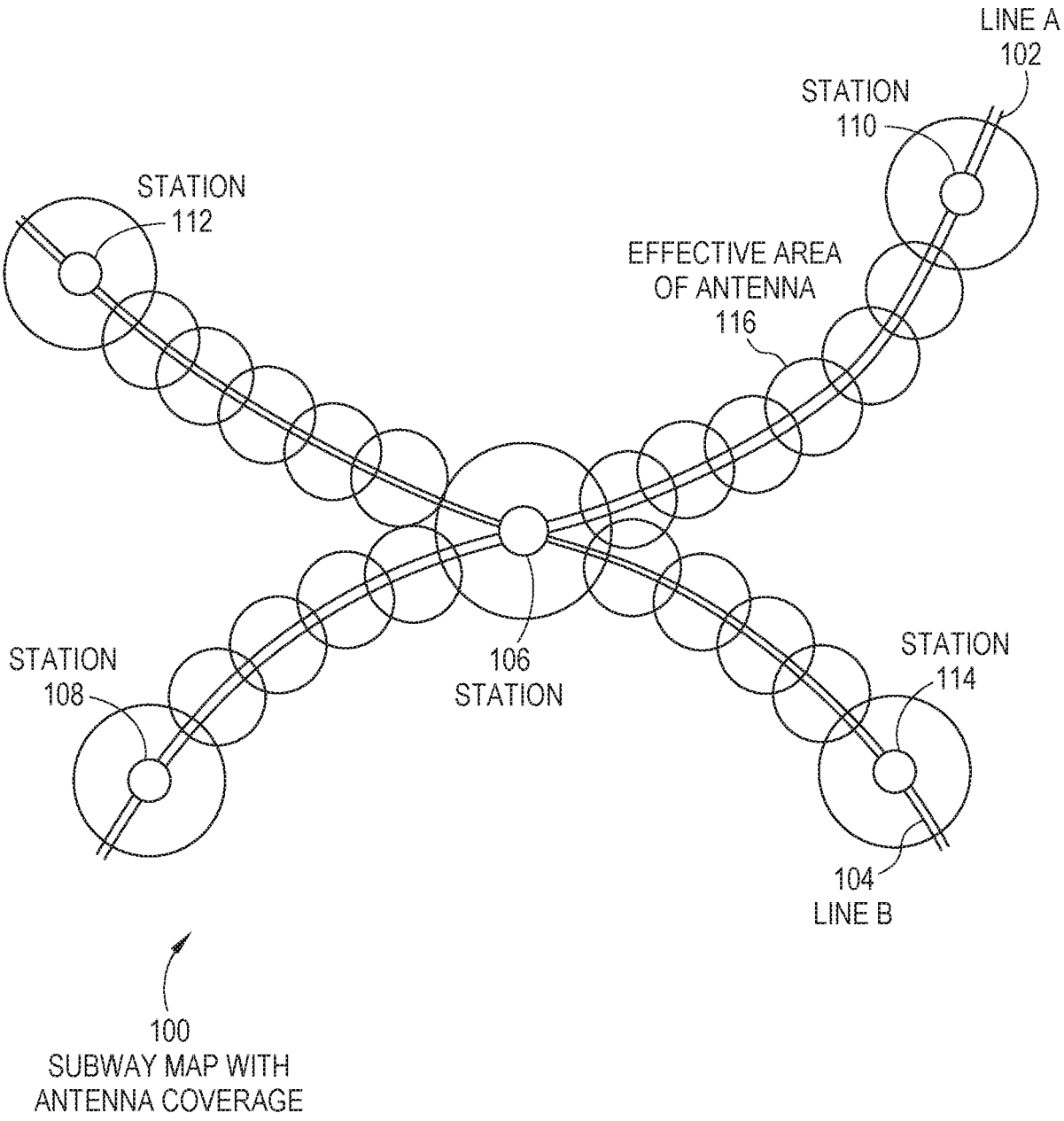
LINE A
102
STATION
110
STATION
112
EFFECTIVE AREA
OF ANTENNA
116
STATION
108
106
STATION
STATION
114
104
LINE B
100
SUBWAY MAP WITH
ANTENNA COVERAGE

FIG. 1A

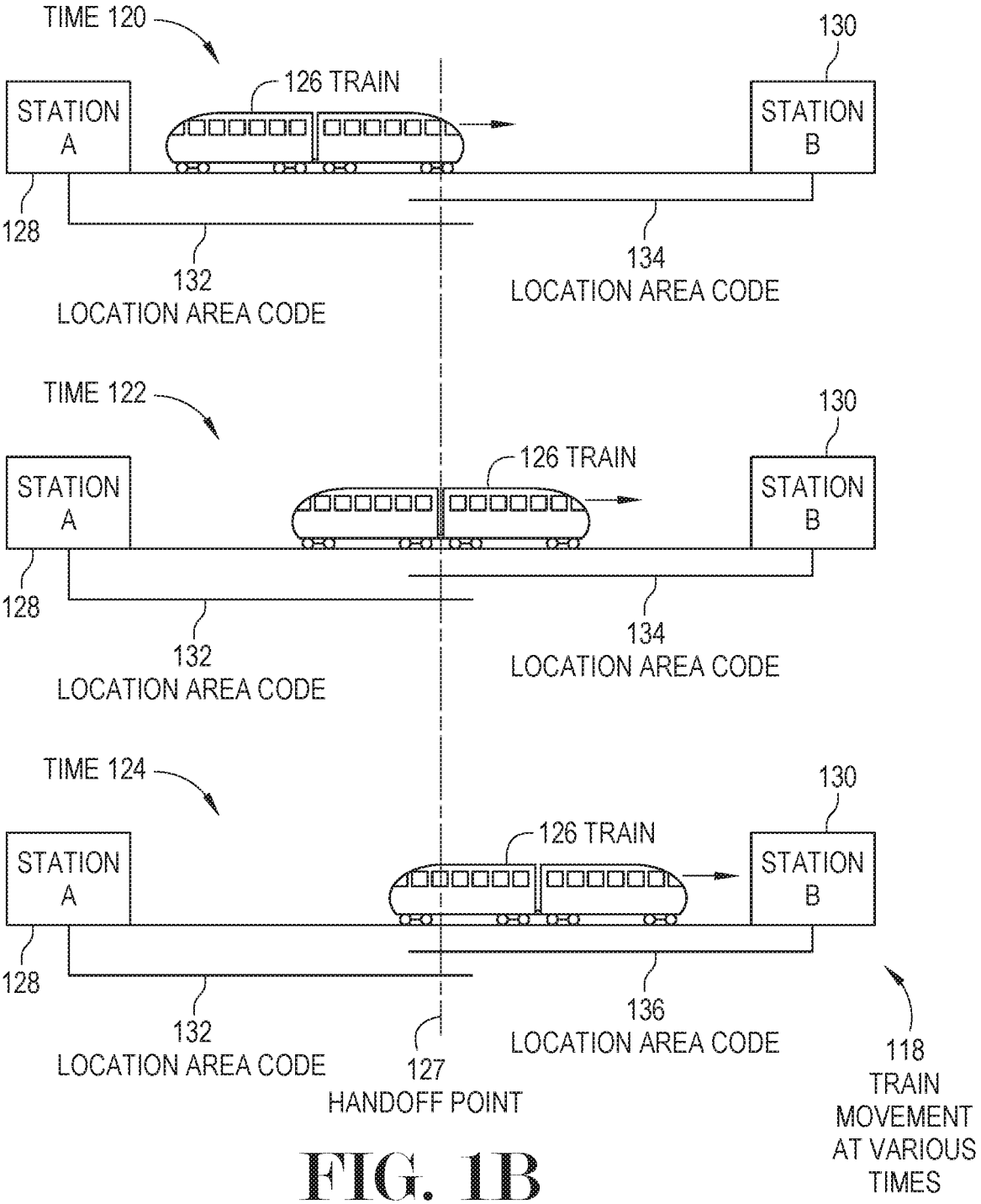
TIME 120
126 TRAIN
130
STATION A
STATION B
128
132
LOCATION AREA CODE
134
LOCATION AREA CODE
TIME 122
126 TRAIN
130
STATION A
STATION B
128
132
LOCATION AREA CODE
134
LOCATION AREA CODE
TIME 124
126 TRAIN
130
STATION A
STATION B
128
132
LOCATION AREA CODE
127
HANDOFF POINT
136
LOCATION AREA CODE
118
TRAIN MOVEMENT AT VARIOUS TIMES

FIG. 1B

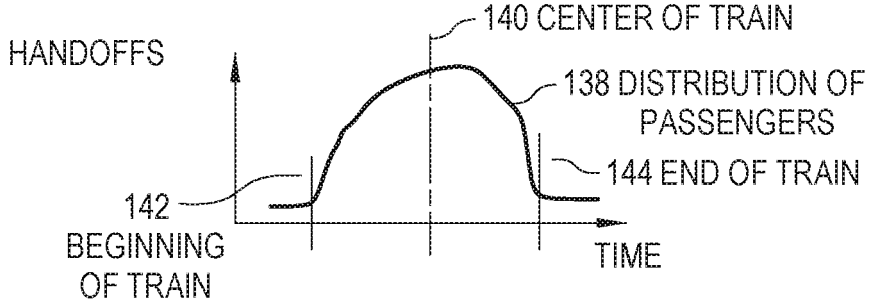
HANDOFFS
140 CENTER OF TRAIN
138 DISTRIBUTION OF PASSENGERS
144 END OF TRAIN
142
BEGINNING OF TRAIN
TIME

FIG. 1C

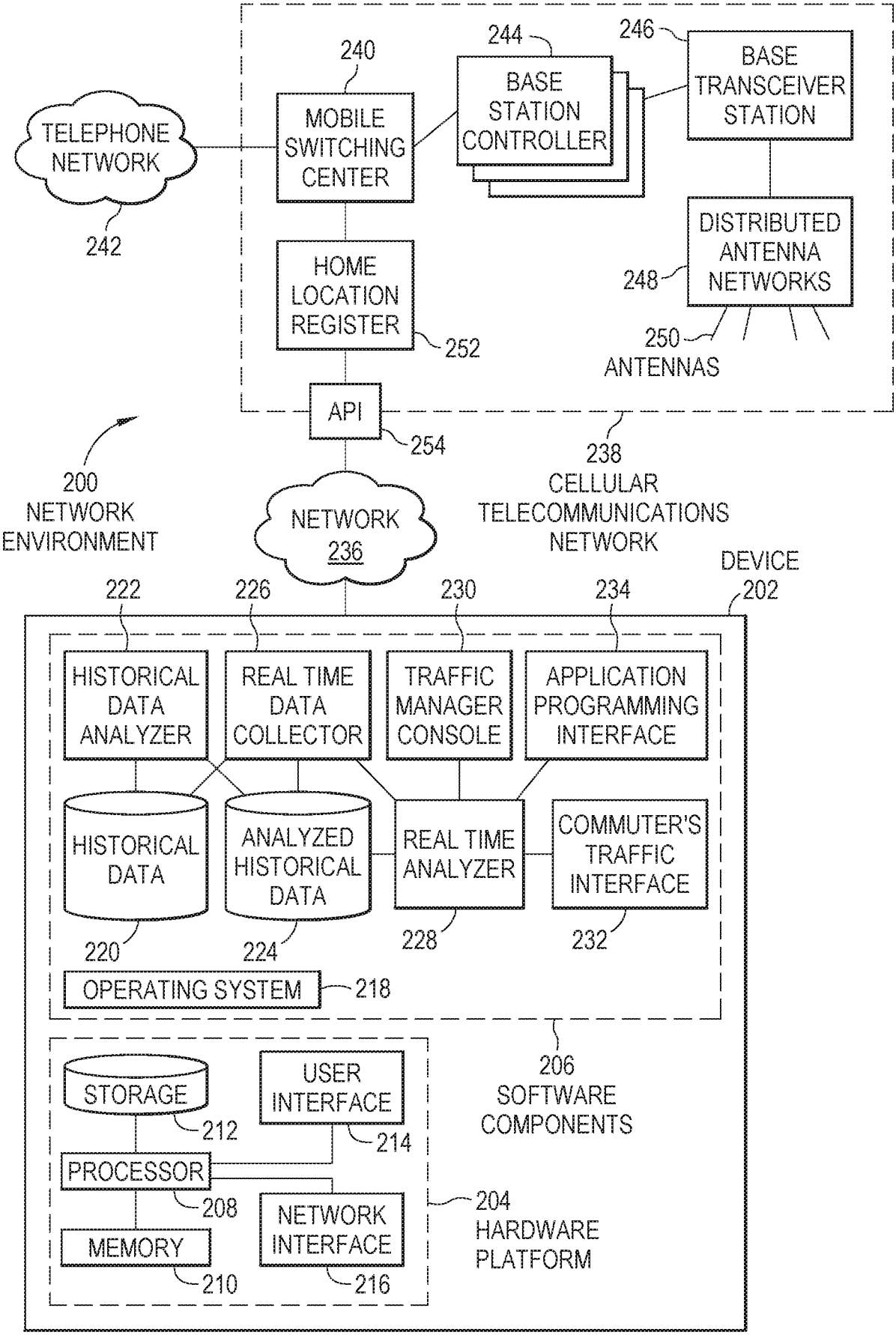
TELEPHONE NETWORK
242
240
MOBILE SWITCHING CENTER
244
BASE STATION CONTROLLER
246
BASE TRANSCEIVER STATION
HOME LOCATION REGISTER
252
DISTRIBUTED ANTENNA NETWORKS
248
250
ANTENNAS
API
254
200
NETWORK ENVIRONMENT
NETWORK 236
238
CELLULAR TELECOMMUNICATIONS NETWORK
DEVICE
202
222
226
230
234
HISTORICAL DATA ANALYZER
REAL TIME DATA COLLECTOR
TRAFFIC MANAGER CONSOLE
APPLICATION PROGRAMMING INTERFACE
HISTORICAL DATA
ANALYZED HISTORICAL DATA
REAL TIME ANALYZER
COMMUTER'S TRAFFIC INTERFACE
220
224
228
232
OPERATING SYSTEM
218
206
SOFTWARE COMPONENTS
STORAGE
212
USER INTERFACE
214
PROCESSOR
208
NETWORK INTERFACE
MEMORY
210
216
204
HARDWARE PLATFORM

FIG. 2

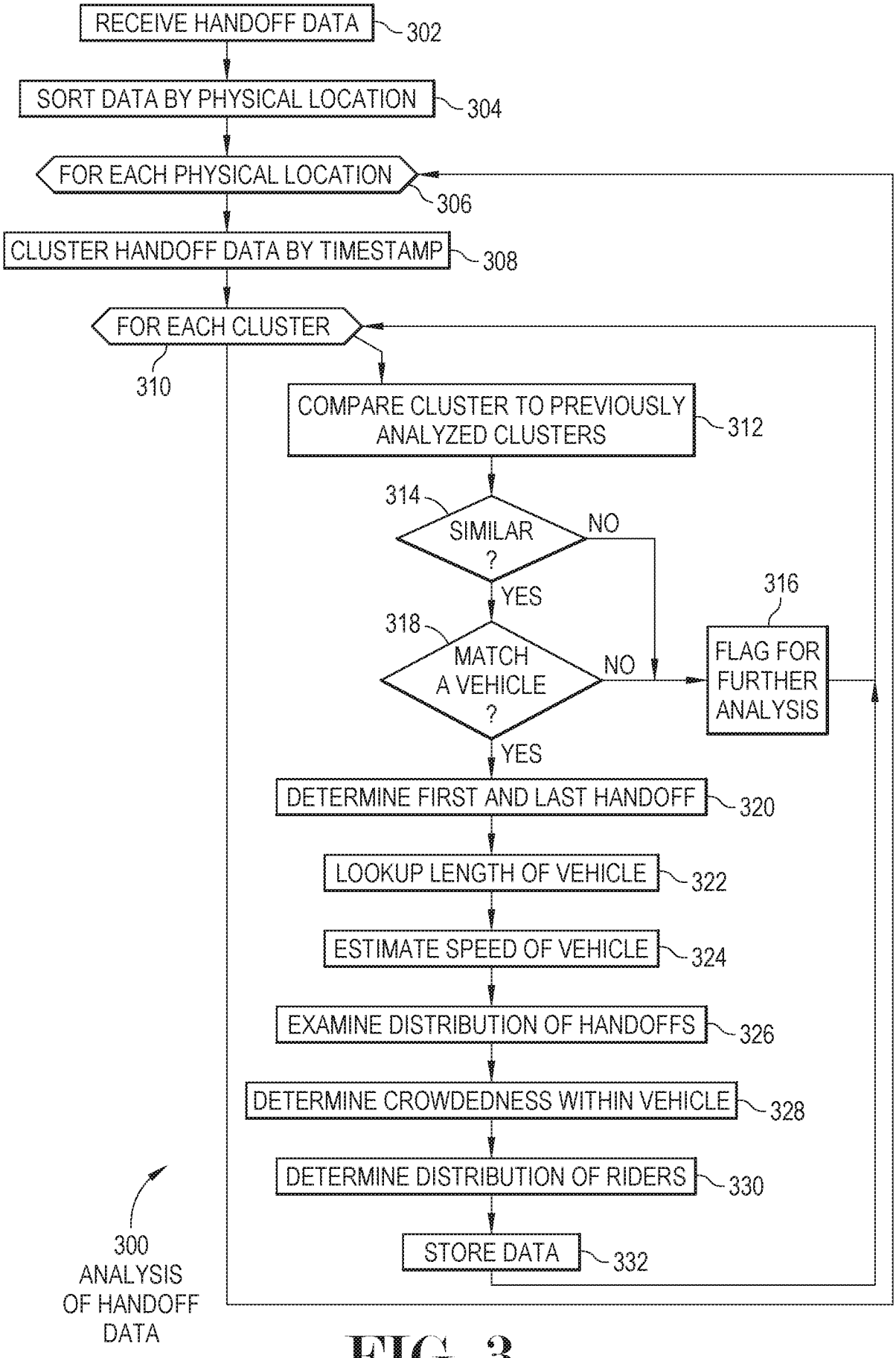
RECEIVE HANDOFF DATA
302
SORT DATA BY PHYSICAL LOCATION
304
FOR EACH PHYSICAL LOCATION
306
CLUSTER HANDOFF DATA BY TIMESTAMP
308
FOR EACH CLUSTER
310
COMPARE CLUSTER TO PREVIOUSLY ANALYZED CLUSTERS
312
314
SIMILAR ?
NO
YES
316
318
MATCH A VEHICLE ?
NO
FLAG FOR FURTHER ANALYSIS
YES
DETERMINE FIRST AND LAST HANDOFF
320
LOOKUP LENGTH OF VEHICLE
322
ESTIMATE SPEED OF VEHICLE
324
EXAMINE DISTRIBUTION OF HANDOFFS
326
DETERMINE CROWDEDNESS WITHIN VEHICLE
328
DETERMINE DISTRIBUTION OF RIDERS
330
STORE DATA
332
300
ANALYSIS OF HANDOFF DATA

FIG. 3

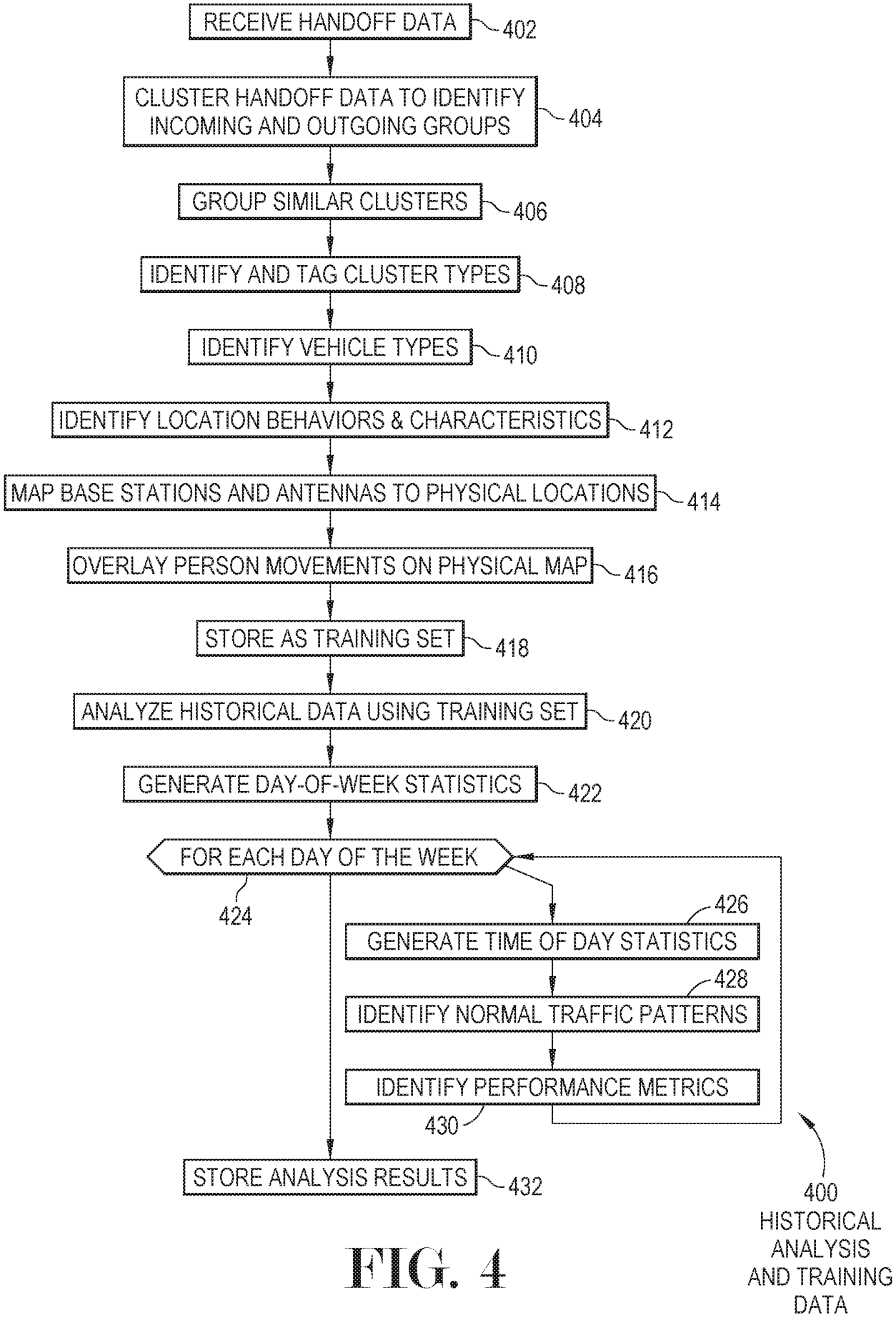
RECEIVE HANDOFF DATA
402
CLUSTER HANDOFF DATA TO IDENTIFY INCOMING AND OUTGOING GROUPS
404
GROUP SIMILAR CLUSTERS
406
IDENTIFY AND TAG CLUSTER TYPES
408
IDENTIFY VEHICLE TYPES
410
IDENTIFY LOCATION BEHAVIORS & CHARACTERISTICS
412
MAP BASE STATIONS AND ANTENNAS TO PHYSICAL LOCATIONS
414
OVERLAY PERSON MOVEMENTS ON PHYSICAL MAP
416
STORE AS TRAINING SET
418
ANALYZE HISTORICAL DATA USING TRAINING SET
420
GENERATE DAY-OF-WEEK STATISTICS
422
FOR EACH DAY OF THE WEEK
424
426
GENERATE TIME OF DAY STATISTICS
428
IDENTIFY NORMAL TRAFFIC PATTERNS
IDENTIFY PERFORMANCE METRICS
430
STORE ANALYSIS RESULTS
432
400
HISTORICAL ANALYSIS AND TRAINING DATA

FIG. 4

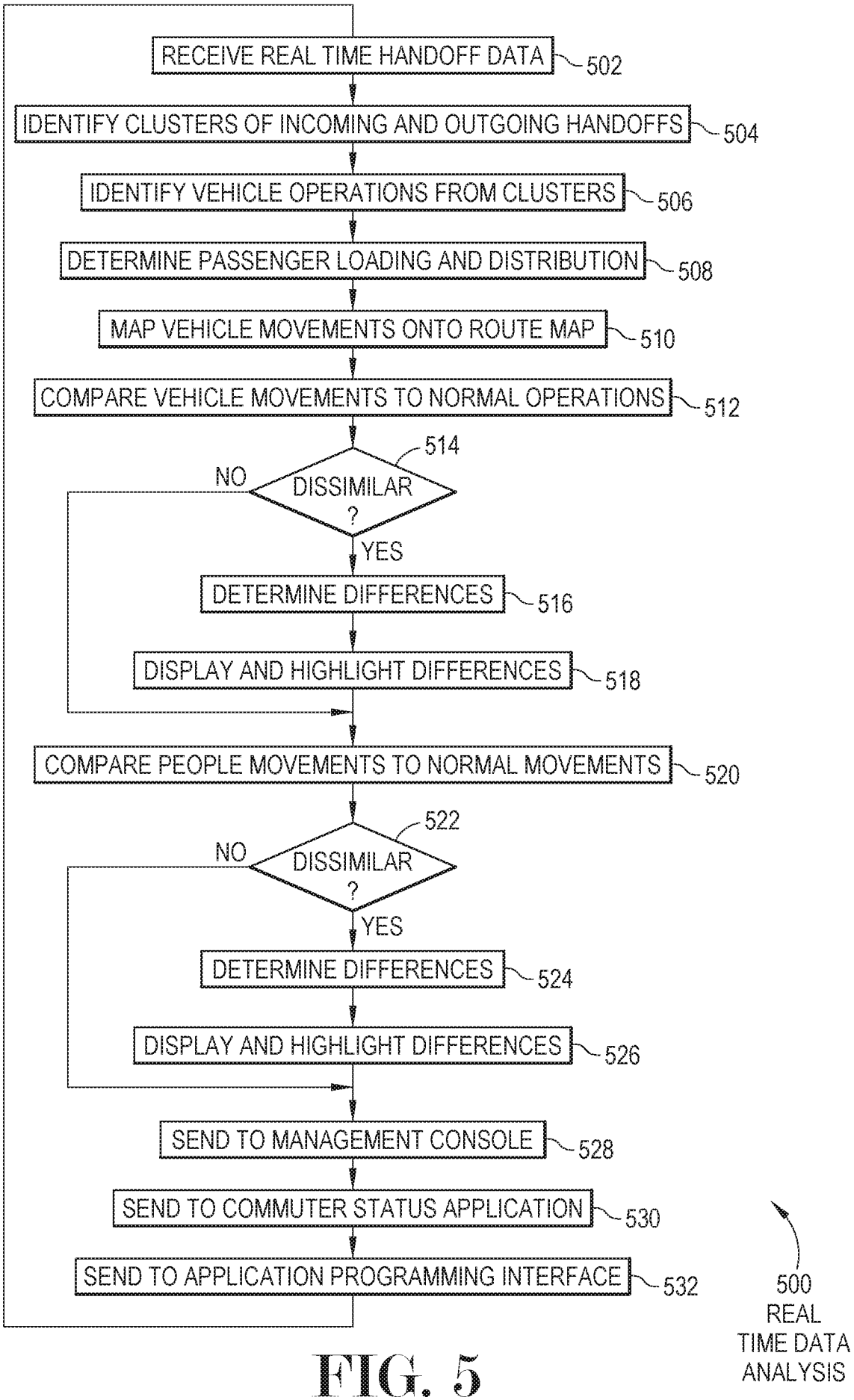
RECEIVE REAL TIME HANDOFF DATA
502
IDENTIFY CLUSTERS OF INCOMING AND OUTGOING HANDOFFS
504
IDENTIFY VEHICLE OPERATIONS FROM CLUSTERS
506
DETERMINE PASSENGER LOADING AND DISTRIBUTION
508
MAP VEHICLE MOVEMENTS ONTO ROUTE MAP
510
COMPARE VEHICLE MOVEMENTS TO NORMAL OPERATIONS
512
514
NO
DISSIMILAR ?
YES
DETERMINE DIFFERENCES
516
DISPLAY AND HIGHLIGHT DIFFERENCES
518
COMPARE PEOPLE MOVEMENTS TO NORMAL MOVEMENTS
520
522
NO
DISSIMILAR ?
YES
DETERMINE DIFFERENCES
524
DISPLAY AND HIGHLIGHT DIFFERENCES
526
SEND TO MANAGEMENT CONSOLE
528
SEND TO COMMUTER STATUS APPLICATION
530
SEND TO APPLICATION PROGRAMMING INTERFACE
532
500
REAL TIME DATA ANALYSIS

FIG. 5

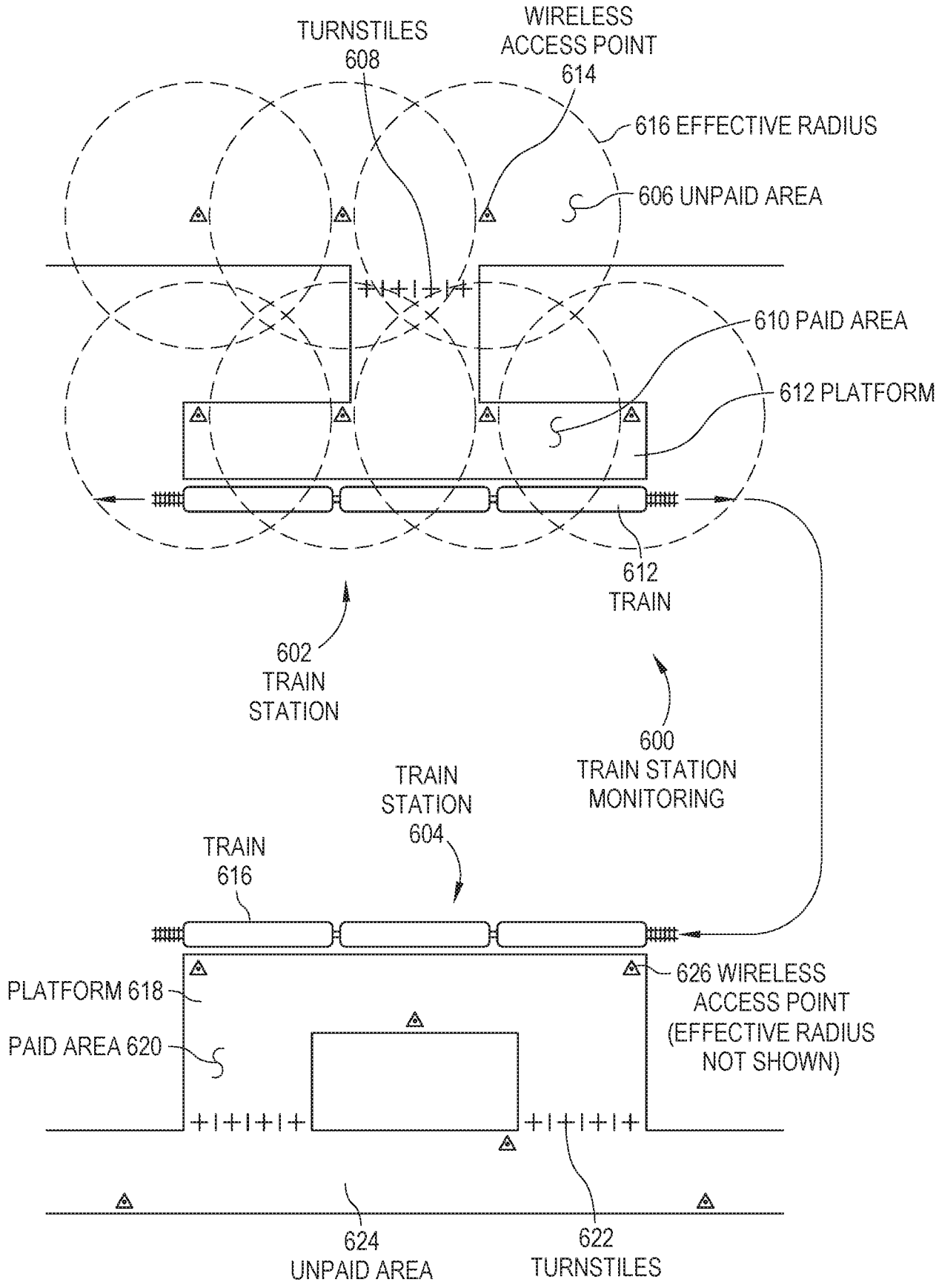
TURNSTILES
608
WIRELESS
ACCESS POINT
614
616 EFFECTIVE RADIUS
606 UNPAID AREA
610 PAID AREA
612 PLATFORM
612
TRAIN
602
TRAIN
STATION
600
TRAIN STATION
MONITORING
TRAIN
STATION
604
TRAIN
616
PLATFORM 618
PAID AREA 620
626 WIRELESS
ACCESS POINT
(EFFECTIVE RADIUS
NOT SHOWN)
624
UNPAID AREA
622
TURNSTILES

FIG. 6

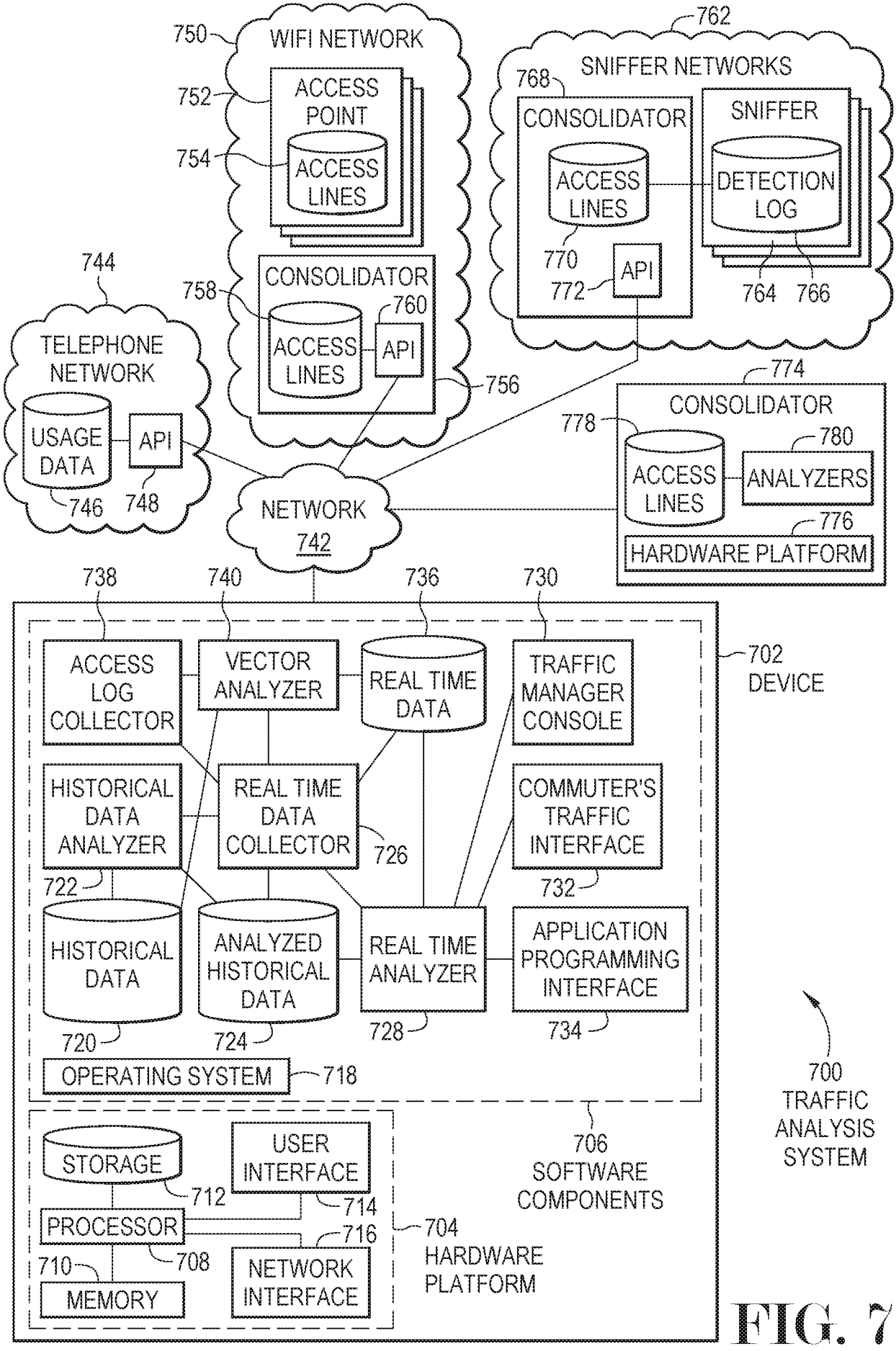
750
WIFI NETWORK
752
ACCESS POINT
754
ACCESS LINES
762
SNIFFER NETWORKS
768
CONSOLIDATOR
ACCESS LINES
770
API
772
SNIFFER
DETECTION LOG
764
766
744
TELEPHONE NETWORK
USAGE DATA
API
746
748
758
CONSOLIDATOR
760
ACCESS LINES
API
756
774
CONSOLIDATOR
778
ACCESS LINES
780
ANALYZERS
776
HARDWARE PLATFORM
NETWORK 742
738
740
736
730
ACCESS LOG COLLECTOR
VECTOR ANALYZER
REAL TIME DATA
TRAFFIC MANAGER CONSOLE
702 DEVICE
HISTORICAL DATA ANALYZER
REAL TIME DATA COLLECTOR
726
COMMUTER'S TRAFFIC INTERFACE
722
732
HISTORICAL DATA
ANALYZED HISTORICAL DATA
REAL TIME ANALYZER
APPLICATION PROGRAMMING INTERFACE
720
724
728
734
OPERATING SYSTEM
718
700 TRAFFIC ANALYSIS SYSTEM
706 SOFTWARE COMPONENTS
STORAGE
712
USER INTERFACE
714
PROCESSOR
716
708
710
MEMORY
NETWORK INTERFACE
704 HARDWARE PLATFORM

FIG. 7

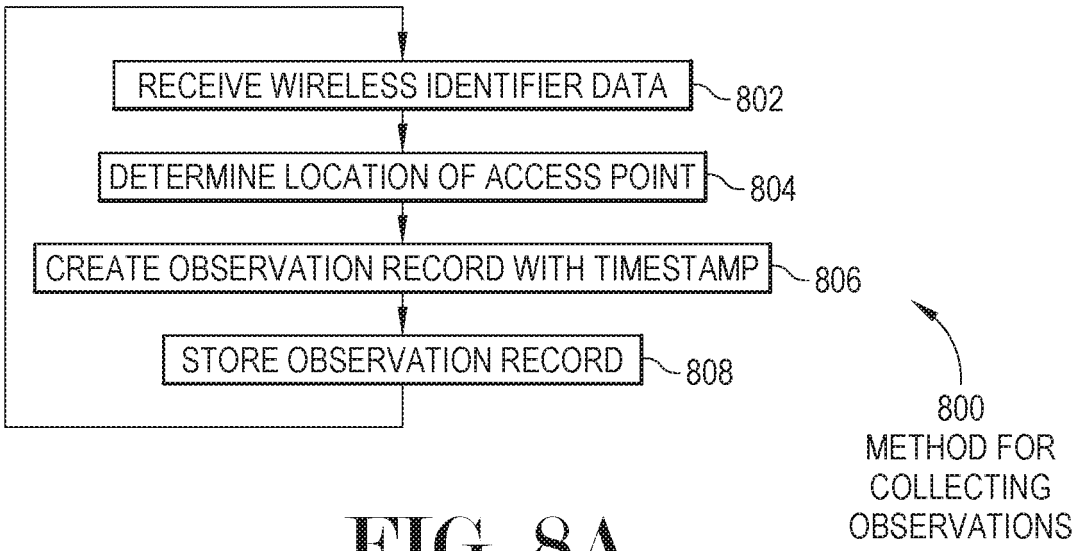
RECEIVE WIRELESS IDENTIFIER DATA
802
DETERMINE LOCATION OF ACCESS POINT
804
CREATE OBSERVATION RECORD WITH TIMESTAMP
806
STORE OBSERVATION RECORD
808
800
METHOD FOR
COLLECTING
OBSERVATIONS

FIG. 8A

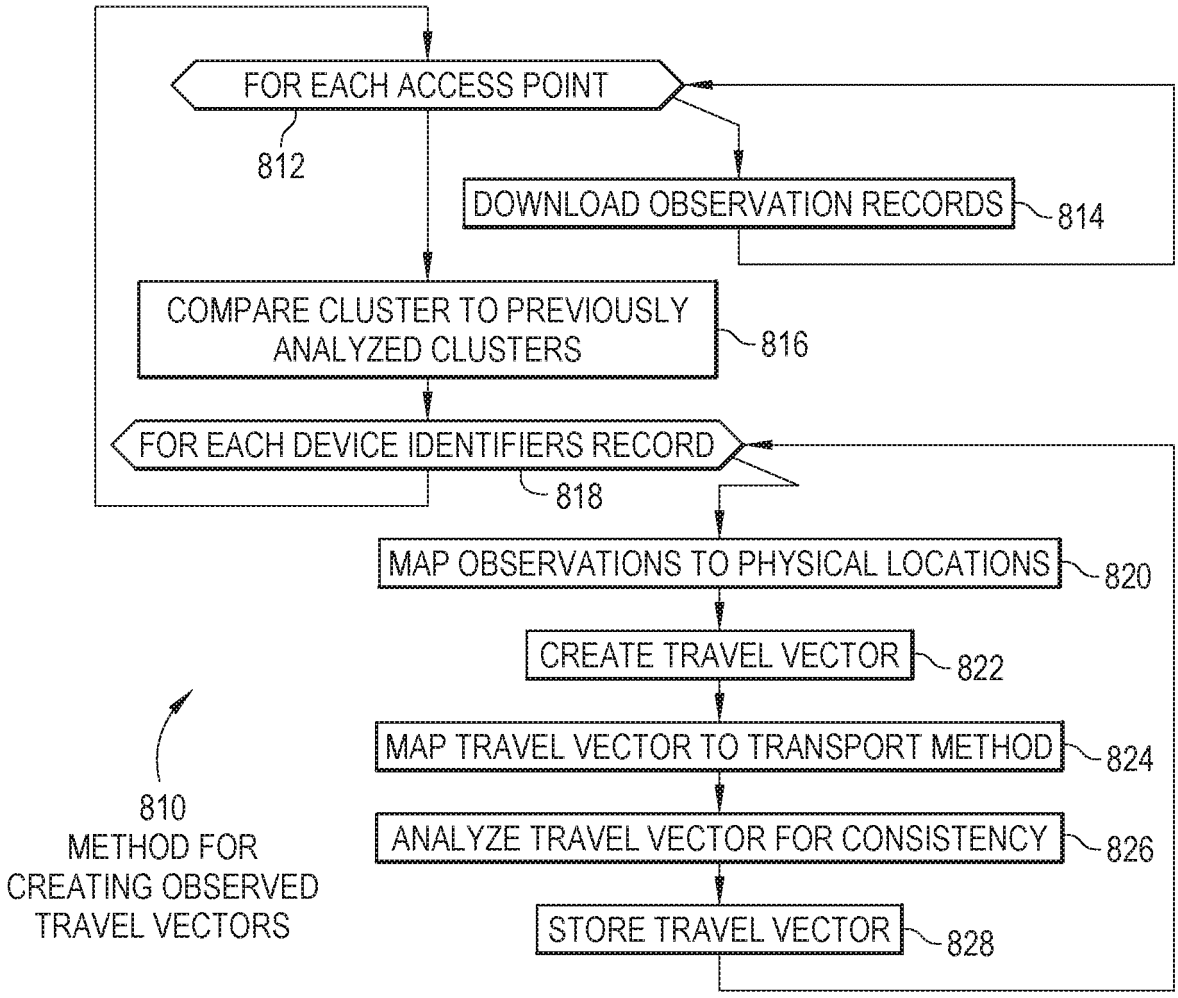
FOR EACH ACCESS POINT
812
DOWNLOAD OBSERVATION RECORDS
814
COMPARE CLUSTER TO PREVIOUSLY
ANALYZED CLUSTERS
816
FOR EACH DEVICE IDENTIFIERS RECORD
818
MAP OBSERVATIONS TO PHYSICAL LOCATIONS
820
CREATE TRAVEL VECTOR
822
MAP TRAVEL VECTOR TO TRANSPORT METHOD
824
ANALYZE TRAVEL VECTOR FOR CONSISTENCY
826
STORE TRAVEL VECTOR
828
810
METHOD FOR
CREATING OBSERVED
TRAVEL VECTORS

FIG. 8B

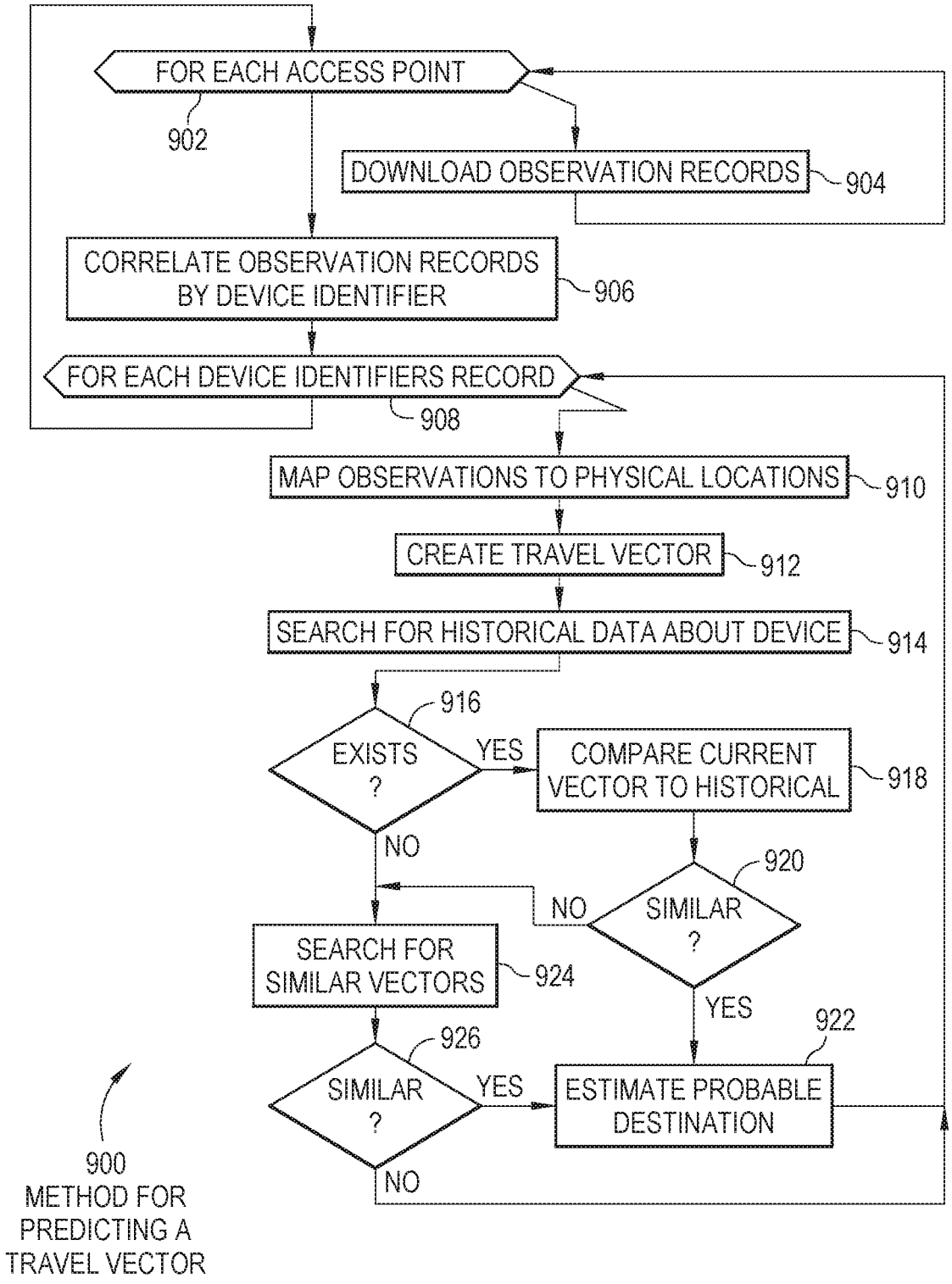
FOR EACH ACCESS POINT
902
DOWNLOAD OBSERVATION RECORDS
904
CORRELATE OBSERVATION RECORDS BY DEVICE IDENTIFIER
906
FOR EACH DEVICE IDENTIFIERS RECORD
908
MAP OBSERVATIONS TO PHYSICAL LOCATIONS
910
CREATE TRAVEL VECTOR
912
SEARCH FOR HISTORICAL DATA ABOUT DEVICE
914
916
EXISTS ?
YES
COMPARE CURRENT VECTOR TO HISTORICAL
918
NO
920
SIMILAR ?
NO
YES
SEARCH FOR SIMILAR VECTORS
924
926
SIMILAR ?
YES
922
ESTIMATE PROBABLE DESTINATION
NO
900
METHOD FOR PREDICTING A TRAVEL VECTOR

FIG. 9

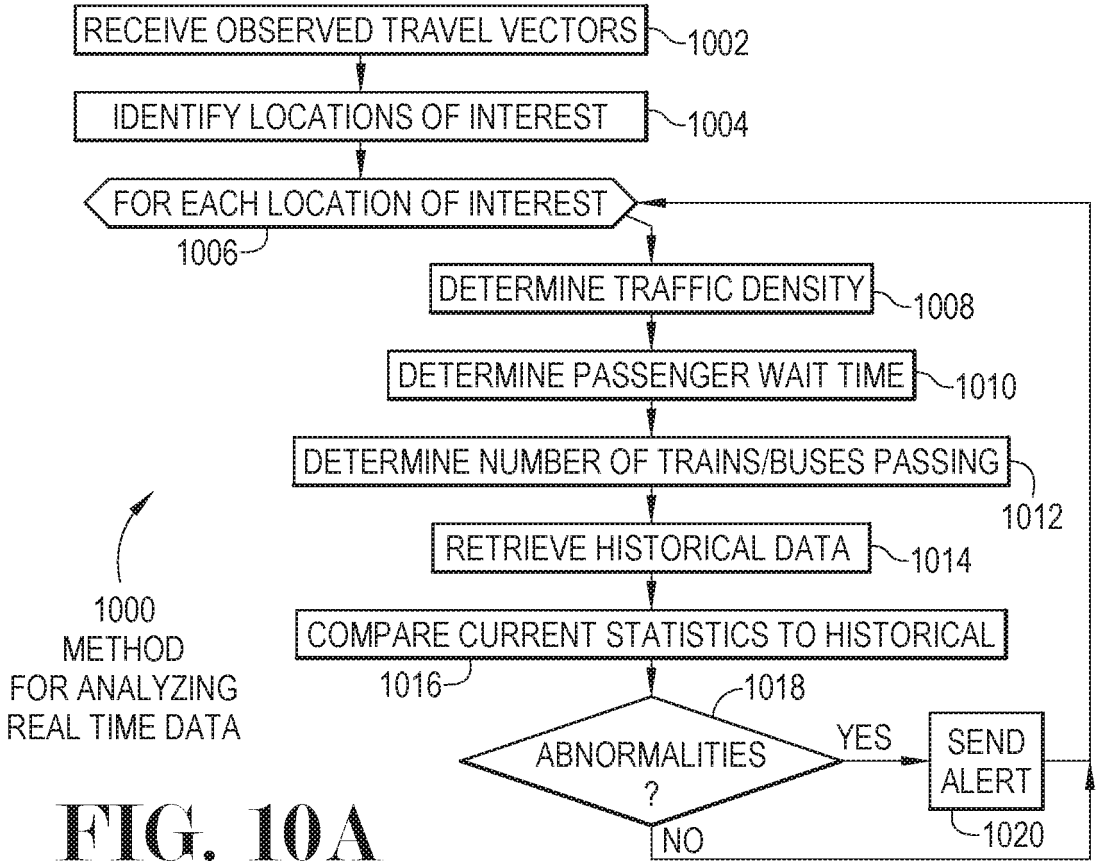

FIG. 10A

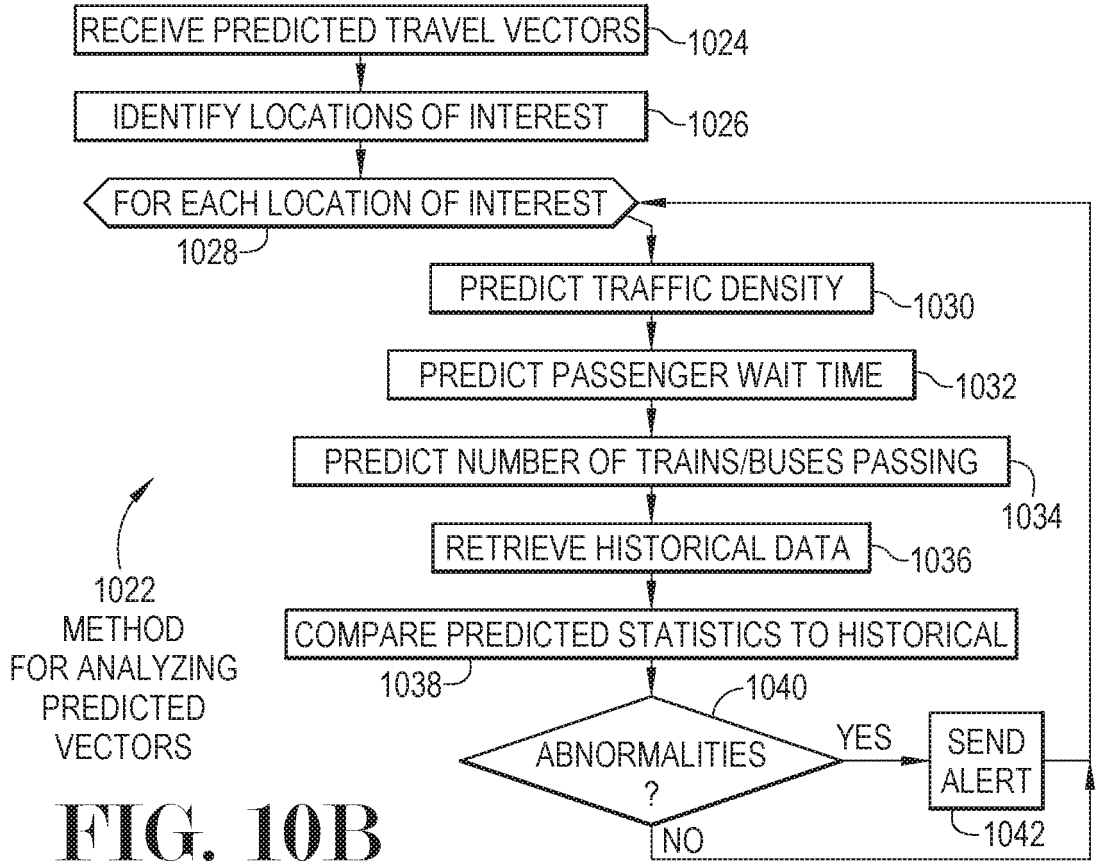

FIG. 10B