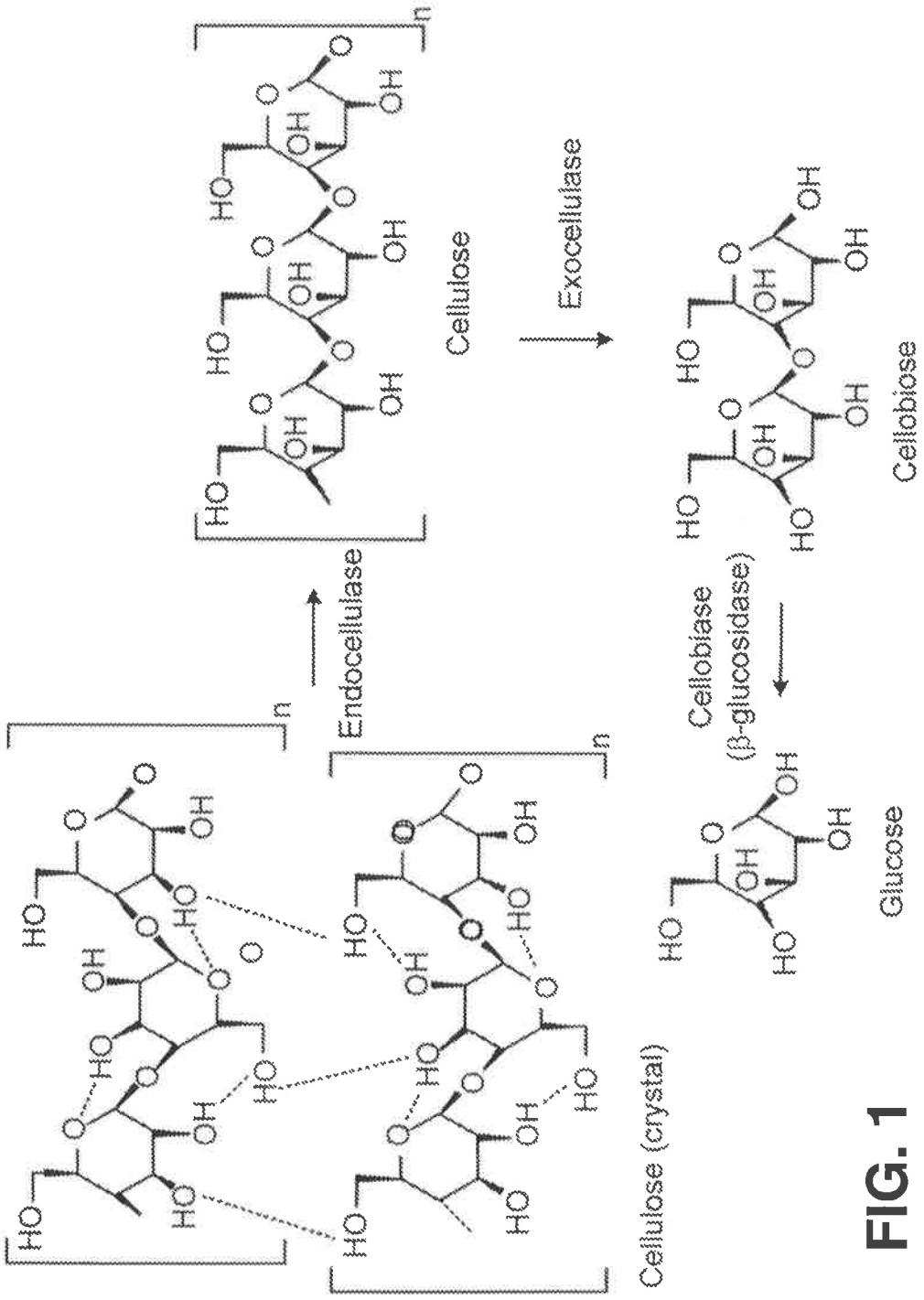

Endocellulase
Cellulose
Exocellulase
Cellobiase
(β-glucosidase)
Cellobiose
Glucose
Cellulose (crystal)

FIG. 1

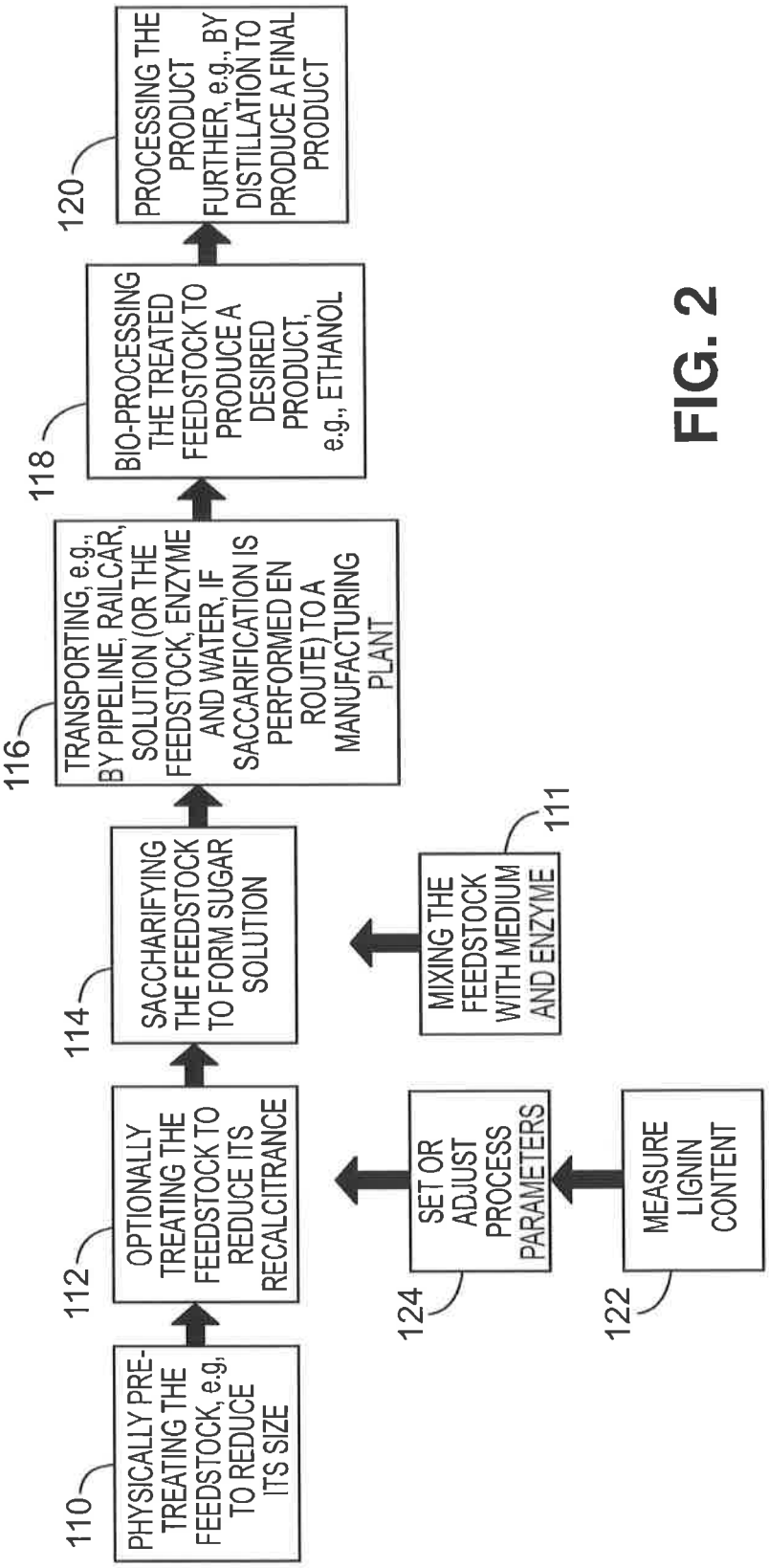

110
PHYSICALLY PRE-TREATING THE FEEDSTOCK, e.g, TO REDUCE ITS SIZE
112
OPTIONALLY TREATING THE FEEDSTOCK TO REDUCE ITS RECALCITRANCE
114
SACCHARIFYING THE FEEDSTOCK TO FORM SUGAR SOLUTION
116
TRANSPORTING, e.g., BY PIPELINE, RAILCAR, SOLUTION (OR THE FEEDSTOCK, ENZYME AND WATER, IF SACCARIFICATION IS PERFORMED EN ROUTE) TO A MANUFACTURING PLANT
118
BIO-PROCESSING THE TREATED FEEDSTOCK TO PRODUCE A DESIRED PRODUCT, e.g., ETHANOL
120
PROCESSING THE PRODUCT FURTHER, e.g., BY DISTILLATION TO PRODUCE A FINAL PRODUCT
111
MIXING THE FEEDSTOCK WITH MEDIUM AND ENZYME
124
SET OR ADJUST PROCESS PARAMETERS
122
MEASURE LIGNIN CONTENT

FIG. 2

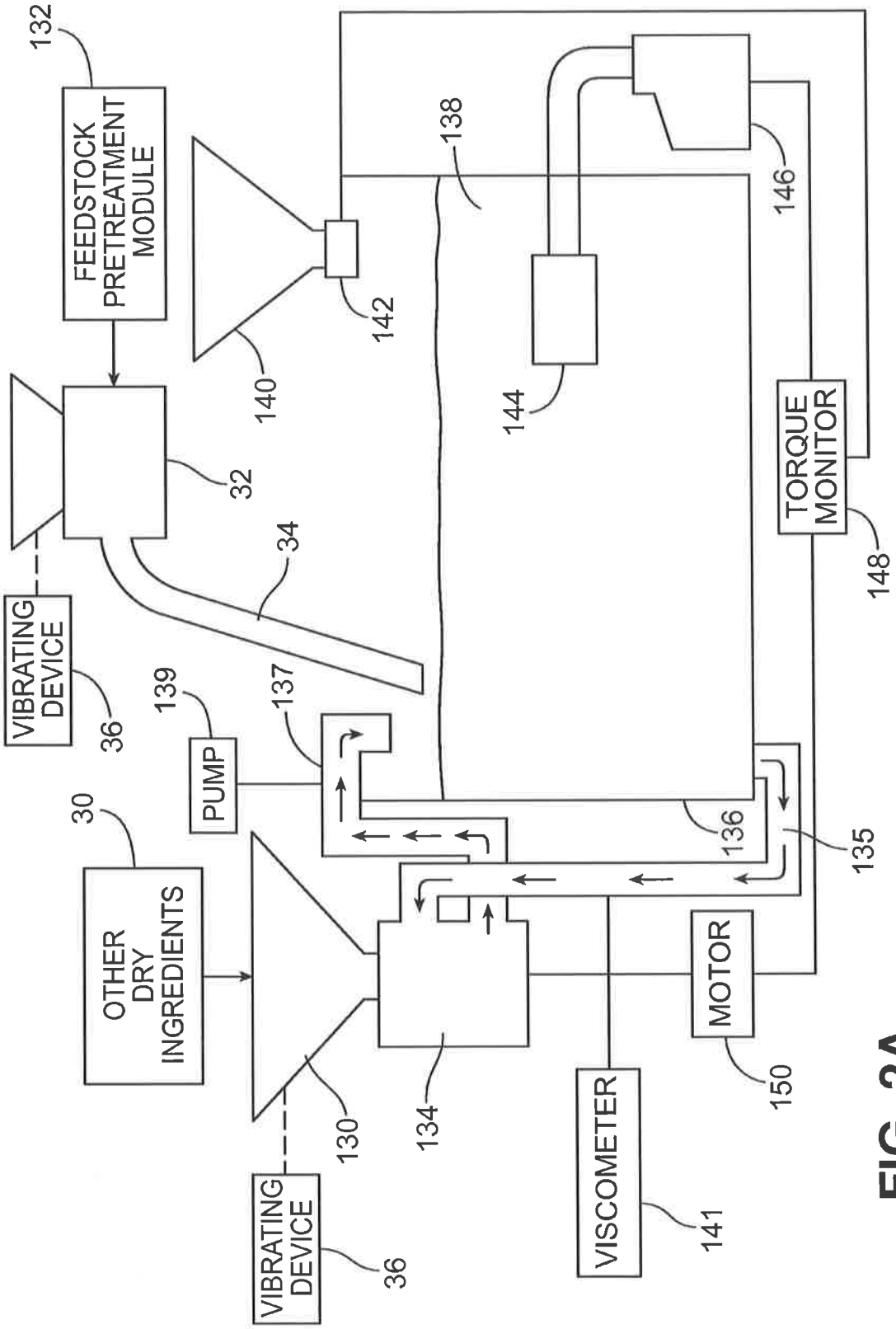

132
FEEDSTOCK PRETREATMENT MODULE
138
146
142
140
144
32
34
TORQUE MONITOR
148
VIBRATING DEVICE
36
139
PUMP
137
30
OTHER DRY INGREDIENTS
136
135
MOTOR
130
134
150
VISCOMETER
141
VIBRATING DEVICE
36

FIG. 2A

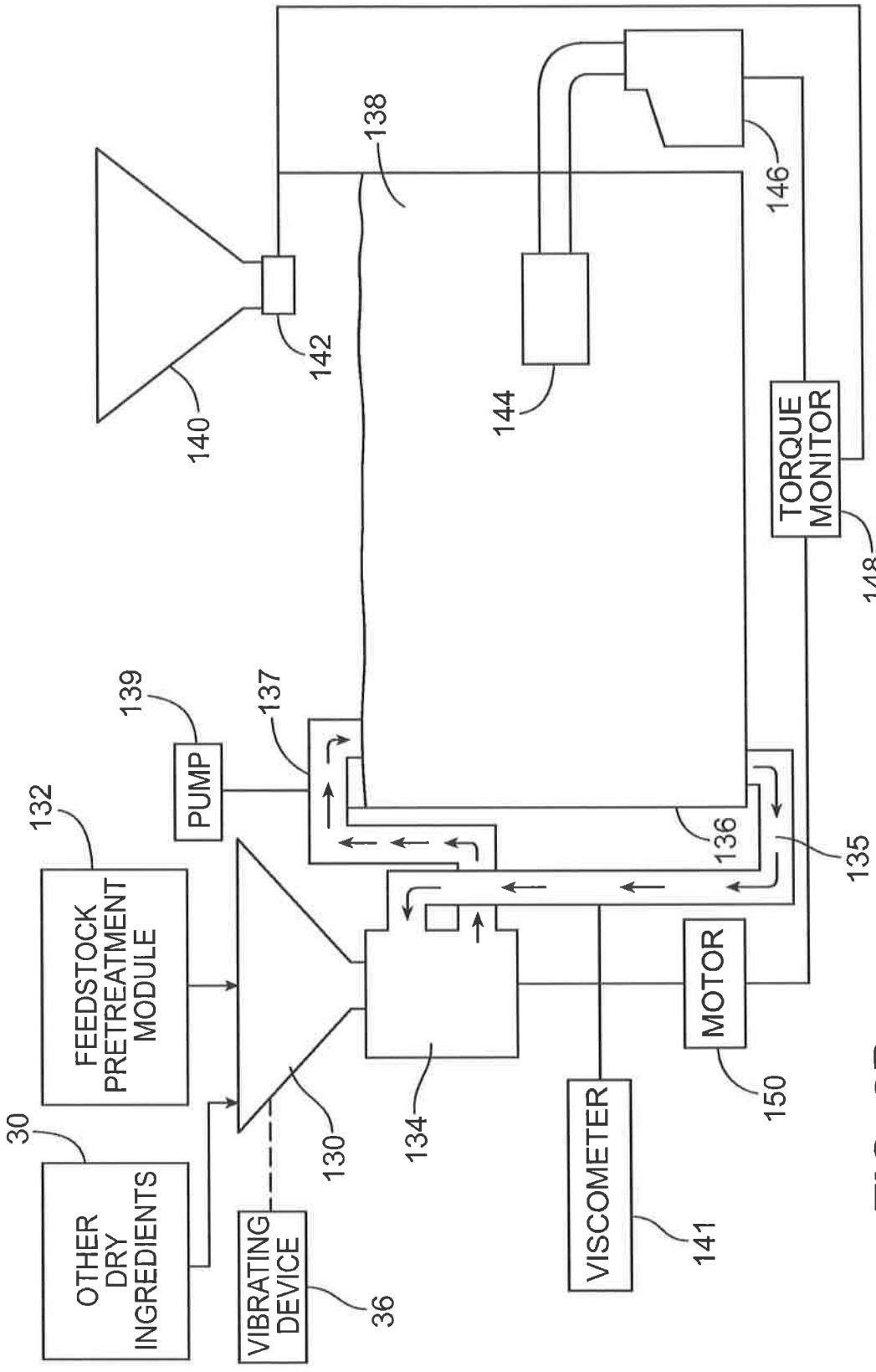

30
OTHER DRY INGREDIENTS
132
FEEDSTOCK PRETREATMENT MODULE
VIBRATING DEVICE
36
130
134
VISCOMETER
141
MOTOR
150
135
136
139
PUMP
137
138
140
142
144
146
TORQUE MONITOR
148

FIG. 2B

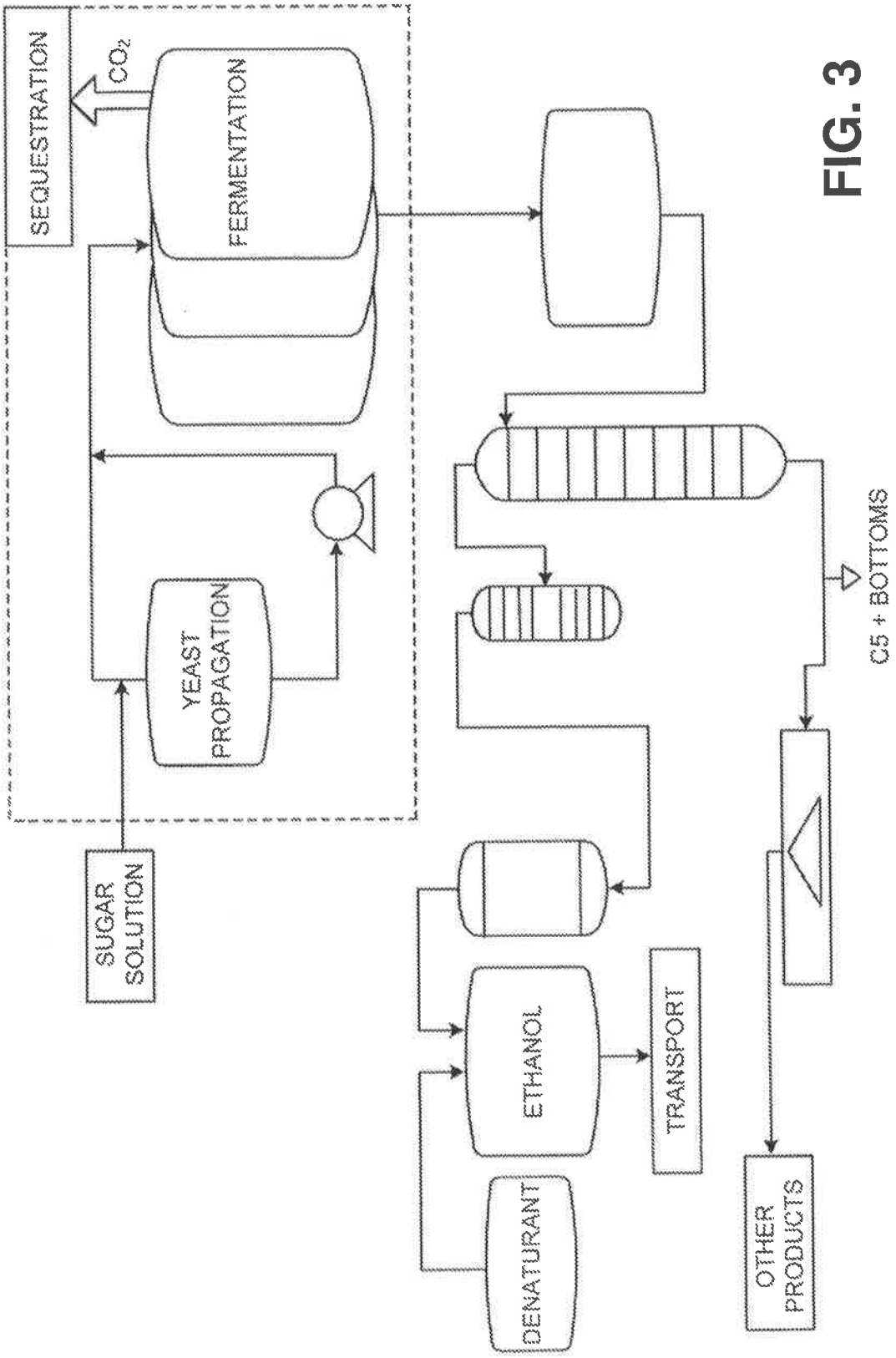

SEQUESTRATION
CO_2
FERMENTATION
YEAST PROPAGATION
SUGAR SOLUTION
C5 + BOTTOMS
ETHANOL
TRANSPORT
DENATURANT
OTHER PRODUCTS

FIG. 3

FIG. 4

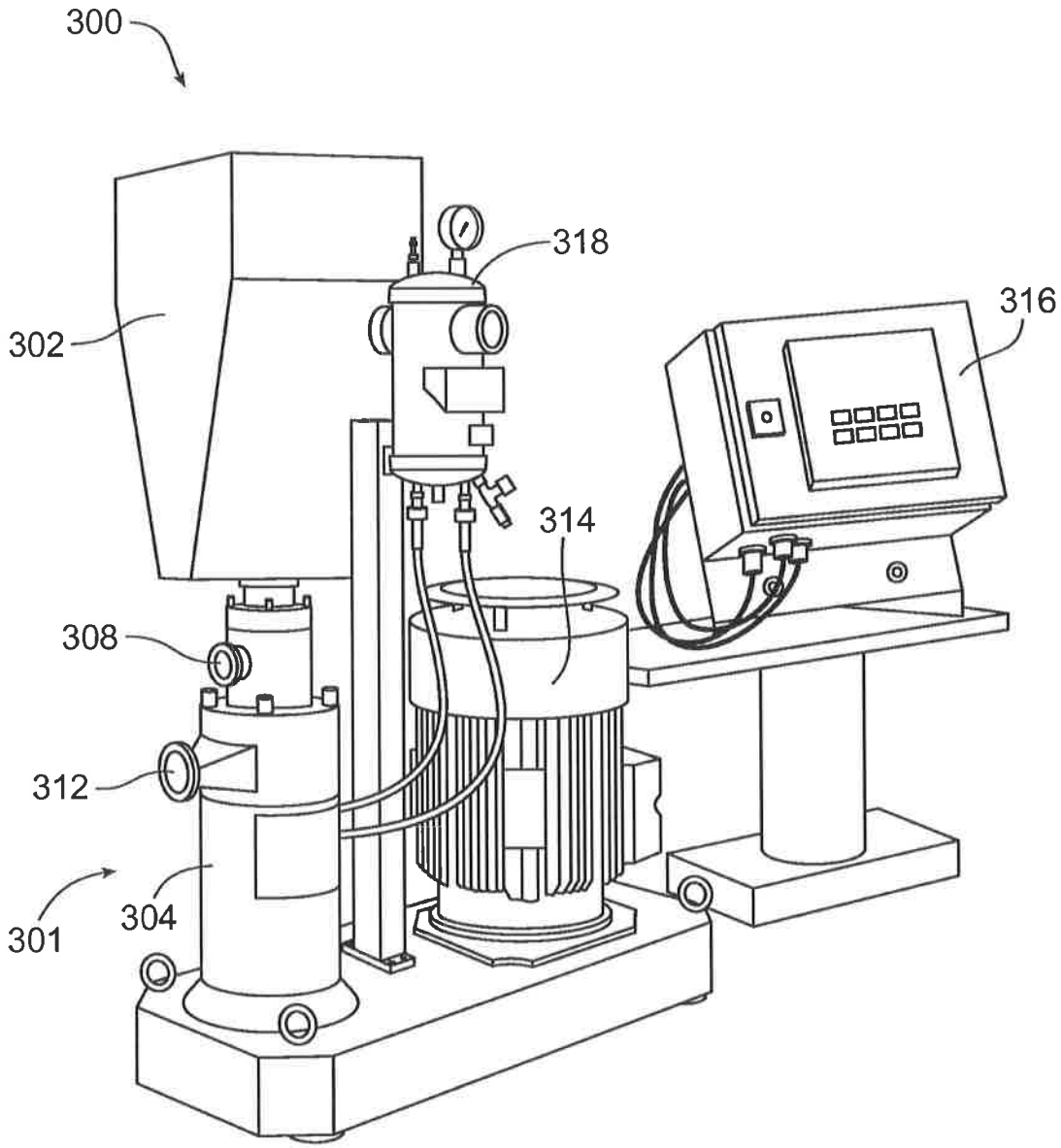


FIG. 5

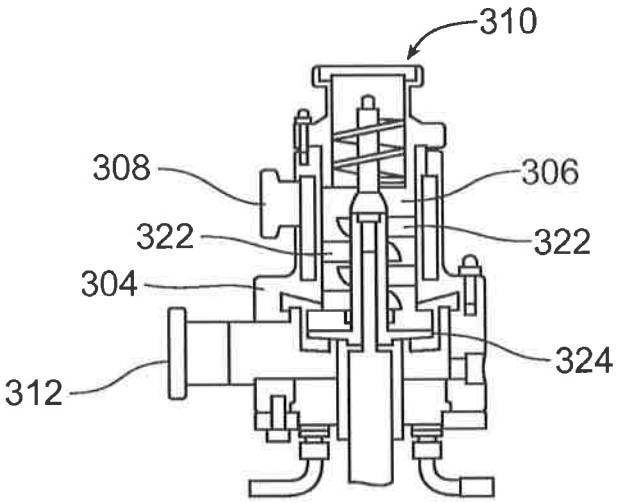

310
308
306
322
322
304
324
312

FIG. 5A

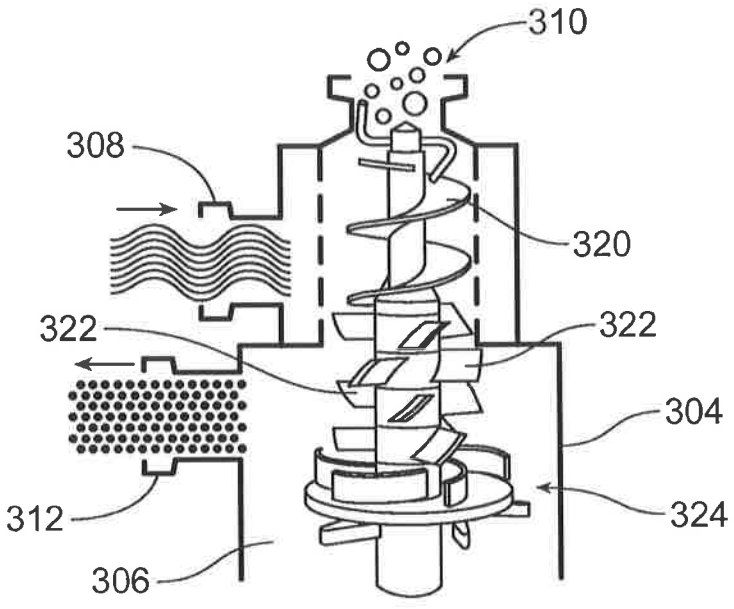

310
308
320
322
322
304
312
324
306

FIG. 6

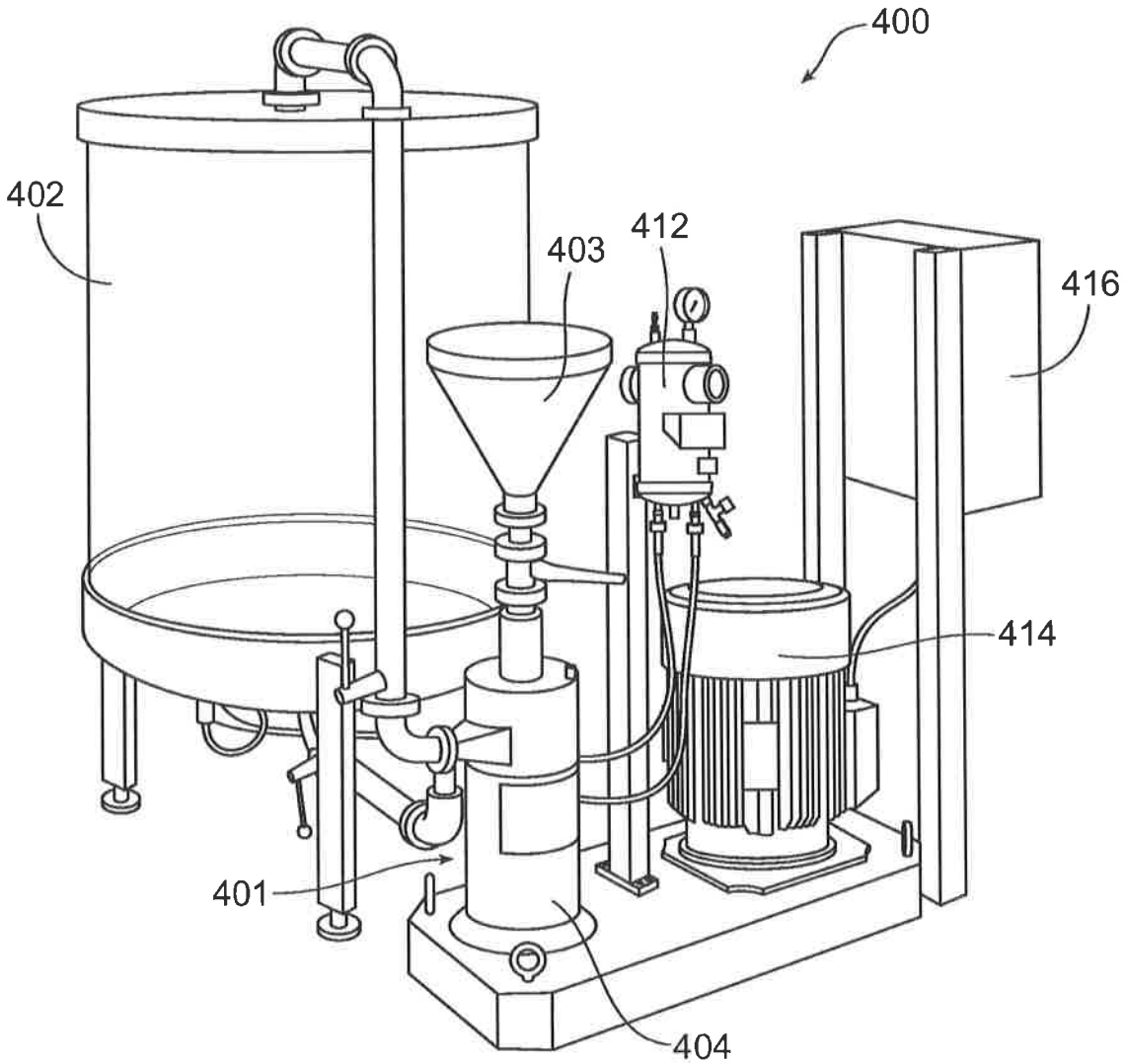


FIG. 7

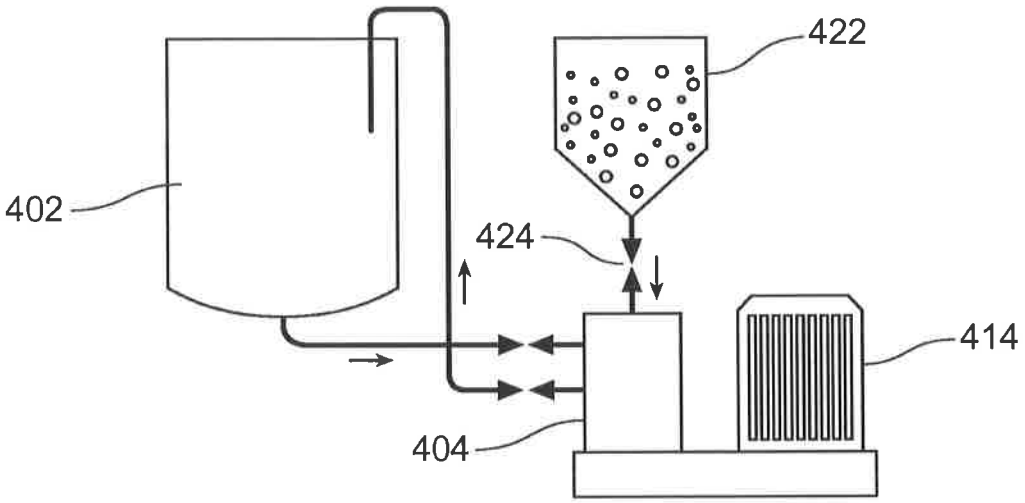


FIG. 7A

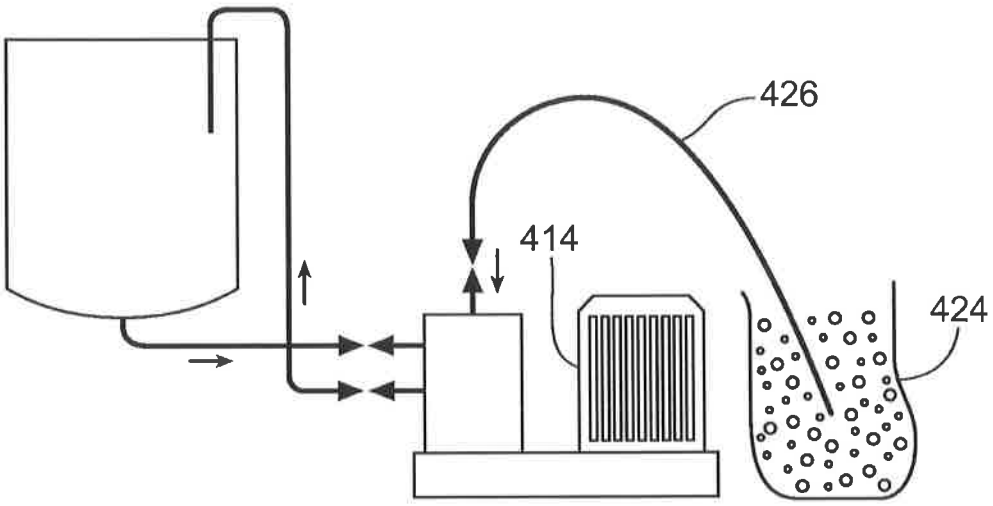
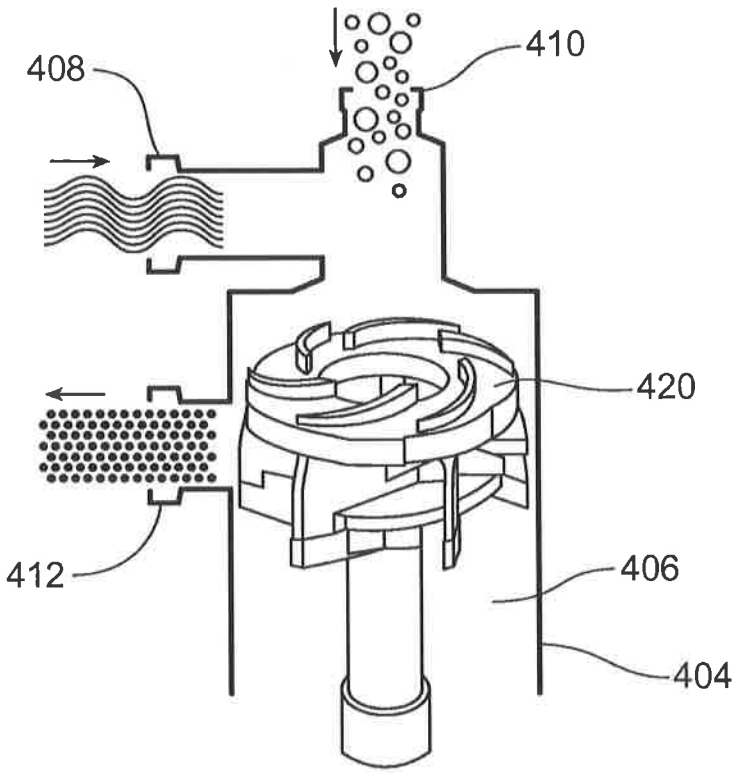


FIG. 8



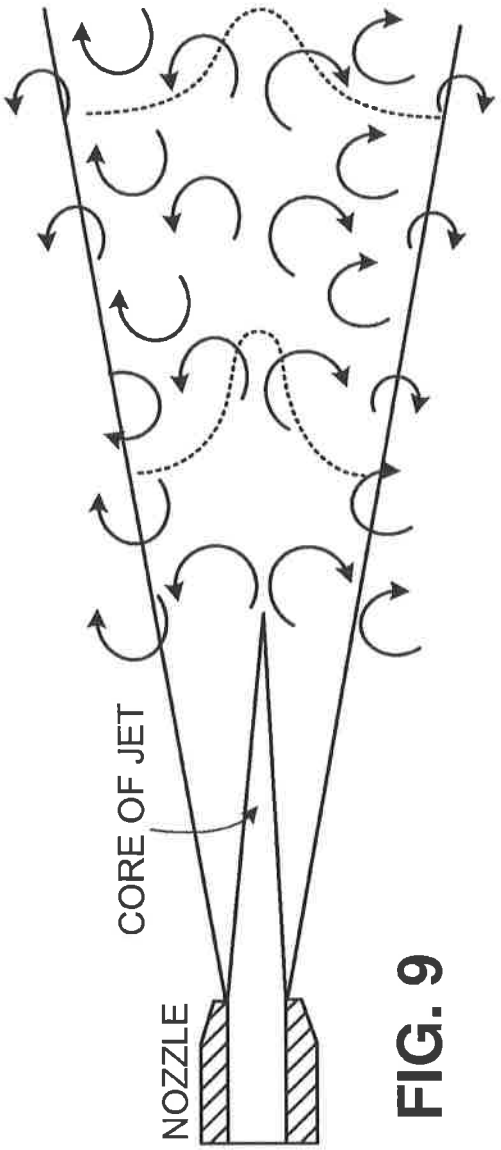

CORE OF JET
NOZZLE

FIG. 9

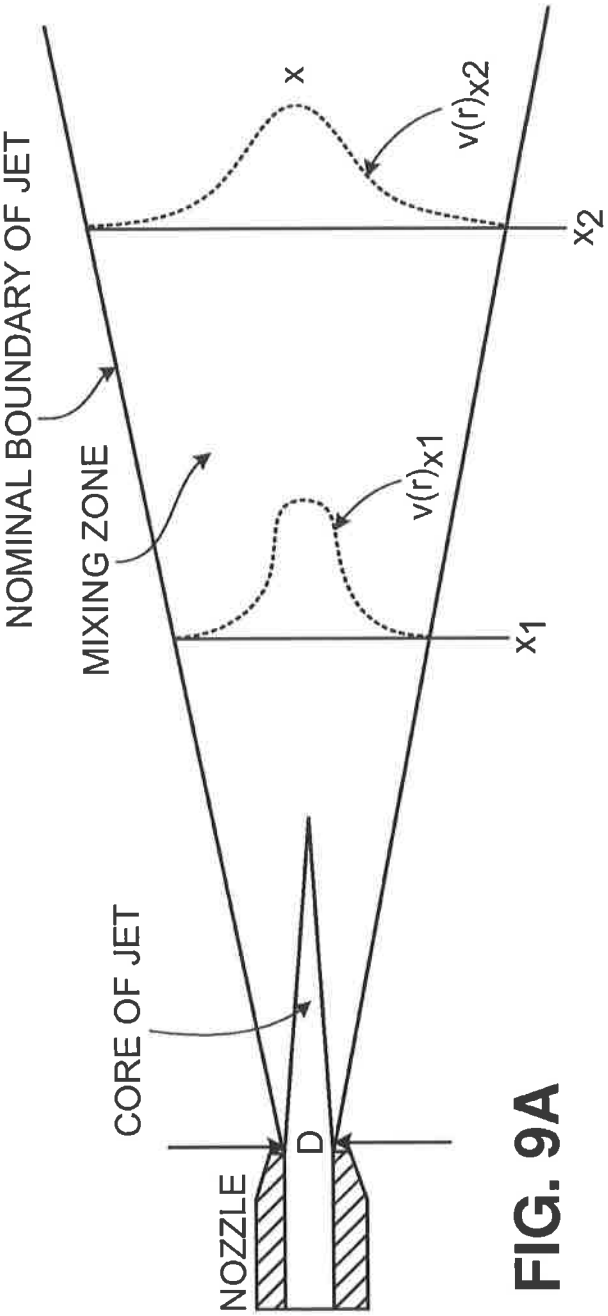

NOMINAL BOUNDARY OF JET
MIXING ZONE
CORE OF JET
NOZZLE
D
x
v(r)x2
x2
v(r)x1
x1

FIG. 9A

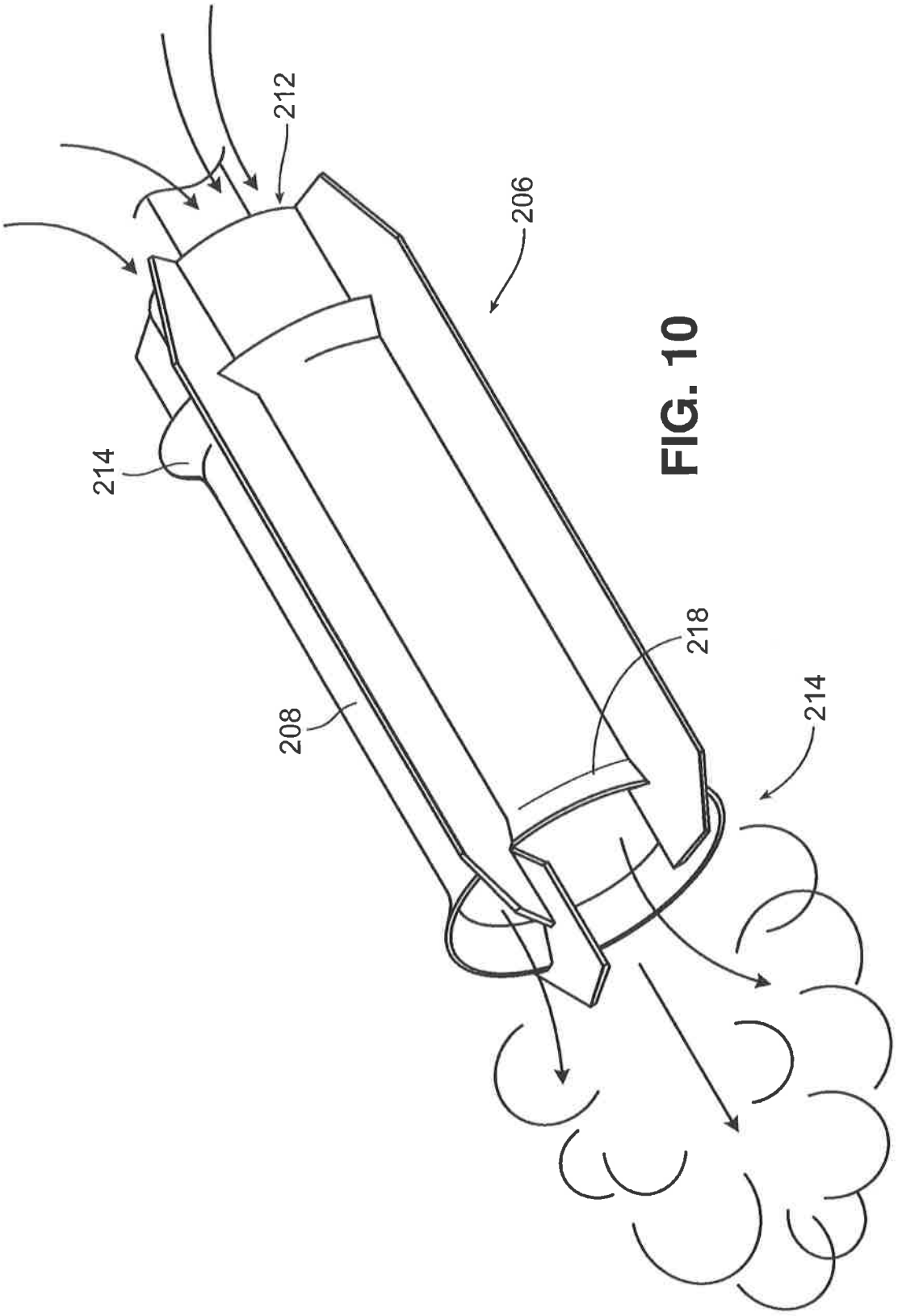


FIG. 10

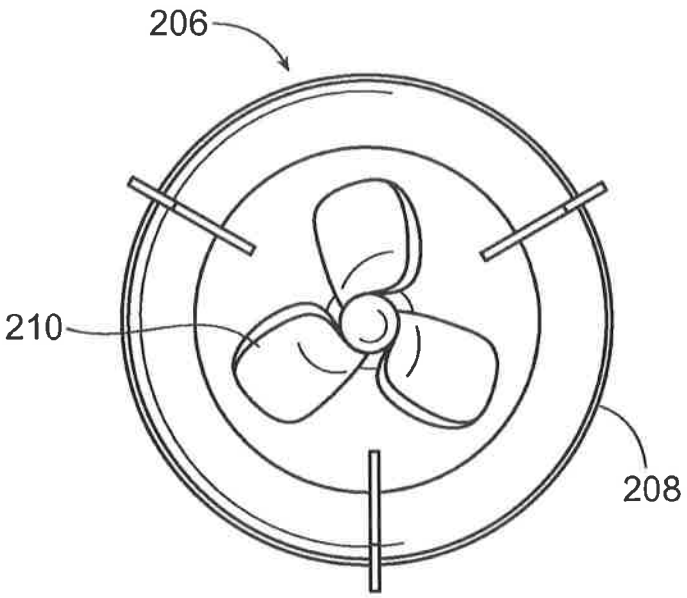


FIG. 10A

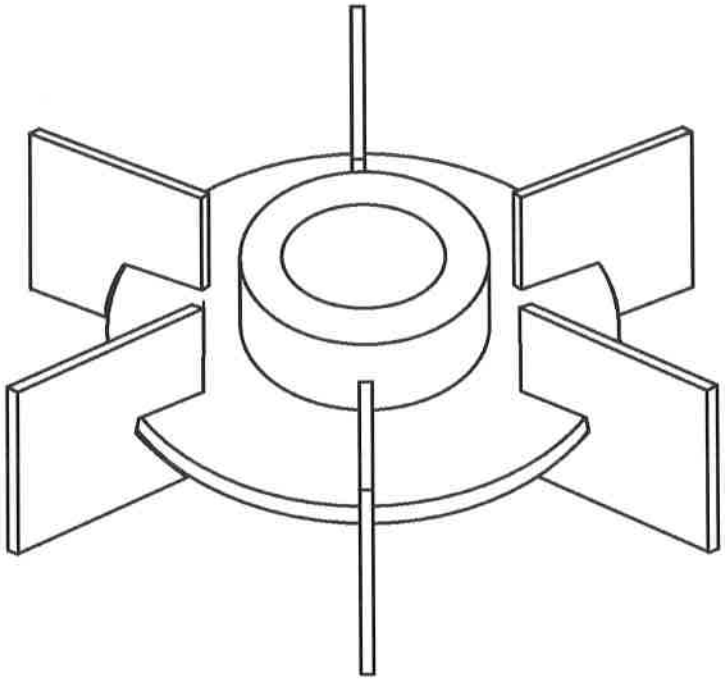


FIG. 10B

FIG. 11

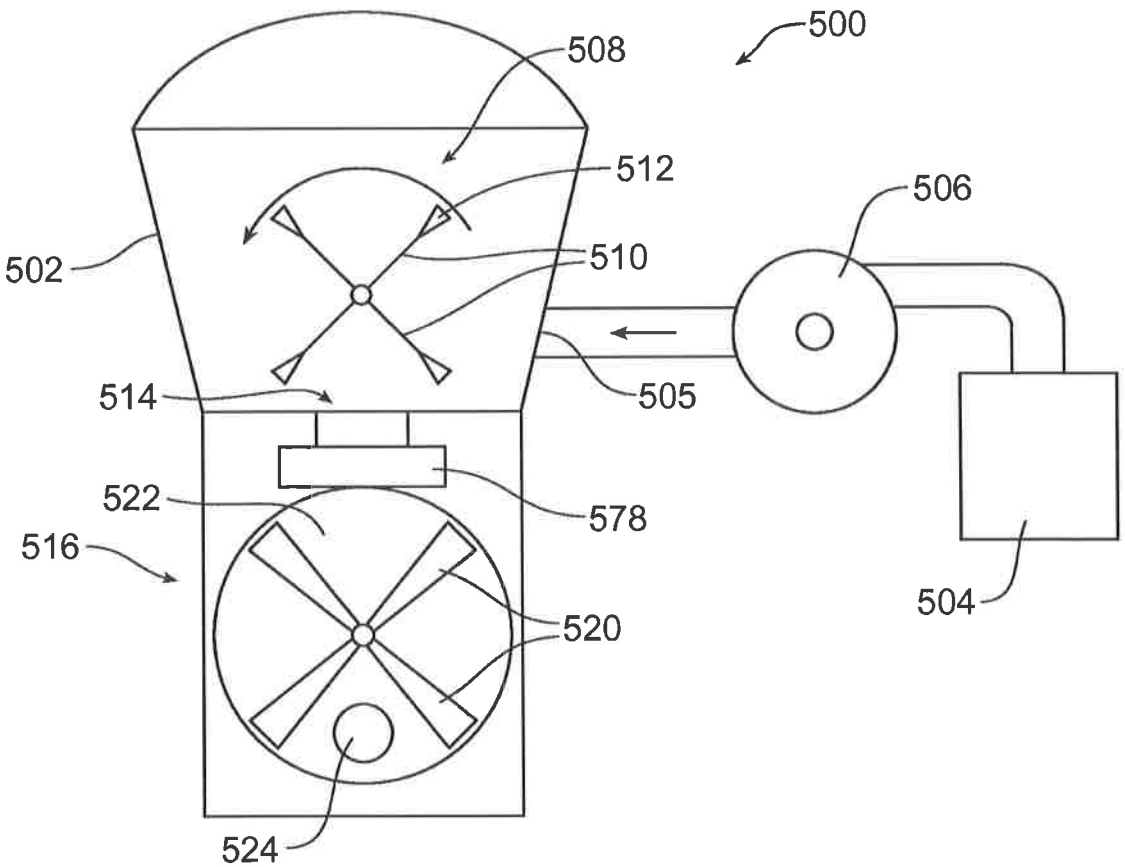


FIG. 12

