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(54) **METHOD FOR CREATING AND MANAGING ULTRASOUND MEASUREMENT-BASED CALCULATIONS IN ULTRASOUND IMAGING SYSTEMS**

VERFAHREN ZUM ERSTELLEN UND VERWALTEN VON ULTRASCHALLMESSBASIERTEN BEZEICHNUNGEN IN ULTRASCHALL-BILDGEBUNGSSYSTEMEN

PROCEDE DE GENERATION ET DE GESTION DE CALCULS BASES SUR DES MESURES PAR ULTRASONS DANS DES SYSTEMES D'IMAGERIE A ULTRASONS

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**EP-A- 1 454 585 WO-A-01/23905**  
**US-A- 5 950 002 US-A1- 2005 049 493**  
**US-B1- 6 458 081**

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## Description

**[0001]** This invention relates to medical ultrasound imaging systems and, more particularly, to a method performed in an ultrasound imaging system that allows for creation and management of measurement-based calculations.

**[0002]** Ultrasonic imaging systems routinely include visual tools by which a sonographer can measure anatomy shown in ultrasound images and calculate values and estimations from these measurements. Such measurements and calculations are quantified measures by reason of the spatially accurate dimensions and scaling with which ultrasound images can be displayed.

**[0003]** A typical use of such measurement and analysis tools can be found in ultrasound systems configured for obstetrical examinations. Obstetrical images can show anatomy such as the head, abdomen and limbs of the developing fetus. These anatomical features can be measured by placing markers and shapes over and around the features with the measurement tools. Measurements such as lengths and areas can be determined from the markers and shapes placed or drawn on the image. Some of the measurements can be directly diagnostic such as determining from the head circumference whether a Caesarian section delivery will be necessary. The measurements can also be used to compute other attributes of the developing fetus, such as estimated gestational age and fetal weight. The ability to make these measurements and calculations thus facilitates proper care and treatment of both the mother and baby.

**[0004]** More sophisticated ultrasound systems, particularly those that can be configured for a variety of clinical applications, are often equipped with the ability to perform dozens of measurements and calculations. As is well known in the art, such a system typically has greater flexibility and versatility than simply designating a default list of measurements and calculations. Such prior art systems typically allow the sonographer to design custom protocols which include custom measurements and calculations not provided by the manufacturer on the ultrasound system. This valuable feature frees the sonographer from the restricted use of only the measurements and calculations provided with the ultrasound system and variations thereof, and enables researchers to develop their own new and more accurate measures and computations which are better adapted to the demographics of their patient population.

**[0005]** WO 01/23905 A1 describes an ultrasonic diagnostic imaging system that is provided with an analysis package by which measurements and calculations can be made using ultrasonic image data. The analysis package includes the ability for a user to define custom exam protocols custom measurements or custom calculations.

**[0006]** Due to user interface limitations in prior art systems, however, development and implementation of custom protocols, measurements and calculations is cumbersome and not intuitive. In such prior art systems, the

user interface presented to the sonographer for creating custom calculations is typically monolithic and features a single screen with many data fields. Any particular field may or may not be required for completing a particular operation. Which fields are, in fact, required is not immediately obvious. Such an interface is not intuitive and imposes on the sonographer the burden of learning how to use the interface to create or edit a custom calculation.

**[0007]** There is therefore a need for a system that provides the sonographer with a more streamlined and intuitive method and interface for creating custom calculations.

**[0008]** The present invention is directed to an ultrasound method and system as claimed in claims 1 and 7, respectively. A sonographer may use such equipment to create images of internal organs and blood vessels, which are displayed on a screen. The ultrasound equipment provides the sonographer with the ability to make onscreen measurements of components of these images. These measurements are then used to derive various calculations useful for clinical and diagnostic purposes. Medical ultrasound equipment typically provides numerous such calculations by default. The ultrasound imaging system and method provides a user interface for creating and managing new custom measurements and calculations beyond those that are provided by the manufacturer. The system and method provides a sequential display of the operations required for any particular management function being carried out on the custom calculation. The system and method may further require the sonographer to input information, which is verified for consistency and correct syntax prior to the next input operation. Additionally, the system and method uses the information gathered in any particular operation to determine which operation the sonographer is presented with next. Lastly, the system and method allows the sonographer to save the custom calculation in the system for later recall. Simplifying management tasks in this manner, into discrete functional steps, increases sonographer efficiency by providing a streamlined and intuitive method and interface for creating custom calculations. Each input screen can be designed with an adequate amount of help and guidance so that the user does not have to constantly refer to system manuals for these operations.

Figure 1 is an isometric view of an ultrasound imaging system according to one example of the invention.

Figure 2 is a block diagram of the electrical components used in the ultrasound imaging system of Figure 1.

Figures 3a-3e illustrate a method for creating a custom calculation in one example of the present invention.

**[0009]** An ultrasound imaging system 10 according to one example of the invention is illustrated Figure 1. The system 10 includes a chassis 12 containing most of the

electronic circuitry for the system 10. The chassis 12 is mounted on a cart 14, and a display 16 is mounted on the chassis 12. An imaging probe 20 is connected through a cable 22 to one of three connectors 26 on the chassis 12. The chassis 12 includes a keyboard and controls, generally indicated by reference numeral 28, for allowing a sonographer to operate the ultrasound system 10 and enter information about the patient or the type of examination that is being conducted. At the back of the control panel 28 is a touchscreen display 18 on which programmable softkeys are displayed for supplementing the keyboard and controls 28 in controlling the operation of the system 10.

**[0010]** In operation, the imaging probe 20 is placed against the skin of a patient (not shown) and held stationary to acquire an image of blood or tissues in a volumetric region beneath the skin. The image is presented on the display 16, and it may be recorded by a recorder (not shown) placed on one of the two accessory shelves 30. The system 10 may also record or print a report containing text and images. Data corresponding to the image may also be downloaded through a suitable data link, such as the Internet or a local area network. In addition to using the probe 20 to produce an image on the display, the ultrasound imaging system may also provide other types of information such as graphs and reports, and it may accept other types of probes (not shown) to provide other types of images.

**[0011]** The electrical components of the ultrasound imaging system 10 are illustrated in Figure 2. As mentioned above, the ultrasound imaging probe 20 is coupled by the cable 22 to one of the connectors 26, which are connected to an ultrasound signal path 40 of conventional design. As is well-known in the art, the ultrasound signal path 40 includes a transmitter (not shown) coupling electrical signals to the probe 20, an acquisition unit (not shown) that receives electrical signals from the probe 20 corresponding to ultrasound echoes, a signal processing unit (not shown) that processes the signals from the acquisition unit to perform a variety of functions such as isolating returns from specific depths or isolating returns from blood flowing through vessels, and a scan converter (not shown) that converts the signals from the signal processing unit so that they are suitable for use by the display 16. The processing unit in this example is capable of processing both B mode (structural) and Doppler signals for the production of various B mode and Doppler volumetric images, including spectral Doppler volumetric images. The ultrasound signal path 40 also includes a control module 44 that interfaces with a processing unit 50 to control the operation of the above-described units. The ultrasound signal path 40 may, of course, contain components in addition to those described above, and, in suitable instances, some of the components described above may be omitted.

**[0012]** The processing unit 50 contains a number of components, including a central processor unit ("CPU") 54, random access memory ("RAM") 56, and read only

memory ("ROM") 58, to name a few. As is well-known in the art, the ROM 58 stores a program of instructions that are executed by the CPU 54, as well as initialization data for use by the CPU 54. The RAM 56 provides temporary storage of data and instructions for use by the CPU 54. The processing unit 50 interfaces with a mass storage device such as a disk drive 60 for permanent storage of data, such as data corresponding to ultrasound images obtained by the system 10. However, such image data is initially stored in an image storage device 64 that is coupled to a signal path 66 extending between the ultrasound signal path 40 and the processing unit 50. The disk drive 60 also preferably stores protocols which may be called up and initiated to guide the sonographer through various ultrasound exams.

**[0013]** The processing unit 50 also interfaces with the keyboard and controls 28. The keyboard and controls 28 may also be manipulated by the sonographer to cause the ultrasound system 10 to produce automatically generated reports at the conclusion of an examination. The processing unit 50 preferably interfaces with a report printer 80 that prints reports containing text and one or more images. The type of reports provided by the printer 80 depends on the type of ultrasound examination that was conducted by the execution of a specific protocol. Finally, as mentioned above, data corresponding to the image may be downloaded through a suitable data link, such as a network 74 or a modem 76, to a clinical information system 70 or other device.

**[0014]** A procedure for creating a custom calculation according to one example of the present invention is illustrated in Figures 3a-3e. Figure 3a illustrates an ultrasound image screen showing the first step in creating a custom calculation. In this example the sonographer may begin this procedure by tapping a predetermined softkey on the touchscreen display 18, as mentioned above. The sonographer must enter the Label in the Calc Label 90 field and then click on the Next 110 button. Also illustrated are the Cancel 100 button and the Finish 120 button. At this stage of the creation process, it is not possible to finish and save the equation since none has been entered nor verified as being valid. The Finish 120 button, therefore, is inactive. The Cancel 100 button functions to completely cancel the entire procedure. After the sonographer clicks on Next 110, but before the next screen is displayed, the system verifies that the Label is unique and that it is less than 16 characters. Once the information is verified, the next step, as illustrated in Figure 3b, is displayed.

**[0015]** Figure 3b illustrates an ultrasound image screen showing the second step in creating a custom calculation. In this step, the sonographer creates a valid custom equation in the Calc field 140. The sonographer may enter an equation directly into the Calc field 140 using the keyboard and/or onscreen touch Keypad 180. The equation may also contain the results of other calculations or measurements computed by or stored in the system. For example, the sonographer may symbolically

insert a pre - defined or previously created custom calculation into the equation in the Calc field 140 by first selecting the calculation in the Calculation Dropdown 150, specifying the units of that calculation in the Calculation Units Dropdown 160 and clicking on the Insert Calc 170 button.

**[0016]** With further reference to Figure 3b, the sonographer may likewise symbolically insert a previously stored measurement into the custom equation as shown in Calc field 140 by first, selecting the measurement in the Measurement Dropdown 190, selecting a parameter in the Measurement Parameter Dropdown 200, specifying the units of that measurement in the Measurement Units Dropdown 210 and clicking on the Insert Meas 220 button. The sonographer must select the units and precision of the new calculation by entering or selecting such in the Units Dropdown 230 and the Precision Dropdown 240 respectively. The sonographer then clicks the Next 110 button. After the sonographer clicks on Next 110, but before the next screen is displayed, the system verifies that the equation is valid. The Previous 130 button allows the sonographer to return to the previous screen and, in this example, change the Label for the calculation under construction. As discussed above, the Cancel 100 button functions to completely cancel the entire procedure. As with the previous step, it is not possible to finish and save the equation at this stage of the processes and the Finish 120 button, therefore, is inactive. After the equation is entered and verified, the next step, as illustrated in Figure 3c, is displayed.

**[0017]** Figure 3c illustrates an ultrasound image screen showing the third step in creating a custom calculation. In a this example of the present invention, the sonographer is able to specify where custom calculations will appear and be viewed during an exam or when generating reports. Figure 3c illustrates one possible example of this capability. Custom calculations can be made to appear in either or both of a Results box or a final Report. The sonographer may have the calculation result appear in the Results box by checking the Results Checkbox 250. Likewise, if the sonographer would like the calculation to appear in the report, the Report Checkbox 260 should be selected. Until one or both of the checkboxes are selected, the Next 110 button is disabled because the calculation must be configured to be displayed in at least one of these two places. If only the Results Checkbox 250 is selected, the Finish 120 button will become active giving the sonographer the ability to complete the entire operation immediately. If the Report Checkbox 260 is selected, further information is required from the sonographer that is gathered in the next step. Because of this, the Finish 120 button is not active when the Report Checkbox 260 is selected. The Previous 130 button allows the sonographer to return to the previous screen to make changes and, as discussed above, the Cancel 100 button functions to completely cancel the entire procedure.

**[0018]** Figure 3d illustrates an ultrasound image

screen showing a fourth step in this example. This screen allows the sonographer to select the locations where the calculation is to appear within a report. The sonographer selects where the calculation is to appear by scrolling through the Location List 270 and selecting the checkbox for the appropriate location. More than one location may be selected, and the calculation will appear in every such location. The contents of the Location List 270 depends on what type of report is being generated, which in turn depends on what type of exam is being conducted. This screen is displayed for the sonographer only if the calculation was designated to be displayed in the previous step. As discussed above, the Cancel 100, Next 110 and Previous 130 buttons are all active and function to cancel the operation or move to the next or previous steps respectively. When the sonographer clicks either the Next 110 or Finish 120 buttons, the system verifies that at least one location in Location List 270 was selected. If the user has not selected at least one location, the user must either do so or click the Previous 130 button to return to the previous screen and deselect the Report Checkbox 260. The Finish 120 button allows the sonographer to complete the operation and store the newly created calculation. Clicking the Next 110 button instructs the system to display the next and final step in the procedure.

**[0019]** Figure 3e illustrates an ultrasound image screen showing a fifth step in this example. This screen displays all the information the sonographer entered in previous steps and allows the sonographer to verify that the information is correct prior to saving the calculation. The Calc field 140 displays the custom equation. The Results Checkbox 300 shows whether or not the sonographer as designated the calculation to appear in the Results. The Precision 280 field displays the precision the sonographer selected for the results and finally, the Location Report 290 field lists all the locations in the report where the calculation will appear. At this stage of the procedure, all the data as entered has been verified as being syntactically valid. The sonographer may, however, find a mistake or wish to make revisions. To make such corrections, the sonographer must click the Previous 130 button one or more times to return to a previous step containing the information that is to be changed. As usual, the Cancel 100 button cancels the entire procedure. The Next 110 button is inactive during this step because this is the last step in the procedure. Finally, if the sonographer is satisfied with all the data, the Finish 120 button is clicked to save the calculation to the system.

**[0020]** Though this description of creating a custom calculation is made in terms of certain steps taking place in a certain order, it will be understood that the particular number of steps and their order is exemplary only. Other examples of the invention might contain more or fewer steps and may be presented to the sonographer in a different order. The Calc Label 90 as shown in Figure 3a, for example, need not be specified in Step 1. Other steps in the creation procedure may proceed independently of the particular Calc Label the sonographer specifies. This

step could, therefore, occur anywhere in the sequence.

**[0021]** The procedure for editing an existing calculation is quite similar to that of creating a new calculation. For example, the sonographer can select an existing calculation from a list displayed on the system screen and then click the Edit button to begin editing the calculation. The system then presents the sonographer with the appropriate series of screens, but with the existing calculation information pre-populated into the appropriate fields. The sonographer may then make changes to this information and save the changes.

**[0022]** The procedure for copying an existing calculation is shorter than that of editing or creating. When copying a calculation, the sonographer only need specify Calc Label 90 for the resulting copy as in Figure 3a above. The copy is saved to the system after the label is entered and verified. The sonographer may then go through the steps explained above to make modifications to the copy as desired.

**[0023]** While the above examples illustrate the use of only ultrasound information, it should be understood that other patient information and information from other medical devices can be used in an equation. For example, patient data such as weight, age, and patient menstrual cycle may be entered and used in an equations, as may data from measurements by other devices such as of blood pressure or hematocrit.

## Claims

1. A method for creating and managing ultrasound measurement-based equations (140) performed in an ultrasound diagnostic system (10), **characterized in that** the method comprises:

sequentially displaying from a command sequence each of a plurality of steps (Figures 3a-3e) necessary to create or manage at least one measurement-based equation;

at each step, accepting information from the user necessary for creating or managing the measurement-based equation;

verifying the accepted information before displaying another step of the plurality of steps; and saving the accepted and verified information of the measurement-based equation in the system.

2. The method of claim 1 wherein accepting information from the user comprises accepting information (260) from the user that adds at least one additional step to the command sequence.
3. The method of claim 1 wherein accepting information from the user comprises accepting information from the user that allows the user to skip at least one step in the command sequence.

4. The method of claim 1 wherein accepting information from the user comprises accepting information from the user that specifies the precision or units (210) of the measurement-based equation.

5. The method of claim 1 wherein a command sequence is comprised of the steps necessary to create, edit, copy or delete a measurement-based equation.

6. A computer program product comprising a set of instructions that when loaded into a processor (50) of an ultrasound diagnostic system enables the processor to carry out the method of any of the claims 1-5.

7. An ultrasonic diagnostic system (10) adapted to carry out the method of any of the claims 1-5.

## Patentansprüche

1. Verfahren zum Erstellen und Verwalten von auf Ultraschallmesswerten basierenden Gleichungen (140), die in einem Ultraschall-Diagnosesystem (10) durchgeführt werden, **dadurch gekennzeichnet, dass** das Verfahren die folgenden Schritte umfasst:

sequentielle Anzeige aus einer Befehlsfolge jedes einer Vielzahl von Schritten (Figuren 3a-3e), die für die Erstellung oder Verwaltung zumindest einer messwertbasierten Gleichung erforderlich sind,

bei jedem Schritt Aufnahme von Informationen vom Benutzer, die für die Erstellung oder Verwaltung der messwertbasierten Gleichung erforderlich sind,

Überprüfen der aufgenommenen Informationen vor der Anzeige eines weiteren Schrittes der Vielzahl von Schritten und

Speichern der aufgenommenen und überprüften Informationen der messwertbasierten Gleichung in dem System.

2. Verfahren nach Anspruch 1, wobei die Aufnahme von Informationen vom Benutzer die Aufnahme (260) von Informationen vom Benutzer umfasst, die zumindest einen zusätzlichen Schritt zu der Befehlsfolge hinzufügt.

3. Verfahren nach Anspruch 1, wobei die Aufnahme von Informationen vom Benutzer die Aufnahme von Informationen vom Benutzer umfasst, die es dem Benutzer erlauben, zumindest einen Schritt in der Befehlsfolge zu überspringen.

4. Verfahren nach Anspruch 1, wobei die Aufnahme von Informationen vom Benutzer die Aufnahme von Informationen vom Benutzer umfasst, die die Präzi-

sion oder Einheiten der messwertbasierten Gleichung spezifiziert (210).

5. Verfahren nach Anspruch 1, wobei die Befehlsfolge aus den Schritten besteht, die für das Erstellen, Bearbeiten, Kopieren oder Löschen einer messwertbasierten Gleichung erforderlich sind. 5
6. Computerprogrammprodukt, das einen Befehlssatz umfasst, der beim Laden in einen Prozessor (50) eines Ultraschall-Diagnosesystems den Prozessor befähigt, das Verfahren nach einem der Ansprüche 1 bis 5 auszuführen. 10
7. Ultraschall-Diagnosesystem (10), das für die Ausführung des Verfahrens nach einem der Ansprüche 1 bis 5 ausgelegt ist. 15

## Revendications 20

1. Procédé visant à créer et à gérer des équations basées sur des mesures d'ultrasons (140), réalisées dans un système de diagnostic à ultrasons (10), **caractérisé en ce que** le procédé comprend : 25
  - l'affichage séquentiel à partir d'une séquence de commande de chacune d'une pluralité d'étapes (Figures 3a-3e) nécessaires pour créer ou gérer au moins une équation basée sur une mesure ; 30
  - à chaque étape, l'acceptation des informations provenant de l'utilisateur nécessaires pour créer ou gérer l'équation basée sur la mesure ;
  - la vérification des informations acceptées avant d'afficher une autre étape de la pluralité d'étapes ; et 35
  - la sauvegarde des informations acceptées et vérifiées de l'équation basée sur la mesure dans le système. 40
2. Procédé selon la revendication 1, dans lequel l'acceptation des informations provenant de l'utilisateur comprend l'acceptation d'informations (260) provenant de l'utilisateur qui ajoute au moins une étape supplémentaire à la séquence de commande. 45
3. Procédé selon la revendication 1, dans lequel l'acceptation des informations provenant de l'utilisateur comprend l'acceptation d'informations provenant de l'utilisateur qui permet à l'utilisateur de sauter au moins une étape dans la séquence de commande. 50
4. Procédé selon la revendication 1, dans lequel l'acceptation des informations provenant de l'utilisateur comprend l'acceptation d'informations provenant de l'utilisateur qui spécifie la précision ou les unités (210) de l'équation basée sur la mesure. 55

5. Procédé selon la revendication 1, dans lequel une séquence de commande comprend les étapes nécessaires pour créer, éditer, copier ou effacer une équation basée sur une mesure.

6. Produit de programme informatique comprenant un ensemble d'instructions qui, lorsqu'elles sont chargées dans un processeur (50) d'un système de diagnostic à ultrasons, permettent au processeur de réaliser le procédé selon l'une quelconque des revendications 1 à 5.

7. Système de diagnostic à ultrasons (10) apte à réaliser le procédé selon l'une quelconque des revendications 1 à 5.

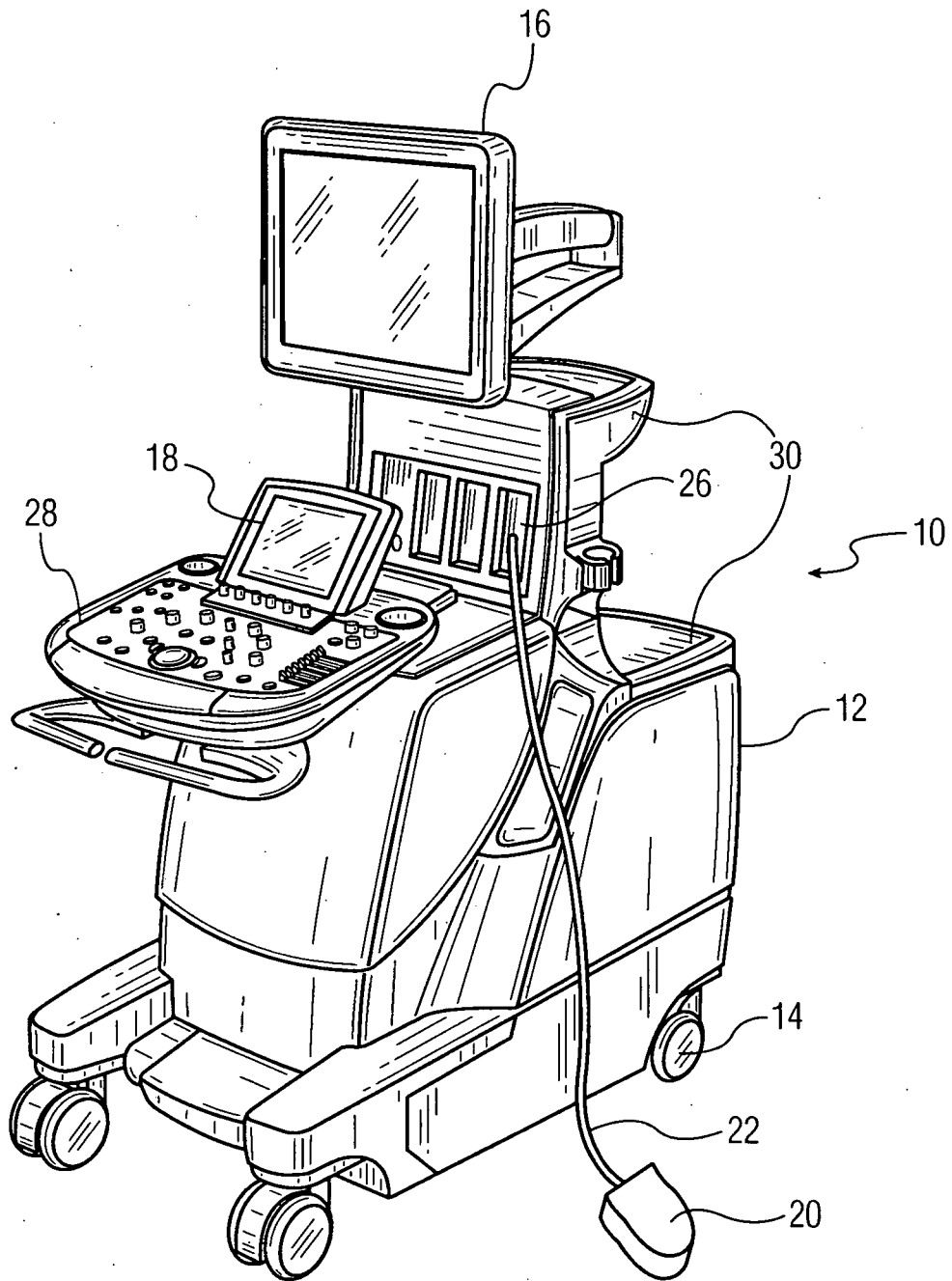


FIG. 1

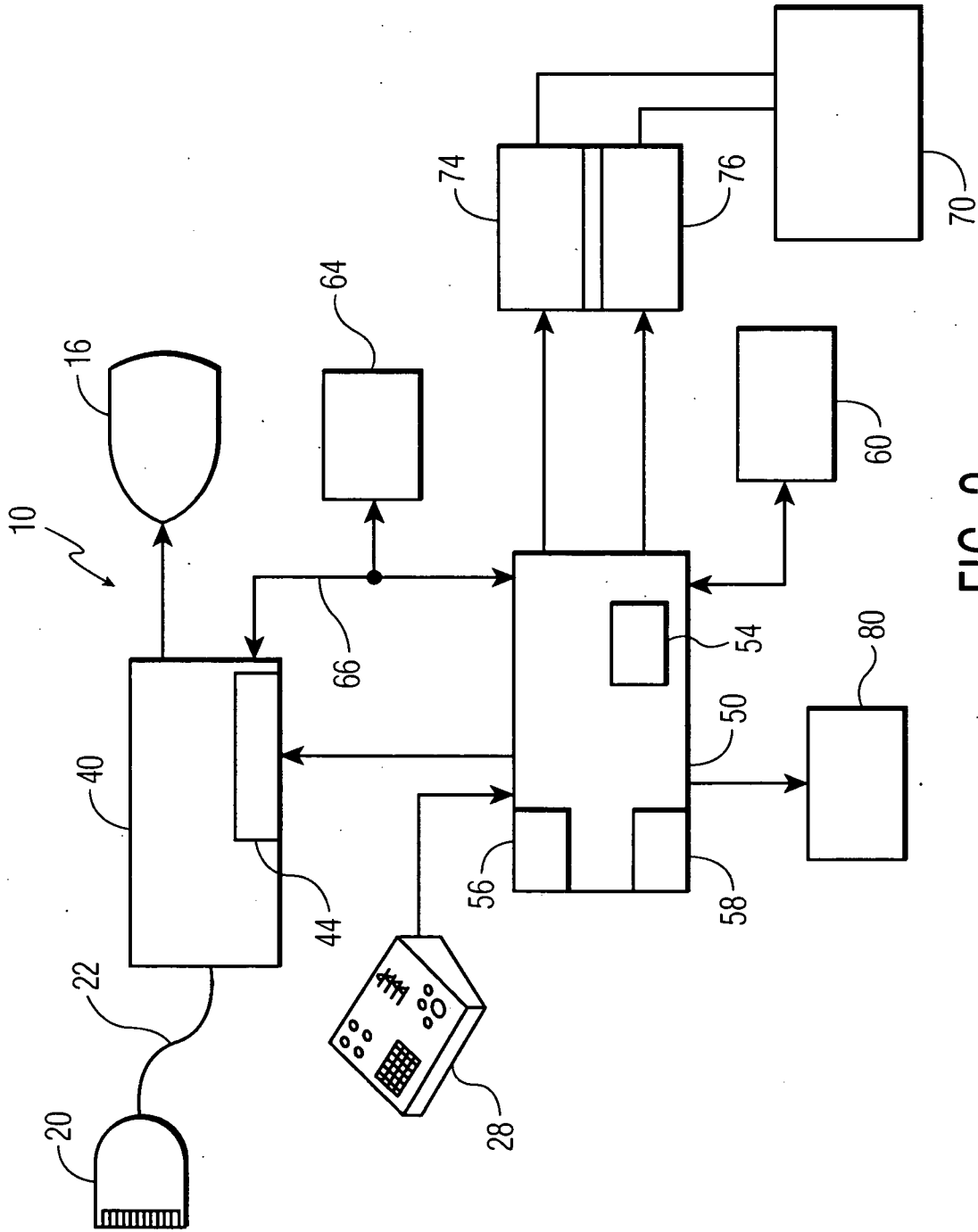


FIG. 2

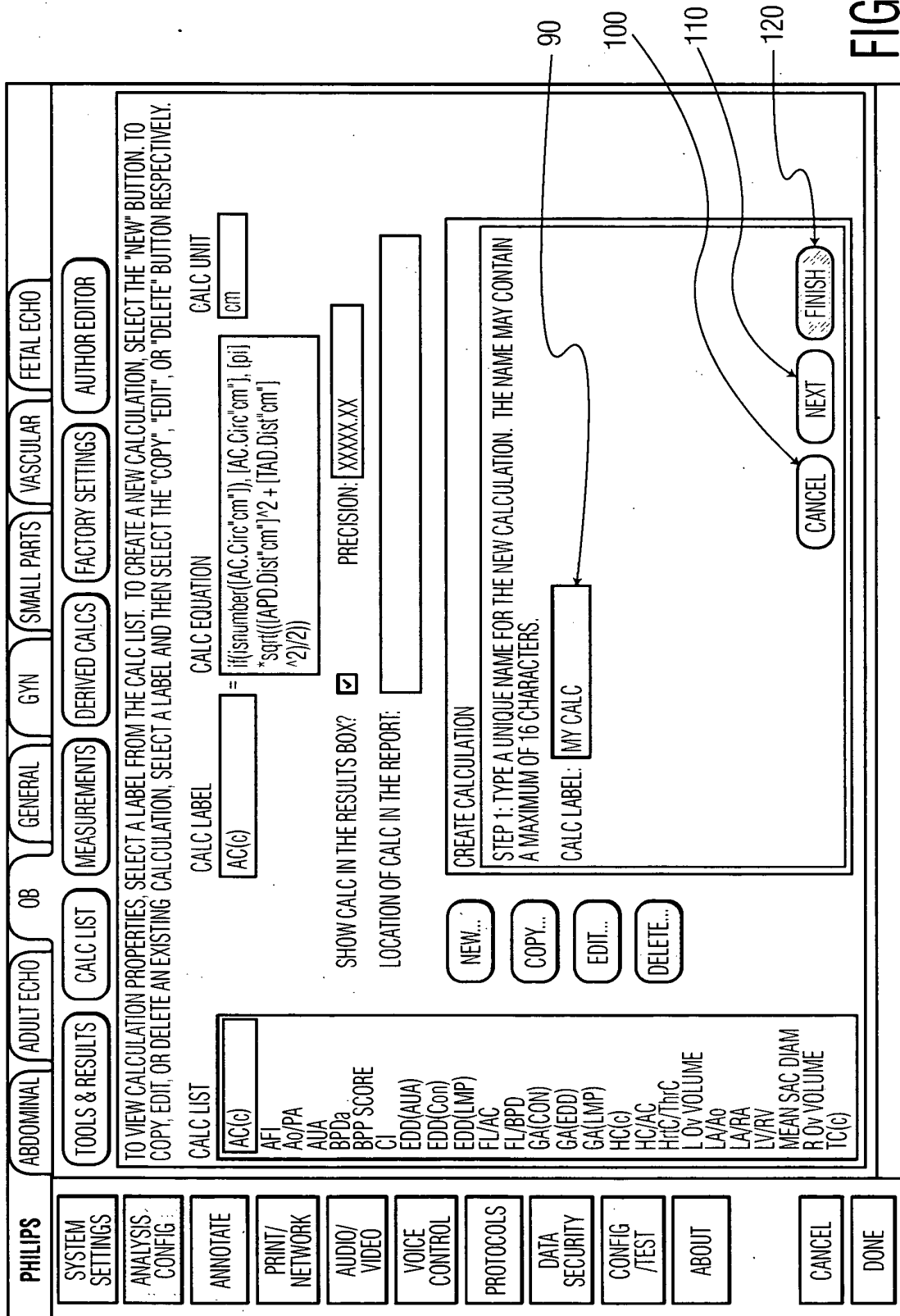


FIG. 3A

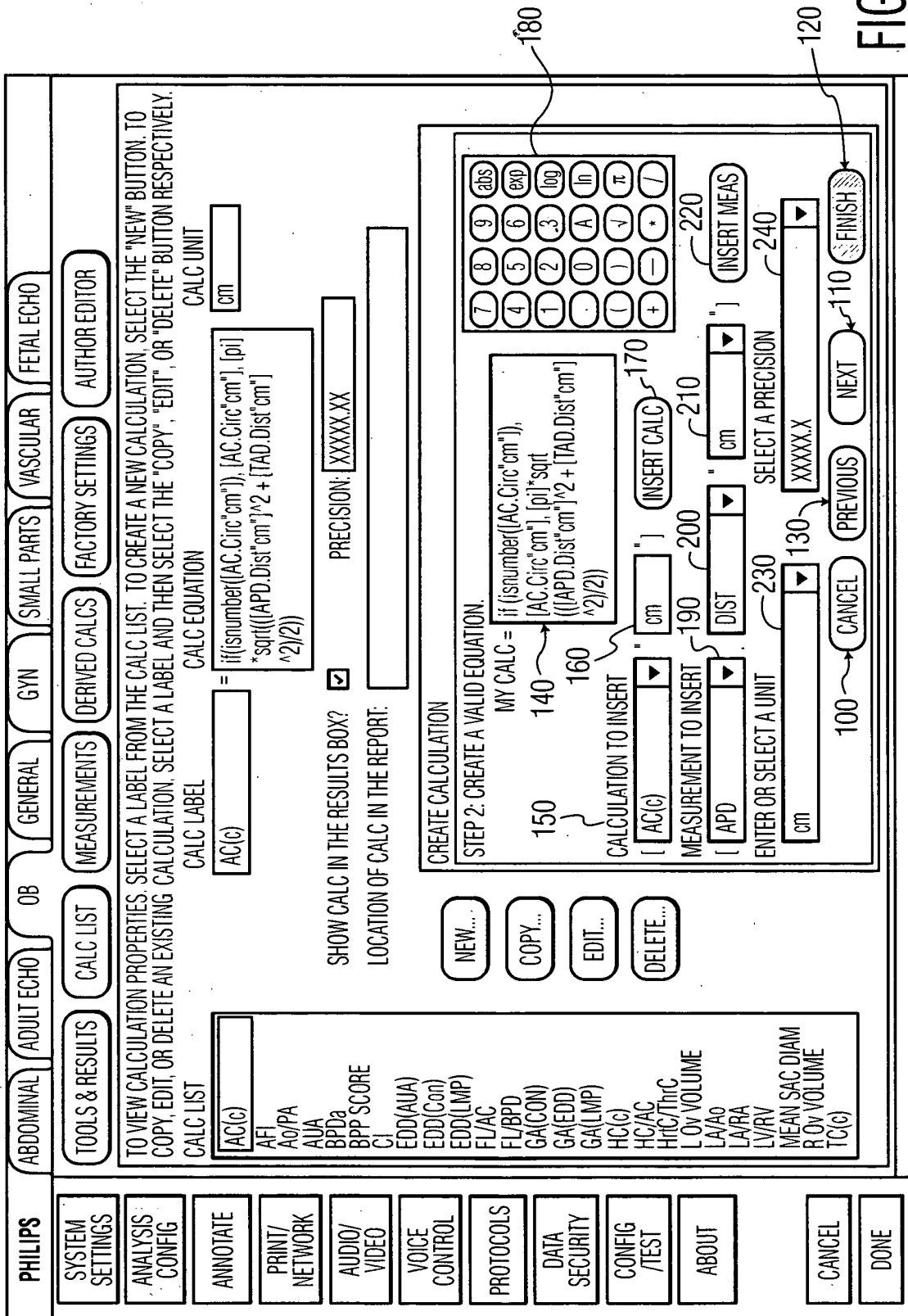


FIG. 3B

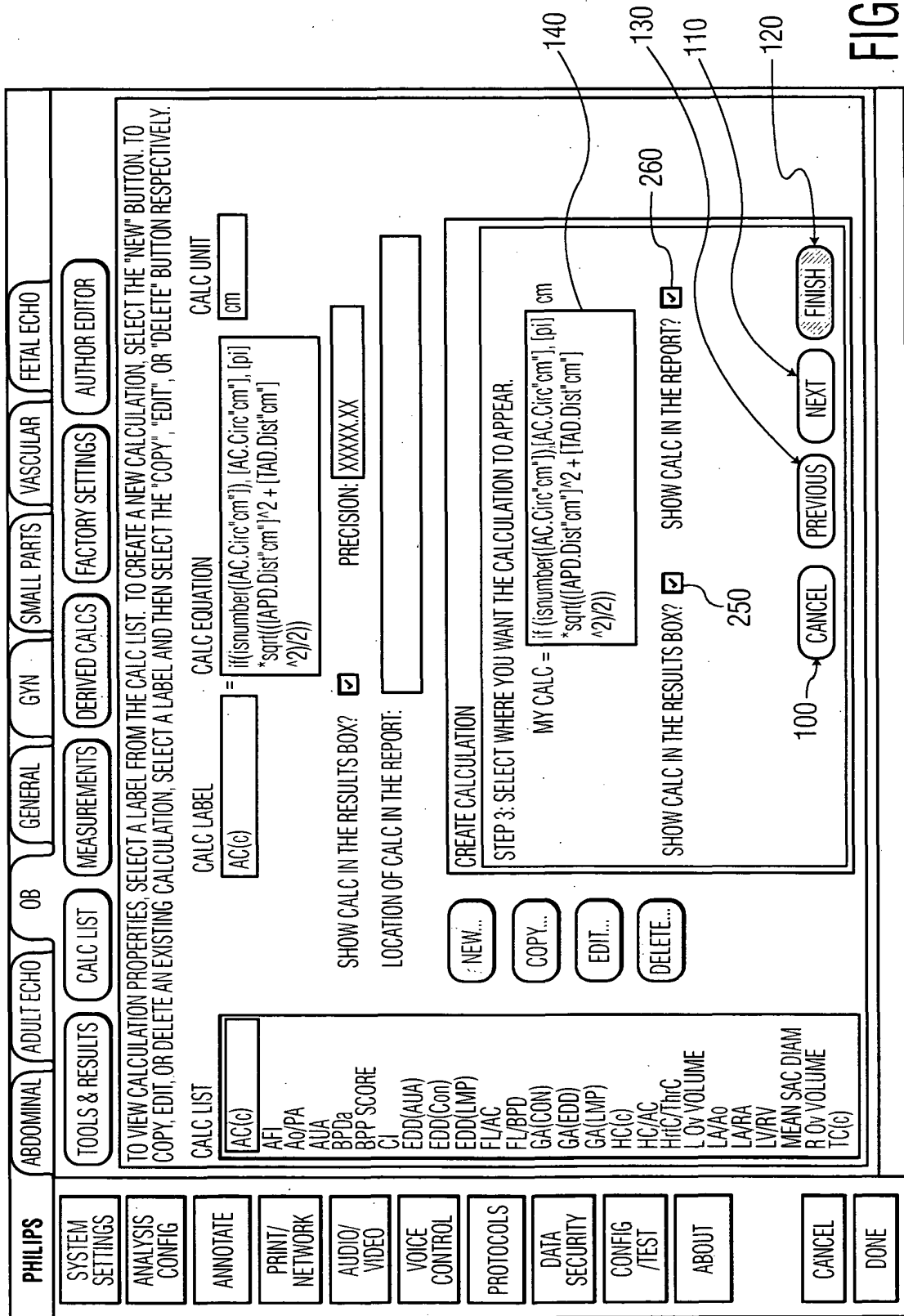


FIG. 3C

PHILIPS

ABDOMINAL ADULT ECHO OB GENERAL GYN SMALL PARTS VASCULAR FETAL ECHO

TOOLS & RESULTS

CALC LIST

MEASUREMENTS

DERIVED CALCS

FACTORY SETTINGS

AUTHOR EDITOR

TO VIEW CALCULATION PROPERTIES SELECT A LABEL FROM THE CALC LIST. TO CREATE A NEW CALCULATION, SELECT THE "NEW" BUTTON. TO COPY, EDIT, OR DELETE AN EXISTING CALCULATION, SELECT A LABEL AND THEN SELECT THE "COPY", "EDIT", OR "DELETE" BUTTON RESPECTIVELY.

CALC LIST

AC(c)
AFI
A0/PA
AUA
BPDa
BPP SCORE
C
EDD(AUA)
EDD(Con)
EDD(LMP)
FL/AC
FL/BPD
GA(CON)
GA(EDD)
GA(LMP)
HC(c)
HC/AC
HrC/ThrC
L Ov VOLUME
LA/A0
LA/RA
LV/RV
MEAN SAC DIAM
R Ov VOLUME
TC(c)

CALC LABEL:  =

CALC EQUATION:

CALC UNIT:

SHOW CALC IN THE RESULTS BOX?  PRECISION:

LOCATION OF CALC IN THE REPORT:

NEW...

COPY...

EDIT...

DELETE...

CREATE CALCULATION

STEP 4: SELECT ALL LOCATIONS WHERE YOU WANT THIS CALCULATION TO APPEAR IN THE REPORT.

MY CALC =

**GENERAL OB**

OB (SUMMARY)

EARLY OB

EARLY OB->MEAN SAC DIAM

EARLY OB->R OVARY

EARLY OB->L OVARY

ADVANCED OB

AFI/BPP

AFI/BPP->AFI

BOLD FRONT INDICATES THE LOCATIONS OF THE MEASUREMENTS USED IN THIS CALCULATION.

100

CANCEL 130

PREVIOUS 110

NEXT

FINISH

270

120

FIG. 3D

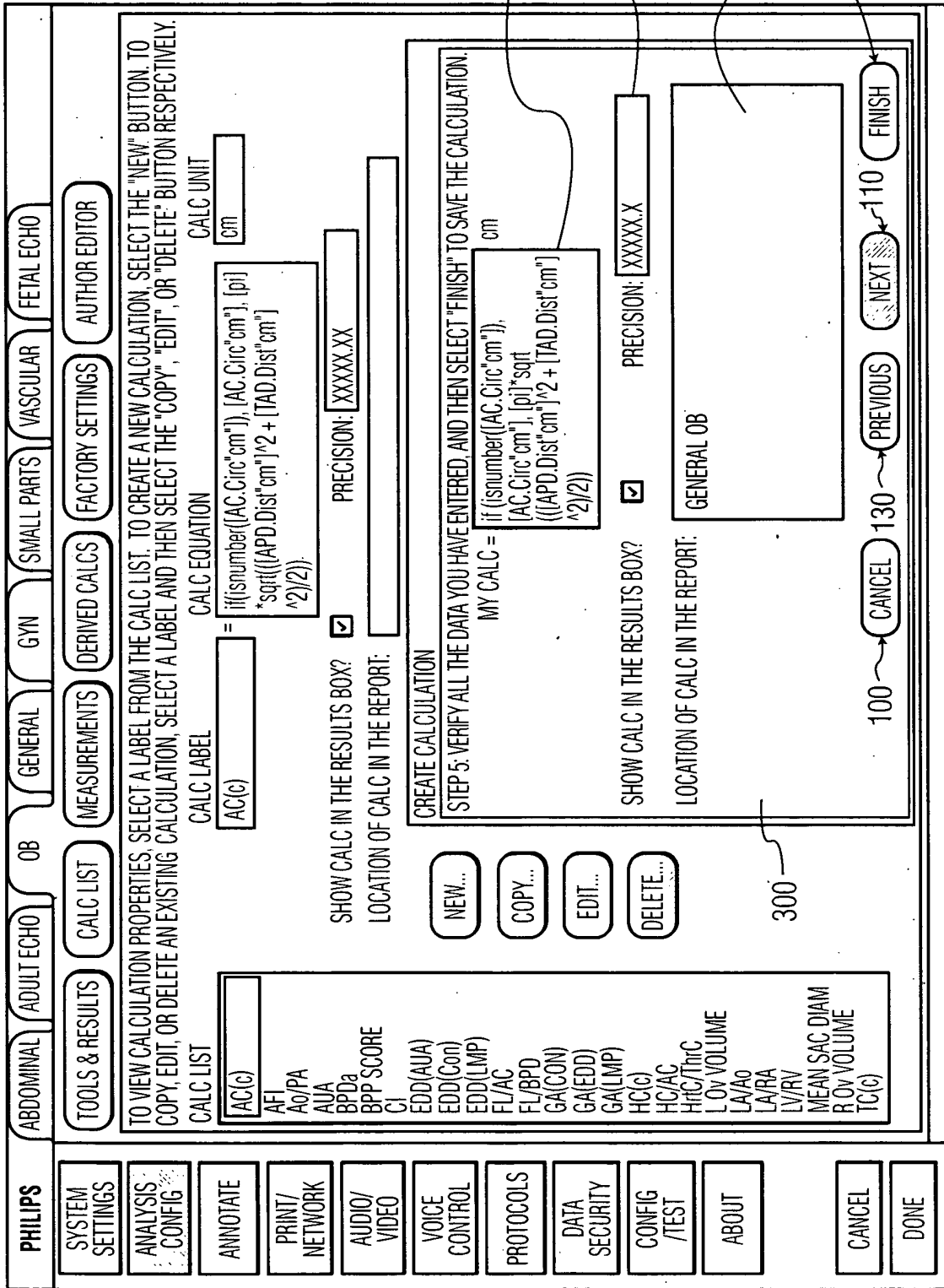


FIG. 3E

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- WO 0123905 A1 [0005]

专利名称(译)	用于在超声成像系统中创建和管理基于超声测量的计算的方法		
公开(公告)号	<a href="#">EP1934864B1</a>	公开(公告)日	2013-12-11
申请号	EP2006809411	申请日	2006-09-26
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦电子N.V.		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	SKYBA DAN CHENAL CEDRIC		
发明人	ZHU, YAN H. SKYBA, DAN CHENAL, CEDRIC		
IPC分类号	G06F19/00 A61B8/00		
CPC分类号	A61B8/00 A61B8/465 A61B8/467		
代理机构(译)	VERWEIJ, PETRONELLA DANIELLE		
优先权	60/722292 2005-09-30 US		
其他公开文献	EP1934864A1		
外部链接	<a href="#">Espacenet</a>		

摘要(译)

超声成像系统 ( 10 ) 包括用于显示超声图像的显示器 ( 16 ) 和可操作地连接到图像显示器的分析包。分析包为用户提供管理基于超声测量的计算的能力。分析包通过向用户显示一系列数据输入步骤来促进基于测量的计算的管理。在每个步骤接受并验证管理计算所需的信息, 然后还用于确定接下来要显示的步骤。在最后一步结束时, 基于测量的计算保存在系统中。

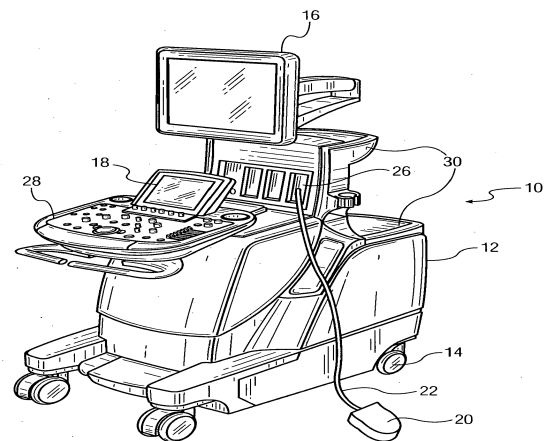


FIG. 1