



- (51) **International Patent Classification:**
A61B 8/00 (2006.01)
- (21) **International Application Number:**
PCT/EP2018/058417
- (22) **International Filing Date:**
03 April 2018 (03.04.2018)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
62/481014 03 April 2017 (03.04.2017) US
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pus 5, 5656 AE Eindhoven (NL).
- (81) **Designated States** (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States** (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) **Title:** METHOD FOR ULTRASONIC DIAGNOSTIC IMAGING PROCEDURES

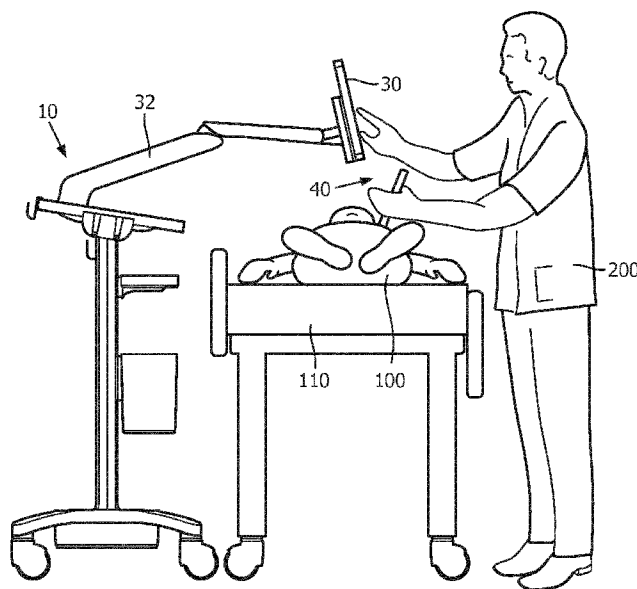


FIG. 6

(57) **Abstract:** An ultrasonic diagnostic imaging system (10) and method are described for conduct of an ultrasonic image-guided invasive procedure. An ultrasound system having a touchscreen display (30) located at the distal end of an articulating display arm (32) is positioned on one side of a patient table (110). The clinician performing the procedure is located on the other side of the patient table. The touchscreen display is extended over the patient table by articulation of the articulating arm. The position of the touchscreen display is adjusted by the clinician for optimal viewing in front of the clinician and above the patient table.



MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

- *with international search report (Art. 21(3))*

METHOD FOR ULTRASONIC DIAGNOSTIC IMAGING PROCEDURES

5 This invention relates to medical diagnostic
ultrasound systems and procedures, in particular, to
ultrasound systems for use in image-guided
procedures.

10 One of the advantages of ultrasound imaging, in
addition to its use of non-ionizing radiation, is its
portability. Even the largest and most complex
ultrasound systems, such as the system shown in US
Pat. 6,516,215 (Roundhill), are wheeled, enabling
them to be brought to a patient's bedside for a
diagnostic procedure. Typically, the sonographer
15 rolls the ultrasound system to the side of the
patient's bed and positions himself or herself at the
side of the bed in front of the ultrasound system
display and keyboard. The sonographer holds the
ultrasound probe against the body of the patient with
20 one hand while using the other to manipulate the
controls of the ultrasound system in order to obtain
the best desired images. The sonographer
concentrates on the images on the display screen,
looking for the right view of the patient's anatomy
25 and image clarity. Experienced sonographers rarely
have to look at the probe as it is manipulated, as
the ultrasound images on the display screen provide
all the visual clues needed to position and
reposition the probe against the patient. The
30 imaging exam proceeds with the sonographer devoting
virtually full attention to the images on the display
screen.

35 Such is not the case, however, when a
clinician is performing an image-guided procedure
such as a needle insertion. In such procedures, the
clinician must not only observe the ultrasound image

and often hold the ultrasound probe, but must also devote focused attention on the insertion and guidance of the needle or other invasive device. In the case where the probe is hand-held rather than
5 taped or strapped to the patient, the procedure requires considerable skill and dexterity. When the ultrasound system is alongside the patient table or bed as in the standard imaging exam described above, the clinician must frequently turn his or her head to
10 observe the display screen on the ultrasound system, noting the position of the instrument inside the body and then turning back to the patient, all while manipulating and guiding the invasive instrument. Thus, it would be desirable to be able to perform an
15 ultrasound image-guided procedure with the display screen positioned as close to the site of the procedure as feasible, so that the clinician can quickly avert his or her eyes to the display screen and back to the site of the instrument procedure
20 without turning the head or body. It would further be desirable to have the ultrasound system controls equally accessible to make any system adjustments necessary to optimize the guiding image on the display screen.

25 In accordance with the principles of the present invention, an ultrasound system and method are described which facilitates an image-guided invasive procedure. The ultrasound system comprises a display system with touchscreen controls which is mounted on
30 a thin, lightweight wheeled stand similar to a medical IV pole. The touchscreen display is located at the distal end of an adjustable articulating arm that is mounted on the stand. The ultrasound system is positioned at the side of the patient table or
35 bed, opposite the side where the clinician performing the procedure is located. The articulating arm is

extended across the patient table toward the position
of the clinician during the procedure. The clinician
can manipulate the touchscreen display and its
articulating arm so that the touchscreen is
5 positioned above the patient and the instrument
insertion site. With the display screen positioned
in this way, the system is out of the way of the
clinician and the screen is located so that the
internal anatomy and path of the invasive device can
10 be seen without movement of the clinician other than
averting the clinician's eyes. The touchscreen
controls of the ultrasound system are also
immediately in front of the clinician for easy access
without diverting attention from the site of the
15 insertion procedure.

In the drawings:

FIGURE 1 is a perspective view of an ultrasound
system of the present invention.

FIGURE 2 is a side view of the ultrasound system
20 of FIGURE 1.

FIGURE 3 is a perspective view of the ultrasound
system of FIGURE 1 with the articulating arm for the
touchscreen display in an extended position.

FIGURE 4 illustrates the range of articulation
25 of the articulating arm of the ultrasound system of
FIGURES 1-3.

FIGURES 5 and 6 illustrate the ultrasound system
of FIGURES 1-4 being used for an image-guided
procedure in accordance with the present invention.

30 Referring first to FIGURES 1 and 2, an
ultrasound system 10 of the present invention is
shown in a perspective view. The system 10 comprises
a base 12 with lockable wheels 14 for moving the
system to the location where an image-guided
35 procedure is to be performed such as a surgical
suite. Located in the base 12 is a power supply

module 15 which supplies power for the system.
Extending upward from the base 12 is a central pole
16. A tray 18 is located at the top of the pole
which can hold instruments to be used in a procedure.
5 Other accessories such as an additional tray and a
basked may be mounted on the pole as shown in the
drawings. Probe holders 20 are located on the sides
of the tray to hold ultrasound probes which are
coupled to the system and not currently being used
10 for imaging. FIGURE 3 illustrates an ultrasound
probe 40 held in one of the probe holders. The cable
42 of probe 40 is plugged into a probe jack located
on the underside of tray 18. A touchscreen display
30 is mounted on top of the tray by an articulating
15 arm 32, which enables the touchscreen 30 to be
manipulated and positioned for an image-guided
procedure as discussed below. Power for the
touchscreen display 30 is provided by wiring (not
shown) extending through the articulating arm 32 and
20 pole 16 to the power supply module 15. Wiring also
extends through the articulating arm from the probe
jack to the touchscreen display.

In FIGURE 2 the articulating display arm 32 is
shown in its stowed position. The articulating arm
25 is locked in this position when the system is moved
for safety purposes. Further details of an
articulating arm with this capability are described
in US pat. appl. pub. no. 2008/0234577 (Murkowski et
al.) When the articulating arm 32 is unlocked so it
30 can be articulated from its stowed position as shown
in FIGURE 3, the lower arm section 56 can be pivoted
around a vertical axis extending through its base 34.
A second articulation joint 36 connects the lower arm
section 56 and the middle arm section 54, which
35 permits the middle arm section 54 to be raised and
lowered. The middle arm section 54 is connected to

an upper arm section 52 by an articulation joint 38 which permits the upper arm section to be raised and lowered and pivoted about a vertical axis with respect to the middle arm section. The upper arm section 52 is coupled to the back of the touchscreen display by another articulation joint 50 at the distal end of the articulating arm, shown in FIGURE 2, which allows the display 30 to be tilted upward and downward and to be pivoted about a vertical axis with respect to a user.

The articulating arm 32 has a wide range of motion so that the touchscreen display 30 can be positioned in a convenient location for a procedure as illustrated diagrammatically in FIGURE 3. This top view of the articulating arm 32 and tray 18 illustrate that the middle arm section 54, in addition to being capable of being raised and lowered, can also pivot a full 360° around the center axis of articulation joint 36, as indicated by the circular range-of-motion arrow 60. This illustration shown the middle arm section 54 in three positions 54, 54', and 54". The upper articulation joint 38 provides additional range of motion as it enables the upper arm section 52 to be pivoted about the joint as illustrated by positions 52' and 52". The upper articulation joint also permits the upper arm section to be raised and lowered with respect to the middle arm section.

This wide and versatile range of motion of the articulating arm 32 enables the ultrasound system 10 to be positioned in a new way for a diagnostic or image-guided procedure as illustrated in FIGURES 5 and 6. FIGURE 5 is a top view of ultrasound system 10 being used for an image-guided procedure such as a biopsy or anesthesiology procedure, and FIGURE 6 is a side view. A patient 100 is in a prone position on a

surgical bed or table 110 and the clinician 200 who is performing the procedure is located on the right side of the table 110. Instead of positioning the ultrasound system on the same side of the patient
5 table 110 as the position of the clinician as is conventionally done, the system 10 is positioned on the left side of the table as shown in the drawing. When the ultrasound system is secured in this
10 position by locking the wheels, the articulating arm can be swung around and articulated to an extended position over the patient 100 and toward the position of the clinician 200 as shown in the drawing. The arm 32 swings around its vertical pivot axis at the base 34, then is articulated at articulation joints
15 36 and 38 so that articulating arm sections 54 and 52 extend over the patient on the surgical table. The clinician 200 can then grab the touchscreen display 30 and position the display where desired above the table 110 and can further tilt the touchscreen
20 display at an optimal viewing angle by virtue of articulation joint 50. With the touchscreen display positioned in front of the clinician and above the patient 100, the clinician can use both hands to hold the ultrasound probe and any instruments needed for
25 the procedure without further interaction with the display. Since the touchscreen display also has control touch points on the screen for control of the ultrasound system, the clinician can, if needed, adjust these system touchscreen controls manually to
30 optimize the system for best visualization of the procedure.

A preferred implementation of the probe 40 for an ultrasound system of the present invention will comprise all of the circuitry and software necessary
35 to send and receive ultrasound signals and process the signals into an ultrasound image for display on

the touchscreen display. Such probes are available from Philips Healthcare of Andover, MA, and are also used with Philips' Visicu ultrasound system.

5 It should be noted that an ultrasound system suitable for use in an implementation of the present invention, and in particular the component structure of the ultrasound system of FIGURES 1-5, may be implemented in hardware, software or a combination thereof. The various embodiments and/or components of an ultrasound system, for example, the touchscreen display and the ultrasound probe described above, also may be implemented as part of or using one or more computers or microprocessors. The computer or processor may include a computing device, an input device, a display unit and an interface, for example, for accessing the Internet. The computer or processor may include a microprocessor. The microprocessor may be connected to a communication bus, for example, to access a PACS system or the data network for importing training images. The computer or processor may also include a memory. The memory devices may include Random Access Memory (RAM) and Read Only Memory (ROM). The computer or processor further may include a storage device, which may be a hard disk drive or a removable storage drive such as a floppy disk drive, optical disk drive, solid-state thumb drive, and the like. The storage device may also be other similar means for loading computer programs or other instructions into the computer or processor.

30 As used herein, the term "computer" or "module" or "processor" or "workstation" may include any processor-based or microprocessor-based system including systems using microcontrollers, reduced instruction set computers (RISC), ASICs, logic circuits, and any other circuit or processor capable

of executing the functions described herein. The above examples are exemplary only, and are thus not intended to limit in any way the definition and/or meaning of these terms.

5 The computer or processor executes a set of instructions that are stored in one or more storage elements, in order to process input data. The storage elements may also store data or other information as desired or needed. The storage
10 element may be in the form of an information source or a physical memory element within a processing machine.

 The set of instructions of an ultrasound system including those controlling the acquisition and
15 processing of ultrasound images as described above may include various commands that instruct a computer or processor as a processing machine to perform specific operations such as the methods and processes of the various embodiments of the invention. The set
20 of instructions may be in the form of a software program. The software may be in various forms such as system software or application software and which may be embodied as a tangible and non-transitory computer readable medium. Further, the software may
25 be in the form of a collection of separate programs or modules such as ones executing the simulation and processing of the equations of the reverberation signal processor described above. The software also may include modular programming in the form of
30 object-oriented programming. The processing of input data by the processing machine may be in response to operator commands, or in response to results of previous processing, or in response to a request made by another processing machine.

35 Furthermore, the limitations of the following claims are not written in means-plus-function format

and are not intended to be interpreted based on 35
U.S.C. 112, sixth paragraph, unless and until such
claim limitations expressly use the phrase "means
for" followed by a statement of function devoid of
5 further structure.

WHAT IS CLAIMED IS:

1. A method for conducting an ultrasonic image-guided procedure using an ultrasound system with an ultrasound image display mounted on a distal end of an articulating arm, comprising:
- 5 positioning the ultrasound system on a first side of a patient table;
- extending the articulating arm over the patient table toward a clinician position on a second side of the patient table; and
- 10 positioning the ultrasound image display for viewing from the clinician position.
2. The method of Claim 1, wherein extending the articulating arm further comprises articulating middle and upper articulating arm segments.
3. The method of Claim 2, wherein articulating middle and upper articulating arm segments further comprises articulating middle and upper articulating arm segments about first and second articulation joints.
- 20
4. The method of Claim 3, wherein extending the articulating arm further comprises pivoting a lower articulating arm segment about a vertical axis.
- 25
5. The method of Claim 3, wherein articulating middle and upper articulating arm segments further comprises pivoting the middle and upper articulating arm segments about vertical axes of first and second articulation joints.
- 30
6. The method of Claim 3, wherein articulating middle and upper articulating arm segments further
- 35

comprises raising or lowering the middle and upper articulating arm segments with respect to the patient table.

5 7. The method of Claim 1, wherein positioning the ultrasound image display further comprises raising or lowering the ultrasound image display with respect to the patient table.

10 8. The method of Claim 7, wherein positioning the ultrasound image display further comprises tilting the ultrasound image display upward or downward.

15 9. The method of Claim 8, wherein positioning the ultrasound image display further comprises adjusting the position of the ultrasound image display with respect to the patient table from the clinician position.

20 10. The method of Claim 1, wherein the ultrasound image display further comprises a touchscreen display, and further comprising:
 controlling the operation of the ultrasound
25 system using the touchscreen display.

 11. The method of Claim 10, wherein controlling the operation of the ultrasound system further comprises touching touch points on the touchscreen
30 display.

 12. The method of Claim 11, wherein controlling the operation of the ultrasound system further comprises touching touch points on the touchscreen
35 display from the clinician position.

1/6

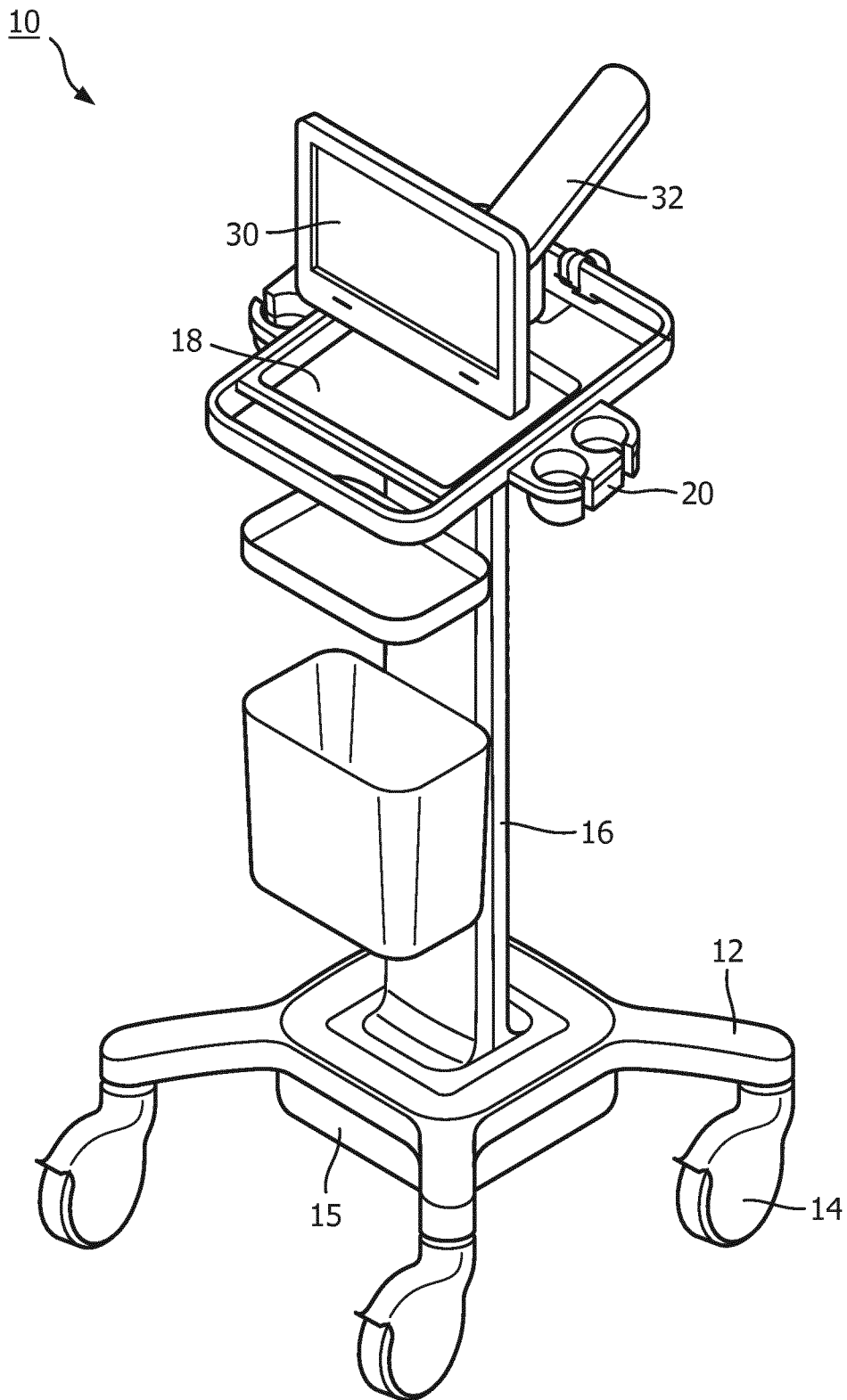


FIG. 1

2/6

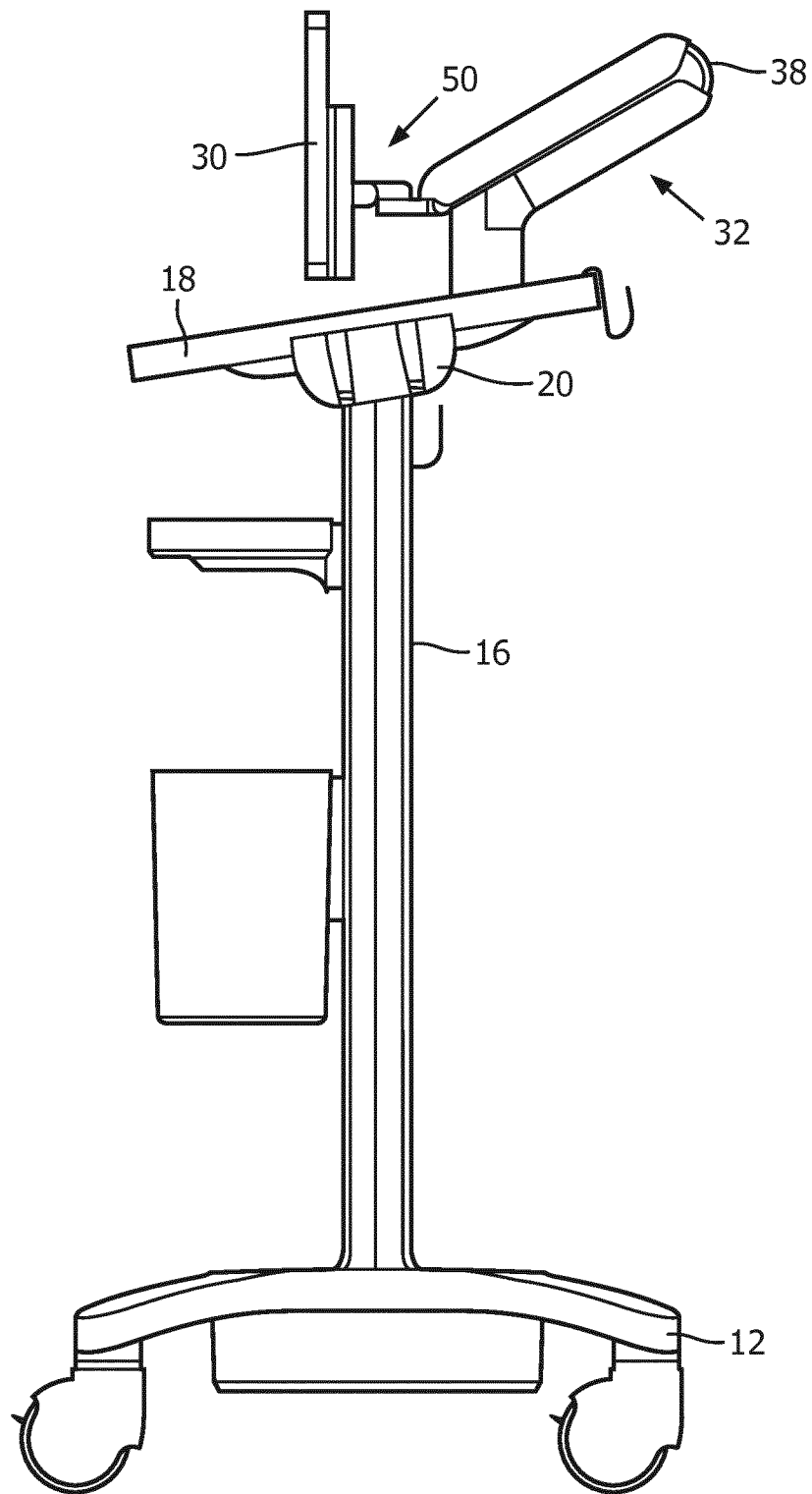


FIG. 2

3/6

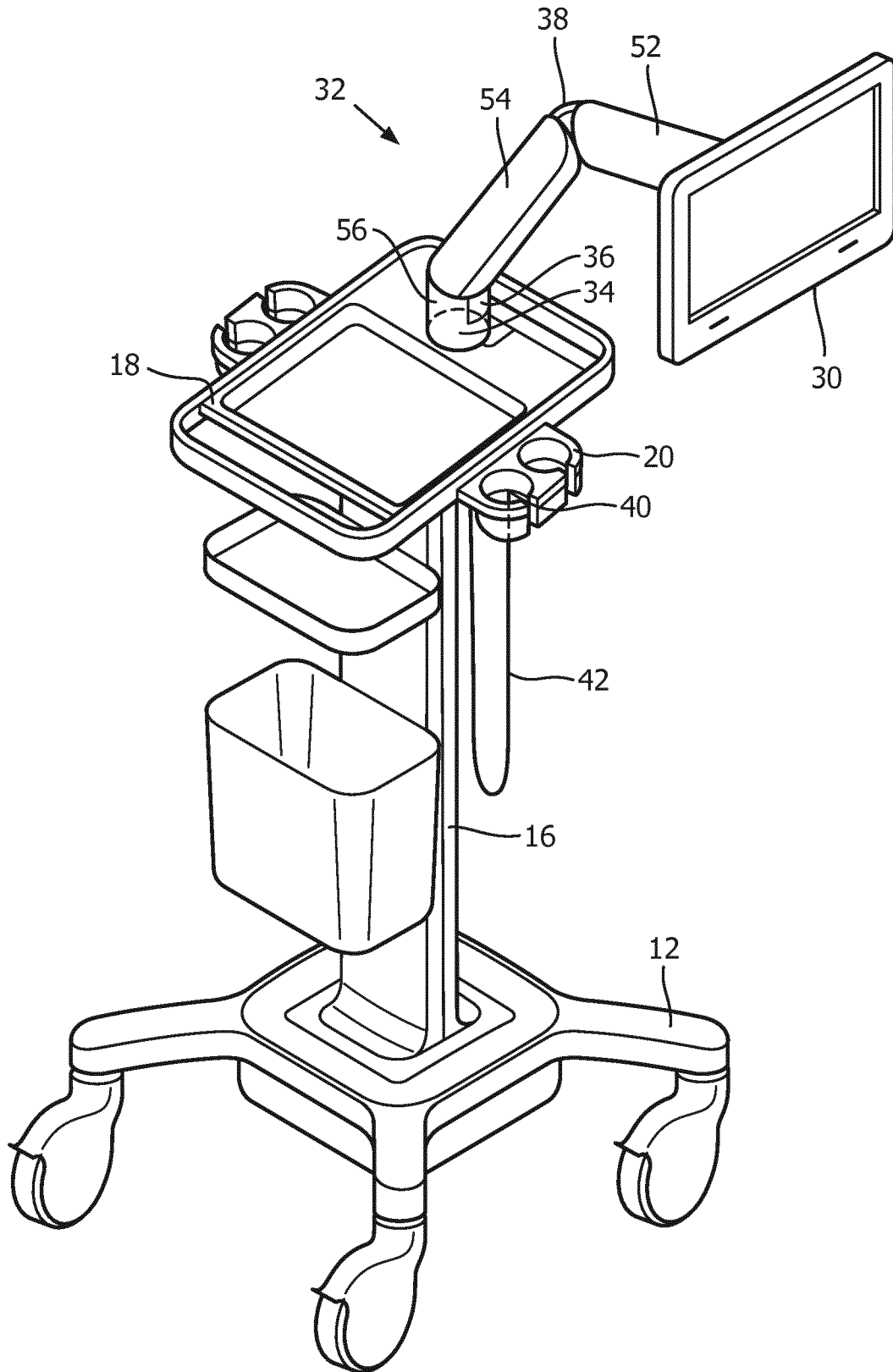


FIG. 3

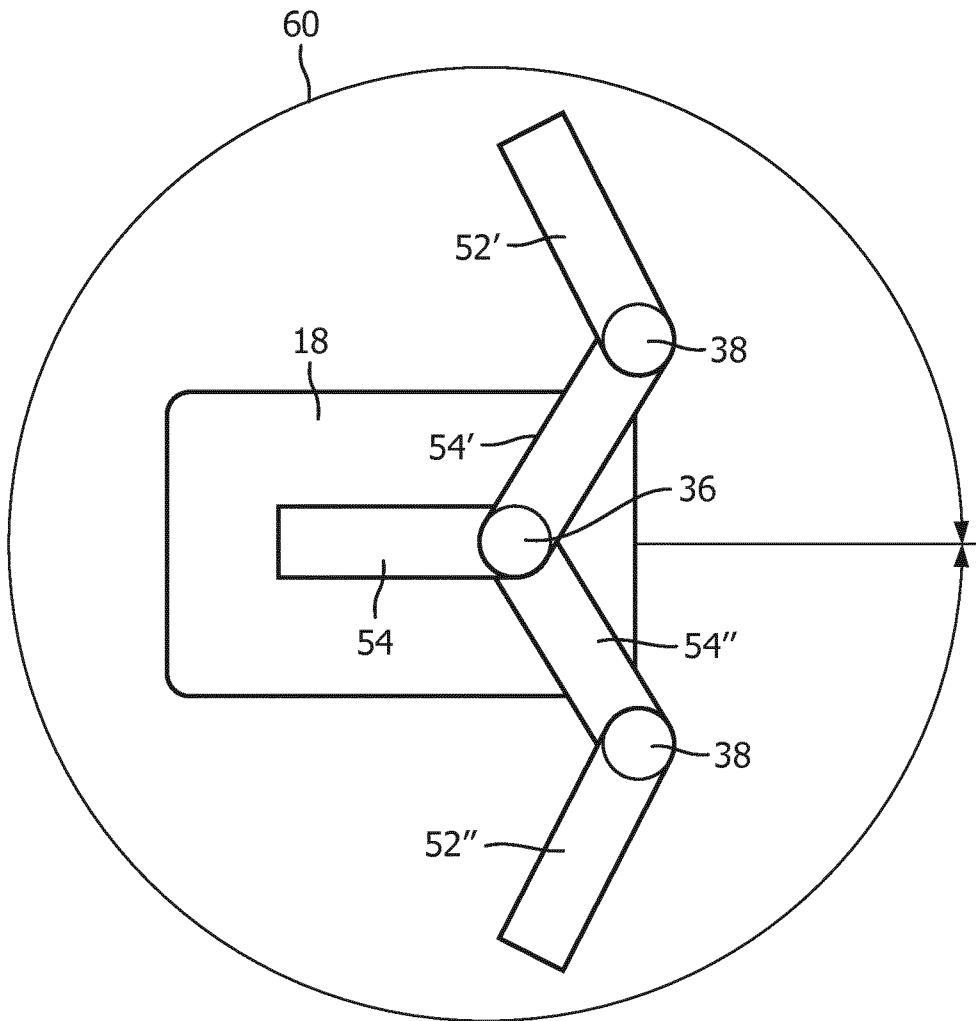


FIG. 4

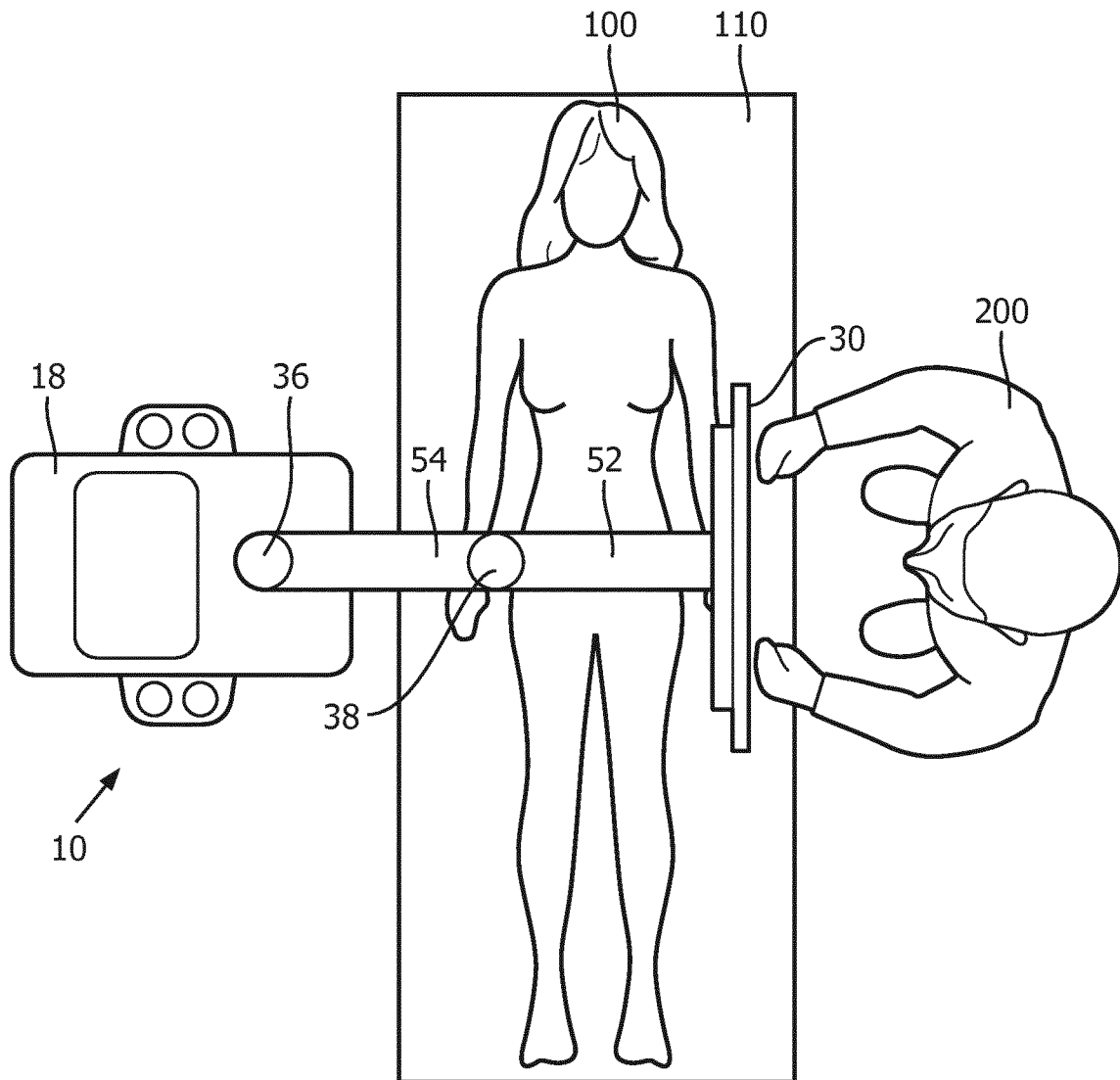


FIG. 5

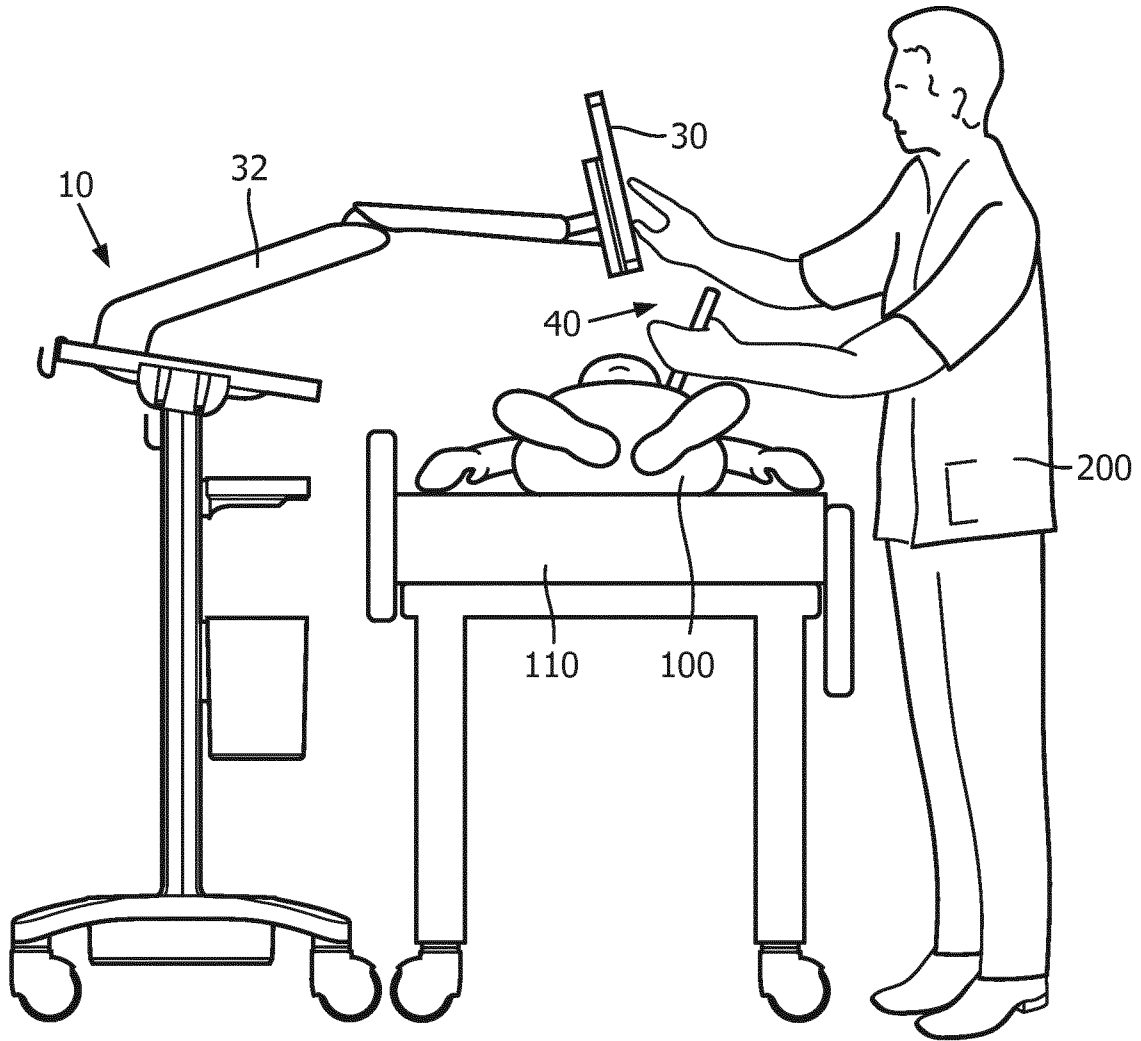


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/058417

A. CLASSIFICATION OF SUBJECT MATTER INV. A61B8/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) A61B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 716 167 B1 (HENDERSON RICHARD W [US] ET AL) 6 April 2004 (2004-04-06) column 3, lines 29-32 column 4, lines 36-43, 65-66 figures 1,6	1
X	----- US 2010/004539 A1 (CHEN JIAYU [US] ET AL) 7 January 2010 (2010-01-07) paragraphs [0006], [0018], [0035] figures 1,9 -----	1-12
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search <p align="center">5 June 2018</p>	Date of mailing of the international search report <p align="center">13/06/2018</p>	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer <p align="center">Willig, Hendrik</p>	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2018/058417

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6716167	B1	06-04-2004	NONE

US 2010004539	A1	07-01-2010	NONE

专利名称(译)	诊断性超声成像的程序		
公开(公告)号	EP3606436A1	公开(公告)日	2020-02-12
申请号	EP2018718726	申请日	2018-04-03
[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N.V.		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	MESAROS ROBERT PAI SHRUTI		
发明人	MESAROS, ROBERT PAI, SHRUTI		
IPC分类号	A61B8/00		
CPC分类号	A61B8/00 A61B8/4405 A61B8/462		
代理机构(译)	飞利浦知识产权及标准		
优先权	62/481014 2017-04-03 US		
外部链接	Espacenet		

摘要(译)

描述了用于进行超声图像引导的侵入性过程的超声诊断成像系统 (10) 和方法。具有位于铰接式显示臂 (32) 的远端的触摸屏显示器 (30) 的超声系统位于患者台 (110) 的一侧。执行该过程的临床医生位于患者床的另一侧。通过铰接臂的铰接, 触摸屏显示器在患者工作台上延伸。触摸屏显示器的位置由临床医生调整, 以便在临床医生前面和患者床上方获得最佳观看效果。