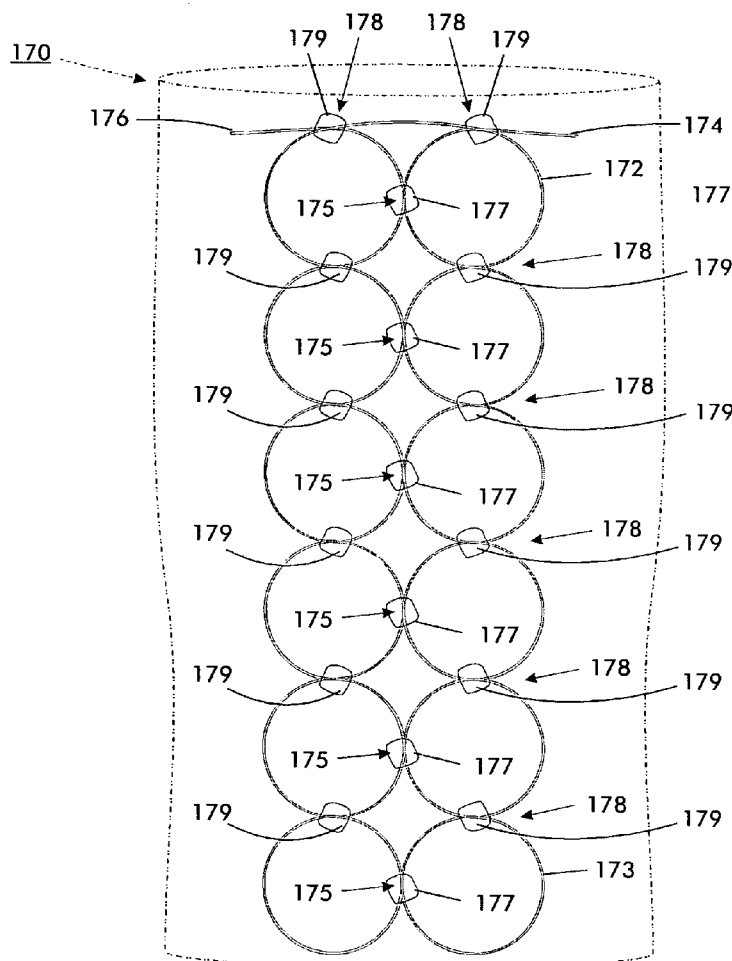




US 20050049688A1

(19) **United States**(12) **Patent Application Publication**
Gray et al.(10) **Pub. No.: US 2005/0049688 A1**(43) **Pub. Date: Mar. 3, 2005**(54) **ELECTROMAGNETIC RADIATION
TRANSPARENT DEVICE AND METHOD OF
MAKING THEREOF****Publication Classification**(51) **Int. Cl.⁷ A61F 2/06**(52) **U.S. Cl. 623/1.16; 600/431**(75) **Inventors: Robert W. Gray, Rochester, NY (US);
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rietta, NY (US)**(21) **Appl. No.: 10/923,293**(22) **Filed: Aug. 20, 2004****Related U.S. Application Data**(60) **Provisional application No. 60/497,591, filed on Aug.
25, 2003.**(57) **ABSTRACT**

A medical device includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially prevents the medical device from creating an imaging artifact and/or substantially allows imaging of a volume within the medical device. The pattern may be formed by multiple "figure-8" shaped electrical conductors, multiple "figure-8" emulating electrical conductors, multiple sine-wave-like shaped electrical conductors, multiple zig-zag patterned electrical conductors, by multiple electrical conductors, each having sequential conductive loops, and/or a single conductor weaved into a loop mesh. The electrically conductive material may be titanium, tantalum, nitinol, stainless steel, and/or NbZr.



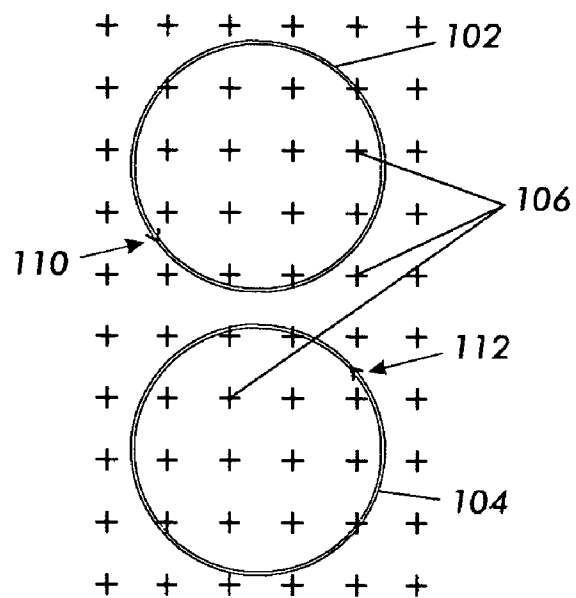


FIG. 1

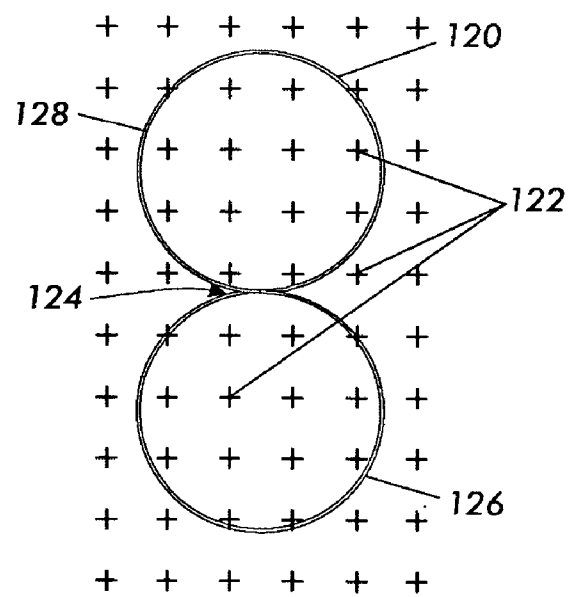


FIG. 2

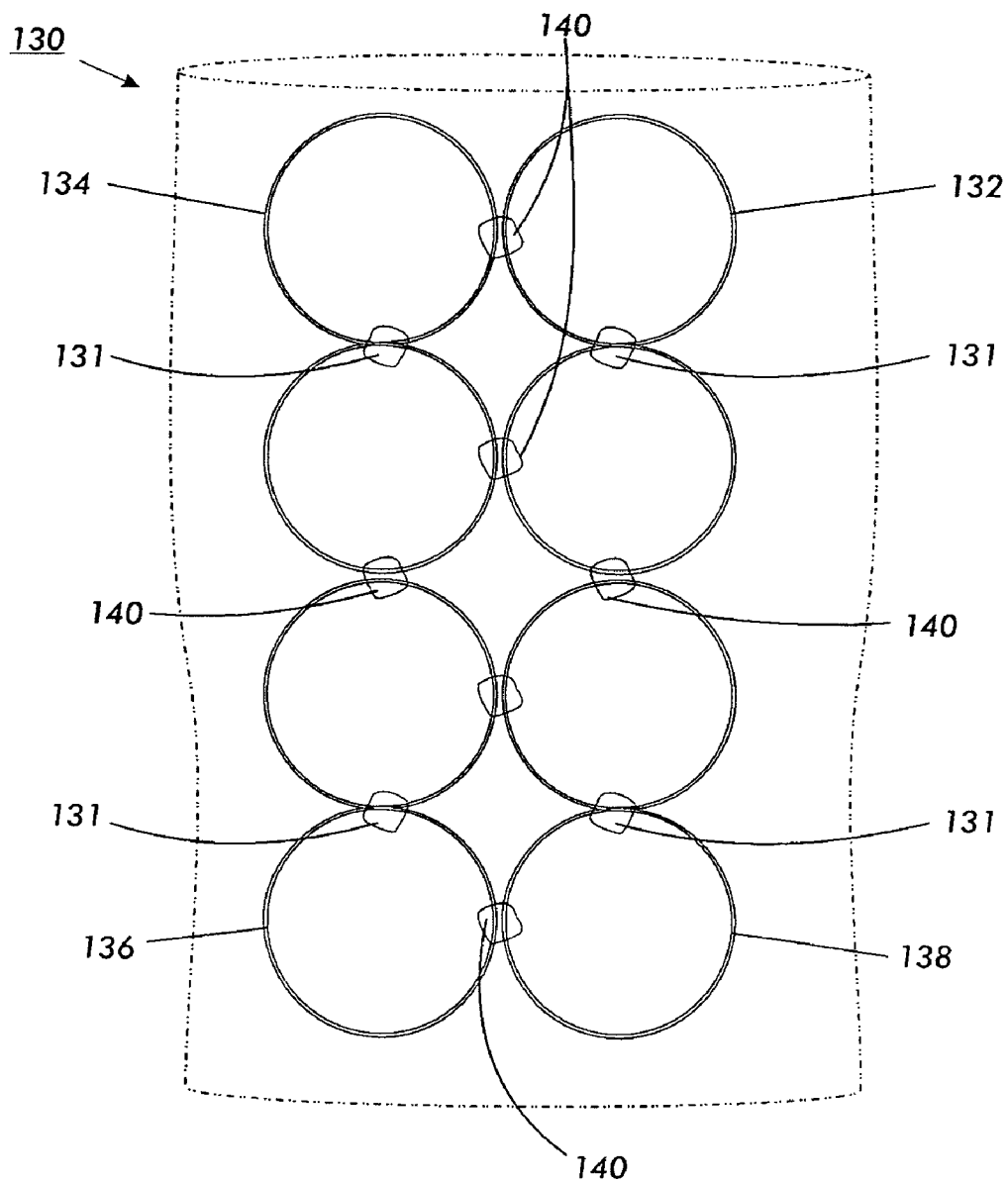


FIG.3

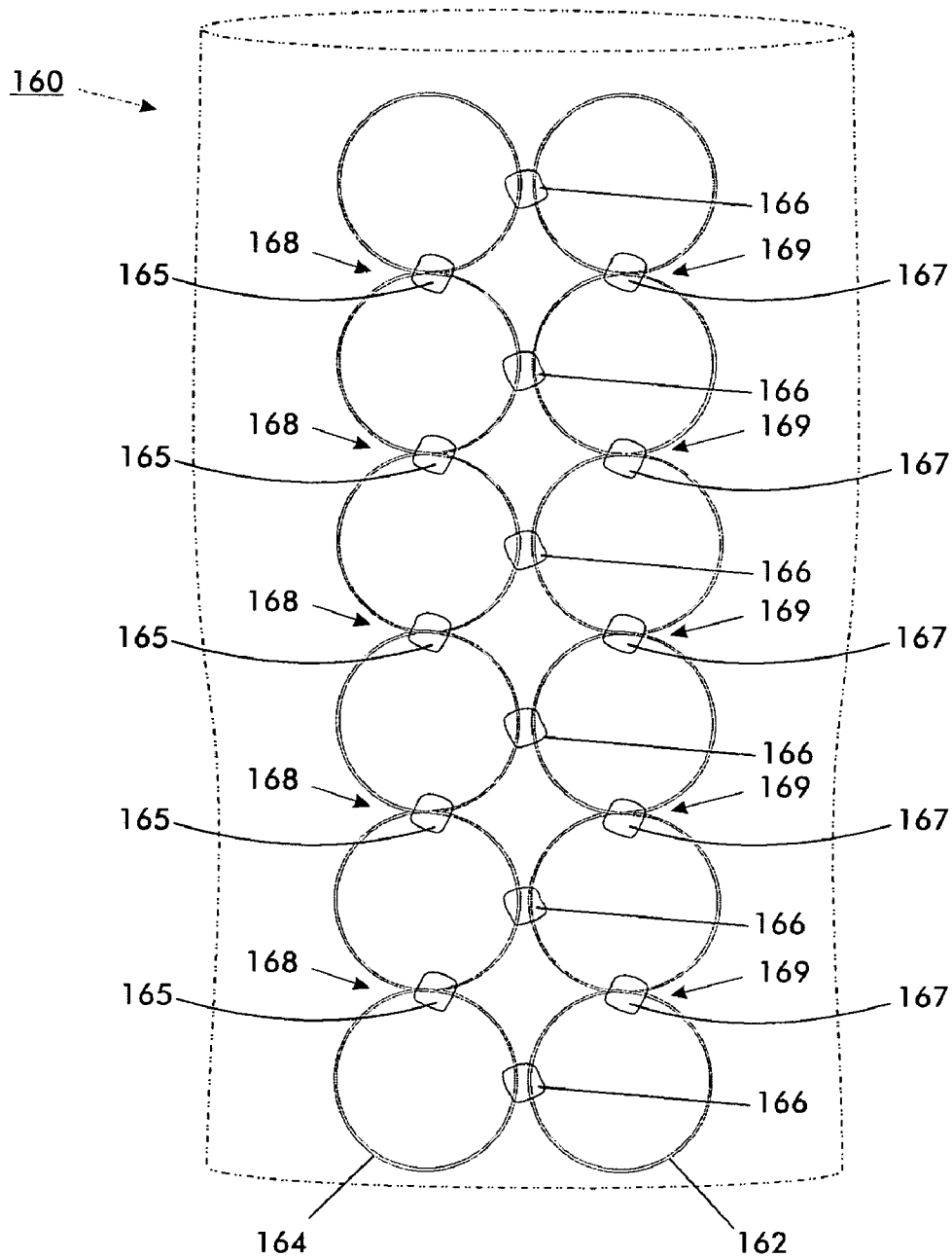


FIG. 4

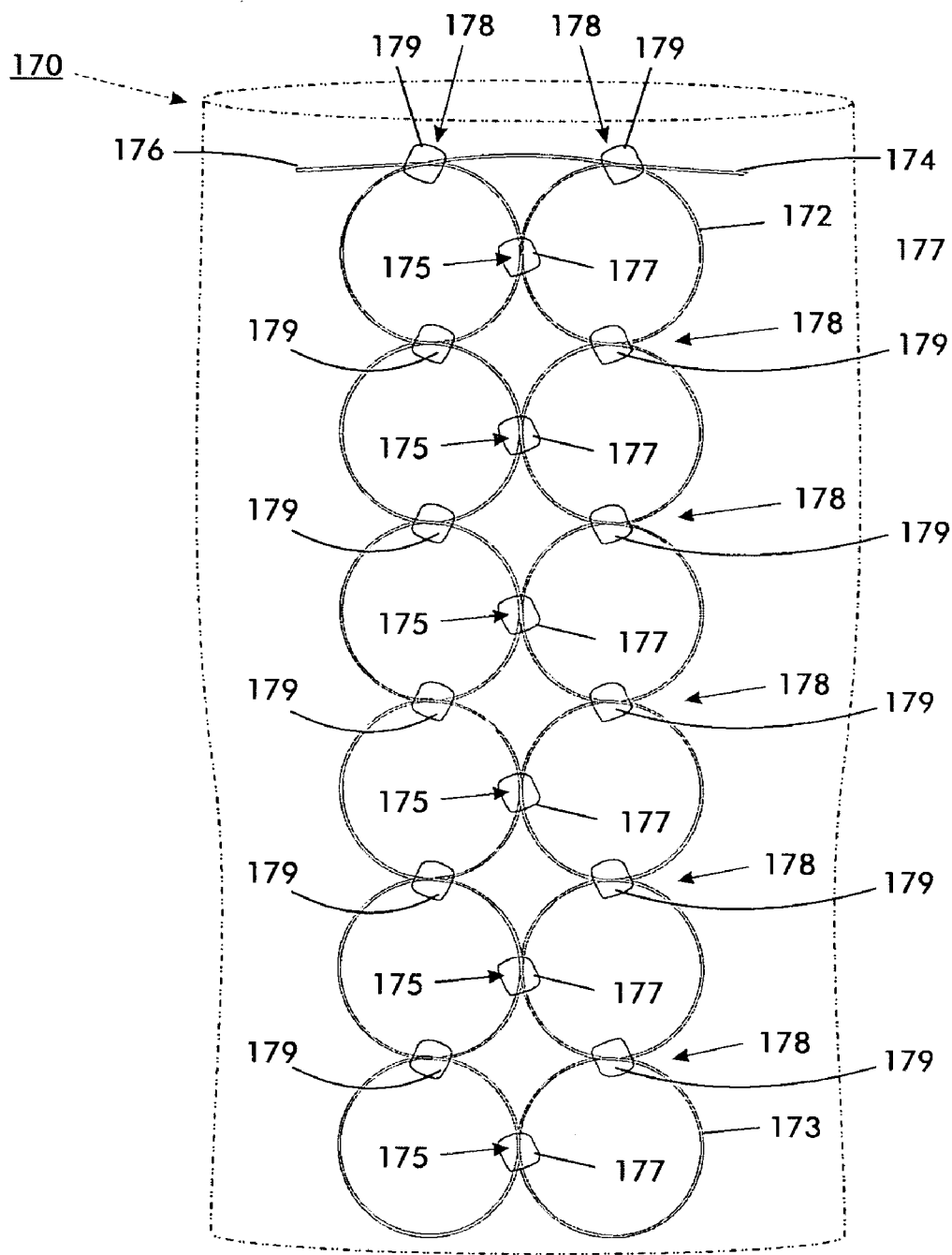


FIG.5

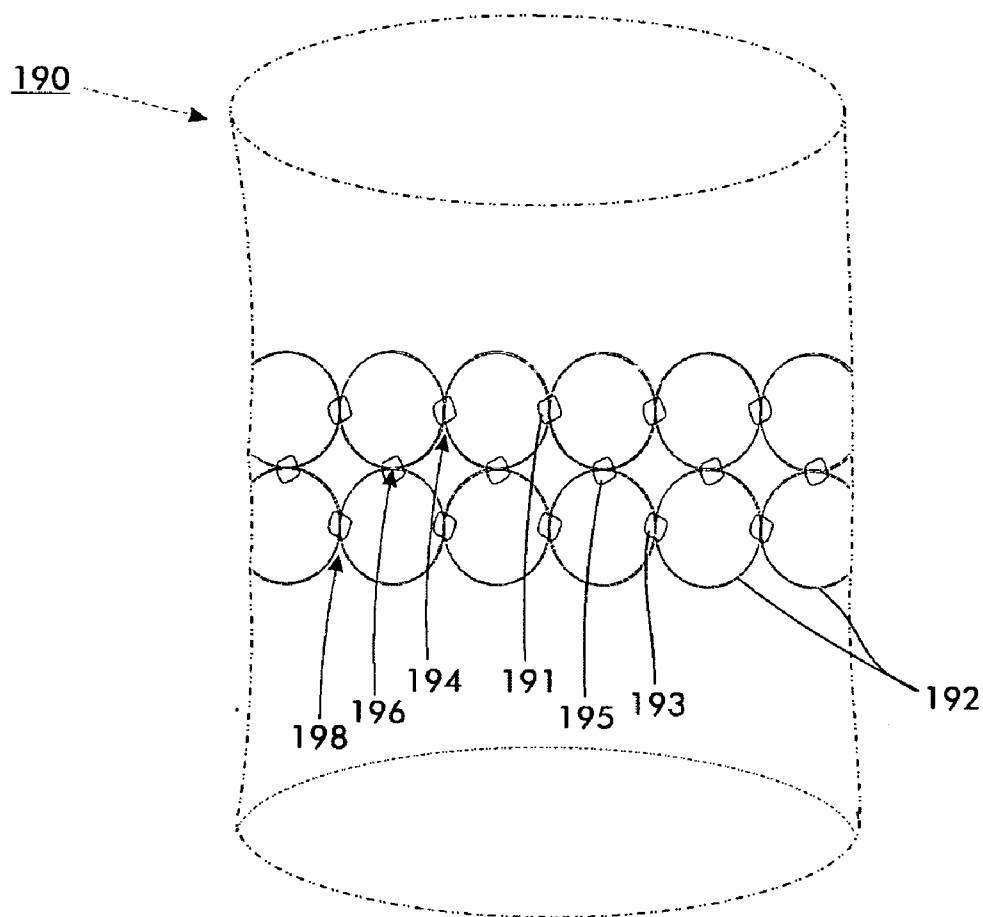


FIG. 6

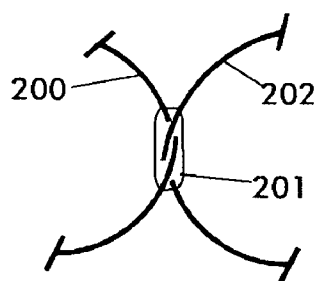


FIG. 7

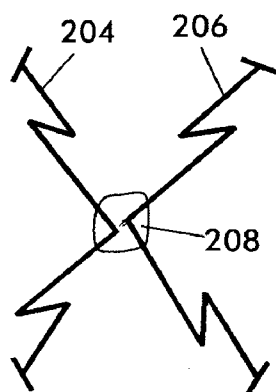


FIG. 8

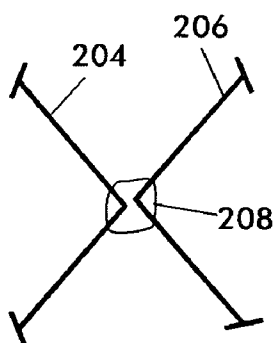


FIG. 9

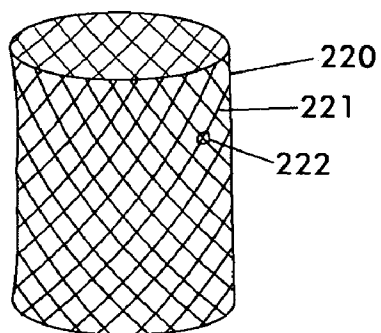


FIG. 10

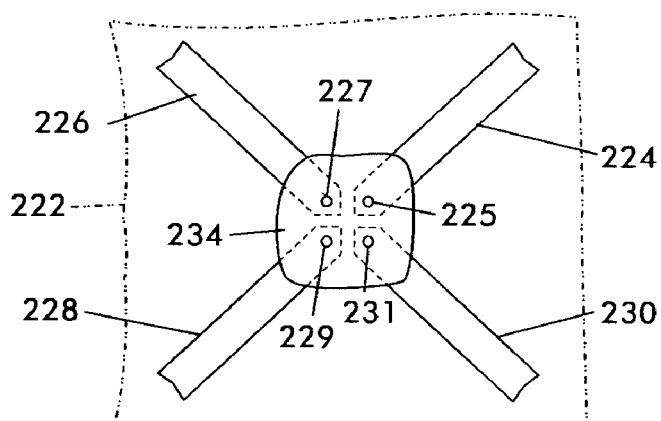


FIG. 11

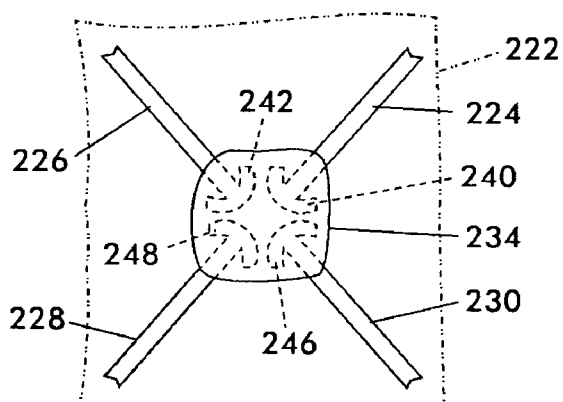


FIG. 12

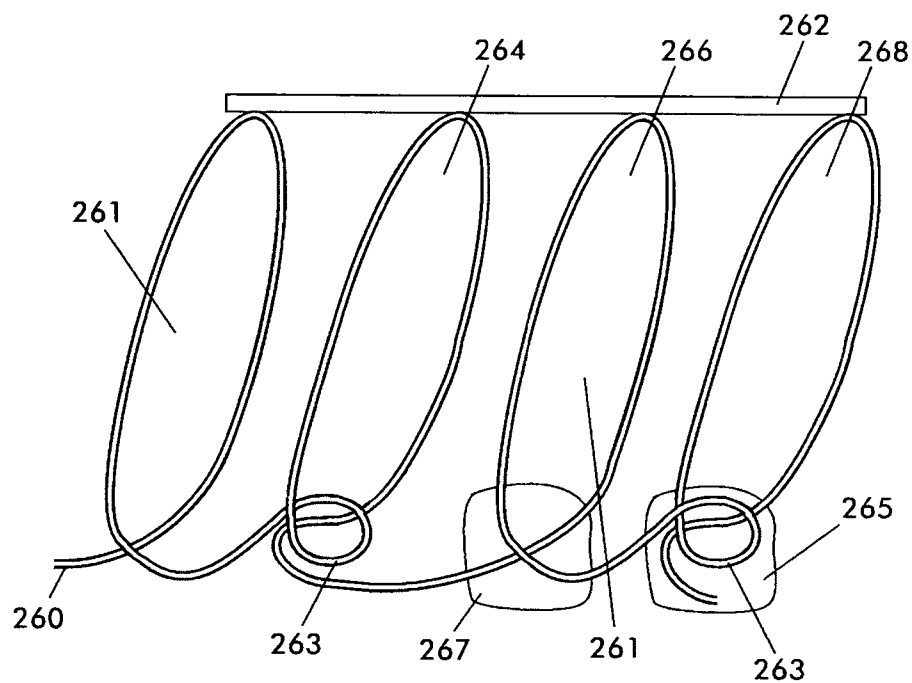


FIG. 13

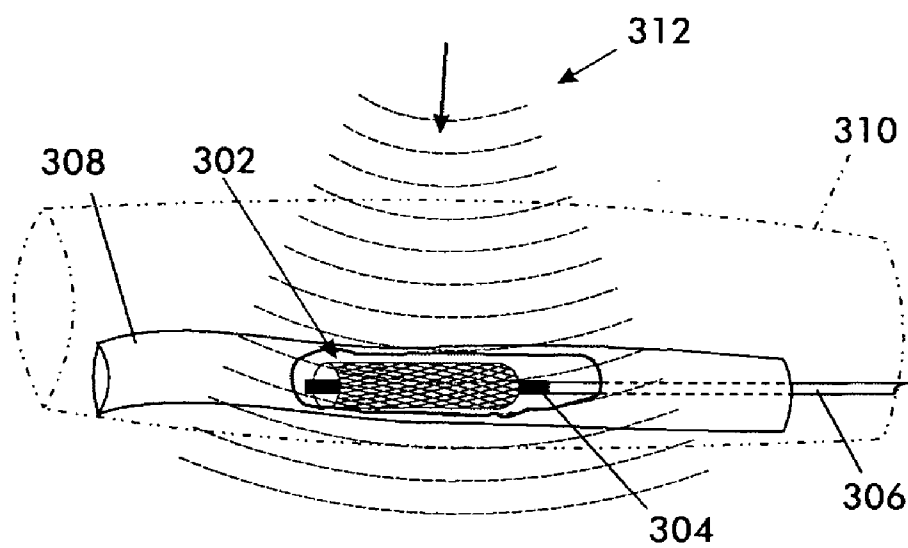


FIG. 14

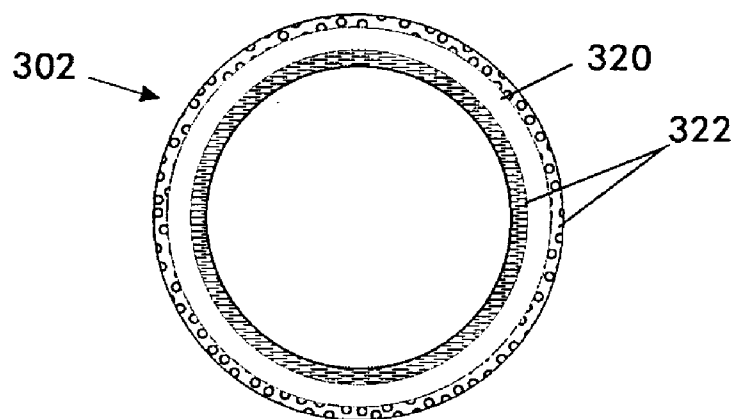


FIG. 15

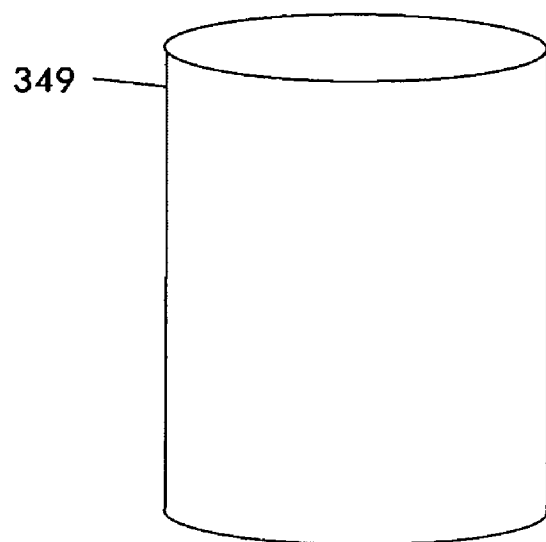


FIG. 16

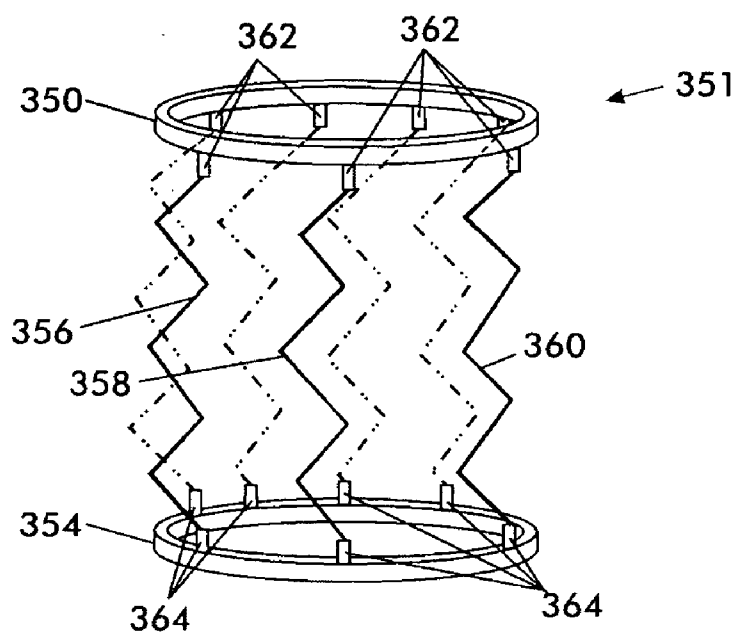


FIG. 17

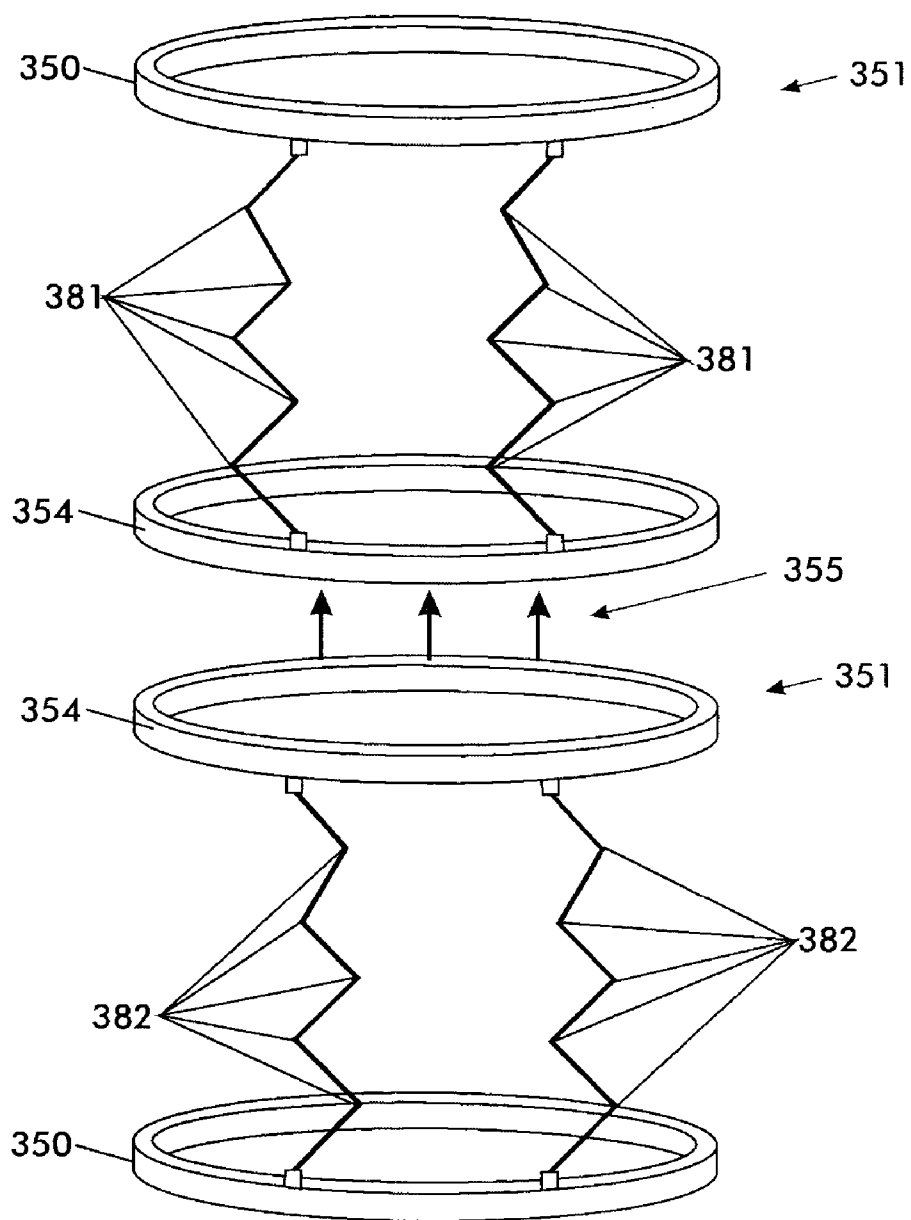


FIG. 18

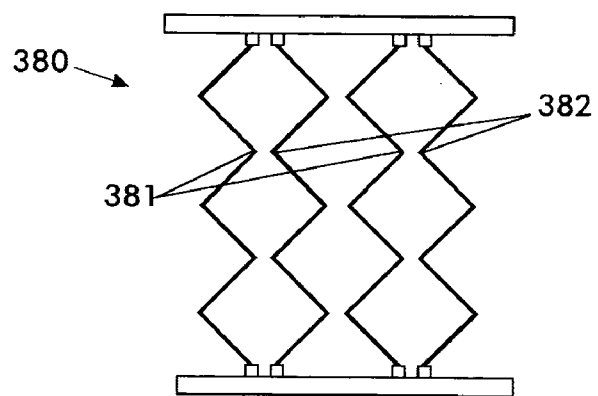


FIG. 19

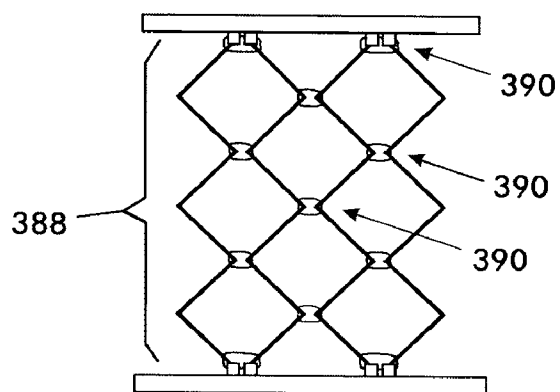


FIG. 20

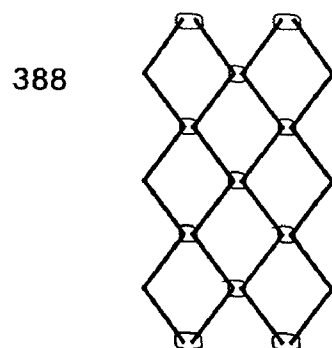


FIG. 21

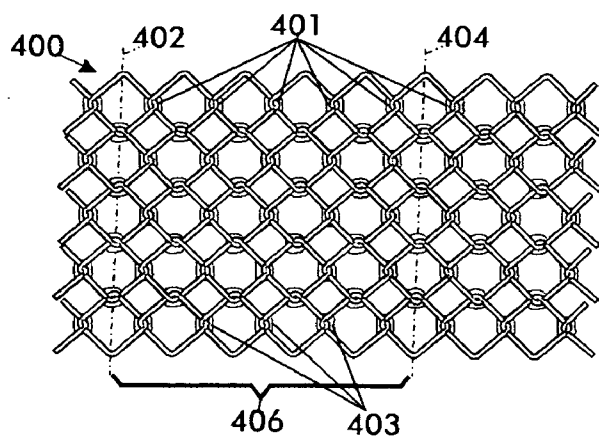


FIG. 22

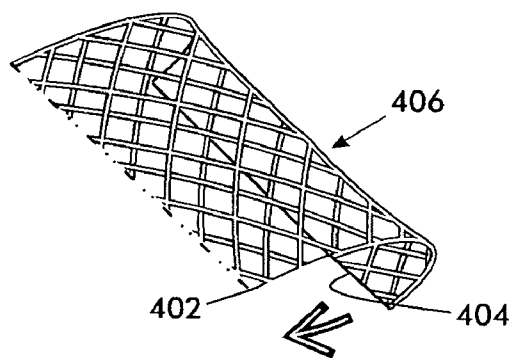


FIG. 23

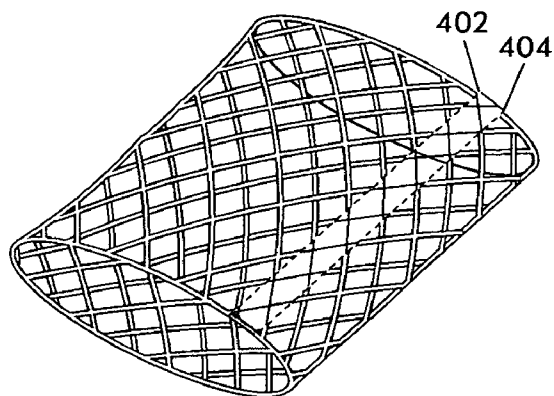


FIG. 24

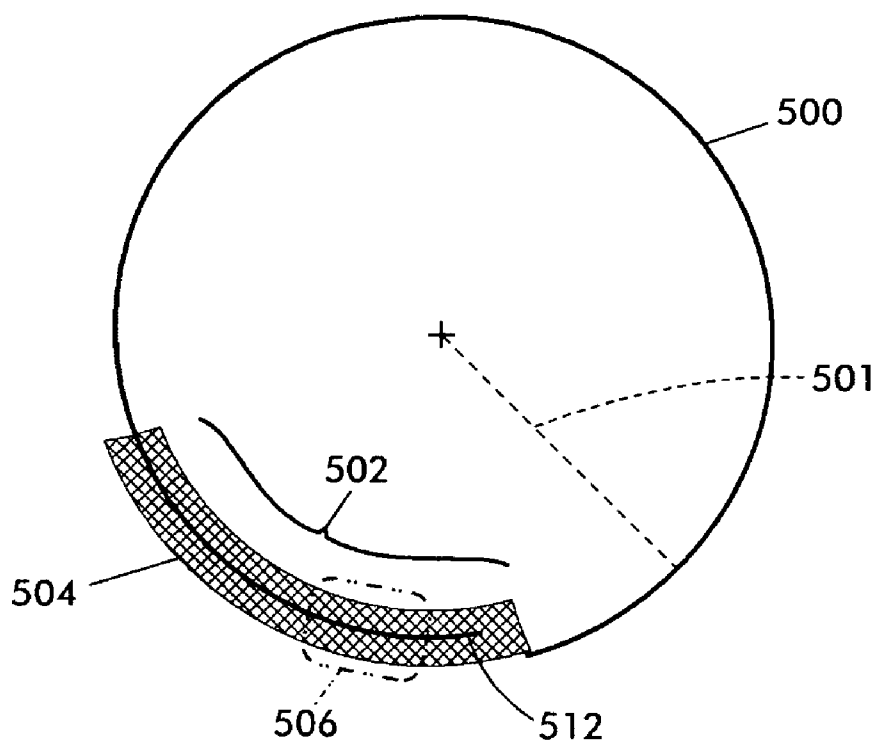


FIG. 25

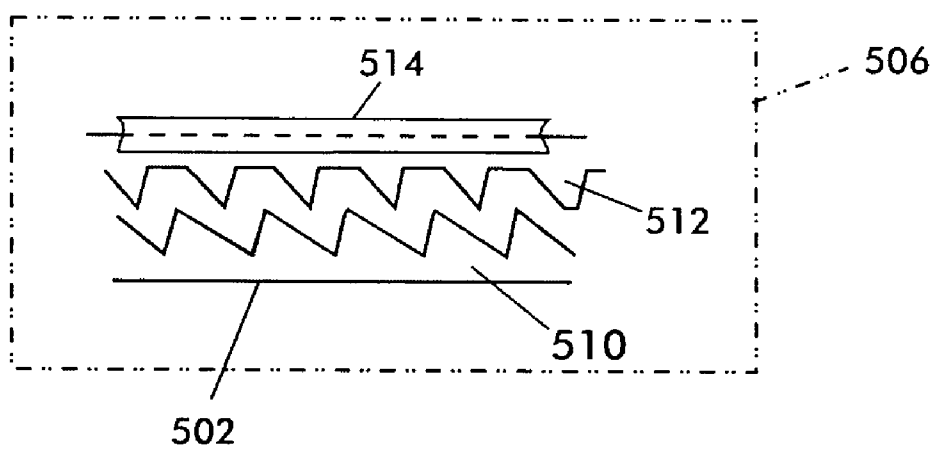


FIG. 26

ELECTROMAGNETIC RADIATION TRANSPARENT DEVICE AND METHOD OF MAKING THEREOF

PRIORITY INFORMATION

[0001] This application claims priority from U.S. Provisional Patent Application Ser. No. 60/497,591, filed on Aug. 25, 2003. The entire content of U.S. Provisional Patent Application Ser. No. 60/497,591 is hereby incorporated by reference.

FIELD OF THE PRESENT INVENTION

[0002] The present invention is directed to stent designs, deployment devices for stents, and the fabrications thereof. More particularly, the present invention is directed to stents which produce little or no magnetic resonance image artifacts and the fabrications thereof.

BACKGROUND OF THE PRESENT INVENTION

[0003] The use of stents as a medical corrective and preventive device is well known.

[0004] For example, U.S. Pat. No. 5,133,732 discloses that a stent can be implanted into a body vessel. The stent is a cylindrical body formed by a coiled generally continuous wire with a deformable zig-zag structure. The stent is further provided with means for preventing the stent body from stretching along its longitudinal axis. This stent is especially useful when implanting very long stents by means of balloon expansion. The entire content of U.S. Pat. No. 5,133,732 is hereby incorporated by reference.

[0005] In another example, U.S. Pat. No. 5,507,767 discloses that a self-expanding endovascular stent is formed of stainless steel wire which is bent into an elongated zigzag pattern. The zigzag pattern has a plurality of substantially straight wire sections of various lengths separating a plurality of bends. The zigzag pattern is helically wound about a central axis to define a tubular shape such that a majority of the bends is disposed in a helix. Adjacent bends in the helix are interconnected with a filament. The entire content of U.S. Pat. No. 5,507,767 is hereby incorporated by reference.

[0006] Magnetic resonance imaging ("MRI") has been developed as an imaging technique adapted to obtain both images of anatomical features of human patients as well as some aspects of the functional activities and characteristics of biological tissue. These images have medical diagnostic value in determining the state of the health of the tissue examined. Unlike the situation with fluoroscopic imaging, a patient undergoing magnetic resonance imaging procedure may remain in the active imaging system for a significant amount of time, e.g. a half-hour or more, without suffering any adverse effects.

[0007] In an MRI process, a patient is typically aligned to place the portion of the patient's anatomy to be examined in the imaging volume of the MRI apparatus. Such an MRI apparatus typically comprises a primary electromagnet for supplying a constant magnetic field (B_0) which, by convention, is along the z-axis and is substantially homogeneous over the imaging volume and secondary electromagnets that can provide linear magnetic field gradients along each of

three principal Cartesian axes in space (generally x, y, and z, or x_1 , x_2 and x_3 , respectively). The MRI apparatus also comprises one or more RF (radio frequency) coils which provide excitation and detection of the MRI induced signals in the patient's body.

[0008] The gradient fields are switched ON and OFF at different rates depending on the MRI scan sequence used. In some cases, this may result in a changing magnetic field on the order of $dB/dt=50$ T/s. The frequency that a gradient field may be turned ON can be between 200 Hz to about 300 kHz.

[0009] Uniformity in the static magnetic B_0 field over the imaging volume is important for image clarity. When the field is not uniform, image distortions called "image artifacts" result. Additionally, if the gradient fields deviate significantly from their ideal linear character over the imaging volume, image artifacts develop.

[0010] Medical devices which are placed into a patient's body can cause the magnetic fields of the MRI system to deviate from their preferred characteristics for clear imaging. If a medical device comprises metallic components (such as iron), image artifacts result due to the metal's magnetic susceptibility properties distorting the MRI system applied magnetic fields. These are known as susceptibility artifacts. Additionally, if the medical device comprises conductive components, eddy currents develop in these conductive components when the MRI system's oscillating magnetic fields are applied. The eddy currents distort the net magnetic fields in the imaging volume, thereby providing another source for MR imaging artifacts.

[0011] After a stent is inserted into a patient, it is often desirable, over time, to determine if the stent is performing as expected. In the case, for example, of deploying a stent to correct a stenosis problem, it is desirable to determine if there is any indication of restenosis. This, as well as for other medical situations, requires obtaining images of the volume inside the stent. Due to the image artifact problems, described above, inherent in metallic, conductive stents, it is not possible to obtain clear MR images of the interior volume of the stents.

[0012] Attempts have been made to overcome these problems. The article, "Artifact-Free In-Stent Lumen Visualization by Standard Magnetic Resonance Angiography Using a New Metallic Magnetic Resonance Imaging Stent" by Arno Buecker, et al., *Circulation*, Apr. 16, 2002, pp. 1772-1775, discloses that a handmade stent can enhance the imaging ability of the stent's lumen. However, the handmade prototypes lacked a radial force comparable to standard stainless steel stents. Additionally, the article discloses the use of a contrasting agent to enhance visualization of the stent lumen.

[0013] The article "MR Imaging of Vascular Stents: Effects of Susceptibility, Flow, and Radiofrequency Eddy Currents" by Lambertus W. Bartels, et al., published in *Journal of Vascular and Interventional Radiology*, volume 12, Number 3, March 2001, pp. 365-371, describes the various image artifacts that prevent clear imaging of stent lumen.

[0014] The article "Improved Lumen Visualization in Metallic Vascular Implants by Reducing RF Artifacts" by Lambertus W. Bartels, et al., published in *Magnetic Resonance in Medicine*, 74:171-180 (2002), describes attempts at

imaging metallic stents lumen by using contrast agents and by increasing the power deposited into the patient during the MRI procedure. The power deposited into the patient body, measured as the Specific Absorption Rate (SAR) can be harmful to the patient undergoing an MRI if set too high. In addition to the higher power deposited into the patient, the article discloses that adjustments in the image reconstruction process need to be implemented.

[0015] United States Patent Application Publication US 2002/0188345 A1, published Dec. 12, 2002, discloses an expandable metallic stent that has discontinuities of non-conducting material. These eliminate electrically conducting paths in the stent rings and cells. This makes the stent easier to image with magnetic resonance imaging (MRI). The entire content of United States Patent Application Publication US 2002/0188345 A1 is hereby incorporated by reference.

[0016] WIPO PCT publication WO 03/015662 A1 discloses that a metallic endoprosthesis causes no significant artifacts on images taken by magnetic resonance tomography (MRT), as a result of the combination of the production materials with a special design, which permits an evaluation of the externally adjacent region and the lumen of the endoprosthesis by means of MRT.

[0017] Although the above-described stents can be used to help a patient, these stents still cause magnetic resonance imaging artifacts. Moreover, the above-described stents prevent the imaging of the volume within the stent during magnetic resonance imaging.

[0018] Therefore, it is desirable to provide a stent which produces little to no magnetic resonance imaging artifacts. Moreover, it is desirable to provide a stent that allows the imaging of the volume within the stent. Furthermore, it is desirable to provide a stent which produces little to no magnetic resonance imaging artifacts and/or allows the imaging of the volume within the stent.

SUMMARY OF THE PRESENT INVENTION

[0019] One aspect of the present invention is a medical stent. The medical stent includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially prevents the medical stent from creating an imaging artifact.

[0020] Another aspect of the present invention is a medical stent. The medical stent includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially allows imaging of a volume within the stent.

[0021] Another aspect of the present invention is a medical stent. The medical stent includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially prevents the medical stent from creating an imaging artifact and substantially allows imaging of a volume within the stent.

[0022] Another aspect of the present invention is an electrically conductive structure. The electrically conductive structure includes a pattern of electrically conductive mate-

rial. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially prevents creation of an imaging artifact by the electrically conductive structure.

[0023] Another aspect of the present invention is a medical device. The medical device includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially prevents creation of an imaging artifact by the medical device.

[0024] Another aspect of the present invention is an electrically conductive structure. The electrically conductive structure includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially allows imaging of a volume within the electrically conductive structure.

[0025] Another aspect of the present invention is an electrically conductive structure. The electrically conductive structure includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially prevents creation of an imaging artifact by the medical device and substantially allows imaging of a volume within the electrically conductive structure.

[0026] Another aspect of the present invention is a medical device. The medical device includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially allows imaging of a volume within the medical device.

[0027] Another aspect of the present invention is a medical device. The medical device includes a pattern of electrically conductive material. The pattern of electrically conductive material has an anti-antenna geometrical shape such that the anti-antenna geometrical shape substantially prevents creation of an imaging artifact by the medical device and substantially allows imaging of a volume within the medical device.

[0028] Another aspect of the present invention is a medical stent. The medical stent includes a pattern of electrically conductive material. The pattern of electrically conductive material substantially prevents the medical stent from creating an imaging artifact.

[0029] Another aspect of the present invention is a medical stent. The medical stent includes a pattern of electrically conductive material. The pattern of electrically conductive material substantially allows imaging of a volume within the stent.

[0030] Another aspect of the present invention is a medical stent. The medical stent includes a pattern of electrically conductive material. The pattern of electrically conductive material substantially prevents the medical stent from creating an imaging artifact and substantially allows imaging of a volume within the stent.

[0031] Another aspect of the present invention is an electrically conductive structure. The electrically conductive structure includes a pattern of electrically conductive mate-

a shape substantially matching the shape of the electrically conductive material so as to allow the electrically conductive material to move in a single direction. The pattern of electrically conductive material substantially prevents the medical stent from creating an imaging artifact. The electrically conductive material is shaped so as to be expandable, the expansion of the electrically conductive material causing an increase in a radius of the medical stent.

[0047] Another aspect of the present invention is a medical stent. The medical stent includes a pattern of electrically conductive material and a track-and-lock mechanism having a shape substantially matching the shape of the electrically conductive material so as to allow the electrically conductive material to move in a single direction. The pattern of electrically conductive material substantially allows imaging of a volume within the stent. The electrically conductive material is shaped so as to be expandable, the expansion of the electrically conductive material causing an increase in a radius of the medical stent.

[0048] Another aspect of the present invention is a medical stent. The medical stent includes a pattern of electrically conductive material and a track-and-lock mechanism having a shape substantially matching the shape of the electrically conductive material so as to allow the electrically conductive material to move in a single direction. The pattern of electrically conductive material substantially prevents the medical stent from creating an imaging artifact and substantially allows imaging of a volume within the stent. The electrically conductive material is shaped so as to be expandable, the expansion of the electrically conductive material causing an increase in a radius of the medical stent.

[0049] Another aspect of the present invention is a medical stent. The medical stent includes a plurality of links, each link being connected together so as to form a cylindrical shaped medical stent, each link being shaped so as to be expandable, the expansion of the links causing an increase in a radius of the medical stent.

[0050] Another aspect of the present invention is a medical stent. The medical stent includes a plurality of links, each link being connected together so as to form a cylindrical shaped medical stent, each link being shaped so as to be expandable upon application of heat, the expansion of the links causing an increase in a radius of the medical stent.

[0051] Another aspect of the present invention is a medical stent. The medical stent includes a plurality of links, each link being connected together so as to form a cylindrical shaped medical stent, each link being shaped so as to be expandable, the expansion of the links causing an increase in a radius of the medical stent; and a track-and-lock mechanism having a shape substantially matching the shape of the links so as to substantially prevent the links from moving in such a way as to reduce the radius of the medical stent.

[0052] Another aspect of the present invention is a medical stent. The medical stent includes a plurality of links, each link being connected together so as to form a cylindrical shaped medical stent, each link being shaped so as to be expandable upon application of heat, the expansion of the links causing an increase in a radius of the medical stent; and a track-and-lock mechanism having a shape substantially matching the shape of the links so as to allow the links to move in a single direction.

[0053] Another aspect of the present invention is a method of fabricating a medical stent. The method cuts a first cylinder of electrically conductive material so as to create a first pattern of conductive mesh strands having a plurality of nodes; cuts a second cylinder of electrically conductive material so as to create a first pattern of conductive mesh strands having a plurality of nodes; positions the first cylinder into a volume of the second cylinder and positioning the first cylinder with respect to the second cylinder such the nodes of the first cylinder are close to the nodes of the second cylinder without the nodes of the first cylinder touching the nodes of the second cylinder; and applies a non-conductive binding material to adjacent nodes of the two cylinders.

[0054] Another aspect of the present invention is a method of fabricating a medical stent. The method cuts a first cylinder of electrically conductive material so as to create a first pattern of conductive mesh strands having a plurality of nodes; cuts a second cylinder of electrically conductive material so as to create a first pattern of conductive mesh strands having a plurality of nodes; positions the first cylinder into a volume of the second cylinder and positioning the first cylinder with respect to the second cylinder such the nodes of the first cylinder are close to the nodes of the second cylinder without the nodes of the first cylinder touching the nodes of the second cylinder; positions a third cylinder of a non-conductive binding material between the first and second cylinders; and applies heat to the adjacent nodes of the first and second cylinders to cause the non-conductive binding material to bind the adjacent nodes together.

[0055] Another aspect of the present invention is a method of fabricating a medical stent. The method produces a web of conductive strands wherein at all the cross-over points, a non-conductive material is applied to hold the cross-over point strands in place and to electrically isolate the conductive strands from one another; cuts a portion of the web to produce a sheet of conductive strands; forms the sheet of conductive strands into a cylinder shape; and attaches ends of sheet together to hold the cylinder shape in place.

BRIEF DESCRIPTION OF THE DRAWINGS

[0056] The present invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating a preferred embodiment and are not to be construed as limiting the present invention, wherein:

[0057] FIG. 1 is a schematic illustration of two conductive loops in a changing magnetic field;

[0058] FIG. 2 is a schematic illustration of a conductor in a "figure-8" configuration in a changing magnetic field;

[0059] FIG. 3 is an illustration of one stent embodiment according to the concepts of the present invention;

[0060] FIG. 4 is an illustration of another stent embodiment according to the concepts of the present invention;

[0061] FIG. 5 is an illustration of another stent embodiment according to the concepts of the present invention;

[0062] FIG. 6 is an illustration of another stent embodiment according to the concepts of the present invention;

[0063] FIG. 7 illustrates a curved stent mesh embodiment according to the concepts of the present invention;

[0064] FIGS. 8 and 9 illustrate a stent mesh by a “Z”-like shape strand according to the concepts of the present invention;

[0065] FIG. 10 illustrates a stent mesh embodiment according to the concepts of the present invention;

[0066] FIG. 11 illustrates a cross-over node in a stent mesh according to the concepts of the present invention;

[0067] FIG. 12 illustrates another cross-over node in a stent mesh according to the concepts of the present invention;

[0068] FIG. 13 illustrates another stent embodiment according to the concepts of the present invention;

[0069] FIG. 14 illustrates a stent within a body which is heated by application of external RF energy;

[0070] FIG. 15 is a cross sectional view of a coated stent according to the concepts of the present invention;

[0071] FIGS. 16 through 21 illustrate various steps in the creation of a medical stent according to the concepts of the present invention;

[0072] FIGS. 22 through 24 illustrate the use of a planar conductive weave sheet material from which a stent is formed according to the concepts of the present invention; and

[0073] FIGS. 25 and 26 illustrate a locking mechanism for an expandable stent according to the concepts of the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0074] The present invention will be described in connection with preferred embodiments; however, it will be understood that there is no intent to limit the present invention to the embodiments described herein. On the contrary, the intent is to cover all alternatives, modifications, and equivalents as may be included within the spirit and scope of the present invention, as defined by the appended claims.

[0075] For a general understanding of the present invention, reference is made to the drawings. In the drawings, like reference have been used throughout to designate identical or equivalent elements. It is also noted that the various drawings illustrating the present invention are not drawn to scale and that certain regions have been purposely drawn disproportionately so that the features and concepts of the present invention could be properly illustrated.

[0076] FIG. 1 is a schematic illustration of induced currents 110 and 112 in two conductive rings 102 and 104, respectively, when the conductive rings 102 & 104 are placed in an environment in which there is an oscillating magnetic field 106. At an instant in time, as illustrated in FIG. 1, both currents 110 & 112 travel in a clockwise direction. But as the magnetic field oscillates, the direction of these currents 110 & 112 will diminish to zero and then begin to circulate in a counter-clockwise direction (not shown.)

[0077] FIG. 2 illustrates when the conductive rings 102 & 104 have been electrically joined together to form a single “figure-8” shaped or emulating conductor 120. The two lobes 126 & 128 of the “figure-8” shaped or emulating conductor 120 have equal planar areas. When placed in changing magnetic field 122 such that the flux of the magnetic field 122 passes through the lobes 126 & 128; no net current will be induced in the “figure-8” shaped or emulating conductor 120. The “figure-8” shaped or emulating conductor 120 is electrically insulated at the cross-over point 124.

[0078] FIG. 3 illustrates a portion of a medical stent 130, according to the concepts of the present invention. The illustrated medical stent 130 includes multiple “figure-8” shaped or emulating conductors 132, 134, 136 & 138. The “figure-8” shaped or emulating conductors 132, 134, 136 & 138 are electrically insulated at the cross-over points 131. The cross-over points 131 may also provide mechanical support for the “figure-8” shaped or emulating conductors 132, 134, 136 & 138.

[0079] The “figure-8” shaped or emulating conductors 132, 134, 136 & 138 are fastened together by non-conductive connectors 140. These connectors 140 may be constructed of Teflon®, Tefzel®, a nonconductive polymer, silicon, or other nonconductive material. The “figure-8” shaped or emulating conductors 132, 134, 136 & 138 may be, for example, tantalum, nitinol, copper, or other conductive material or conductive composite material, which has a low magnetic susceptibility.

[0080] The “figure-8” shaped or emulating conductors realize immunity from the electromagnetic interference or insult. In other words, each “figure-8” shaped or emulating conductor has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0081] FIG. 4 illustrates a portion of a medical stent 160, according to the concepts of the present invention. The illustrated medical stent 160 includes conductors 162 & 164 having sequential conductive loops to form the cylindrical surface of the medical stent 160. The sequential conductive loops form two or more sequential “figure-8” shaped or emulating conductive loop pairs wherein each sequentially looped conductor 162 & 164 contains an even number of loops.

[0082] At crossover point 168, the conductor 164 is electrically isolated by an insulation member 165 to prevent short circuiting the overall loop sequence. At crossover point 169, the conductor 162 is electrically isolated by an insulation member 167 to prevent short circuiting the overall loop sequence. The insulation members 165 and 167, at the crossover points 168 & 169, can also provide mechanical support for conductors 162 & 164 so that the shape is maintained.

[0083] The sequentially looped conductors 162 & 164 are fastened to each other using non-conductive material 166. Material 166 also provides means for securing the sequentially looped conductor 162 & 164 from slipping through the fasteners 166. Additional sequentially looped conductors (not shown) are added to complete the stent construction.

[0084] The sequentially looped conductors realize immunity from the electromagnetic interference or insult. In other

words, each sequentially looped conductor has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0085] FIG. 5 illustrates a portion of a medical stent 170, according to the concepts of the present invention. The illustrated medical stent 170 includes a single conductor 172 weaved into a loop mesh to define the stent cylinder. The weave, for example, beginning at 174, traces down the length of the to-be-constructed stent cylinder 170 and then back up the cylinder length to define an even number of loops. The pattern formed by the weave may be sinusoidal, "Z" shaped, zig-zag shaped, or sawtooth shaped or other such pattern that traverses back and forth with respect to a direction that is perpendicular to the progressive direction of travel of the trace. This pattern forms two or more runs of two or more sequential "figure-8" shaped or emulating conductive loop pairs wherein each run of two or more sequential "figure-8" shaped or emulating conductive loop pairs contains an even number of loops.

[0086] Continuing to follow the weave pattern, the conductor 172 continues to weave down and up the length of the cylinder to the point 176. To complete the stent, the weave continues in a like fashion around the circumference of the yet to-be-defined cylinder stent 170.

[0087] At each intra-run cross-over point 178, a nonconductive material 179 is used to electrically insulate the conductor 172 from itself. Additionally, the nonconductive material 179 secures the crossed-over conductor, along a run, from deforming or slipping or otherwise changing the intra-run cross-over points.

[0088] At each inter-run cross-over point 175, a nonconductive material 177 is used to electrically insulate the conductor 172 from itself. Additionally, the nonconductive material 177 secures the crossed-over conductor, between runs, from deforming or slipping or otherwise changing the inter-run cross-over points.

[0089] The weave pattern of the conductor realizes immunity from the electromagnetic interference or insult. In other words, the weave pattern has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0090] FIG. 6 illustrates a portion of a cylinder shaped stent 190 being constructed from a single conductive material 192 in a weave pattern. In this case, the conductor completes a circumferential sine-wave-like pattern rather than the longitudinal sine-wave-like pattern shown in FIG. 5.

[0091] It is noted that the circumferential pattern formed by the weave may also be sawtooth or other such pattern that traverses back and forth with respect to a direction that is perpendicular to the progressive direction of travel of the trace.

[0092] At intra-run cross-over points 194 & 198, nonconductive materials 191 & 193 are used to electrically insulate the conductive material 192 from itself. Additionally, the nonconductive materials 191 & 193 secure the crossed-over

conductive material 192, along a run, from deforming or slipping or otherwise changing the intra-run cross-over points.

[0093] At each inter-run cross-over point 196, a nonconductive material 195 is used to electrically insulate the conductive material 192 from itself. Additionally, the nonconductive material 195 secures the crossed-over conductive material 192, between runs, from deforming or slipping or otherwise changing the inter-run cross-over points.

[0094] The circumferential pattern realizes immunity from the electromagnetic interference or insult. In other words, the circumferential pattern has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0095] FIGS. 7-9 illustrate how the curved segments of the sine-wave like shape of the weaves mentioned in FIGS. 3, 4, 5, and 6 can be replaced by "Z" shaped, zig-zag shaped, or sawtooth shaped segments.

[0096] FIG. 7 shows a typical cross-over point of a stent weave. Conductors 200 and 202 (or a single conductor) of a stent weave are fastened together by a non-conductive material 201 which electrically insulates the conductors 200 and 202 (or a single conductor) from each other. It is noted that conductors 200 and 202 are continuous, not discontinuous, through non-conductive material 201.

[0097] FIG. 8 shows one possible alternative to the curved weave segments 200 and 202 of FIG. 7. In FIG. 8, the conductive segments have a "Z" shaped, zig-zag shaped, or sawtooth shaped. The conductive segments 204 and 206 do not cross over each other. The conductive segments 204 and 206 are fastened to each other by material 208 which electrically isolates conductive segments 204 and 206 from each other.

[0098] When the stent is to be positioned and expanded in the body, the "Z" shaped segments of conductive segments 204 and 206 straighten out to increase the overall diameter of the cylinder defined by the stent. This is shown in FIG. 9 wherein the conductive segments 204 and 206 have been straightened, thus increasing their span length and the overall diameter of the cylinder defined by the stent.

[0099] FIG. 10 shows a conductive cylinder medical stent 220 mesh comprising many conductive strands 221 and junctions 222. In this case, the conductors complete a sine-wave-like pattern. The pattern formed by the conductors may be circumferential or longitudinal. It is noted that the pattern formed by the conductors may also be "Z" shaped, zig-zag shaped, or sawtooth shaped or other such pattern that traverses back and forth with respect to a direction that is perpendicular to the progressive direction of travel of the trace.

[0100] The pattern formed by the conductors realizes immunity from the electromagnetic interference or insult. In other words, the pattern formed by the conductors has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0101] FIG. 11 illustrates an expanded view of a junction 222, according to the concepts of the present invention. The

junction **222** includes four conductive strands **224**, **226**, **228** & **230** fastened together and electrically isolated from one another by the non-conductive material **234**. Small holes **225**, **227**, **229** & **231** are optionally fabricated into the ends of the conductive strands **224**, **226**, **228** & **230** so that the fastening material **234** may be shaped to include protrusions to securely fasten to the strands **224**, **226**, **228** & **230** with no possibility of any of the strands slipping out of the material **234**.

[0102] It is noted that, although not shown, certain ends of the conductive strands **224**, **226**, **228** & **230** may be electrically connected to each other to form the proper loop circuitry needed to produce the opposing currents in the stent so that a net zero current is realized. For example, conductive strand **224** may be electrically connected to conductive strand **230**, while conductive strand **226** may be electrically connected to conductive strand **228**. On the other hand, for another example, conductive strand **224** may be electrically connected to conductive strand **226**, while conductive strand **230** may be electrically connected to conductive strand **228**.

[0103] The connection pattern of certain ends of the conductive strands realizes immunity from the electromagnetic interference or insult. In other words, the connection pattern of certain ends of the conductive strands has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0104] Other shapes for the conductive strand ends to help secure the conductive strands **224**, **226**, **228** & **230** together, while keeping the conductive strands **224**, **226**, **228** & **230** electrically isolated, may be used. For example, FIG. 12 shows the conductive strands **224**, **226**, **228** & **230** with barbed ends **240**, **242**, **246** & **248**, respectively, so that the fastening material **234** may be shaped around the barbed ends **240**, **242**, **246** & **248** to securely fasten to the strands **224**, **226**, **228** & **230** with no possibility of any of the strands slipping out of the material **234**.

[0105] It is noted that, although not shown, certain of the barbed ends **240**, **242**, **246** & **248** of the conductive strands **224**, **226**, **228** & **230** may be electrically connected to each other to form the proper loop circuitry needed to produce the opposing currents in the stent so that a net zero current is realized. For example, conductive barbed end **240** may be electrically connected to conductive barbed end **242**, while conductive barbed end **246** may be electrically connected to conductive barbed end **248**. On the other hand, for another example, conductive barbed end **240** may be electrically connected to conductive barbed end **246**, while conductive barbed end **248** may be electrically connected to conductive barbed end **242**.

[0106] The connection pattern of certain barbed ends of the conductive strands realizes immunity from the electromagnetic interference or insult. In other words, the connection pattern of certain barbed ends of the conductive strands has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0107] FIG. 13 illustrates another type of conductive stent weave which can be employed as a stent or as a component

of a stent. The conductor **260** is formed to produce a loop **261** that would have induced current flowing in a first direction, a loop **264** that would have induced current flowing in a second direction, a loop **266** that would have induced current flowing in the first direction, and a loop **268** that would have induced current flowing in the second direction, the first direction being opposite of the second direction. The direction changing pattern **263** enables the adjacent loops to have induced currents flowing in opposite directions.

[0108] An example of such a configuration is a loop- $\frac{1}{2}$ hitch-loop- $\frac{1}{2}$ hitch pattern wherein the $\frac{1}{2}$ hitch would correspond to the direction changing pattern **263** of FIG. 13.

[0109] As illustrated in FIG. 13, stacking such loops **261**, **264**, **266**, **268** . . . , with the interspersed direction changing pattern **263**, forms a cylindrical coil. In this way, when following the conductor **260** from one end to the other, a trace would travel clockwise around the first loop **261**, counter-clockwise around the next loop **264**, clockwise around the next **266**, counter-clockwise around the next **268**, and so on.

[0110] At each cross-over point, nonconductive materials **267** & **265** are used to electrically insulate the conductive material **260** from itself. Additionally, the nonconductive materials **267** & **265** secure the crossed-over conductive material **260** from deforming or slipping or otherwise changing the cross-over points.

[0111] Optionally, non-conductive structural ribbing **262** may also be added to increase the structure strength and integrity of the overall stent.

[0112] The stacked loop pattern, with interspersed direction changing pattern, realizes immunity from the electromagnetic interference or insult. In other words, the stacked loop pattern, with interspersed direction changing pattern, has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0113] FIG. 14 illustrates the deployment of an arterial stent **302**. The arterial stent **302** is initially attached to a guidewire **306** at its distal end **304** and is positioned into place within a body **310** and within an artery **308**. The arterial stent **302** is fabricated out of a memory material, for example, nitinol which, when heated, returns to a previous manufactured shape.

[0114] Initially the arterial stent **302** has a small cylindrical diameter. When RF energy **312** is transmitted through the body **310**, the arterial stent **302** will heat up and expand to its final deployed diameter.

[0115] In one embodiment, the distal end **304** of the guidewire **306** is coated with a material which is particularly efficient at converting the RF energy **312** into heat energy to heat and activate the stent **302** expansion.

[0116] In another embodiment, the arterial stent **302**, which may be a mesh or weave like stent as describe above, is coated with a material **322** (see FIG. 15) which is particularly efficient at converting the RF energy **312** (see FIG. 15) into heat energy. It is noted that the arterial stent **302** should be constructed to realize immunity from the electromagnetic interference or insult. In other words, the

arterial stent **302** should be constructed to have an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0117] **FIG. 15** shows a cross-section of the arterial stent **302** which is comprised of the stent mesh shape memory material **320** coated with heating material **322**. Alternatively, only the outside of the stent mesh **320** is coated with the heating material **322**. Alternatively, only the inside of the stent mesh **320** is coated with the heating material **322**.

[0118] The RF energy **312** may be that which is transmitted by an MRI system (not shown) or may be that from some other RF transmitter (not shown). It is known that in some cases and under some conditions long conductors in an MRI environment can heat up. When this phenomenon is incorporated into the catheter or guide-wire which is part of the overall stent delivery system, this heat energy can be utilized to activate the shape memory material expansion, thus expanding the stent.

[0119] **FIG. 16-21** illustrate one possible fabrication process for a medical stent. Referring to **FIG. 16**, the initial stock material **349**; for example, tantalum; is in the shape of a hollow cylinder. The cylinder may be cut into a pattern as illustrated in **FIG. 17**, for example. The cutting of the cylinder stock material **349** may be accomplished by laser cutting or by other means.

[0120] **FIG. 17** shows the resulting cut cylinder **351** which comprises end rings **350** and **354**, and one half of the stent pattern mesh strands **356**, **358** & **360**. (Other mesh strands are shown as dashed lines for clarity.)

[0121] The mesh strands **356**, **358** & **360** are connected to the end rings **350** & **354** by tabs **362** & **364**.

[0122] **FIG. 18** shows two such cut cylinders **351** positioned such that one cylinder has been rotated by 180 degrees; so that the two end rings **354** are close to each other. As the arrows **355** in **FIG. 18** illustrate, one cylinder is to be slid into the other. This may be accomplished in several different ways including: heating one of the cut cylinders so that it expands and/or fabricating one of the two cut cylinders out a cylinder stock material which is slightly smaller in diameter than the other.

[0123] **FIG. 19** illustrates the two cut cylinders in their final position. The orientation is such that the nodes in the cut pattern **381** & **382** are close together, but are not touching.

[0124] The two cut cylinders realize immunity from the electromagnetic interference or insult. In other words, the two cut cylinders have an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0125] **FIG. 20** illustrates the application of a non-conductive binding material **390**, for example, silicon rubber or other thermoplastic or thermoset polymer, or glass, etc. at each of the nodes **381** & **382** which rigidly fasten the conductive mesh strands **356**, **358** & **360** together. The resulting stent mesh **388** is then cut from the supporting nubs **362** & **364** of **FIG. 17**, giving the final stent portion **388** shown in **FIG. 21**.

[0126] The pattern that is cut out of the initial hollow cylinder stock of **FIG. 16** may alternatively include "Z" shaped, zig-zag shaped, or sawtooth shaped segments as shown in **FIG. 8** which facilitates the final stent's ability to expand radially.

[0127] In one embodiment (not shown, but referring to **FIG. 21**), the non-conductive binding material **390** of **FIG. 20** is initially in the form of a hollow cylinder which is so dimensioned as to fit between the two cut cylinders **351** forming three concentric cylinders, the binding material **390** cylinder being the middle layer. The application of a laser or other means then melts the binding material **390** at the nodes as well as eliminates unwanted binding material.

[0128] In one embodiment, the weaving of the conductive material (see, for example, **FIG. 5**) is used to produce a sheet stock planar material **400** illustrated in **FIG. 22**. As mentioned for other conductive weaves (see description of **FIG. 5**), at all the cross-over points, non-conductive materials **401** and **403** is applied to hold the cross-over point strands in place and to electrically isolate the conductive strands from one another. A portion **406** of the planar woven sheet or web is cut from the initial woven sheet **400**. The dashed lines **402** and **404** indicate where a cut through the woven sheet or web **400** is made.

[0129] **FIGS. 23 and 24** show the cut portion **406** being rolled into a cylinder shape. The cut strand, which come together as the cut edges **402** and **404**, are brought together and then attached to one another to hold the stent together. The attachment may be affected by either a conductive material (solder, welding, etc.) or by a non-conductive means (glass, polymer, etc.)

[0130] In one embodiment (not shown) conductive metallic stents are coated with a nano-magnetic thin film coating which reduces the amount of eddy currents generated by the oscillating magnetic fields of an MRI system. In one such embodiment, multiple lays of various compositions and/or thicknesses are applied to the stents. In another embodiment, only portions of the stent are coated with the nano-magnetic thin films, thus changing the MRI system induced eddy current flow pattern.

[0131] In one embodiment, non-magnetic stents are coating with a nano-magnetic thin film coating which alters the magnetic fields of the MRI system enough for the stent to be visible in an MR image without distorting the image of the tissue a short distance from the stent.

[0132] In another embodiment (not shown) conductive metallic stent is coated with a carbon composite material, in part, in patterns, or in whole.

[0133] In another embodiment (not shown) non-conductive stents are coated with a carbon composite material, in part, in patterns, or in whole.

[0134] **FIGS. 25 and 26** illustrate a stent **500** which is, initially, at its smallest radius "r"**501**. The stent **500** is in the shape of a cylinder.

[0135] **FIG. 25** illustrates a cross section of the stent **500**. A stent strand **512** is wrapped within the stent **500** to reduce the cylindrical radius **501** before deployment with a body. The stent **500** has a track-and-lock mechanism **502** through which stent strand **512** passes and is confined to.

[0136] FIG. 26 gives one example of a track-and-lock mechanism 502. A portion 506 of the track-and-lock mechanism 502 is shown as a cut-away view in FIG. 26. The stent strand 512 has teeth which match that of the teeth 510 within the track-and-lock mechanism 502. The stent strand 512 is confined to move in the guide slot 514 and can only move in such a way so as to increase the overall radius 501 of the cylinder stent 500.

[0137] The shape of the teeth of the stent strand 512 and the shape of the teeth of the track-and-lock mechanism 502 prevent the stent strand 512 from moving in such a way as to reduce the cylinder radius 501. Thus, when deployed with; e.g. a balloon catheter system (not shown); the stent may be expanded to its full and final radius and locked into that radius.

[0138] In summary, the various stent embodiments, described above, realize immunity from the electromagnetic interference or insult. In other words, the stent has an anti-antenna geometrical shape such that the anti-antenna geometrical shape prevents the medical stent from creating an imaging artifact and/or allows the imaging of the volume within the stent.

[0139] Although the various embodiments discussed above have been described in the context of a medical stent, the various concepts and aspects of the present invention are readily applicable to other devices and uses.

[0140] For example, the pattern of electrically conductive material, according to the various concepts of the present invention, can be used in medical devices having electrically conductive structures that would, under normal circumstances, generate imaging artifacts and/or heat in response to the imaging processes, such as magnetic radiation imaging (MRI), and/or radio frequency radiation so as to make the medical devices imaging artifact immune and heat resistant. More specifically, the pattern of electrically conductive material, according to the various concepts of the present invention, could be used to create an imaging artifact immune and heat resistant mail for a doctor's glove or clothing.

[0141] While various examples and embodiments of the present invention have been shown and described, it will be appreciated by those skilled in the art that the spirit and scope of the present invention are not limited to the specific description and drawings herein, but extend to various modifications and changes.

What is claimed is:

1. A medical stent, comprising:
 - a pattern of electrically conductive material;
 - said pattern of electrically conductive material substantially preventing the medical stent from creating an imaging artifact;
 - said electrically conductive material being shaped so as to be expandable, said expansion of said electrically conductive material causing an increase in a radius of the medical stent.
2. The medical stent as claimed in claim 1, wherein said pattern is formed by multiple "figure-8" shaped electrical conductors.

3. The medical stent as claimed in claim 1, wherein said pattern is formed by multiple "figure-8" emulating electrical conductors.

4. The medical stent as claimed in claim 1, wherein said pattern is formed by multiple sine-wave-like shaped electrical conductors.

5. The medical stent as claimed in claim 1, wherein said pattern is formed by multiple zig-zag patterned electrical conductors.

6. The medical stent as claimed in claim 1, wherein said pattern is formed by multiple electrical conductors, each having sequential conductive loops.

7. The medical stent as claimed in claim 1, wherein said pattern is formed by a single conductor weaved into a loop mesh, said loop mesh being formed of two or more sequential "figure-8" shaped conductive loop pairs.

8. The medical stent as claimed in claim 7, wherein said single conductor is sine-wave-like shaped.

9. The medical stent as claimed in claim 7, wherein said single conductor is zig-zag patterned.

10. A medical stent, comprising:

- a pattern of electrically conductive material;

- said pattern of electrically conductive material substantially allowing imaging of a volume within the stent;

- said electrically conductive material being shaped so as to be expandable, said expansion of said electrically conductive material causing an increase in a radius of the medical stent.

11. The medical stent as claimed in claim 10, wherein said pattern is formed by multiple "figure-8" shaped electrical conductors.

12. The medical stent as claimed in claim 10, wherein said pattern is formed by multiple "figure-8" emulating electrical conductors.

13. The medical stent as claimed in claim 10, wherein said pattern is formed by multiple sine-wave-like shaped electrical conductors.

14. The medical stent as claimed in claim 10, wherein said pattern is formed by multiple zig-zag patterned electrical conductors.

15. The medical stent as claimed in claim 10, wherein said pattern is formed by multiple electrical conductors, each having sequential conductive loops.

16. The medical stent as claimed in claim 10, wherein said pattern is formed by a single conductor weaved into a loop mesh, said loop mesh being formed of two or more sequential "figure-8" shaped conductive loop pairs.

17. The medical stent as claimed in claim 16, wherein said single conductor is sine-wave-like shaped.

18. The medical stent as claimed in claim 16, wherein said single conductor is zig-zag patterned.

19. A medical stent, comprising:

- a pattern of electrically conductive material;

- said pattern of electrically conductive material substantially preventing the medical stent from creating an imaging artifact and substantially allowing imaging of a volume within the stent;

- said electrically conductive material being shaped so as to be expandable, said expansion of said electrically conductive material causing an increase in a radius of the medical stent.

20. The medical stent as claimed in claim 19, wherein said pattern is formed by multiple "figure-8" shaped electrical conductors.

21. The medical stent as claimed in claim 19, wherein said pattern is formed by multiple "figure-8" emulating electrical conductors.

22. The medical stent as claimed in claim 19, wherein said pattern is formed by multiple sine-wave-like shaped electrical conductors.

23. The medical stent as claimed in claim 19, wherein said pattern is formed by multiple zig-zag patterned electrical conductors.

24. The medical stent as claimed in claim 19, wherein said pattern is formed by multiple electrical conductors, each having sequential conductive loops.

25. The medical stent as claimed in claim 19, wherein said pattern is formed by a single conductor weaved into a loop mesh, said loop mesh being formed of two or more sequential "figure-8" shaped conductive loop pairs.

26. The medical stent as claimed in claim 25, wherein said single conductor is sine-wave-like shaped.

27. The medical stent as claimed in claim 25, wherein said single conductor is zig-zag patterned.

28. The medical stent as claimed in claim 1, wherein said pattern is formed by multiple "Z"-shaped electrical conductors.

29. The medical stent as claimed in claim 1, wherein said pattern is formed by multiple sawtooth shaped electrical conductors.

30. The medical stent as claimed in claim 7, wherein said single conductor is "Z"-shaped.

31. The medical stent as claimed in claim 7, wherein said single conductor is sawtooth shaped.

32. The medical stent as claimed in claim 10, wherein said pattern is formed by multiple "Z"-shaped electrical conductors.

33. The medical stent as claimed in claim 10, wherein said pattern is formed by multiple sawtooth shaped electrical conductors.

34. The medical stent as claimed in claim 16, wherein said single conductor is "Z"-shaped.

35. The medical stent as claimed in claim 16, wherein said single conductor is sawtooth shaped.

36. The medical stent as claimed in claim 19, wherein said pattern is formed by multiple "Z"-shaped electrical conductors.

37. The medical stent as claimed in claim 19, wherein said pattern is formed by multiple sawtooth shaped electrical conductors.

38. The medical stent as claimed in claim 25, wherein said single conductor is "Z"-shaped.

39. The medical stent as claimed in claim 25, wherein said single conductor is sawtooth shaped.

40. The medical stent as claimed in claim 1, wherein said electrically conductive material is tantalum.

41. The medical stent as claimed in claim 1, wherein said electrically conductive material is nitinol.

42. The medical stent as claimed in claim 1, wherein said electrically conductive material is stainless steel.

43. The medical stent as claimed in claim 1, wherein said electrically conductive material is NbZr.

44. The medical stent as claimed in claim 1, wherein said electrically conductive material is titanium.

45. The medical stent as claimed in claim 10, wherein said electrically conductive material is tantalum.

46. The medical stent as claimed in claim 10, wherein said electrically conductive material is nitinol.

47. The medical stent as claimed in claim 10, wherein said electrically conductive material is stainless steel.

48. The medical stent as claimed in claim 10, wherein said electrically conductive material is NbZr.

49. The medical stent as claimed in claim 10, wherein said electrically conductive material is titanium.

50. The medical stent as claimed in claim 19, wherein said electrically conductive material is tantalum.

51. The medical stent as claimed in claim 19, wherein said electrically conductive material is nitinol.

52. The medical stent as claimed in claim 19, wherein said electrically conductive material is stainless steel.

53. The medical stent as claimed in claim 19, wherein said electrically conductive material is NbZr.

54. The medical stent as claimed in claim 19, wherein said electrically conductive material is titanium.

55. The medical stent as claimed in claim 1, further comprising:

non-conductive binding material located at areas where said electrically conductive material produces a cross-over point so as to prevent a short circuit between crossing-over electrically conductive materials.

56. The medical stent as claimed in claim 55, wherein said non-conductive binding material providing structural support to said pattern of electrically conductive material.

57. The medical stent as claimed in claim 55, wherein said non-conductive binding material is silicon rubber.

58. The medical stent as claimed in claim 55, wherein said non-conductive binding material is a thermoplastic.

59. The medical stent as claimed in claim 55, wherein said non-conductive binding material is a thermoset polymer.

60. The medical stent as claimed in claim 55, wherein said non-conductive binding material is glass.

61. The medical stent as claimed in claim 10, further comprising:

non-conductive binding material located at areas where said electrically conductive material produces a cross-over point so as to prevent a short circuit between crossing-over electrically conductive materials.

62. The medical stent as claimed in claim 61, wherein said non-conductive binding material providing structural support to said pattern of electrically conductive material.

63. The medical stent as claimed in claim 61, wherein said non-conductive binding material is silicon rubber.

64. The medical stent as claimed in claim 61, wherein said non-conductive binding material is a thermoplastic.

65. The medical stent as claimed in claim 61, wherein said non-conductive binding material is a thermoset polymer.

66. The medical stent as claimed in claim 61, wherein said non-conductive binding material is glass.

67. The medical stent as claimed in claim 19, further comprising:

non-conductive binding material located at areas where said electrically conductive material produces a cross-over point so as to prevent a short circuit between crossing-over electrically conductive materials.

68. The medical stent as claimed in claim 67, wherein said non-conductive binding material providing structural support to said pattern of electrically conductive material.

69. The medical stent as claimed in claim 67, wherein said non-conductive binding material is silicon rubber.

70. The medical stent as claimed in claim 67, wherein said non-conductive binding material is a thermoplastic.

71. The medical stent as claimed in claim 67, wherein said non-conductive binding material is a thermoset polymer.

72. The medical stent as claimed in claim 67, wherein said non-conductive binding material is glass.

73. The medical stent as claimed in claim 7, wherein said single conductor is shaped to form a first-loop/direction-changing-pattern/second-loop pattern such that current induced in the first loop of said loop/direction-changing-pattern/loop pattern flows has substantially a same magnitude but opposite direction as current induced in the second loop.

74. The medical stent as claimed in claim 73, wherein said first-loop/direction-changing-pattern/second-loop pattern is a first-loop/half-hitch/second-loop pattern such that the direction changing pattern is a half hitch pattern.

75. The medical stent as claimed in claim 73, wherein said first-loop/direction-changing-pattern/second-loop pattern is repeated along a length of the medical stent.

76. The medical stent as claimed in claim 16, wherein said single conductor is shaped to form a first-loop/direction-changing-pattern/second-loop pattern such that current induced in the first loop of said loop/direction-changing-

pattern/loop pattern flows has substantially a same magnitude but opposite direction as current induced in the second loop.

77. The medical stent as claimed in claim 76, wherein said first-loop/direction-changing-pattern/second-loop pattern is a first-loop/half-hitch/second-loop pattern such that the direction changing pattern is a half hitch pattern.

78. The medical stent as claimed in claim 76, wherein said first-loop/direction-changing-pattern/second-loop pattern is repeated along a length of the medical stent.

79. The medical stent as claimed in claim 25, wherein said single conductor is shaped to form a first-loop/direction-changing-pattern/second-loop pattern such that current induced in the first loop of said loop/direction-changing-pattern/loop pattern flows has substantially a same magnitude but opposite direction as current induced in the second loop.

80. The medical stent as claimed in claim 79, wherein said first-loop/direction-changing-pattern/second-loop pattern is a first-loop/half-hitch/second-loop pattern such that the direction changing pattern is a half hitch pattern.

81. The medical stent as claimed in claim 79, wherein said first-loop/direction-changing-pattern/second-loop pattern is repeated along a length of the medical stent.

* * * * *