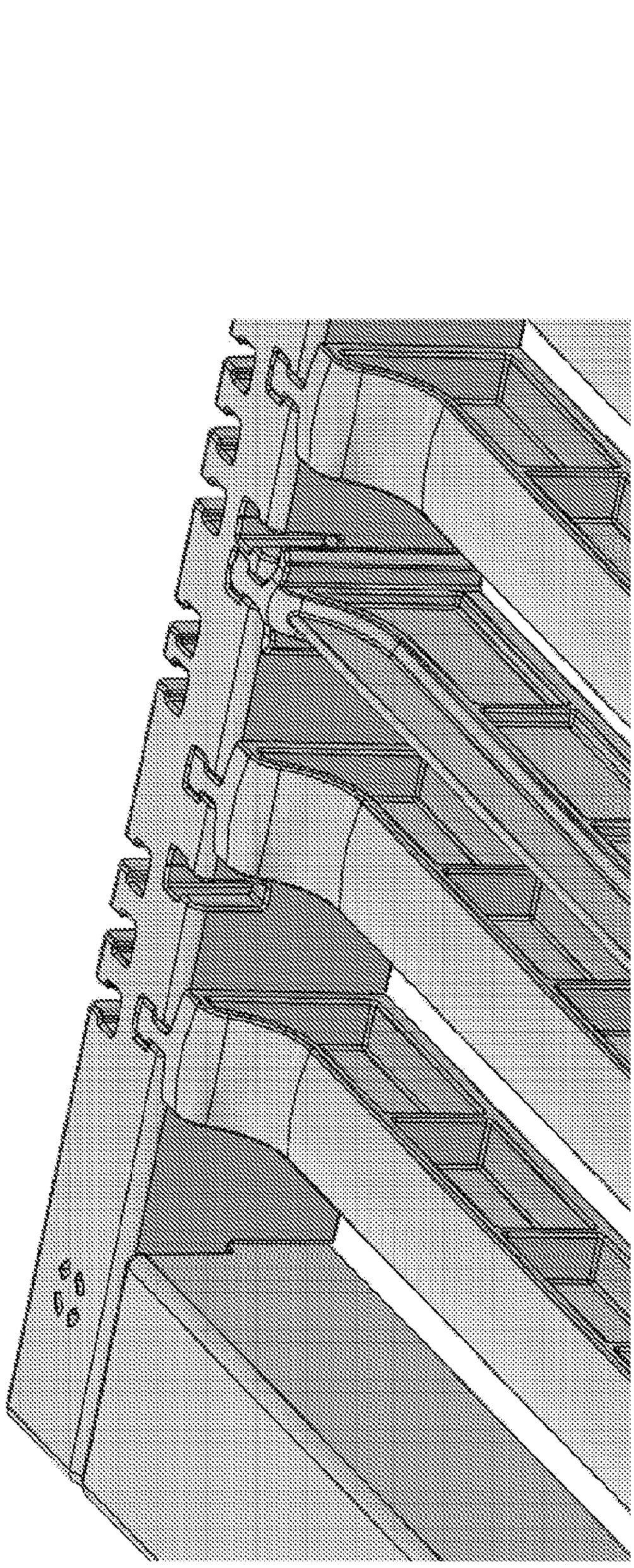


FIG. 66A

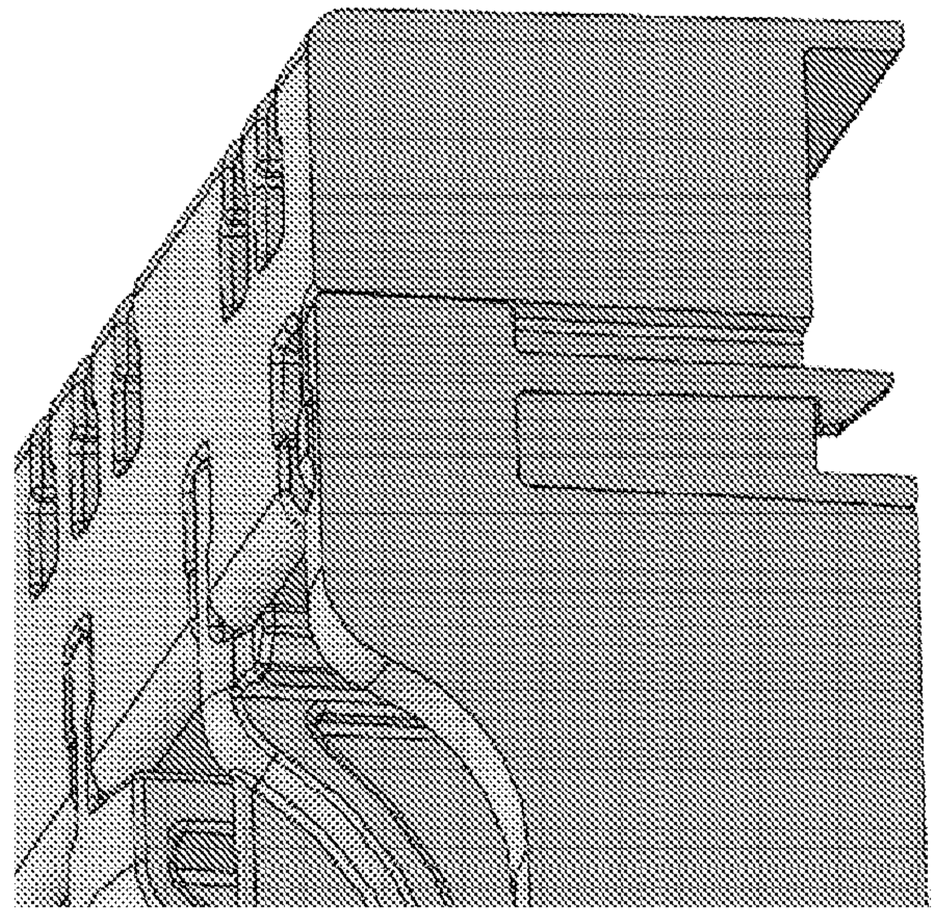


FIG. 66B

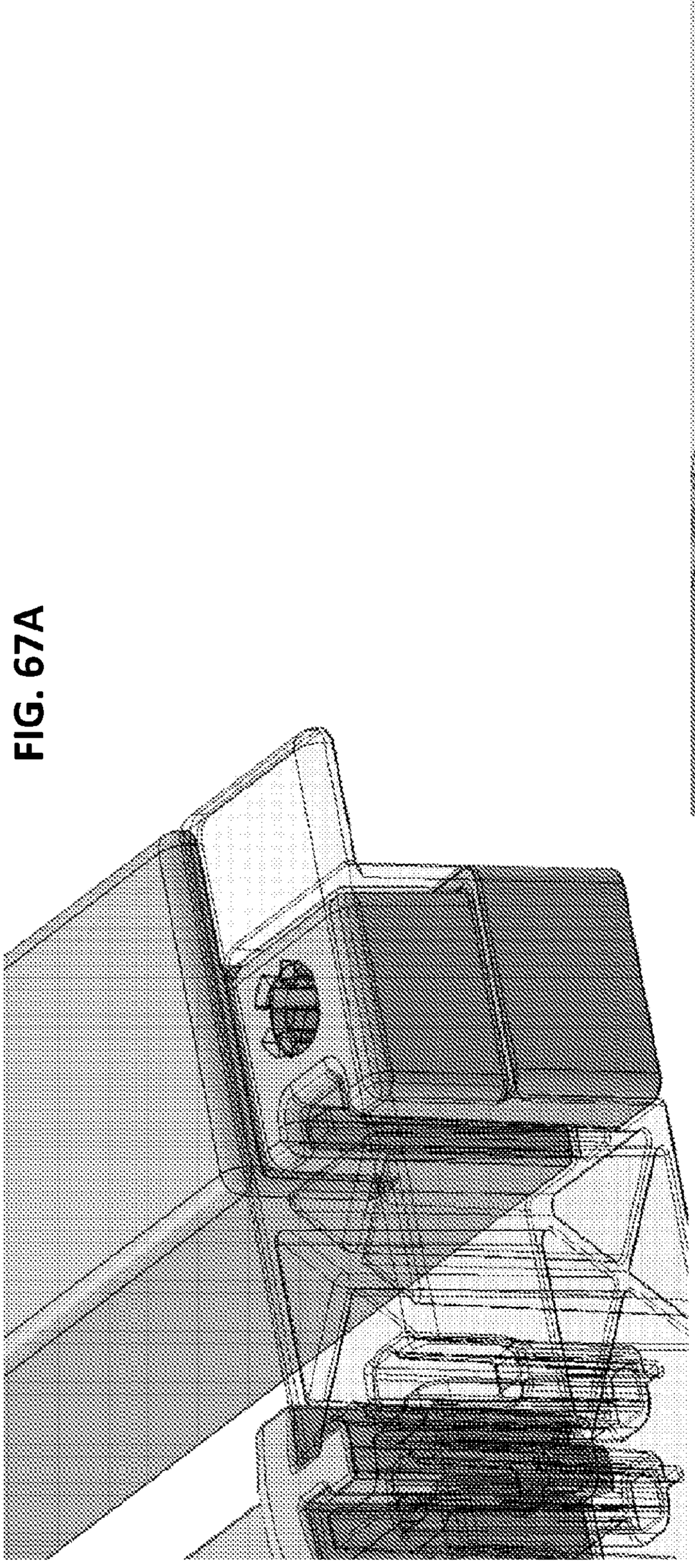


FIG. 67A

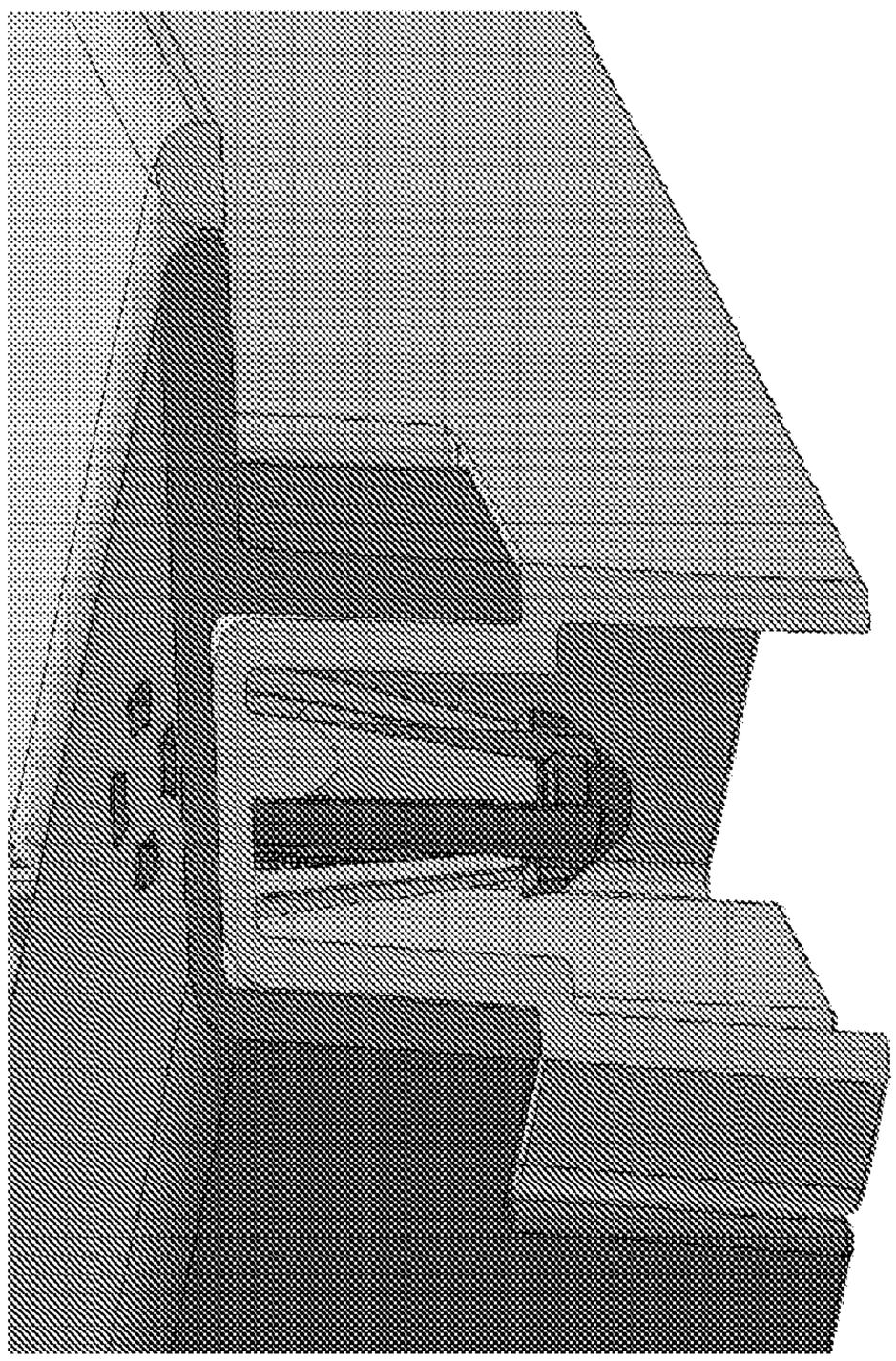


FIG. 67B

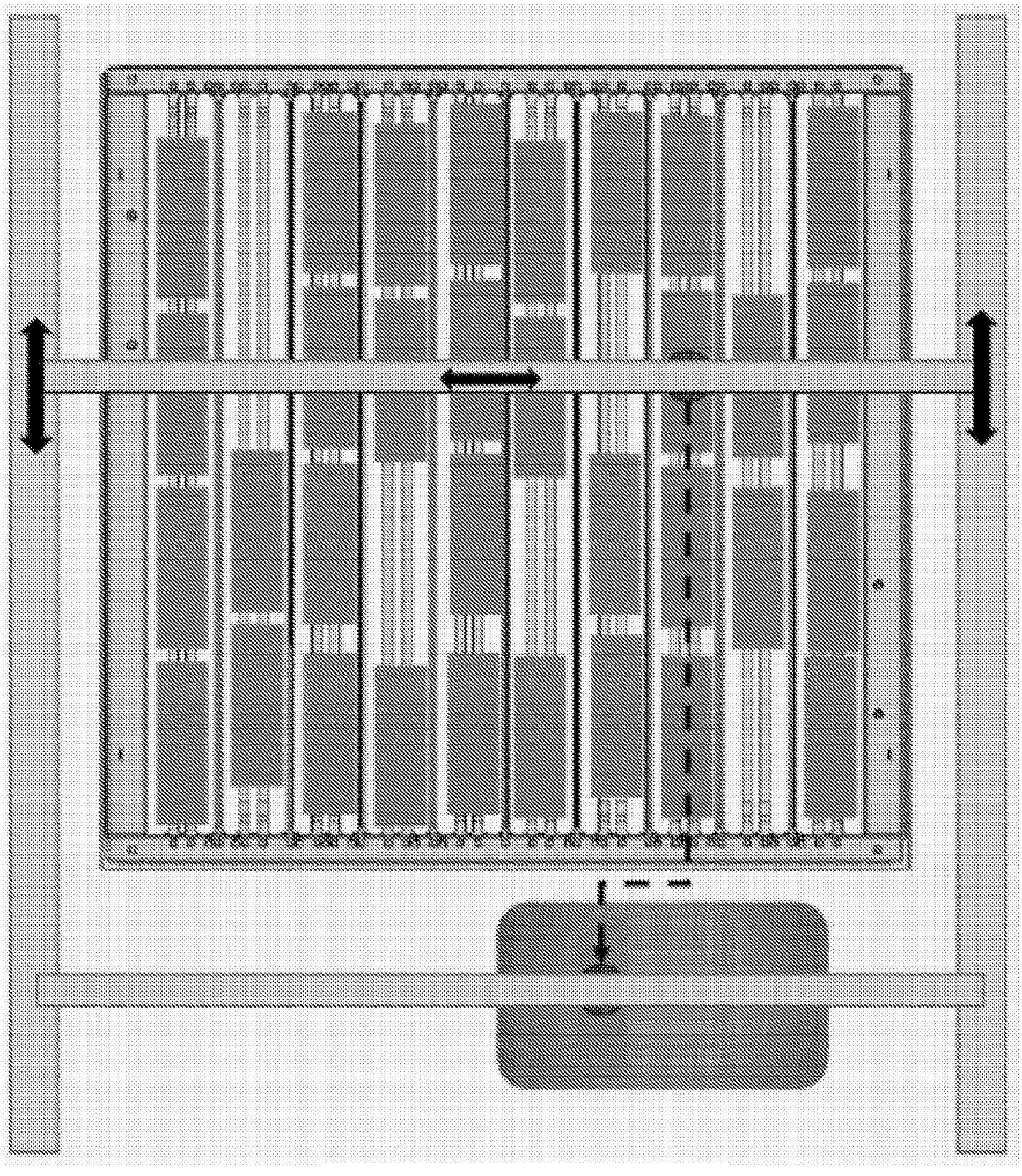


FIG. 68

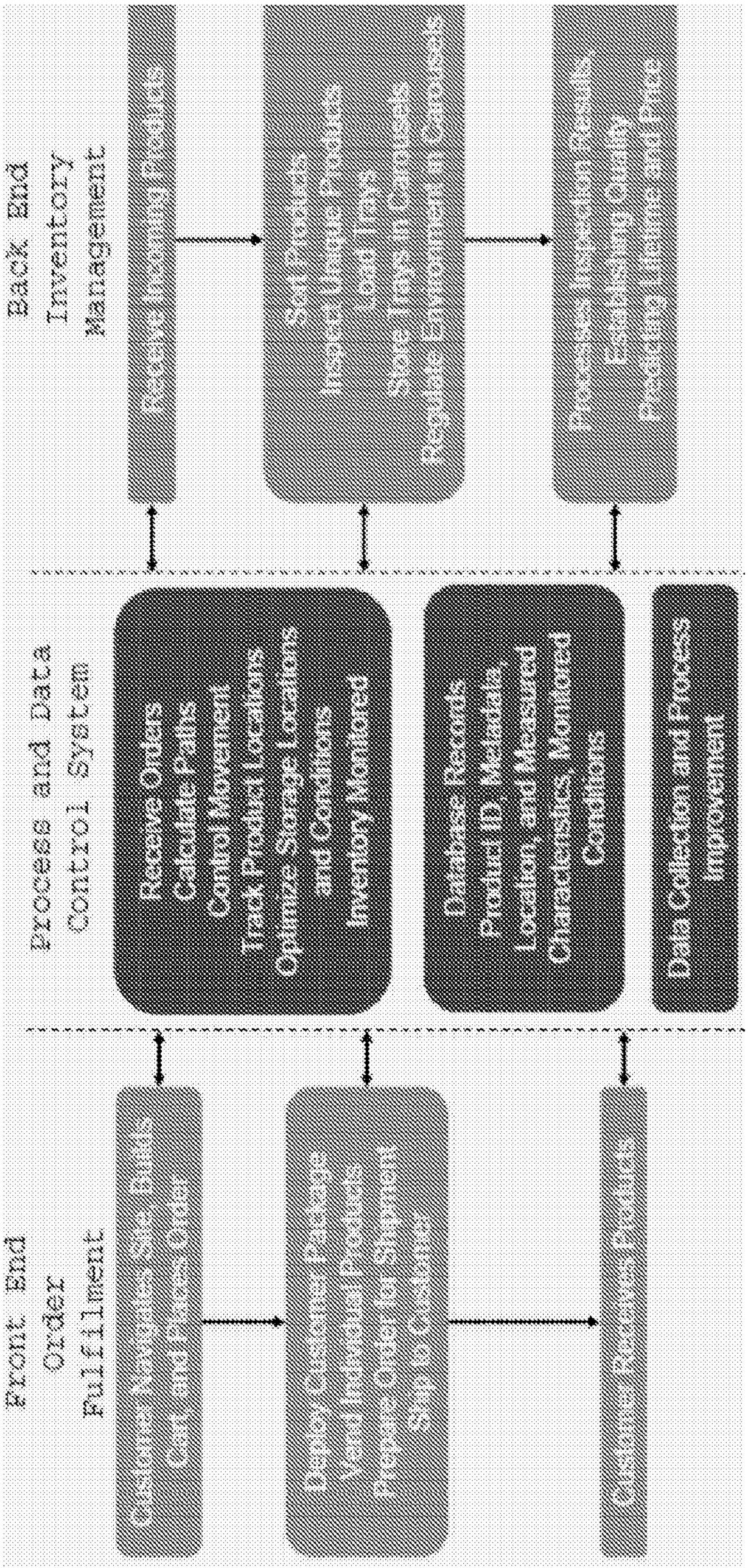

Back End
Inventory
Management
Receive Inventory
Store Inventory
Ship Inventory
Process and Data
Control System
Receive Order
Schedule Paths
Control Movement
Predict Locations
Store Locations
Control Conditions
Inventory Monitored
Receive Items
Create Inventory Records
Assign Inventory Identifiers
Store Inventory
Ship Inventory
From End
Order
Fulfillment
Receive Order
Schedule Paths
Control Movement
Predict Locations
Store Locations
Control Conditions
Inventory Monitored
Receive Items
Create Inventory Records
Assign Inventory Identifiers
Store Inventory
Ship Inventory

FIG. 69

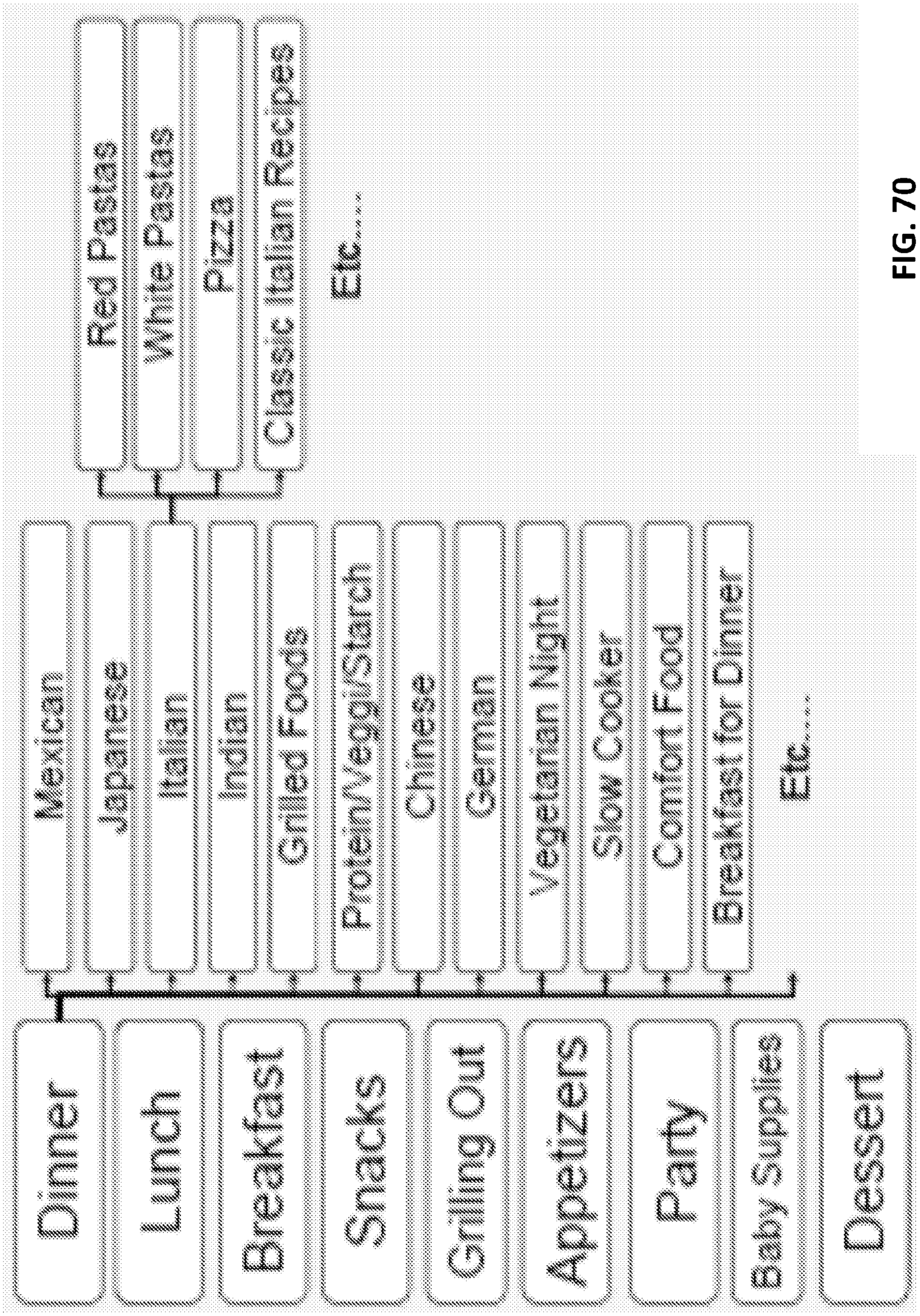

Red Pasta
White Pasta
Pizza
Classic Italian Re
Etc...
Mexican
Japanese
Italian
Indian
Grilled Foods
Protein/Veggie/Starch
Chinese
German
Vegetarian Night
Slow Cooker
Comfort Food
Breakfast for Dinner
Etc...
Dinner
Lunch
Breakfast
Snacks
Grilling Out
Appetizers
Party
Baby Supplies
Dessert

FIG. 70

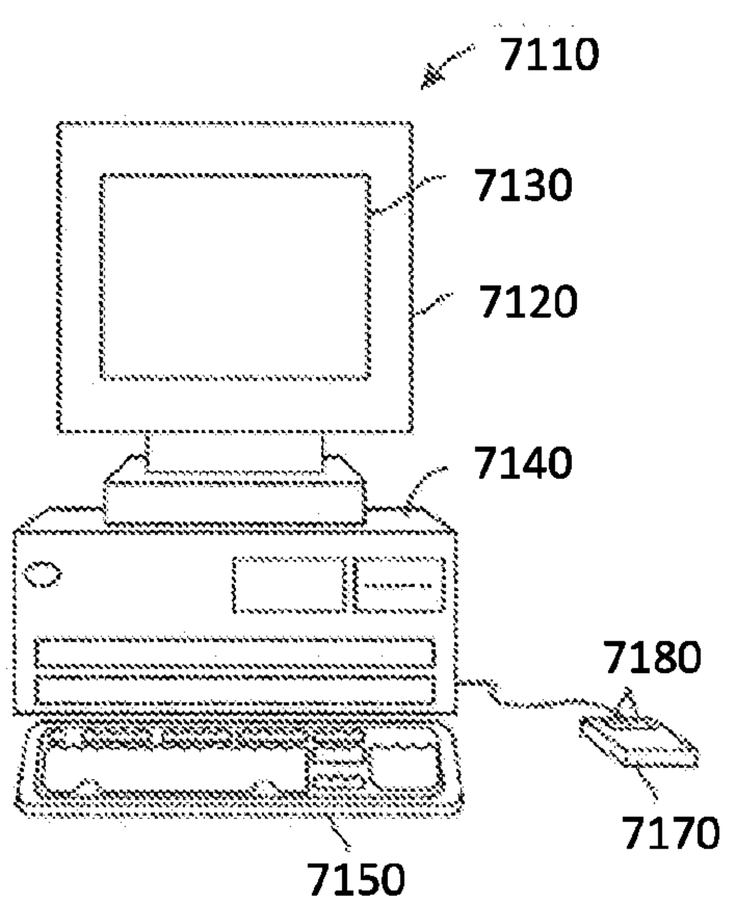


FIG. 71

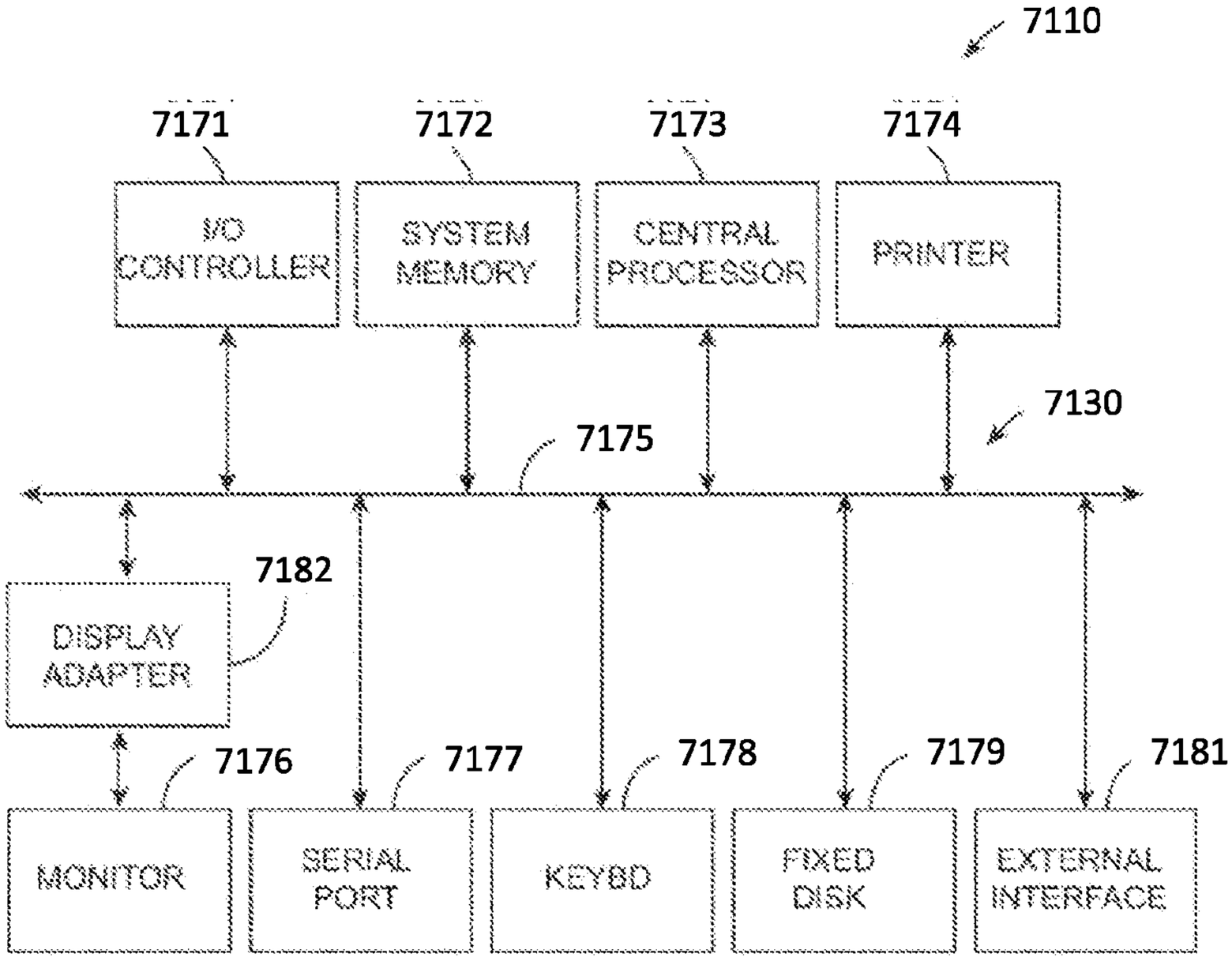
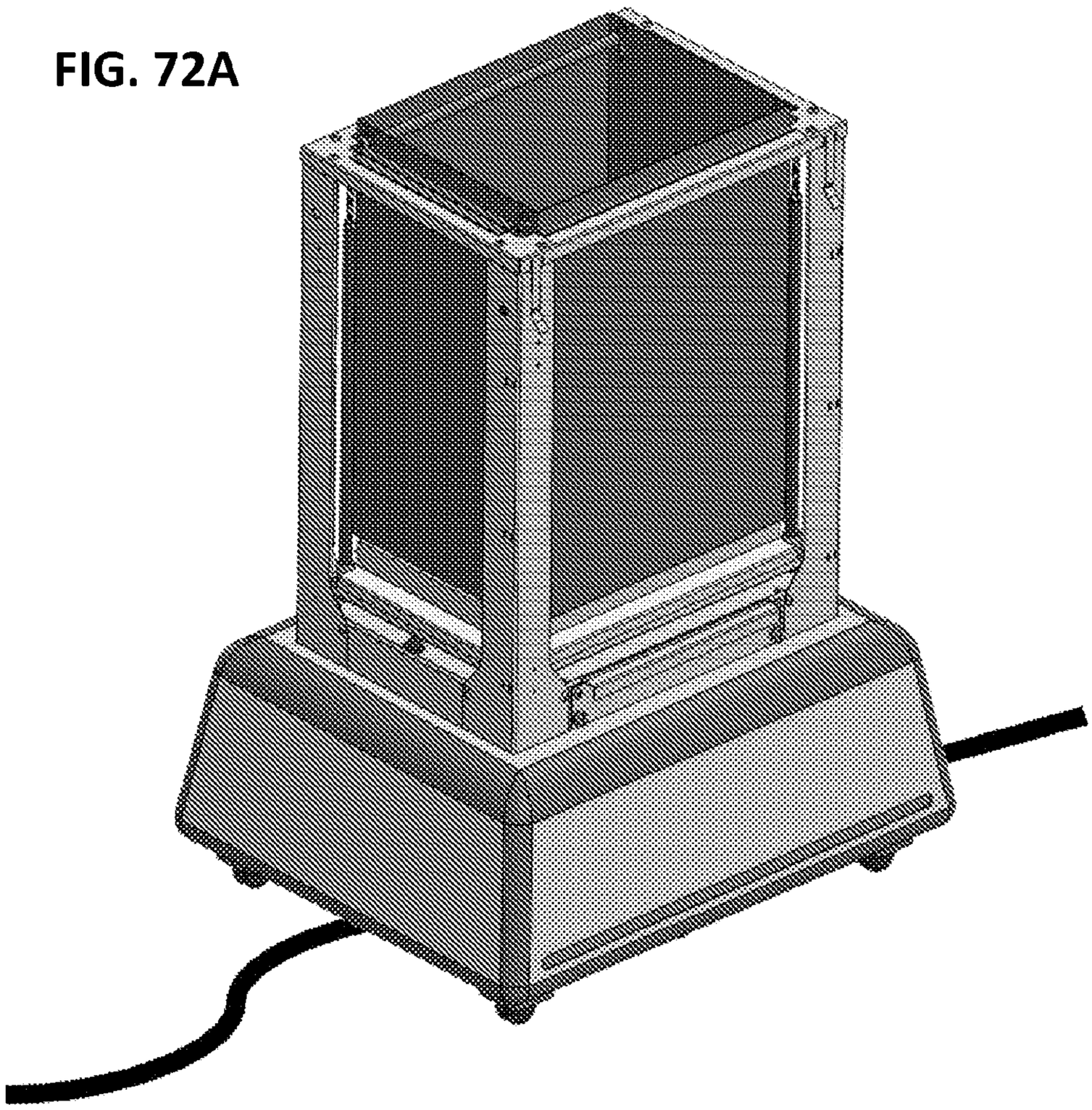


FIG. 71A

FIG. 72A



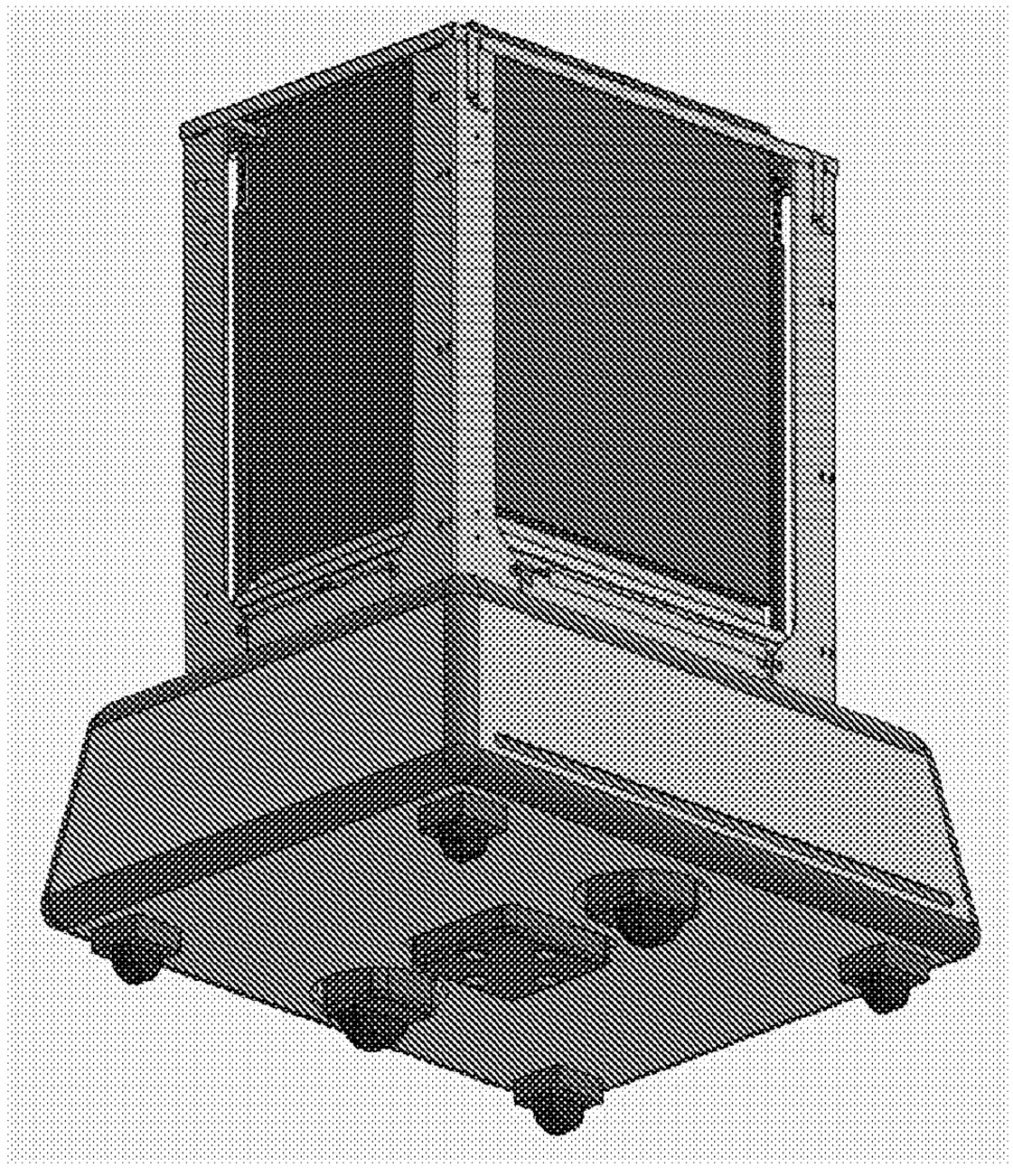


FIG. 72B

FIG. 73A

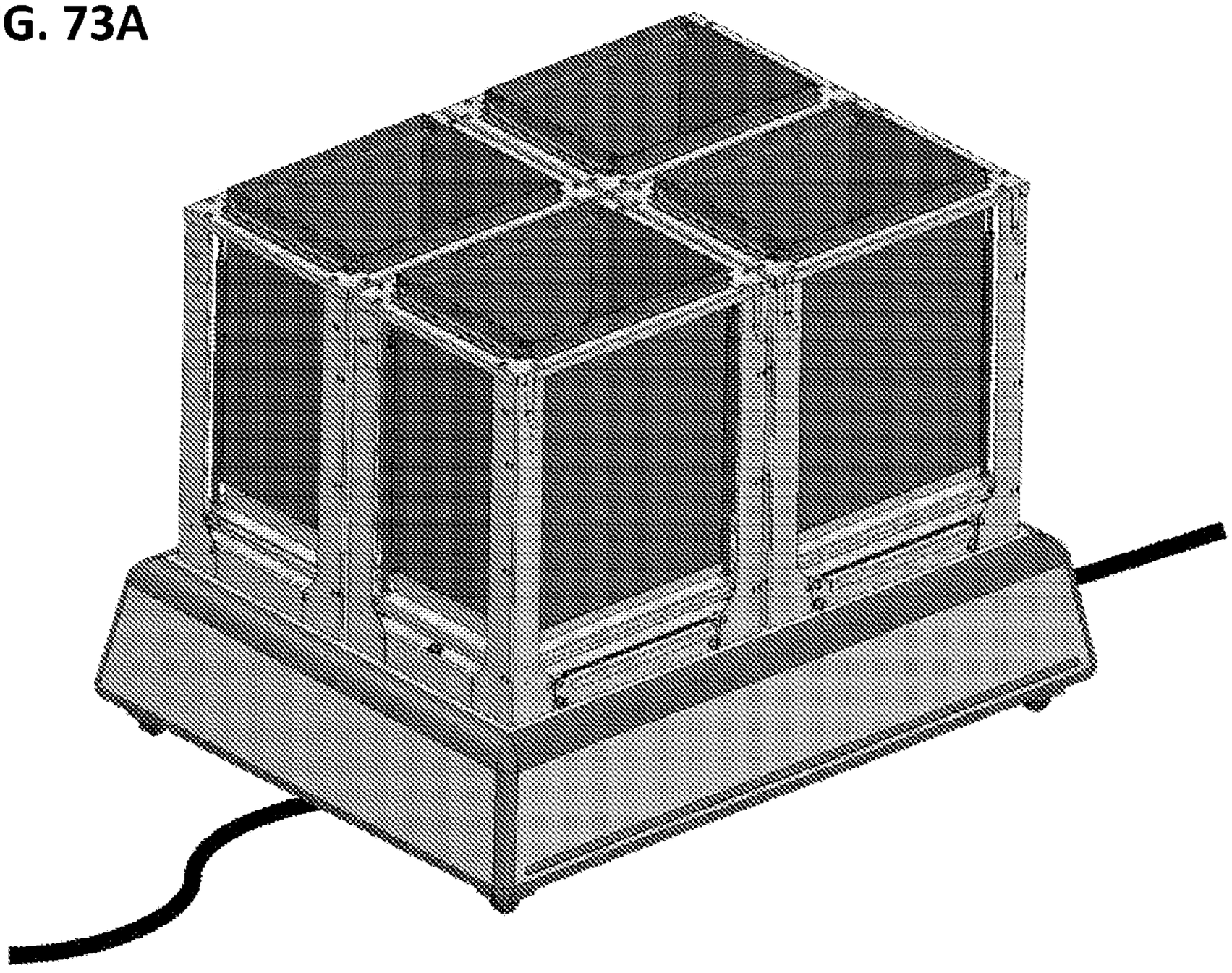
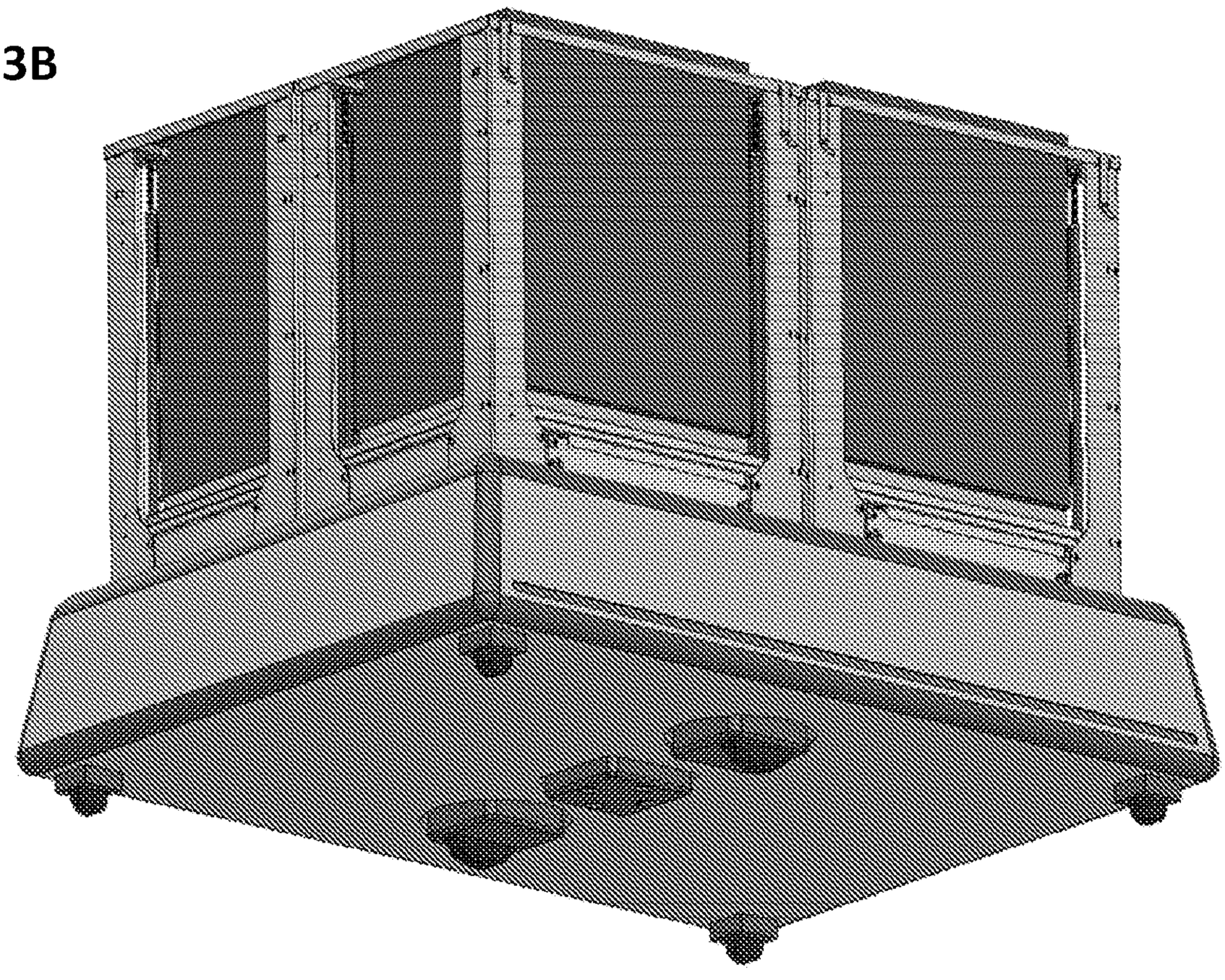


FIG. 73B



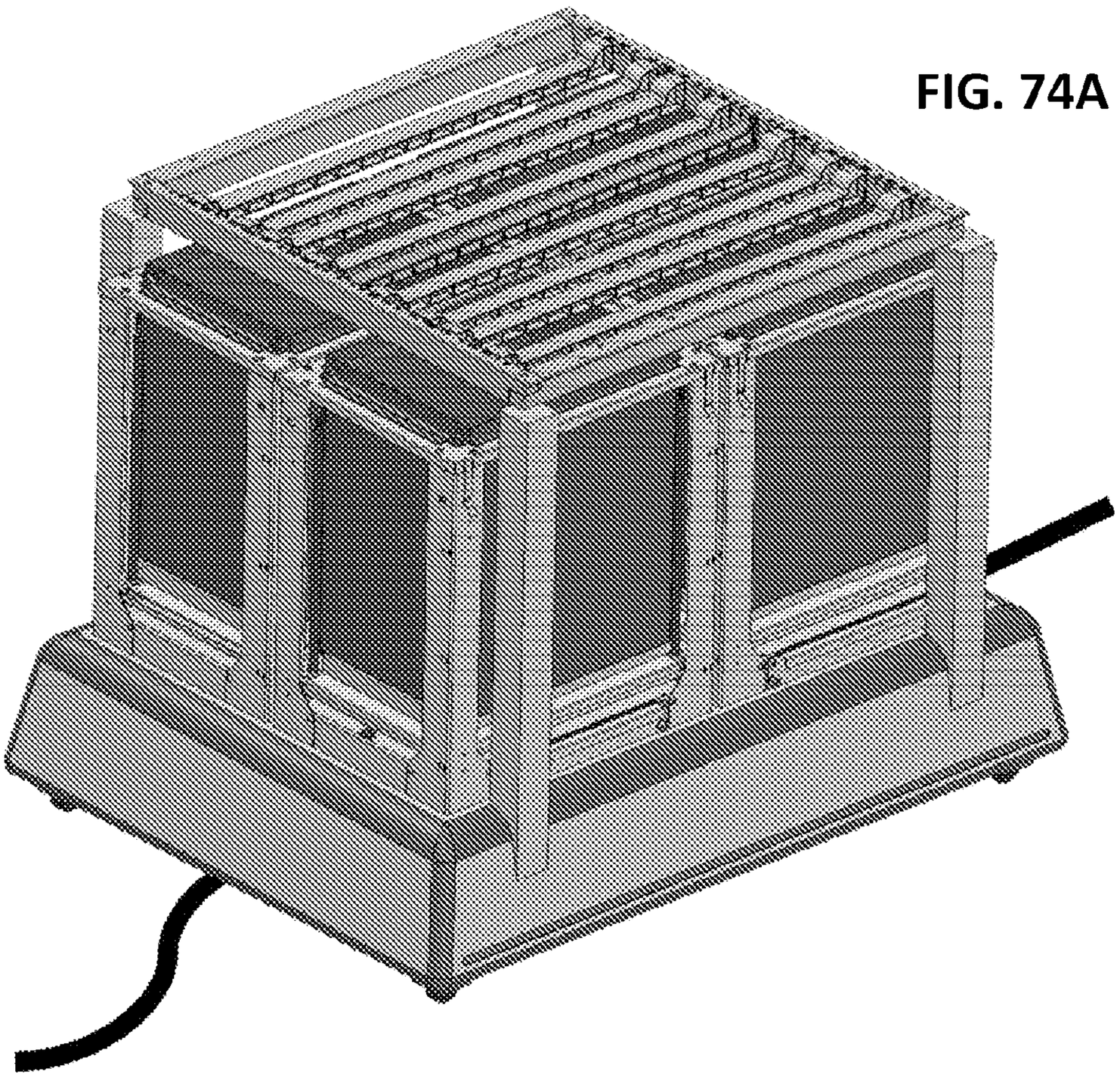


FIG. 74A

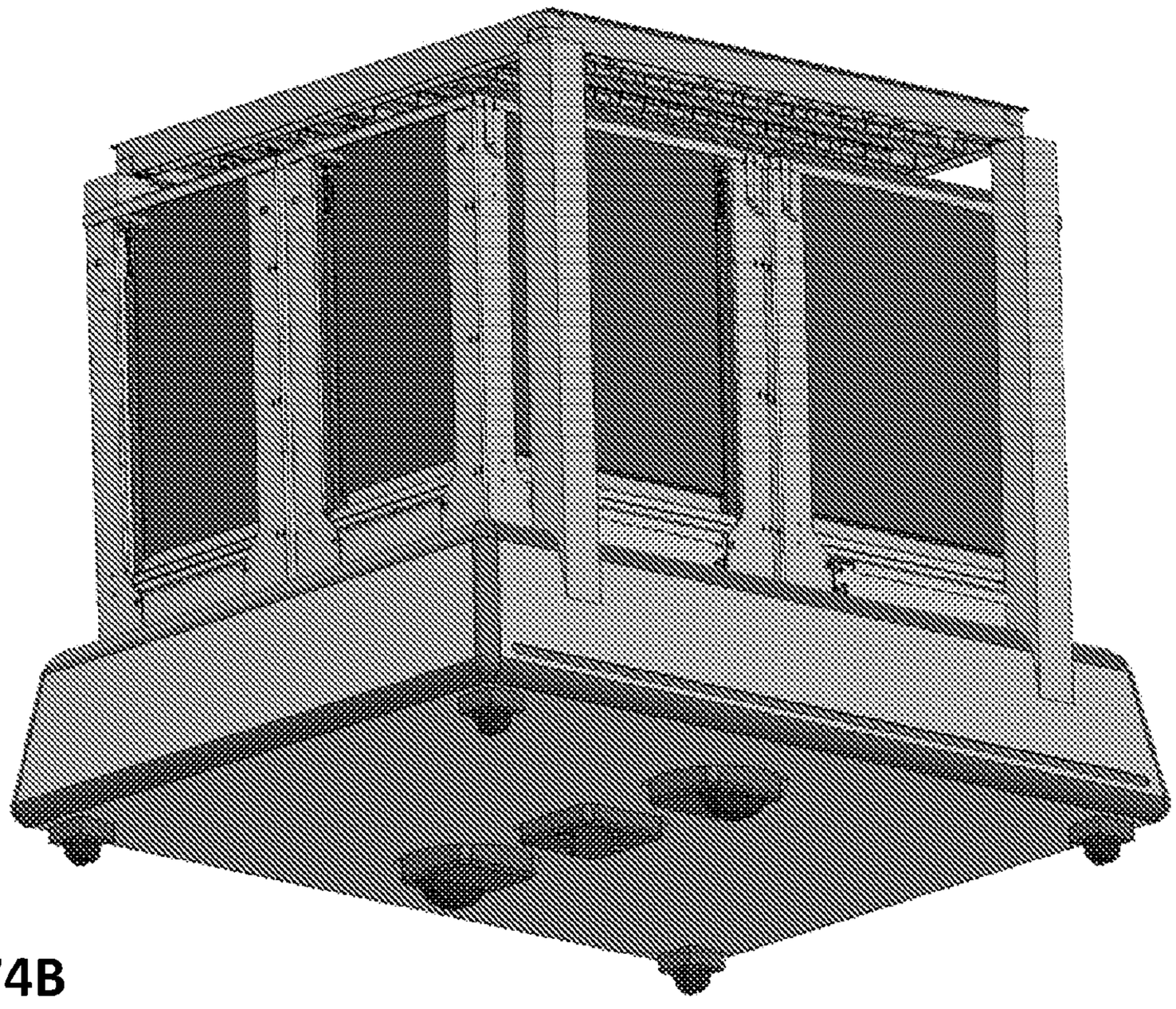


FIG. 74B

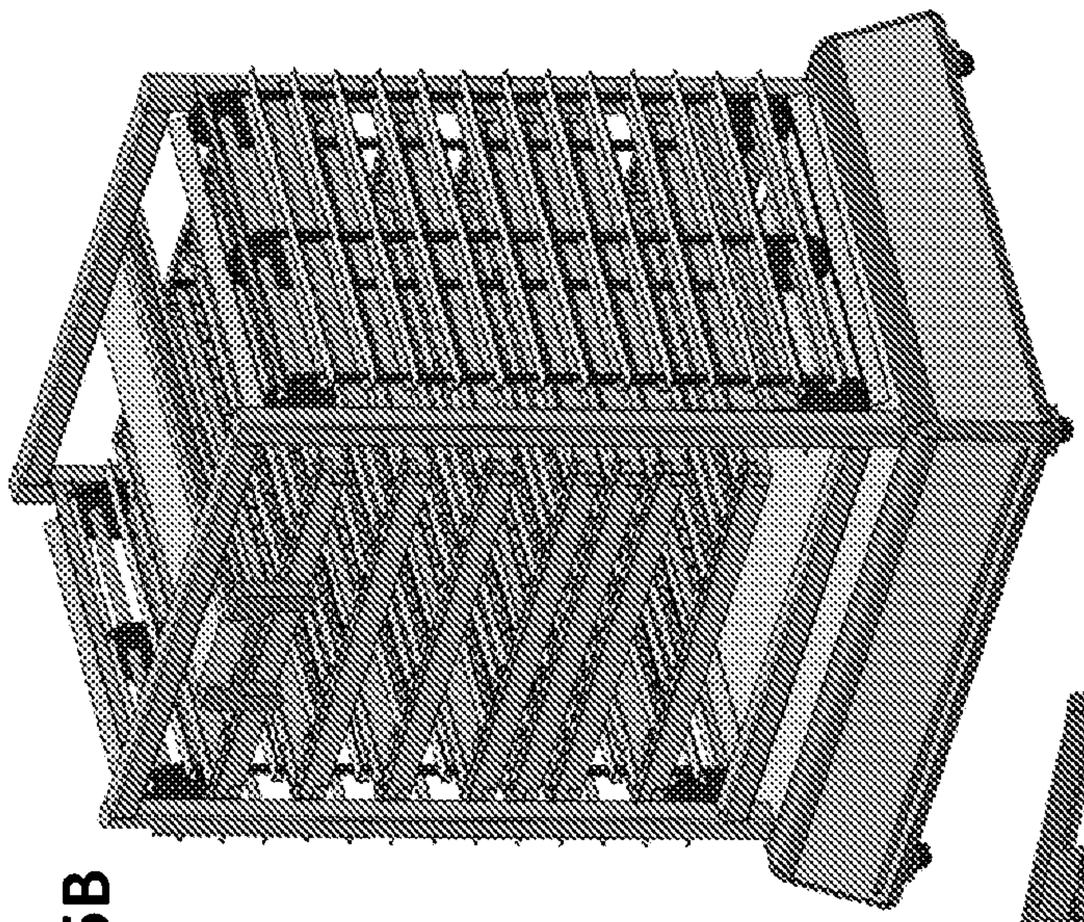


FIG. 75B

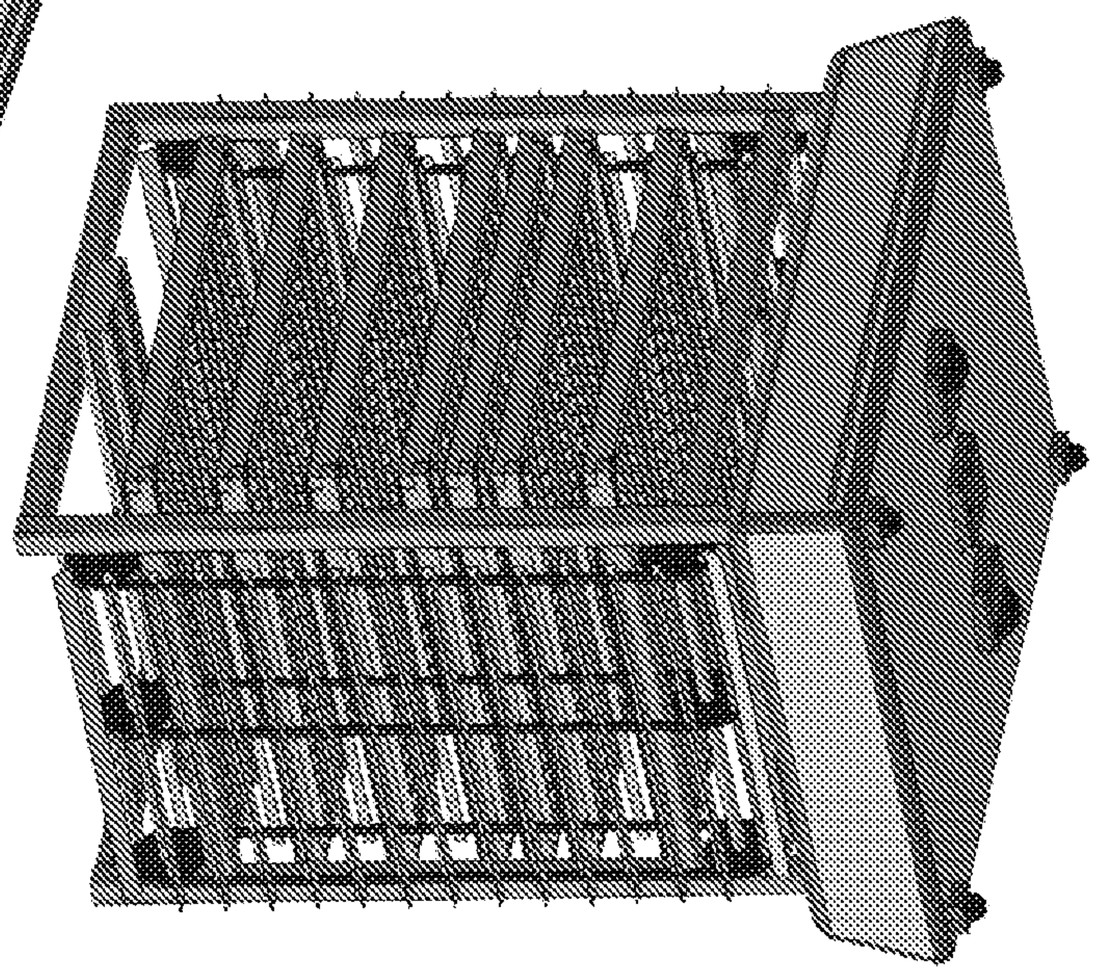


FIG. 75C

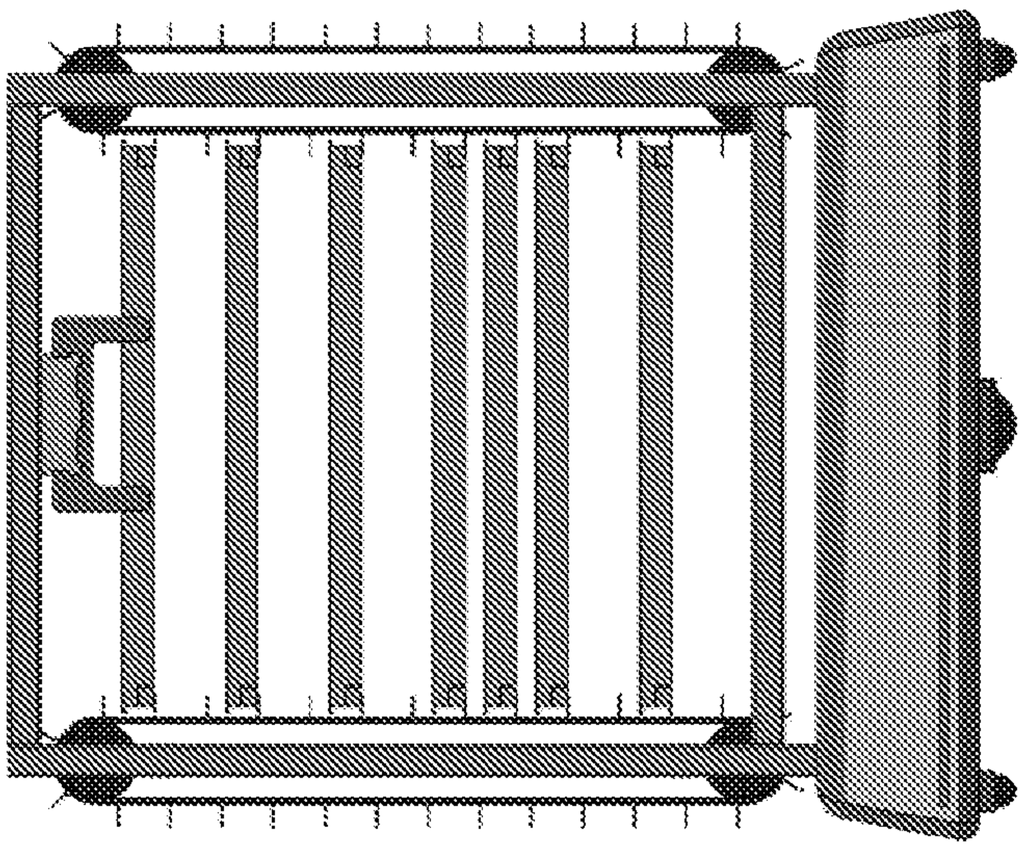
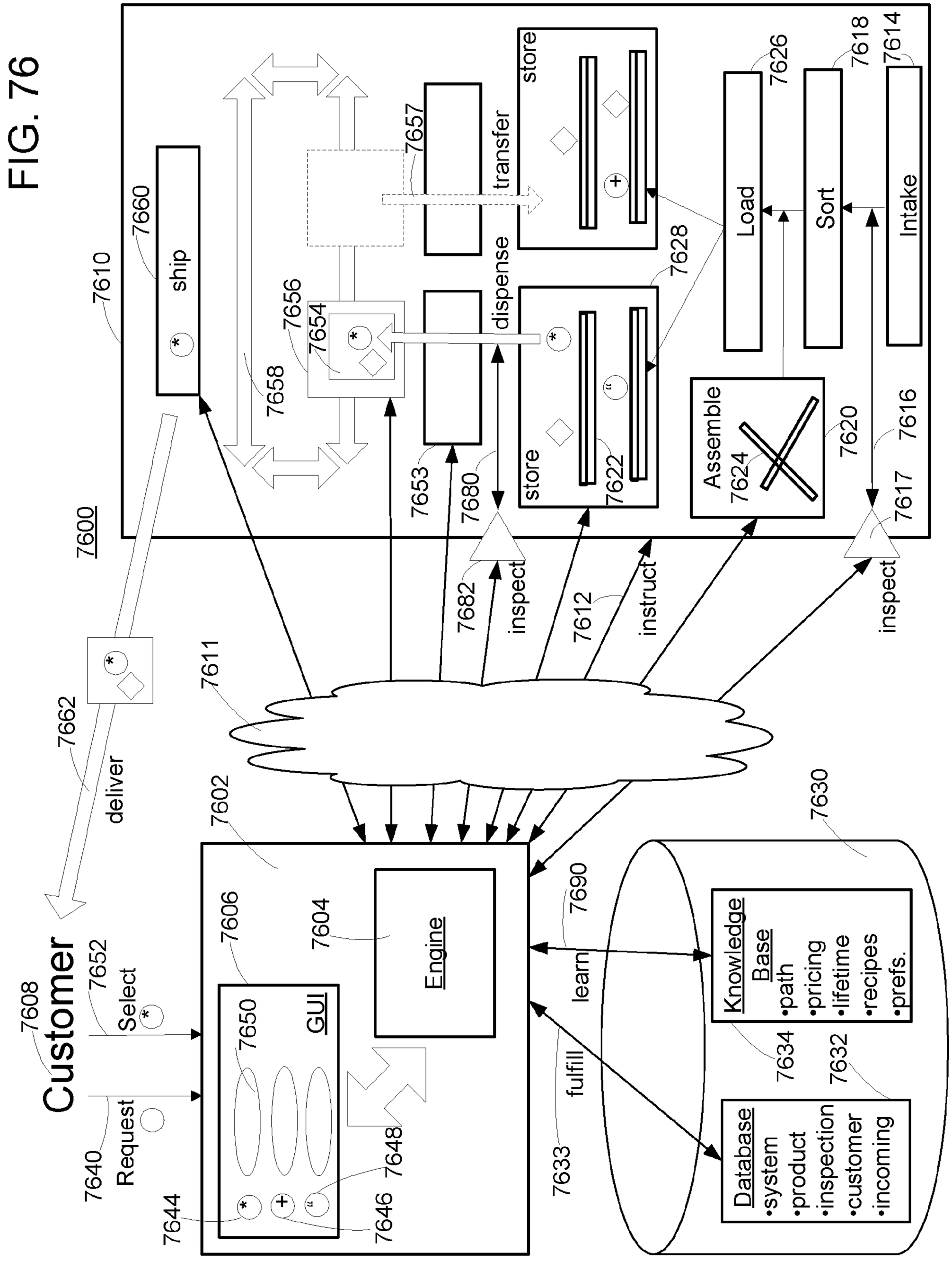


FIG. 75A

FIG. 76


7600
7610
7660
ship
7657
transfer
store
7626
Load
7618
Sort
7614
Intake
7656
7654
7658
dispense
7628
7653
7680
store
7622
Assemble
7624
7620
7616
7617
7682
inspect
7612
instruct
inspect
7611
7662
deliver
7602
7630
7608
Customer
7652
Select
7606
7604
Engine
7690
learn
7650
GUI
Knowledge Base
•path
•pricing
•lifetime
•recipes
•prefs.
7634
7632
fulfill
7640
Request
7644
7646
7648
7633
Database
•system
•product
•inspection
•customer
•incoming

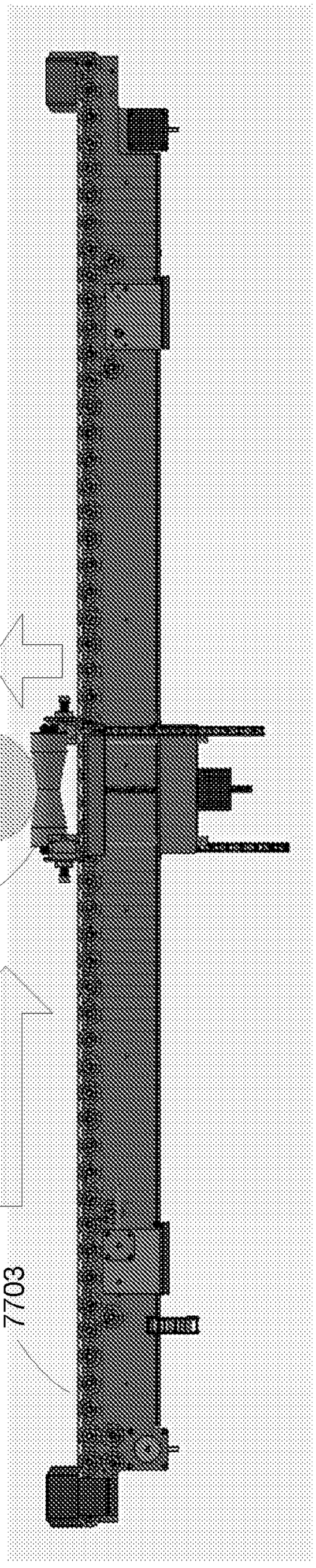


FIG. 77A

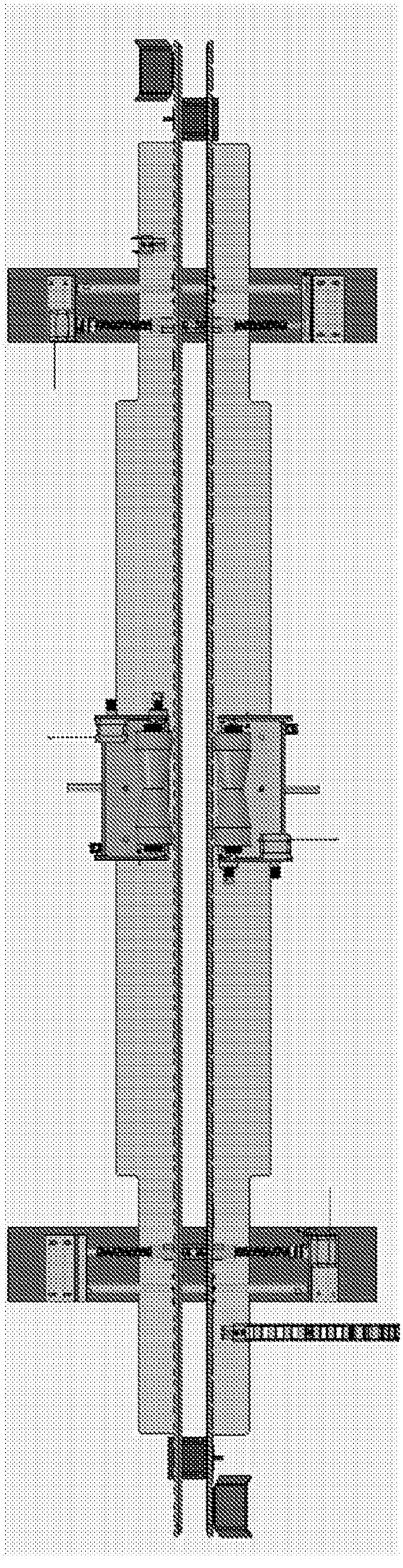


FIG. 77B

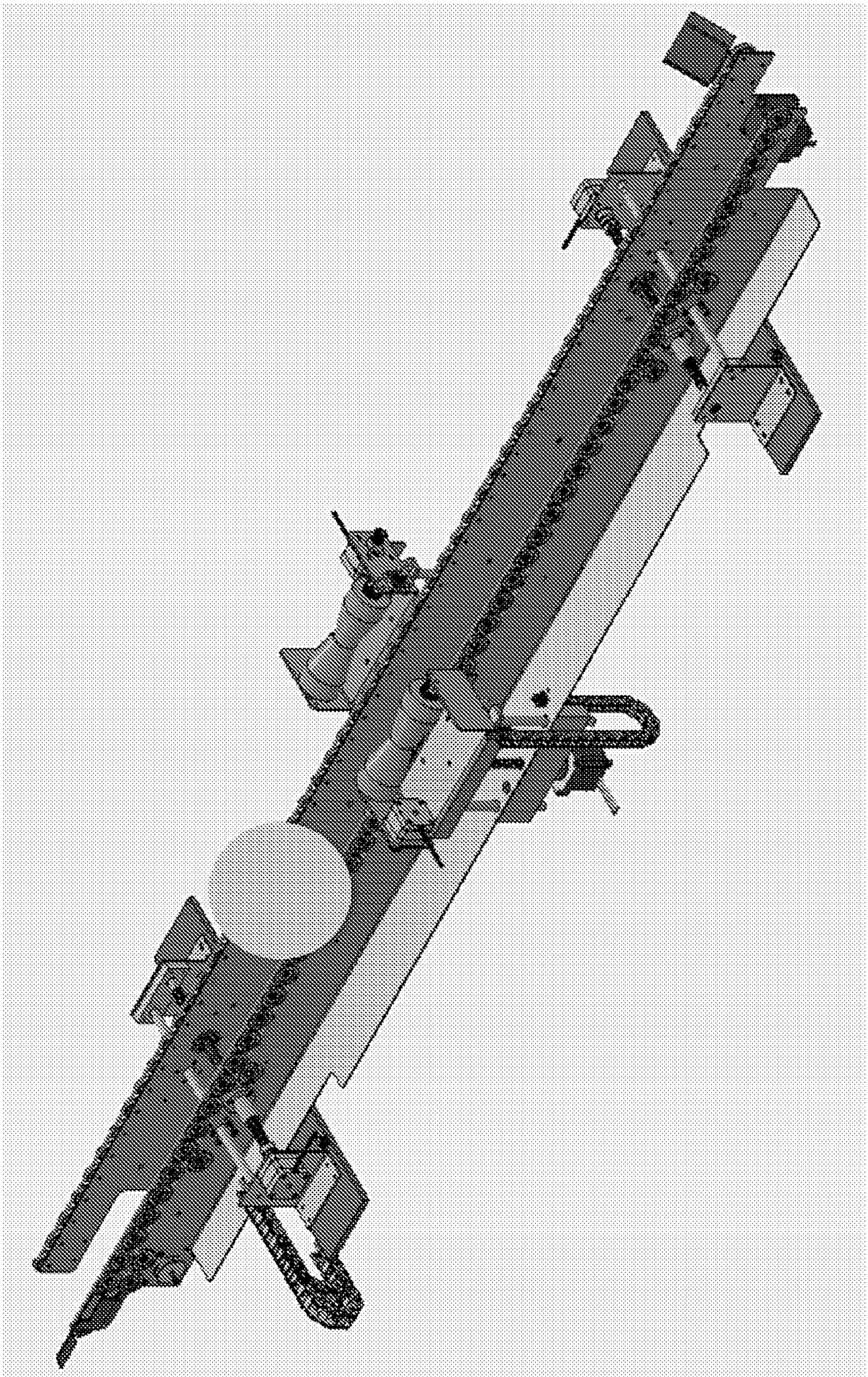


FIG. 77C

FIG. 77D

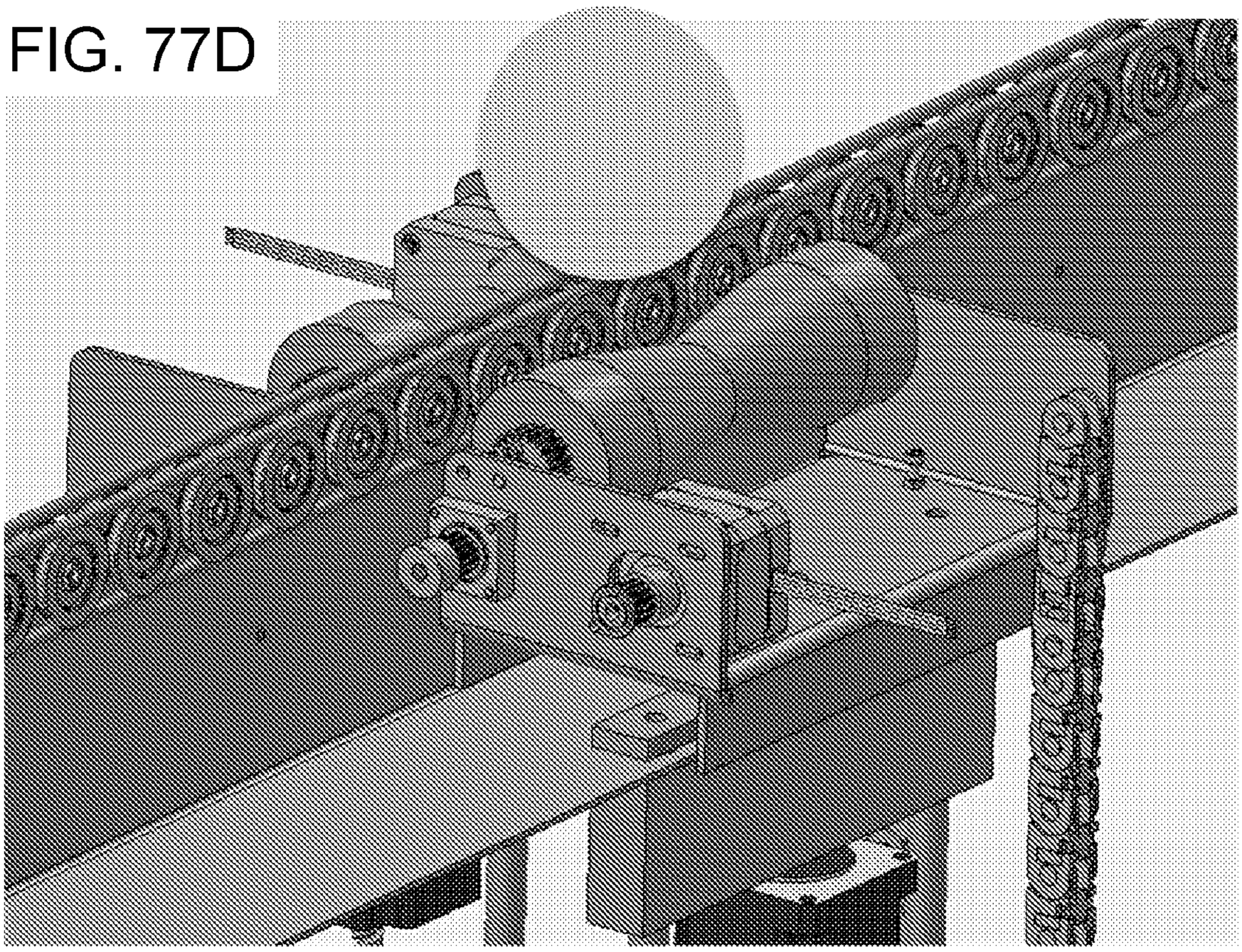
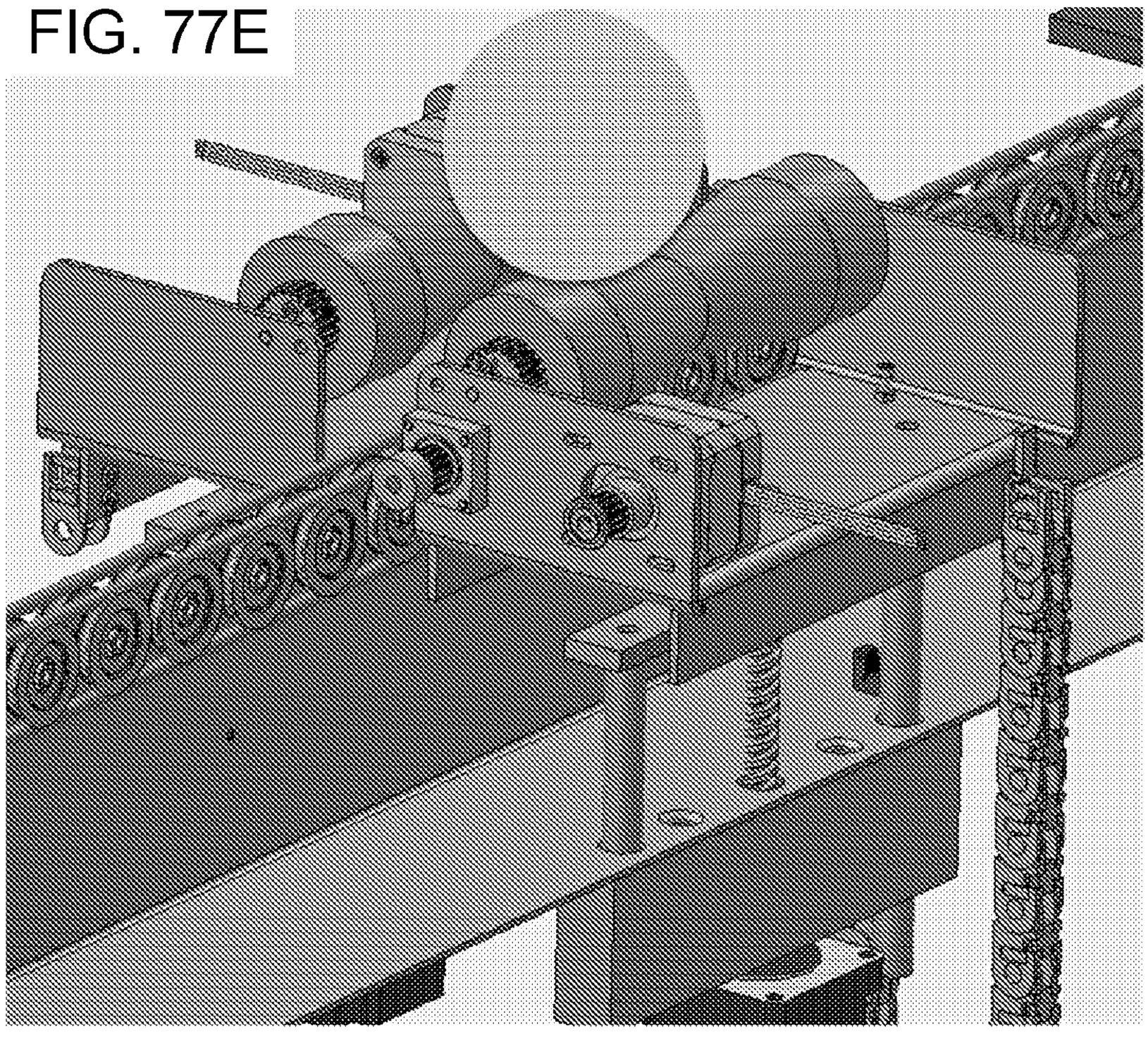


FIG. 77E



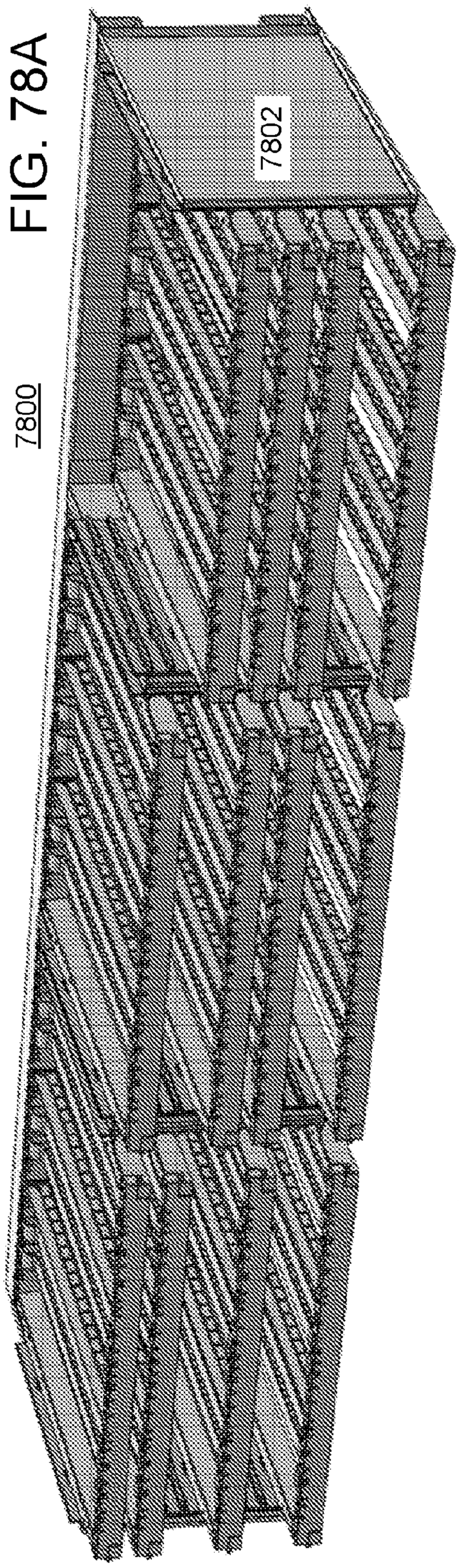


FIG. 78A

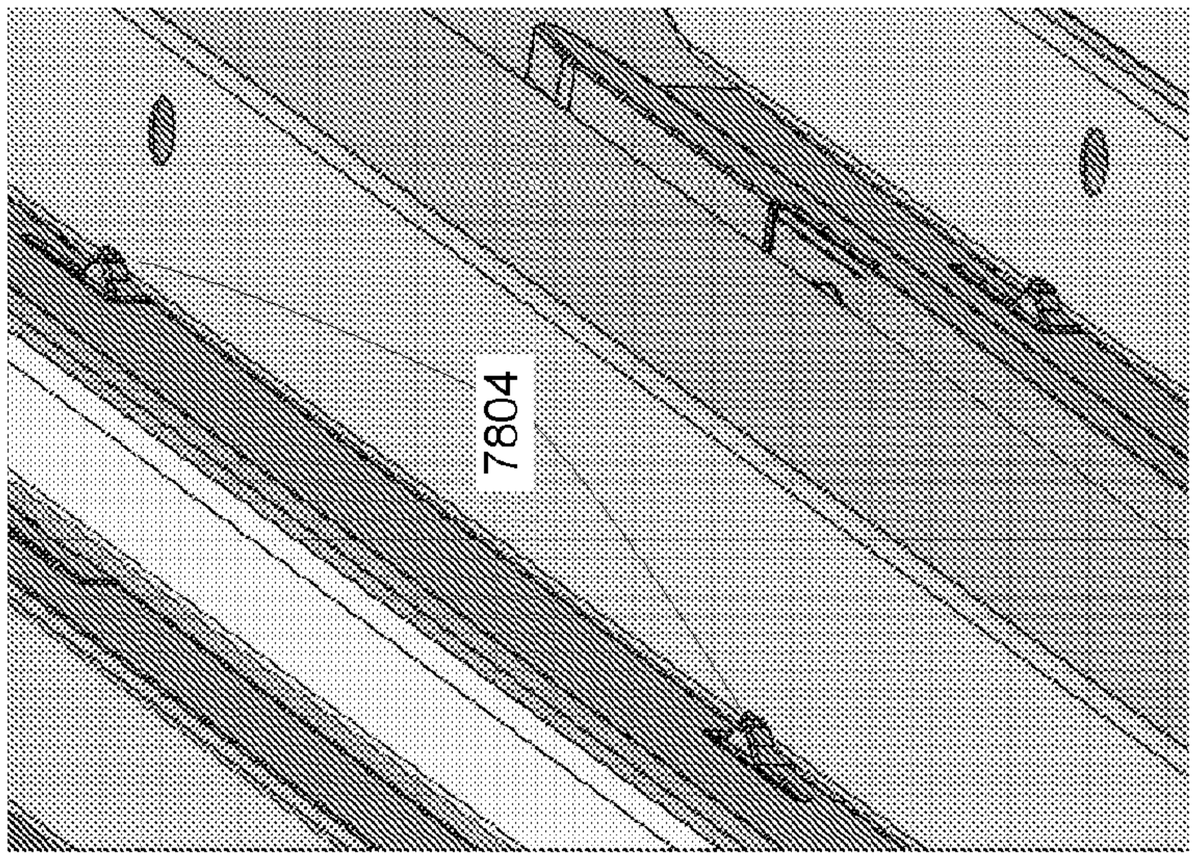


FIG. 78C

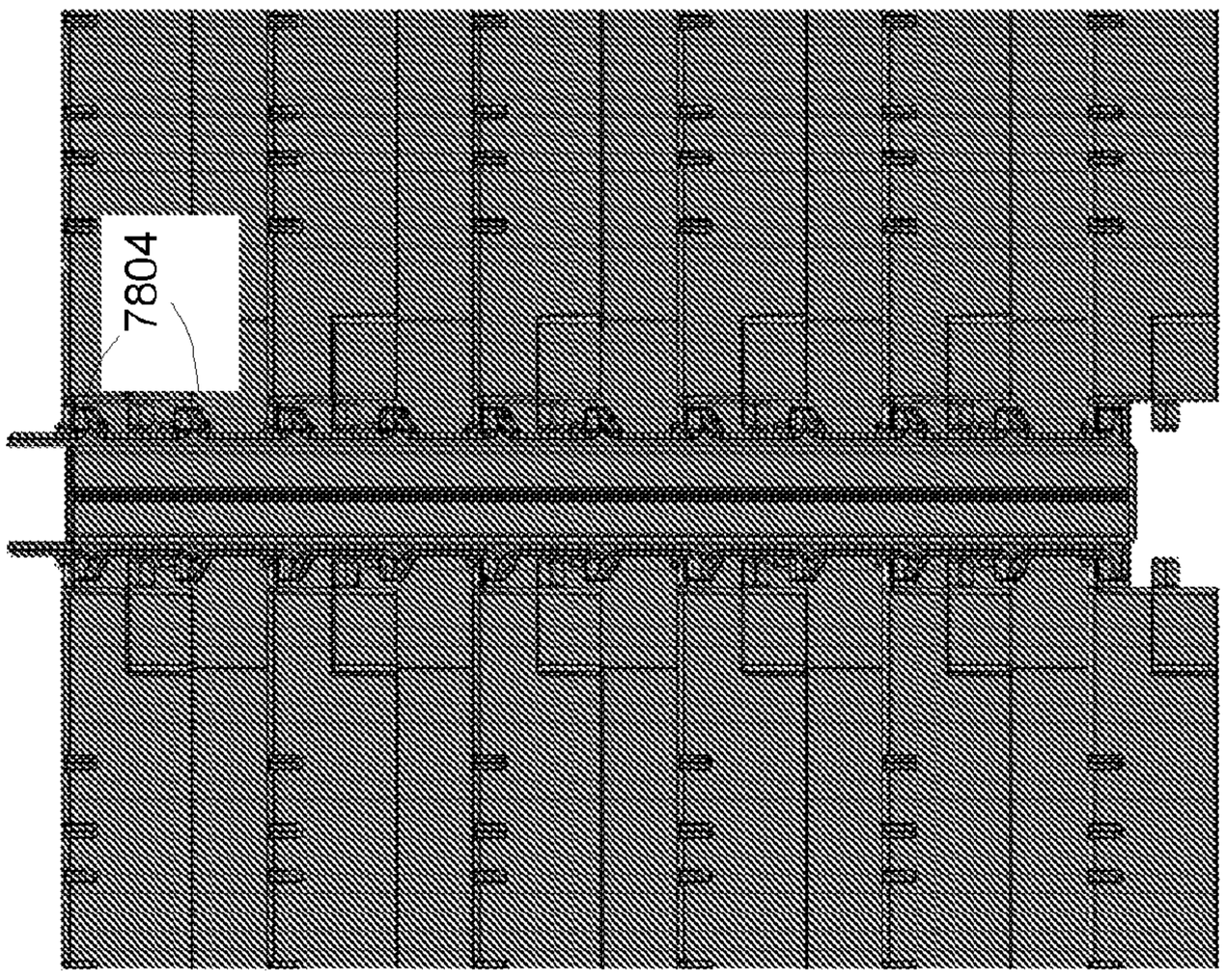


FIG. 78B

FIG. 79A

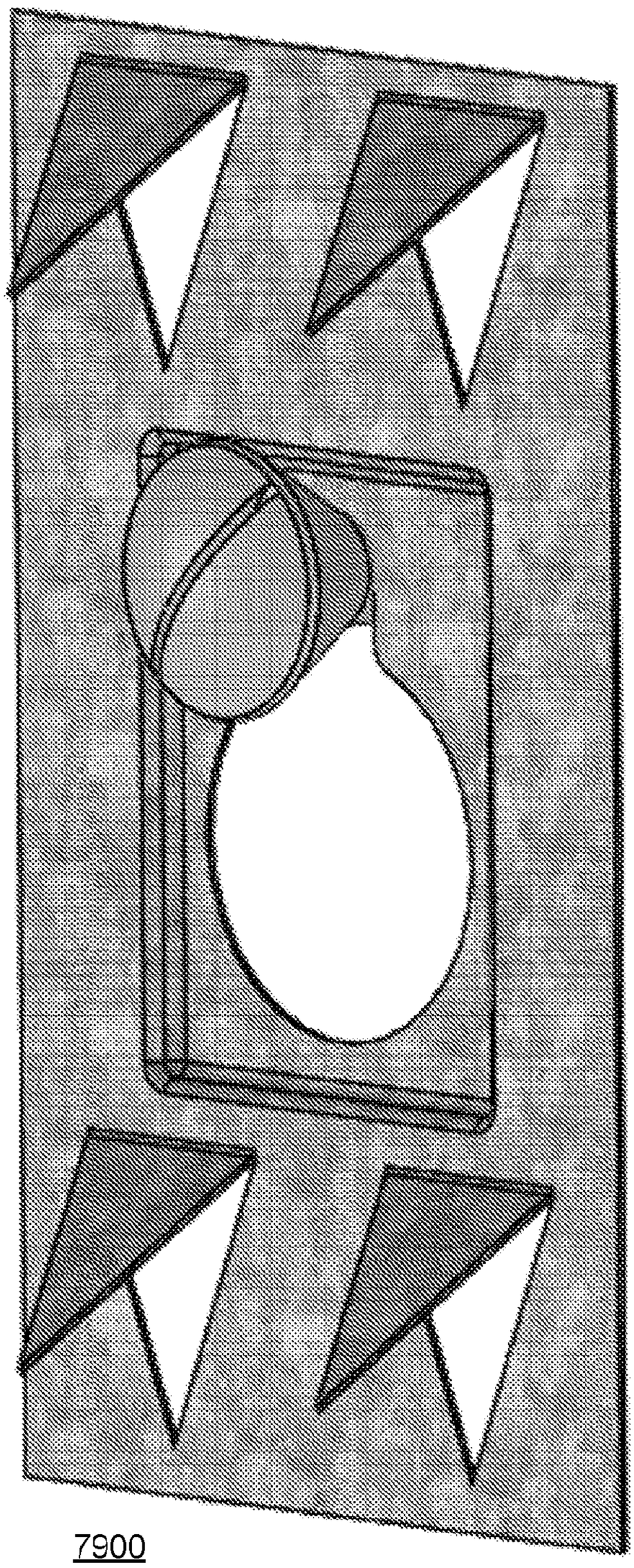
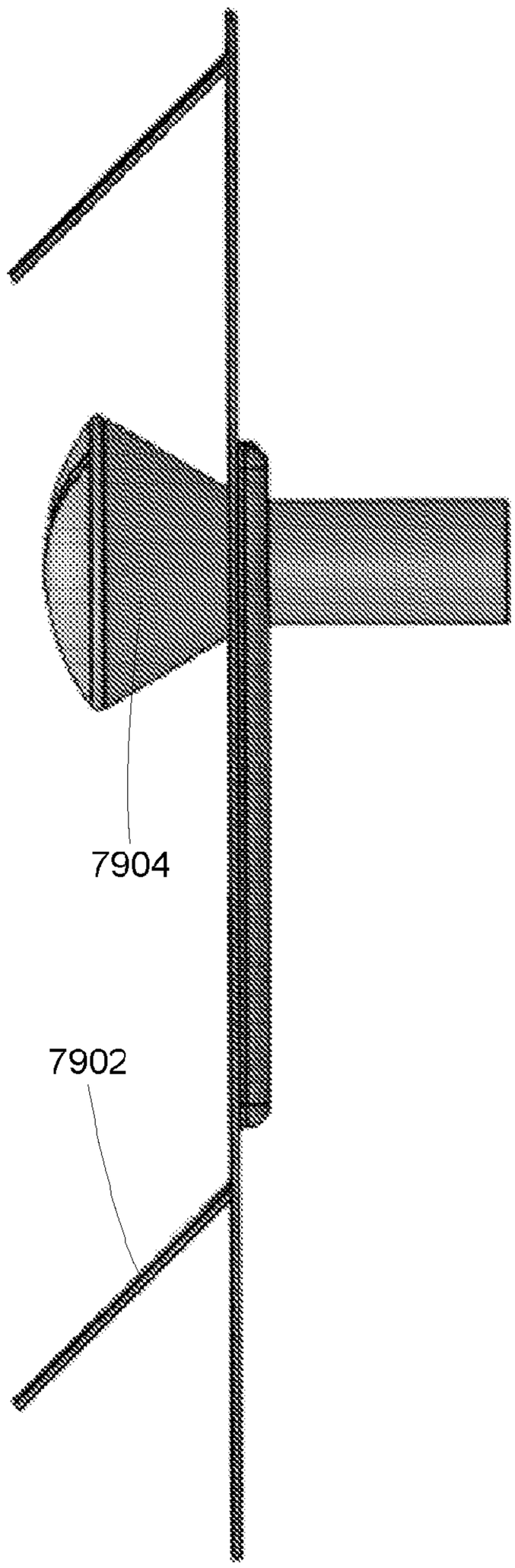


FIG. 79B



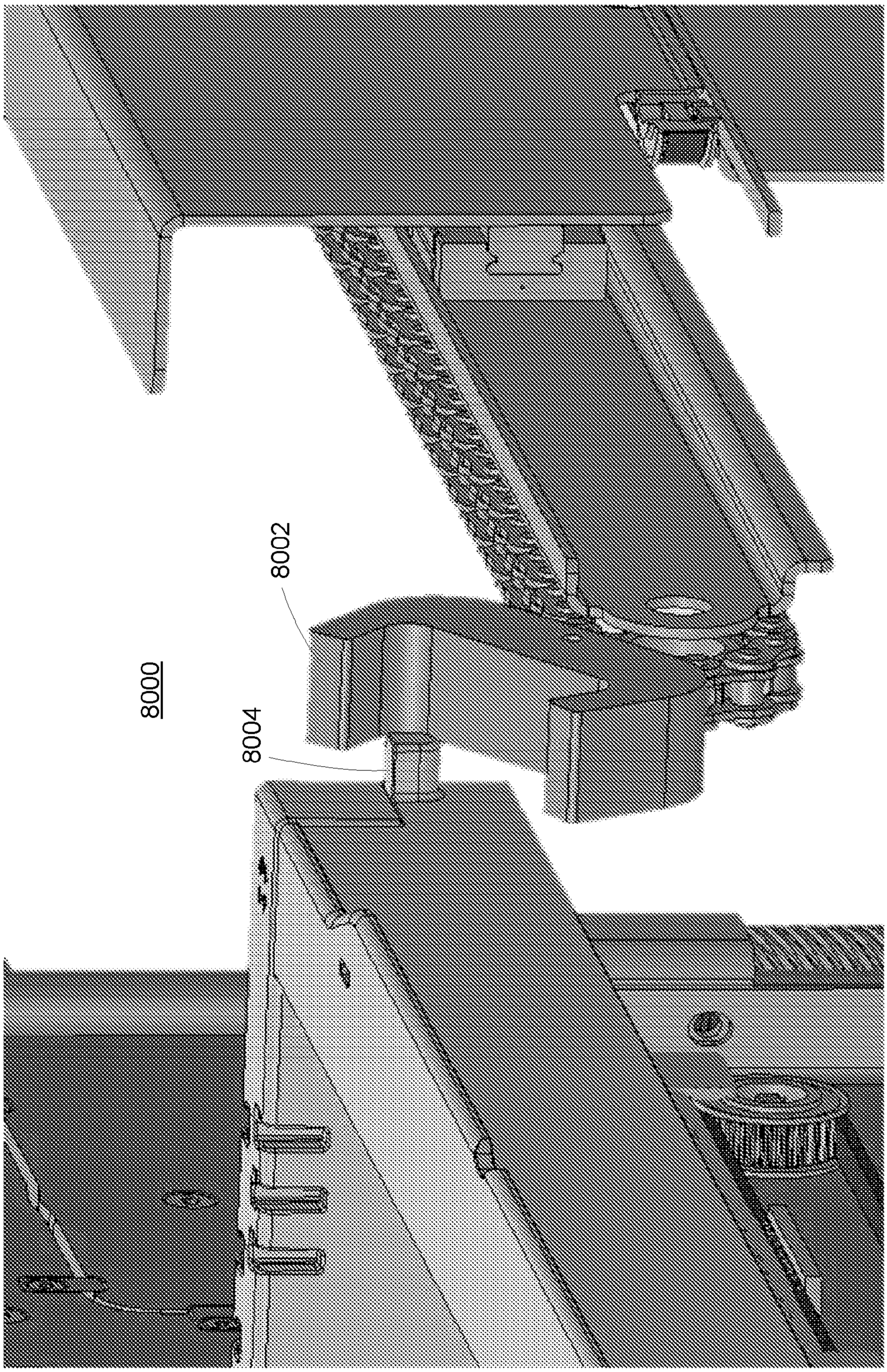


FIG. 80A

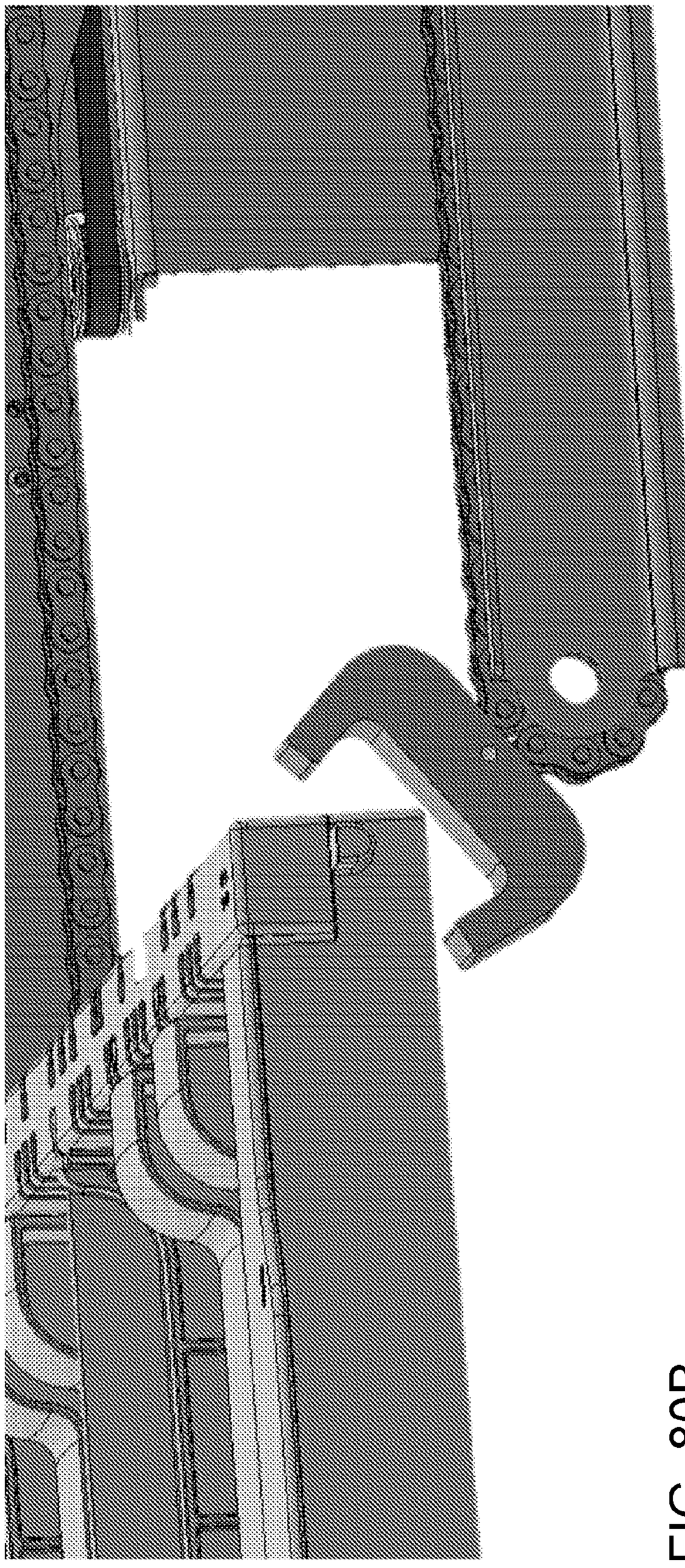


FIG. 80B

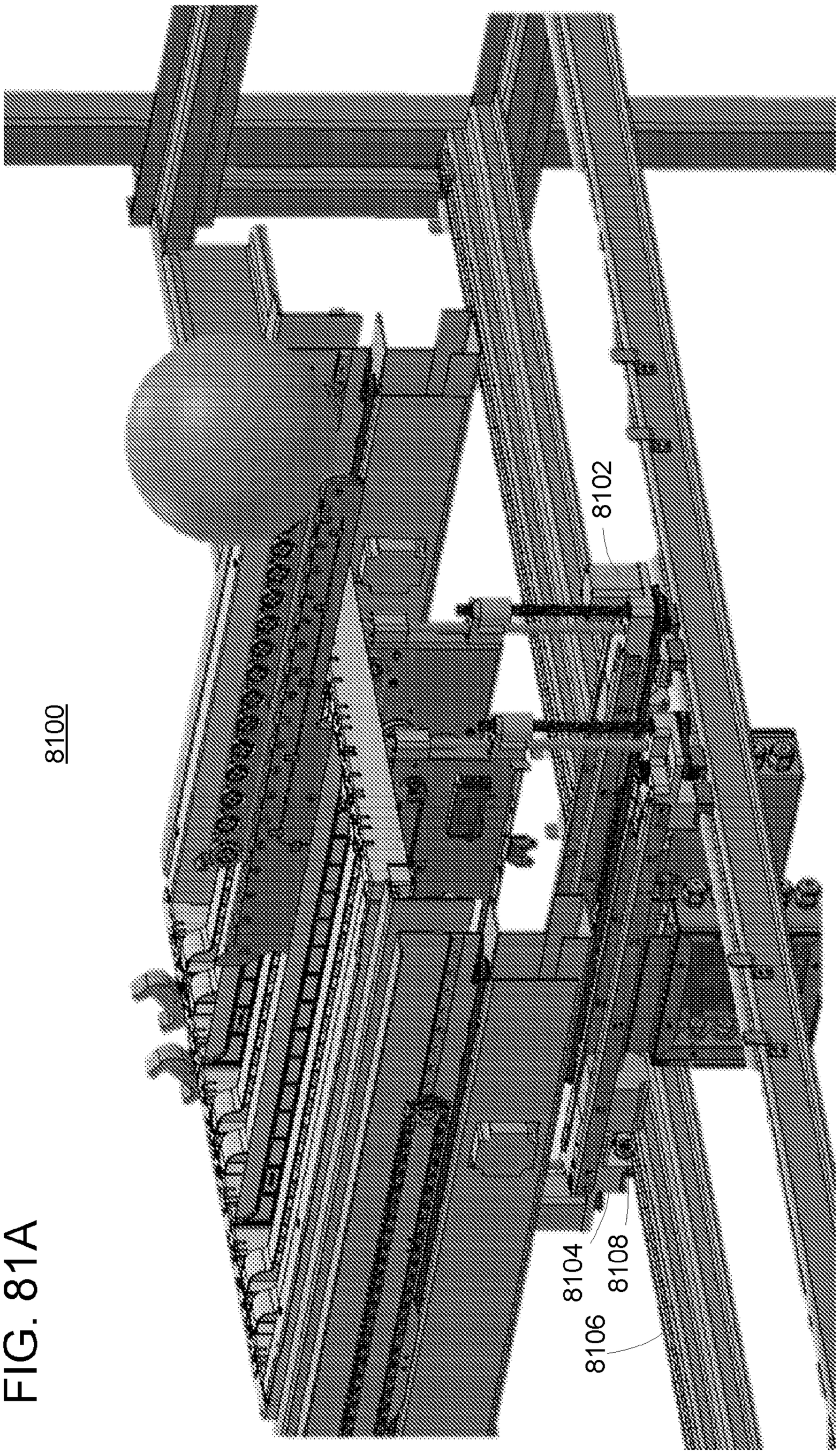


FIG. 81A

FIG. 81B

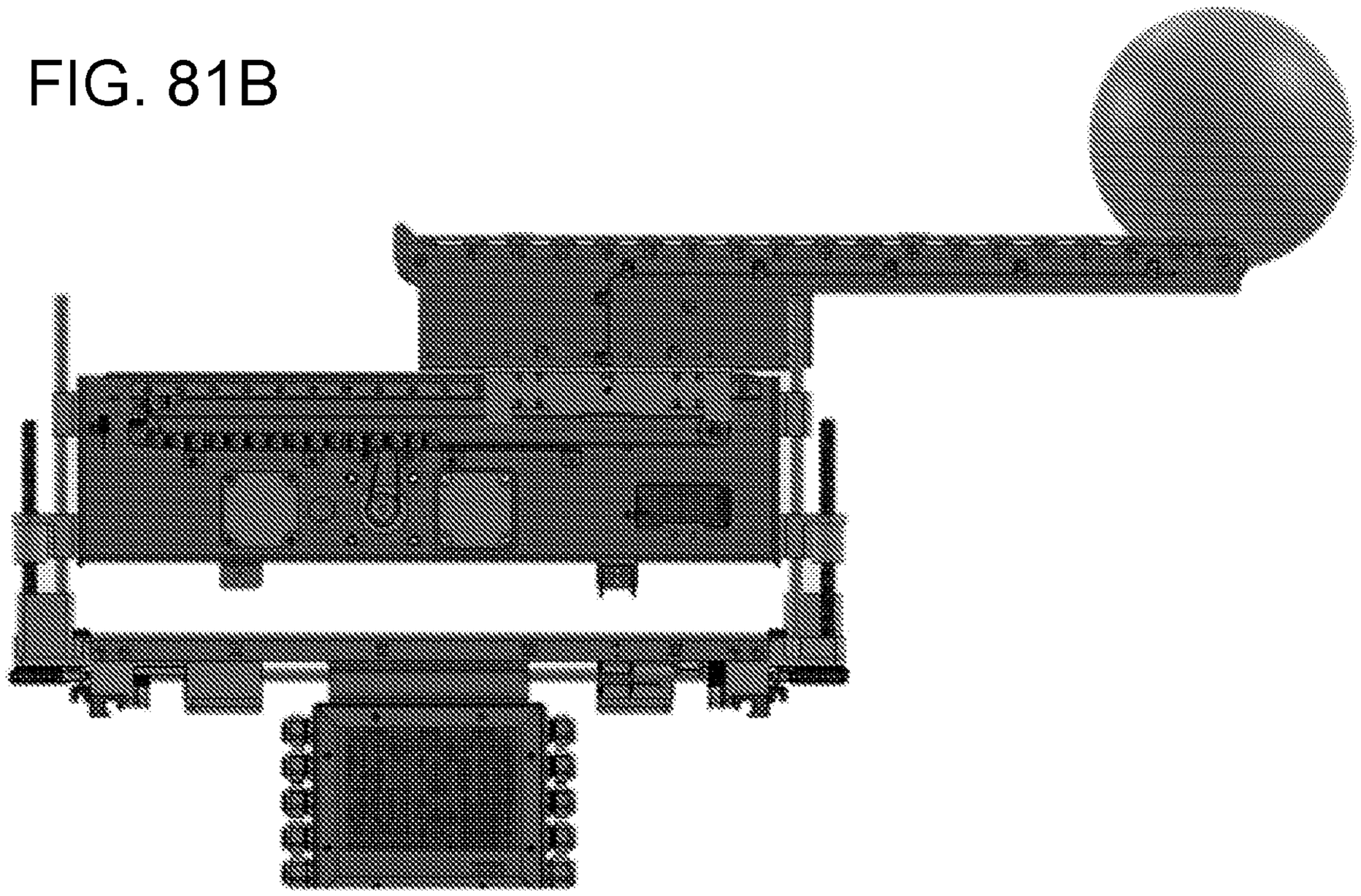
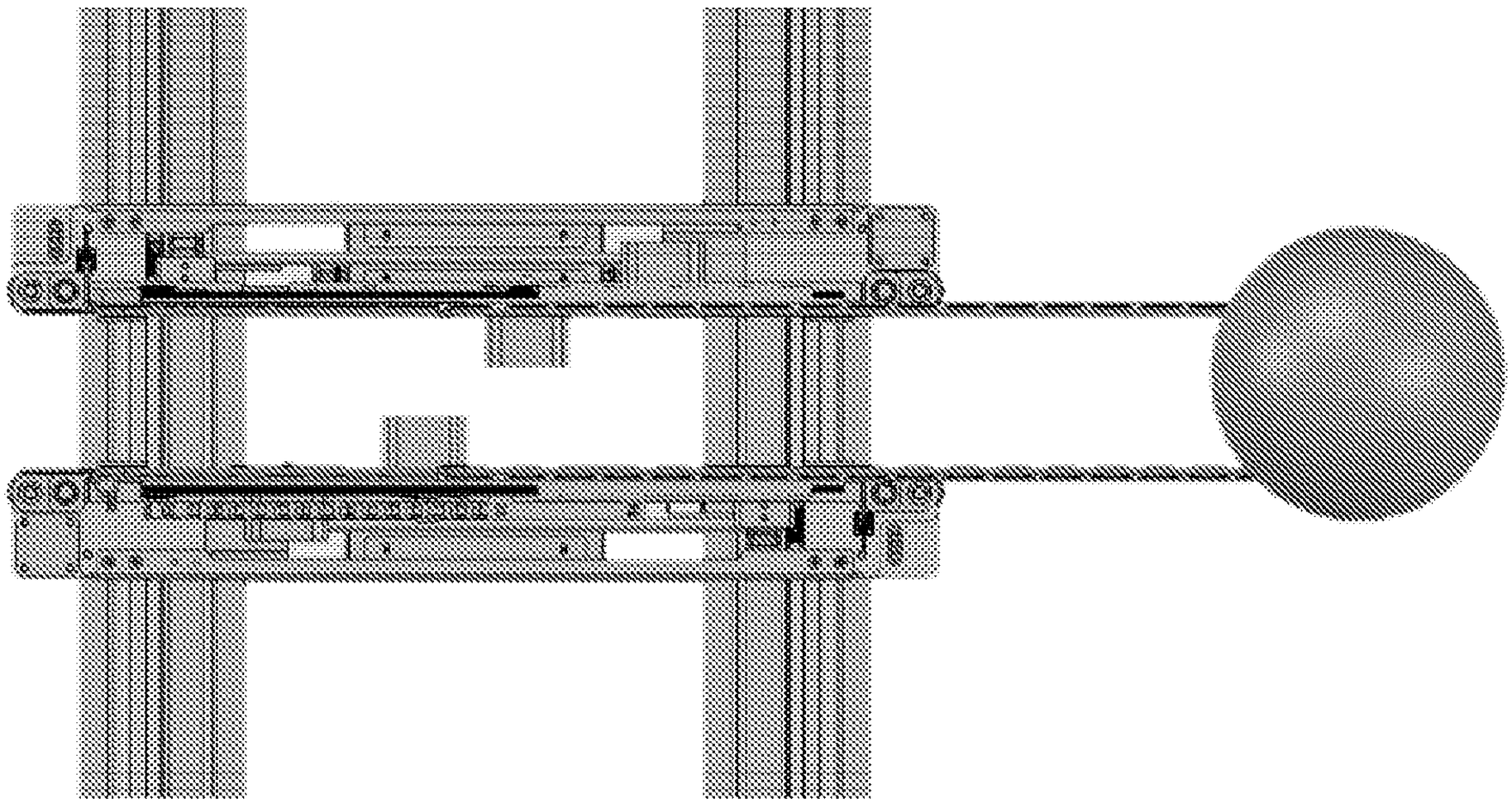


FIG. 81C



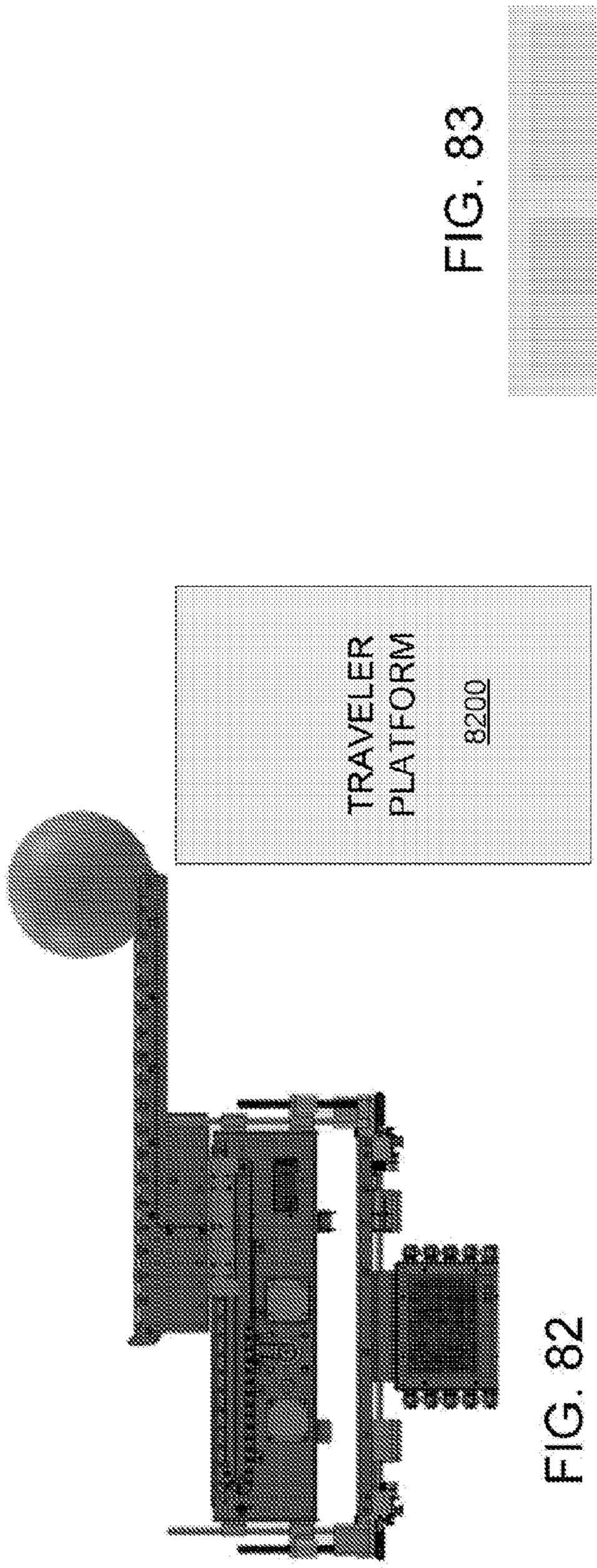


FIG. 82

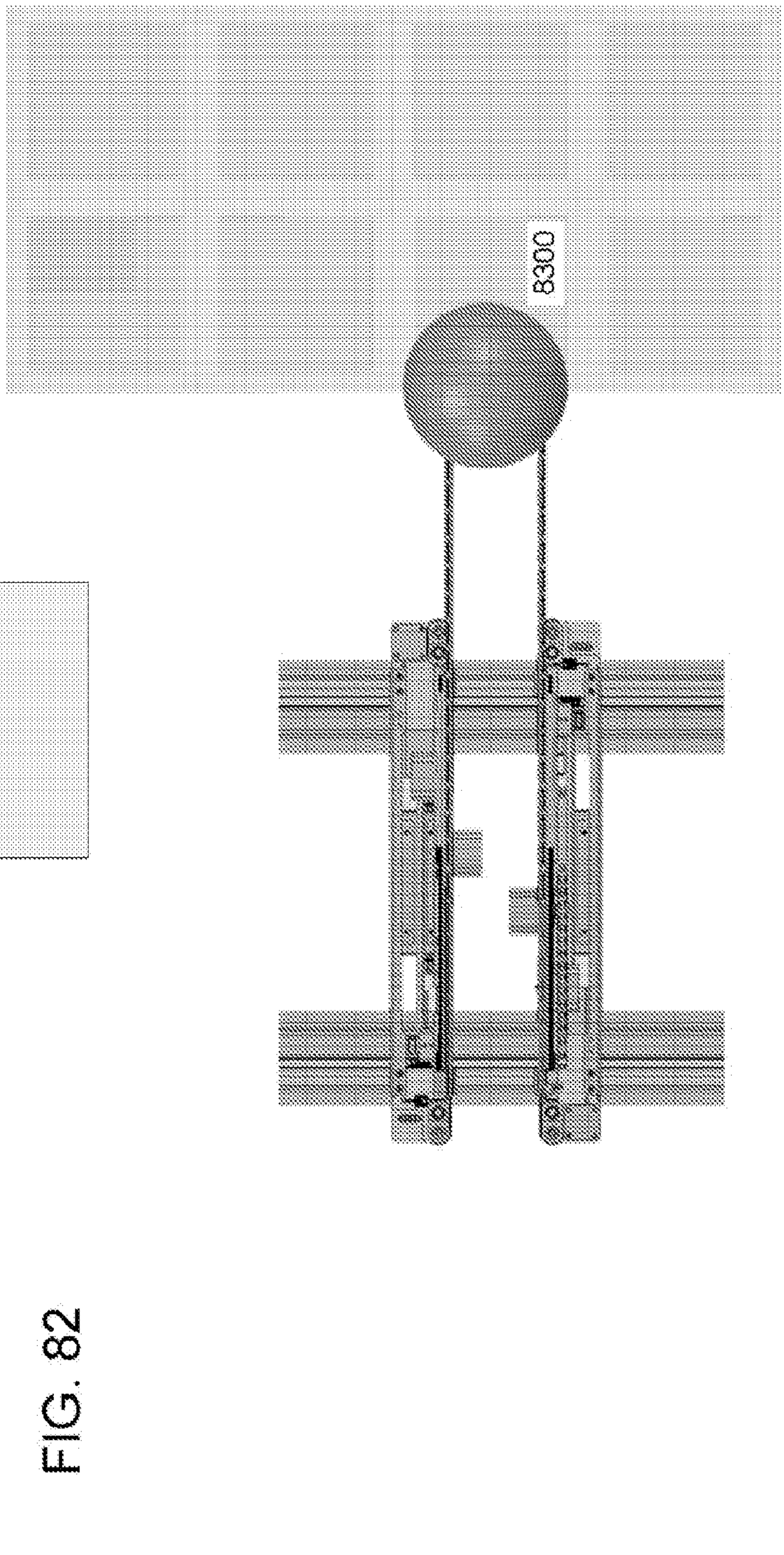


FIG. 83