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(54) **ELECTRONIC MAINTENANCE WORK CARDS**

(75) Inventor: **Barry Sinex**, Duluth, MN (US)

Correspondence Address:
KINNEY & LANGE, P.A.
THE KINNEY & LANGE BUILDING, 312 SOUTH THIRD STREET
MINNEAPOLIS, MN 55415-1002

(73) Assignee: **Sinex Aviation Technologies Corporation**, Duluth, MN (US)

(21) Appl. No.: **12/029,265**

(22) Filed: **Feb. 11, 2008**

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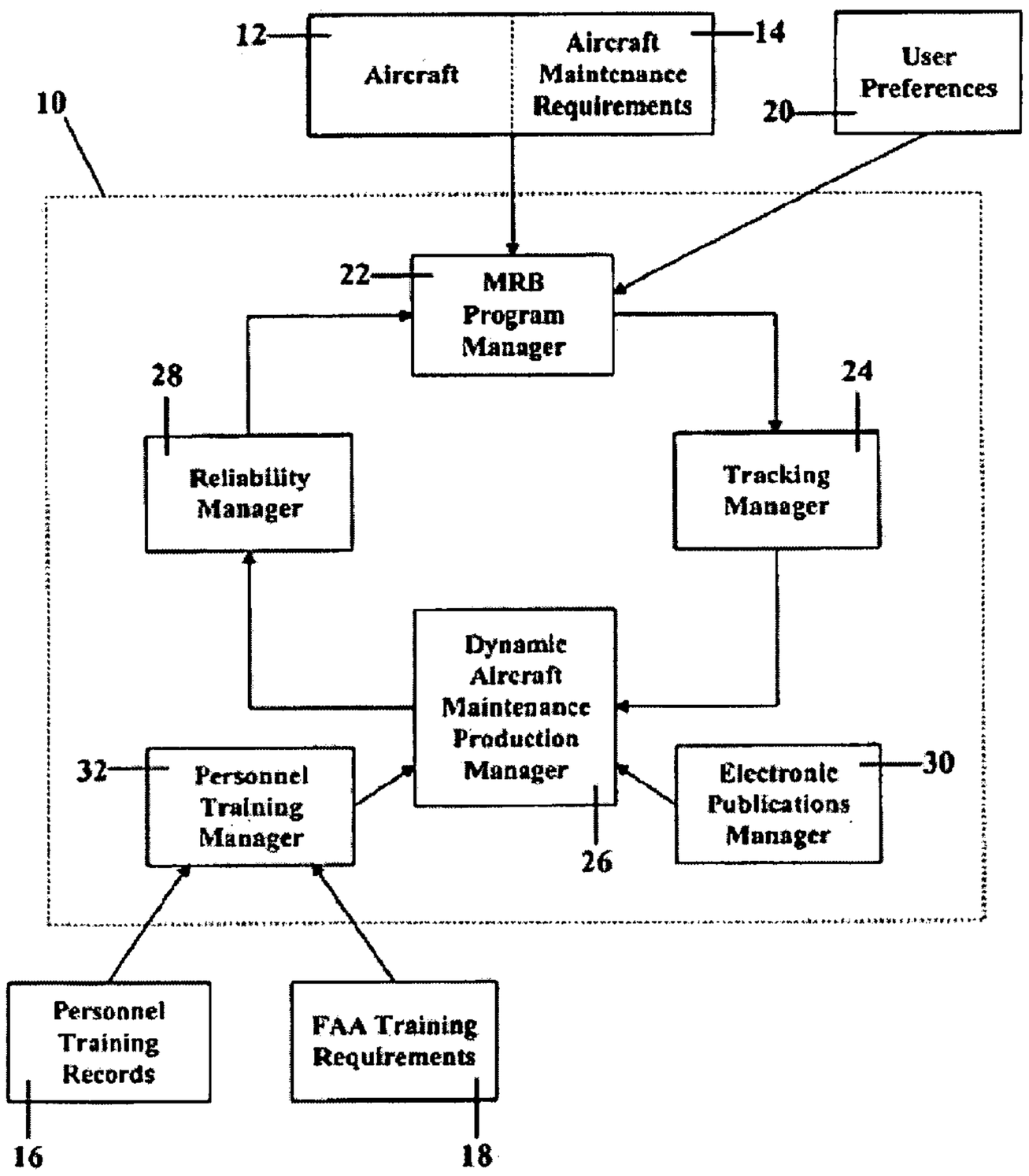
Publication Classification

(51) **Int. Cl.**
G01M 17/00 (2006.01)

(52) **U.S. Cl.** **701/29**

(57) **ABSTRACT**

A method for electronically documenting the completion of maintenance tasks in a maintenance industry which requires recordation of maintenance tasks performed, and in which required maintenance tasks are documented on a plurality of work cards, the method includes retrieving a legacy work card that is an electronic document itemizing a plurality of maintenance tasks to be performed and specifying by skill level whom may perform the itemized maintenance tasks, creating, from the legacy work card, an electronic work card including a plurality of data entry fields that include at least a sign-off field, receiving data corresponding to a designated data entry field, and modifying the electronic work card to include the received data corresponding to the designated data entry field.



(SYSTEM OVERVIEW)

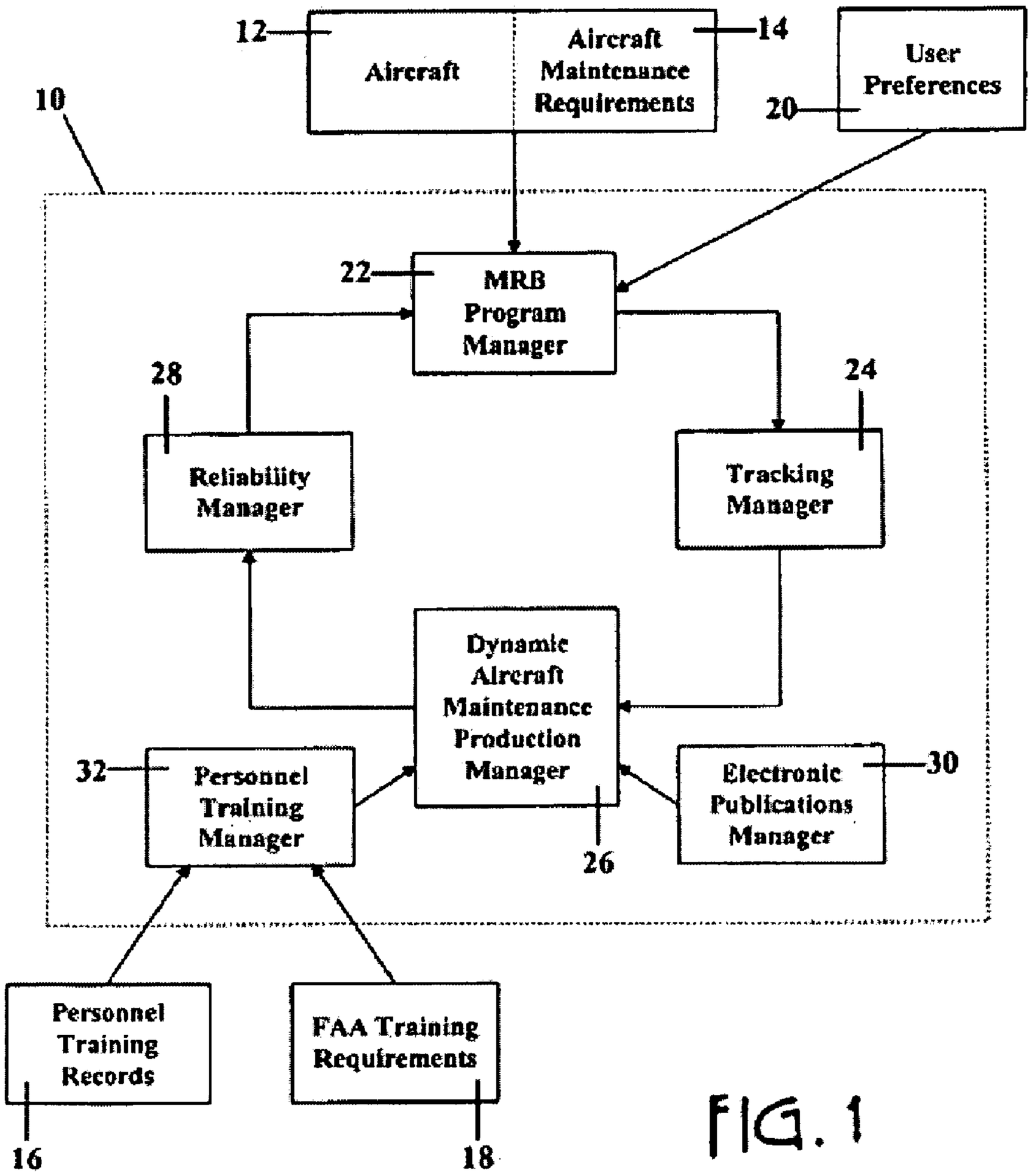


FIG. 1

(SYSTEM OVERVIEW)

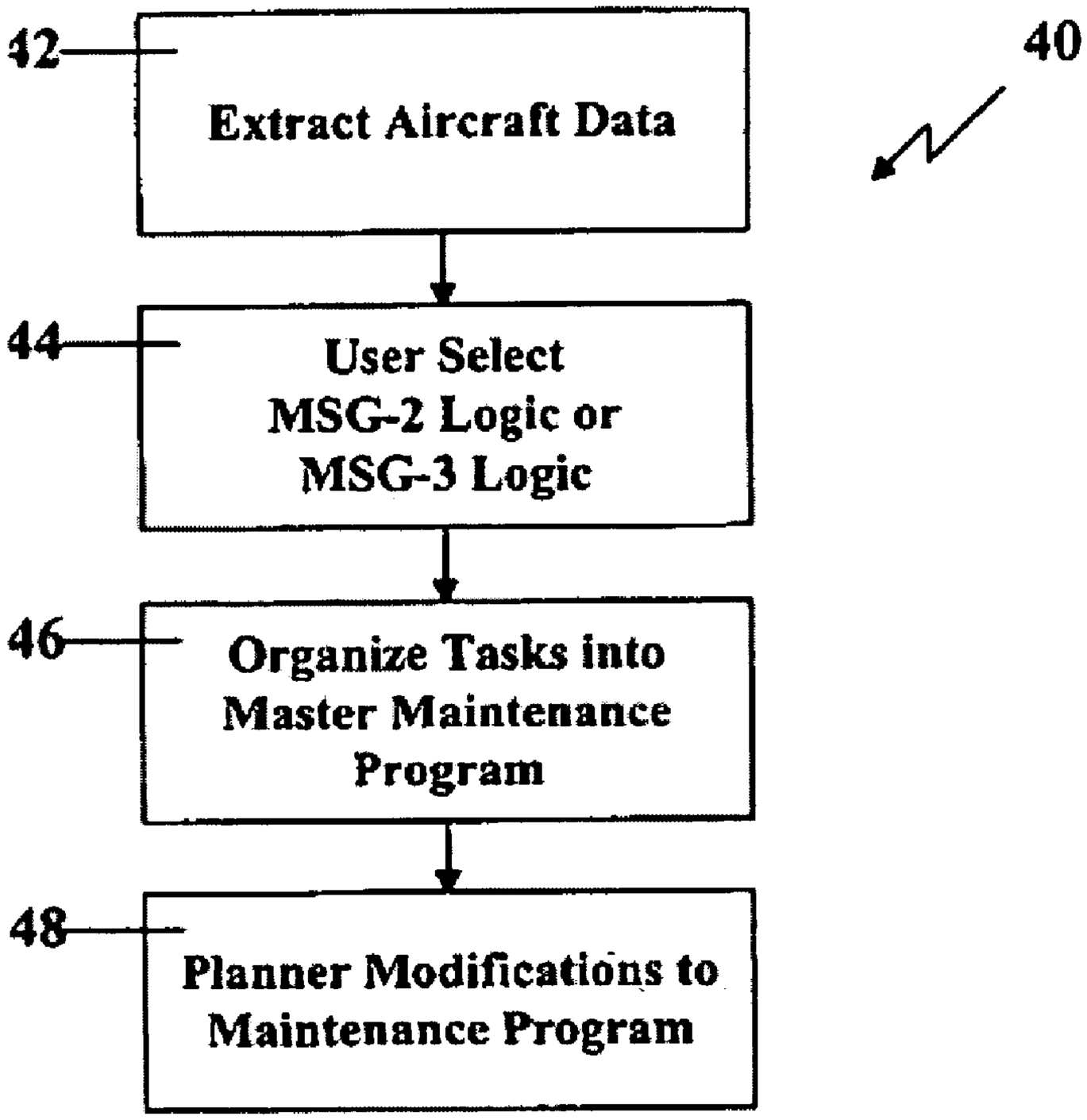


FIG. 2
(MRB PROGRAM MANAGER)

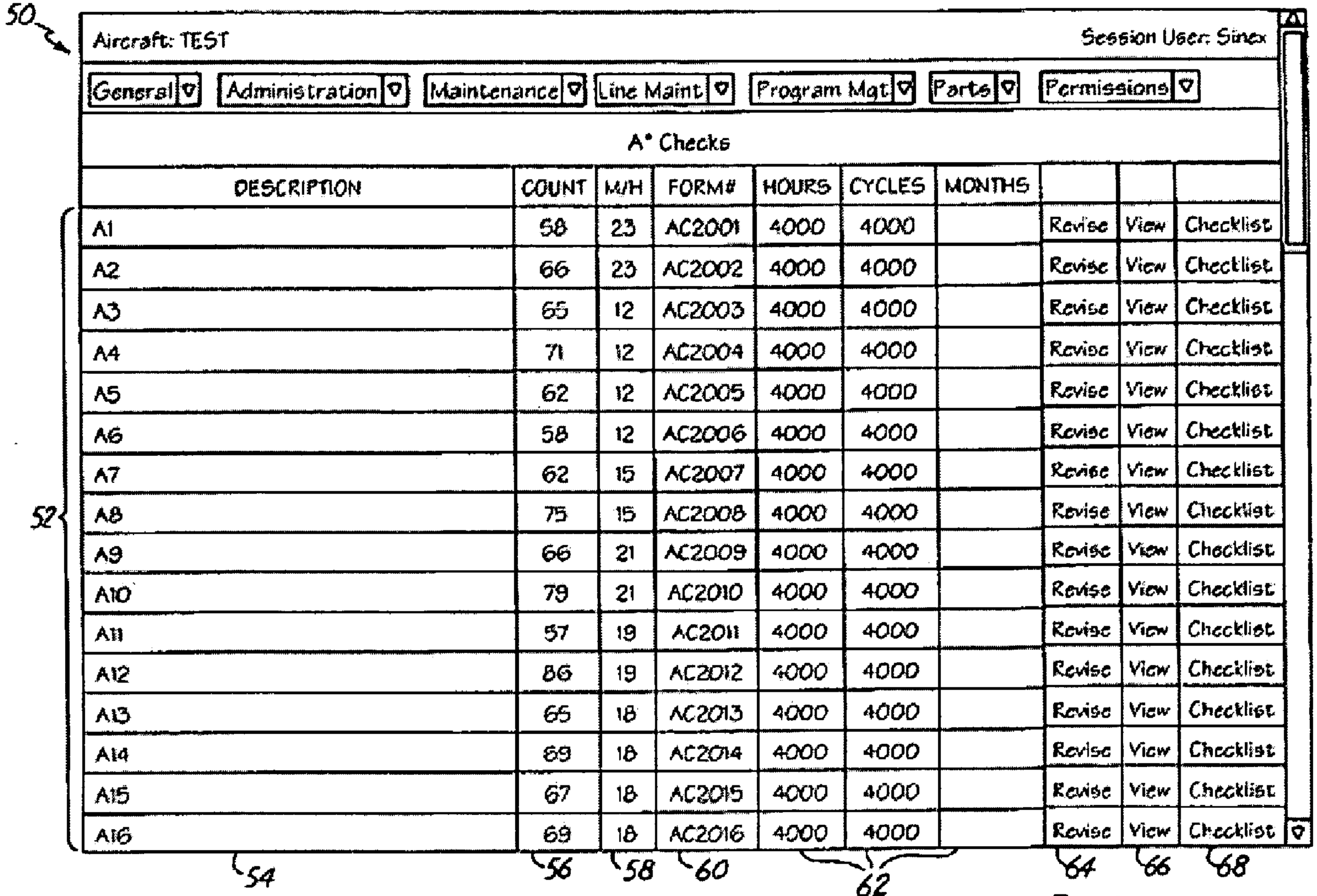

50
Aircraft: TEST
Session User: Sinex
General
Administration
Maintenance
Line Maint
Program Mgt
Parts
Permissions
A* Checks
DESCRIPTION
COUNT
M/H
FORM#
HOURS
CYCLES
MONTHS
A1 58 23 AC2001 4000 4000 Revise View Checklist
A2 66 23 AC2002 4000 4000 Revise View Checklist
A3 65 12 AC2003 4000 4000 Revise View Checklist
A4 71 12 AC2004 4000 4000 Revise View Checklist
A5 62 12 AC2005 4000 4000 Revise View Checklist
A6 58 12 AC2006 4000 4000 Revise View Checklist
A7 62 15 AC2007 4000 4000 Revise View Checklist
A8 75 15 AC2008 4000 4000 Revise View Checklist
A9 66 21 AC2009 4000 4000 Revise View Checklist
A10 79 21 AC2010 4000 4000 Revise View Checklist
A11 57 19 AC2011 4000 4000 Revise View Checklist
A12 86 19 AC2012 4000 4000 Revise View Checklist
A13 65 18 AC2013 4000 4000 Revise View Checklist
A14 69 18 AC2014 4000 4000 Revise View Checklist
A15 67 18 AC2015 4000 4000 Revise View Checklist
A16 69 18 AC2016 4000 4000 Revise View Checklist
52
54
56
58
60
62
64
66
68

FIG. 3

80

61-13	Check SECONDARY LOW-PITCH STOP (BETA) operation. O	400FH	0.1	OP	221, 222, 411, 421	revise
61-13	Check SECONDARY LOW-PITCH STOP (BETA) operation. O	400FH	0.1	OP	221, 222, 411, 421	revise
71-10	Verify DRAIN COLLECTOR TANK RETURN LINE check valves operation. O	1C	0.1	OP	433	revise
71-12	Check EEC Nh OVERSPEED PROTECTIVE FUNCTION OPERATION (MSI 73-20-02). O	600FH	0.45	OP	221	revise
760-07	Check flight idle stop system. O	1A	0.08	OP	221, 222	revise
79-10	Check engine model PW118/118A/118B chip detector. NOTE - According to manufacturer's recommendation approved by Canadian DOT. (See MRB Appendix 8.7 or MPG Appendix VI). O	SPECIAL	0.17	OP	412	revise
UPPER FUSELAGE ABOVE CABIN FLOOR						
24-08	Test MAIN BATTERY load capacity. O	5A	0.9	FC	115	revise
24-09	Check MAIN BATTERY electrolite level. 1	1A	0.5	IN	115	revise
5310-131-02E	Toilet flush valve support. NOTE - Applicable to FWD lavatory installation only. 1	1A	0.08	ESU	131, 132	revise
2710-143-01E	Perform external surveillance in wing center section. Lower skin panel and access panels from CL to wing rib 3. Requires fairing removal. 1	2A	3	ESU	143	revise
TAILCONE & EMPENNAGE GROUP						
322-012	ZONE 322 - DORSAL FIN - Perform external surveillance of the one, including visual examination of the vortex generators (Pre-Mod. SB 120-055-0008). 1	1A	0.08	ISU	322	revise
323-012	ZONE 323 - VERTICAL STABILIZER LEADING EDGE - Perform external surveillance of the zone, including visual examination of the vortex generators (Pre-MOD. SB 120-055-0008). 3	1A	0.08	ESU	323	revise
326-012	ZONE 326 - RUDDER 1 - Perform external surveillance of	1A	0.17	ESU	326	revise

82

84 86 88 90 92 94 96

FIG. 4

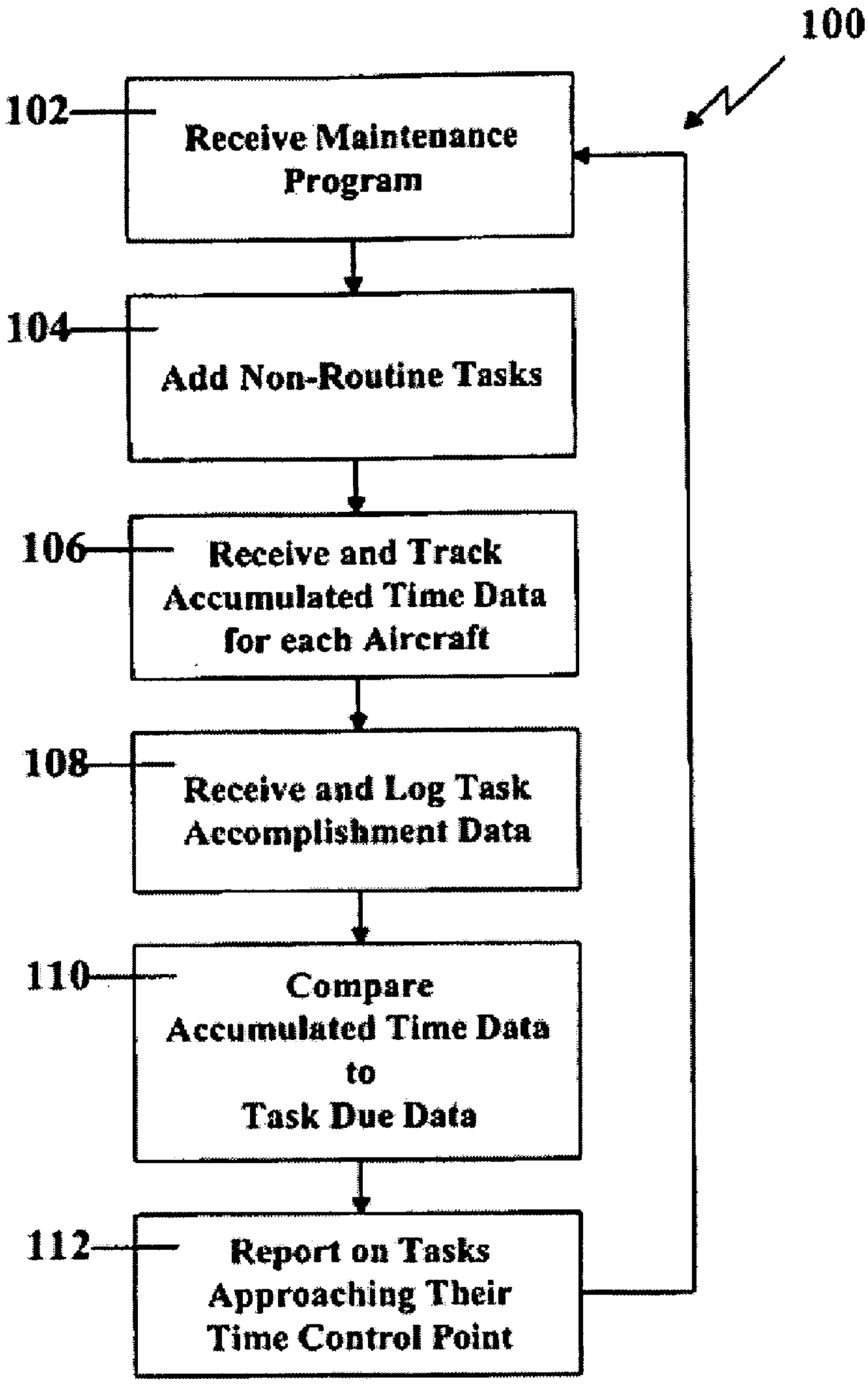


FIG. 5
(TRACKING MANAGER)

120

Aircraft: TEST — Session User: Sinex

General | Administration | Maintenance | Line Maint | Program Mgt | Parts | Permissions

STRUCTURES

SOURCE	DESCRIPTION	DONE	DUE	
5210-811-01E Interval 800 FC	5210-811-01 Passenger/crew entry door visible structure, stops and fittings. Program Interval A2, A5, A11, A17, A8, A14, A20,	8/23/99 dte 22871.1 hrs 23468 cyc	dte hrs 24268 cyc	VIEW
5210-811-01I Interval 24000FC	5210-811-01I Passenger/crew entry door internal elements, including stops and fittings. Requires door lining removal. Program Interval 24000FC.	9/26/00 dte 23160.1 hrs 23794 cyc	dte hrs 47794 cyc	VIEW
5220-812-01E Interval 24000FC	5220-812-01E Escape hatches visible structure. Program Interval 8000FC.	10/25/99 dte 23152.1 hrs 23789 cyc	dte hrs 31789 cyc	VIEW
5220-812-01E Interval 8000FC	5220-812-01E Escape hatch internal elements, including window frame. Requires door lining removal. Program Interval 32000FC.	dte hrs 0 cyc	dte hrs 32000 cyc	VIEW
5220-812-01I Interval 32000FC	5220-812-02E Perform external surveillance in escape hatch window frame. Program Interval A3, A8, A13, A18,	10/2/99 dte 23145 hrs 23786 cyc	dte hrs 24986 cyc	VIEW
5220-812-02E Interval 1200FC	5230-813-01E Cargo door visible structure. Program Interval 4000FC	10/25/99 dte 23152.1 hrs 23789 cyc	dte hrs 27789 cyc	VIEW

122

124 126 128 130 132

FIG. 6

140

Aircraft: N205CA — Session User: Sinex

General | Administration | Maintenance | Line Maint | Program Mgt | Parts | Permissions

Tasks Due by 11/30/2000 or within 1000 hours or within 10 cycles

142 — Select tasks due within 1000 Hours or 10 Cycles or by 11/30/2000 Date — 144 — 146

Edit Workorders

150 — Retrieve Records — 148

Select a Workorder

156

Description		152 Last Completed			154 Limits			Remaining		
Description	Meter	Hrs	Cyc	Date	Hrs	Cyc	Mo's	Hrs	Cyc	Days
24-10 Restore APU STARTER-GENERATOR. NOTE - According to manufacturer's recommendation. (See MRB Appendix B.7 or MPG Appendix VI).	APU	12457.0			1200			9	158	
49-06 Discard GARRET APU model GTCP36-150(A)(AA) OIL FILTER ELEMENT. NOTE - According to mfr. recommendation. (See MRB appendix B8.7 or MPG Appendix VI)	APU	13050.0			750			152		
49-05 Check APU CHIP DETECTOR. NOTE - According to manufacturer's recommendation. (See MRB Appendix B.7 or MPG Appendix VI).	APU	13050.8		1/22/00	750		12	153		53
24-13 Verify APU starter-generator GCU (GENERATOR CONTROL UNIT) operation	APU	12357.0			1600			309	159	
24-11 Visually check APU starter-generator QUICK ATTACH/DETACH QAD fit generator condition. NOTE - At the time of starter-generator restoration.	APU	13050.6			1200			603		
4 Day - Service Check	A/C			11/24/00						2
520-07 Verify operation of escape hatch locking mechanism. NOTE - Requires removal of escape hatches - 400FH or 2MO	A/C	19965.5	20415	10/2/00	400		2	367		2

FIG. 7

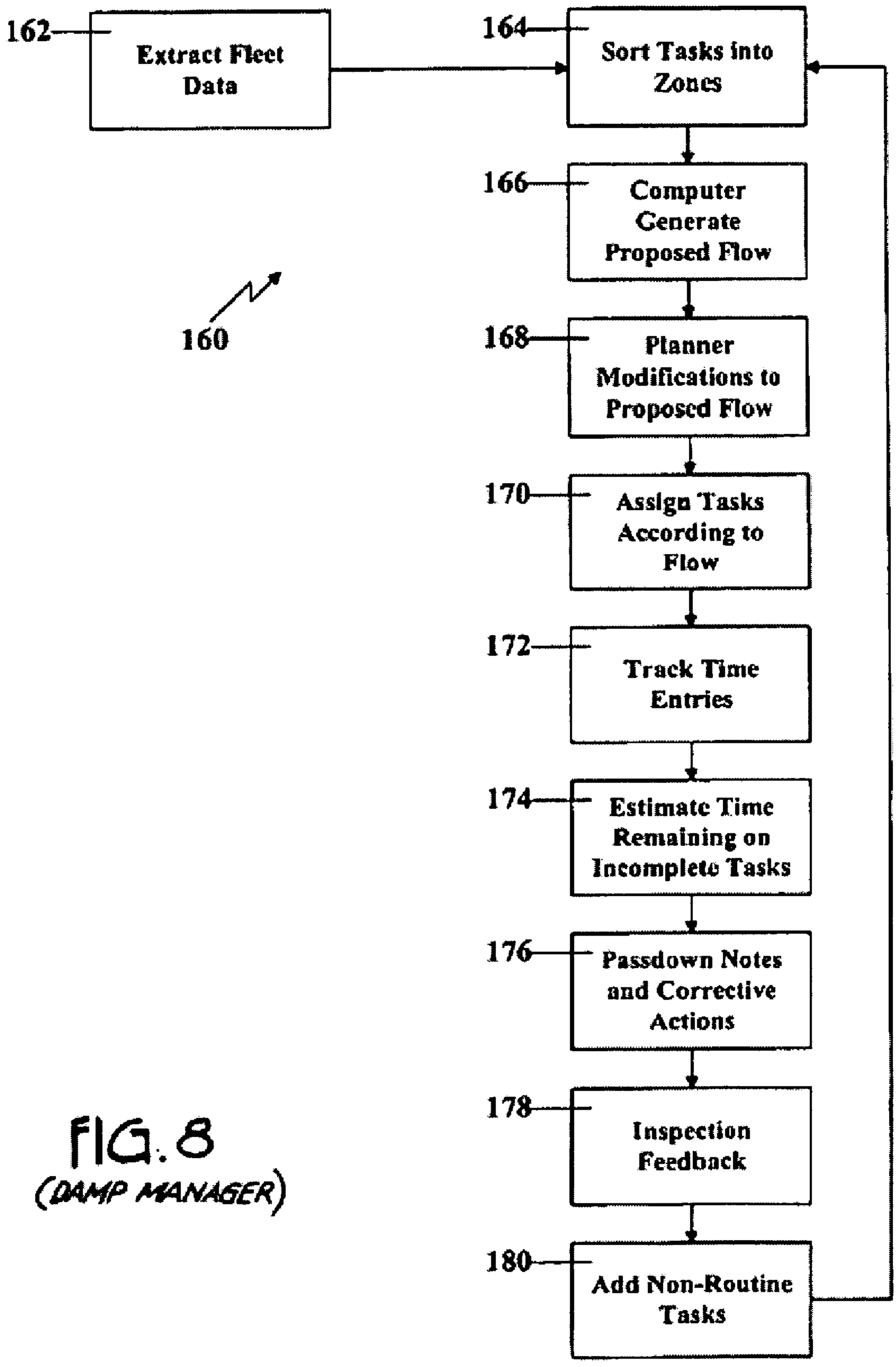


FIG. 8
(DAMP MANAGER)

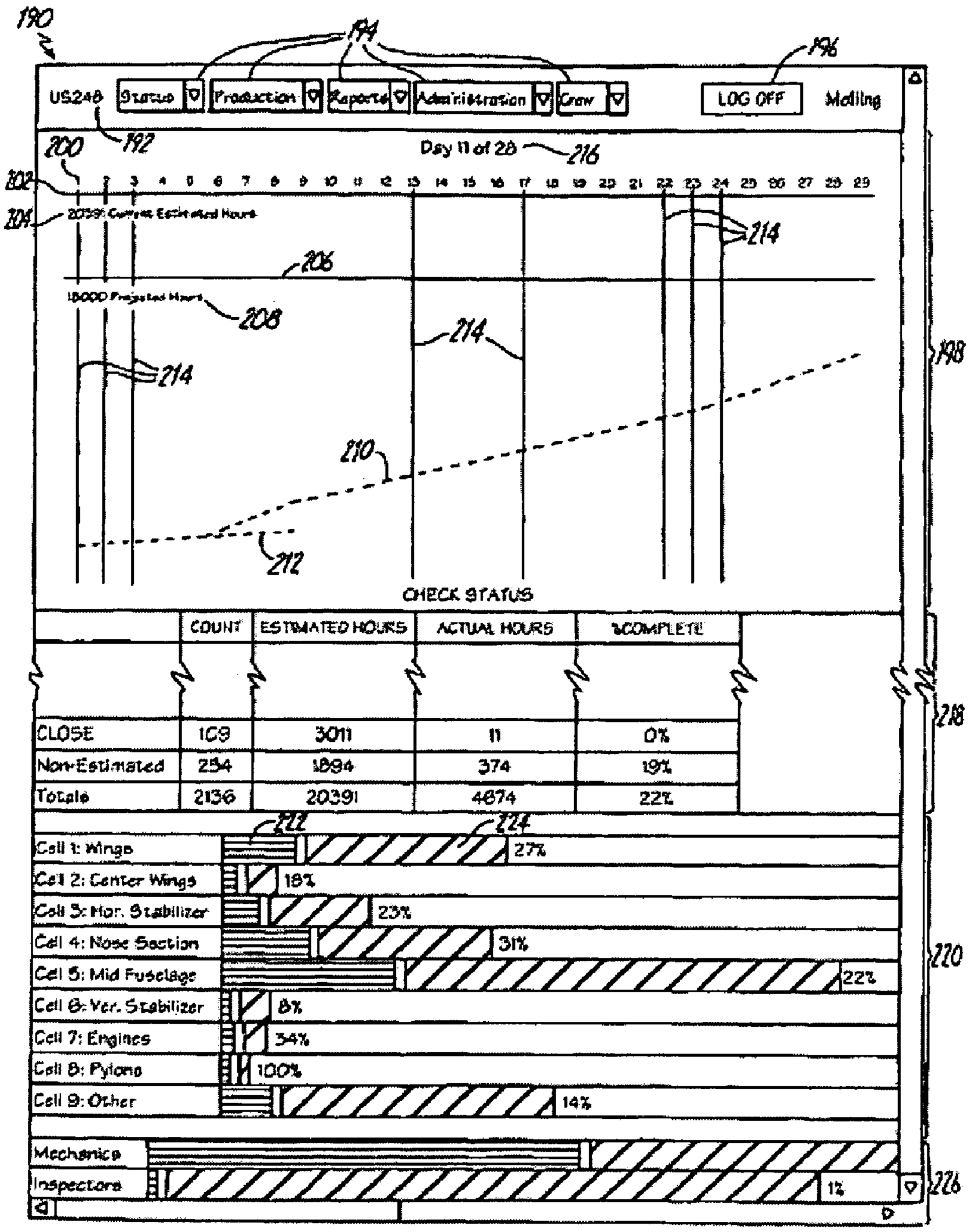

190
194
196
US248
Status
Production
Reports
Administration
Crew
LOG OFF
Malling
200
192
Day 11 of 28
216
202
204
206
208
214
210
212
198
CHECK STATUS
COUNT
ESTIMATED HOURS
ACTUAL HOURS
%COMPLETE
CLOSE 109 3011 11 0%
Non-Estimated 254 1894 374 19%
Totals 2136 20391 4674 22%
222
224
Cell 1: Wings 27%
Cell 2: Center Wings 18%
Cell 3: Hor. Stabilizer 23%
Cell 4: Nose Section 31%
Cell 5: Mid Fuselage 22%
Cell 6: Ver. Stabilizer 8%
Cell 7: Engines 34%
Cell 8: Pylons 100%
Cell 9: Other 14%
Mechanics
Inspectors 1%
218
220
226

FIG. 9

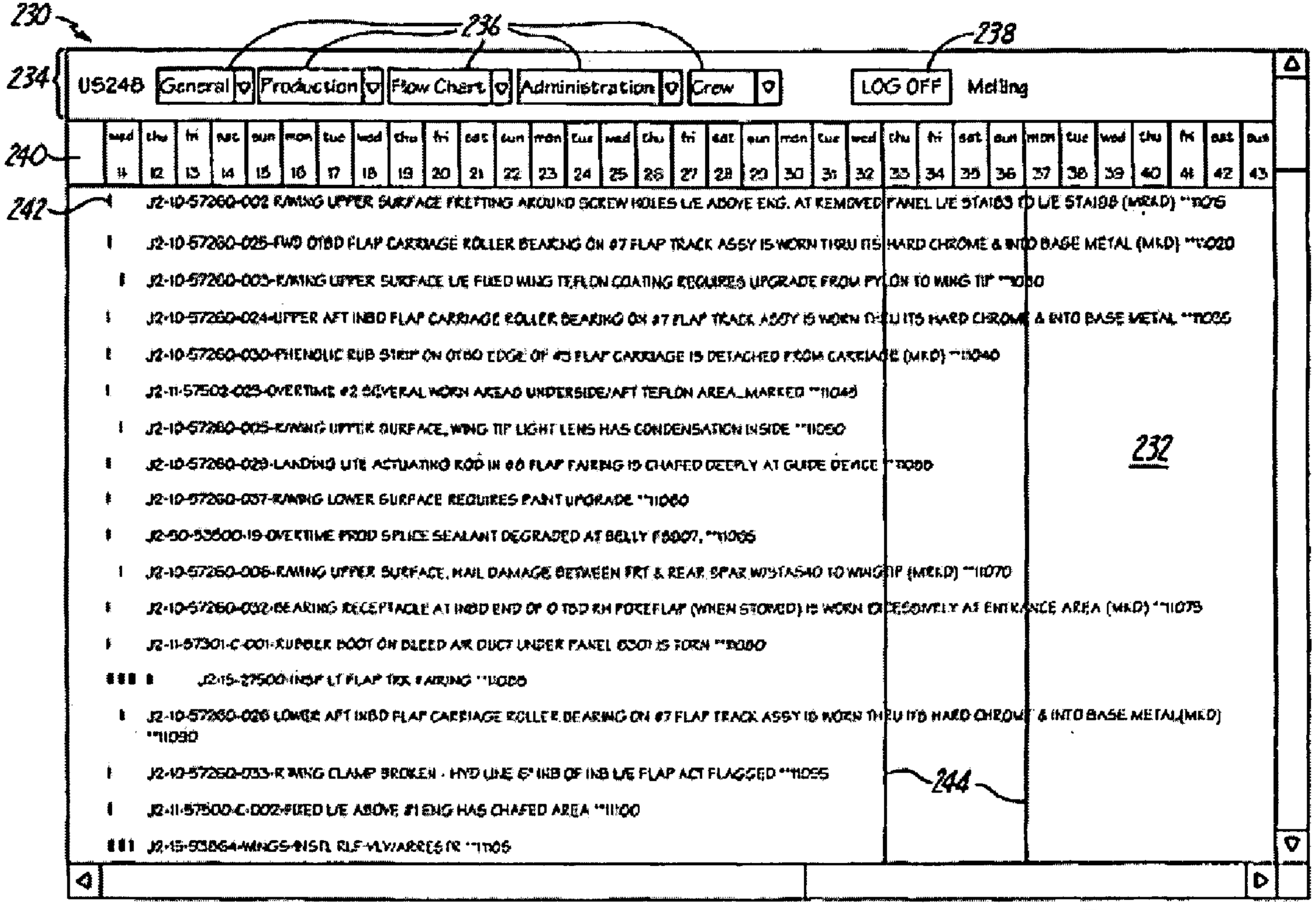

230
234
236
238
US248
General
Production
Flow Chart
Administration
Crew
LOG OFF
Melling
240
wed thu fri sat sun mon tue wed thu fri sat sun mon tue wed thu fri sat sun mon tue wed thu fri sat sun mon tue wed thu fri sat sun
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
242
J2-10-57260-002 R/WING UPPER SURFACE FRETTING AROUND SCREW HOLES L/E ABOVE ENG. AT REMOVED PANEL L/E STA183 TO L/E STA198 (MRD) **11015
J2-10-57260-025-FWD OTBD FLAP CARRIAGE ROLLER BEARING ON #7 FLAP TRACK ASSY IS WORN THRU ITS HARD CHROME & INTO BASE METAL (MRD) **11020
J2-10-57260-005-R/WING UPPER SURFACE L/E FIXED WING TEFLON COATING REQUIRES UPGRADE FROM PYLON TO WING TIP **11030
J2-10-57260-024-UPPER AFT INBD FLAP CARRIAGE ROLLER BEARING ON #7 FLAP TRACK ASSY IS WORN THRU ITS HARD CHROME & INTO BASE METAL **11035
J2-10-57260-030-PHENOLIC RUB STRIP ON OTBD EDGE OF #5 FLAP CARRIAGE IS DETACHED FROM CARRIAGE (MRD) **11040
J2-11-57503-023-OVERTIME #2 SEVERAL WORN AREAS UNDERSIDE/AFT TEFLON AREA_MARKED **11045
J2-10-57260-005-R/WING UPPER SURFACE, WING TIP LIGHT LENS HAS CONDENSATION INSIDE **11050
J2-10-57260-029-LANDING L/E ACTUATING ROD IN #6 FLAP FAIRING IS CHAFED DEEPLY AT GUIDE DEVICE **11060
J2-10-57260-007-R/WING LOWER SURFACE REQUIRES PAINT UPGRADE **11060
J2-50-53500-19-OVERTIME PROD SPLICE SEALANT DEGRADED AT BELLY F8007, **11065
J2-10-57260-006-R/WING UPPER SURFACE, HAIL DAMAGE BETWEEN FRT & REAR SPAR W/STA340 TO WING TIP (MRD) **11070
J2-10-57260-032-BEARING RECEPTACLE AT INBD END OF O TDD RH FORCEFLAP (WHEN STORED) IS WORN EXCESSIVELY AT ENTRANCE AREA (MRD) **11075
J2-11-57301-C-001-RUBBER BOOT ON BLEED AIR DUCT UNDER PANEL 6001 IS TORN **11080
J2-15-27500-INSP LT FLAP TRK FAIRING **11085
J2-10-57260-026 LOWER AFT INBD FLAP CARRIAGE ROLLER BEARING ON #7 FLAP TRACK ASSY IS WORN THRU ITS HARD CHROME & INTO BASE METAL(MRD) **11090
J2-10-57260-033-R/WING CLAMP BROKEN - HYD LINE 6" INB OF INB L/E FLAP ACT FLAGGED **11095
244
J2-11-57500-C-002-FIXED L/E ABOVE #1 ENG HAS CHAFED AREA **11100
J2-15-53864-WINGS-INSTL RLF-VLV/ARRESTR **11105
232

FIG. 10

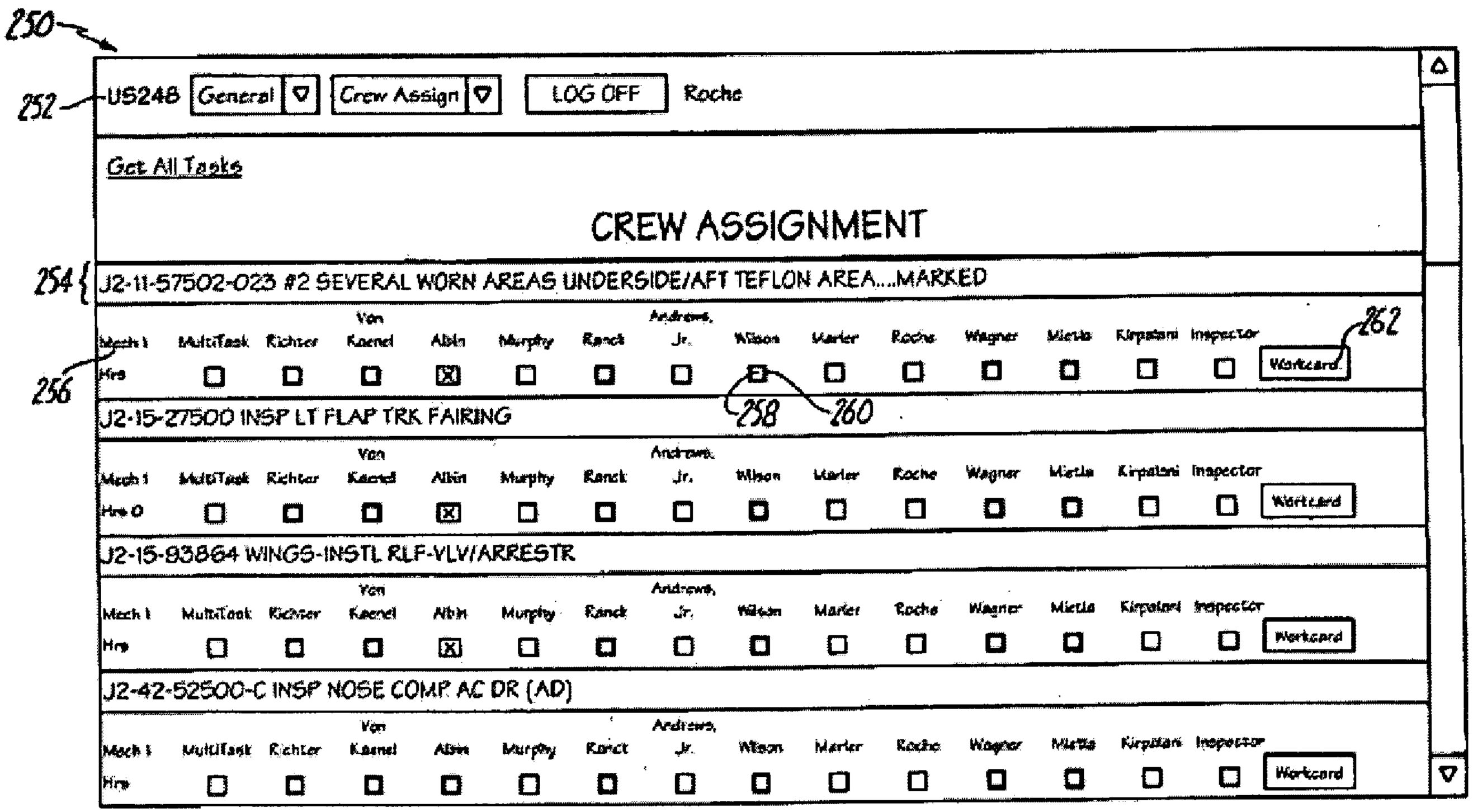

250
252
US248
General
Crew Assign
LOG OFF
Roche
Get All Tasks
CREW ASSIGNMENT
254
J2-11-57502-023 #2 SEVERAL WORN AREAS UNDERSIDE/AFT TEFLON AREA....MARKED
Mech 1
Hrs
MultiTask
Richter
Van Kaenel
Albin
Murphy
Ranck
Andrews, Jr.
Wilson
Marler
Roche
Wagner
Mietla
Kirpalani
Inspector
Workcard
256
262
258
260
J2-15-27500 INSP LT FLAP TRK FAIRING
Hrs 0
J2-15-93864 WINGS-INSTL RLF-VLV/ARRESTR
J2-42-52500-C INSP NOSE COMP AC DR (AD)

FIG. 11A

US248 General Crew LOG OFF Albin

Get All Tasks

CURRENT ASSIGNMENT

J2-11-57502-023 #2 SEVERAL WORN AREAS UNDERSIDE/AFT TEFLON AREA...MARKED M.Albin, Inspector	Work Card
J2-15-27500 INSP LT FLAP TRK FAIRING M. Albin, Inspector	Work Card
J2-15-93864 WINGS-INSTL RLF-VLV/ARRESTR M. Albin, Inspector, Callison	Work Card

FIG. 11B

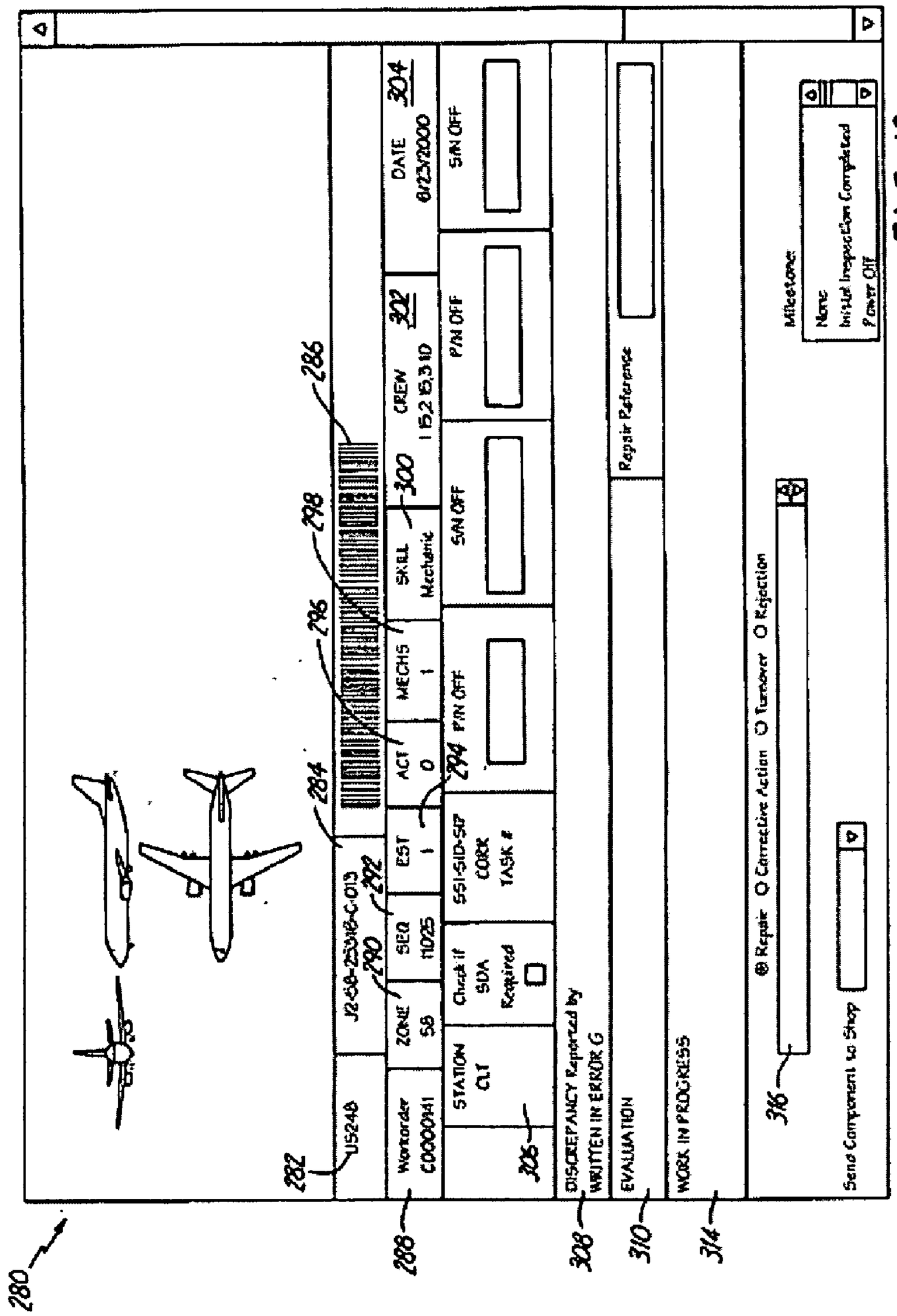

280
282
284
286
288
290
292
294
296
298
300
302
304
305
306
308
310
312
314
316
DATE 304
8/23/2000
S/N OFF
302
S/N OFF
Milestone
None
Initial Inspection Completed
Power Off
SEQ
11025
551-510-50
CODE
TASK #
ACT
0
P/N OFF
MECHS
1
SKILL
Mechanic
S/N OFF
CREW
152 153 ID
P/N OFF
Repair Reference
Check if SDA Required
Work order
C0000941
STATION
CLT
DISCREPANCY Reported by
WRITTEN IN ERROR G
EVALUATION
WORK IN PROGRESS
Repair
Corrective Action
Turnover
Rejection
Send Component to Shop

FIG. 12

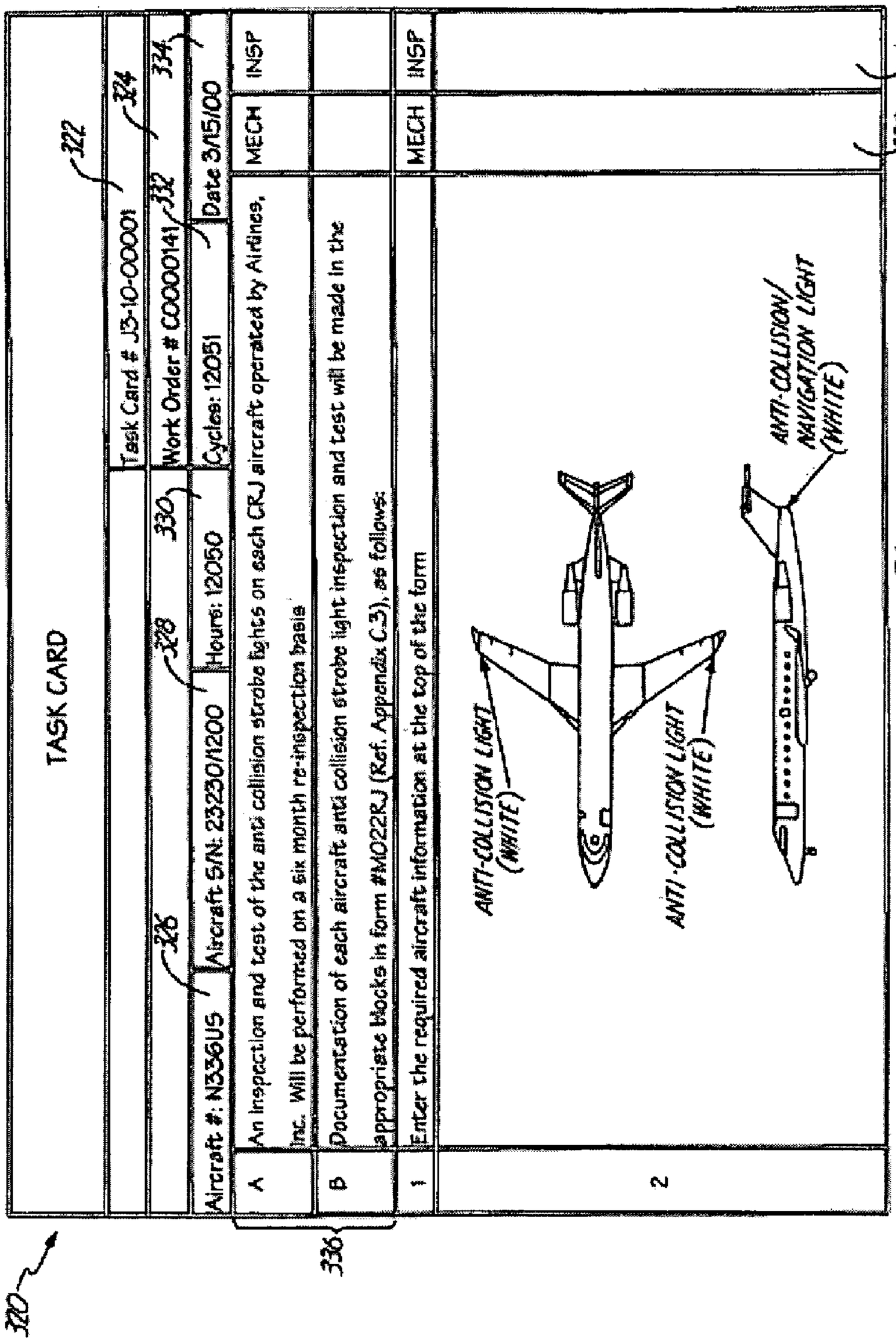

TASK CARD
Task Card # J3-10-000
Work Order # C0000141
Cycles: 12051
Hours: 12050
Aircraft S/N: 23230/1200
Aircraft #: N336US
Date 3/15/00
INSP
MECH
INSP
MECH
An inspection and test of the anti collision strobe lights on each CRJ aircraft operated by Airlines,
Inc. Will be performed on a six month re-inspection basis
Documentation of each aircraft anti collision strobe light inspection and test will be made in the
appropriate blocks in form #M022RJ (Ref. Appendix C.3), as follows:
Enter the required aircraft information at the top of the form
ANTI-COLLISION LIGHT (WHITE)
ANTI-COLLISION LIGHT (WHITE)
ANTI-COLLISION/ NAVIGATION LIGHT (WHITE)
A
B
1
2
320
322
324
326
328
330
332
334
336
338
339

FIG. 13

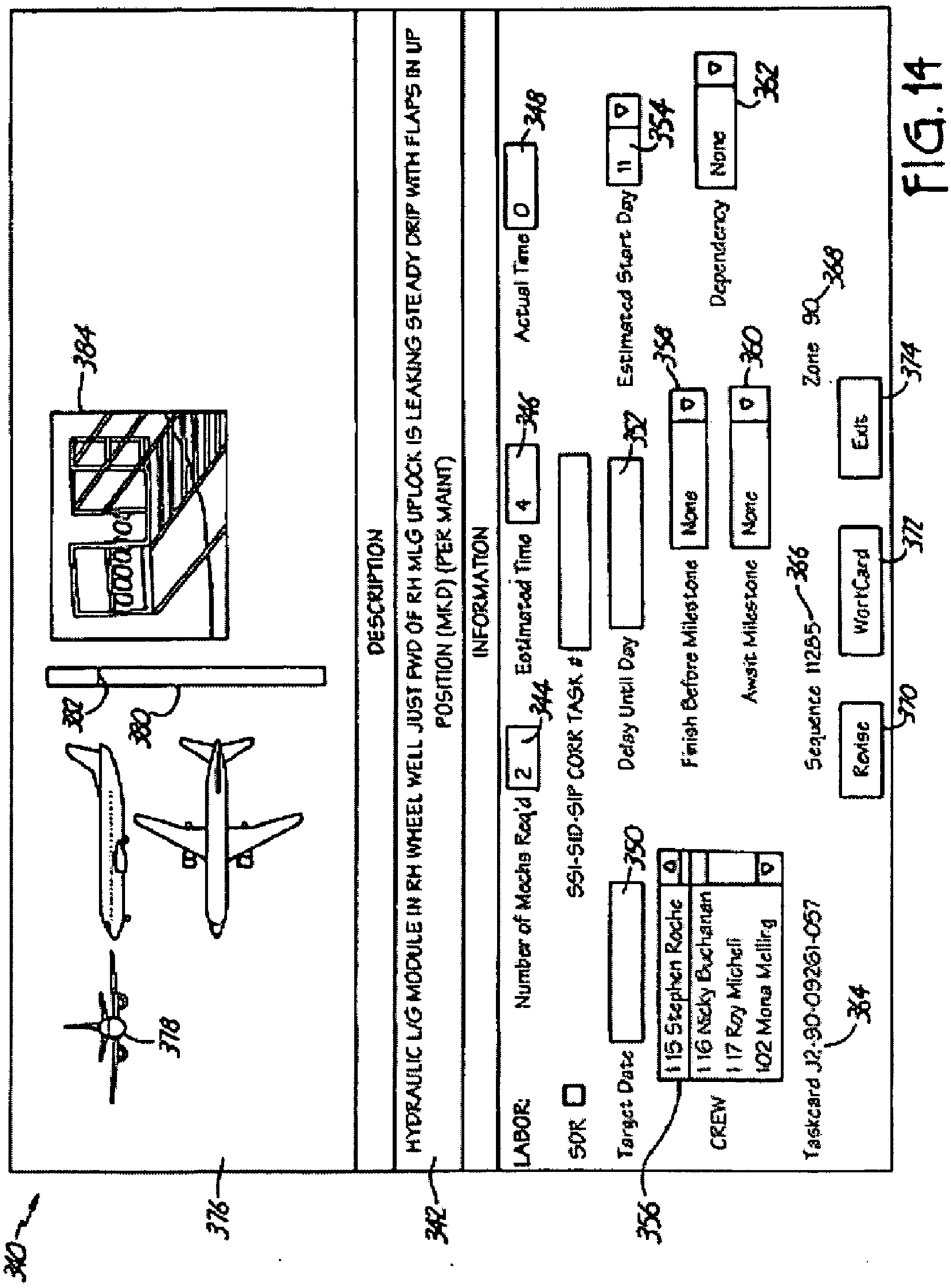

340
376
342
356
DESCRIPTION
HYDRAULIC L/G MODULE IN RH WHEEL WELL JUST FWD OF RH MLG UPLOCK IS LEAKING STEADY DRIP WITH FLAPS IN UP POSITION (MKD) (PER MAINT)
INFORMATION
LABOR:
Number of Mechs Req'd 2
344
Estimated Time 4
346
Actual Time 0
348
SDR
SSI-SID-SIP CORK TASK #
Target Date
Delay Until Day
352
Estimated Start Day 11
354
Finish Before Milestone None
358
Await Milestone None
360
Dependency None
362
CREW
1 15 Stephen Roche
1 16 Nicky Buchanan
1 17 Roy Michell
102 Mona Mellirg
Sequence 11285
366
Zone 90
368
Taskcard J2-90-09261-057
364
Revise
370
WorkCard
372
Exits
374
330
332
378
384

FIG. 14

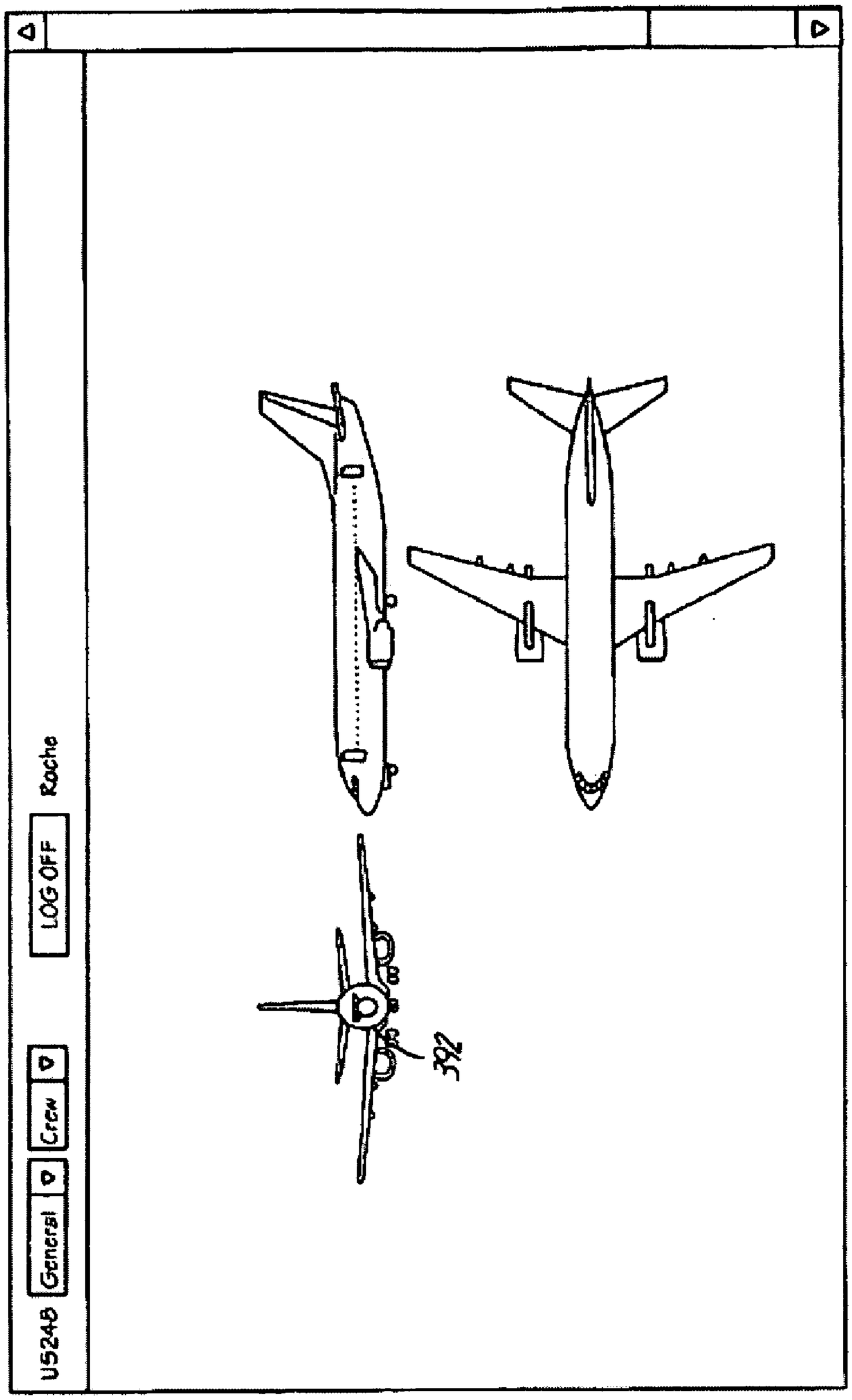


FIG. 15

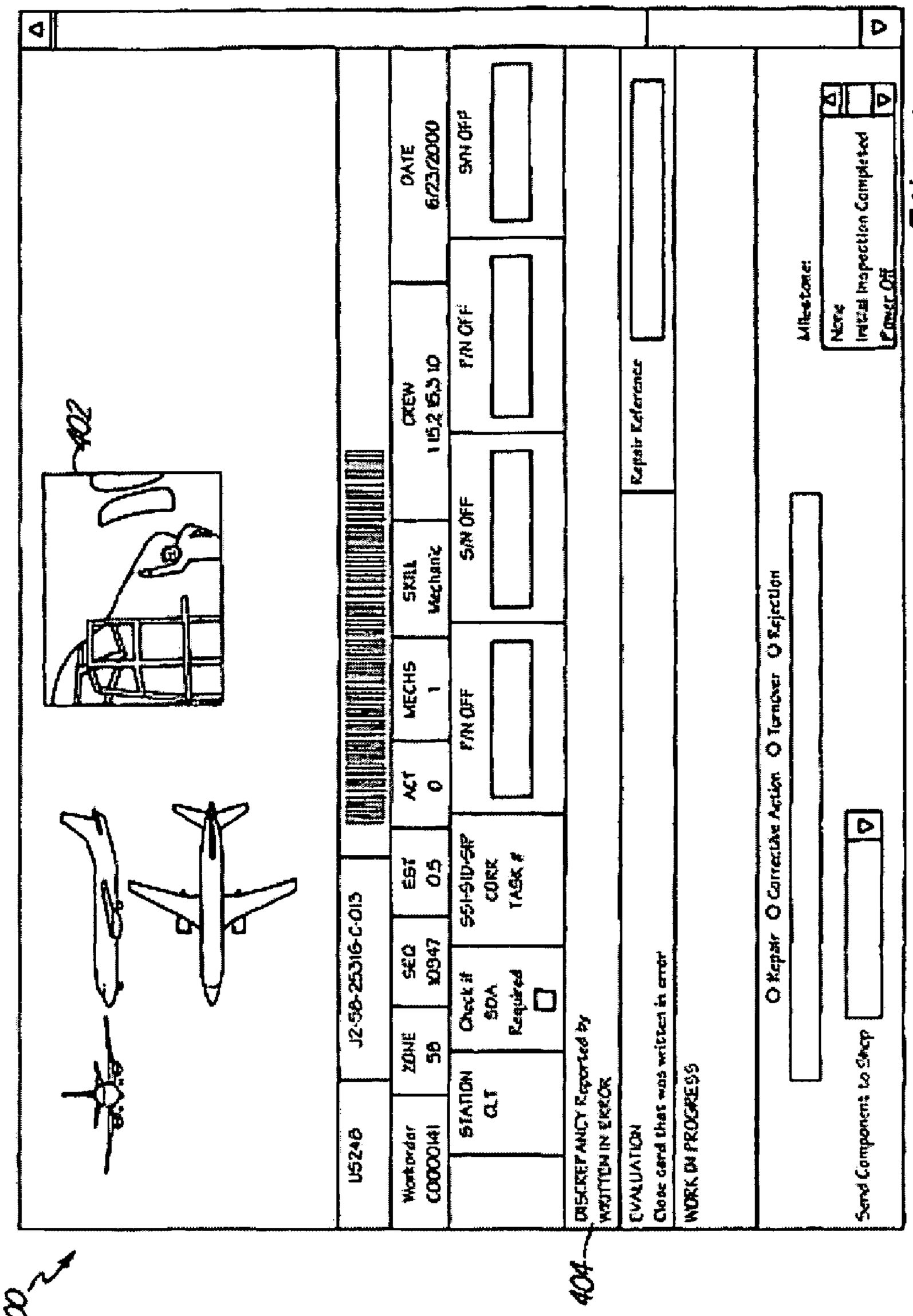

400
402
404
DATE 6/23/2000
SIN OFF
F/N OFF
Milestone:
None
Initial Inspection Completed
Repair Off
J2-58-25316-C-013
EST 05
ACT 0
MECHS 1
SKILL Mechanic
CREW
SEQ 10947
ZONE 58
STATION CLT
Check if SDA Required
Work order C0000141
U5248
DISCREPANCY Reported by
WRITTEN IN ERROR
EVALUATION
Close card that was written in error
WORK IN PROGRESS
Repair Reference
O Repair
Send Components to Shop

FIG. 16

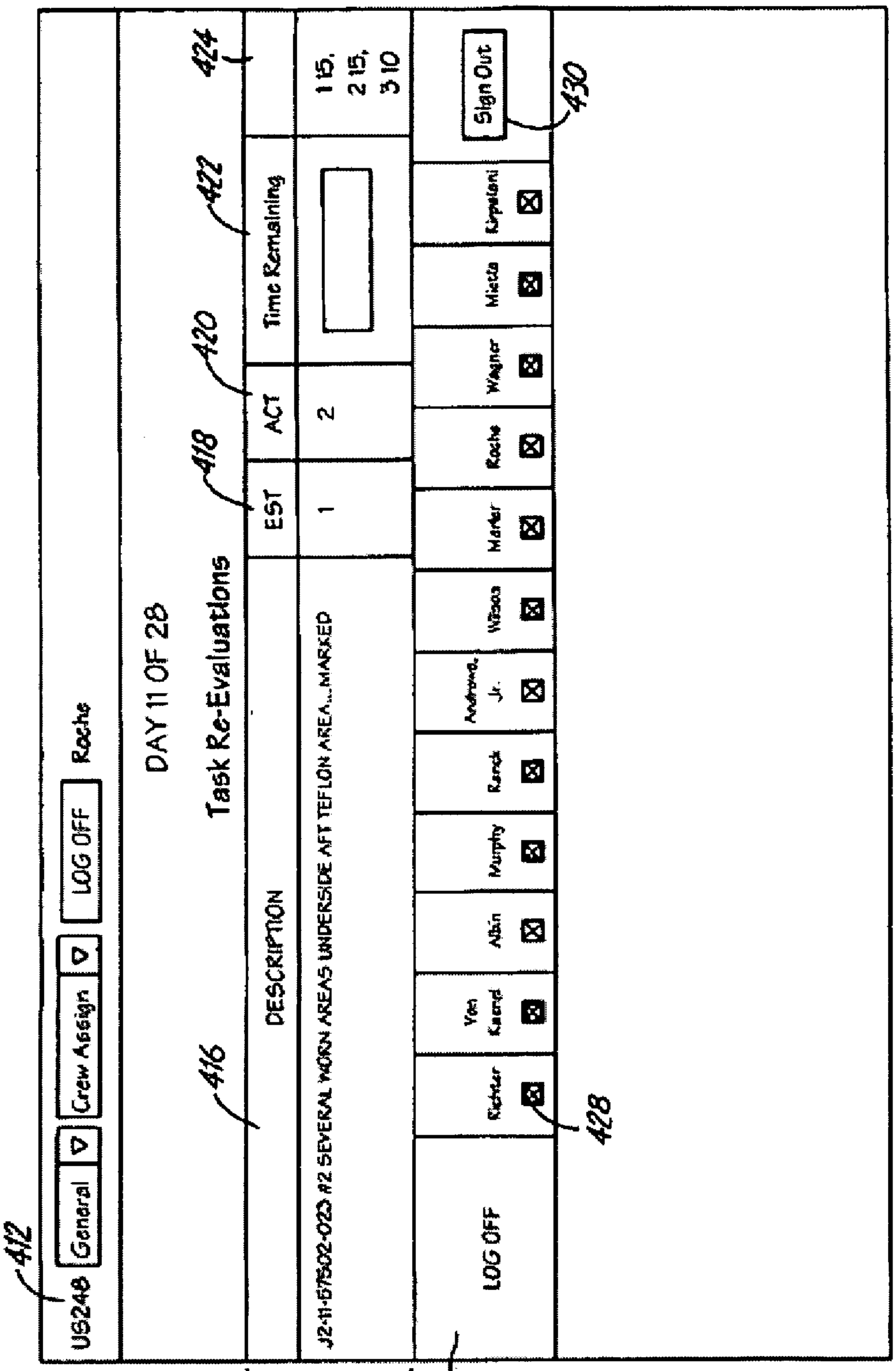

410
412
US248
General
Crew Assign
LOG OFF
Roche
DAY 11 OF 28
Task Re-Evaluations
418
414
416
420
422
424
426
428
430
DESCRIPTION
EST
ACT
J2-11-67502-023 #2 SEVERAL WORN AREAS UNDERSIDE AFT TEFLON AREA...MARKED
1
2
Time Remaining
115,
215,
310
Sign Out
Albin
Murphy
Ranck
Anderson, Jr.
Wilson
Marker
Roche
Wagner
Mietla
Kilpatrick
Richter
Van Kamp
LOG OFF

FIG. 17

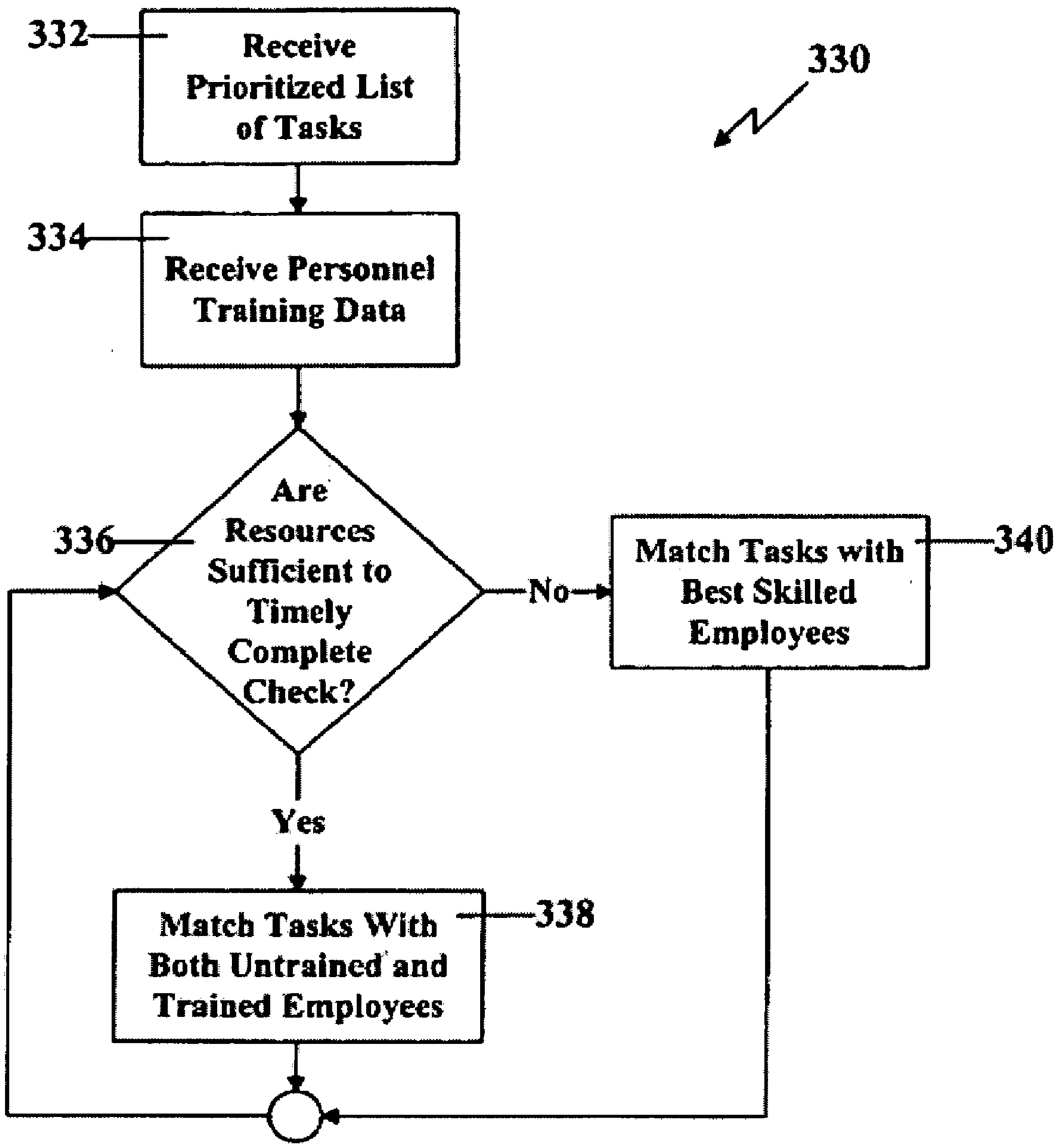


FIG. 18
(AUTO ASSIGN)

ELECTRONIC MAINTENANCE WORK CARDS

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application is a continuation of U.S. patent application Ser. No. 10/154,748, filed May 24, 2002 entitled DYNAMIC MANAGEMENT OF PART RELIABILITY DATA, which is a continuation of U.S. patent application Ser. No. 09/728,565, filed Dec. 1, 2000 entitled DYNAMIC MANAGEMENT OF AIRCRAFT PART RELIABILITY DATA and claiming priority from Provisional Application No. 60/168,400, filed Dec. 1, 1999 entitled "Computerized Aircraft Maintenance Tracking Programming System" by Barry Sinex.

BACKGROUND

[0002] The present invention relates to the field of maintenance. More specifically, the present invention relates to a system for and method of documenting the completion of maintenance tasks on electronic work cards.

[0003] Aircraft maintenance occupies a key position in airline operation because such maintenance is essential to the safety of passengers and the reliability of airline schedules. Each aircraft has its own maintenance requirements which are designed to keep the aircraft in an airworthy condition. These aircraft maintenance requirements typically originate from the aircraft's manufacturer, and can be revised throughout the life of the aircraft by the aircraft manufactures, the Federal Aviation Administration (FAA) and/or the Maintenance Review Board (MRB).

[0004] These aircraft maintenance requirements are documented in aircraft-specific MRB documents. An MRB document details each task that must be accomplished on a particular aircraft, the requirements of that task, and the frequency with which the task must be performed. The MRB document includes tasks that need to be accomplished anywhere from once a day to once every 20 years, as well as tasks that need to be accomplished after the aircraft has achieved a specific number of flight hours, flight cycles or other triggering indicia. For most major aircraft types, the MRB document lists somewhere between 800 to 2,000 different tasks.

[0005] The MRB document details a very complicated maintenance schedule. To ensure compliance with the MRB document, airlines must implement various tracking programs to monitor for the dates when tasks come due, as well as to log the completion of those tasks and any corrective actions taken.

[0006] Because an aircraft produces revenue only when it is flying, it is essential for airline management to keep maintenance time at a minimum. Thus, airlines commonly group tasks together (into letter-checks) rather than perform the tasks one at a time as they come due. Letter checks commonly include "A checks", "B checks", "C checks" and "D checks", with A checks occurring most frequently and having the fewest number of tasks. A and B checks typically can be performed overnight in a "line maintenance" environment, in which, assuming no complications arise, the aircraft typically loses little or no flight time. In this environment, the aircraft remains airworthy because it can be reassembled quickly.

[0007] Conversely, C and D checks comprise a greater number of tasks, many of which require a substantial amount of time to complete. Thus C and D checks are typically performed in a heavy maintenance environment in which the aircraft is taken out of service. In this environment, an aircraft is taken into a hanger, where it is taken apart, inspected, fixed and reassembled during the course of one week to over a month. During this heavy maintenance period, non-routine tasks (those not detailed in the MRB document) are identified (often as a result of an inspection mandated by the MRB document), and parts that have reached their hard limits specified by the MRB document are replaced. Upwards of 300 persons (including cleaners, mechanics, lead mechanics, inspectors and lead inspectors) may work on the maintenance of the aircraft. In addition, a management team including managers, supervisors, directors, production coordinators and shops managers coordinate the completion of the maintenance. This maintenance team typically works in three shifts a day, seven days a week, to complete the needed maintenance.

[0008] To minimize the number of days the aircraft is removed from operation, a maintenance plan must be developed to assign and monitor the completion of tasks. The development of such a plan is made more difficult by the identification of non-routine tasks during the maintenance, back orders on parts which preclude the completion of certain tasks and the failure to complete timely critical path tasks (those which prevent subsequent tasks from being completed). No computer-based method exists to dynamically prepare such a maintenance plan using dynamically changing information, such as available labor hours, sequence and dependency of tasks, and the addition of non-routine tasks.

[0009] Airlines can further save costs by escalating, when permissible, the intervals at which tasks are performed. Based upon reliability data collected by an airline during maintenance of their own aircrafts, the FAA may allow the airline to more favorably escalate tasks beyond the requirements of the MRB document (i.e, require the task to be performed at longer intervals). Thus, if a task to inspect a particular part is performed as required every six months, and the part is consistently (throughout the fleet) in good condition, the task may be escalated to one a year (or some other interval). Such escalations of tasks can significantly affect the time and cost of maintaining an airline's fleet of aircraft. A reliability program thus modifies, for a particular airline only, an aircraft's MRB document by changing the intervals required between overhauls, inspections and checks of aircraft equipment. Guidance on reliability program elements is listed in Advisory Circular (AC) 120-17, Maintenance Program Management Through Reliability Methods, as amended, the Airline/Manufacturer Maintenance Program Planning Document, MSG-2/3, and/or Maintenance Tasks.

[0010] A reliability program can further help airlines determine whether individual warrantied parts have met the manufacturer's predicted life limits. Often, manufacturers of aircraft parts, especially engine parts, guarantee that the part will not fail before a specified number of hours. Thus, a reliability program can enable airlines to get warranty money back from warranty administration on that part if the part does not meet the manufacturer's predicted life limits. There is no computer-based program for monitoring the reliability program of an entire fleet of aircraft as it relates to the requirements of the MRB document, which uses data dynamically collected during the process of maintenance.

[0011] Another aspect of an aircraft maintenance program for an airline is the proper training of its personnel. The FAA has very strict standards regarding the training required of

aircraft mechanics. Before permitting a mechanic to perform a task, the FAA requires that the mechanic have been previously supervised doing the task or specifically trained for the task. The FAA additionally requires much of the training to be performed on a recurrent basis. Therefore, airlines must monitor and log all training received by its maintenance employees.

[0012] Airlines must also maintain a significant number of publications, such as the MRB document, training manuals, maintenance manuals, illustrated parts catalogs, structural repair manuals, aircraft wiring diagrams and a general engineering and maintenance manual. Presently, these documents are mostly maintained in paper format.

[0013] No system presently exists to integrate all of the above-listed facets of a successful aircraft maintenance program. Additionally, no system presently exists to dynamically manage an aircraft's MRB document, to dynamically monitor for the dates when tasks are due on an aircraft, to log the completion of tasks and corrective actions taken on an aircraft, to dynamically prepare a maintenance plan, to dynamically collect reliability data or to dynamically collect personnel training records. Accordingly, there is a need for a system and method for dynamically managing, in real-time, aircraft maintenance requirements.

SUMMARY

[0014] A method for electronically documenting the completion of maintenance tasks in a maintenance industry which requires recordation of maintenance tasks performed, and in which required maintenance tasks are documented on a plurality of work cards, the method includes retrieving a legacy work card that is an electronic document itemizing a plurality of maintenance tasks to be performed and specifying by skill level whom may perform the itemized maintenance tasks, creating, from the legacy work card, an electronic work card including a plurality of data entry fields that include at least a sign-off field, receiving data corresponding to a designated data entry field, and modifying the electronic work card to include the received data corresponding to the designated data entry field.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a simplified block diagram of a system in accord with the present invention for dynamically managing, in real-time, aircraft maintenance requirements.

[0016] FIG. **2** is a flow diagram of an MRB program manager component of the system of FIG. **1**.

[0017] FIGS. **3-4** illustrate example graphical user interfaces (GUI) used in conjunction with the MRB program manager component of the system of FIG. **1**.

[0018] FIG. **5** is a flow diagram of a tracking manager component of the system of FIG. **1**.

[0019] FIGS. **6-7** illustrate example graphical user interfaces (GUI) used in conjunction with the tracking manager component of the system of FIG. **1**.

[0020] FIG. **8** is a flow diagram illustrating a preferred method of using a DAMP manager component of the system of FIG. **1** to complete a maintenance check of an aircraft.

[0021] FIGS. **9-17** illustrate example graphical user interfaces (GUIs) used in conjunction with the DAMP manager component of the system of FIG. **1**.

[0022] FIG. **18** is a flow diagram of an automatic task assignment component of the DAMP manager component of the system of FIG. **1**.

DETAILED DESCRIPTION

[0023] FIG. **1** is a simplified block diagram of system **10** in accord with the present invention for dynamically managing, in real-time, aircraft maintenance requirements. System **10** interfaces with a plurality of aircraft, such as aircraft **12**, corresponding aircraft maintenance requirements, such as aircraft maintenance requirements **14**, personnel training records **16**, FAA training requirements **18**, and user preferences **20**. System **10** is a multiple component system which includes Maintenance Review Board (MRB) program manager **22**, aircraft tracking manager **24**, Dynamic Aircraft Maintenance Production (DAMP) manager **26**, reliability manager **28**, electronic publications manager **30** and personnel training manager **32**.

[0024] From aircraft maintenance requirements **14**, MRB program manager **22** extracts maintenance tasks required for aircraft **12** and, for each task, time control points (or limits by which the task must be performed). MRB program manager uses this information to allow an airline operator to organize these tasks into logical groups which can be simultaneously performed. MRB program manager **22** provides the maintenance plan, along with the corresponding time control points, to aircraft tracking manager **24**.

[0025] Tracking manager **24** monitors accumulated time data, such as flight hours and cycles), and compares this data to the data received from MRB program manager, to report on which tasks are approaching their time control point. Tracking manager **24** may also be used by an airline operator to schedule tasks during maintenance visits managed by DAMP manager **26**.

[0026] When aircraft **12** enters a heavy maintenance period, DAMP manager **26** allows airline operators to create a dynamic maintenance program for assigning and monitoring the completion of tasks on aircraft **12**.

[0027] Upon completion of a heavy maintenance period, reliability manager **28** records data relating to reliability of individual aircraft parts. The airline's reliability board may later use reliability manager **28** to query the reliability data and generate reports useful for recommending changes to the MRB program.

[0028] Electronic publications manager **30** is a tool which gathers the multitude of publications needed in the aircraft maintenance industry, and provides them in an on-line environment.

[0029] Personnel training manager **32** provides tools for an airline operator to assign instructors, students, classrooms and audio visual equipment to specific training courses. Personnel training manager **32** further provides access from DAMP manager **26** to personnel training records **16** to enable an airline to know exactly when and what training its employees need.

[0030] Although it is preferable that an airline maintenance program utilize each of the components included in system **10** of FIG. **1**, those skilled in the art will recognize that each of the individual components may be used independently, collectively, or in combinations of the components. Thus, an airline may incorporate only MRB program manager **22** and

DAMP manager **26** with its own existing legacy system for monitoring when tasks are due on an aircraft.

System Inputs

[0031] Aircraft maintenance requirements **14**, which originate from the aircraft manufacturer, list the tasks that must be accomplished on aircraft **12** and the timescale for how often the tasks must be accomplished in order to keep aircraft **12** in airworthy condition. The Maintenance Review Board (MRB) collects this information. These requirements can be revised throughout the life of aircraft **12** by any of the aircraft manufacturer, the Federal Aviation Administration (FAA), the Maintenance Review Board (MRB) or the airline operator (with FAA approval). Aircraft maintenance requirements **14** may include information regarding routine tasks, customer-specific tasks, FAA Airworthiness Directives, Manufacturer's Service Bulletins and Letters, and other trackable tasks required for airline maintenance.

[0032] Personnel training records **16** include data regarding the types of training each maintenance employee has received, and when that training was administered. FAA training requirements **18** document the training required of a maintenance employee before that employee can perform specified maintenance tasks.

MRB Program Manager

[0033] MRB program manager **22** takes aircraft maintenance requirements **14** and creates a maintenance program for aircraft **12**. MRB program manager **22** allows an airline operator to organize all of the maintenance tasks into logical groups based on frequency, type, and an airline's operational scheduling preferences **20**. As a result, MRB program manager **22** provides a customized maintenance schedule that allows the airline to not only keep track of each maintenance task individually, but also carry out the maintenance tasks much more efficiently.

[0034] FIG. **2** is a flow diagram **40** of MRB program manager **22** of system **10** of FIG. **1**. During its initial setup, which is step **42**, MRB program manager **22** extracts from aircraft maintenance requirements **14**, all of the tasks that must be performed on an aircraft of type aircraft **12**, as well as the time control points (or limits by which the task must be performed) for each task.

[0035] At step **44**, an airline operator will select whether logic formula MSG-2 (Maintenance Steering Group) or logic formula MSG-3 MRB will be used to organize tasks. With logic formula MSG-2, parts are changed at standard times regardless of whether the part actually needs to be changed. Thus, under MSG-2 logic, a part is always replaced at or before its normal life expectancy. Conversely, under logic formula MSG-3, parts are not replaced until broken. MSG-3 logic allows the MRB document to be revised based upon reliability data for the part during its life cycle. Thus, the types of tasks assigned under MSG-2 logic varies from the types of tasks assigned in MSG-3 logic; that is, more inspection tasks will be performed under MSG-3 logic than under MSG-2 logic, while more part replacement tasks will be performed under MSG-2 logic than under MSG-3 logic.

[0036] At step **46**, the extracted tasks are organized into letter checks, flight cycle checks (those tasks scheduled by flight cycles), separately tracked tasks and special tasks.

[0037] Depending on individual requirements, at step **48**, airline management may modify, at any time, the initial grouping of tasks, as long as none of the time control points, or limits by which a task must be performed, is exceeded by the modified plan.

[0038] MRB program manager **22** preferably provides both the master maintenance program and the airline-modified maintenance program, along with the corresponding time control points, to aircraft tracking manager **24**.

[0039] FIG. **3** illustrates example graphical user interface (GUI) **50** used in conjunction with MRB program manager **22** of system **10**. In the example of FIG. **3**, the tasks of a test aircraft are organized into a plurality of checks including A checks **52**. Other types of checks not illustrated in FIG. **3** are C checks, eight-year checks, flight cycle checks, and special checks. In GUI **50**, column **54** lists the name of each check. Column **56** details the number of tasks included within each of the plurality of checks. Column **58** details the forecasted hours required to complete each task. Column **60** lists the form number of each task. Columns **62** list the time control points (or interval periods at which each of the plurality of checks is to be performed). The time control point may be listed as a specific number of flight hours, flight cycles or months. For each of the plurality of checks, buttons are provided to allow an airline operator to revise the checks ("Revise" button in column **64**), view the tasks within the check ("View" button in column **66**), or generate a checklist of the tasks within the check ("Checklist" button in column **68**).

[0040] FIG. **4** illustrates example graphical user interface (GUI) **80** used in conjunction with MRB program manager **22** of system **10**. GUI **80** illustrates a partial listing of tasks **82** to be performed in conjunction with a selected one of A checks **52** of FIG. **3**. Tasks **82** within selected A check **52** are organized by region of the aircraft, such as "upper fuselage above cabin floor" and "tailcone & empennage group". For each task **82** listed in GUI **80**, column **84** provides a task number, column **86** provides a task description, column **88** provides the task's official MRB interval (or time control point), column **90** provides an approximation of the amount of time required to perform the task, column **92** provides the task type, and column **94** provides the zone in which the work is to be performed. Details of each task **82** can be revised by selecting the corresponding "Revise" button provided in column **96**.

[0041] In a preferred embodiment, MRB program manager **22** will include data converters to convert information stored in an airline's legacy system into a format usable by MRB program manager **22**.

Aircraft Tracking Manager

[0042] Aircraft tracking manager **24** functions as an aircraft scheduling tool by keeping track of all maintenance activities accomplished on aircraft **12**.

[0043] Tracking manager **24** receives a maintenance program as an input from MRB program manager **22**, tracks the amount of accumulated time for each maintenance task, and outputs tracking information in the form of a status report. If tracking manager **24** is used independently, the maintenance program is input from aircraft maintenance requirements **14**.

[0044] FIG. **5** is a flow diagram **100** of tracking manager **24** of system **10**. At step **102**, tracking manager **24** receives the maintenance program. Preferably, MRB program manager **22** provides the master maintenance program, the airline-modified maintenance program, and corresponding time control points to aircraft tracking manager **24**.

[0045] At step **104**, non-routine tasks are added to the maintenance program, thereby allow both routine and non-routine tasks to be tracked. When a non-routine task is generated, it is linked to a particular routine task (the performance of which resulted in the non-routine task). Reliability manager **28** may then use that relationship to determine whether a maintenance interval for a part can be escalated, or if it needs to be de-escalated.

[0046] At step **106**, tracking manager **24** keeps track of information such as how many flight cycles, flight hours and time aircraft **12** has accumulated. When integrated with MRB program manager **22**, tracking manager **24** ensures that aircraft **12** is not flown through one of its maintenance limits. Tracking data may be automatically entered into tracking manager **24** by an automated system installed **25** aboard aircraft **12** or manually by airline ground crews. Manually-entered data may be entered at the end of a day by maintenance crews performing the aircraft's daily line check. Tracking data may also be provided by dispatch employees who also monitor this information.

[0047] At step **108**, tracking manager **24** receives and logs all maintenance activities accomplished on aircraft **12**, thereby serving as a maintenance logbook for aircraft **12**. In this capacity, tracking manager **24** stores such information about each discrete task accomplished on aircraft **12** as what was done, what was replaced, who did the work and when was the work done. To meet FAA requirements, the electronic logbook may be printed and stored in paper format. When, if ever, the FAA approves the electronic storage of aircraft maintenance logbooks, airlines will no longer need to store paper copies of its maintenance records.

[0048] At step **110**, tracking manager **24** compares, for each task, the accumulated time data to the task due data to determine which tasks will soon require maintenance, and at step **112**, tracking manager **24** reports these results. By tracking each task as both an individual task and as a part of a task group (or check), the airline may move tasks into different groups without the danger of exceeding the task limitations.

[0049] Various status reports can be generated by users of tracking manager **24** by making inquires as to what tasks need to be completed within selected parameters. FIG. **6** illustrates example graphical user interface (GUI) **120** used in conjunction with tracking manager **24**. The example of FIG. **6** is a partial status report for test aircraft **12**. The status report lists a plurality of tasks **122**, and includes information on each task, such as, the MRB document source numbers listed in column **124** and a task description listed in column **126**. Column **128** details the flight hour, flight cycle and date at which task **122** was last completed. Column **130** lists the flight hour, flight cycle or date by which task **122** must be performed. Finally, column **132** provides a "Revise" button allowing an airline operator to revise the specifications of a particular task.

[0050] FIG. **7** illustrates example graphical user interface (GUI) **140** used in conjunction with tracking manager **24**. GUI **140** is an example "Tasks Due" screen **140** of system **10**. Screen **140** shows, in real-time, a list of tasks due within a user-specified range of dates, hours, or cycles. The user can enter a number of hours **142**, a number of cycles **144**, or a date **146**, and click on button **148** ("Retrieve Records") to retrieve a list of tasks due within the entered range. The resulting screen lists the task descriptions **150**, the date last completed **152** (as well as the flight hours and flight cycles accrued by that completion date), the time limits **154** (or time control point), and the time remaining **156** for each task. The time remaining column will preferably provide a graphical cue to the user as to which tasks are overdue, which are nearing their due date, and which are not yet due. Such a graphical cue could be color-coding the remaining time information. In the example of FIG. **7**, cells could be colored red to signify overdue tasks (not shown), cells **158** could be colored yellow to signify task which will be due within the user-specified range, and cells **159** could be colored white to signify tasks which are not yet due and outside the user-specified range. As the tasks are completed, the historical record for each task is updated in real-time to the current status. Screen **140** assists the user in developing the best plan and work order for an aircraft to insure that tasks are completed in a timely manner.

[0051] Tracking manager **24** may also be used by an airline operator to schedule tasks during maintenance visits managed by DAMP manager **26**.

Dynamic Aircraft Maintenance Production (DAMP) Manager

[0052] DAMP manager **26** creates a dynamic maintenance program for assigning and monitoring the completion of tasks on aircraft **12** in a heavy maintenance environment. DAMP manager **26** is designed for multiple users of a production coordination system. Briefly, DAMP manager **26** is a system which allows maintenance employees to quickly, and easily, know what routine and non-routine tasks they are scheduled to complete; provides mechanic crew leads the ability to dynamically assign tasks to mechanics and to query which tasks are currently assigned and to whom they are assigned; and provides maintenance employees and supervisors the ability to compare actual time expended to complete a maintenance check to forecasted time for the maintenance check.

[0053] In the heavy maintenance environment, each individual maintenance team member, from mechanic to top-tier management, has a specific job to complete. An ideal maintenance plan for an aircraft would take into account the knowledge and experience of all employees working to maintain the aircraft.

[0054] DAMP manager **26**, in a sense, allows each employee to contribute to the overall maintenance production plan. In the DAMP system, each employee is given the tools they need to do their job. Each employee has access to computer screens containing information relevant to the completion of their own job. In using the system, each employee enters information into the system in response to the computer screens presented to the employee. That information is processed by DAMP manager **26**; with the end result being that the mechanics always know exactly what tasks on which to work. Additionally, DAMP manager **26** creates a history of events to enable production coordinators to identify what works and what does not work in the maintenance plan.

[0055] FIG. **8** is a flow diagram **160** illustrating a preferred method of using DAMP manager **26** to complete a heavy maintenance check of aircraft **10**. Initially, at step **162**, DAMP manager **26** extracts data from MRB program manager **22** and tracking manager **24** to identify the routine tasks that need to be performed on aircraft **10**. If DAMP manager **26** were operated in a stand-alone environment, this data would be retrieved directly from aircraft maintenance requirements **14**, which would be abstracted by the airline operator.

[0056] At step **164**, DAMP manager **26** preferably sorts the tasks into aircraft zones in which those tasks pertain, such as nose, tail or west wing.

[0057] At step **166**, DAMP manager **26** generates a proposed flow for the aircraft. This flow may further be broken down by zone. In creating a proposed flow, DAMP manager **26** considers whether the completion of certain tasks is essential for the completion others.

[0058] At step **168**, the production planner (the personnel member in charge of monitoring production flow) can modify the flow proposed by DAMP manager **26** based upon the availability of parts and employees, as well as the existence of non-routine tasks. Typically, the production planner knows the status of the shop and its available parts. For instance, if the planner knows that tires will not be available during the first week of maintenance, the planner can modify the flow to ensure that tasks relating to tire replacement do not occur during the first week. The planner may also add any known non-routine tasks to the flow.

[0059] Tasks are assigned to mechanics at step **170** in either a semiautomatic or automatic mode. If the semiautomatic mode is selected, tasks will be automatically be pulled from the flow diagram for a crew lead to assign to his crew. In this mode, the crew lead starts each shift by entering into DAMP manager **26** which employees are available. In response, DAMP manager **26** will generate a flow diagram for a user-selected number of shifts which includes tasks with forecasted completion times roughly matching the available manpower. The crew lead can then distribute those generated tasks to the mechanics in his crew. In the automatic mode, tasks are automatically assigned at the start of each shift by DAMP manager **26**. This automatic mode is discussed later in this specification.

[0060] At step **172**, mechanics sign into DAMP manager **26** to retrieve their task cards. When the mechanic signs in and accepts a first task, the clock starts running on the first task, and when the employee signs onto a second task, the clock stops running on the first task. DAMP manager **26** uses this information to monitor the amount of time spent completing each task. Later, the actual times can be compared to the forecasted times to determine if the maintenance program is on schedule. This information can also be accumulated over a number of checks, and used by crew leads to determine which employees are most efficient at each task.

[0061] When signing out of the DAMP manager **26** at the end of a shift, at step **174**, the mechanics and/or crew lead estimate the amount of time remaining on any incomplete tasks.

[0062] Also when signing out of DAMP manager **26**, at step **176**, mechanics enter any passdown notes or corrective actions taken during the performance of a task. Often, tasks left incomplete at the end of a shift are picked up by a mechanic on the next shift. Passdown notes enable those mechanics who continue working on the task to know what was completed by the previous mechanic. These notes do not remain part of the maintenance records, and are discarded once the task has been completed. Corrective action notes indicate what corrective actions were taken by a mechanic, and become part of the official maintenance logbook for the aircraft.

[0063] At step **178**, inspectors review the work performed by mechanics. If the work is acceptable, the task card is signed off by the inspector. If the work is unacceptable, the task remains in the production schedule to be reassigned. DAMP manager **26** also monitors the work of the inspectors. Thus, as with the tasks performed by mechanics, DAMP manager **26** monitors the amount of time the inspectors take to complete each inspection.

[0064] Often, while performing a routine task, the mechanics and inspectors will identify additional tasks that need to be accomplished to maintain the aircraft in an airworthy condition. At step **180**, these non-routine tasks are entered into DAMP manager **26**.

[0065] DAMP manager **26** constantly updates the overall completion time and tracks critical path jobs which will prevent subsequent jobs from being done. Thus, steps **164-180** are repeated until the maintenance check on the aircraft is complete.

[0066] An example implementation of DAMP manager **26** is illustrated in FIGS. **9-17**. FIG. **9** illustrates example graphical user interface (GUI) **190** used in conjunction with DAMP manager **26**. GUI **190** is an example status screen of system **10**. Screen **190** shows in real-time the current maintenance status of aircraft **12**. Section **192** of GUI **190** displays the tail number of aircraft **12** (US248 in this example) and user name (Melling). Section **192** also includes pull-down menus **194**. Each pull-down menu **194** provides additional levels of access in DAMP manager **26**. Thus, a crew member would be provided with only one pull-down menu, while senior management would be provided with several pull-down menus. In this example, user Melling is provided with five pull-down menus. In addition, section **192** includes button **196** ("Log Off") which allows the user to log off of DAMP manager **26**.

[0067] Section **198** of GUI **190** is a line chart indicative of overall maintenance program progress with hours plotted vertically and days progressing horizontally. Time scale **200**, which runs horizontally across section **198**, chronologically displays the number of days in the check. Solid horizontal line **202**, which is located immediately below time scale **200**, represents the currently estimated number of hours required to complete the aircraft maintenance check. Estimate **204**, which is displayed beneath solid horizontal line **202**, provides a numeric representation of the total number of hours currently estimated to complete the check. Solid horizontal line **206** represents the projected number of hours required to complete the aircraft maintenance check, while forecast **208**, which is displayed beneath solid horizontal line **204**, provides a numeric representation of the total number of hours projected to complete the check. First broken line **210** represents the planned available labor for the check (as it accrues each day), while second broken line **212** represents the actual labor expended each day on the check. Lines **210** and **212** can be color coded to allow easy differentiation by the airline operator.

[0068] The planned day of completion is represented by the intersection of first broken line **210** with solid horizontal line **202**. Similarly, the actual day of completion is represented by the intersection of second broken line **212** with solid horizontal line **202**. Vertical lines **214** represent milestones in the check. Count **216** indicates the current day of the check, as well as the total number of days planned to complete the check.

[0069] Section **218** of GUI **190** (entitled, "Check Status") illustrates, in real-time, the number of work cards ("Count"), the estimated number of hours required ("Estimated Hours"), the actual number of hours applied ("Actual Hours"), and the percentage complete ("% Complete") for various collections of tasks. In the example of GUI **190**, tasks are organized by

open tasks ("Open"), close tasks ("Close"), and non-estimated tasks ("Non-Estimated"), as well as totals for all tasks ("Total").

[0070] Section **220** of GUI **190** is a bar graph indicative of the real-time progress in individual cells (or zones) of aircraft **12**. For each cell, the bars graphically illustrates the forecast of when the maintenance check of aircraft **12** will be complete. For example, in cell **1** (the wings zone), bar **222** indicates the number of labor hours that have been applied against that cell, the total bar (formed of bar **222** and bar **224**) indicates the total number of hours that have been estimated in that cell, and the number following the total bar indicates the percentage complete of that zone (27% in this example). Similar section **226** (not fully shown) displays a bar graph indicative of the real-time progress by skill type and the total number of mechanics available by skill.

[0071] FIG. **10** illustrates example graphical user interface (GUI) **230** used in conjunction with DAMP manager **26** of system **10**. GUI **230** includes a dynamic GANTT chart **232** (hereinafter referred to as flow chart **232**) indicating the proposed maintenance check flow. Flow chart **232** is designed to pull together all available resources to graphically deliver a dynamic indication of how the check is to proceed if the maintenance plan relating to such variables as task priorities, crew assignments, mechanic availability, task dependencies and task delay is followed. Flow chart **232** is constantly updated to always reflect the most current data.

[0072] As in FIG. **9**, section **234** of GUI **230** displays the tail number of aircraft **12** (US248) and user name (Melling). Section **234** also includes pull-down menus **236**. In addition, section **234** includes button **238** ("LogOff") which allows the user to log off of DAMP manager **26**.

[0073] Flow chart **232** shows, in real-time, a list of all tasks that are required to be completed during the maintenance check of aircraft **12**. Time scale **240** chronologically displays the number of days in the check. In flow chart **232**, a width of task bar **242** indicates the time duration of a specific task, while the location of task bar **242** indicates its placement in the overall schedule. As flow chart **232** is dynamically updated, completed tasks will be represented by their actual duration and placement, while incomplete tasks will be represented by their planned duration and placement.

[0074] Vertical lines **244** in flow chart **232** represent milestones in the production plan. These milestones are determined by airline management to represent their goals. Vertical lines **244** provide a graphical representation of where the production is in relationship to the milestones. These milestones can also be included in section **198** of GUI **190**.

[0075] Flow chart **232** can be color-coded to provide a visual cue as to which tasks will fall behind schedule if the current maintenance plan is followed. For instance, completed tasks, tasks presently being worked on, tasks having a scheduled start time that has already elapsed, and future tasks could each be displayed in different colors to allow the airline operator to reallocate resources to get back on track. Flow chart **232** also allows the airline operator to reorder tasks, assign crews, assign dependencies to tasks, and make other decisions in order to avoid missing the check completion date.

[0076] FIG. **11** illustrates an example graphical user interface (GUI) **250** used in conjunction with DAMP manager **26**. GUI **250** is an example crew assignment screen listing tasks assigned to a specific crew working on aircraft **12**. Again, section **252** displays information about aircraft **12** and the user, as well as pull-down menus and a log off-button. In this example, user "Roche" has access to only two pull-down menus (compared with five in FIG. **9**), indicating that user "Roche" has less access to DAMP manager **26** than user "Melling" of FIG. **9**.

[0077] In GUI **250**, tasks are organized according to status. For instance, tasks could be ordered such that top-most tasks have the highest priority, followed sequentially by tasks on hold and non-scheduled tasks. To convey a visual cue as to the urgency of each task, title bar **254** can be colored to indicate the status of the task. Such a visual cue allows the crew lead to better decide how tasks should be assigned.

[0078] Title bar **254** details the task identification number, the task description, and other information pertinent to the task. For each task, required skill level **256** ("Mechanic **1**" for the first-listed task) is displayed.

[0079] To assign a crew member to a task, the user simply checks box **258** under the name of the crew member to whom the task is assigned. Once the task is assigned, the crew member may sign onto the task, at which time the clock starts running on that crew member to collect the total amount of time spent on that task. If a crew member has not logged into DAMP manager **26**, a visual cue **260**, such as a red square drawn around his corresponding check box **258**, may be displayed to instantly alert the user of which employees are absent, whereas a green box could be used to indicate that a crew member is awaiting task assignment. A similar visual cue could be provided if the crew member is in training. This visual signal is helpful because tasks cannot be assigned to crew member who are absent or in training.

[0080] In GUI **250**, the user can select button **262** ("Work Card") to access a particular task's printable work card for distribution to the crew members. Alternatively, crew members can print their own work cards when checking into DAMP manager **26** to see what tasks have been assigned to them (preferably presented in sequential order of how they should be completed). Not shown in FIG. **11***a*, GUI **250** can also provide a revise button to allow the user to access a task revision screen for a particular task.

[0081] FIG. **11***b* illustrates example graphical user interface (GUI) **270** used in conjunction with DAMP manager **26** of system **10**. GUI **270** is an example crew member assignment screen listing tasks currently assigned to a specific crew member working on aircraft **12**. Again, section **272** displays information about aircraft **12** and the user, as well as pull-down menus and a log off button. In this example, user "Albin" (crew member from FIG. **11***a*) has access to two pull-down menus.

[0082] In GUI **270**, tasks are organized according to log in status. For instance, tasks could be color-coded such that tasks that the crew member is currently logged in to work on are colored in gray, followed by tasks that the crew member is not currently logged in to work on which are colored in white.

[0083] Title line **274** details the task identification number, the task description, and other information pertinent to the task. For each task, the names of the crew members assigned to the task **276** are displayed. The crew member can select button **278** ("Work Card") to access a particular task's printable work card.

[0084] FIG. **12** illustrates example graphical user interface (GUI) **280** used in conjunction with DAMP manager **26** of system **10**. GUI **280** is an example work card screen which shows, in real-time, the current status of a selected task. GUI **280** can be accessed in several ways, one of which is the selection of work card button **262** of GUI **250**.

[0085] GUI **280** presents the following information about the selected task: aircraft tail number **282**, task number **284**, bar code **286** corresponding to task number **284**, work order number **288**, zone number **290**, sequence number **292**, estimated hours **294**, actual hours accrued **296**, suggested number of crew members **298**, skill required **300**, crew numbers **302** of crews assigned to task, current date **304**, station number **306**, and discrepancy or task description **308**.

[0086] GUI **280** also provides box **310** to enable the assigned mechanic to record evaluation notes, box **312** to enable assigned mechanic to record repair reference, box **314** to enable the assigned mechanic to record work-in-progress notes, and box **316** to enable the assigned mechanic to record notes regarding repair, corrective action, turnover, or rejection. Not shown in FIG. **12**, GUI **280** also provides a box to enable the assigned mechanic to sign off on the task, a box to indicate that the task is ready for inspection, and a box to enable the assigned inspector to completely sign off on the task.

[0087] To generate a task card, which lists instructions for how a task is to be completed, the user selects a task card button (which is not shown in FIG. **12**).

[0088] FIG. **13** illustrates example graphical user interface (GUI) **320** used in conjunction with DAMP manager **26** of system **10**. GUI **320** is an example task card screen which provides instructions for how a selected task is to be performed. GUI **320** can be accessed in several ways, one of which is the selection of a task card button (which is not shown) of GUI **280**.

[0089] GUI **320** presents the following information about a selected task: task card number **322**, work order number **324**, aircraft tail number **326**, aircraft serial number **328**, accrued flight hours **330**, accrued cycles **332**, and date **334**. GUI **320** also presents a series of steps **336** which provide instructions on how the task is to be performed. In the example illustrated, there are two steps (A and B), with step B having two substeps (1 and 2). Columns **338** and **339** indicate what skill types should perform each step. GUI **320** is configured according to the standards of the airline operator for which DAMP manager **26** is designed.

[0090] FIG. **14** illustrates example graphical user interface (GUI) **340** used in conjunction with DAMP manager **26** of system **10**. GUI **340** is an example task revision screen used to revise information about a specific task. GUI **340** can be accessed in several ways, one of which is the selection of a revise button on GUI **250** (not shown in FIG. **11***a*).

[0091] GUI **340** includes the following real-time information, all of which can be edited in GUI **340**: task description **342**, number of crew members required **344**, estimated time **346**, actual time accrued **348**, target day for accomplishment **350**, delay amount **352**, estimated start day **354**, assigned crew number **356**, milestone the task must precede **358**, milestone the task must follow **360**, task dependency **362**, task card number **364**, sequence number **366**, and zone number **368**.

[0092] GUI **340** may be accessed for several reasons. Management may want to revise the number of resources (i.e., number of crew members required **344** and estimated time **346**) assigned to a task, or some complication which delays completion of the task. If a task need be delayed, the user can select the number of days the task should be delayed, along a reason for the delay. A user selects button **370** ("Revise") to indicate that the task revision form has been completed, and to enter the new information into the system **10**. Button **372** ("Work Card") allows the user to access the work card screen for the task. Button **374** ("Exit") allows the user to exit GUI **340**.

[0093] Section **376** of GUI **340** visually indicates (preferably by a color-coded dot **378** or an arrow) the location on aircraft **12** where the selected task is targeted. Photograph **384** of the task location is also provided. GUI **340** also indicates, in real-time, where this task falls in the overall production plan. Combined, bar graph **380** and indicator mark **382** represent the current priority of the selected task in relation to all the other maintenance tasks within the check. The priority of the task can be increased by sliding indicator mark **382** toward the top of bar graph **380**. Conversely, the priority of the task can be decreased by sliding indicator mark **382** toward the bottom of bar graph **380**. A similar bar graph and indicator mark can also be provided to indicate where in the current overall status of the maintenance check the task lies.

[0094] FIG. **15** illustrates example graphical user interface (GUI) **390** used in conjunction with DAMP manager **26** of system **10**. GUI **390** is an example work locations screen of system **10**. GUI **390** presents a graphical image of aircraft **12** (from three different perspectives) and dots to identify where on aircraft **12** maintenance needs to be performed. As a user moves the cursor over selected dot **392**, a roll-over description of the maintenance task can be provided. The user can click on dot **392** to access the work card screen for that particular maintenance task.

[0095] FIG. **16** illustrates example graphical user interface (GUI) **400** used in conjunction with DAMP manager **26** of system **10**. GUI **400** is an example work card screen for a non-routine task. GUI **400** is essentially identical to GUI **280** (work card screen for a routine task), except that GUI **400** includes photograph **402** of reported discrepancy **404**.

[0096] FIG. **17** illustrates example graphical user interface (GUI) **410** used in conjunction with DAMP manager **26** of system **10**. GUI **410** is an example "Task Re-Evaluation" shift end screen. Section **412** displays information about aircraft **12** and the user, as well as pull-down menus and a log off button.

[0097] Section **414** of GUI **410** lists all tasks having more hours applied to them than last estimated. Column **416** lists the task number and description of each task, column **418** lists the estimated number of hours to complete that task, column **420** lists the actual hours accrued (so far) to that task, column **422** provides a box in which the crew lead can supply a new estimate of the time remaining on that task, and column **424** provides the crew numbers of crews assigned to that task.

[0098] Section **426** of GUI **410** provides a tool to log crew members out of DAMP manager **26**. To log a specific crew member off, the user need only check box **428** located beneath the crew member's name, and then select button **430** ("Sign Out").

Reliability Manager

[0099] Upon completion of a heavy maintenance period, reliability manager **28** records data relating to reliability of individual aircraft parts. The airline's reliability board may later use reliability manager **28** to query the reliability data and generate reports useful for recommending changes to the MRB program.

[0100] Reliability manager collects information about non-routine tasks. Tracking manager **24** links each non-routine task to its generating routine task to allow reliability manager

28 to determine whether a maintenance interval for a part can be accelerated, or if it needs to be decelerated.

[0101] Reliability manager **28** also collects all the information regarding rotable parts (those parts which can be repaired) including when they were installed, when they were removed, what were the non-routine tasks performed in their life cycle, when they came in for line maintenance checks and their parent-child relationship with other rotable parts. Reliability manager **28** allows airlines to evaluate whether or not a rotable part is actually meeting the manufacturer's predicted life limits. In addition, reliability manager **28** analyzes the maintenance program produced by MRB program manager **22** and the maintenance logbook produced by tracking manager **24** to analyze the reliability of each rotable part. If a rotable part never has a deficiency within the suggested inspection interval, the airline may modify its maintenance program based upon the reliability data produced by reliability manager **28**.

[0102] The primary purpose of an MRB document is to assist the regulatory authorities in determining the initial scheduled maintenance requirements for new or derivative types of transport-category aircraft. The MRB document is used as the basis from which an airline develops its own continuous airworthiness maintenance program. Any change to the maintenance program requires an analysis phase and an appropriate sampling of aircraft reliability data. The resulting information serves as justification for any modifications to the airline's maintenance program.

[0103] A reliability program establishes the time limitations or standards for determining intervals between overhauls, inspections and checks of aircraft equipment. Guidance on reliability program elements is listed in Advisory Circular (AC) 120-17, Maintenance Program Management Through Reliability Methods, as amended, the Airline/Manufacturer Maintenance Program Planning Document, MSG-2/3, and/or Maintenance Tasks. A reliability program typically collects reliability data from sources including unscheduled removals of parts, confirmed failures of parts, pilot reports, sampling inspections, shop findings, functional checks, bench checks, service difficulty reports, mechanical interruption summaries and other sources the airline considers appropriate.

Electronic Publications Manager

[0104] Electronic publications manager **30** is a tool which gathers the multitude of publications needed in the aircraft maintenance industry, and provides them in an on-line environment.

[0105] The airline maintenance industry is a highly regulated industry which produces a substantial number of disparate publications essential for operation of an airline maintenance facility. Electronic publications manager **30** is a tool that gathers this multitude of publications into an electronic form, thus making the publications more easily accessible to aircraft maintenance personnel.

[0106] Electronic publications manager **30** works cooperatively with MRB program manager **22**, tracking manager **24** and DAMP manager **26** to provide access to needed documents as needed by maintenance personnel.

[0107] Electronic publications manager **30** stores such publications as training manuals, maintenance manuals, illustrated parts catalogs, structural repair manuals, aircraft wiring diagram manuals, FAA directives and an airline's specific general engineering and maintenance manual.

[0108] Electronic publications manager **30** can work with the other components of system **10** to instantly link each task in the maintenance program to work cards, which explain an airline's preferred method of performing that task, or may include photographs or wiring diagrams helpful to performing the task.

Personnel Training Manager

[0109] Personnel training manager **32** provides tools for an airline operator to assign instructors, students, classrooms and audio visual equipment to specific training courses. Personnel training manager **32** further provides access from DAMP manager **26** to personnel training records **16** to enable an airline to know exactly when and what training its employees need.

[0110] Personnel training manager **32** provides tools for an airline to assign instructors, students, classrooms and audio visual equipment to specific courses. Personnel training manager **32** further provides access to personnel training records **16** to enable an airline to know exactly when and what training its employees need.

[0111] Personnel training manager **32** allows an airline to organize personnel training records **16** in a variety of formats, including lists of those individuals requiring recurrent training in a specific course, those individuals who are scheduled for training within a specified period of time, those individuals who require recurrent training in a specific course, those individuals who require recurrent training in all courses, those individuals who are scheduled for training within a specified time frame, those courses that are currently scheduled (along with corresponding instructors and trainees) and those classrooms that are available.

[0112] As training occurs, personnel training manager **32** supplements personnel training records **16** to incorporate information regarding training each employee receives, thereby keeping personnel records **16** up-to-date. Personnel training manager **32** keeps track of both classroom training and on-the-job training.

[0113] In addition, personnel training manager **32** compares personnel training records **16** with FAA training requirements **18** to monitor which tasks each employee is qualified to perform. By integrating personnel training manager **32** with DAMP manager **26**, crew leads can quickly ascertain which mechanics have the training necessary to perform specific tasks, thereby ensuring that only qualified mechanics are assigned to tasks. The FAA has very strict standards regarding the training required of aircraft mechanics. Before a mechanic can independently perform a task, the FAA requires that the mechanic have either been previously supervised performing the task or been specifically trained for that task.

[0114] Another advantage of integrating personnel training manager **32** with DAMP manager **26**, is that employees, as well as maintenance management, are instantly notified of the employee's training schedule.

[0115] Additionally, as employees are scheduled off the floor for training, DAMP manager **26** instantaneously makes adjustments to the number of employee hours available to complete maintenance of an aircraft. Thus, the production coordinator can immediately ascertain the effect of removing those employees from the work floor, and will be able to plan the maintenance production accordingly. If the production schedule is negatively affected by the training (i.e., one or more days are added to the production schedule), the produc-

tion planner may schedule some personnel to work overtime or shift personnel in from other maintenance bays to make up the missing production hours. A production coordinator may also consult with training personnel to reschedule the training to minimize harm to the production schedule (e.g., perhaps only six of twelve employees scheduled for training will actually attend the training). Effectively, the management team is given early options to control its production schedule.

Automatic Assignment of Employees

[0116] As mentioned in reference to step **170** of FIG. **8**, DAMP manager **26** can integrate with personnel training manager **32** to automatically assign employees to tasks. DAMP manager **26** prioritizes the tasks within the maintenance program, analyzes data regarding training of employees (gained from personnel training manager **32**), and assigns the best mechanic to the job.

[0117] FIG. **18** is a flow diagram of the automatic task assignment component of DAMP manager **26**. At step **332**, the auto-assign system receives a prioritized list of tasks to be accomplished in one to two days, and at step **334**, the auto-assign system receives personnel training data from personnel training manager **32**. At step **336**, the auto-assign system compares the available resources to the need resources to timely complete the maintenance check. If there is enough time and enough mechanics to enable the completion of all necessary tasks within the necessary time period, the auto-assign system will enter a training mode. In this training mode, at step **338**, DAMP manager **26** will assign to specific tasks, when possible, those mechanics who need on the job training along with a mechanic who has the necessary training. To enable this automatic training function, DAMP manager **26** analyzes the maintenance flow of the aircraft, how much maintenance time is remaining, how many tasks need to be accomplished, how many mechanics are scheduled to work and personnel training records **16**.

[0118] DAMP manager **26** continues to monitor the maintenance flow during production. If maintenance flow falls behind schedule, the automatic assignment of tasks will switch from a training mode to a best skilled mode. In this mode, at step **340**, each task is assigned the best skilled employee(s) to ensure the timely completion of the maintenance check. If the available resources become sufficient at anytime during the check, the auto-assign system can switch back to the training mode. Additionally, this automatic assignment of employees can be overwritten by crew leads or production management at any time.

Implementation

[0119] According to the present invention, a system and method are provided for dynamically managing, in real-time, aircraft maintenance requirements. The system and method of the present invention brings a distributed computing framework of using client/server and Internet technologies to the field of aircraft maintenance, allowing end-users to react quickly to the dynamics of everyday events. The system and method of the present invention take advantage of a process of using the Internet browser technology to deliver real-time distributed software products for the aircraft maintenance industry.

Applications

[0120] The airline industry is formed of four tiers of airline operators: the major airlines, the regional airlines, the corporate owners of small fleets of aircraft and the individual (or private) owners of aircraft. Each of these tiers of operators has need for some-scaled version of system **10** of the present invention. Certainly, an individual owner of a single aircraft will have different needs that a multiple-hubbed major aircraft operator of a large fleet of aircraft. Nonetheless, each of the above-described components of system **10** has applicability to each tier of aircraft operators.

Application to Major Airlines

[0121] Major airlines typically operate a large and varying fleet of passenger aircraft. These operators generally fly into a large number of cities, with maintenance potentially occurring in any of those cities, and heavy maintenance bases in several of those cities. The major airlines stand to lose a substantial amount of revenue each day one of its aircraft is grounded due to maintenance. Therefore, one of the main priorities for the major airline is to minimize the number of days that its aircraft remain in heavy maintenance (without sacrificing the airworthiness of the aircraft) by efficiently managing the completion of tasks during heavy maintenance periods. For that reason, DAMP manager **26** is likely the most important component of a major airline's maintenance management program. Similarly, personnel training manager **32** aids the airline in ensuring that their maintenance personnel are training

Application to Regional Airlines

[0122] Regional airlines will typically operate a much smaller fleet of aircraft than the major airlines, with less variety in the type of aircraft. Additionally, the aircraft owned by the regional airlines tend to be smaller than those owned by the major airlines, and tend to require fewer maintenance tasks to keep them airworthy. Because of the smaller scale of the regional airlines, they do not have the same manpower and resources of the major airlines to create individualized maintenance programs. Thus, the regional airlines tend to be more concerned with simply gathering all of the information about their maintenance program in one place. For that reason, MRB program manager **22** and tracking manager **24** are likely the most important components of a regional airline's maintenance management program. MRB program manager **22** and tracking manager **24** will provide the regional airlines with the tools needed to organize their maintenance tasks into logical groupings, and to monitor those tasks for when they are due.

[0123] At the regional airlines, reliability analysis also suffers due to the limited resources available to the regional airlines. A reliability program to monitor warranty issues and MRB document modifications is a particularly complicated (and expensive) program to implement. Such a program simply requires a large number of resources (typically personnel) to gather and analyze the large amount of data needed to (1) establish individual parts have met manufacturer's warranty, and (2) meet the FAA regulations for modifying one's MRB

document. Thus, reliability manager **28** can be another key component to add to their maintenance management system.

Application to a General or Corporate Aviation Environment

[0124] Corporate and general aviation aircraft operators typically own one to five aircraft. Often, the aircraft owned by corporate and individual operators do not have MRB maintenance documents associated with them, but only a maintenance manual supplied by the aircraft manufacturer. In lieu of an MRB maintenance document, the tasks and suggested performance intervals listed in the maintenance manual can loaded into MRB program manager **22** to create a well-organized maintenance program, and into tracking manager **24** to track the tasks listed in the maintenance manual.

Summary

[0125] The system and method of the present invention is a software system designed for the multiple users of a production coordination system within the aircraft maintenance industry. It allows mechanics to understand exactly what routine and non-routine items they are to work on, it allows the crew leads to assign tasks to crew members and query as to what tasks are currently being worked on and by whom, and it provides the managers the opportunity to compare actual time expended on aircraft compared to forecasted time and to adjust crew priorities in real-time. Crew leads, managers and executive management can quickly evaluate where the aircraft is in relation to the forecasted time of the aircraft check as to percentage complete and estimated time of completion visually by the use of easy-to-understand charts.

[0126] Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

1. A method for electronically documenting the completion of maintenance tasks in a maintenance industry which requires recordation of maintenance tasks performed, and in which required maintenance tasks are documented on a plurality of work cards, the method comprising:

retrieving a legacy work card, the legacy work card being an electronic document itemizing a plurality of maintenance tasks to be performed and specifying by skill level whom may perform the itemized maintenance tasks;

creating, from the legacy work card, an electronic work card comprising a plurality of data entry fields, the data entry fields comprising at least a sign-off field;

receiving data corresponding to a designated data entry field; and

modifying the electronic work card to include the received data corresponding to the designated data entry field.

2. The method of claim **1**, wherein the data entry fields are selected from a group of fields consisting of one or more task notes inputs, one or more maintenance personnel sign-off inputs, and a task inspection readiness input.

3. A system for documenting maintenance tasks, which are performed on an aircraft and which are documented on a plurality of electronic work cards, the system comprising:

computer readable memory configured to store and access data associated with the work cards; and

a processor configured to process the work cards, each of which work cards comprise:

at least one maintenance task for the aircraft;

a plurality of information fields related to the task and the aircraft on which the task is performed; and

one or more data entry fields comprising at least a sign-off field.

4. The system of claim **3**, wherein the information fields are selected from a group of fields consisting of an identifier for the aircraft on which the task is performed, a task identifier, a task description, a task location identifier, an estimated task completion time, an actual task time accrued, a work order identifier, a suggested or required task skill level.

5. The system of claim **3**, wherein the data entry fields are selected from a group of fields consisting of one or more task notes inputs, one or more maintenance personnel sign-off inputs, and a task inspection readiness input.

6. The system of claim **3**, wherein each of the work cards further comprise a graphical representation of the aircraft on which the maintenance is performed.

7. The electronic work card of claim **3**, wherein one or more of the information fields are editable.

8. An electronic system for facilitating a maintenance task performed on an aircraft and documented on an electronic task card, the system comprising:

computer readable memory configured to store and access data associated with the task card; and

a processor configured to process the task card, wherein the task card comprises:

a plurality of information fields related to the task performed and the aircraft on which the task is performed; and

at least one task step for performing the task.

9. The electronic task card of claim **8**, wherein the information fields are selected from a group of fields consisting of a task card identifier, a work order identifier, an identifier for the aircraft on which the task is performed, accrued flight hours, and accrued cycles.

10. The electronic task card of claim **8**, wherein the at least one task step comprises a plurality of task steps.

11. The electronic task card of claim **10**, wherein one or more of the task steps comprise one or more sub-steps.

12. The electronic task card of claim **8**, wherein the at least one task step comprises:

instructions for performing the task step; and

a suggested or required skill level for performing the task step.

13. The electronic task card of claim **8**, wherein one or more of the information fields are editable.

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