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(54) IMMUNITY FROM MAGNETIC DISTURBANCE FOR A MAGNETIC LOCATION TRACKER

IMMUNITÄT GEGEN MAGNETISCHE STÖRUNG FÜR EINEN MAGNETISCHEN POSITIONSVERFOLGER

IMMUNITÉ CONTRE LES PERTURBATIONS MAGNÉTIQUES POUR UN SUIVEUR DE LOCALISATION MAGNÉTIQUE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to magnetic tracking systems, and specifically to counteracting disturbances in the magnetic field produced by the systems.

BACKGROUND OF THE INVENTION

[0002] Particularly in nasal sinus surgery, positioning of instruments during the surgery is critical due to the proximity of the sinuses to sensitive features such as the brain and the optic nerves. Various methods are known in the patent literature for facilitating positioning of such instruments.

[0003] For example, U.S. Patent Application 2012/0265094 (U.S. Patent 9,468,362), to Goldfarb et al., describes a method that is useable to facilitate transnasal insertion and positioning of a guidewire. The method involves direct viewing of the guidewire via an endoscope.

[0004] U.S. Patent Application 2012/0078118(U.S. Patent 9,155,492), to Jenkins et al., describes an illuminating guidewire device. The disclosure states that the device may be employed to provide trans-illumination, and may facilitate visualization of target anatomy.

[0005] U.S. Patent 6,246,231, to Ashe, describes a magnetic field position and orientation measurement system. The system is stated to contain, confine and redirect the magnetic field from one or more transmitters such that the fields are attenuated in areas outside of the operating volume in areas where metallic objects are commonly found.

[0006] WO 01/69594 discusses a distortion immune magnetic field generator for magnetic tracking systems, which includes a plurality of magnetic field generators; a layer of magnetic material; and a layer of conductive, nonmagnetic material, and method of generating magnetic fields.

SUMMARY OF THE INVENTION

[0007] An embodiment of the present invention provides an apparatus and a method according to the appended claims.

[0008] The present disclosure will be more fully understood from the following detailed description of the embodiments thereof, taken together with the drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is a schematic illustration of a sinus surgery system;

Fig. 2 is a schematic perspective illustration of a magnetic radiator assembly used in the system of Fig. 1, according to an embodiment of the present invention; and

Fig. 3 is a schematic exploded cross-section of the assembly, according to embodiments of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

OVERVIEW

[0010] Magnetic tracking systems, wherein magnetic fields are radiated into a volume, and the fields induce signals in a magnetic sensor located in the volume, are well known in the tracking arts. The signals from the sensor may be used to track locations of the sensor in the volume. Such systems are often used in tracking the position and orientation of invasive probes used in surgery, particularly where other forms of tracking, such as viewing with an endoscope, are inconvenient or even impossible.

[0011] However, particularly in surgery situations, the systems are prone to error because the magnetic fields used for the tracking may be altered by the presence and/or introduction of metallic objects into, or even fairly close to, the volume. Since the magnetic fields are alternating, the errors may be caused by the introduction of ferromagnetic or non-ferromagnetic metals, because the eddy currents induced in the latter change the magnetic fields. In a surgery situation the error introduction may present a critical problem, since even an error of 1 mm in the location of a tool used for an invasive procedure may lead to a possibly tragic result.

[0012] Embodiments of the present invention provide a magnetic tracking assembly that is substantially immune to the introduction of metals. The assembly comprises a ferromagnetic sheet which is mounted in proximity to at least one radiator, typically a plurality of radiators held in a frame. The radiators radiate a magnetic field into a region in proximity to the ferromagnetic sheet. A solid sheet of thermal insulation is mounted between the radiators and the ferromagnetic sheet, so as to prevent the transfer of thermal energy from the radiators to the ferromagnetic sheet.

[0013] Mounting the ferromagnetic sheet in proximity to the radiators alleviates the deleterious effects on the radiated magnetic field, caused by introduction of extraneous metals to the side of the sheet opposite to that of the radiators. However, in operation the radiators generate heat, and, absent the separate sheet of thermal insulation, the heat transfers to the ferromagnetic sheet, raises its temperature, and thereby changes its characteristics. Changes of the characteristics negatively affect the operation of the assembly by, for example, causing a calibration of the assembly to become invalid.

[0014] Mounting the thermal insulation sheet between the radiators and the ferromagnetic sheet prevents the generated heat of the radiators transferring to the ferromagnetic sheet, so that the temperature of the ferromagnetic sheet remains substantially constant during operation of the radiators. By keeping the temperature of the ferromagnetic sheet substantially constant, the characteristics of the sheet remain unchanged, so that operation of the assembly is unaffected.

SYSTEM DESCRIPTION

[0015] Reference is now made to Fig. 1, which is a schematic illustration of a sinus surgery system 20, to Fig. 2, which is a schematic perspective illustration of a magnetic radiator assembly 24 used in the system, and to Fig. 3, which is a schematic exploded cross-section of the assembly, according to embodiments of the present invention. By way of example and for clarity, in the following description surgery system 20 is assumed to be used for a nasal sinus procedure performed on a patient 22, so that in this case magnetic radiator assembly 24 is positioned beneath the patient's head, and on a bed 25 supporting the patient, prior to the procedure. However, alternate positions and other configurations of assembly 24 for other invasive procedures performed on patient 22 will be apparent to those having ordinary skill in the art. Assembly 24, described in more detail below, comprises magnetic field radiators 26 which transmit alternating sinusoidal magnetic fields into a region 30 wherein the head of patient 22 is located. During the procedure a probe 28, comprising a magnetic sensor 32 at a distal end 34 of the probe, is inserted via a nostril of the patient into one of the patient's sinuses. The signals induced in the sensor in response to its interaction with the magnetic fields enable the position of distal end 34 to be tracked within the patient, once assembly 24 has been calibrated. The Carto® system produced by Biosense Webster, of Diamond Bar, CA, uses a system similar to that described herein for finding the location and orientation of a coil in a region irradiated by magnetic fields.

[0016] Elements of system 20, including radiators 26, may be controlled by a system processor 40, comprising a processing unit communicating with one or more memories. Processor 40 may be mounted in a console 50, which comprises operating controls 58 that typically include a keypad and/or a pointing device such as a mouse or trackball. Console 50 connects to the radiators via a cable 60, and also connects to other elements of system 20, such as a proximal end 52 of probe 28. A physician 54 uses the operating controls to interact with the processor while performing the procedure, and the processor may present results produced by system 20 on a screen 56.

[0017] Processor 40 uses software stored in a memory of the processor to operate system 20. The software may be downloaded to processor 40 in electronic form, over a network, for example, or it may, alternatively or additionally, be provided and/or stored on non-transitory tangible media, such as magnetic, optical, or electronic memory.

[0018] Processor 40 uses the software, *inter alia,* to operate magnetic radiators 26 of assembly 24. As stated above the radiators transmit sinusoidal alternating magnetic fields of different frequencies into region 30, including the head of patient 22, and the fields from the radiators induce signals in sensor 32. The processor analyzes the signals to derive location and orientation values, measured with respect to a frame of reference defined by the assembly, for the sensor and thus for the distal end of probe 28.

[0019] In order to accommodate movements of the patient's head during the procedure, one or more magnetic field sensors (not shown in the figures) are fixed to the patient's head, and processor 40 uses the signals from these "head" sensors to derive location and orientation values for the patient's head. The head sensors define a frame of reference of the patient's head, and the processor is configured to use the head sensor signals to register the two frames of reference, so that the location and orientation of the probe distal end is known with respect to the patient's head.

[0020] In prior art magnetic tracking systems the magnetic fields produced by the radiators of the prior art systems may be influenced by the presence, introduction, or removal of extraneous ferromagnetic and non-ferromagnetic materials in the vicinity of the radiators, or in the vicinity of the region into which the radiators are radiating their fields. Embodiments of the present invention substantially reduce the effects of extraneous materials on the magnetic fields of radiators 26 by incorporating the radiators into assembly 24.

[0021] Assembly 24 comprises a ferromagnetic sheet 70, having a thickness denoted by "a", and which typically comprises a "soft" magnetic material having a high initial permeability and a low coercivity that is lower than or equal to 2 Oersted. In one embodiment a = 2 mm and the ferromagnetic sheet comprises a sheet of galvanized iron, having an initial permeability of several thousand and a coercivity of approximately 2 Oersted. The inventors believe that other high initial permeability/low coercivity ferromagnetic materials are suitable materials for sheet 70. A typical range of values of thickness "a" for sheet 70 is between 1 mm and 5 mm, although in some embodiments sheet 70 has a thickness outside this range. Ferromagnetic sheet 70 has an upper surface 76.

[0022] Radiators 26 are incorporated into a frame 72, which is typically in the shape of a horseshoe for procedures that are on the head of patient 22. As shown in Fig. 3, frame 72 is assumed to have a thickness denoted by "c", and the center of radiators 26 is assumed to be a distance "d" from a base 74 of the frame. The horseshoe shape fits around the patient's head while enabling radiators 26 to be placed in proximity to the patient, and while still allowing the patient's head to recline on bed 25. Alternative shapes for frame 72, for invasive procedures on different portions of patient 22, such as on the patient's heart, will be apparent to those having ordinary skill in the art. Frame 72 is typically formed from an electrical insulator such as a polycarbonate material. The frame typically has a low coefficient of expansion and a high rigidity, since, as described below, once a distance between the radiators in the frame and the ferromagnetic sheet has been set, the distance should stay as constant as possible. In one embodiment frame 72 is constructed in two separate halves, each half having a horseshoe shape. The two separate halves allow radiators 26 to be inserted into one of the halves. Once the radiators have been inserted and connected to driving cable 60, the two halves are connected together, so that radiators 26 are completely enclosed in the frame. In a disclosed embodiment frame 72 has an overall width of approximately 35 cm, an overall length of approximately 40 cm, and a thickness, "c" in Fig. 3, of approximately 3 cm.

[0023] There are five radiators 26, each radiator comprising a set of three coils having axes which are mutually orthogonal. Using five radiators improves the accuracy of the location determined by assembly 24, compared to using fewer, such as three, radiators. In an embodiment the coils are wound on rectangular air-cored bobbins having dimensions of 50 mm width × 50 mm length × 23 mm depth; the bobbins are typically centralized within frame 72, so that "d" in Fig. 3, the distance from the center of the radiators to the base of the frame, is approximately 1.5 cm. In the one embodiment referred to above the radiators are connected to driving cable 60, and are then inserted into frame 72 as described above.

[0024] Each coil in a given radiator 26 may be driven, by processor 40, at a frequency that is unique to the coil. Typically the frequencies at which the coils are driven are of the order of 20 KHz, but other driving frequencies may be used. As stated above, the radiators induce signals of corresponding frequencies in sensor 32, and the unique frequency of each coil in radiators 26 enables the processor to identify which coil of the radiators is producing the corresponding signal in the sensor.

[0025] In embodiments of the present invention the distance from radiators 26 to face 76 is set so that the magnetizing field H at the sheet from a given coil never saturates the sheet. I.e., ferromagnetic sheet 70 operates in an unsaturated manner.

[0026] The alternating magnetic field from a given coil in radiators 26 induces a respective magnetic image of the coil in ferromagnetic sheet 70, and the magnetic image in turn acts as a magnetic field radiator. Because sheet 70 operates in an unsaturated region of its B-H curves, (B is the magnetic field and H is the magnetizing field) substantially no distortion is introduced into the alternating radiation from the magnetic image compared to the alternating radiation from radiators 26. Thus, the sinusoidal alternating radiation from radiators 26 causes the magnetic images in sheet 70 to transmit undistorted sinusoidal radiating magnetic fields.

[0027] For any given radiator coil and its image the two sinusoidal fields add, as will be understood by those with ordinary skill in the art, to a composite sinusoidal field having a composite source location intermediate the locations of the radiator coil and its image. The distance from radiators 26 to sheet 70 is typically set within a range of 1 cm - 5 cm, although distances outside this range are possible. In embodiments of the present invention the distance is set, as stated above, so that the magnetizing field H at the sheet from a given coil introduces a distortion into the sinusoidal field radiation from the image that is less than 0.1%.

[0028] Once the distance is set, the calibration of assembly 24 referred to above may be performed. The calibration generates, *inter alia,* respective positions for the composite source locations of each coil and its image. However, the inventors have determined that the calibration of assembly 24 is dependent on the temperature of ferromagnetic sheet 70, and believe this to be the case because the magnetic characteristics of sheet 70 depend on the material of the sheet, and also on the temperature of the sheet.

[0029] In a disclosed embodiment, the power dissipated by each radiator 26, as its coils are driven by processor 40, is approximately 30 W. A substantial portion of this power is dissipated as thermal energy, leading in turn, absent the presence of a thermal insulator sheet 80, to an increase in temperature of sheet 70 because of the proximity of the radiators to the ferromagnetic sheet.

[0030] The inventors have found that the introduction of a solid sheet of thermal insulation 80, also referred to herein as insulator sheet 80, between radiators 26 and ferromagnetic sheet 70 substantially reduces the thermal energy absorbed by the ferromagnetic sheet, so virtually eliminating any change of temperature of the sheet due to the operation of the radiators. The calibration referred to above thus remains valid. Insulator sheet 80 is assumed to have a thickness of "b". The insulator sheet may be positioned so that frame 24 contacts one face of the sheet, and ferromagnetic sheet 70 contacts the other face of the sheet. In this case there is thus a distance of d + b between the center of radiators 26 and upper surface 76 of ferromagnetic sheet 70.

[0031] In one embodiment insulator sheet 80 is formed of wood, with a thermal conductivity of approximately 0.1 $W{\cdot}m^{-1}{\cdot}K^{-1}$, and the sheet has a thickness b = 3 mm. In an alternative embodiment insulator sheet 80 is formed of carbon fiber sheet, with a thermal conductivity of approximately 0.7 $W{\cdot}m^{-1}{\cdot}K^{-1}$, and the sheet has a thickness b = 2 mm. If, as exemplified above, d = 1.5 cm, then distance d + b is 1.8 cm for wood and 1.7 cm for carbon fiber sheet.

[0032] Insulator sheet 80 acts to prevent transfer of thermal energy from radiators 26 to ferromagnetic sheet 70. Sheet 80 is perforated by one or more holes 82 (Figs. 2 and 3) . Such holes act as good thermal insulators, since there is substantially no convection within the holes.

[0033] The inventors have found that positioning ferromagnetic sheet 70 beneath radiators 26 significantly mitigates the effect, on the magnetic fields in region 30, of the introduction of the extraneous materials referred to above.

[0034] It will be appreciated that the embodiments described above are cited by way of example, and that the present invention is not limited to what has been particularly shown and described hereinabove.

Claims

1. Magnetic tracking assembly (24), comprising,
a ferromagnetic sheet (70);
at least one radiator (26), mounted at a distance of 1 cm to 5cm from the ferromagnetic sheet and configured to radiate a magnetic field into a region in proximity to the ferromagnetic sheet; and
a solid sheet of thermal insulation (80), mounted between the ferromagnetic sheet and the at least one radiator so as to prevent transfer of thermal energy from the at least one radiator to the ferromagnetic sheet,
wherein the solid sheet of thermal insulation comprises a plurality of perforations.

2. A method of providing a magnetic tracking assembly (24), comprising,
providing a ferromagnetic sheet (70);
mounting at least one radiator (26) at a distance of 1cm to 5cm from the ferromagnetic sheet (70) and configuring the at least one radiator to radiate a magnetic field into a region in proximity to the ferromagnetic sheet; and
mounting a solid sheet of thermal insulation (80) between the ferromagnetic sheet and the at least one radiator so as to prevent transfer of thermal energy from the at least one radiator to the ferromagnetic sheet,
wherein the solid sheet of thermal insulation comprises a plurality of perforations.

3. The magnetic tracking assembly according to claim 1 or the method according to claim 2, wherein the solid sheet (80) has a thermal conductivity of no more than 0.7 $W \cdot m^{-1} \cdot K^{-1}$.

4. The magnetic tracking assembly according to claim 1 or the method according to claim 2, wherein the solid sheet (80) comprises wood.

5. The magnetic tracking assembly according to claim 1 or the method according to claim 2, wherein the solid sheet (80) comprises a carbon fiber sheet.

6. The magnetic tracking assembly according to claim 1 or the method according to claim 2, wherein the ferromagnetic sheet (70) comprises galvanized iron.

7. The magnetic tracking assembly according to claim 1 or the method according to claim 2, wherein the ferromagnetic sheet (70) comprises a soft magnetic material having a coercivity less than 2 Oersted.

8. The magnetic tracking assembly according to claim 1 or the method according to claim 2, wherein the magnetic field causes the ferromagnetic sheet (70) to operate in an unsaturated manner.

9. The magnetic tracking assembly according to claim 1 or the method according to claim 2, wherein the at least one radiator (26) comprises a coil generating a magnetic image of the coil in the ferromagnetic sheet (70), and wherein a distance between the ferromagnetic sheet and the at least one radiator is set so that the magnetic image radiates an image magnetic field having a distortion of less than 0.1% of the magnetic field.

10. The magnetic tracking assembly according to claim 1, and comprising an invasive probe (28) having a sensor (32) which generates a signal, indicative of a location of the probe with respect to the at least one radiator (26), in response to the magnetic field.

11. The method according to claim 2, and comprising providing an invasive probe (28) having a sensor (32) which generates a signal, indicative of a location of the probe with respect to the at least one radiator (26), in response to the magnetic field.

Patentansprüche

1. Magnetische Verfolgungsanordnung (24), aufweisend
eine ferromagnetische Platte (70);
mindestens einen Strahler (26), der in einem Abstand von 1 cm bis 5 cm von der ferromagnetischen Platte angebracht ist und konfiguriert ist, ein Magnetfeld in einen Bereich in der Nähe der ferromagnetischen Platte abzustrahlen; und
eine massive Wärmeisolationsplatte (80), die zwischen der ferromagnetischen Platte und dem mindestens einen Strahler angebracht ist, um so eine Übertragung von Wärmeenergie von dem mindestens einen Strahler auf die ferromagnetische Platte zu verhindern,
wobei die massive Wärmeisolationsplatte mehrere Perforationen aufweist.

2. Verfahren zum Bereitstellen einer magnetischen Verfolgungsanordnung (24), aufweisend
Bereitstellen einer ferromagnetischen Platte (70);
Anbringen mindestens eines Strahlers (26) in einem Abstand von 1 cm bis 5 cm von der ferromagnetischen Platte (70) und Konfigurieren des mindestens einen Strahlers, um ein Magnetfeld in einen Bereich

in der Nähe der ferromagnetischen Platte abzustrahlen; und
Anbringen einer massiven Wärmeisolationssplatte (80) zwischen der ferromagnetischen Platte und dem mindestens einen Strahler, um so eine Übertragung von Wärmeenergie von dem mindestens einen Strahler auf die ferromagnetische Platte zu verhindern,
wobei die massive Wärmeisolationsplatte mehrere Perforationen aufweist.

3. Magnetische Verfolgungsanordnung nach Anspruch 1 oder Verfahren nach Anspruch 2, wobei die massive Platte (80) eine Wärmeleitfähigkeit von nicht mehr als 0,7 $W \cdot m^{-1} \cdot K^{-1}$ aufweist.

4. Magnetische Verfolgungsanordnung nach Anspruch 1 oder Verfahren nach Anspruch 2, wobei die massive Platte (80) Holz aufweist.

5. Magnetische Verfolgungsanordnung nach Anspruch 1 oder Verfahren nach Anspruch 2, wobei die massive Platte (80) eine Kohlefaserplatte aufweist.

6. Magnetische Verfolgungsanordnung nach Anspruch 1 oder Verfahren nach Anspruch 2, wobei die ferromagnetische Platte (70) galvanisiertes Eisen aufweist.

7. Magnetische Verfolgungsanordnung nach Anspruch 1 oder Verfahren nach Anspruch 2, wobei die ferromagnetische Platte (70) ein weichmagnetisches Material mit einer Koerzitivfeldstärke von weniger als 2 Oersted aufweist.

8. Magnetische Verfolgungsanordnung nach Anspruch 1 oder Verfahren nach Anspruch 2, wobei das Magnetfeld bewirkt, dass die ferromagnetische Platte (70) in einer ungesättigten Weise arbeitet.

9. Magnetische Verfolgungsanordnung nach Anspruch 1 oder Verfahren nach Anspruch 2, wobei der mindestens eine Strahler (26) eine Spule aufweist, die ein magnetisches Bild der Spule in der ferromagnetischen Platte (70) erzeugt, und wobei ein Abstand zwischen der ferromagnetischen Platte und dem mindestens einen Strahler so eingestellt ist, dass das magnetische Bild ein magnetisches Bildfeld mit einer Verzerrung von weniger als 0,1% des Magnetfeldes ausstrahlt.

10. Magnetische Verfolgungsanordnung nach Anspruch 1, und aufweisend eine invasive Sonde (28) mit einem Sensor (32), der in Antwort auf das Magnetfeld ein Signal erzeugt, das eine Position der Sonde in Bezug auf den mindestens einen Strahler (26) angibt.

11. Verfahren nach Anspruch 2, und aufweisend das Bereitstellen einer invasiven Sonde (28) mit einem Sensor (32), der in Antwort auf das Magnetfeld ein Signal erzeugt, das eine Position der Sonde in Bezug auf den mindestens einen Strahler (26) angibt.

Revendications

1. Ensemble de suivi magnétique (24), comprenant :

une feuille ferromagnétique (70) ;
au moins un radiateur (26), monté à une distance allant de 1 cm à 5 cm de la feuille ferromagnétique et configuré pour émettre un champ magnétique dans une région à proximité de la feuille ferromagnétique ; et
une feuille solide d'isolation thermique (80), montée entre la feuille ferromagnétique et le ou les radiateurs de sorte à empêcher un transfert d'énergie thermique du ou des radiateurs à la feuille ferromagnétique,
dans lequel la feuille solide d'isolation thermique comprend une pluralité de perforations.

2. Procédé de fourniture d'un ensemble de suivi magnétique (24), consistant :

à fournir une feuille ferromagnétique (70) ;
à monter au moins un radiateur (26) à une distance allant de 1 cm à 5 cm de la feuille ferromagnétique (70) et à configurer le ou les radiateurs pour émettre un champ magnétique dans une région à proximité de la feuille ferromagnétique ; et
à monter une feuille solide d'isolation thermique (80) entre la feuille ferromagnétique et le ou les radiateurs de sorte à empêcher un transfert d'énergie thermique du ou des radiateurs à la feuille ferromagnétique,
dans lequel la feuille solide d'isolation thermique comprend une pluralité de perforations.

3. Ensemble de suivi magnétique selon la revendication 1 ou procédé selon la revendication 2, dans lequel la feuille solide (80) présente une conductivité thermique inférieure ou égale à 0,7 $W \bullet m^{-1} \bullet K^{-1}$.

4. Ensemble de suivi magnétique selon la revendication 1 ou procédé selon la revendication 2, dans lequel la feuille solide (80) comprend du bois.

5. Ensemble de suivi magnétique selon la revendication 1 ou procédé selon la revendication 2, dans lequel la feuille solide (80) comprend une feuille de fibres de carbone.

6. Ensemble de suivi magnétique selon la revendica-

tion 1 ou procédé selon la revendication 2, dans lequel la feuille ferromagnétique (70) comprend du fer galvanisé.

7. Ensemble de suivi magnétique selon la revendication 1 ou procédé selon la revendication 2, dans lequel la feuille ferromagnétique (70) comprend un matériau magnétique souple ayant une coercivité inférieure à 2 Oersted.

8. Ensemble de suivi magnétique selon la revendication 1 ou procédé selon la revendication 2, dans lequel le champ magnétique contraint la feuille ferromagnétique (70) à agir de manière insaturée.

9. Ensemble de suivi magnétique selon la revendication 1 ou procédé selon la revendication 2, dans lequel le ou les radiateurs (26) comprennent une bobine générant une image magnétique de la bobine dans la feuille ferromagnétique (70) et dans lequel une distance entre la feuille ferromagnétique et le ou les radiateurs est définie de telle sorte que l'image magnétique émette un champ magnétique d'image ayant une distorsion inférieure à 0,1 % du champ magnétique.

10. Ensemble de suivi magnétique selon la revendication 1, et comprenant une sonde invasive (28) ayant un capteur (32) qui génère un signal, indiquant un emplacement de la sonde par rapport au ou aux radiateurs (26), en réponse au champ magnétique.

11. Procédé selon la revendication 2, et consistant à fournir une sonde invasive (28) ayant un capteur (32) qui génère un signal, indiquant un emplacement de la sonde par rapport au ou aux radiateurs (26), en réponse au champ magnétique.

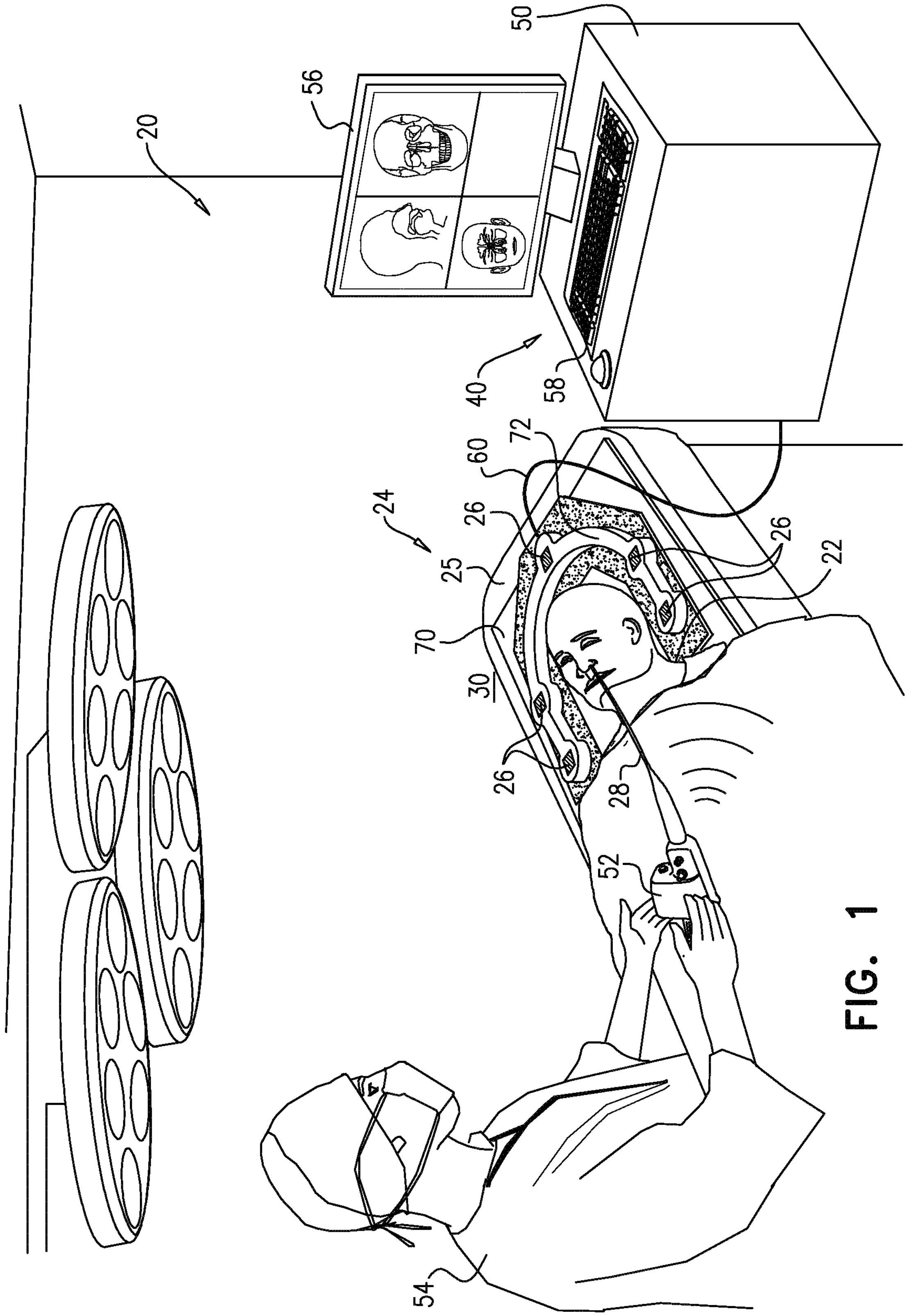

FIG. 1

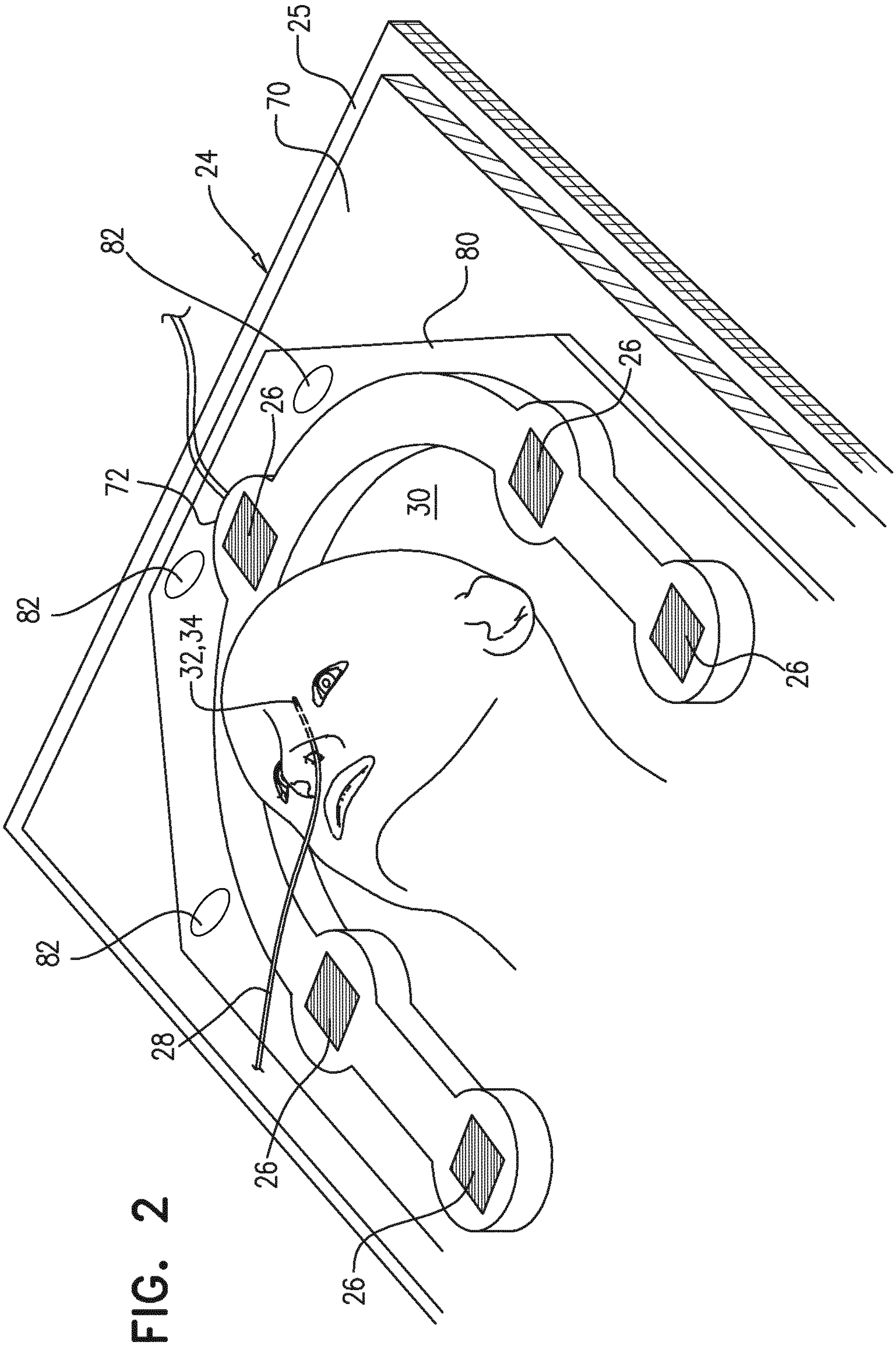

FIG. 2

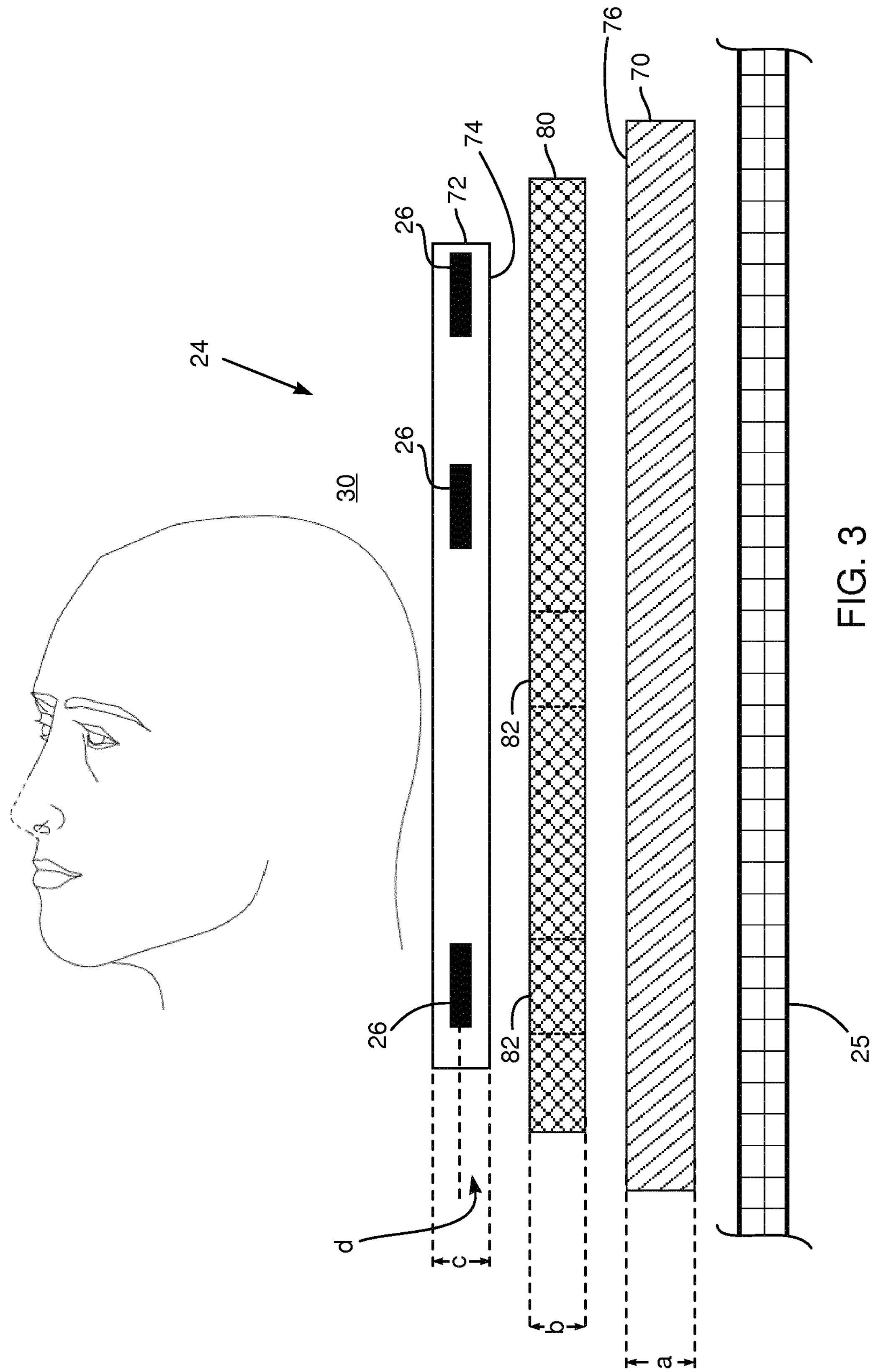

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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- US 20120078118 A **[0004]**
- US 9155492 B **[0004]**
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- WO 0169594 A **[0006]**

专利名称(译)	磁位置跟踪器对磁干扰的免疫力		
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[标]申请(专利权)人(译)	韦伯斯特生物官能(以色列)有限公司		
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外部链接	Espacenet		

摘要(译)

装置，其包括铁磁片和至少一个辐射器，所述装置安装在铁磁片附近并且配置成将磁场辐射到与其接近的区域中。该设备进一步包括安装在铁磁片和至少一个散热器之间的固体绝热片，以防止热能从至少一个散热器传递到铁磁片。

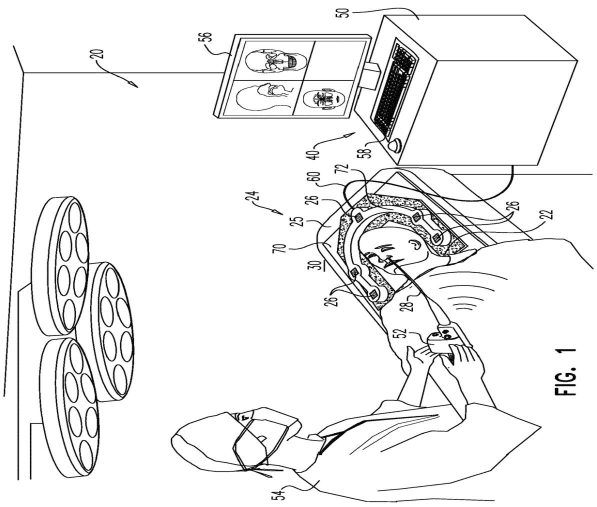

FIG. 1