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(54) ULTRASOUND LABORATORY INFORMATION MANAGEMENT SYSTEM AND METHOD

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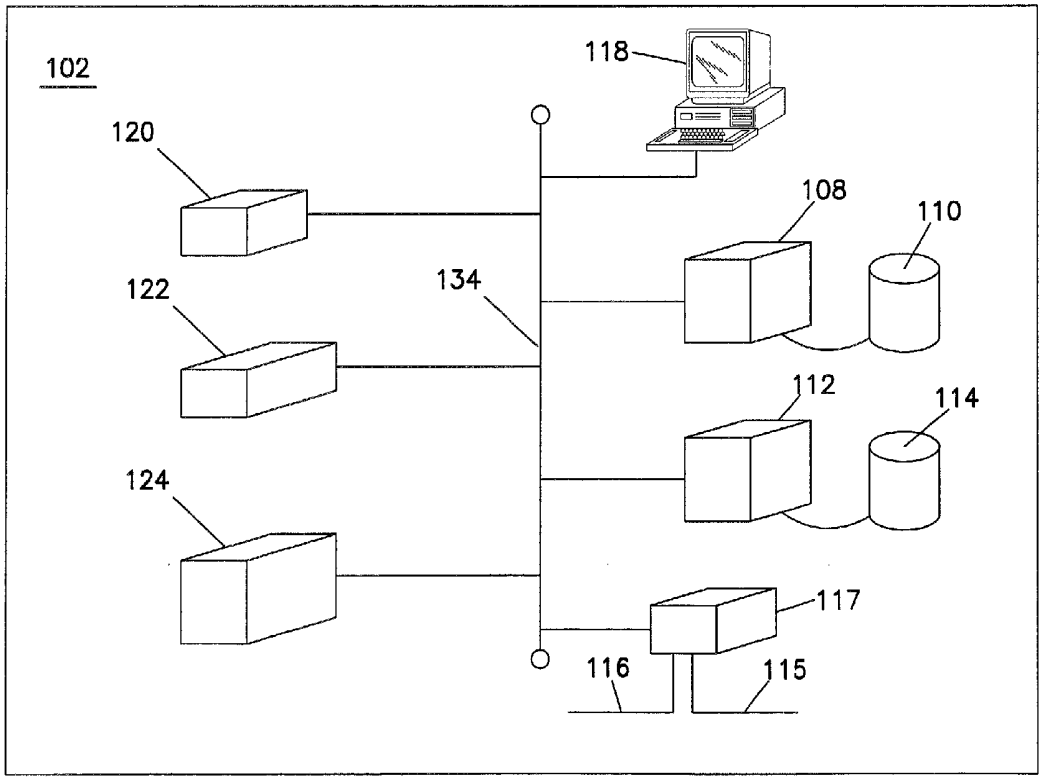
Publication Classification

(51) **Int. Cl.**[7] **A61B 8/00**; G06F 17/00

(52) **U.S. Cl.** **600/437**; 705/3; 706/45

(57) **ABSTRACT**

A multifunctional information management system that integrates a plurality of modules, each of the modules being interfaced via a relational database. The integrated system manages a large volume of business, data, and image information and is capable of being accessed/organized via the Internet. One embodiment of the multifunctional information management system is an ultrasound laboratory information management system (ULIMS) for a medical ultrasound imaging and hemodynamic laboratory, e.g., an echocardiographic or comparable medical laboratory environment, incorporating a multifunctional management system. The ULIMS includes: 1) Scheduling and Workflow Modules; 2) Patient Information and Demographics Modules; 3) Billing Modules; 4) Procedure Information and Referral Diagnosis Modules; and 5) Measurement, Templates and Calculations Modules; 6) Final Impressions and Interpretation Modules; 7) Procedure Report Modules; 8) Serial Studies Module; 9) Research Protocols Module; 10) User Interface and Services Modules; 11) Web Based Modules; 12) Unique Reports Modules; 13) Database Modules; 14) Systems Administration Modules; 15) Security, Privacy and User Configuration Modules; 16) Image Modules; 17) Systems and Technical Support Modules; and 18) Knowledge Base Modules.



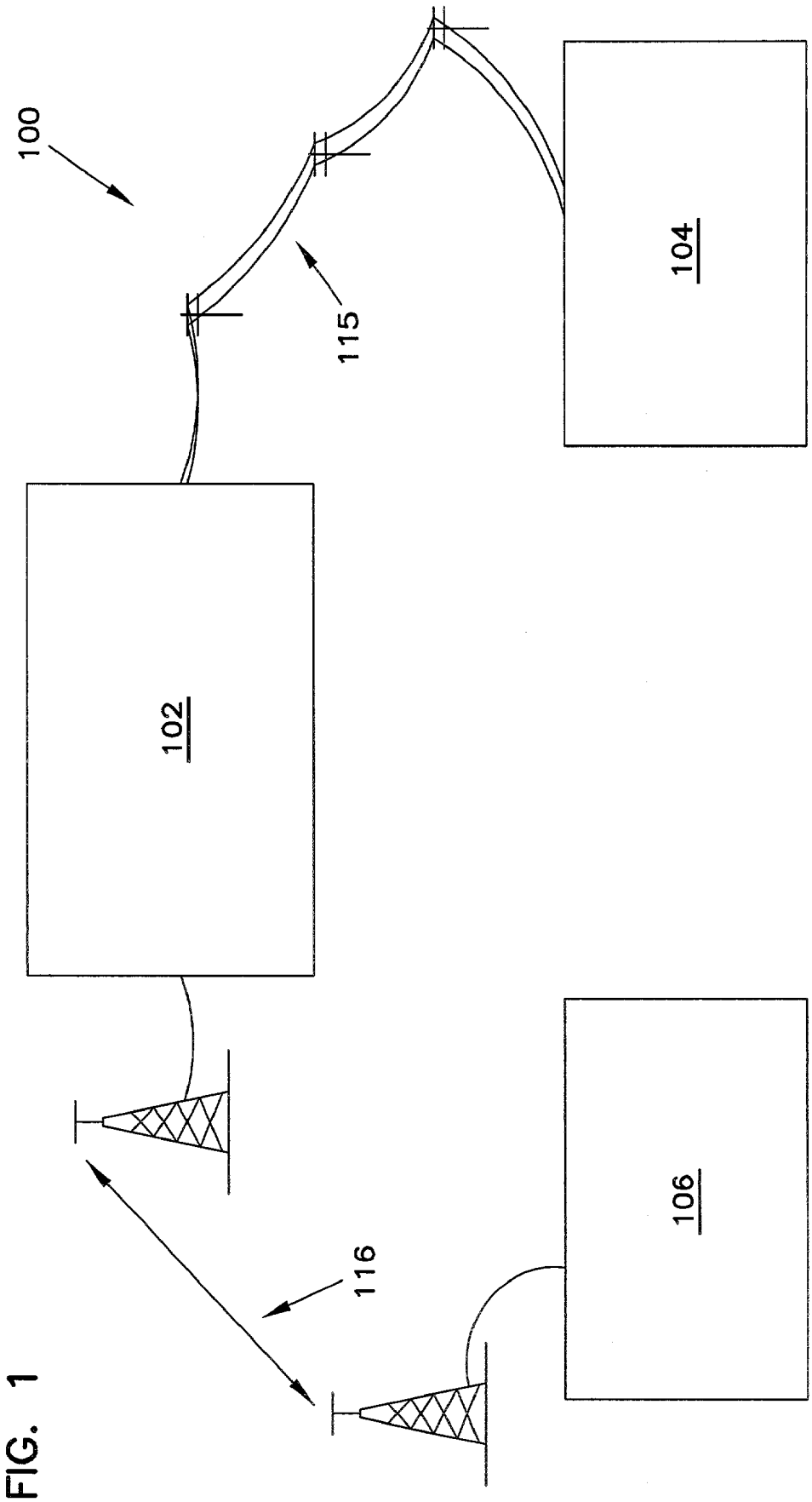


FIG. 1

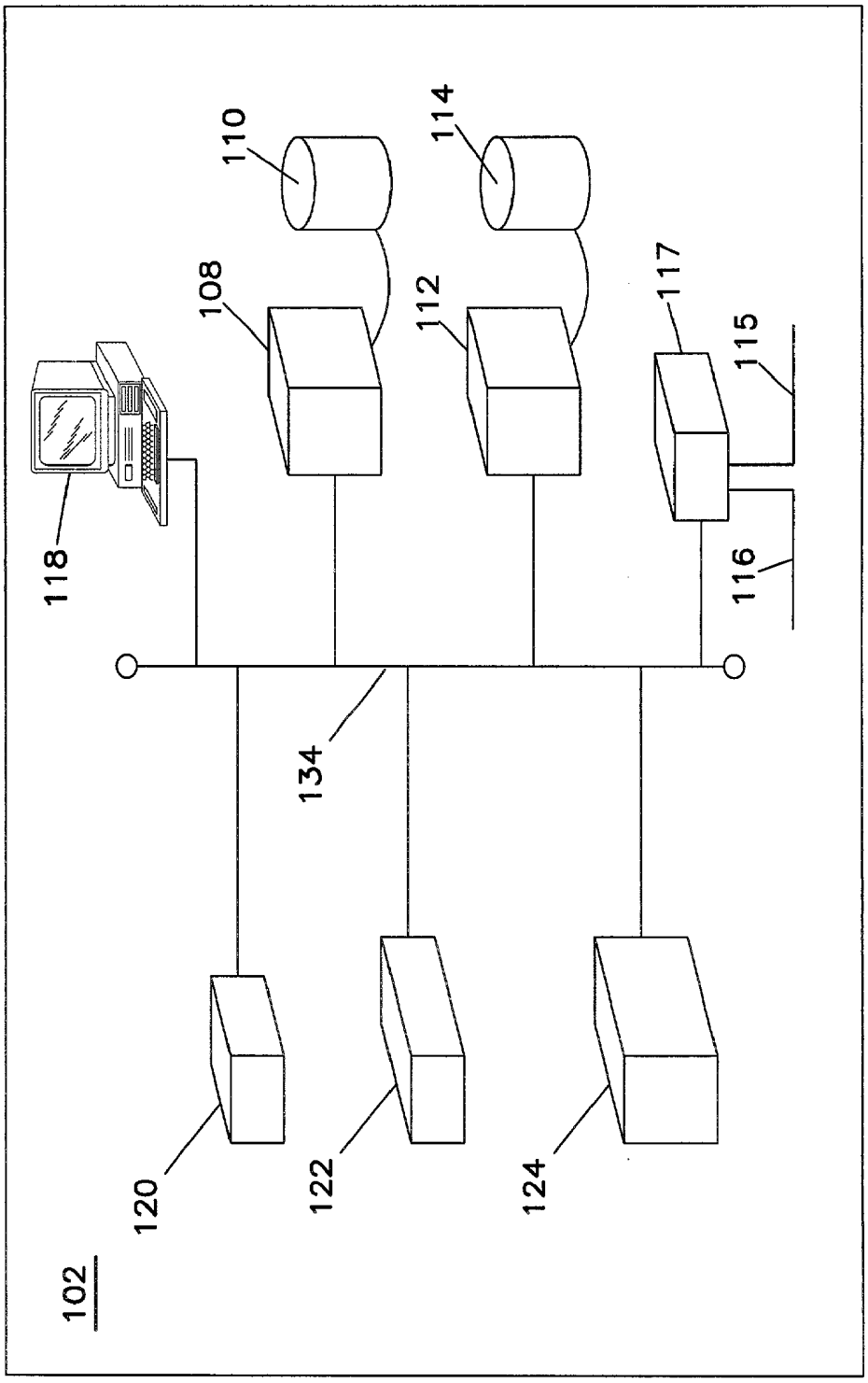


FIG. 2

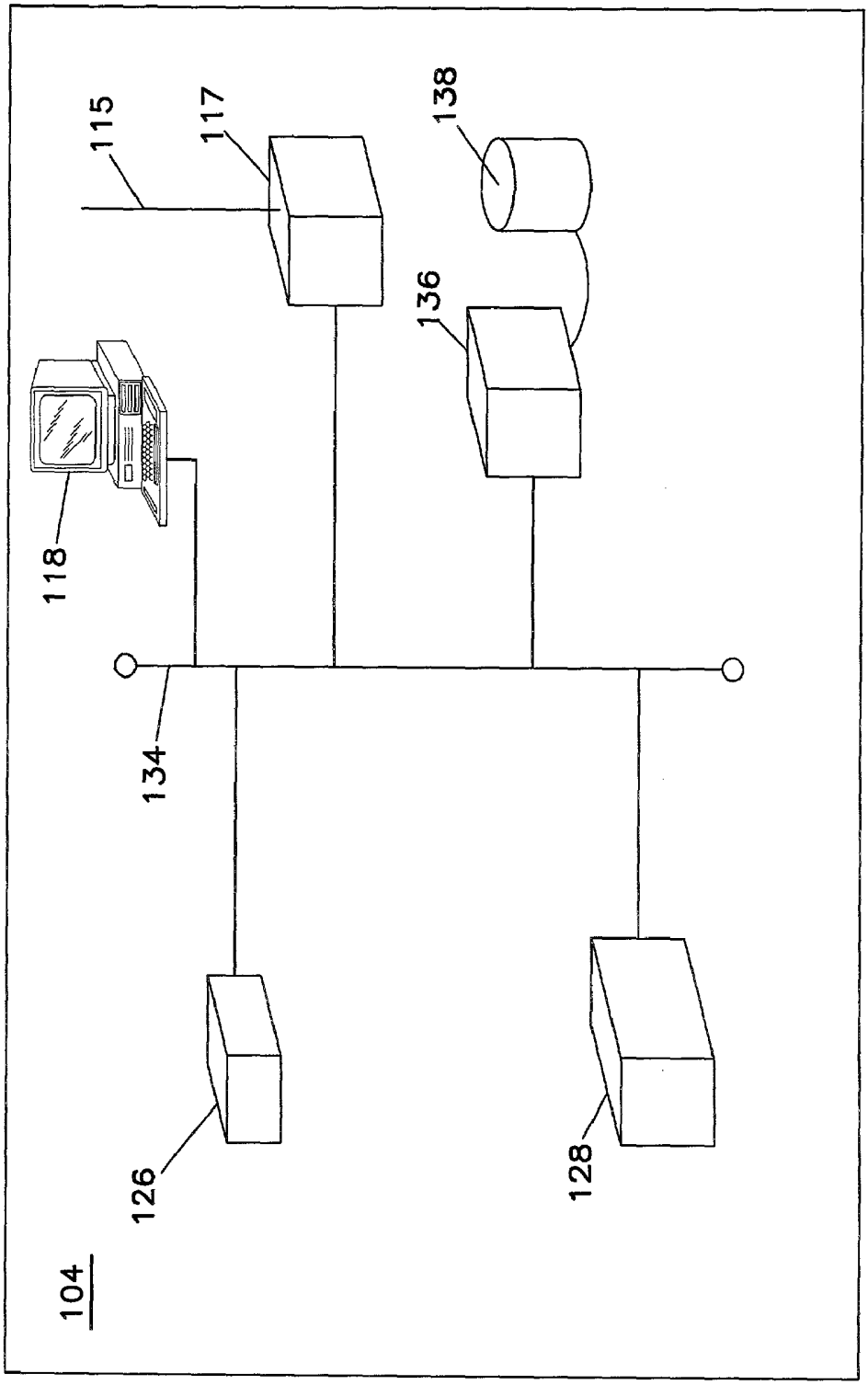


FIG. 3

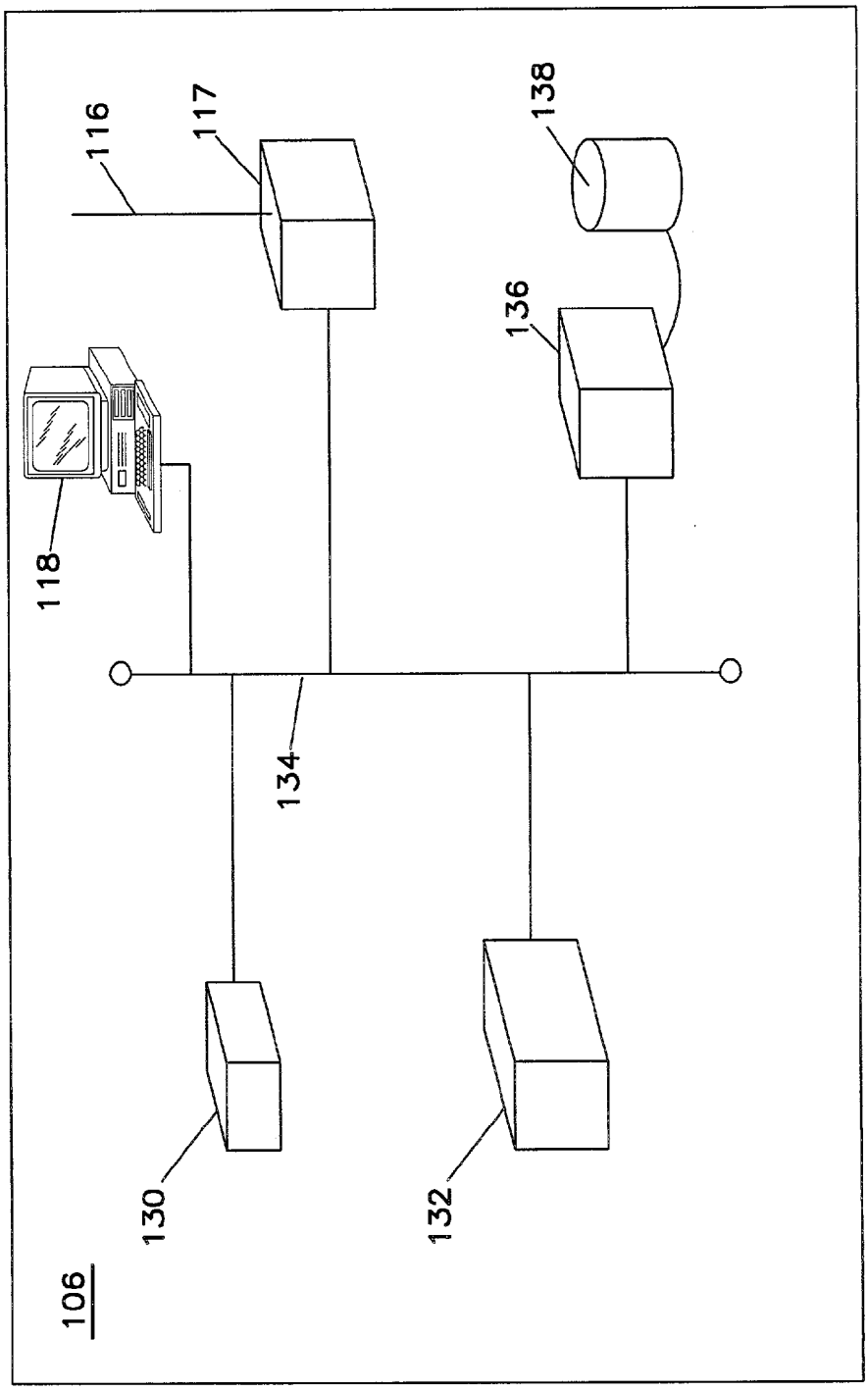


FIG. 4

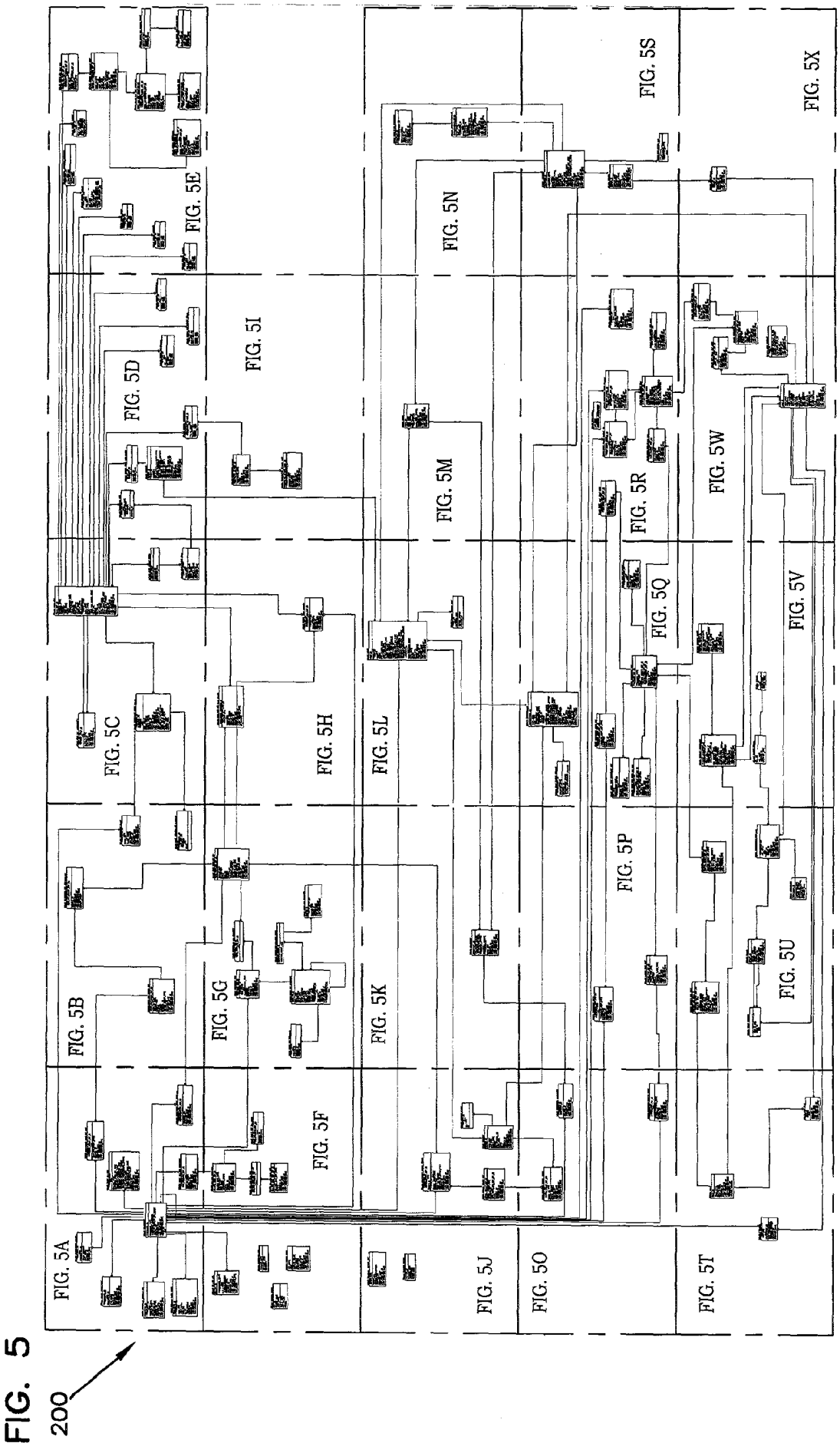
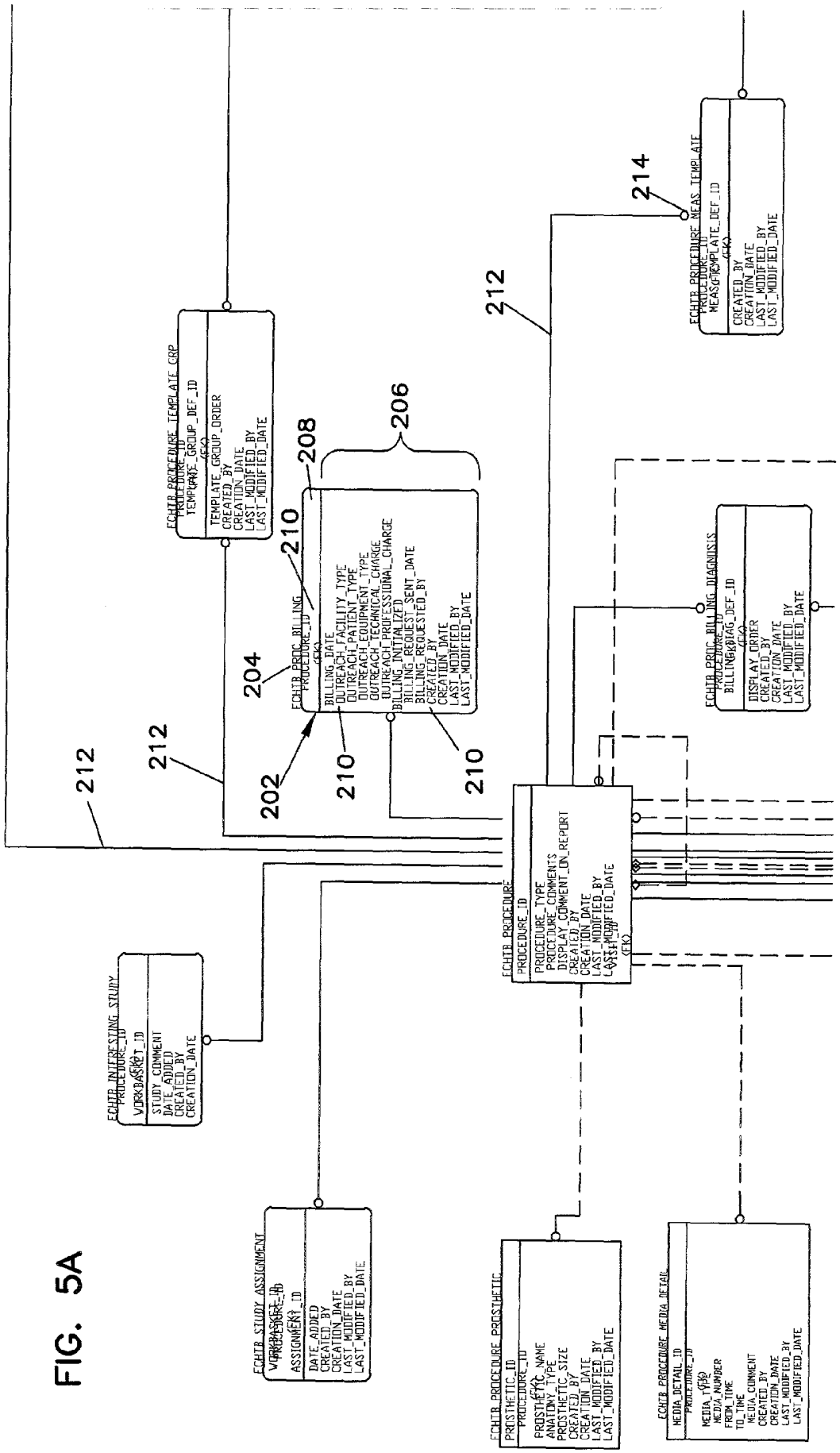


FIG. 5
200
FIG. 5A
FIG. 5B
FIG. 5C
FIG. 5D
FIG. 5E
FIG. 5F
FIG. 5G
FIG. 5H
FIG. 5I
FIG. 5J
FIG. 5K
FIG. 5L
FIG. 5M
FIG. 5N
FIG. 5O
FIG. 5P
FIG. 5Q
FIG. 5R
FIG. 5S
FIG. 5T
FIG. 5U
FIG. 5V
FIG. 5W
FIG. 5X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(FK)
BILLING_DATE
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OUTREACH_PATIENT_TYPE
OUTREACH_EQUIPMENT_TYPE
OUTREACH_TECHNICAL_CHARGE
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LAST_MODIFIED_DATE
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PROCEDURE_TYPE
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(FK)
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TO_TIME
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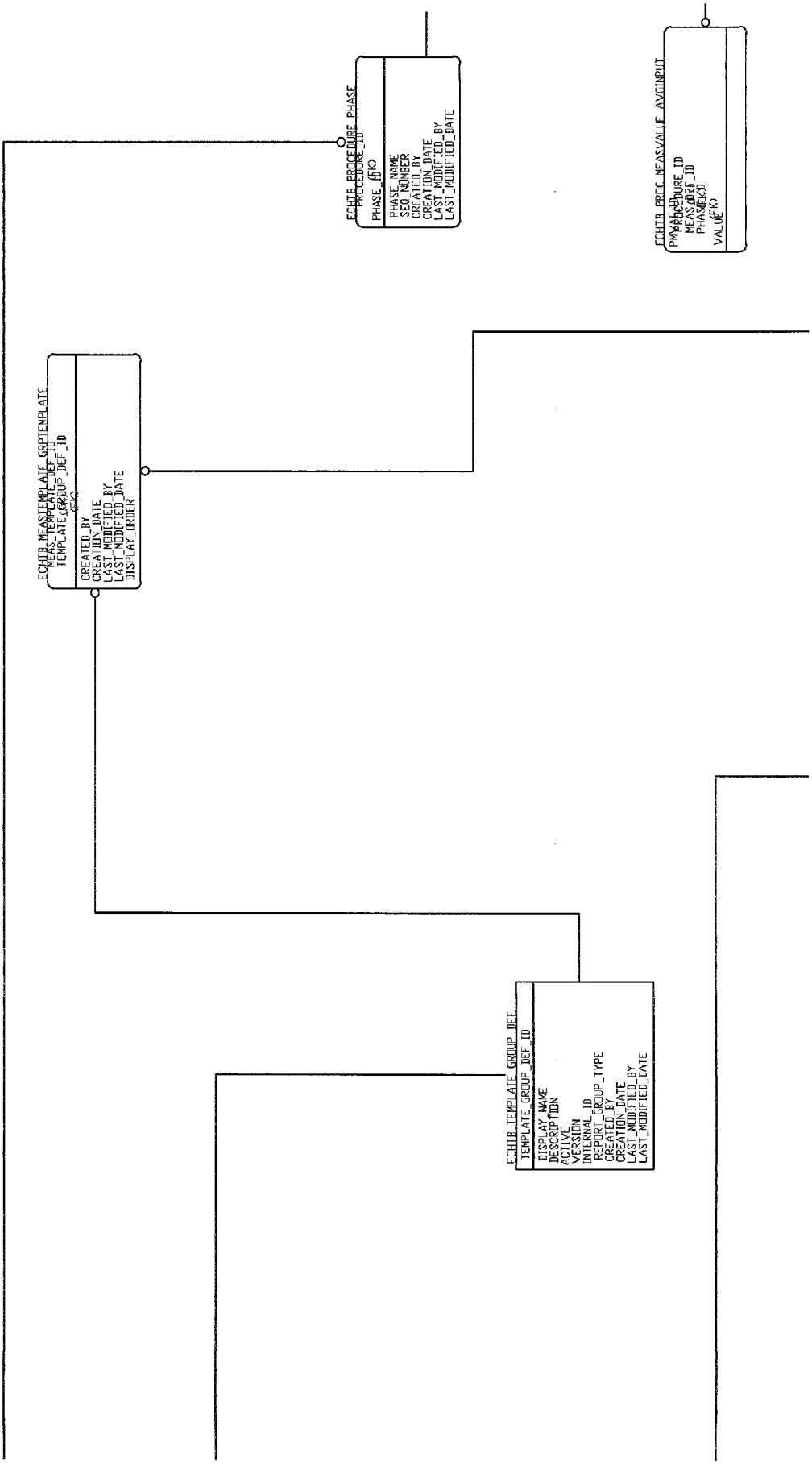
LAST_MODIFIED_DATE
202
204
206
208
210
212
214

FIG. 5A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LAST_MODIFIED_DATE
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CREATION_DATE
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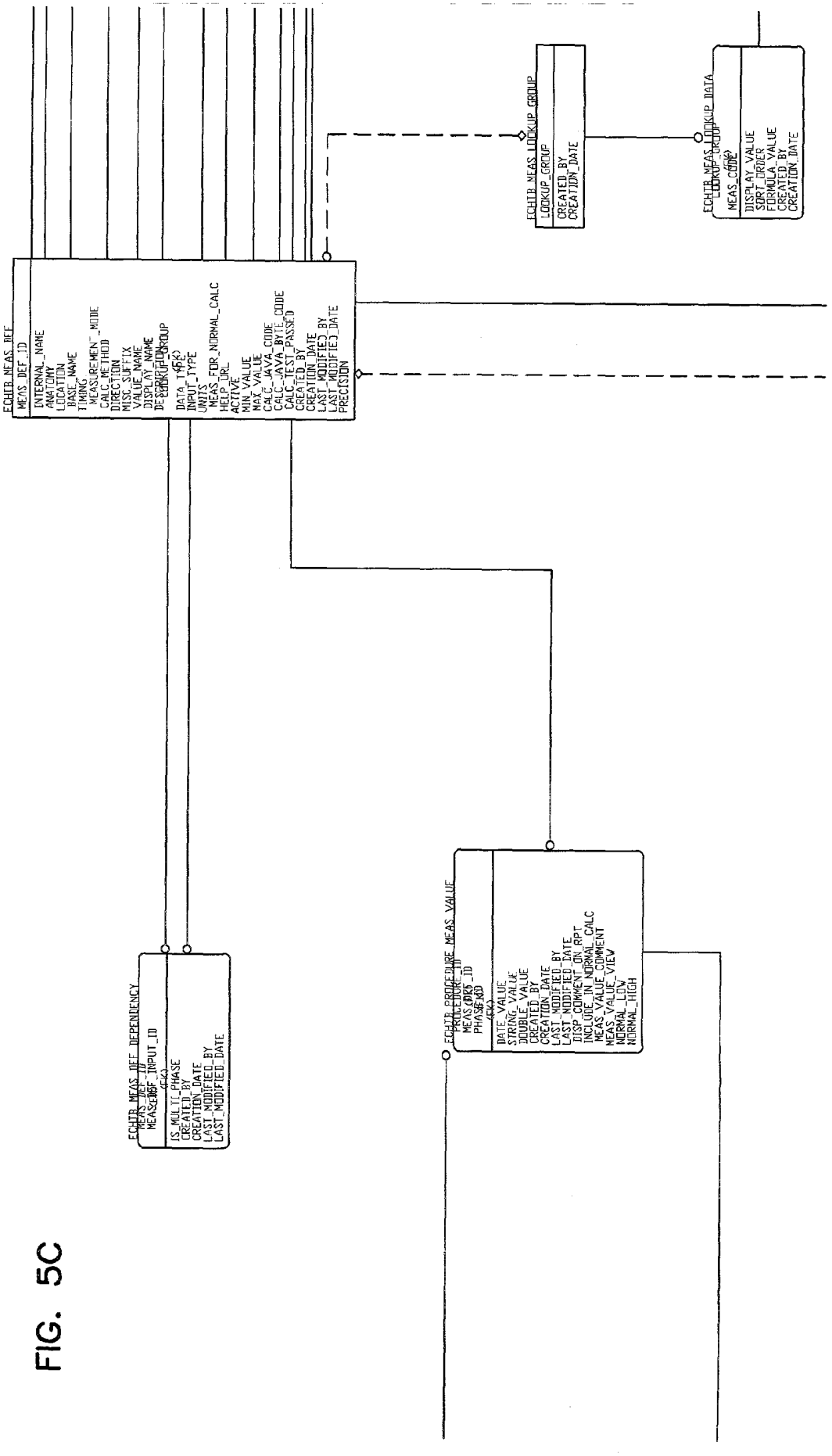
LAST_MODIFIED_DATE

FIG. 5B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DISPLAY_NAME
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MAX_VALUE
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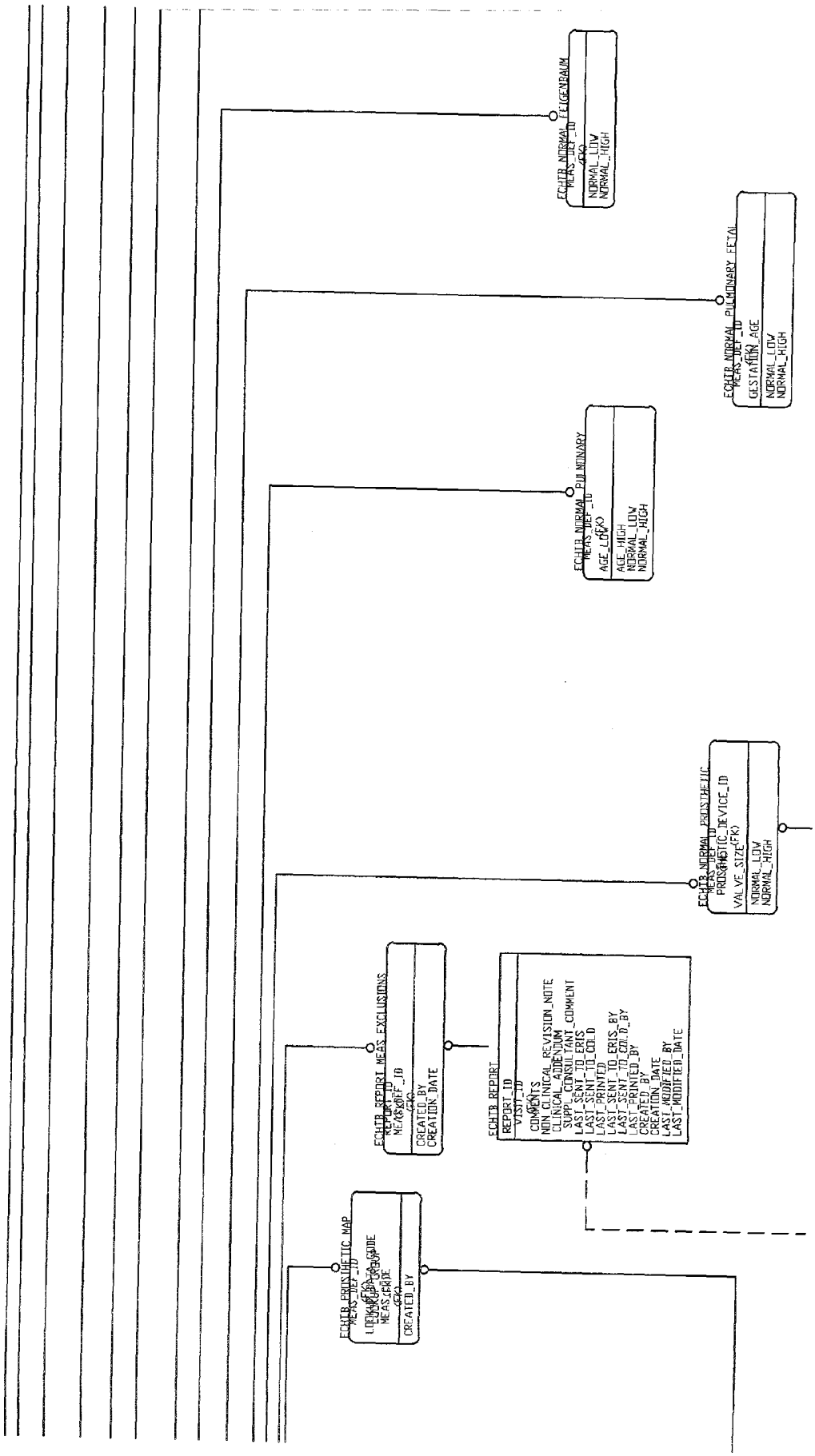
NORMAL_HIGH

FIG. 5C

FIG. 5D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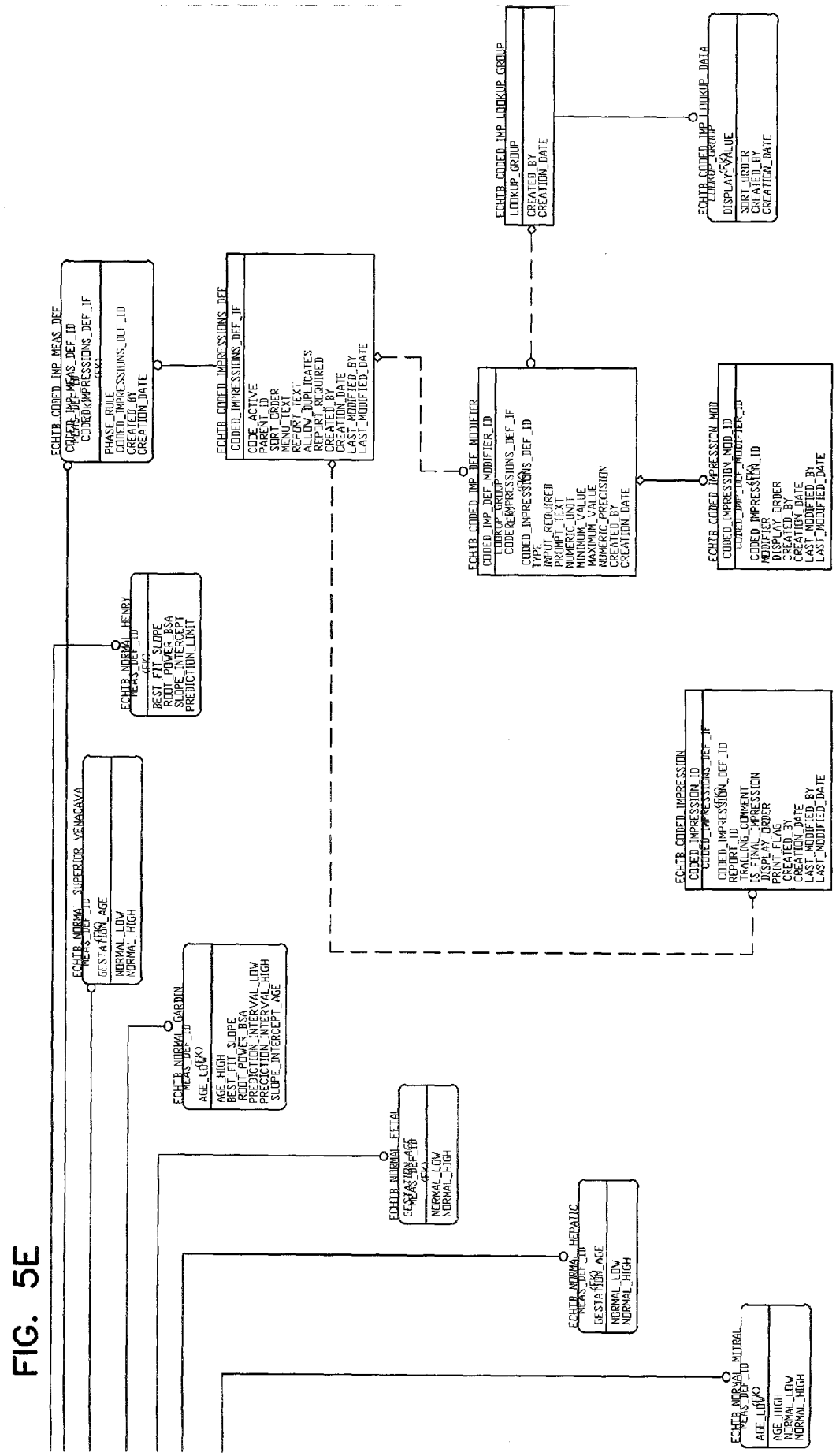
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FIG. 5E

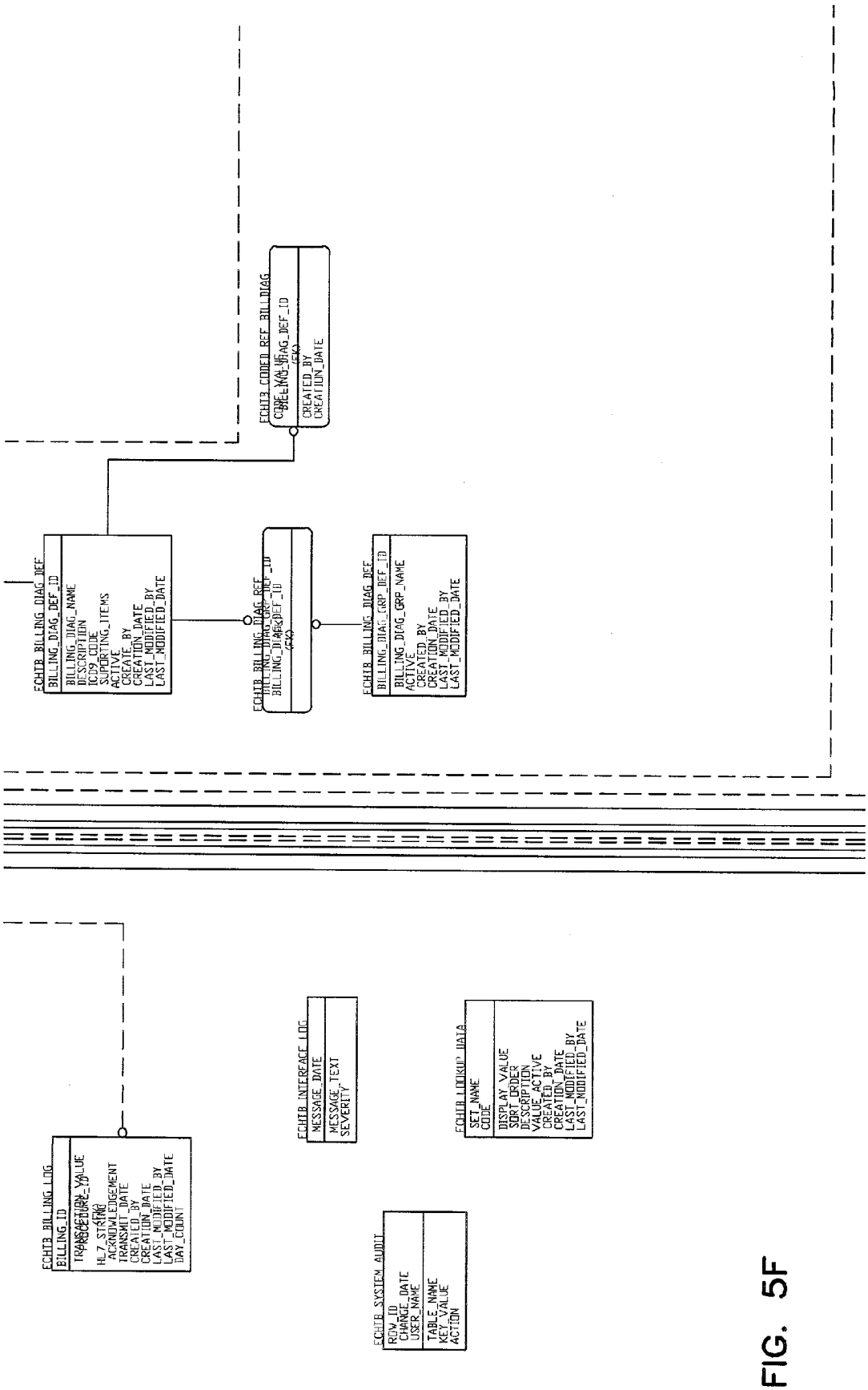
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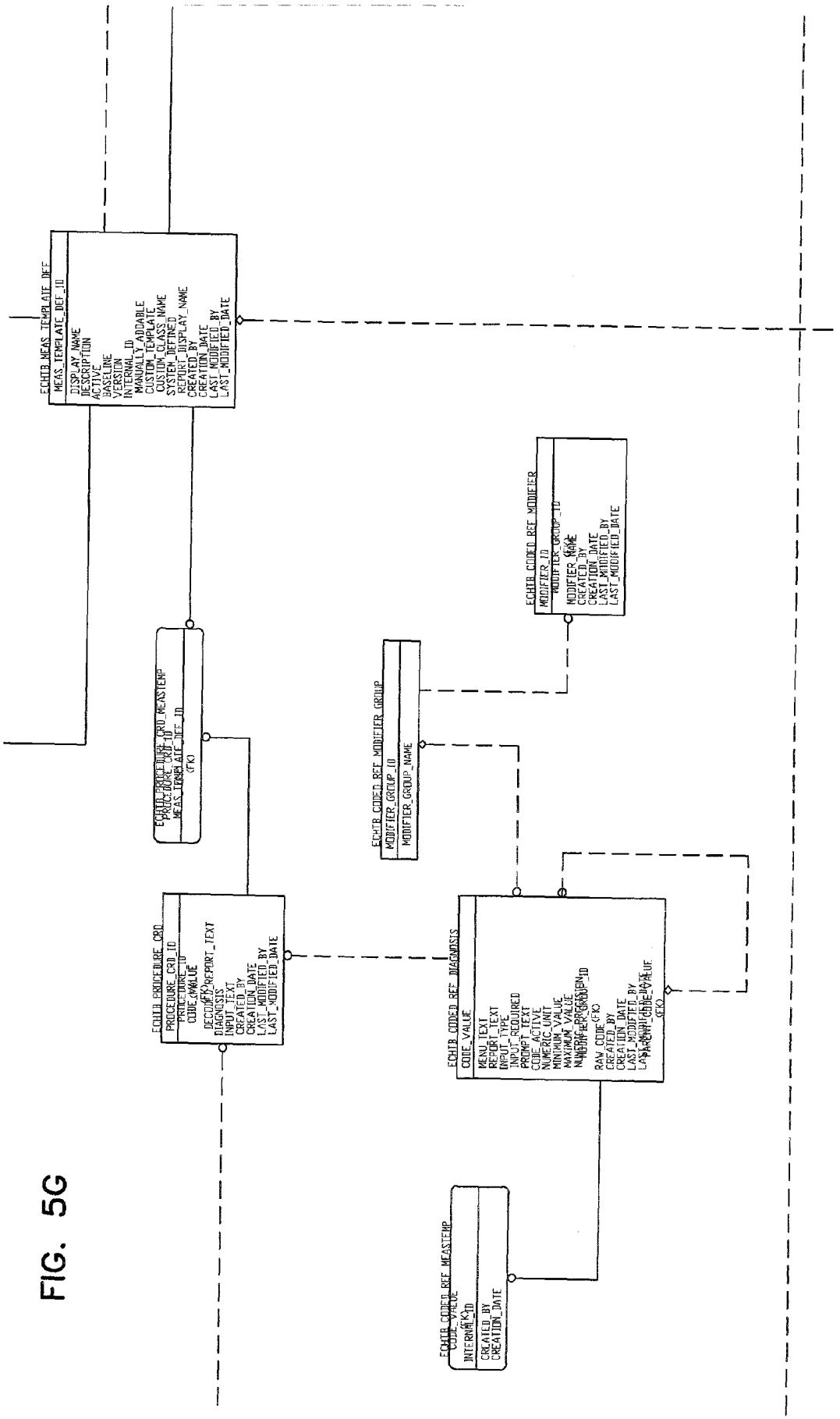
FIG. 5F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REPORT_TEXT
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MAXIMUM_VALUE
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CREATION_DATE

FIG. 5G

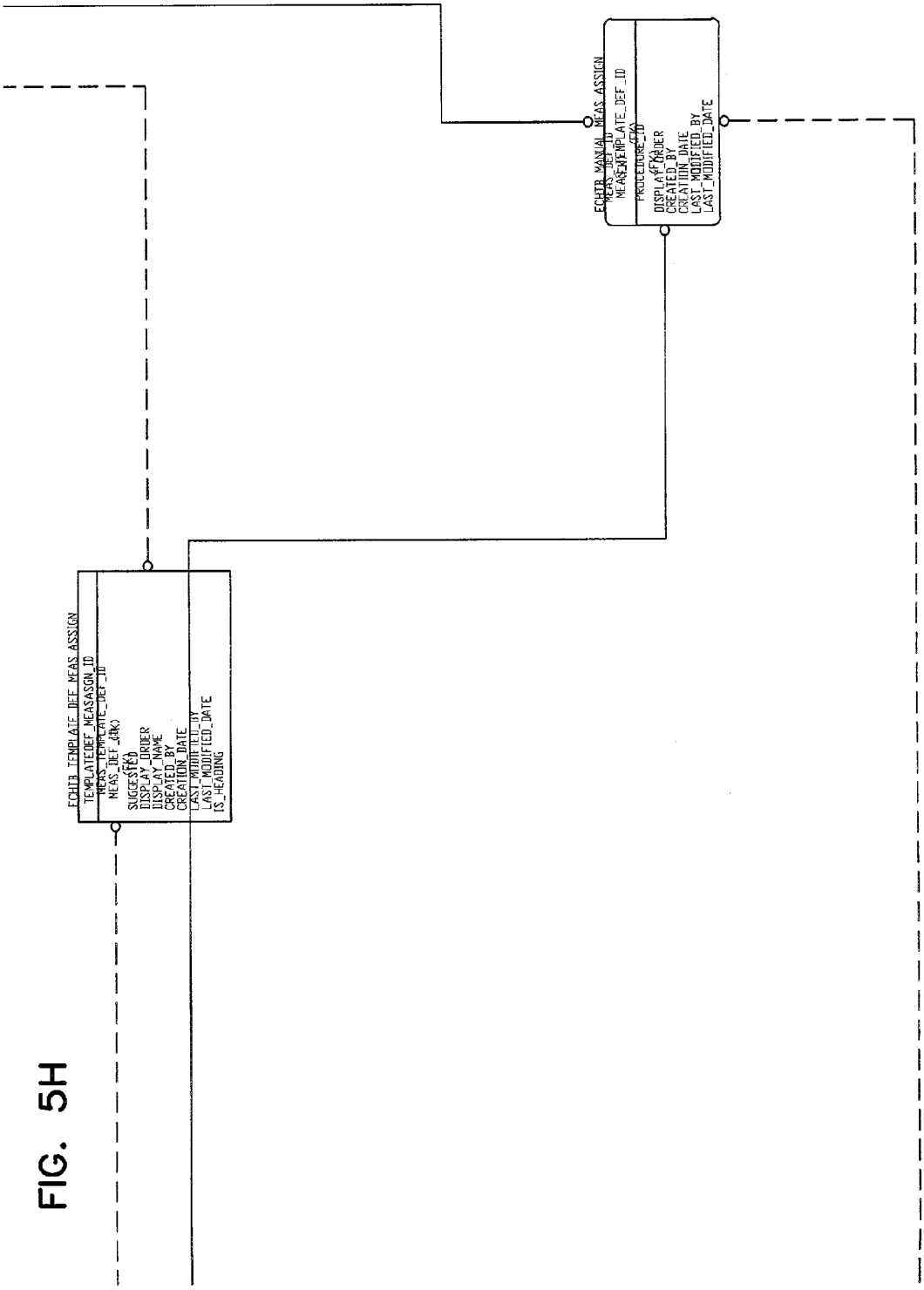
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FIG. 5H

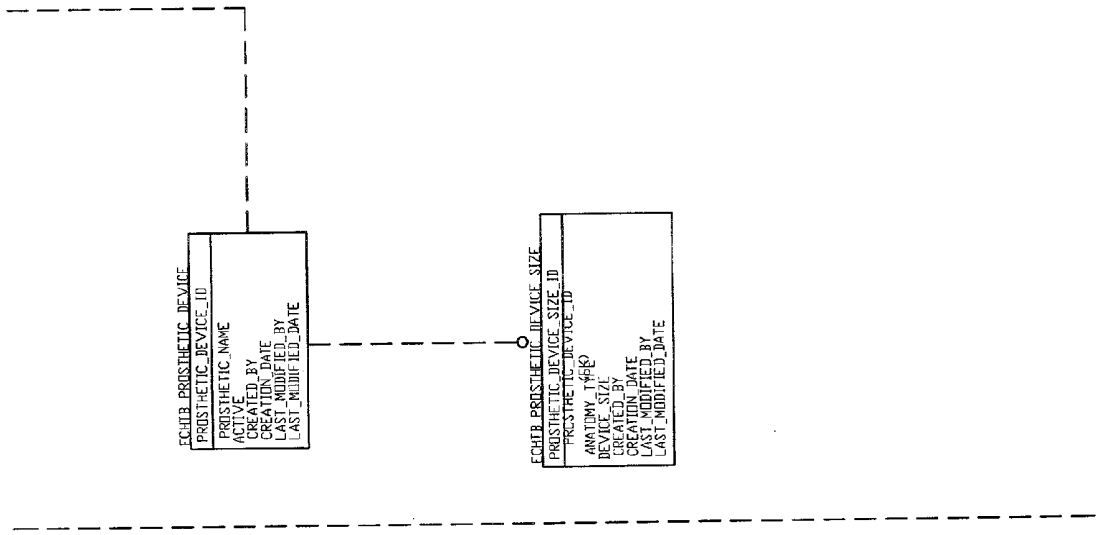
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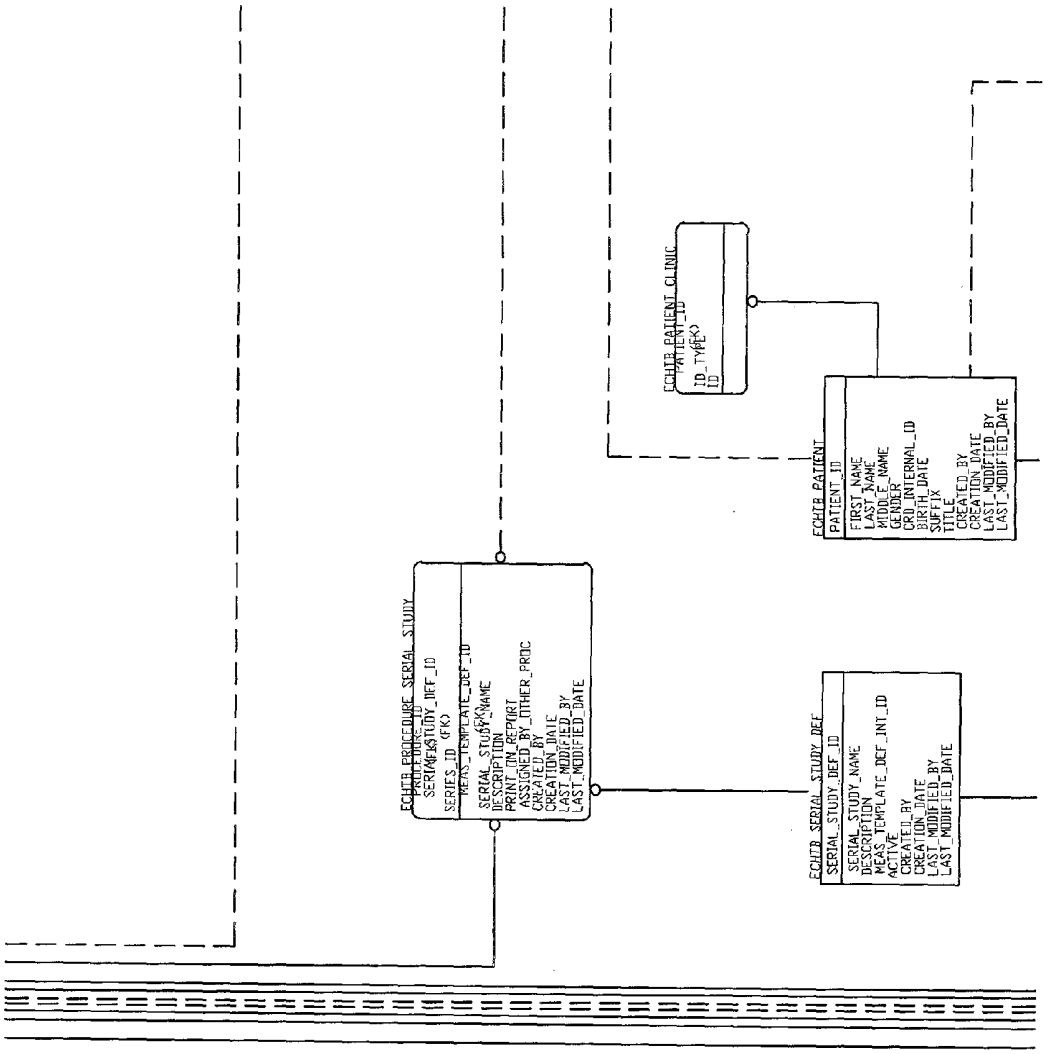
FIG. 51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GENDER
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SUFFIX
TITLE
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CREATION_DATE
LAST_MODIFIED_BY
LAST_MODIFIED_DATE
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DESCRIPTION
QUEUE_NAME

FIG. 5J

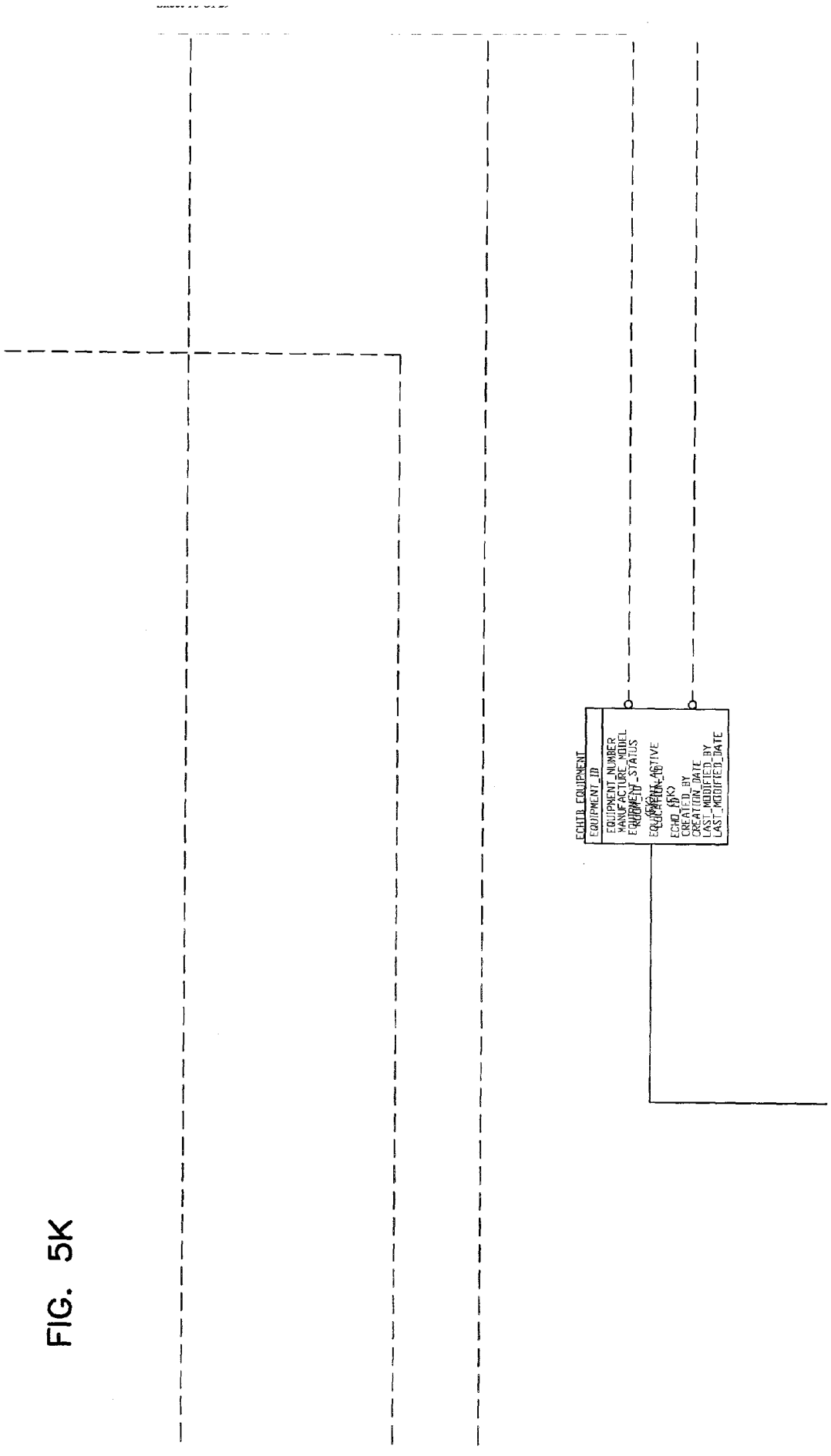
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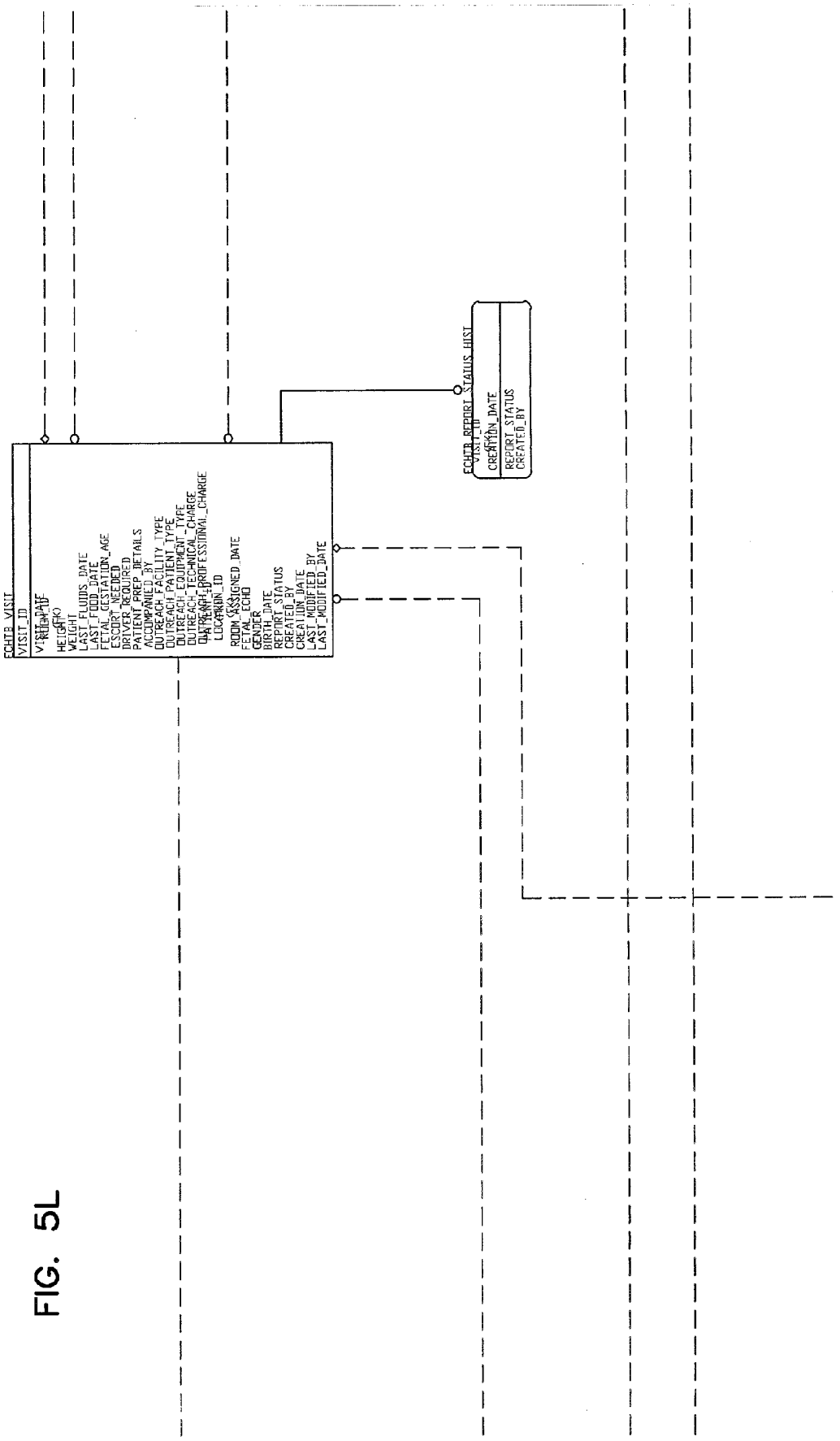
FIG. 5K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DRIVER_REQUIRED
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OUTREACH_EQUIPMENT_TYPE
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OUTREACH_PROFESSIONAL_CHARGE
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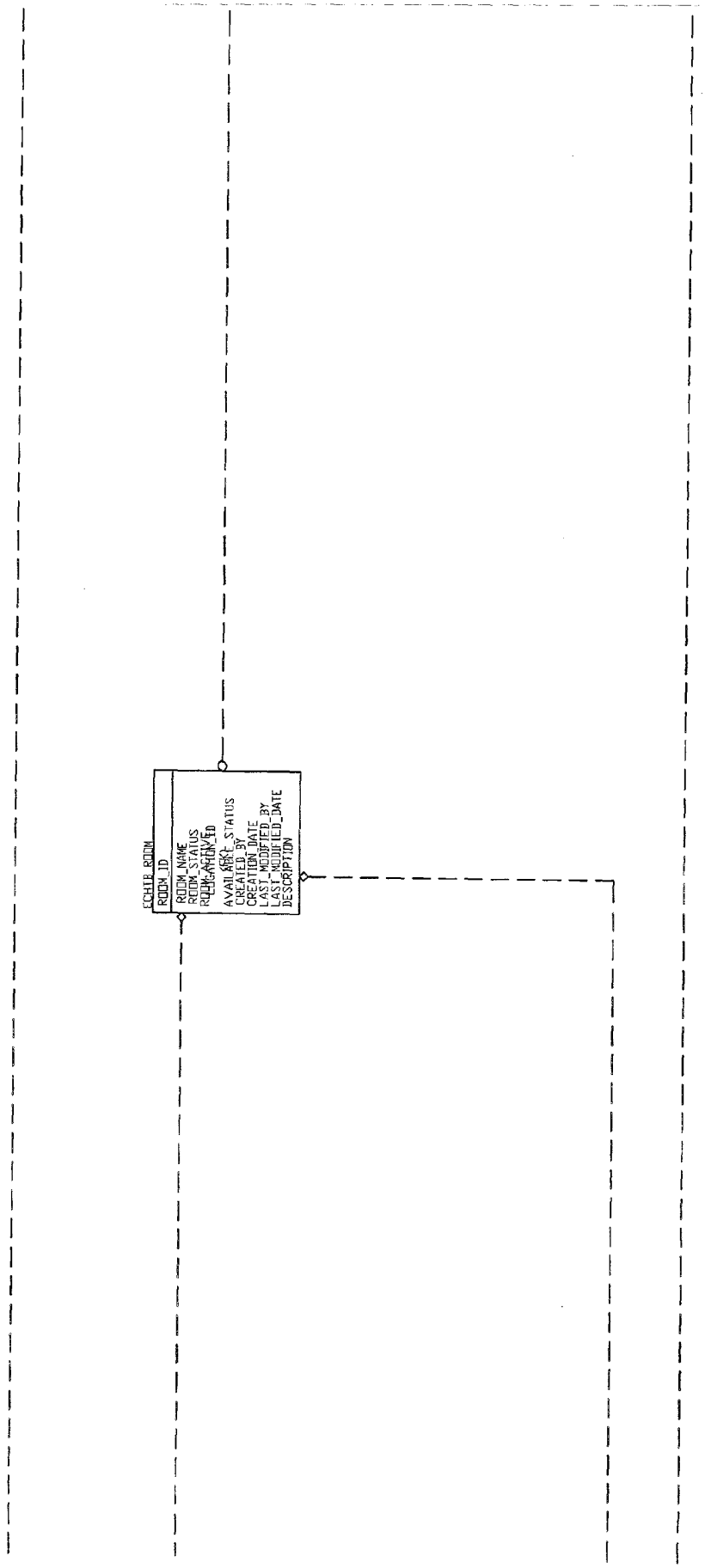
FIG. 5L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ROOM_STATUS
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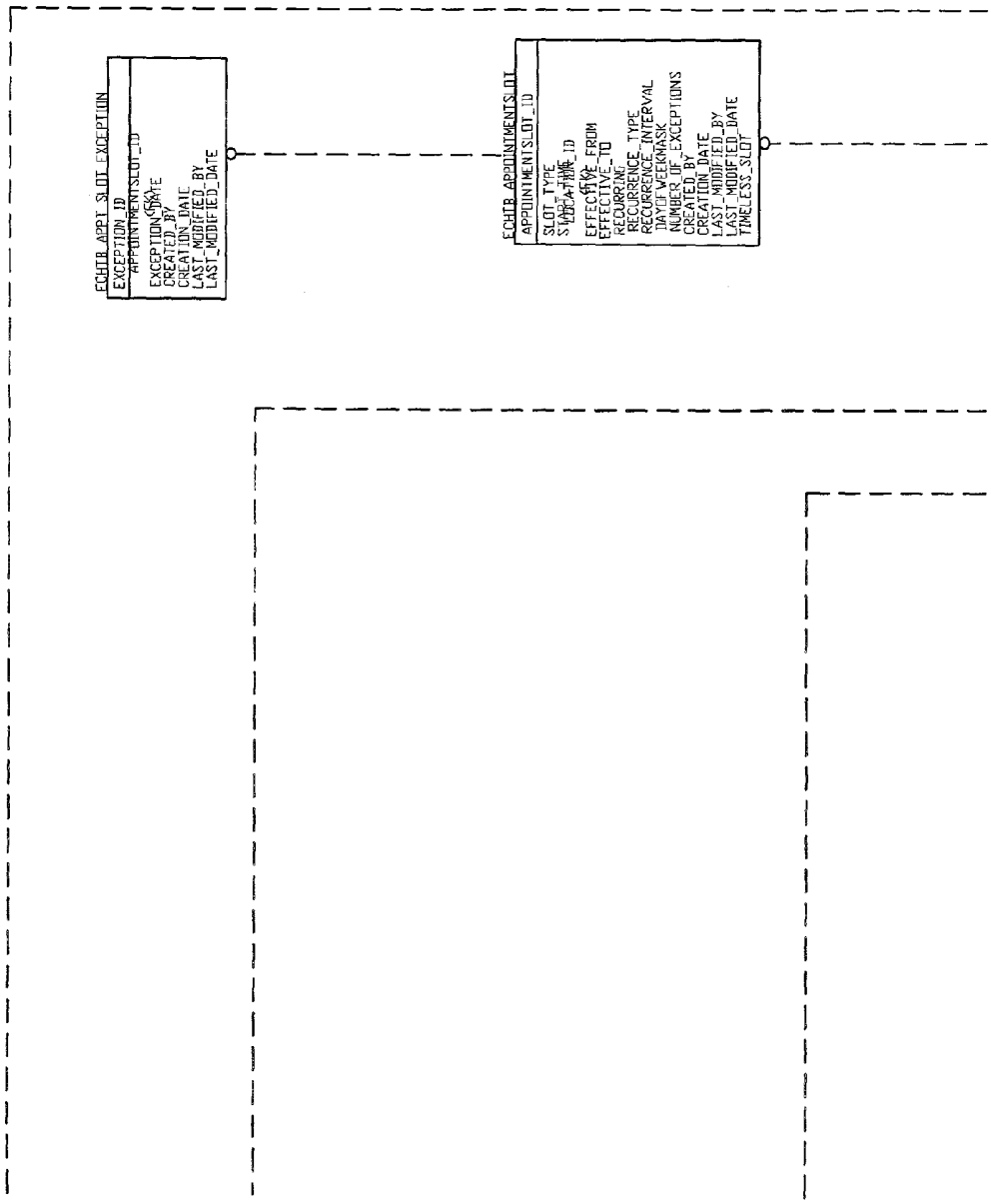
DESCRIPTION

FIG. 5M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ECHIB_APPOINTMENTSLOT
APPOINTMENTSLOT_ID
SLOT_TYPE
EFFECTIVE_FROM
EFFECTIVE_TO
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RECURRENCE_TYPE
RECURRENCE_INTERVAL
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LAST_MODIFIED_DATE
TIMELESS_SLOT

FIG. 5N

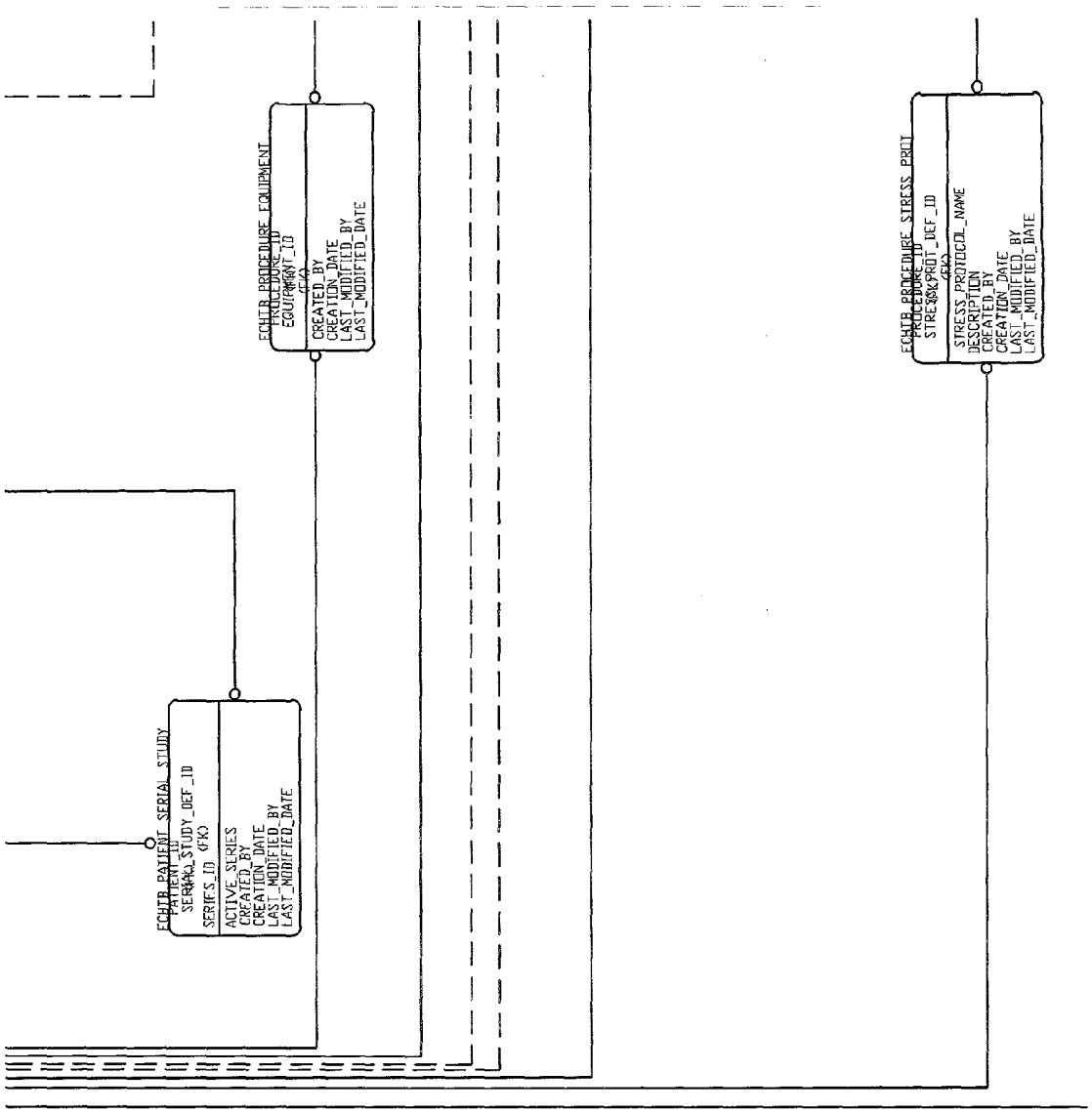
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FIG. 50

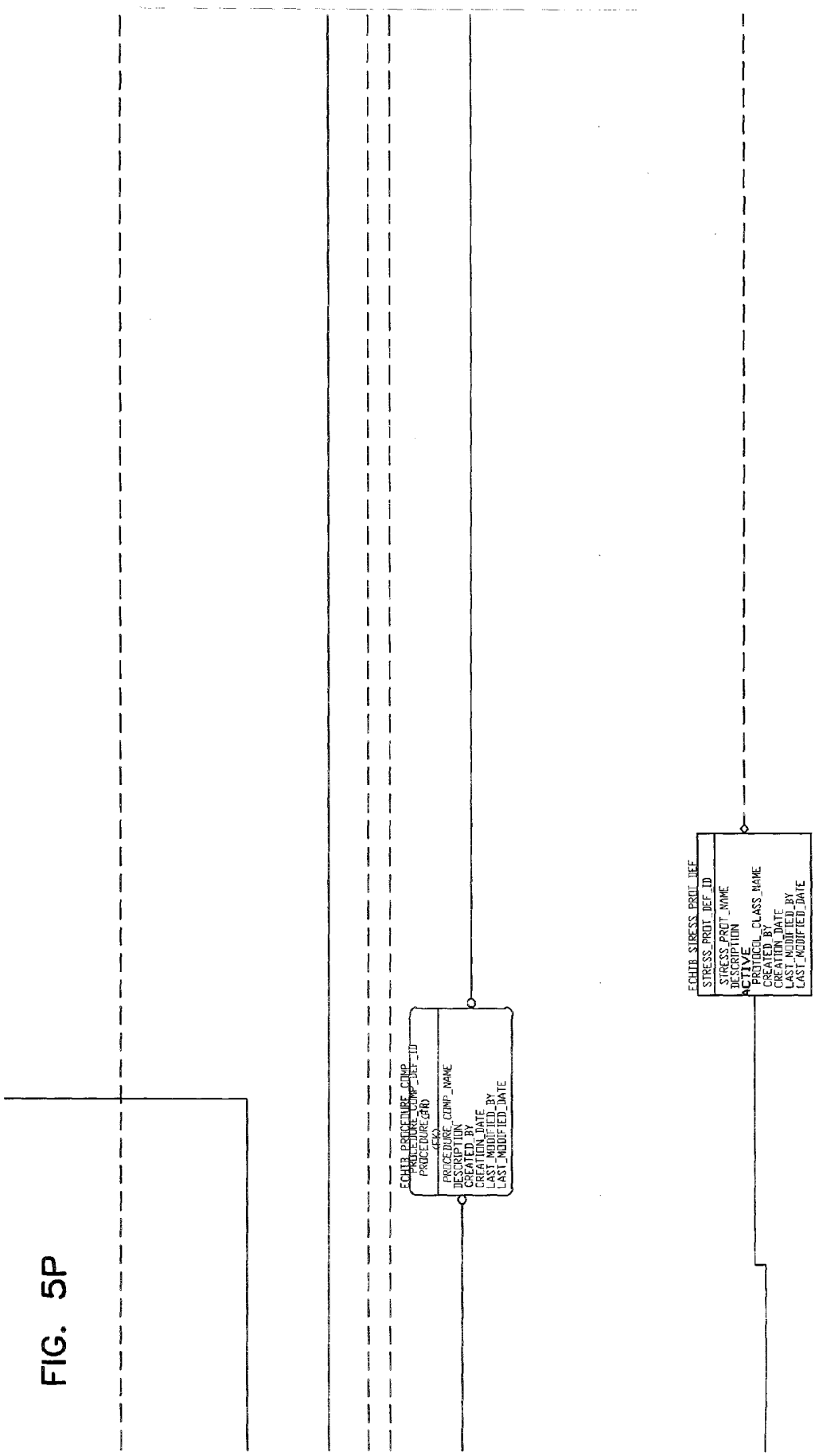
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FIG. 5P

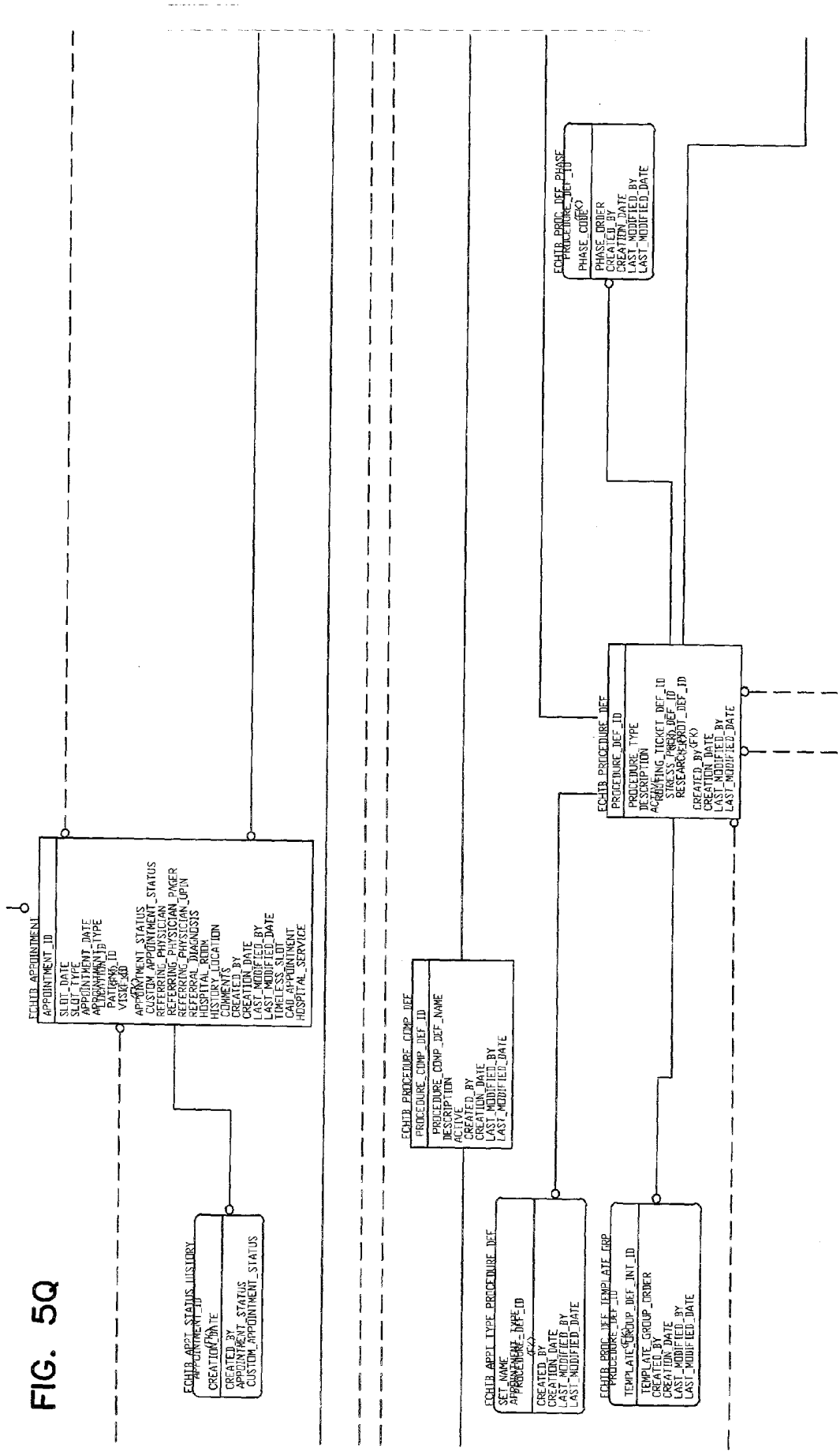
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FIG. 5Q

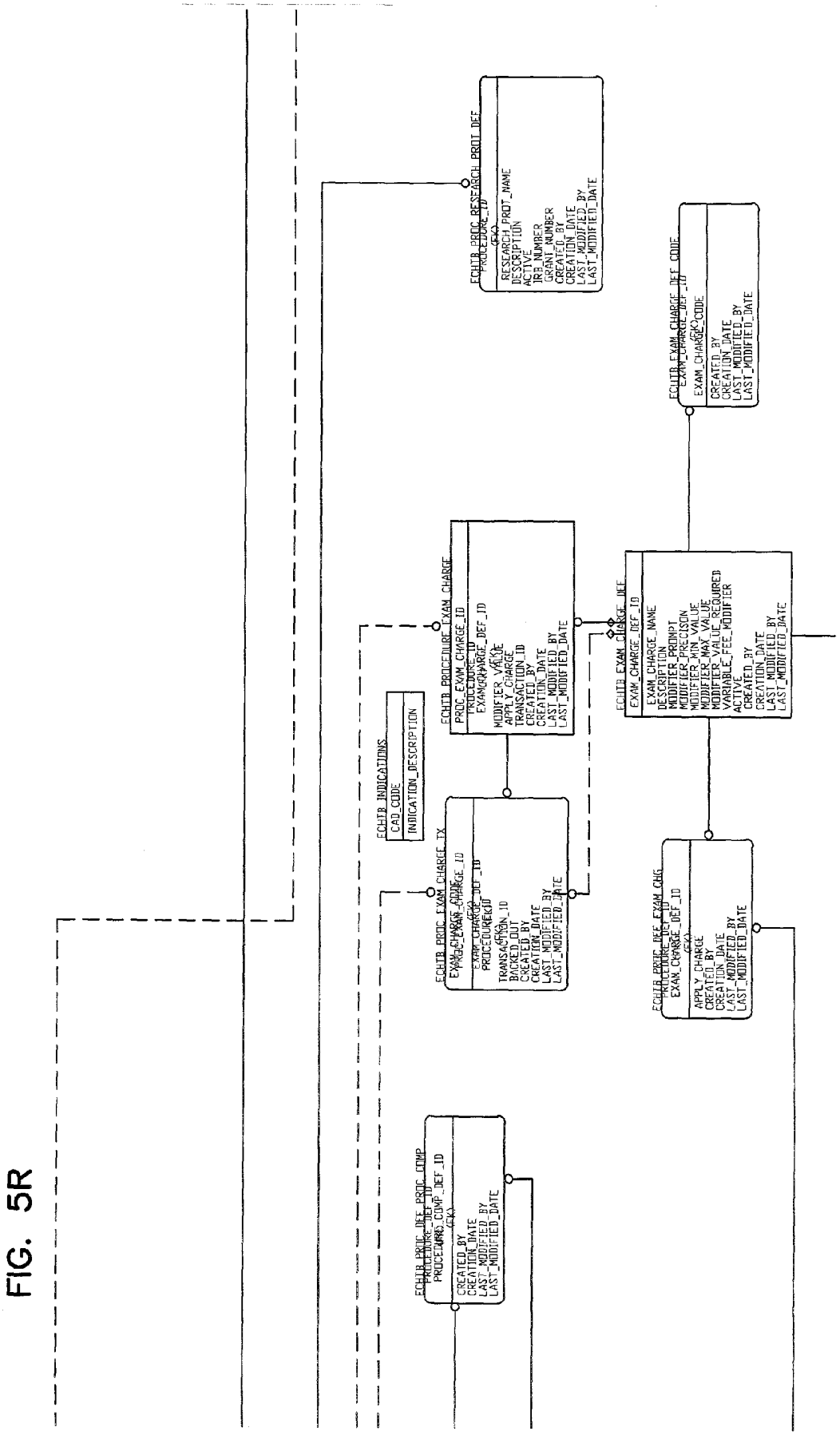
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FIG. 5R

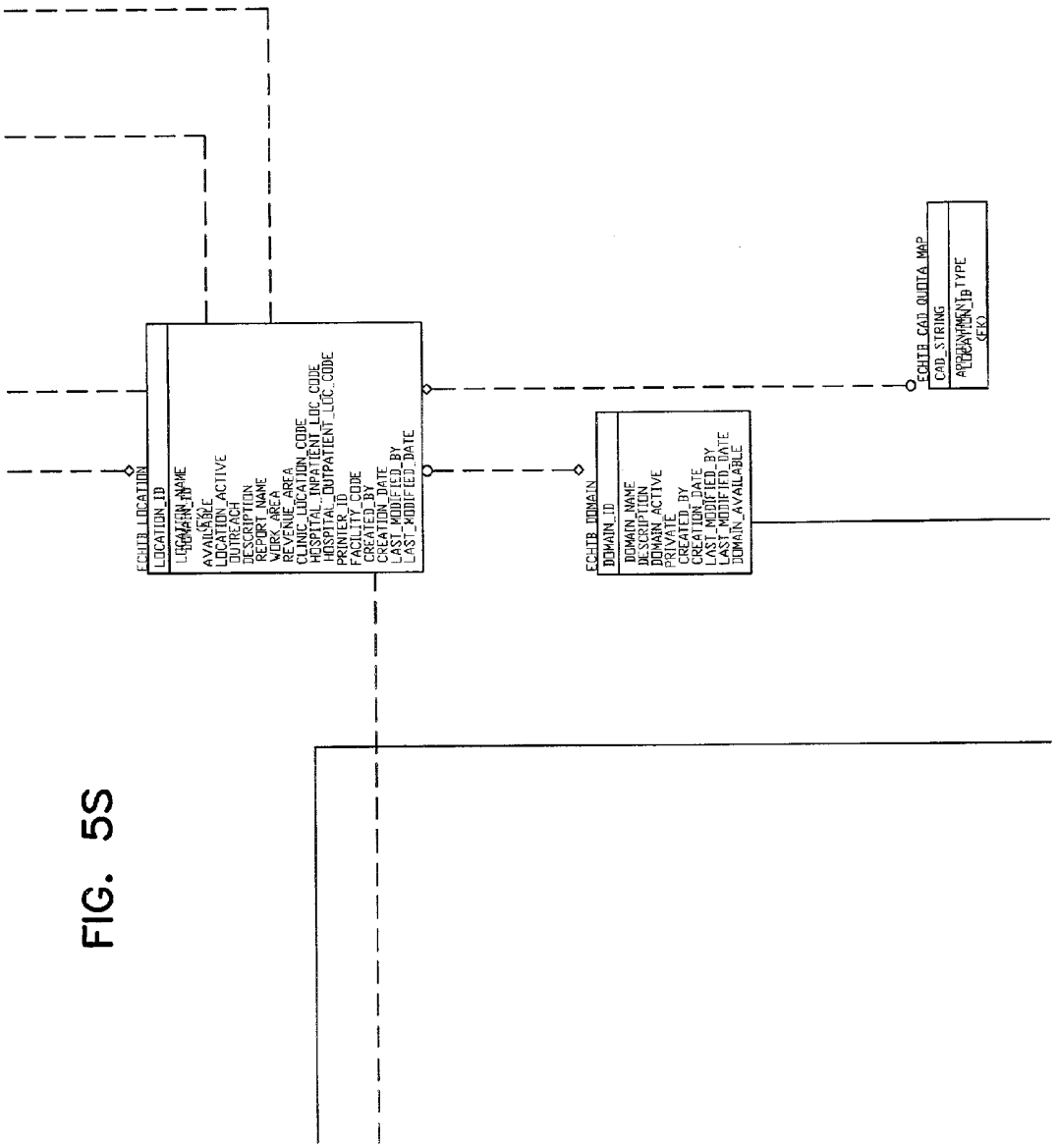
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FIG. 5S

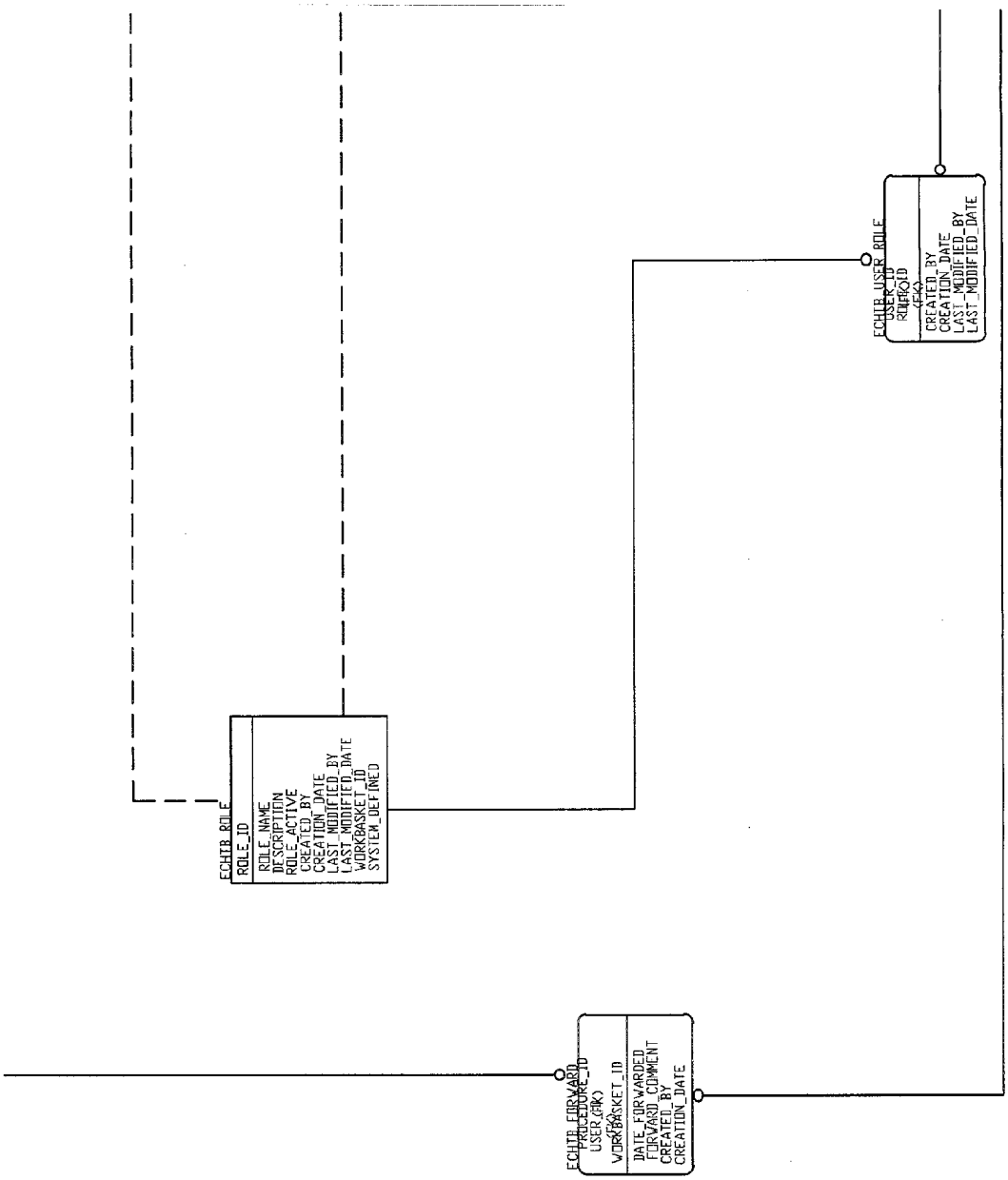
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FIG. 5T

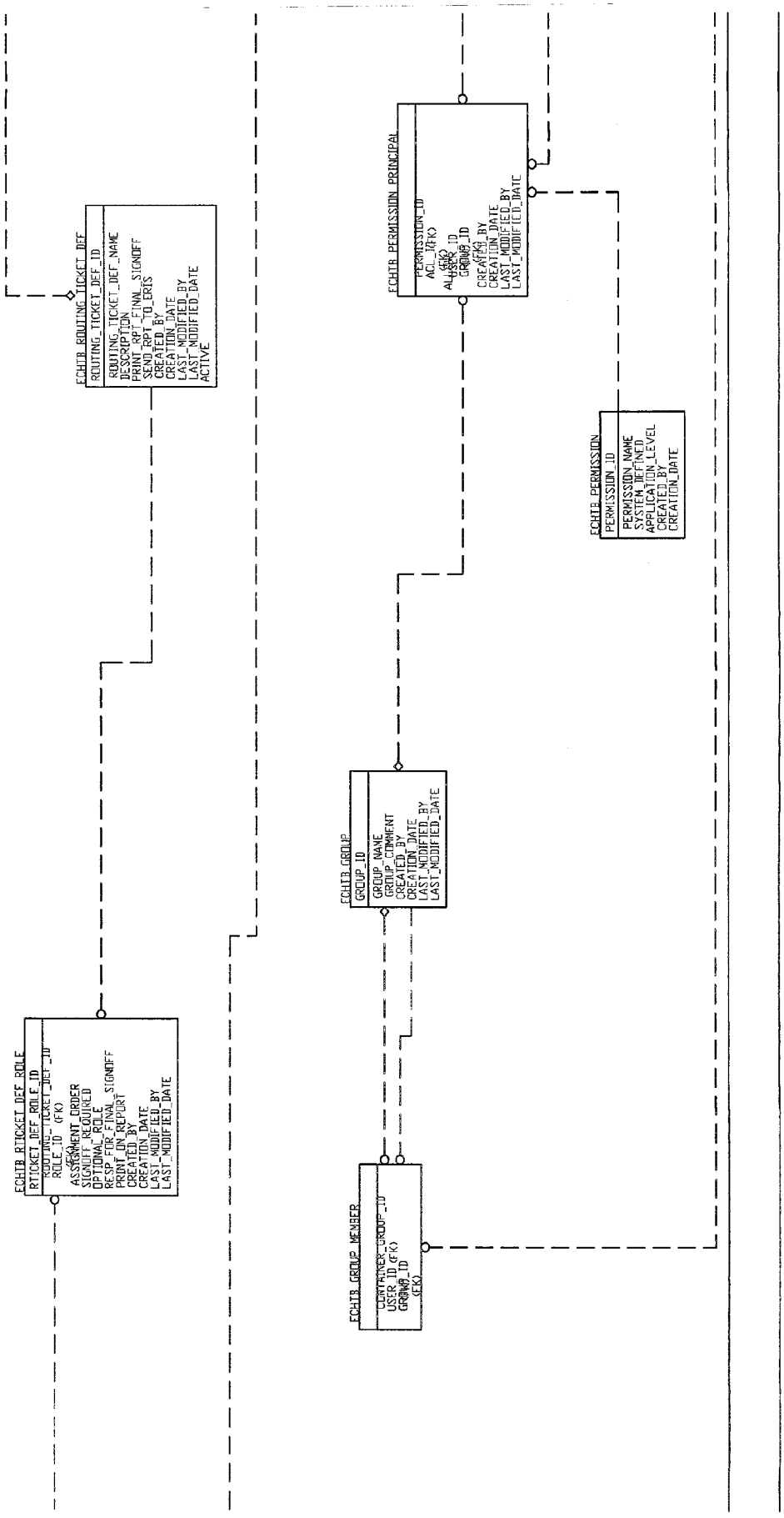
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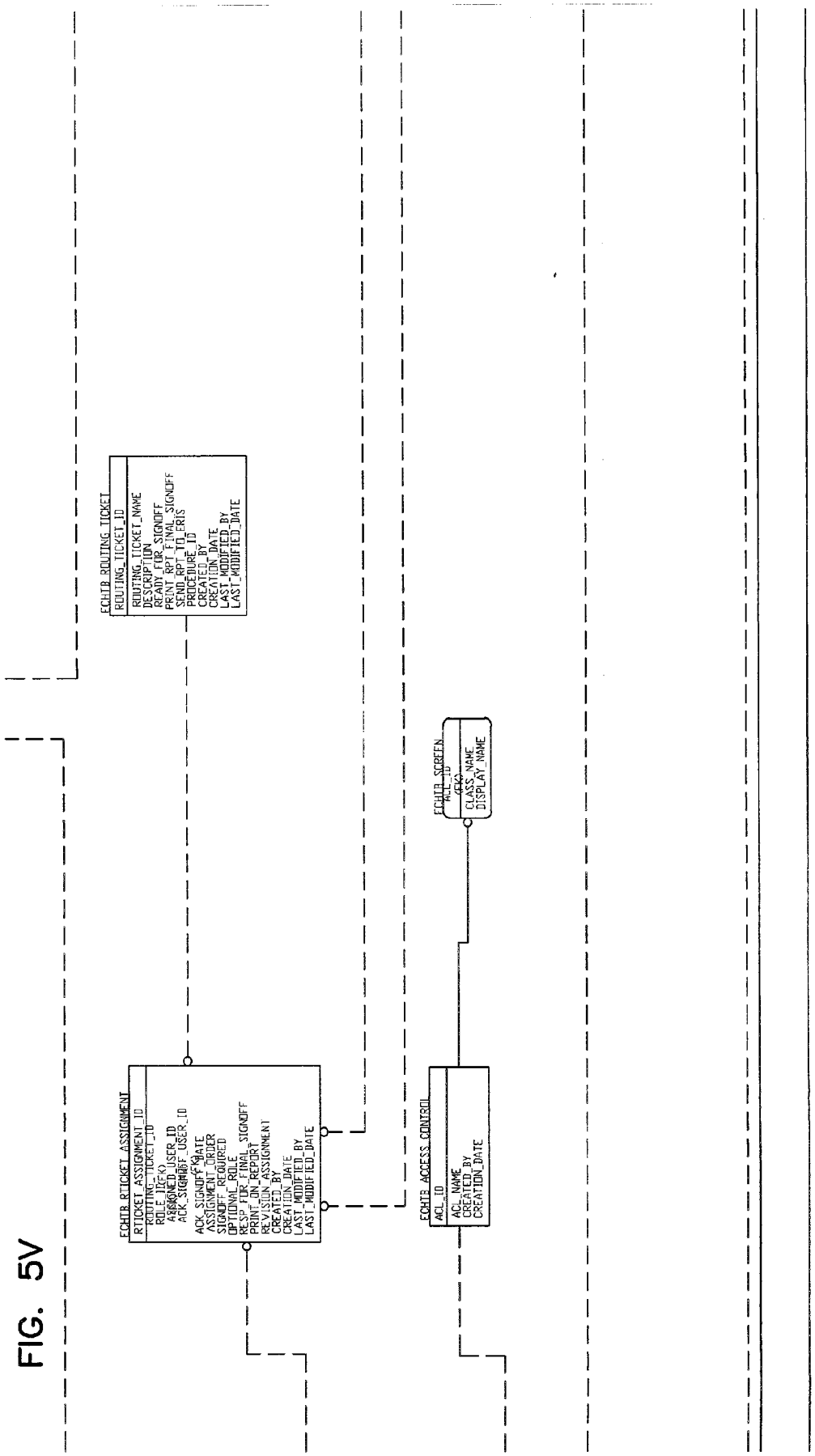
FIG. 5U

FIG. 5V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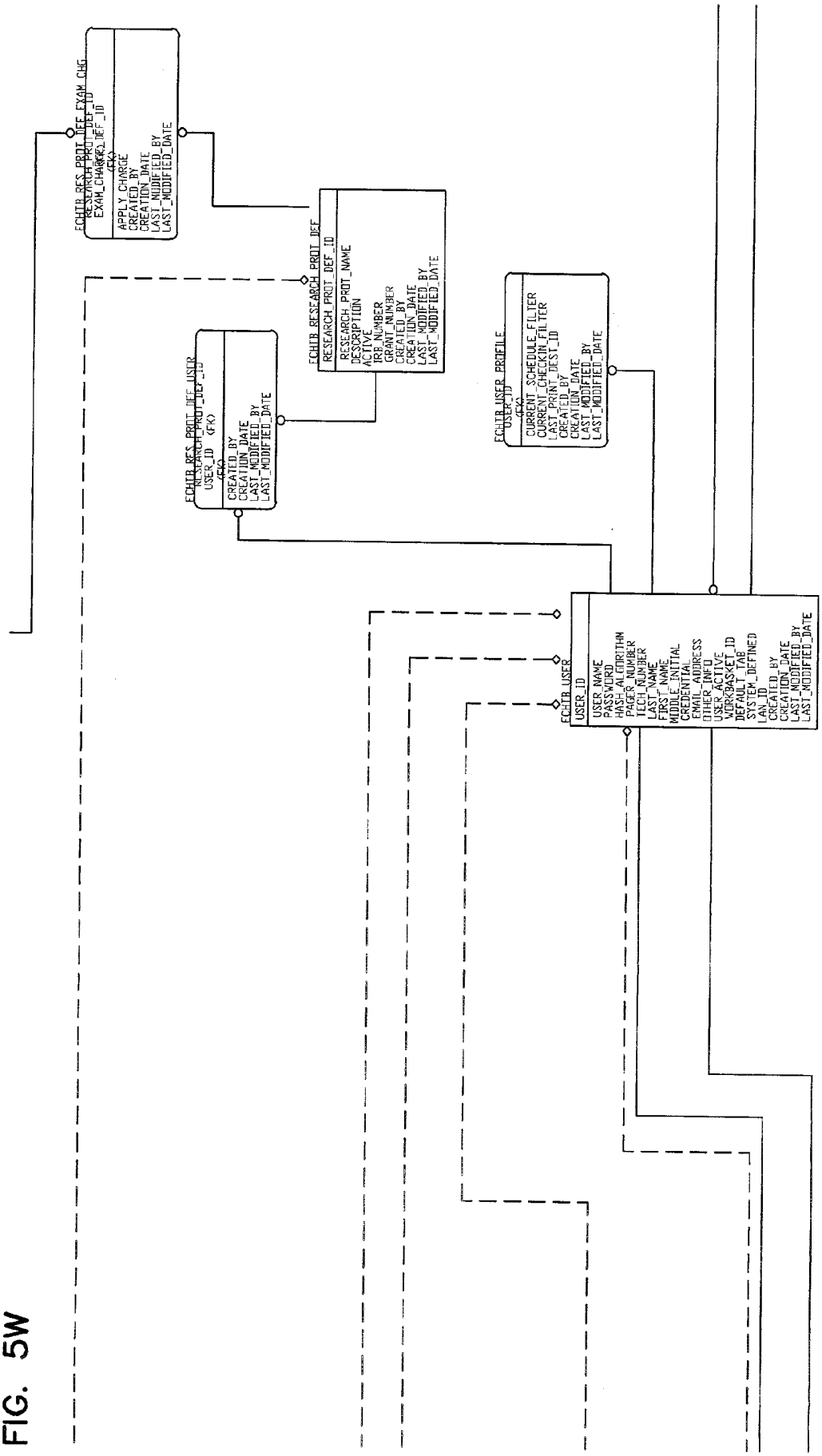
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FIG. 5W

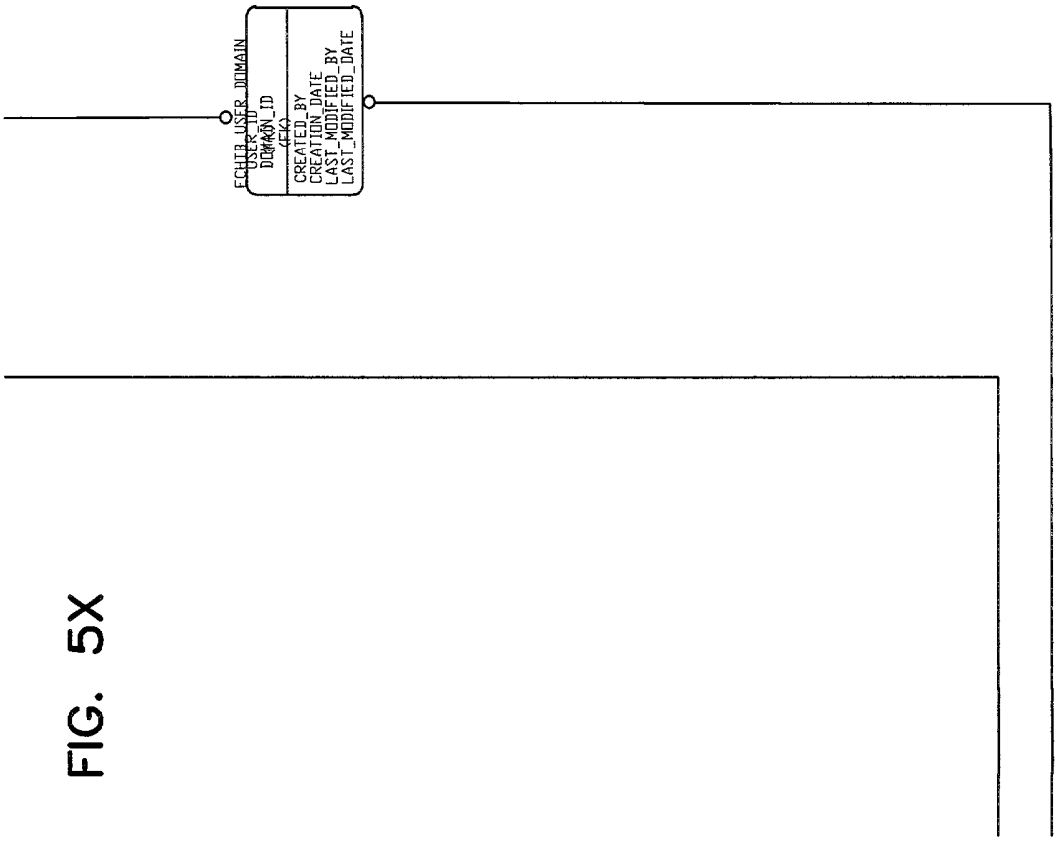
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FIG. 5X

ULTRASOUND LABORATORY INFORMATION MANAGEMENT SYSTEM AND METHOD

FIELD OF THE INVENTION

[0001] The present invention relates in general to an information management system and method, and more particularly, to an ultrasound laboratory information management system and method.

BACKGROUND OF THE INVENTION

[0002] Medical ultrasound is currently used throughout the practice of modem medicine and one of the most commonly performed examinations. Medical ultrasound is a very safe energy source with no known toxic effects under normal use circumstances. A medical ultrasound laboratory supports a diverse number of functions formally performed by more invasive technologies, e.g., imaging, functional cardiovascular assessment, Doppler hemodynamics, and visualization of blood flow, etc. Ultrasound can be formulated into numerous sizes and shapes in order to accommodate specific applications, e.g., transesophageal echo, intravascular echo, handheld, transvaginal echo, etc. Meanwhile, new innovations, which include multidimensional imaging, miniaturized devices, digital imaging, intravascular and other invasive devices, and the use of tracer contrast agents, have been developed. Therapeutic ultrasound and parametric imaging are also being developed. Today, a large amount of relevant clinical, research and education information can be acquired, collated, stored and transmitted. These diverse applications and functionality, in conjunction with the evolution of computer technology, create a need to increase the efficiency of information management within the field of medical ultrasound.

[0003] In order to support numerous functions of a modem ultrasound laboratory, a robust, state-of-the-art information management system is needed. Attempts to develop management systems for medical ultrasound facilities have thus far been fraught with disappointing results. Most current systems are immature and do not bring to bear the full resources of a large clinical laboratory system, such as the Noninvasive Ultrasound Imaging and Hemodynamic Laboratory developed by Mayo Clinic in Rochester, Minn.

[0004] There currently is need for an information management system capable of handling diverse ultrasound resources and processes, to collate and database these into a sophisticated and unified application.

[0005] It is with respect to these or other considerations that the present invention has been developed.

SUMMARY OF THE INVENTION

[0006] In accordance with this invention, the above and other problems were solved by providing a multifunctional information management system that integrates a plurality of modules, each of the modules being interfaced via a relational database. The integrated system manages a large volume of functional, anatomic and work related data, as well as image information. The system is capable of being accessed and organized via an Internet interface.

[0007] In one embodiment, the present invention provides an integrated ultrasound laboratory information management system suitable for a medical cardiovascular ultrasound imaging and hemodynamic laboratory, or an echocardiographic or comparable medical ultrasound laboratory environment. The system is capable of supporting patient management, data collection, and final report preparation. The system has the flexibility to support scaleable input of data from multiple sources in multiple locations via wired and wireless connections. The system is also dynamic and can easily be enhanced to grow with a laboratory's capacity and configuration. A final report of the system supports graphics that are accessed via an Internet web browser operating system.

[0008] An information management system in accordance with the principles of the present invention is designed and built to fulfill the needs of diverse type of ultrasound laboratory. The system can be distributed to a diverse number of users with varied needs. The system is capable of fulfilling the needs of stand-alone facilities as well as outreach services. Further, the system is scaleable to accommodate projected increase in volume, capacity, personnel, and space. Furthermore, the system is built in components, which can be removed, modified, and/or replaced as desired. Moreover, the system is extensible and does accommodate data, graphic, and image management technology.

[0009] Still in one embodiment, a medical ultrasound laboratory information management system is integrated mainly from three parts: a business management part, an ultrasound data management part, and an ultrasound image management part. The business management part of the system manages all aspects from running a small clinic to a very large medical enterprise. Within a medical ultrasound environment, the business management part generally refers to documenting exam encounters, patient demographics, accounting, scheduling, billing, productivity measures, clinical accountability, etc. Immediately connected to these functions are the systems related to accounting, such as a third party billing, coding, documentation, reimbursement, etc. Other related connections include remote access to extended practices and locations, national and international access and communications, etc.

[0010] Further in one embodiment, the ultrasound data management part of the system includes acquisition, collation, and reporting of acquired alphanumeric information, such as measurements, hemodynamics, function, flow calculations, derived information, impressions, text descriptors, etc. This is a complex and ever changing aspect of clinical ultrasound examinations. The presentation of data can be tabular, textural, graphic, or pictorial. Further, the presentation of data may continue to evolve such that an information management system of the present invention is designed to accommodate and support a dynamic process. The data is typically used for clinical decision-making. Also, the system of the present invention allows the data to be used for fields such as education, research, treatment, and therapeutics, etc. Accordingly, the data or information in the information management system of the present invention are collated as well as retrieved in a systematic manner.

[0011] Further incorporated into the ultrasound data management part of the system is a knowledge based artificial intelligence.

[0012] The ultrasound image management part of the system accommodates large-sized documents, such as graphics, still and cinematic pictures, digital documents,

parametric information, etc. A large-sized digital document, for example, an image or graphic document that is displayed with a high frame rate (e.g., 200 to 300 images frames per second), is managed by the system of the present invention. All image information are collated as well as retrieved in a systematic manner and treated similar to the other data. The data volume in the image management component is significantly greater than the data volume in the previous two functions.

[0013] Yet in one embodiment, all information provided by the business management part, the ultrasound data management part, and the ultrasound image management part are integrated into a single information management system.

[0014] These and various other advantages and features of novelty which characterize the invention are pointed out with particularity in the claims annexed hereto and form a part hereof. However, for a better understanding of the invention, its advantages, and the objects obtained by its use, reference should be made to the drawings which form a further part hereof, and to accompanying descriptive matter, in which there are illustrated and described specific examples of an apparatus in accordance with the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

[0016] **FIG. 1** illustrates an operational environment for a laboratory information management system in accordance with the present invention.

[0017] **FIG. 2** illustrates an operational environment for a central installation of a laboratory information management system in accordance with the present invention.

[0018] **FIG. 3** illustrates an operational environment for a remote installation of a laboratory information management system in accordance with the present invention, the remote installation being linked to the central installation of **FIG. 2** via a wired connection.

[0019] **FIG. 4** illustrates an operational environment for a remote installation of a laboratory information management system in accordance with the present invention, the remote installation being linked to the central installation of **FIG. 2** via a wireless connection.

[0020] **FIGS. 5 and 5**A through **5**X illustrate a database table diagram for a laboratory information management system in accordance with the principles of the present invention. **FIG. 5** illustrates the overall table with a drawing location reference grid comprising **24** tiles. Each tile is labeled **5**A through **5**X and corresponds to the similarly numbered **FIGS. 5A through 5X**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] The present invention discloses a multifunctional information management system that integrates a plurality of modules, each of the modules being interfaced via a relational database. The integrated system manages a large volume of business, data, and image information and is capable of being accessed/organized via the Internet.

[0022] As an example, the present invention provides an integrated ultrasound laboratory information management system suitable for a medical cardiovascular ultrasound imaging and hemodynamic laboratory, or an echocardiographic or comparable medical laboratory environment. The system supports patient management, data collection, and final report preparation and has the flexibility to support scaleable input of data from multiple sources. The system is dynamic and can easily be enhanced to grow with a laboratory's capacity and configuration. A final report of the system supports graphics that are accessed via an Internet web browser operating system.

[0023] The ultrasound laboratory information management system in accordance with the principles of the present invention is integrated mainly from three parts: a business management part, an ultrasound data management part, and an ultrasound image management part. The integrated system is capable of being used for a medical cardiovascular ultrasound imaging and hemodynamic laboratory (i.e., echocardiographic or comparable medical laboratory environment). In one embodiment, the integrated system includes a plurality of modules: 1) Scheduling and Workflow Module; 2) Patient Information and Demographics Module; 3) Billing Module; 4) Procedure Information and Referral Diagnosis Module; and 5) Measurement, Template, and Calculation Module; 6) Final Impression and Interpretation Module; 7) Procedure Report Module; 8) Serial Study Module; 9) Research Protocol Module; 10) User Interface and Service Module; 11) Web Based Module; 12) Unique Reports Module; 13) Database Module; 14) Systems Administration Module; 15) Security and User Conation Module; 16) Image Module; 17) System and Technical Support Module; and 18) Knowledge Base Module.

[0024] The advantages of the present invention are that the system is robust, template-driven, and Internet-accessible. The system has increased its reporting functionalities and provides guided billing functionality. In addition, the system provides outreach practice support and allows serial study of the measured data and information. Further, the system encompasses business management, data management, and image management.

[0025] The above-described modules of the system are described in detail as follows:

[0026] 1) Scheduling and Workflow Module

[0027] The scheduling and workflow module of the system tracks a patient from initial scheduling of an appointment, through checkin, procedure, and checkout, i.e., discharge. The module may also contain the requirements for physicians, sonographers, and support staff to review workflow or workloops. It is appreciated that the system may receive information from other scheduling systems with an appropriate interface.

[0028] The operation of the scheduling and workflow module starts with a patient arriving at a specific echocardiography lab location for a procedure. The patient's visit is completed when the patient is discharged. There is a possibility that a patient may have more than one visit in a day, and that each visit may have multiple procedures scheduled. There may also be emergency situations where all the information needed to "check-in" a patient may be added later.

[0029] One step of the operation is to identify a patient's schedule on a given visit/day. This can be by a patient name,

identification number, or other relevant information such as ID tag, time, lab location, referring physician, appointment type, and referral diagnosis, etc. Patient status, report status, assigned personnel, comments, and/or hospital information can then be viewed as they become available. The style of a scheduling display and/or variations of the scheduling display are dependent on the user's preference and may be used at the desk or checkin location for a lab.

[0030] Another step of the operation is to filter out certain viewed information from a scheduling display as a user may be only authorized to view certain information of the scheduling display. This filtering feature allows a user to readily change appointment dates and locations, appointment types, report status, patient status, and assigned personnel, etc. Further, a report filter allows one to look at all of the variables/fields or a combination of the available variables/fields. It is appreciated that additional report filter may be used to allow viewing all appointments or only filled appointments within the scope of the present invention, and that default views or templates may be configured by a user or a system administrator.

[0031] A further step of the operation is to provide a display that shows room status information at any point in time. The room status view illustrates that the data or information is arranged in such a way that it can be accessed by the other users, like viewing an "airport display board". In one embodiment, the display shows all rooms for a location. If a patient's record reflects "Roomed" or "Waiting Review", then the patient is reflected on the display.

[0032] In the scheduling and workflow module, all data recorded may have system-generated time stamps, as a patient proceeds through the visit from arrival to discharge.

[0033] The patients' appointments can be made at a central appointment desk (CAD) system and communicated to the other modules of the system through an external interface. It is also appreciated that patients' appointments can be made remotely. When an appointment is made in a remote site, the appointment is sent to the system. The system then matches the location, time, and appointment type and fills in the appropriate slot on the scheduling and workflow module. If the system does not find an appropriate slot to fill the appointment, then the system forces to fill in the appointment on the schedule and flag the appointment as "a forced appointment".

[0034] Also, a scheduled appointment can be deleted via the system. It is appreciated that the scheduled appointment can be deleted via a separate or remote appointment system. Such deletion is communicated to the system to further modify the scheduling and workflow module.

[0035] An additional step of the operation is to capture patient status information, such as the beginning time, current state, etc., throughout the visit. The step may also capture report status information, such as the beginning time, current state, etc., throughout the visit.

[0036] The changes made in the system can be automatically triggered or manually triggered, appointments can be made for any appointment type, and the module includes a flexibility to override most of the predefined fields. It is also appreciated that all appointments within a user specified time frame for an individual patient can be viewed. It is further appreciated that the scheduling and workflow module has the capability of moving appointments around and the capability of searching for appointments by person, referring physician, date, time, and status. Furthermore, it is appreciated that the scheduling and workflow module has the capability of searching for open appointments by a date range, location, and an appointment type. If a specific personnel is requested, the scheduling and workflow module may assign the personnel at the scheduling time. The schedule display highlights any specific personnel assigned to a patient that the status of the patient is less than roomed.

[0037] The scheduling and workflow module allows to identify sonographers, ECG tech and Echo staff availability by location. This can be accomplished by "check in" and "check out" statuses that are changed on the display. The scheduling and workflow module may also provide capability to view and monitor the unfilled capacity by location, appointment type, date, and day of week, etc. For example, the module creates an assignment list of available sonographers, physicians, and additional personnel as needed. This list is used to assign a specific personnel to a patient at check-in or at any other time during a medical procedure. Also, a patient status is changed manually by a system user or automatically, when applicable. Each change in status may create a system-generated time stamp. Thus, the module provides a dynamic display of patient status information, distinguishes in-patients from out-patients, allows to cancel a scheduled visit and make available history of cancel or rescheduled appointments, provides views for cancelled or rescheduled appointments, and allows the patient data to be searchable by a clinic number or patient number.

[0038] Also, the module provides capability of checking a patient's status on an individual basis and any available details, such as timestamp, length of time in status. For example, the module may provide the "No Show" review list and/or "Master Review List" by day and the ability to change their status on the display. The default view may looks like "Scheduled/Check In" view but in addition contains appointment date. The display may contain only patients with a report status of "Open" through "Report Complete". The patients remain on this list until they are in their final status. Filtering is available for all other statuses except scheduled, canceled, no show, and final. Accordingly, the module allows for a "Review List" but filtered by personnel. The default for the "Review List" may be all available report statuses and a logon user. A filter is established for users of the system so they only view certain locations/status of patients.

[0039] The module also monitors and assigns equipment available for lab usage. An equipment list is provided for such function. In one embodiment, a table is established to associate rooms with equipment so when rooms are assigned to patients, the equipment assignment takes place automatically. This equipment, by serial number and other identifier, would be kept with a record in the module. Accordingly, the module displays a location for each equipment. For example, if an electronic environment device (EED) is located outside a group of rooms, the module would provide default views of the patient studies currently in progress in these rooms. The module also provides capability for lab status view. For example, the module monitors, at any point during the day, a status of patients waiting, scheduled, or completed.

[0040] 2) Patient Information and Demographics Module

[0041] The patient information and demographics module of the system is incorporated into the process of checking a patient in. It also includes demographic data and coordiantes where that type of information is used or displayed. Some of this information is also described in the description of the scheduling and workflow module, above.

[0042] In an operation, as soon as a patient's visit begins, data are accumulated specific to the patient and procedure. Some of the data are available from an external system, such as a central review device (CRD). Additional data are recorded on the patient through the visit duration. An example of this data is hemodynamics, such as blood pressure, weight, height, etc.

[0043] The operation continues with accumulating/recording patient's registration and check-in information. The information collected at check-in is, for example, height, weight, BSA, BMI, birth date, sex, gestation age (if applicable), and fasting information, etc. Some of the information may be pre-loaded from the system through a user interface. When patient check-in is complete, a time stamp is taken, and the patient status is changed to "Check In". The patient information and demographics module keeps track of all item changed in a "change log" and shows demographic data on multiple views. For example, in outreach, the patient information and demographics module provides a place to input maiden name and previous married names of a patient, additional comments, etc. Based on the information in the module, a quick navigation to access information from a schedule can be made. It is appreciated that demographic data collection views may be different for outreach than in a central lab.

[0044] 3) Billing Module

[0045] The billing module of the system accumulates and sends information to a remote billing system.

[0046] In an operation, for each procedure performed, the billing module captures all billable components and associates all billable entries with a specific patient, diagnosis, visit, and ordering physician. For example, the billing module creates an association between billing diagnoses and billing entries. This association validates that appropriate items are charged for the procedure. For all professional services provided, the billing module allows for the distinction between different classifications of procedures and the respective billing rates. Examples may include the classifications of "limited", "no charge", "complex", "grant", and "research account", etc. Accordingly, the billing module provides a unique list of billing items for each distinct billing classification of procedures and provides a reporting mechanism that communicates when procedures are completed but a billing record has not yet been sent.

[0047] Also, the billing module provides a monthly/daily summary of billing charges organized by day, site, and type of charge, procedure type. In one example, the billing module may provide a report of accounts of patients who have completed the procedure. In another example, the billing module provides a summary of charges year-to-date (YTD). Further, the billing module provides a clue of billing items, referral diagnoses, measurement performed, procedure type, and procedure components, etc. It is appreciated that the billing items, referral diagnoses, measurement performed, procedure type, and procedure components, can be coded or bar-coded for searching and other functions.

[0048] 4) Procedure Information and Referral Diagnoses Module

[0049] A procedure or study is the primary designation for the various activities surrounding a patient visit. A lab may perform multiple distinct procedures encompassing, for example, the gamut from pediatric to stress echo to intra-operative procedures. A physician referral diagnosis is provided whenever an appointment is created. It is generally a text that gives one as much information as possible about the reason the patient is scheduled for a study. The module may replace the text by a "coded" referral diagnosis. The "coded" referral diagnosis is determined by a sonographer early in a patient visit. This diagnosis then appears on a final report and is used for any retrospective retrieval. Billing referral diagnoses can be suggested based on the "coded" referral diagnoses. Also, billing referral diagnoses can be designated at the end of the patient visit based on the procedures performed, equipment used, and other practice-related factors. These diagnoses correspond to valid charge codes on the billing system.

[0050] As an example, when a patient is roomed, the system assigns personnel if not already assigned. This allows for easy navigation to assign personnel whenever they are available and allows for assignment of roles to a study when a specific individual is not known.

[0051] Also, procedure types are assigned to each study. The procedure types can be defaulted initially by an appointment type. For example, an appointment type of "EXERCI" stands for the procedure type of "Exercise Stress". By selecting an appropriate procedure type, the module uses this information to guide one to the best templates and tabs available in the system. For example, if a procedure type choice is transesophageal echo, then a tab is available to collect sedation information.

[0052] It is appreciated that some procedure types need further sub-division in order to guide a user to appropriate templates. An example of this is Exercise Stress procedure type. An Exercise Stress procedure type can be further divided into treadmill, bicycle, and interpretation only.

[0053] Procedure types are also associated with procedure components. Procedure components are descriptions of what is actually done during a study. For example, the procedure type of basic adult echo generates procedure components of 2D, Mmode, and Color Doppler, etc. There is still an outstanding issue of whether the procedure components are needed for a final report. The system also allows multiple procedure components to be selected and assigned during a single visit if needed. The system determines initial required medical history information based on referring diagnoses and procedure component and supports the use of templates for organizing measurements into predefined groups. Accordingly, the system allows the ability to select or use any template. The system can also determine the initial required medical history information based on referring diagnosis and procedure type.

[0054] In operating the Procedure Information and Referral Diagnoses Module, time stamps are collected during a procedure that records check-in, roomed, and discharge times, and preliminary impressions or other comments are

recorded from sonographers and other clinicians throughout the patient visit whenever needed. The user may designate which of these should appear on a procedure report. Clinician comments and dictated physician comments should be optionally checked for spelling errors.

[0055] As an example, an appointment type of "Research XXX" indicates that this is for a specific set of procedure types. Once this is chosen, very specific templates for the studies can be selected. Research templates must have every data item as a required field. This is different from other study templates. Based on this, a requirement of the templates is to vary whether fields are required or optional.

[0056] Also, based on the capabilities of the measurement and calculation database, there may be an additional need to store specific "stress" information outside of the configurable database. Different protocols may require different templates and different data items.

[0057] The module also provides access to sedation template for any procedure type that may require sedation. Data items needed for printed report are a subset of the standard data recorded on all patients, plus significant other data. A lot of this data is a free form text that does not easily fit into the measurement database.

[0058] 5) Measurements, Templates, and Calculations Module

[0059] Measurements are the core data components that provide the ability to effectively diagnose patient health. A lab, such as an echo lab, operates in a dynamic environment due to advances in medical knowledge and diagnostic instrument capabilities. The present system has the ability to define new measurements and incorporate them into procedures. With the number of measurements and calculation possibilities, it is important to be able to dynamically organize data items according to the type of study being performed. The use of templates (pre-organized data) facilitates the quickest data entry possible. The system also organizes the data for analysis that may be different than the organization necessary for input. Templates facilitate this as well. The module allows the definition of custom numeric measurements and depends on the configurable numeric measurements for all procedure measurement data acquisition. These measurements include echo-specific and other clinical measurements. Each measurement may ask for sufficient information to describe the data type and precision, anatomical section, valid modalities, display and symbolic labels, units of measure, timing, and measurement name/type. Some notion of versioning may be required to ensure proper interpretation and retrospective aggregation of "modified" measurements.

[0060] The module also allows the definition of qualitative measurements. Qualitative measurements provide the ability to make subjective assessments or general comments regarding a particular anatomical area or other miscellaneous procedure aspect. The most basic type of qualitative measurement is a free form text string. Other qualitative measurements may make use of selection lists. This latter type may be used in calculated measurement expressions, primarily as the test condition in "If" tests.

[0061] Further, the module allows the definition and validation of calculated measurements. Calculated measurements are the product of previously defined numerical measurements, constants, and logic selection based on selection list-based qualitative measurements. Formulas are created using the measurement symbolic names and mathematical operators. Certain patient/visit attributes, such as height and weight, need to be available to a calculation engine. Editing any entered measurements result in re-computation of a calculated result. Descriptions of measurements may be available via a help function key. Descriptive information may also include externally created text as well as a symbolic representation of calculations used for calculated measurements. The module allows the definition of measurement templates to facilitate date entry. Measurement template also allows the user to organize measurements into groups based on anatomy, modality, or other paradigms chosen by the lab. For example, a stress protocol template can be included for capturing time-series measurement values. Stress protocols identify predetermined control variables applied and measurements collected overtime during a stress procedure. In an exercise stress echo, a treadmill grade and speed are control variables, while heart rate and blood pressure are acquired measurements. In a pharmacological stress procedure, medication and dosage may replace grade and speed. The protocol also defines the time interval (or possibly another event) between stages.

[0062] The module also supports the creation of predefined stress protocols that provide the stages or steps of stress echo procedures. Typically, this involves specifying the "control variables" and time intervals. Automatically generated procedure measurement entry screens are based on template content. Templates may require additional information to help in screen layout. Such information may include grouping indicators and orientation. The order of measurements in a template helps determine ordering on the entry screens. An example would be a stenosis indicator on a template that, when pushed, would change the template or template content.

[0063] The module further supports capability of report templates. These templates are used to produce a framework or roadmap for a report, e.g. an Echo report. The template supplies the interpretation requirements and measurements. Additional items can be added adhoc to the echo report as it is being built.

[0064] In addition, the module supports the storage, retrieval, and calculations of normal ranges for measurements. Normals result from data collection and analysis over time. Demographic categorization is the primary method of differentiating normals across a population. For example, all males over 20 may share normals for a particular set of measurements. The approach to implementing normals supports the ability to stratify a patient and return values from database tables and/or calculations, and to add new tables and algorithms for normals computation and lookup without modifying the primary application.

[0065] As research proceeds or new prosthetic devices are brought to market, the need arises to extend the existing normals models. The present system provides a solution by creating normals models and returning values that are independent or well abstracted from the primary application. The system may utilize the following tables: Feignbaum tables for adults without BSA measurement; Gardin tables for adults with BSA measurement; Henry tables for pediatric patients; Prosthetic valve normal ranges —from manufac-

turer; and Diastolic function normal ranges. The module allows to visually flag any measurements falling outside normal ranges and provides ability to organize measurements by normals and those outside the normal range.

[0066] Furthermore, the module provides ability/extensibility to dynamically build templates based on an image and measurements recorded on the image. A specific measurement is only required to be input once, regardless of any change in templates, procedure type, or hemodynamic data. The system also accommodates enhancements necessary for future association of measurements to data acquired from multi-vendor ultrasound equipment via interfaces, such as the Digital Imaging and Communications in Medicine (DICOM) interface. The measurements accept more than one input value, resulting in an average for the measurement. The system stores and displays all entered data and allow them to be reedited, resulting in a re-computation of the average. An averaged result can be flagged visually on entry screens and reports.

[0067] Moreover, measurements are retrievable via a relational database query tools. Due to the desire for a measurement system to be configurable, the database tables used for storing measurements may not conform with the traditional notion of a database field corresponding to each measurement. Rather, a name/value approach is used, which would require intermediate processing in order to create optimal tables and queries for research purposes. Such intermediate processing may probably occur after hours, which in turn would minimize performance impact of queries on a production database. Measurement entry and storage allow for entering multiple sets of measurements at user-defined points during the procedures.

[0068] Procedures, such as respiratory comparisons, require that two or more sets of measurements be obtained. The module provides default stages for these procedure types, such as prestress/poststress, as well as allowing for new measurement sets to be created and labeled as needed.

[0069] The module also supports a graphic-based annotation method for wall motion data interpretation and scoring. The graphic display may include multiple cross-sectional views. The views may include peristernal short axis, apical 4 chamber; apical long axis; apical 2 chamber; and peristernal long axis.

[0070] The module may also support a graphic-based annotation method for thoracic aorta measurements. The data generated from the measurements supports a thoracic aorta serial study.

[0071] 6) Final Impressions and Interpretations Module

[0072] The interpretation of a clinical patient visit is summarized via final impressions. Physicians create final impressions to communicate clinical assessments and recommendations to the patient and other caregivers associated with the patient's current and ongoing care and treatment. The physician final impressions are an important component of a patient's report, such as an echo report. Sonographers create independent "coded" final impressions to aid in retrospective retrieval of studies based on standardized phrases and terms. These coded final impressions are not included in the procedure report. The final impressions and interpretations module provides a free form comment area that the consultant or sonographer can dictate or type comments that are significant about the study that cannot be captured easily by the final impression statements.

[0073] In the measurement capture and analysis templates, the module provides ability to access final impressions statements. This requires that specific templates or measurements have a logical relationship to final impression statements. For example, an ejection fraction measurement may have a statement that states an observation about the ejection fraction and puts in the measurement result into the statement. Another statement may require that a measurement be recognized as normal and automatically generate a statement that describes normal function.

[0074] Different procedure types display different report templates. These report templates have categories of statements that must be coded in order for the report to be complete. They help facilitate completeness and consistency. These coded statements generate text or bullet items for an interpretation section of the report, e.g. an echo report. In addition, these coded statements are used for retrospective studies.

[0075] The report interpretation section can be dynamically generated by the measurements, sonographer coding, and/or consultant coding. The module allows to extract or mark any coded item to be also shown as a final impression. A coding mechanism may be required to allow the assembly of final impression phrases with corresponding numeric representations that may be accessed for retrospective research via relational database access. The module also has the capabilities which include prompted numeric values and ranges, singular/plural modifiers, test substitution, ordered parameters, modifiers, report or entry form suppression, free-form text entry, date/time prompting, and linking of phrases into paragraphs, etc.

[0076] 7) Procedure Report Module

[0077] As soon as a patient is checked in, data becomes available that makes up the patient visit report. There are two primary "views" of the visit data from a reporting standpoint. The "Procedure Log" contains all data collected during a visit. The "Procedure Report" contains the sections of the "Procedure Log" that are considered important to the patient and clinical clients of the lab.

[0078] Until the procedure report has been approved by the assigned physician, it is considered a preliminary report. At specific stages during the visit (and the life time of a report), a version of this report is sent to a system, e.g. ERIS system. A copy of the final report is placed in the patient history folder. All data applying to a patient visit is organized by sections to facilitate assembly and customization of the procedure log and report. Examples of the a report sections may include Demographics; Referring Diagnosis; Hemodynamics; Doppler Measurements; Stress Parameters; and Wall Motion Graphics, etc.

[0079] The report module also allows default inclusion/exclusion and ordering of data sections for multiple versions of the report. Report versions may include Online procedure Log; Online procedure report; Printed procedure report; and ERIS procedure report, etc. The report module also specifies ad hoc inclusion/exclusion of data sections for a specific report version applied to a particular visit.

[0080] In a reporting process, typically a report signoff sequence requires sonographer signoff prior to physician

signoff. In the present system, the physicians and sonographers may perform report signoffs from remote locations via Web access. During an online report review, specific signoffs may be authorized and performed by required clinician regardless of whether a current user logged into the system. In the report module, customized versions of a preliminary or final report can be sent to an electronic report system based on either specific data modifications or specific patient visit status transitions or events. This allows efficient navigation to and from data sources from the online report. Further, access to data element helps text and calculation definition from the online report. Also, an immediately update report data based on changes to underlying visit data can be generated.

[0081] Further, the report module may incorporate all graphic elements of data, for example, wall motion graphics, thoracic aorta view, on devices with a graphic display capability. The report may also provide an alternate textual representation of graphically generated data, for example, wall motion comments/scoring, to be used for output targets without a graphic display capability. The final reports may be faxed to outreach or other remote locations. Any data modifications subsequent to a final report signoff may result in future reports indicating that the report has been modified. Modified data may be optionally flagged in an online report.

[0082] It is appreciated that an online report is optional, and that the report can be a printed report. The module may use distinct, easily seen graphical cues online and printed reports to distinguish between preliminary and final reports, and between original and modified final reports.

[0083] 8) Serial Studies Module

[0084] Serial studies allow for the time-based analysis of particular measurements regarding a specific patient. They are typically used for tracking the progress and health of a particular patient. In contrast, research studies or protocols aggregate measurements from many patients for the purpose of statistical analysis.

[0085] Serial studies are identified and created by study type. Serial study types may include oncological and hypertensive types. Each patient may only have one serial study of each type active at a given time. Additional serial study types can be created at any time. Serial studies may be initiated for a patient at any time. The incorporation of a particular visit into an ongoing serial study may be at the discretion of the clinicians.

[0086] It is appreciated that in some instances, a particular visit may not be flagged, as the visit is not applicable to a serial study so as not to skew trend data or due to emergency procedures. By default, a visit may become a part of a serial study, but a user may override the default.

[0087] Once a measurement has been assigned to a particular study type, the module may prompt or otherwise aid the user in acquiring the measurement in future studies. The serial studies module provides the ability to review the measurements assigned to serial studies across all applicable visits. Data are displayed in a convenient format, such as a tabular format. Individual measurements should be selectable for graphic representation and/or comparison over time. Serial studies may be included on a procedure log and/or a procedure report as desired.

[0088] 9) Research Protocols Module

[0089] Research protocols module provides retrospective statistical analysis of aggregated patient data to support the research and educational needs of a practice and other organizations. Data for research protocols module may include measurements, demographics, and/or other subjective information. Research can be partitioned for clinical information in order to accommodate rules of privacy.

[0090] Unique billing codes may be assigned to research protocols. The module may prompt or otherwise aid a user in identifying missing protocol measurements since it may be preferred that all measurements assigned to a protocol are collected during a protocol visit. It is appreciated that a visit may be scheduled in support of multiple protocols. The data associated with a protocol are provided to researchers by the research protocols module or any other modules in the system.

[0091] The module allows the creation of research protocol definitions at any time and allows measurements to be assigned to research protocols. Also, the module accommodates the creation of questionnaire-style informational data items that can be quantified or stratified for research purposes.

[0092] 10) User Interface and Common Services Module

[0093] The user interface and common services module provides both automatic and user-initiated mechanism for storing data. The module provides an "expert mode"support for rapid entry of data to familiar users. The module thus allows efficient, intuitive navigation to all components of a patient visit. It is appreciated that the automatic data storing mechanism or user-initiated data storing mechanism can be any known type, such as the computer software wizards or templates, etc. It is also appreciated that the user interface and common services module can be operated in the Internet environment.

[0094] 11) Web-based Module

[0095] The web-based module provides all application interface screens primarily deployed within a web browser. The security feature is implemented in the web-based module to restrict certain operational interface access, for example, measurement entry, scheduling, etc., to the appropriate departmental or institutional personnel. The security implementation allows for viewing of a report, such as a patient's final report, by a variety of interested parties, especially referring physicians. The security features can be configured in a separate module, such as a security and user configuration module (see later discussion).

[0096] Accordingly, the system can be web-based. The system may be implemented by using a combination of XML, dynamic HTML, static HTML, Java, or an Oracle database, etc. The technologies simplify deployment by allowing the application to be deployed in a web browser. For example, by using Enterprise Java Beans, the system may generate an XML report that can be stored in a database allowing for easy access from any electronic medical system.

[0097] In one exemplary implementation, the system may incorporate the following applications:

[0098] At the server side technology:

[0099] Java and EJB (server-side component architecture, rapid application development, maintainability and extensibility),

[0100] Database and XML (dynamic document-oriented view of visit and measurements, portable data format, XML-to-relational mapping of reports), or

[0101] Sun-Oracle-BEA's WebLogic (scaleable, reliable, secure);

[0102] At the client side technologies:

[0103] Java Applets ("List" oriented views, synchronization of data),

[0104] DHTML (patient-centered views, frame management, Javascript for local validation where appropriate), or

[0105] Sun-Oricle-BEA's WebLogic (track record, scaleable, reliable and secure).

[0106] 12) Unique Reports Module

[0107] In addition to a procedure report, other reports may be generated to aid in various phases of user operations. Some of these reports are automatically generated based on specific system actions or visit statuses. Others can be generated upon request. Also, the module identifies which location or a remote location a report is sent to.

[0108] The module also provides a relational database with supporting views to allow effective creation of pre-defined and ad hoc practice management reports.

[0109] 13) Database Module

[0110] The database module stores all application data in a relational database for ad hoc query and statistical analysis access. It is appreciated that any known relational database can be used without departing from the scope of the present invention.

[0111] 14) System Administration Module

[0112] The system administration module configures a select list for selection fields/combo boxes not specifically populated from database contents or measurement configuration. It is appreciated that any known system manager functions may be used within the scope of the present invention.

[0113] 15) Security and User Configuration Module

[0114] The security and user configuration module provides security functions for the system both internally and externally. For example, the module identifies particular users to access particular fields of the system according to defined users' roles in the system.

[0115] For example, identified users' roles may include sonographer, physician, appointment secretary, desk secretary, technician, and administrator, etc. It is appreciated that users may be added or deleted from a pre-defined user list. Accordingly, the module provides the capability to restrict access to application screens by lab role and individual user.

[0116] The implementation for the security access to the system can be any known mechanism, such as the traditional security access by login ID and password. The login ID and password mechanism can be separate or distinct from other applications operated on a system. Further, workstation locations can be pre-defined by the system at login, and defaults for initial screens, room coverage, and printer location can be pre-defined.

[0117] Medical information and patient privacy are heavily regulated in the United States and in foreign countries. The security and user configuration module are preferably compliant with the current known regimes of regulation in the country of implementation of the system, and are adaptable to meet new requirements and regulations as new regimes are enacted. In the U.S. at this time, the Health Information Patient Privacy Act (HIPPA) is the principal regulatory structure. The security and user configuration module is preferably compliant with and adaptable to meet all current and future HIPPA requirements.

[0118] 16) Image Integration Module

[0119] The image integration module may be implemented in association with imaging systems, such as echocardiogram imaging systems, etc. Accordingly, the module is capable of adapting to the features and/or functions similar to the imaging systems. For example, the module stores image data from a patient study, measurements, demographic, and/or other relevant data available, on electronic media, such as DICOM-enabled ultrasound systems.

[0120] The image integration module also transfers demographic information from a lab system to another appropriate ultrasound device via DICOM prior to beginning of a study or when information is made available. This allows rapid random access to the stored image data that corresponds to a study.

[0121] In addition, the image integration module provides an enhanced user interface that includes measurement "tools" familiar to ultrasound users so that it allows measurements to be created or modified retrospectively.

[0122] Further, the image integration system may incorporate selected images and video segments into an online patient report at the discretion of users. It is appreciated that restrictions on delivery technologies, such as printers and electronic record system, may restrict the selected images and video segments on certain formats.

[0123] In cases where a single measurement is made multiple times, a user can either select a single instance or have the module to average selected values.

[0124] 17) System/Technical Support Module

[0125] The system/technical support module supports separate test, integration, and production environments, provides on-line access to manuals covering user navigation and system overview, and/or provides a Technical Engineering Document. It is appreciated that the system/technical support module may adhere to certain guidelines, such as published system/technical user interface guidelines, a systems administrator guide, etc. Further, the module provides schedules for backup and system maintenance activities.

[0126] The module further provides a robust, automatic distribution, and installation feature. This feature allows

easy dissemination of updated software to client hardware. When a workstation first accesses the system, the system ascertains whether a more up-to-date version of the software exists. If so, the system downloads and installs the up-to-date version before a user proceeds.

[0127] Furthermore, the module archives data based on user-specified aging parameters and provides a capability to retrieve archived data for query. For example, the module supports a data capacity based on patient visits for the number of patients in the first year, with the practice growing by a percentage per year thereafter. Another example is that the module supports a minimum 3-year on-line data capacity based on performing a number of procedures in the first year, with the practice growing by a percentage per year thereafter. A further example is that the module supports an installed base of 100 to 17,000 workstations, with 150 users logged on at a time, and allowing for 100 concurrent data entry users.

[0128] In one implementation, the system runs on WINDOW NT 4.0 with 32M of RAM, 133 to 300 Megahertz CPUs.

[0129] For enhanced system performance, activities taking place in the patient's presence are prioritized higher than administrative reporting activities. The module displays a warning when concurrent updates are attempted. Within each major task of a patient visit, the module expedites the processing of screens so as not to impede progress. The module is optimized for response time performance, once a patient has been selected and once task has been initiated.

[0130] In one implementation, the module supports maximum system response times of less than two seconds when moving between patient states, or when switching to a patient visit from history that is not cached. During a patient visit (either a current one or a past visit which has been loaded to cache), responses from a server to a client are within one half second. For all responses that rely on external interfaces, the response time is preferably less than two seconds. It is appreciated that other response time can be implemented within the scope of the invention.

[0131] 18) Knowledge Base Module

[0132] In one implementation, the knowledge base can provide information to users of the system and clinicians as which tests should be performed or which measurements should be collected for a given initial diagnosis. Valid ranges for measurements or outcomes for particular procedures are provided to clinicians and technicians carrying out the test and measurements to ensure that valid data are collected. Once initial data has been collected during a patient visit, the knowledge base can provide the clinician feedback regarding the initial diagnosis and whether the data collected appears to support that diagnosis. If the data appear to suggest a different diagnosis, the knowledge base can prompt the clinician to perform additional measurements and gather additional information that may further confirm the initial diagnosis or point to a new diagnosis.

[0133] The knowledge base module may be developed from the collective background knowledge of the ultrasound laboratory derived from many years of operation. Statistical and other historical analysis of data and diagnosis of prior patient outcomes, in combination with the knowledge and expertise of current clinicians contribute to the knowledge base. As new ultrasound tools and techniques are incorporated into laboratory operations, initial assumptions as to appropriate valid measurement ranges are included in the knowledge base and verified against the actual measurements observed during clinical usage. Further, the initial and revised diagnoses supported by particular measurements derived from such new tools and techniques are also incorporated into the knowledge base. As more experience with the new tools and techniques are gained through clinical use, these initial assumptions may be tested against actual patient outcomes to revise and refine the contents of the knowledge base.

[0134] In another implementation of the knowledge base, the knowledge base incorporates a universal glossary related to the operation of an ultrasound laboratory. By supplying all users of the laboratory information management system with a common taxonomy, more uniform and consistent data regarding diagnoses, measurements and outcomes can be promoted, which will in turn allow the knowledge base to be maintained, improved and extended. To permit and promote this on-going improvement and extension of the knowledge base, users of the laboratory information management system may be required to agree to use of the common glossary when taking and compiling measurements.

[0135] Referring now to **FIGS. 1 through 4**, a sample operational environment for an ultrasound laboratory information management system **100** is illustrated. System **100** includes a central office or laboratory installation **102**, and two remote laboratory installations **104** and **106**. Installation **102** includes a module server **108** with an attached database **110**, a knowledge base server **112** with an attached database **114**, at least one client intake system **118** and multiple ultrasound devices **120**, **122**, and **124**. Also included in installation **102** is a communications gateway **117**. These elements which comprise installation **102** are linked by a local area network or LAN **134**. It is anticipated that more ultrasound devices may be included in installation **102**. In addition to ultrasound devices, other laboratory analysis tools may be incorporated into installation **102** and linked to the other elements of installation **102** via LAN **134**. Module server **108** may include multiple physical servers or a single high-throughput server. Databases **110** and **114** can be logical partitions of a single database server or may be physically distinct database servers. In addition, each of the database servers **110** and **112** may include multiple physical servers. The size and number of hardware devices included in central laboratory installation **102** will depend on the size and overall complexity of installation **102**, the number of users supported by installation **102**, the number of ultrasound devices **120**, **122** and **124** included in installation **102** and the capabilities of the hardware and software which comprise the installation.

[0136] Remote laboratory installations **104** and **106** are similarly configured to installation **102**. It is anticipated that remote installations **104** and **106** will be smaller and support fewer users than installation **102**. However, a remote installation **104** or **106** may actually be larger or more complex than installation **102**. It is also anticipated that more or fewer remote installations may be incorporated into system **100**.

[0137] Remote installation **104** includes a client intake system **118**, a number of ultrasound devices **126** and **128** and a LAN **134**. Remote installation **104** also includes a com-

munication gateway **117** which is linked with communications gateway **117** of installation **102** via a wired connection **115**, such as an intranet, the Internet, a leased line or a combination thereof. Remote installation **104** may also include a local server **136** and local database **138** to capture and maintain data from patients seen at remote installation **104** which is only of interest to laboratory staff at remote location **104**.

[**0138**] Remote installation **106** includes a client intake system **118**, a number of ultrasound devices **130** and **132** and a LAN **134**. Remote installation **106** also includes a communication gateway **117** which is linked with communications gateway **117** of installation **102** via a connection **116** which includes a wireless communication element such as satellite networking, cellular technology or radio communication. Remote installation **106** may also include a local server **136** and local database **138** to capture and maintain data from patients seen at remote installation **104** which is only of interest to laboratory staff at remote location **106**.

[**0139**] It is anticipated that more ultrasound devices may be included in remote installations **104** and **106**. In addition to ultrasound devices, other laboratory analysis tools may be incorporated into remote installations **104** and **106** and linked to the other elements of remote installations **104** and **106** via LANs **134**.

[**0140**] Referring now to **FIG. 5**, an overall table layout **200** which supports the integrated laboratory information management system is shown. **FIG. 5** indicates the individual grids into which table layout **200** has been broken down into and indicates which of the following **FIGS. 5A through 5X** includes a more detailed view of data tables and data linkages within the grids.

[**0141**] Referring now to **FIG. 5**A, an exemplary table **202** within table layout **200** includes a table title **204**, a table header **208**, and table data **206**. Table header **208** and table data **206** may include one or a plurality of data elements **210**, and some data elements **210** may be designated primary or secondary indexing keys. In the interest of clarity, each table **202** within table layout **200** has not been labeled but is understood to include the same structure described above.

[**0142**] Between tables within table layout **200** are a plurality of table linkages **212**, indicated by both dashed and solid lines, which may include end symbols **214** including diamonds and circles, some of which are labeled on **FIG. 5A**. In the interest of clarity, each table linkage **212** and end symbol **214** within table layout **200** has not been labeled but is understood to indicate a logical link defined between data elements **210** inside the tables. The various lines **212** and end symbols **214** indicate the nature of the relationship between data tables **202** connected by lines **212**.

[**0143**] The foregoing description of the exemplary embodiment of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be limited not with this detailed description, but rather by the claims appended hereto.

What is claimed is as follows:

1. A laboratory information management system comprising:

a plurality of linked modules which perform the following functions:

tracking patient status from initial appointment scheduling to discharge from the laboratory following appointment;

capturing demographics information regarding the patient;

capturing information regarding patient treatment during the appointment for the generation of a bill for the treatment provided;

indicating a set of suggested procedures to be performed during the appointment based on a referral diagnosis for the patient;

capturing information regarding measurements taken or derived during the appointment;

capturing measurement information and image data generated during the appointment;

capturing final impressions and interpretations of laboratory staff regarding the procedures performed and the measurements derived during the appointment;

generating a plurality of standard reports based on the procedures preformed during the appointment, the standard reports incorporating measurement information and image data captured during the appointment;

verifying if patient has been assigned to a serial study and prompt for laboratory staff to perform additional procedures required for the serial study if not the necessary information and image data have not been captured during the appointment;

assigning information and image data collected regarding the patient during an appointment to a research protocol if the patient has been assigned to the research protocol;

a user interface for system users and laboratory staff interaction with the modules including required and user-customizable elements derived from at least one of the modules;

creating ad hoc reports which incorporate information and image data captured or derived during the appointment, referral diagnoses, and laboratory staff impressions and interpretations;

configuring user input fields, which may include specification of the nature of information to be entered into the fields and a list of allowable field entries;

configuring and administering access privileges for system users based on an assigned role of the user and security of patient clinical and research data;

provide separate development, testing, integration and production environments, and provide on-line access to user manuals and technical documentation regarding the environments and modules to system users;

storing and indexing patient information, information captured during the appointment and other reports generated from the patient information and the infor-

mation captured during the appointment in a relational database linked to the plurality of modules.

2. The laboratory information management system of claim 1, wherein the laboratory is a medical ultrasound laboratory.

3. The laboratory information management system of claim 1, wherein the user interface is delivered to a web browser and users and laboratory staff interact with the modules through the web browser.

4. The laboratory information management system of claim 2, wherein the image data for the patient captured during the appointment is indexed and stored in a separate imaging database, and imaging data stored within the imaging database is linked to the information regarding the patient.

5. The laboratory information management system of claim 2, wherein the modules are linked to a knowledge base which provides suggested measurements and analysis techniques for a given proposed diagnosis, normal value ranges for measurements taken during a patient visit, and a suggested diagnosis for a given set of patient measurements and observations.

6. The laboratory information management system of claim 5, wherein the knowledge base is derived from historical diagnosis, measurement and medical outcomes information collected.

7. The laboratory information management system of claim 6, wherein the knowledge base allows measurements outside the normal value ranges to be entered into the patient record upon validation by an approved operator.

8. The laboratory information management system of claim 7, wherein measurements included in the patient's record during an appointment may be flagged for further review and analysis.

9. The laboratory information management system of claim 2, wherein the security tool is fully compliant with health information privacy protection standards.

10. The laboratory information management system of claim 2, wherein the modules are accessible by a remote user.

11. The laboratory information management system of claim 10, wherein the remote user accesses the modules via a wired link.

12. The laboratory information management system of claim 10, wherein the remote user accesses the modules via a wireless link.

13. The laboratory information management system of claim 2, wherein the modules are developed utilizing at least one non-proprietary open source development environment.

14. A method of managing information within an ultrasound imaging medical laboratory comprising the steps of:

providing a laboratory information management system including a plurality of linked modules;

tracking patient status from initial appointment scheduling to discharge from the laboratory following an appointment;

capturing demographics information regarding the patient;

capturing information regarding patient treatment during the appointment for the generation of a bill for the treatment provided;

indicating a set of suggested procedures to be performed during the appointment based on a referral diagnosis for the patient and;

capturing information regarding measurements taken or derived during the appointment;

capturing final impressions and interpretations of laboratory staff regarding the procedures performed and the measurements derived during the appointment;

capturing measurement data generated during the procedures and provide this data to a report generation tool;

verifying if patient has been assigned to a serial study and prompting for any additional measurement data required for the serial study if these measurement data have not been captured during the procedures;

assigning data collected regarding the patient during the appointment to a research protocol;

delivering a user interface to a web browser, the user interface including required and user-customizable elements derived from other modules;

limiting access privileges for system users and laboratory staff based on an assigned role of the users and staff; receiving, indexing, and storing imaging information captured during the appointment, and providing a linkage between the patient's records and imaging information related to that patient;

utilizing a relational database for the storage, organization and retrieval of the patient's information including data and imaging information captured or derived during the appointment.

15. The method of claim 14, wherein the method further includes the step of providing laboratory staff with a knowledge base, the knowledge base suggesting measurements to be taken during the appointment based on the referral diagnosis, and valid ranges for measurements taken during the appointment based on patient demographic information and other physical characteristics of the patient.

16. The method of claim 15, wherein the system includes an ad hoc report generating tool and the method further includes the creation of ad hoc reports which may incorporate data and image information captured or derived during the appointment, including the referral diagnoses, and any laboratory staff impressions and interpretations.

17. A multifunctional, integrated ultrasound laboratory information management system of claim comprising:

a business management part of the integrated system manages all aspects of the operation of a ultrasound laboratory, and includes documenting exam encounters, demographics, accounting, scheduling, billing, productivity measures, clinical accountability, and is linked to external systems for functions including third party billing, coding, documentation, and reimbursement;

a ultrasound data management part includes acquisition, collation, and reporting of acquired alphanumeric information, such as measurements, hemodynamics, function, flow calculations, derived information, impressions, text descriptors, derived from clinical ultrasound examinations, and supports the presentation of data in tabular, textural, graphic, or pictorial formats,

and the content and structure of the ultrasound data management part adaptable to accommodate new data types and formats, the ultrasound data management part further supporting the designation of particular data for education, research, treatment, and therapeutics;

a ultrasound image data management part accommodates large-sized documents, such as graphics, still and cinematic pictures, digital documents, parametric information, and permits retrieval and display of the image data at high levels of graphics density and at a high frame rate.

18. The multifunctional, integrated ultrasound laboratory information management system of claim 17, wherein the information managed by the business management part, the ultrasound data management part, and the ultrasound image management part are integrated into a single information management system.

19. The multifunctional, integrated ultrasound laboratory information management system of claim 18, wherein the integrated system is built from a plurality of modular components, which can be removed, modified, and/or replaced as desired, and wherein the integrated system is extensible and supports multiple data and graphic formats, and image management technologies.

20. The multifunctional, integrated ultrasound laboratory information management system of claim 17, wherein the integrated system is for use by a medical cardiovascular ultrasound imaging and hemodynamic laboratory.

21. The multifunctional, integrated ultrasound laboratory information management system of claim 17, wherein the parts of the integrated system include a plurality of integrated modules, each of the modules being interfaced via a relational database.

22. The multifunctional, integrated ultrasound laboratory information management system of claim 21, wherein the information managed by the parts of the integrated system, including acquired information, reported information, and administration functions, may be accessed via web-based protocols, and the integrated system is hosted on industry standard hardware and software platforms.

23. The multifunction, integrated ultrasound laboratory information management system of claim 22, wherein one of the plurality of modules includes a logic program which flags missing data during a clinical ultrasound procedure and informs a user if the objectives of the procedure have been met.

24. The multifunction, integrated ultrasound laboratory information management system of claim 22, wherein one of the plurality of modules includes a comprehensive ultrasound related repository of source material, such as medical literature validation of measurements, calculations, source information, vocabulary and definitions.

25. The multifunction, integrated ultrasound laboratory information management system of claim 22, wherein one of the plurality of modules is a serial study module supporting tabular and graphic presentations of data, including sequential data from a single encounter or from multiple encounters, and allows the collation of these data into a tabular or graphic report.

26. The multifunction, integrated ultrasound laboratory information management system of claim 22, wherein one of the plurality of modules is a security module including communication algorithms to maintain user and client security when the integrated system is accessed through local or extended networks linked to the integrated system.

27. An ultrasound laboratory information management system comprising:

a comprehensive ultrasound related repository of source material, such as medical literature validation of measurements, calculations, source information, vocabulary and definitions, and a logic program which flags missing and out-of-range measurement data during a clinical ultrasound procedure and informs a user if the objectives of the procedure have been met.

28. An ultrasound laboratory information management system comprising:

a security application including communication algorithms to maintain user and client security when the integrated system is accessed by a local or a remote user linked to the integrated system which maintains privacy of patient health information in compliance with governmental regulations.

29. An ultrasound laboratory information management system comprising:

an application permitting the system to be accessible by a remote user utilizing a web browser.

* * * * *

专利名称(译)	超声实验室信息管理系统和方法		
公开(公告)号	US20020198454A1	公开(公告)日	2002-12-26
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[标]申请(专利权)人(译)	梅约医学教育与研究基金会		
申请(专利权)人(译)	梅奥基金会的医学教育和研究		
当前申请(专利权)人(译)	梅奥基金会的医学教育和研究		
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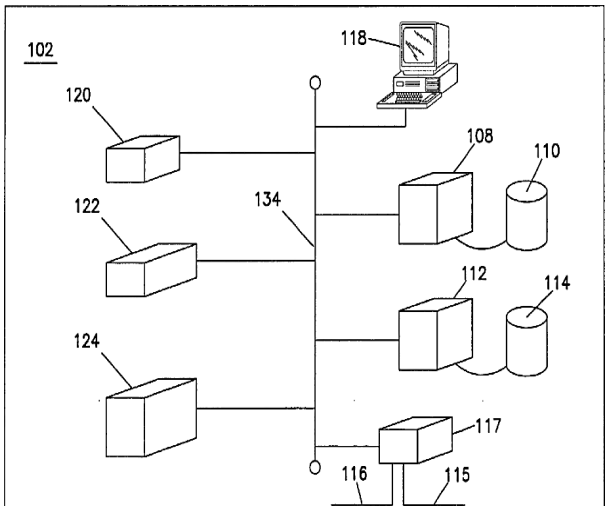
摘要(译)

一种多功能信息管理系统，集成了多个模块，每个模块通过关系数据库连接。集成系统管理大量业务，数据和图像信息，并且能够通过因特网访问/组织。多功能信息管理系统的一个实施例是用于医学超声成像和血液动力学实验室的超声实验室信息管理系统（ULIMS），例如超声心动图或类似的医学实验室环境，其结合了多功能管理系统。 ULIMS包括：1）调度和工作流程模块; 2）患者信息和人口统计模块; 3）计费模块; 4）程序信息和推荐诊断模块; 5）测量，模板和计算模块; 6）最终印象和解释模块; 7）程序报告模块; 8）系列研究模块; 9）研究协议模块; 10）用户界面和服务模块; 11）基于Web的模块; 12）独特的报告模块; 13）数据库模块; 14）系统管理模块; 15）安全，隐私和用户配置模块; 16）图像模块; 17）系统和技术支持模块;和18）知识库模块。