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AUTOMATED SYSTEM AND METHOD FOR IMPLEMENTING UNIT AND COLLECTIVE LEVEL BENCHMARKING OF POWER PLANT OPERATIONS

Abstract of the Invention

Systems and methods for implementing benchmarking analysis (168) for power plant operations comprise electronically accessing power plant operational data (166) within at least one type of operation within a power plant, electronically analyzing data from one or more power plant components within one or more different power plant units in one or more collections of multiple power plant units to identify cycles and key events on one or more of a component level (220) , a unit level (230) and a collective level of multiple power plants (240), generating at least one scorecard summary (252) of calculated power plant operational characteristics on selected levels of operation comprising one or more of a component level, unit level and collective level of power plant units, and providing the at least one scorecard summary as electronic output to a user. Additional optional steps include using the data from the scorecard summary to detect outliers (262) and/or to cluster (264) selected components, units or fleets having similar operational characteristics.

We claim:

1. A method of implementing benchmarking analysis for power plant operations, comprising:

electronically accessing power plant operational data (166) including one or more monitored parameters (202) defining at least one type of operation within a power plant;

electronically analyzing data from one or more power plant components within one or more different power plant units in one or more collections of power plants to identify cycles and key events on one or more of a component level (220), a unit level (232) and a collective level of multiple power plant units (240);

generating at least one scorecard summary (252) of calculated power plant operational characteristics on selected levels of operation comprising one or more of a component level, unit level and collective level of multiple power plant units; and

providing said at least one scorecard summary as electronic output to a user.

2. The method of claim 1, wherein said at least one scorecard summary comprises information comparing at least one given power plant component, unit or collection of power plant units to other plant components, units or collections of power plant units or to an entitlement curve defining ideal performance levels for the at least one given power plant component, unit or fleet.

3. The method of claim 1, wherein said at least one scorecard summary comprises power plant operational characteristics for a particular power plant unit as well as for selected turbine components and other components within the particular power plant unit.

4. The method of claim 1, wherein said at least one scorecard summary comprises operational characteristics on a collective level of multiple power plants, wherein the collective level of multiple power plants is defined by one or more of a fleet level, sub fleet level, customer level and site level.

5. The method of claim 1, wherein said at least one scorecard summary comprises a plurality of time values characterizing the duration of time that respective power plant components and/or units spend in a given segment of operation as defined by identified key events within the operation (276).

6. The method of claim 1, further comprising a step of applying statistical analysis (260) to the calculated power plant operational characteristics for multiple power plant components, units or collections of power plants in order to detect outliers (262) whose data patterns fall outside of at least one pre-configured standard, and further providing selected results of the outlier detection as electronic output to a user.

7. The method of claim 1, further comprising a step of electronically clustering (264) power plant components, units or collections of multiple power plant units into respective groups, each group having one or more similar power plant operational characteristics, and providing selected results of the clustering analysis as electronic output to a user.

8. The method of claim 1, further comprising a step before said step of electronically analyzing data of electronically identifying missing data (214) within a power plant operation and buffering the missing data (216).

9. The method of claim 1, further comprising electronically segmenting (276) power plant operations having similar operational characteristics on the unit level and collective level of multiple power plant units, and providing selected results of the segmenting step as electronic output to a user.

10. The method of claim 1, further comprising electronically identifying failed starts for selected power plant units, calculating startup reliability of selected plants, and providing selected of the identified failed starts and the calculated startup reliability as electronic output to a user.

11. The method of claim 1, further comprising electronically generating an alarm (268) when non-optimal or anomalous behavior is detected within the analyzed power plants.

12. The method of claim 1, further comprising electronically identifying lag and lead gas turbines (236) and providing an indication of the identified turbines as electronic output to a user.

13. The method of claim 1, further comprising electronically classifying the starts associated with selected power plant units as one of a preconfigured list of start types, said preconfigured start types comprising at least one level of hot start, at least one level of cold start, and at least one level of warm start.

14. The method of claim 1, wherein said at least one type of operation within a power plant comprises one or more of starts, shutdowns, trips, load rejections, grid disturbances, fuel transfers, combustion mode transfers, islanded load steps, periods suitable for steady-state performance evaluation, loading, unloading, and transients affecting component life.

15. The method of claim 1, further comprising electronically generating a map-based visualization of a collection of multiple power plant units, whereby each power plant unit is represented by a respective graphical icon on the map-based visualization, and whereby user selection of a particular graphical icon initiates the display of additional summary information for the corresponding particular power plant.

16. The method of claim 1, further comprising electronically generating a customer-specific summary of key performance indicators, active alarms and current operational status for each of a customer's power plant units and providing the customer-specific summary as output to a user.

17. The method of claim 1, further comprising electronically calculating an optimized time for performing a water wash event within selected power plant components and providing the calculated optimized time as output to a user.

18. A power plant analysis and display system, comprising:

at least one processing device (186,196);

at least one memory (184,194) comprising computer-readable instructions for execution by said at least one processing device (184, 194), wherein said at least one processing device is configured to electronically access power plant operational data (166) including one or more monitored parameters (202) defining at least one type of operation within a power plant, to electronically analyze data from one or more power plant components within one or more different power plant units in one or more collections of multiple power plants to identify cycles and key events on one or more of a component level (220), a unit level (230) and a collective level (240), and to generate at least one scorecard summary (252) of calculated power plant operational characteristics on selected levels of operation comprising one or more of a component level, unit level and collective level of multiple power plant units; and

at least one output device (188,198) for providing said at least one scorecard summary as electronic output to a user.

19. The system of claim 18, wherein said power plant analysis and display system is accessible to a user via a web-based portal accessed via one or more wired or wireless networks (170).

20. The system of claim 19, wherein a user gains access to the web-based portal using a unique customer identifier such that data analysis conducted within the power plant analysis and display system is specific to the components, units and collections of power plants matched to an identified customer.

Dated this 12th day of April, 2012

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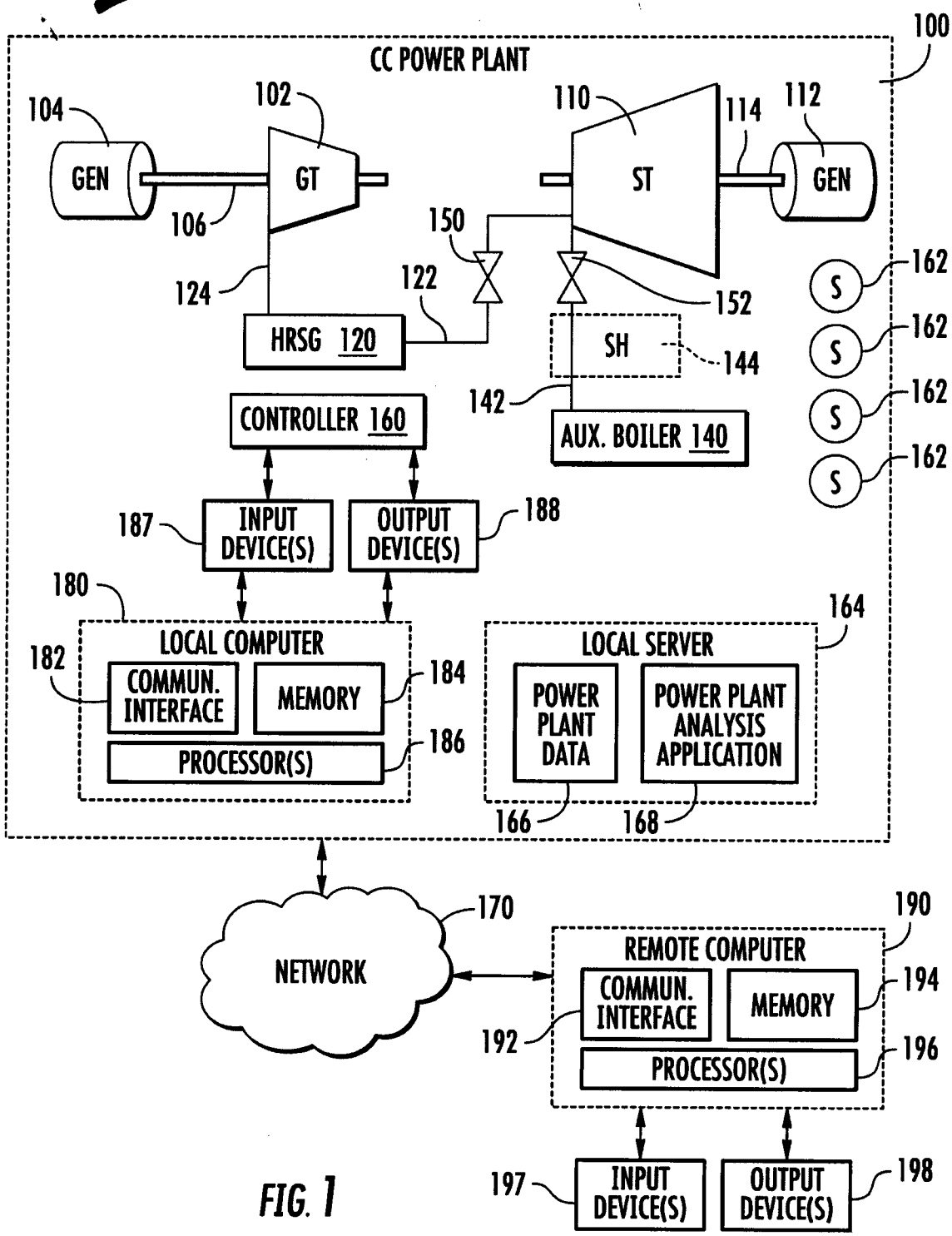

FIG. 1

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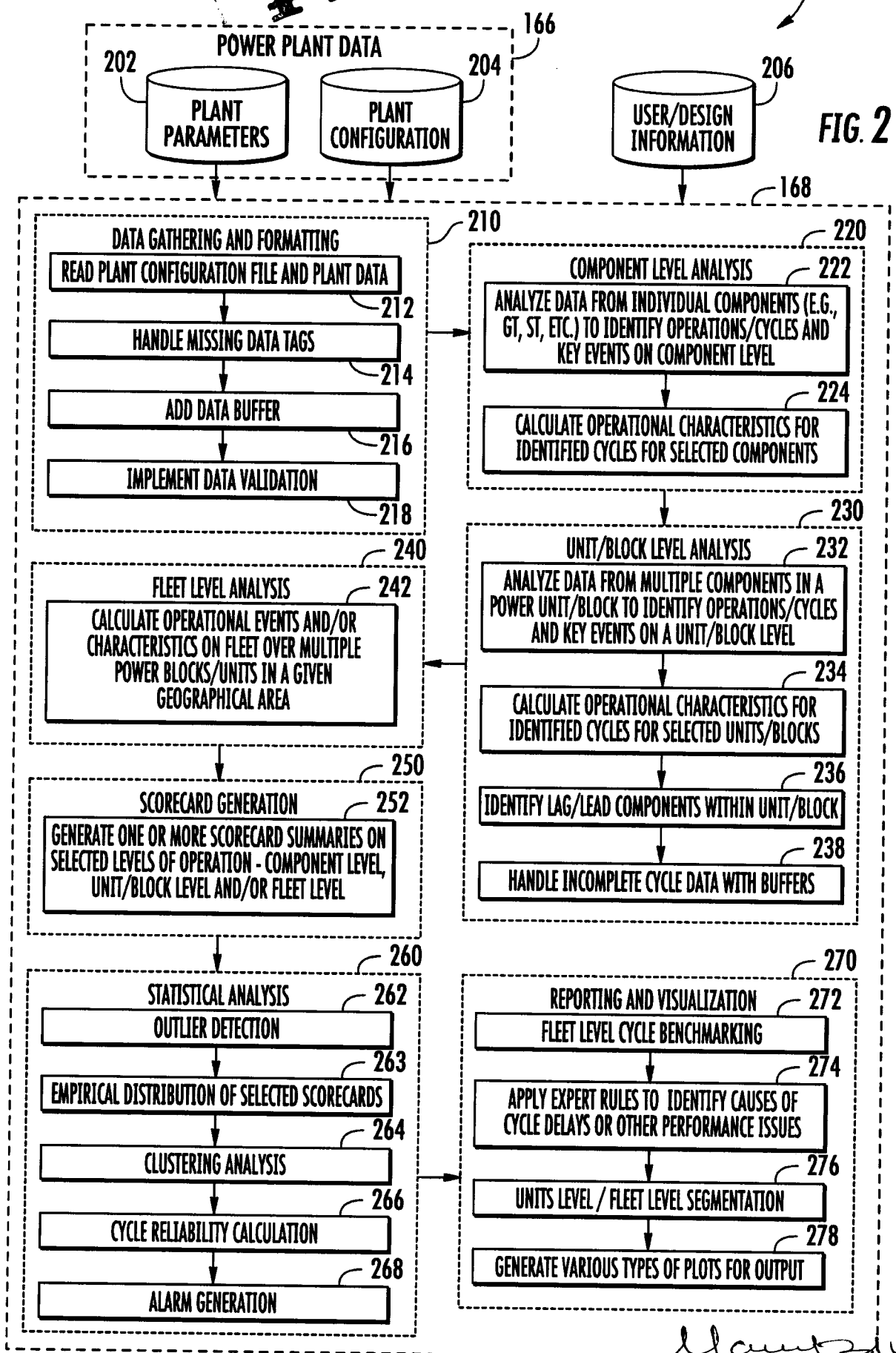

FIG. 2

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BLOCK_NAME	DATE	START_CLASSIFICATION	PLANT_ECM	PLANT_BL	1X1_ECM	1X1_BL	GT1_START	GT1_FSNL	GT1_BREAKER	GT1_ECM	GT1_BL	GT2_START	GT2_FSNL	GT2_BREAKER	GT2_ECM	GT2_BL	ST1_START	ST1_FSNL	ST1_BREAKER	ST1_FFM	ST1_IPC	ST1_BL	ST_BOWL METAL TEMP	ST_1ST STAGE METAL TEMP
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PLANT A	2009/12/09 05:32	WS			89							0	25	26	89		68	85	86	86	89		898	698
PLANT A	2009/12/12 05:26	HS			103	199						0	25	26	103	199	75	91	92	92	95		839	777
PLANT A	2009/12/13 05:02	HS			132	240	760					0	26	27	132	240	46	60	61	62	64		1033	1033
PLANT A	2009/12/14 05:23	HS	106				0	27	27	106	114	37	63	63	106		83	98	99	100	103	168	984	936
PLANT A	2009/12/21 03:00	HS	242	249			151	178	179	242	249	0	32	32	181	188	84	102	110	97	111	258	859	804
PLANT A	2009/12/25 02:01	HS	371	1021			0	26	30	240	245	211	237	237	371	1021	98	128	136	133	184	431	839	812
PLANT A	2009/12/31 05:00	HS	121	127			0	26	26	121	127	36	62	64	121	127	36	51	52	53	68	146	993	945
PLANT A	2010/01/02 18:00	HS			85	91	0	26	26	85	91	86					41	57	58	59	62		1018	1002
PLANT A	2010/01/13 06:05	HS			62	696	177					0	26	26	62	696	41	56	57	57	61		1030	1023
PLANT A	2010/01/29 02:02	HS	317	875			213	239	239	217	875	0	26	27	297	363	94	131	132	135	154	361	862	860
PLANT A	2010/02/22 03:26	WS	217	221			123	149	152	215	221	0	27	59	215	221	95	117	119	96	136	237	662	527
PLANT A	2010/03/01 02:35	HS	266	1019			190	217	218	266	1019	0	26	27	208	215	87	109	110	93	202	1025	910	875
PLANT A	2010/03/14 20:23	CS					0	28	29			28	57	58									178	107
PLANT A	2010/03/18 02:00	HS	360	366			0	26	27	299	306	279	307	309	359	376	115	175	202	206	206	378	849	877
PLANT A	2010/03/20 04:09	HS	199	853			0	27	27	171	177	113	139	141	199	853	75	93	94	96	176	858	890	768
PLANT A	2010/03/26 05:02	CS			196	202	0	26	30	196	202						94	113	113	113	119		664	382
PLANT B	2010/01/06 15:10	HS	1183				0	31	76	614	952	856	1062	1065	1183	1189	127	418	422	150	495	1194	1022	1029
PLANT B	2010/01/20 17:46	WS			110							0	27	28	107	112	80	96	97	98	110		858	671
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PLANT B	2010/03/15 05:34	HS	113	160			0	29	28	113	160	33	59	61	113	160	63	82	83	84	87	160	981	915

FIG. 3

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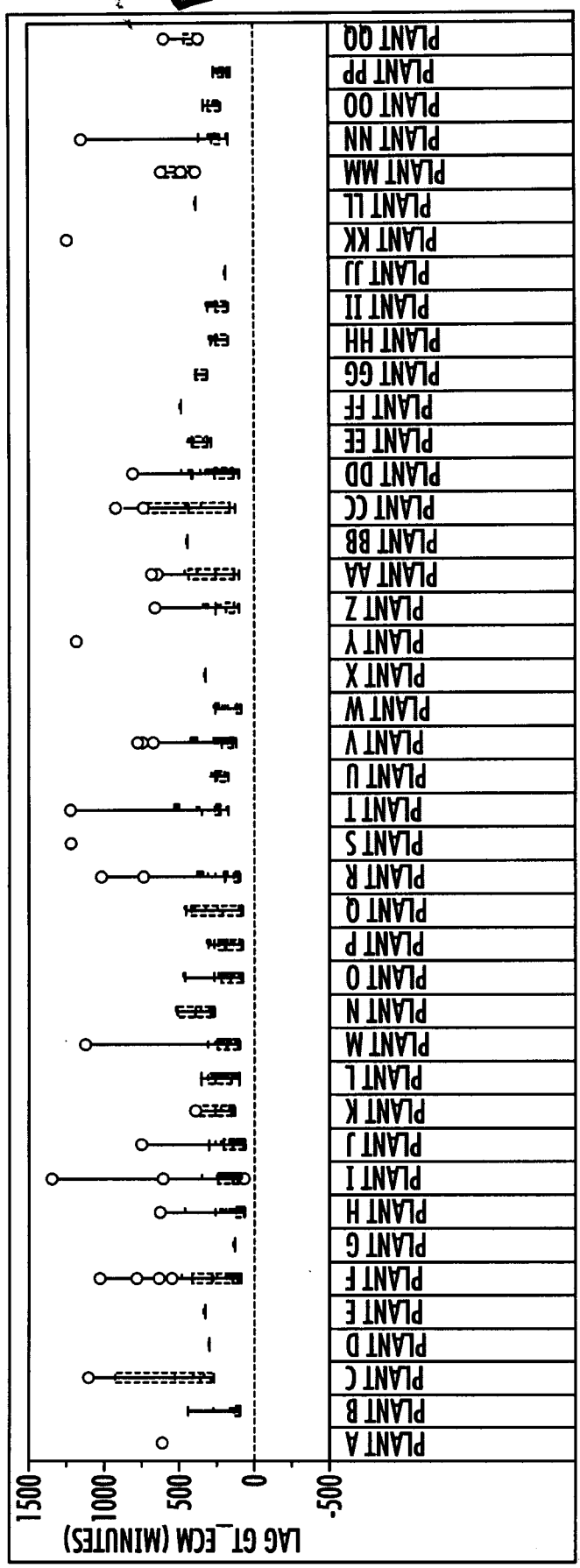

FIG. 4

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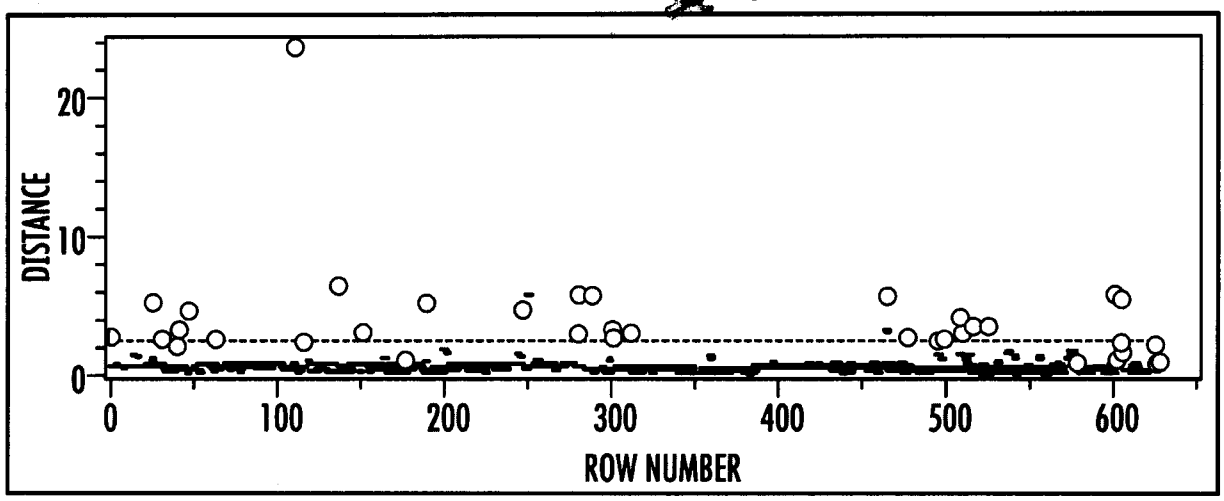

FIG. 5

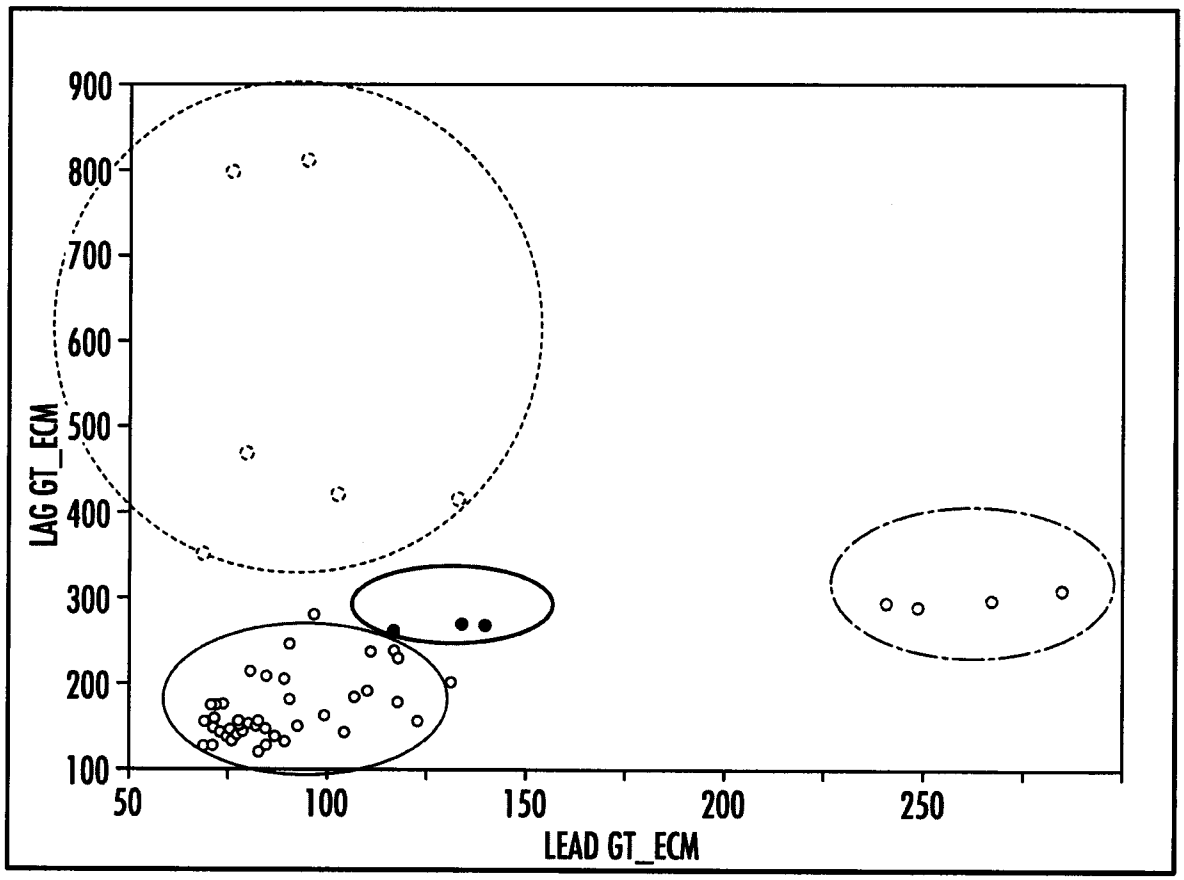

FIG. 6

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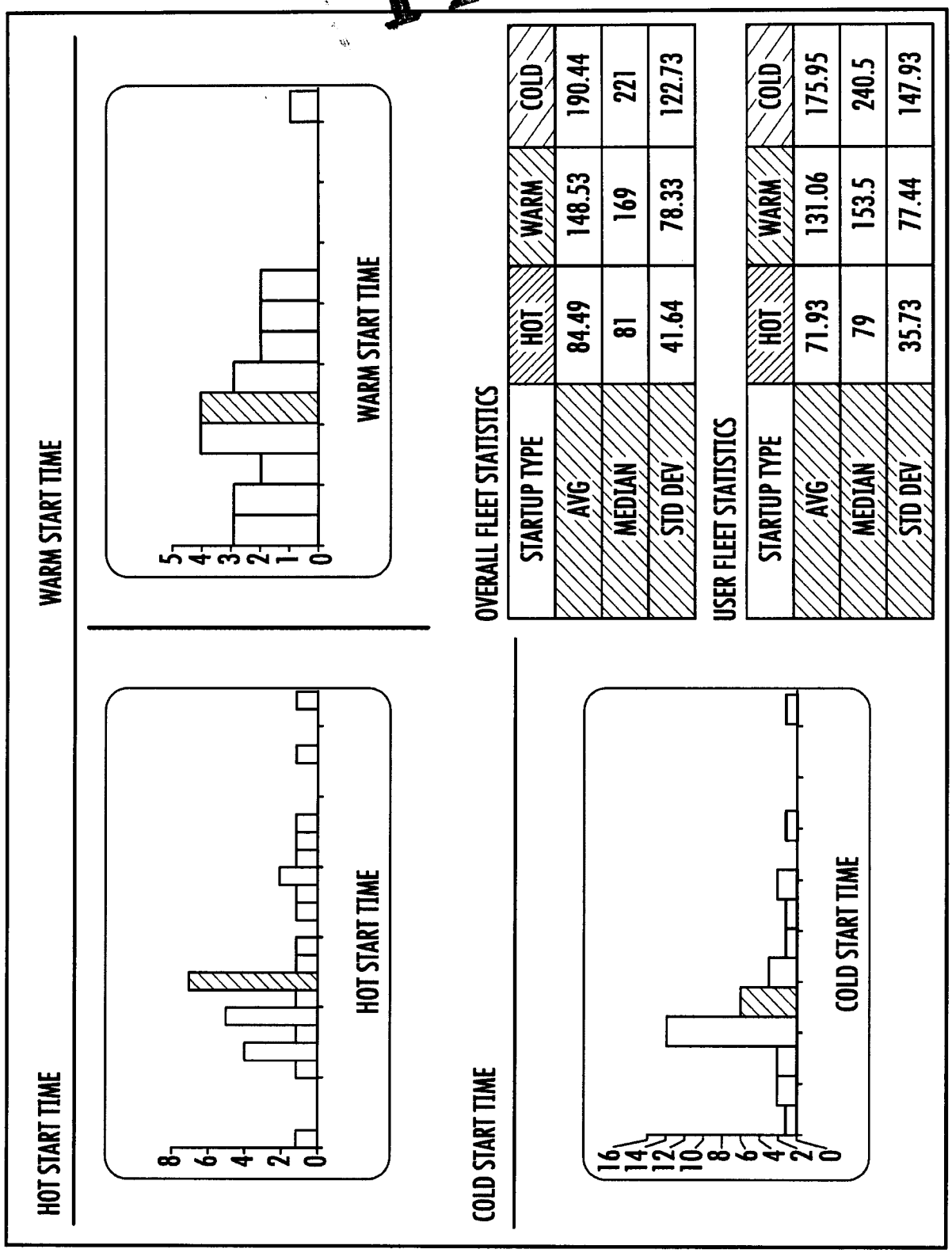

FIG. 7

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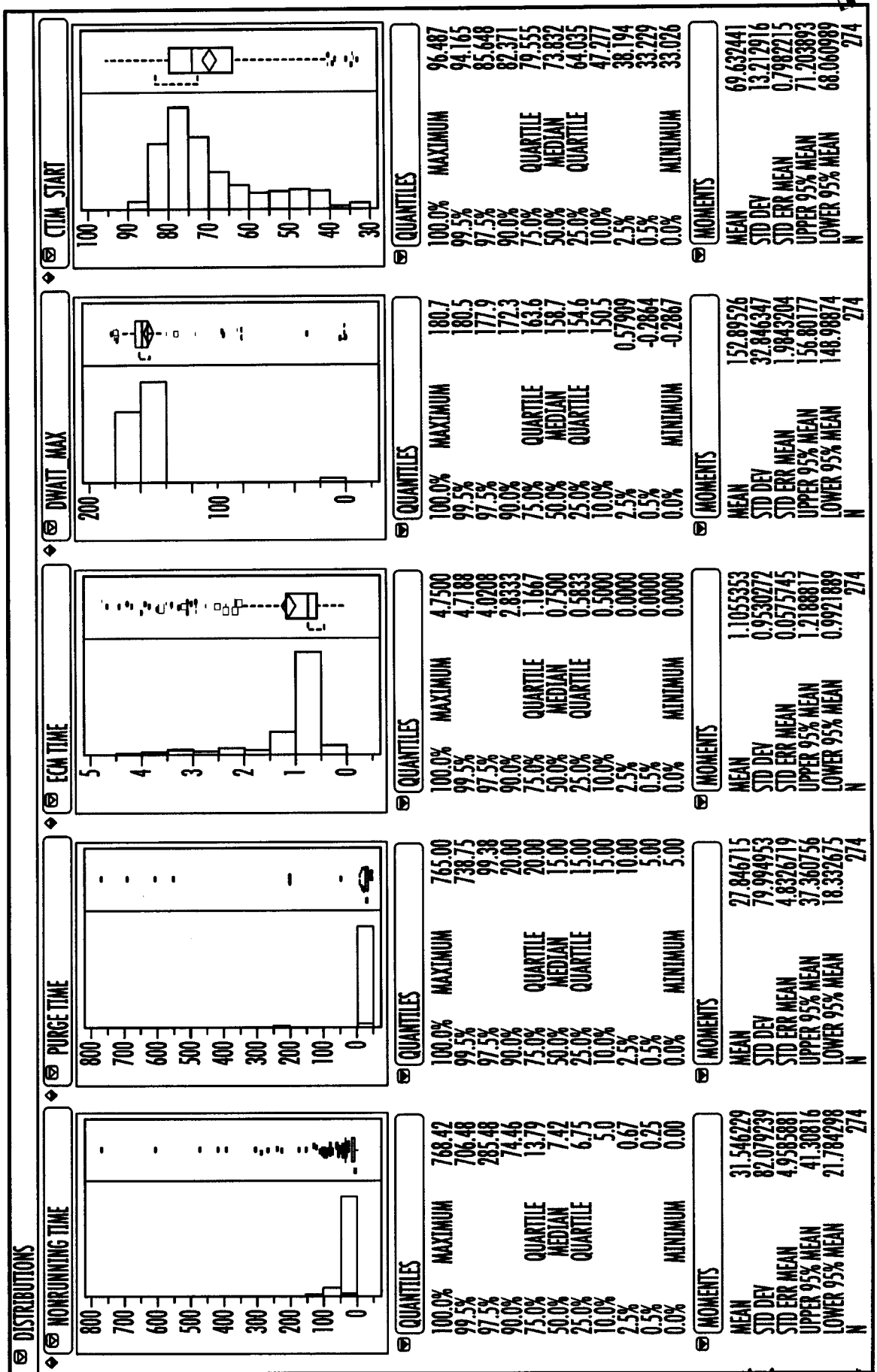

FIG. 8

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FIG. 9

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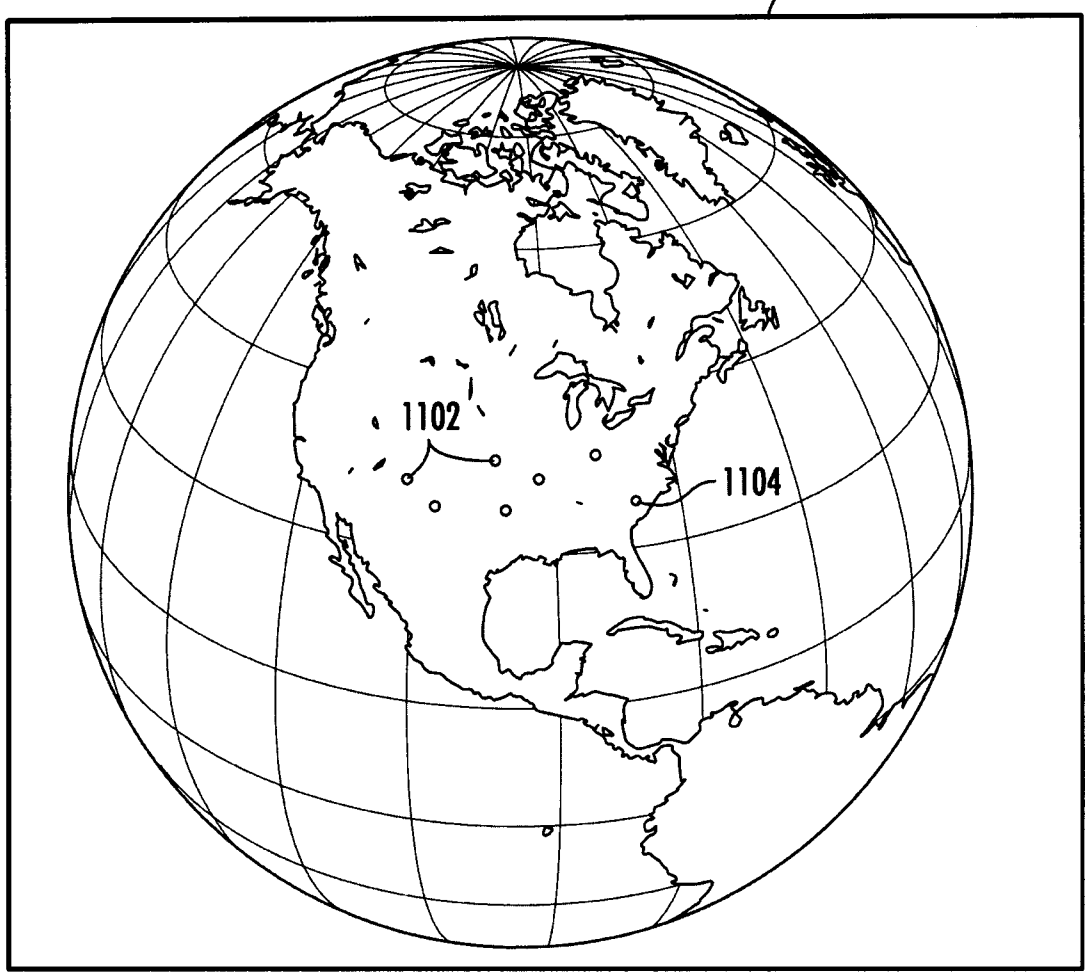

FIG. 11

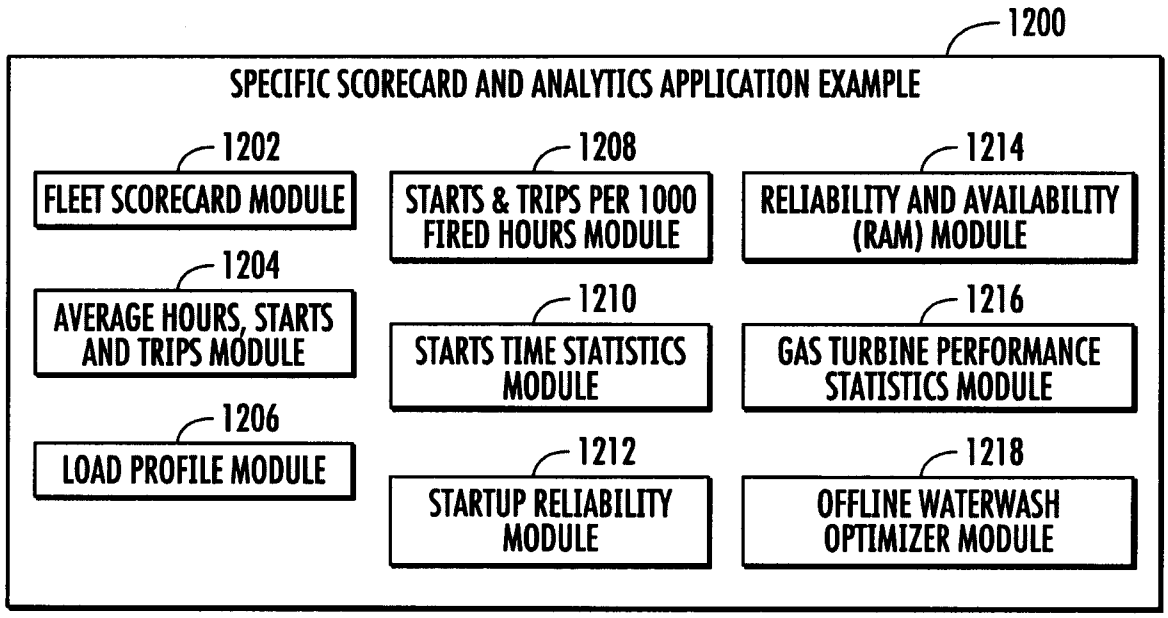

FIG. 12

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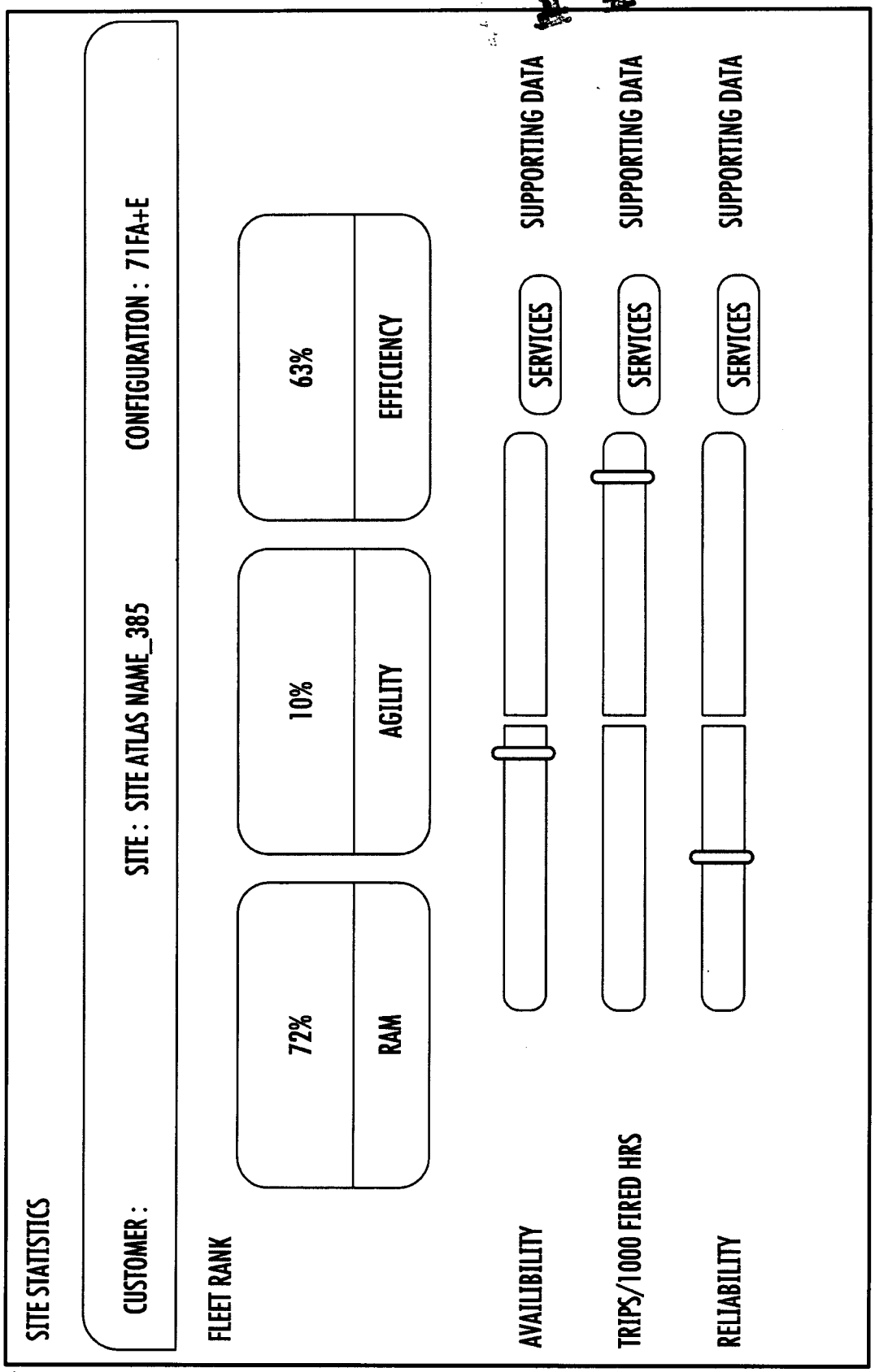

FIG. 10

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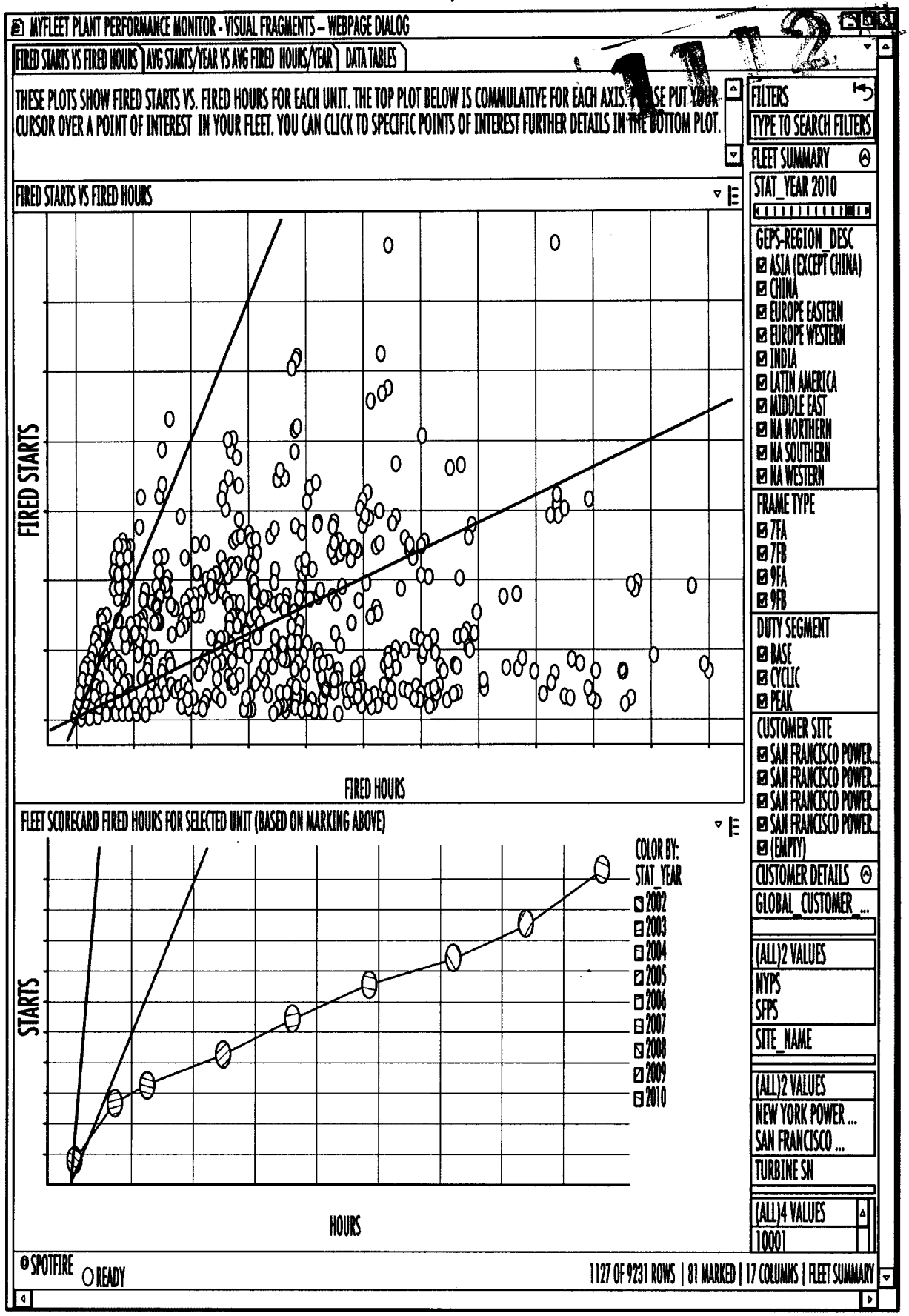

FIG. 13

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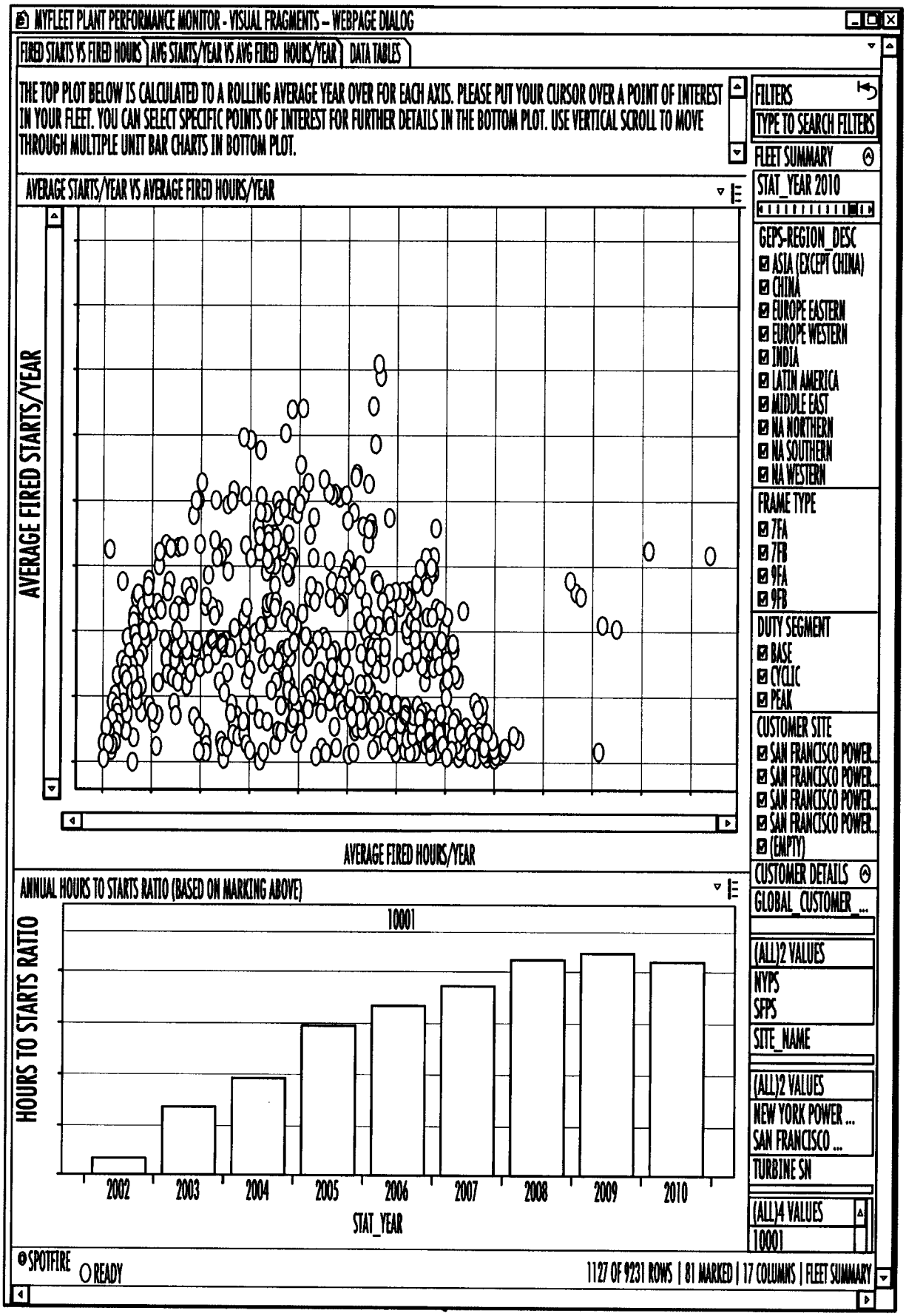

FIG. 14

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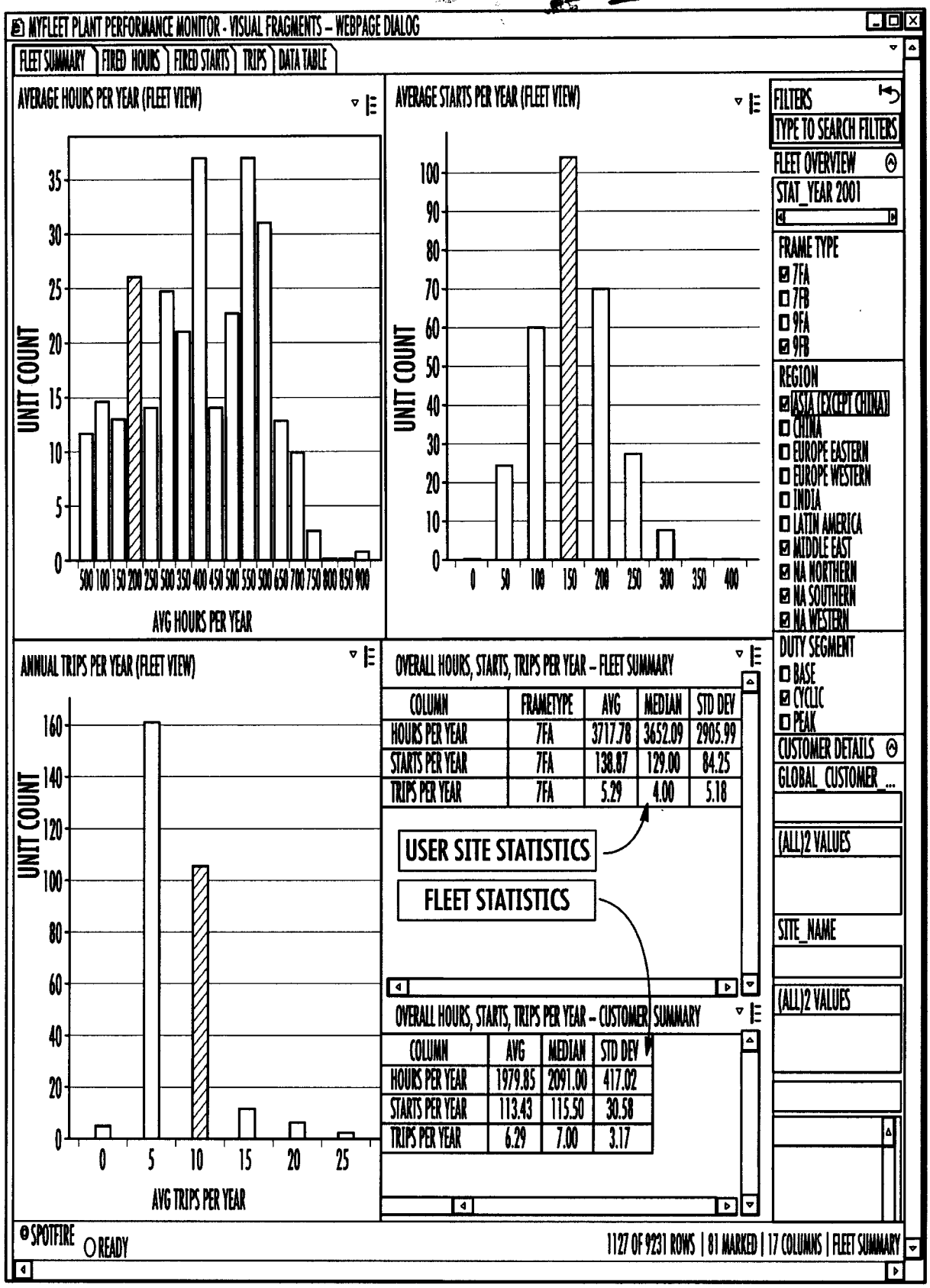

FIG. 15

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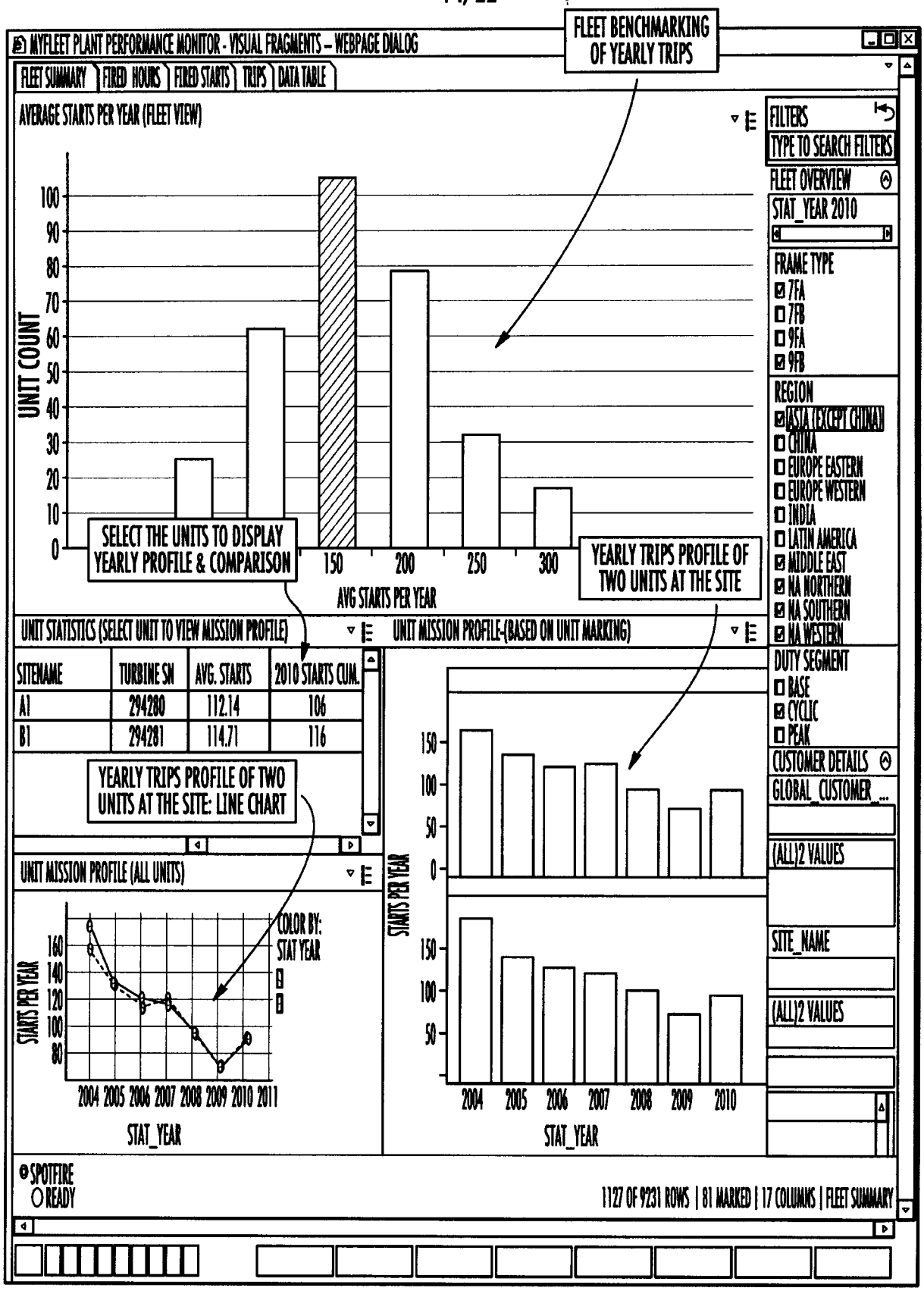

FIG. 16

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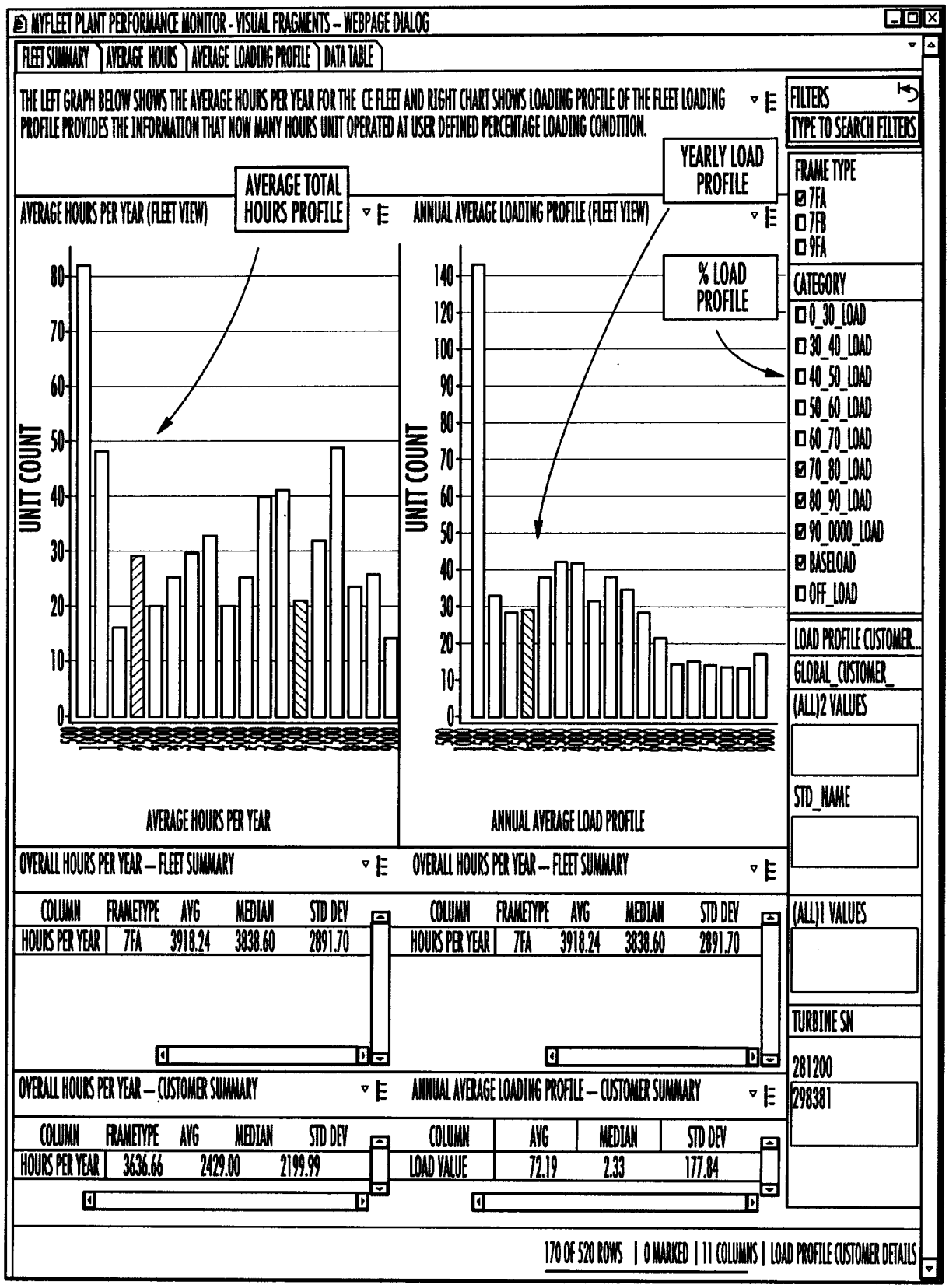

FIG. 17

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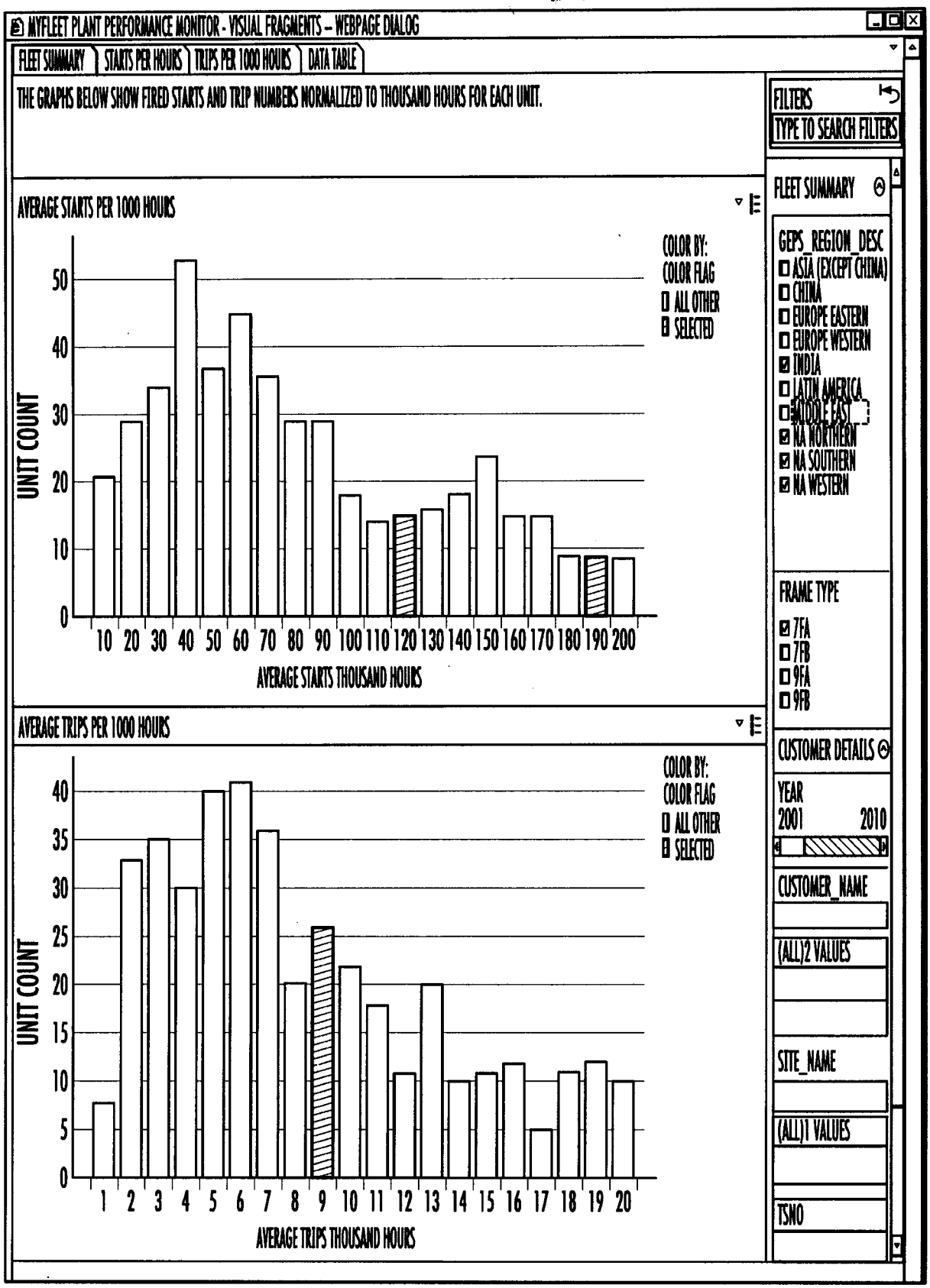

FIG. 18

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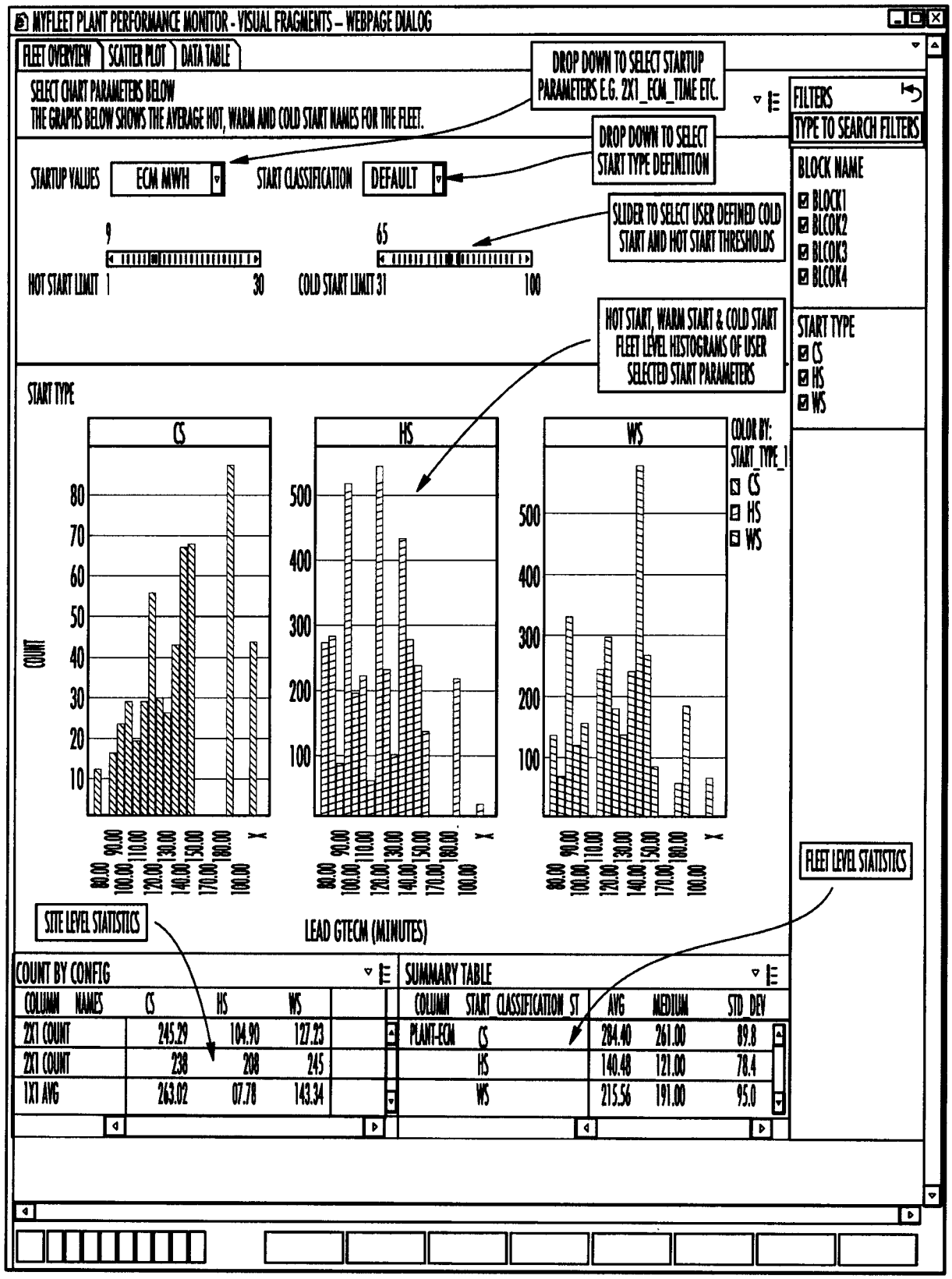

FIG. 19

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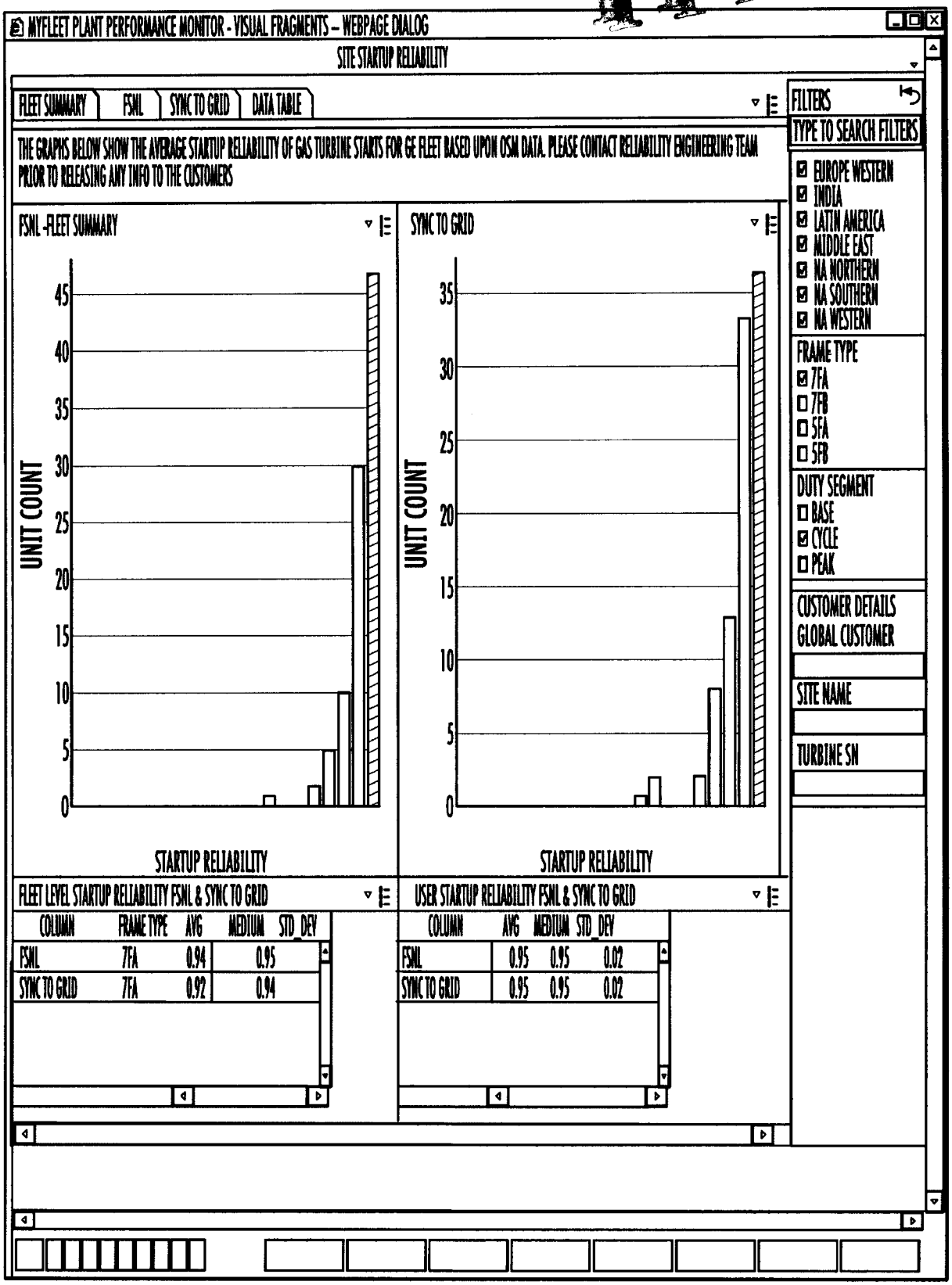

FIG. 20

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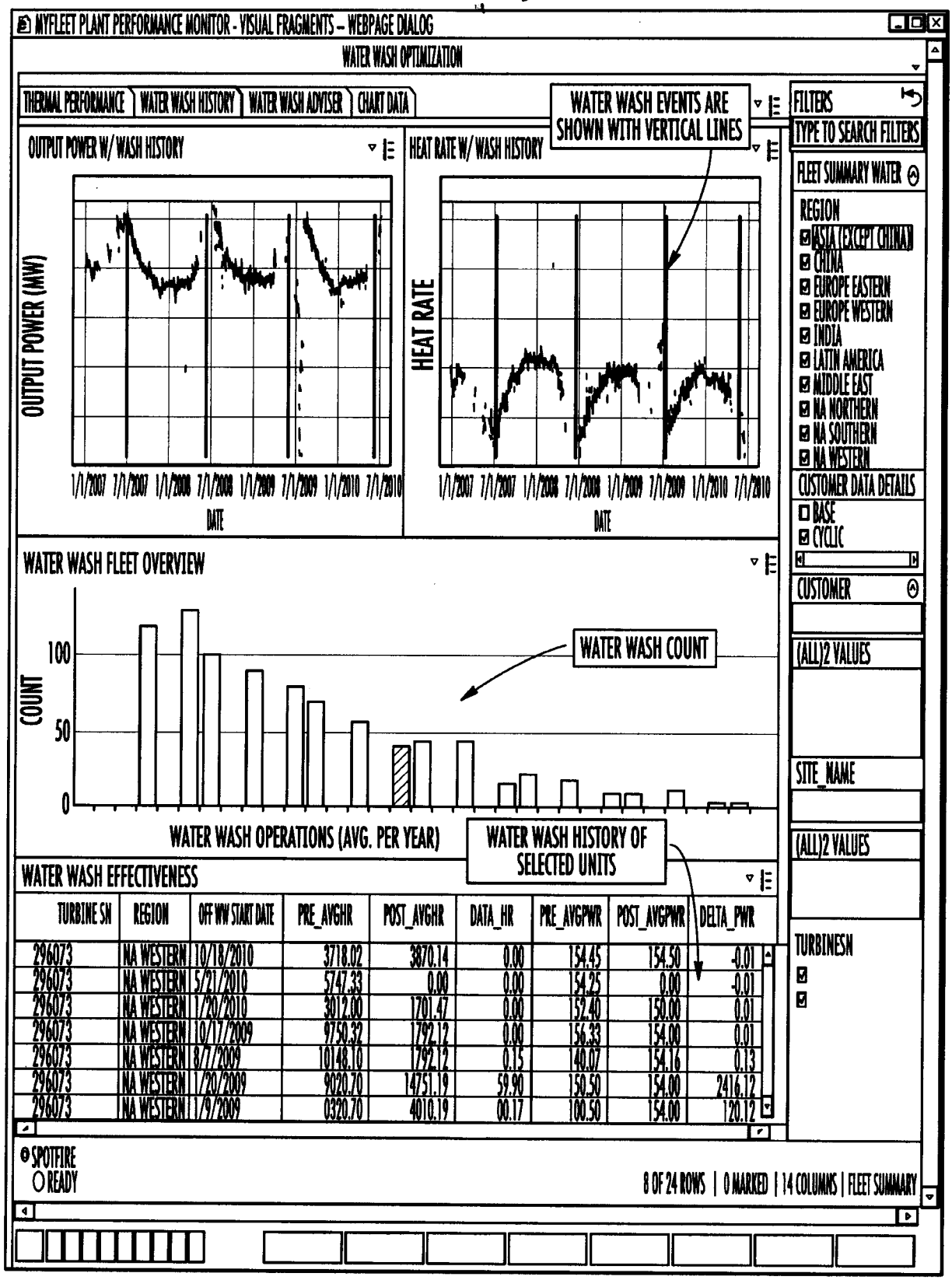

FIG. 21

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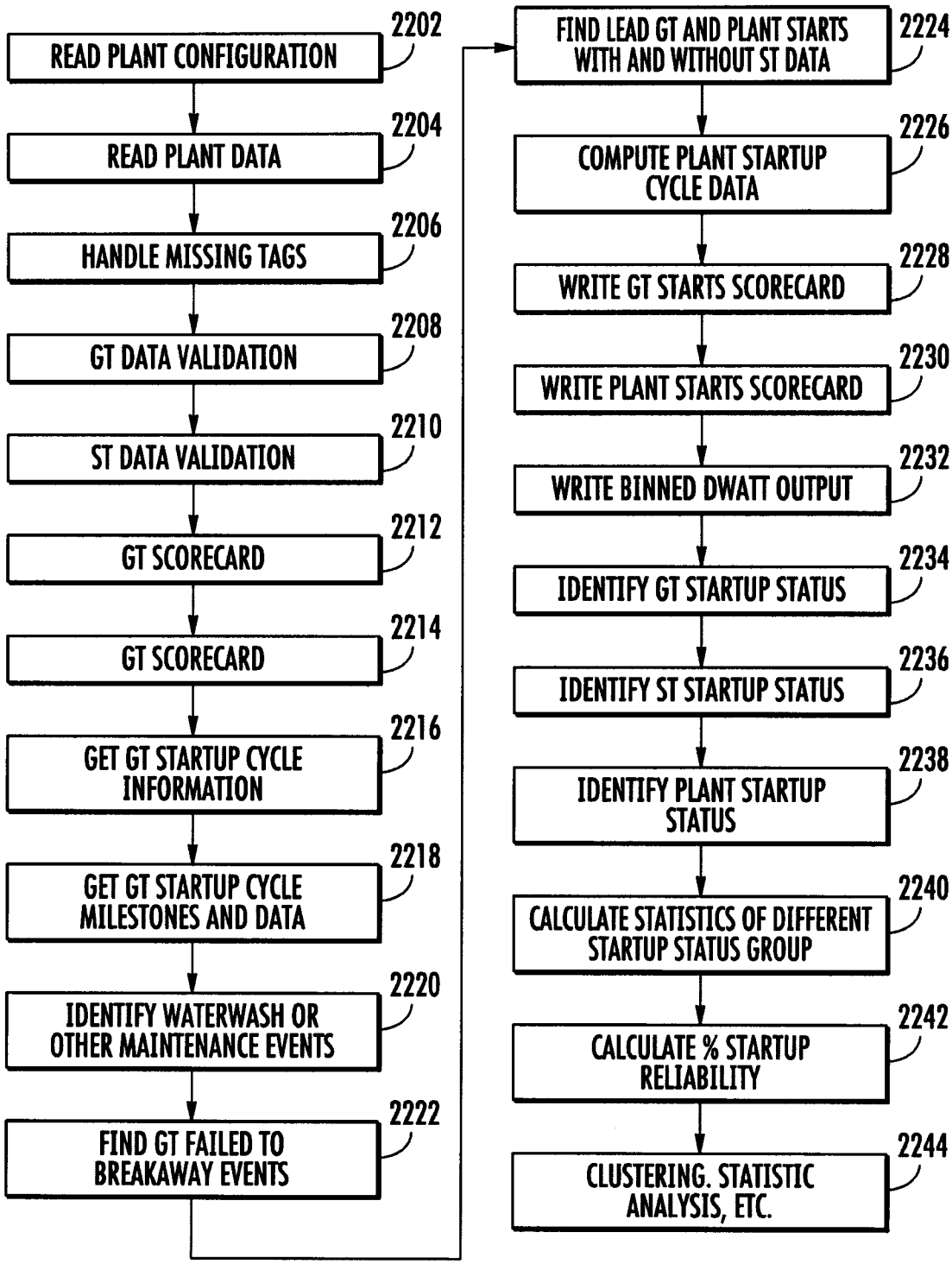

FIG. 22

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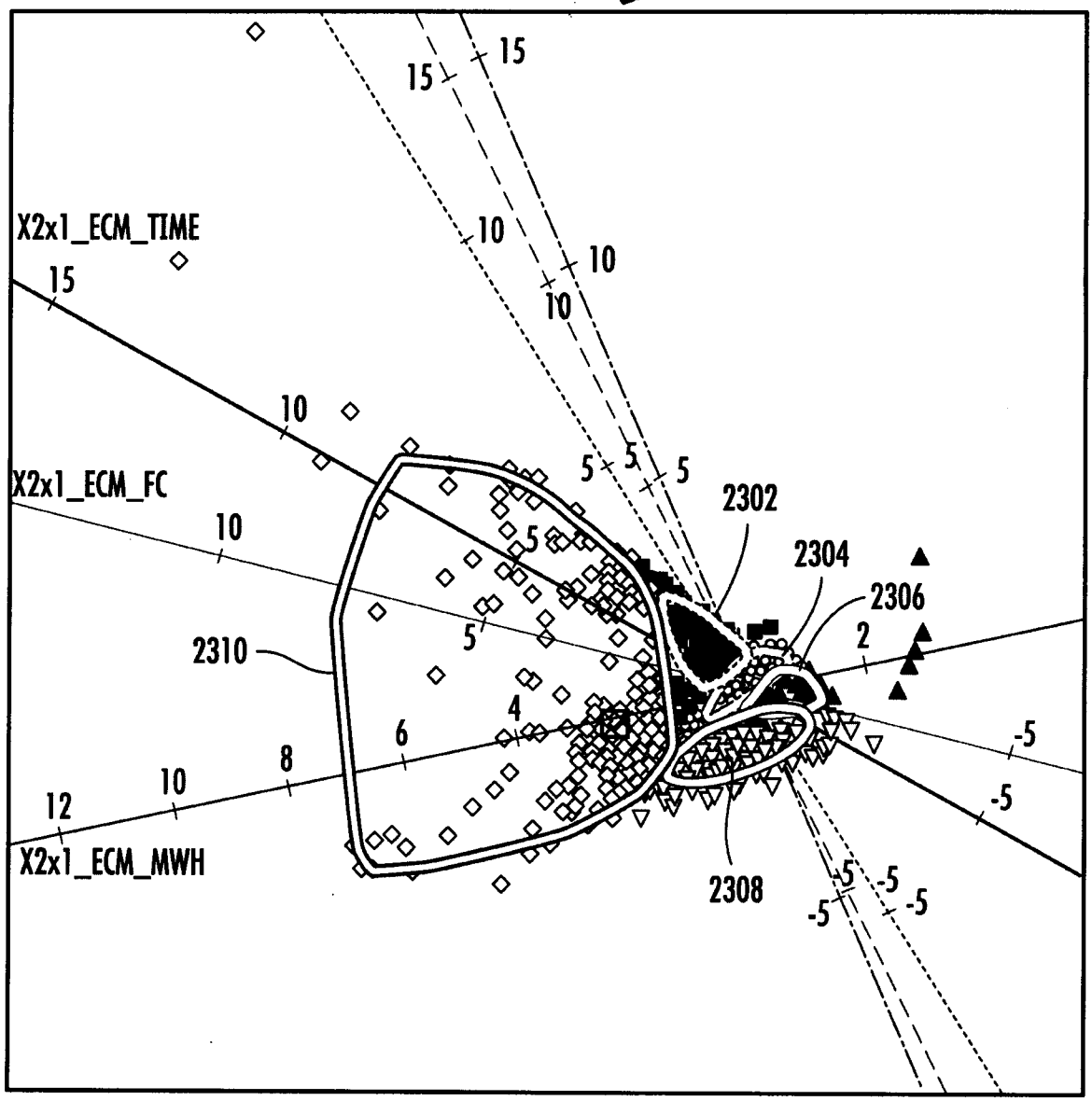

FIG. 23

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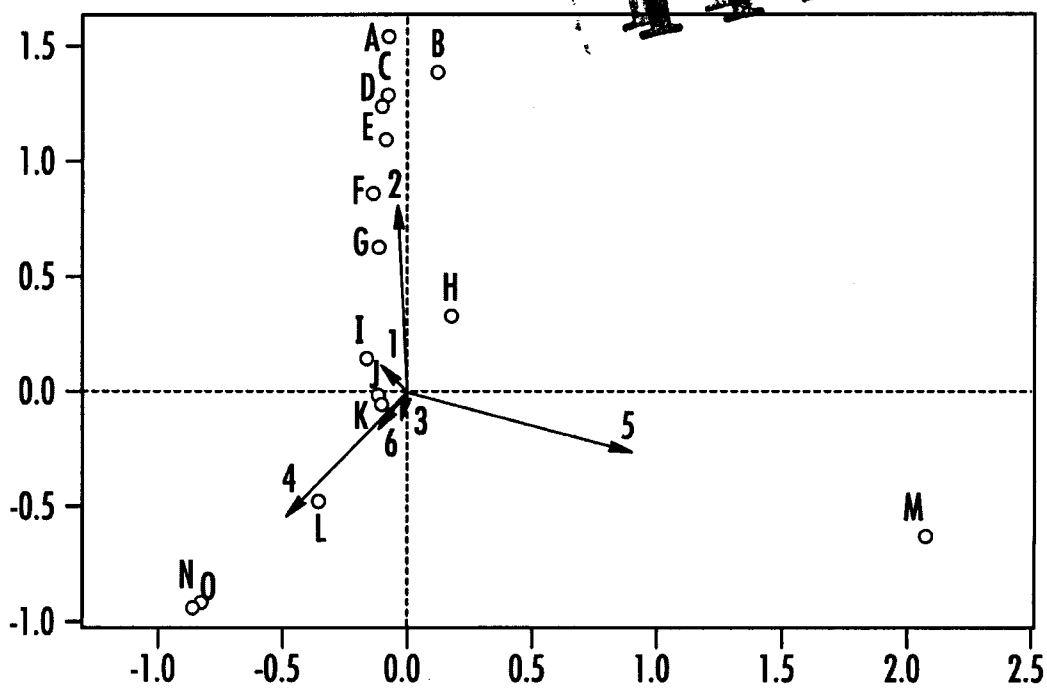

FIG. 24

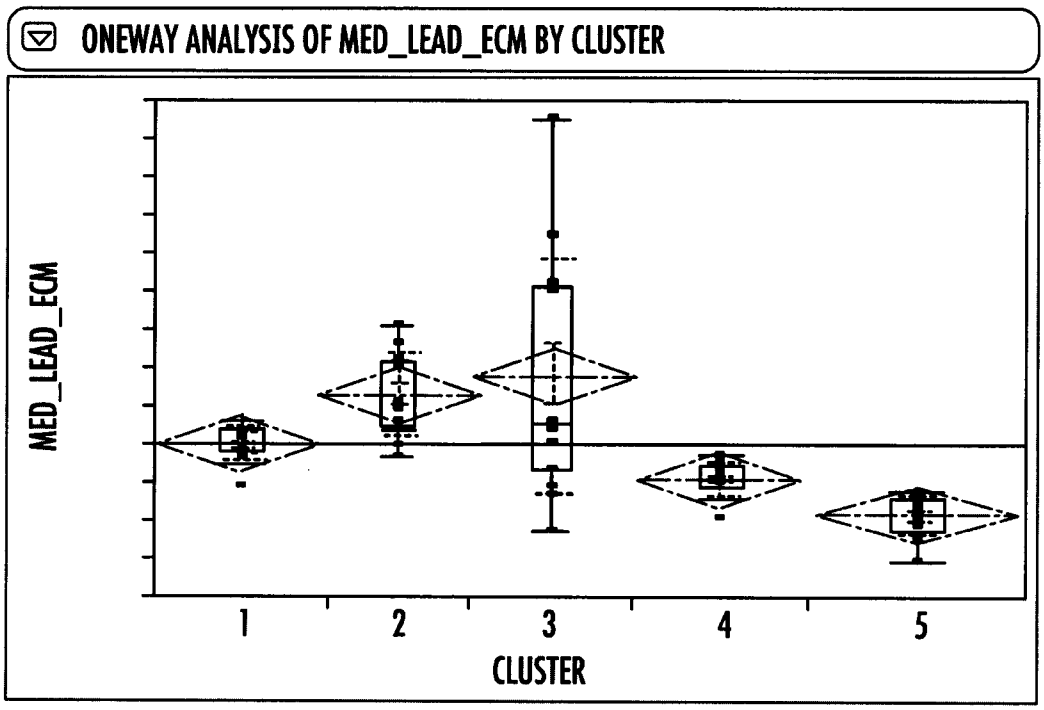

FIG. 25

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FIELD OF THE INVENTION

The subject matter disclosed herein relates to systems and methods for implementing automated unit level and/or collective level benchmarking analysis within a power plant environment, and more particularly includes such particular features as scorecard generation, outlier detection and benchmarking visualization.

BACKGROUND OF THE INVENTION

Highly complex industrial operations such as implemented within a power plant environment often involve the sophisticated coordination of multiple machines and associated processes. Many of the industrial components within such a power plant environment may include sensors or other monitoring equipment in conjunction with a computing device so that the real-time conditions of such components can be electronically tracked. For example, some display panels within a power plant environment are capable of displaying various present plant operating conditions associated with the monitored respective components or processes within the plant.

The operational data for power plants described above is often available only in the form of a continuous time series. In other words, sensors constantly monitor a component and provide a non-stop flow of data such that an operator can observe real-time statistics of the present operational state of various plant components. To pick out specific plant operations from that data is a non-trivial matter.

Some known techniques are able to analyze specific plant operations only by undergoing a manual process of sorting and reviewing information on an ad hoc basis as necessary in response to a particular issue or concern. Such techniques typically involve manually mining reams of data to find particular plant operations and/or events, filtering through those operations/events to find ones that are relevant, extracting a few signals from the data, and then plotting them against one another. All of these lengthy and complex steps are normally done on an ad hoc basis, and typically have to be repeated for each issue as it arises. As such, a need remains to