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(54) METHODS AND DEVICES FOR DETECTING VULNERABLE PLAQUE

(75) Inventors: **Jaydeep Y. Kokate**, Maple Grove, MN (US); **Eric M. DoBrava**, Crystal, MN (US); **Michael J. Urick**, Beaconsfield (CA)

Correspondence Address:
Glenn M. Seager
CROMPTON, SEAGER & TUFTE, LLC
Suite 895
331 Second Avenue South
Minneapolis, MN 55401-2246 (US)

(73) Assignee: **SciMed Life Systems, Inc.**

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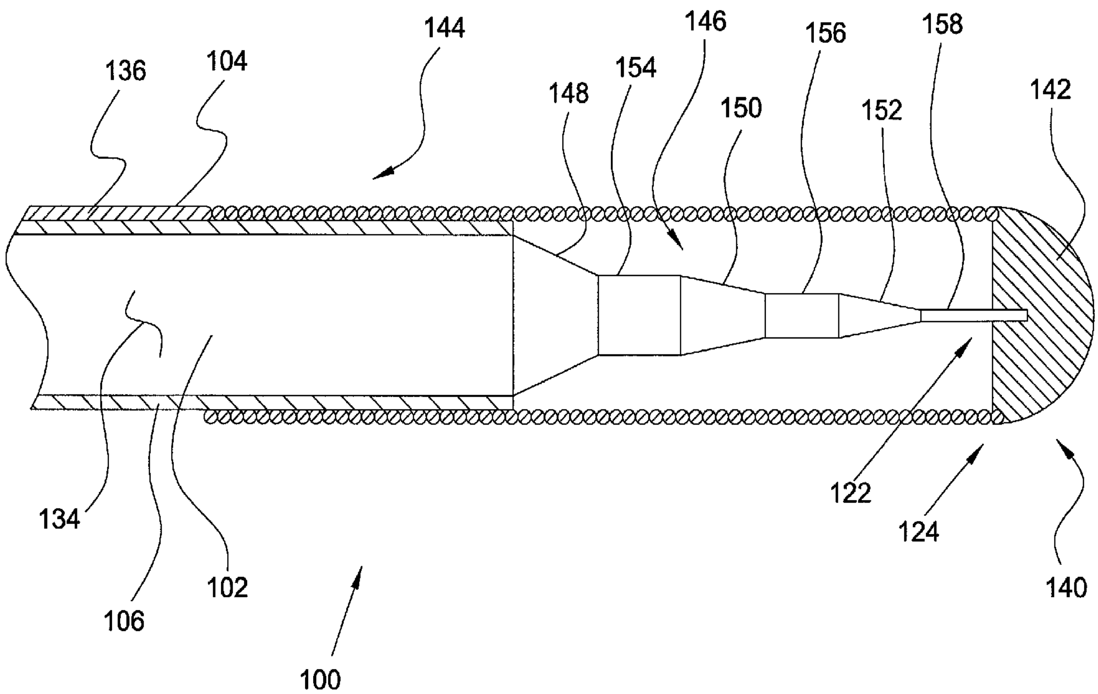
(57) **ABSTRACT**

Devices and methods for detecting vulnerable plaque within a blood vessel are disclosed. A system in accordance with the present invention includes a first wire having a distal end coupled to a voltage source and a proximal end coupled to an instrument capable of measuring voltage. A distal end of a second wire is also coupled to the voltage source and a proximal end of the second wire is coupled to the instrument. The amplitude of the electromotive force produced by the voltage source preferably varies with the temperature of a tissue proximate the voltage source.



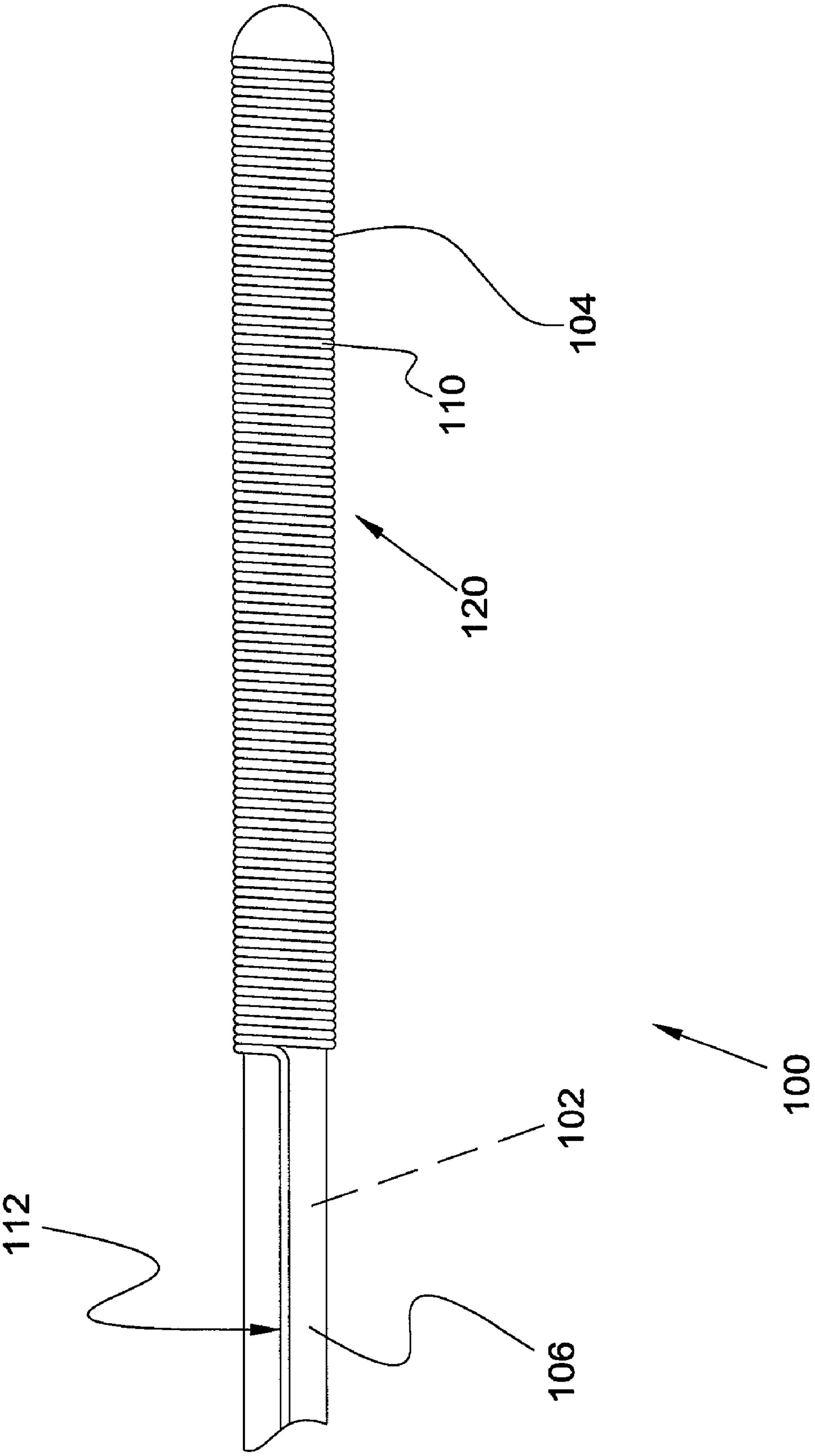
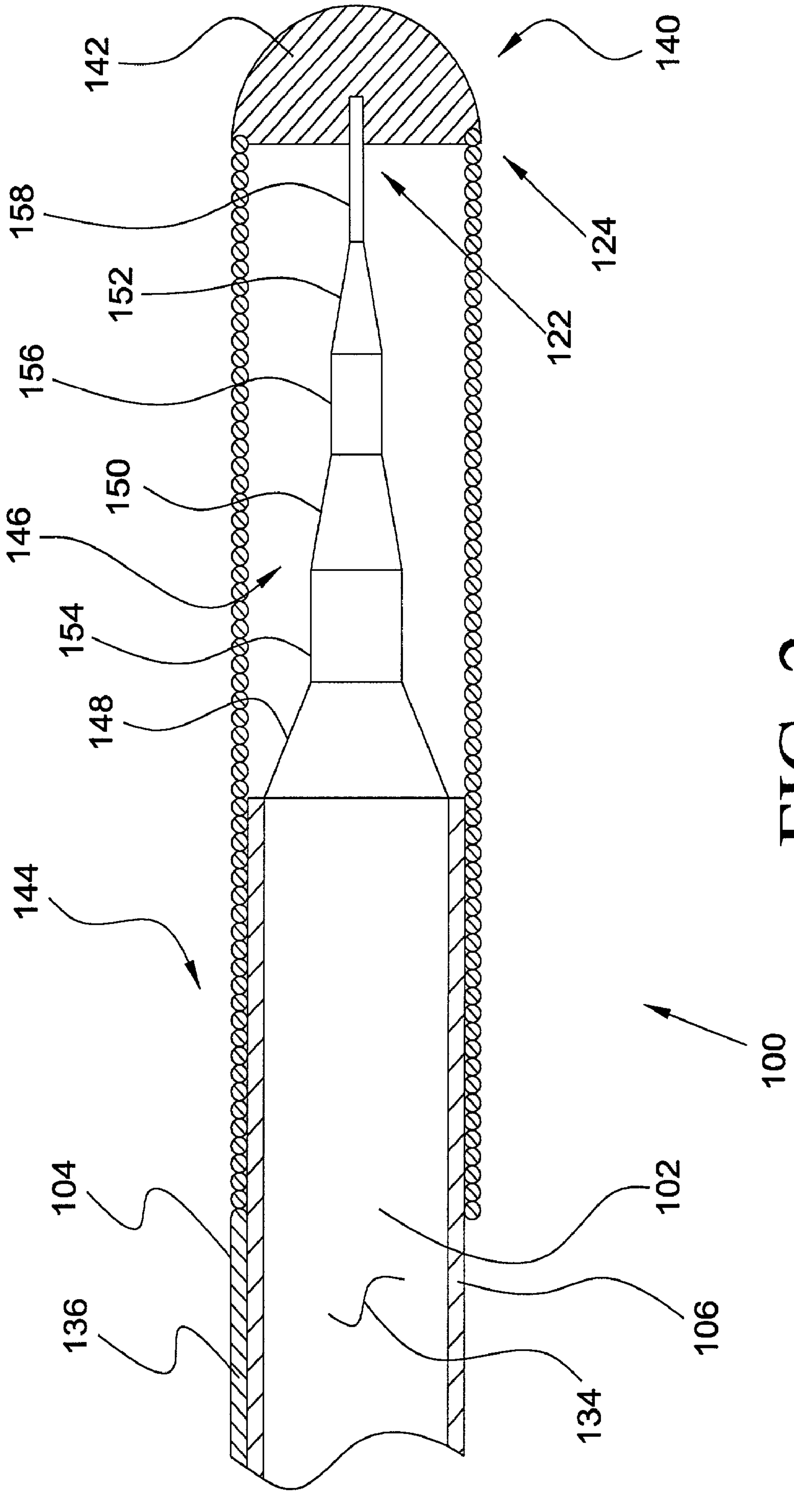


FIG. 1


142
140
158
124
152
122
156
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146
154
148
144
100
104
102
136
106
134

FIG. 2

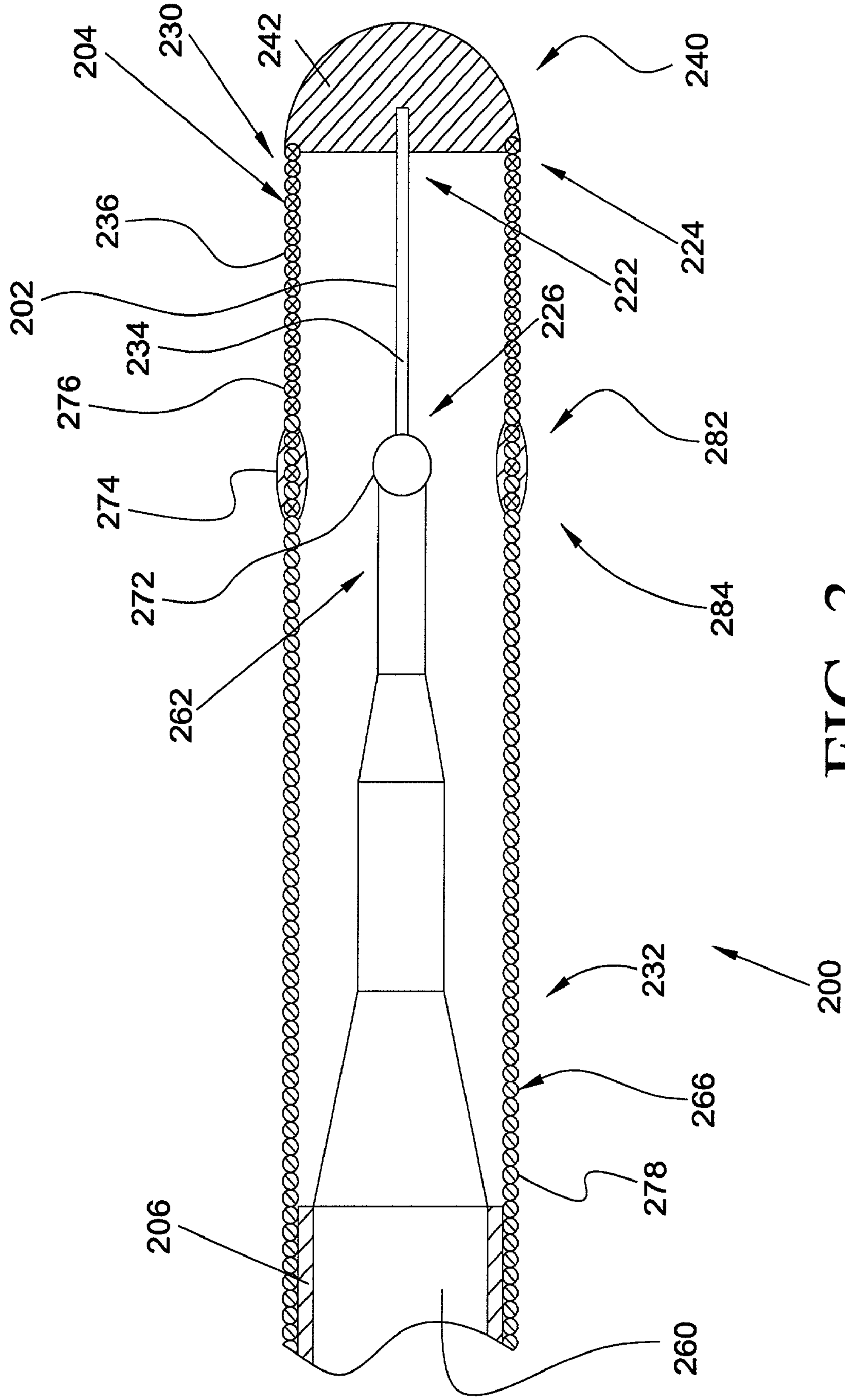

204
230
242
240
236
224
222
202
226
234
276
282
274
272
284
262
232
200
266
206
278
260

FIG. 3

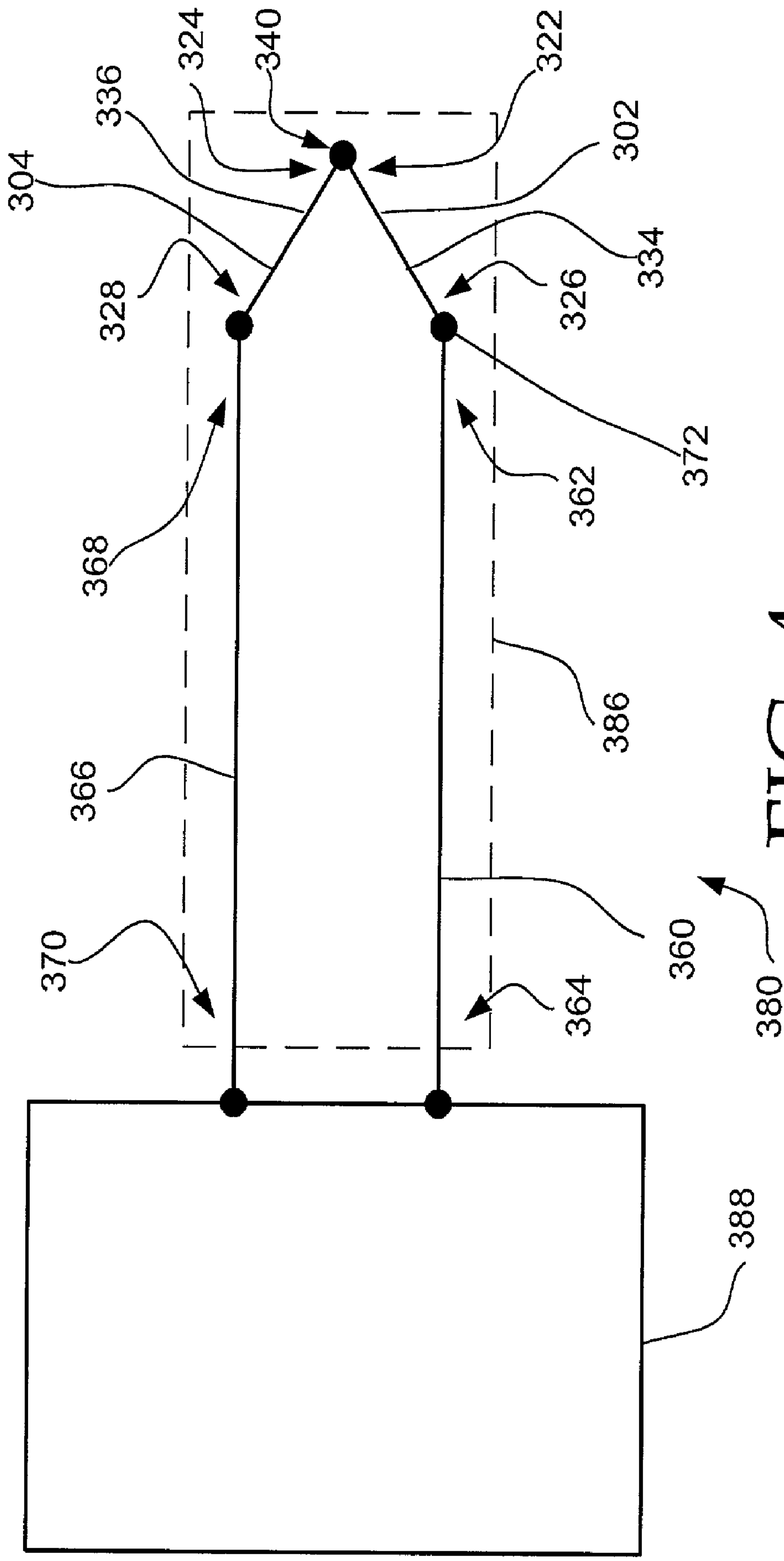

324
340
322
336
302
304
334
328
326
372
368
362
386
366
360
370
364
380
388

FIG. 4

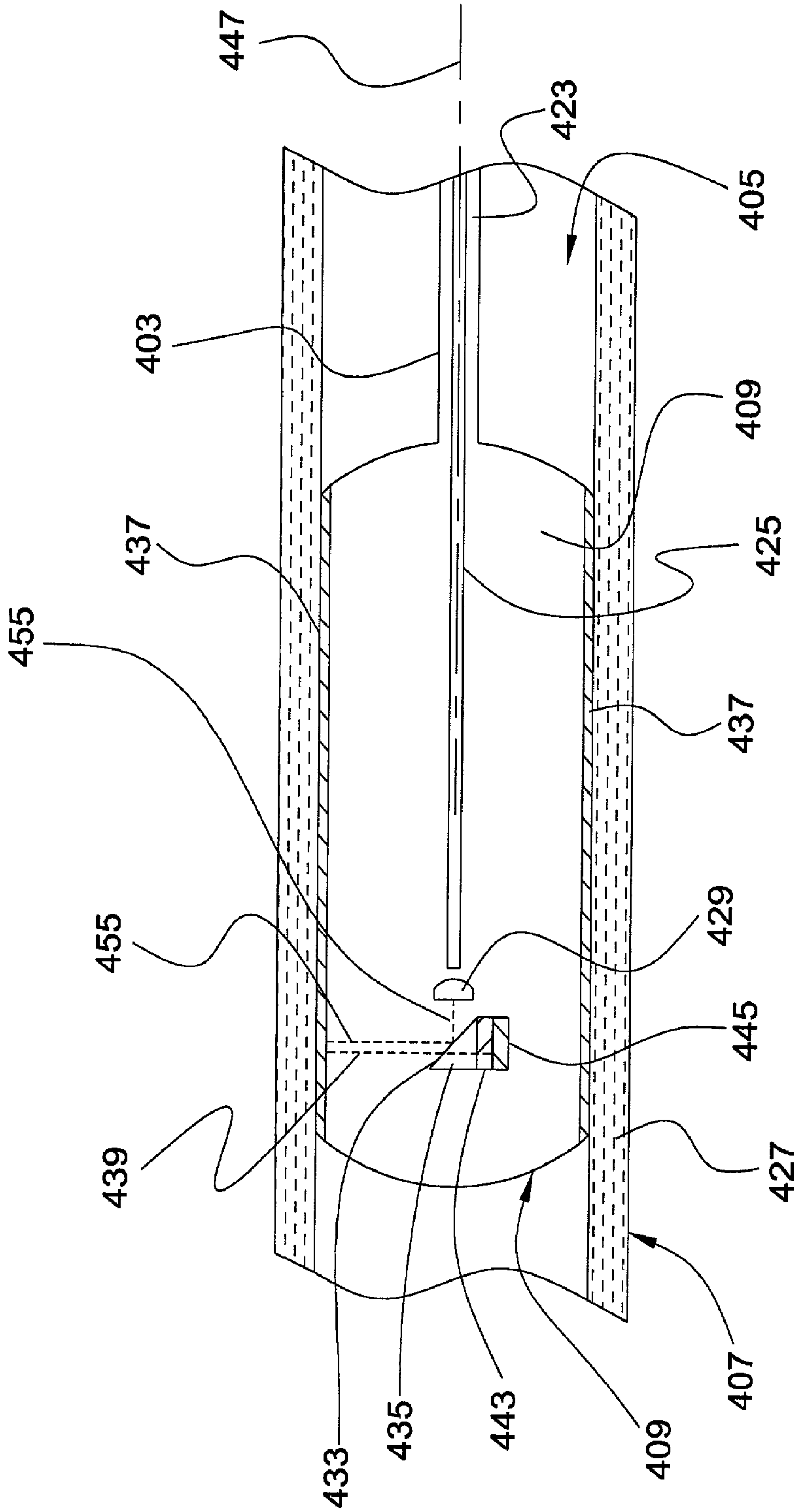
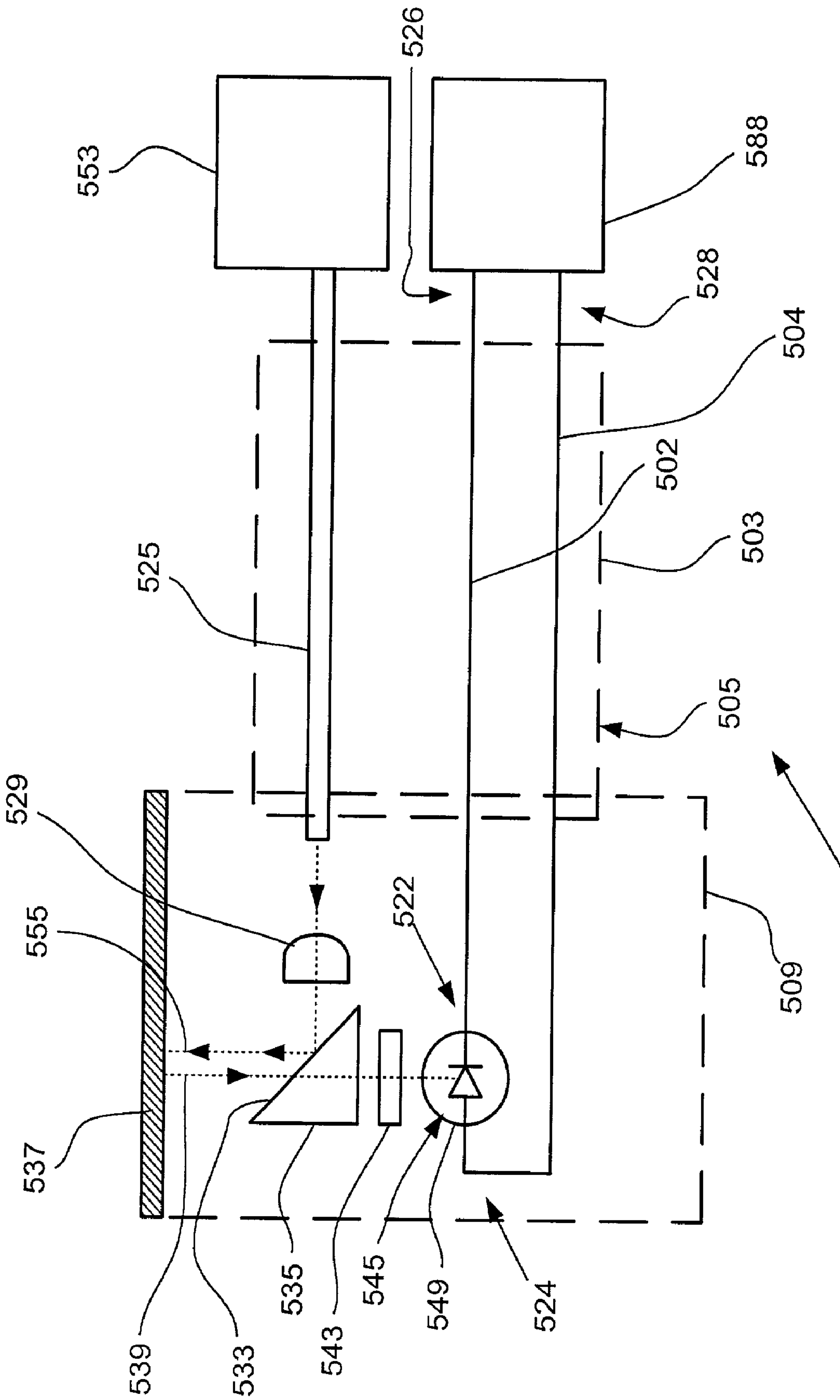

447
423
405
403
409
437
425
455
437
455
429
445
439
427
433
435
443
409
407

FIG. 5


526
553
588
528
504
502
503
525
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522
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580
509
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545
549
524
543
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533

FIG. 6

METHODS AND DEVICES FOR DETECTING VULNERABLE PLAQUE

FIELD OF THE INVENTION

[0001] The present invention relates generally to medical devices for detecting cardiac disease. More particularly, the present invention relates to medical devices for detecting vulnerable plaque within a blood vessel.

BACKGROUND OF THE INVENTION

[0002] Therapy modalities for heart disease have traditionally focused on treating blood vessels which have become occluded (blocked) or stenotic (narrowed) by calcified plaque deposits. Blood vessels which have become occluded or stenotic in this manner may interrupt the flow of blood which supplies oxygen to the heart muscle. Occluded or stenotic blood vessels may be treated with a number of medical procedures including angioplasty and atherectomy. Angioplasty techniques such as percutaneous transluminal angioplasty (PTA) and percutaneous transluminal coronary angioplasty (PTCA) are relatively non-invasive methods of treating restrictions in blood vessels. In these procedures, a balloon catheter is advanced over a guidewire until the balloon is positioned proximate a restriction in a diseased vessel. The balloon is then inflated and the restriction in the vessel is opened. During an atherectomy procedure, the stenotic lesion is mechanically cut or abraded away from the blood vessel wall using an atherectomy catheter.

[0003] Calcified plaque deposit typically comprise hard materials. Plaque may also comprise soft materials or combinations of soft and hard materials. Soft plaque typically comprises deposits of cholesterol and other fats which build up within the blood vessels as a patient ages. The build up of plaque in the blood vessels is sometimes referred to as atherosclerosis, or hardening of the arteries.

[0004] Atherosclerosis often begins as a small injury to an artery wall. This injury triggers a cyclic cascade of injury and response, inflammation, and healing, which may ultimately lead to the narrowing of the artery. As the atherosclerotic plaque worsens, inflammatory cells, especially macrophages, collect at the site to isolate the debris of the damaged tissue. The result is a core of lipid, macrophages or foam cells and nectrotic tissue, covered by a fibrous cap of scar tissue. If the fibrous cap becomes weakened or is subjected to excessive stress, it may rupture, exposing the trombogenic contents of the core to the blood stream. If the resulting blood clot is severe enough, it may occlude the artery. If this obstruction persists in a coronary artery, a myocardial infarction may result.

[0005] Plaque deposits which are at risk of rupturing are sometimes referred to as vulnerable plaque. Vulnerable plaque typically comprises a core of soft materials covered with a fibrous cap. Many vulnerable plaque deposits do not limit the flow of blood through the blood vessels. It has recently been appreciated that vulnerable plaques which do not limit flow may be particularly dangerous because they produce no warning symptoms, but can rupture suddenly causing heart attack and death. This may occur, for example, when the vulnerable plaque ruptures a blood clot may be formed inside the blood vessel lumen causing a blockage.

[0006] Recently, the pivotal role of inflammation in the progression of athersclerosis has been recognized. A systemic increase in temperature is often associated with infection (e.g., a fever). Likewise, a local infection or localized damage to tissue may result in a localized increase in temperature. An increase in temperature is thought to be caused by the response of the immune system to infection, known as inflammation. It has been observed that the inflamed necrotic core of a vulnerable plaque maintains itself at a temperature which may be one or more degrees Celsius higher than that of the surrounding tissue. For example, an inflamed plaque in a human heart, where the normal temperature is about 37° C. may be at a temperature as high as 40° C.

SUMMARY OF THE INVENTION

[0007] The present invention relates generally to medical devices for detecting cardiac disease. More particularly, the present invention relates to medical devices for detecting vulnerable plaque within a blood vessel. A system in accordance with the present invention includes a first wire having a distal end coupled to a voltage source and a proximal end coupled to an instrument capable of measuring voltage. A distal end of a second wire is also coupled to the voltage source and a proximal end of the second wire is coupled to the instrument. The amplitude of the electromotive force produced by the voltage source preferably varies with the temperature of a tissue proximate the voltage source.

[0008] One embodiment of system in accordance with the present invention includes a guidewire including the first wire and the second wire. In this embodiment, a distal end of the first wire and a distal end of the second wire are coupled to form a junction. In a preferred embodiment, the first wire comprises a first material and the second wire comprises a second material which is different than the first material. Also in a preferred embodiment, the first material and the second material are selected so that an electromotive force is produced across the junction therebetween. In a particularly preferred embodiment, the first material and the second material are selected so that the amplitude of the electromotive force across the junction varies with changes in the temperature of the junction. Also in a particularly preferred embodiment the amplitude of the electromotive force produced by the junction varies with the temperature of a tissue proximate the voltage source (i.e., the temperature of the junction is effected by the temperature of tissue proximate the junction).

[0009] An additional embodiment of system in accordance with the present invention includes a catheter including a first wire having a distal end coupled to a detector and a proximal end coupled to an instrument. The catheter also includes a second wire having a distal end coupled to the detector and a proximal end coupled to the instrument. In a preferred embodiment, the detector produces a voltage which varies with the temperature of tissue located proximate a balloon of the catheter. The detector may comprise, for example, a photodiode. In this embodiment, the catheter also includes an optical fiber having a proximal end that is coupled to a light source. Light from light source passes through optical fiber, and is collimated by a lens. This light is partially reflected by a partially reflecting surface of a reflector so that it illuminates a portion of a layer of the balloon. The layer of the balloon preferably has temperature dependent optical properties which may effect, for example, the wavelength and/or intensity of the light which is reflected by layer. The portion of the light which is reflected by this layer forms a light signal. At least a portion of this light signal passes through the partially reflecting surface of the reflector and illuminates the detector.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a plan view of a guidewire in accordance with an exemplary embodiment of the present invention;

[0011] **FIG. 2** is a partial cross-sectional view of a distal portion of the guidewire of **FIG. 1**;

[0012] **FIG. 3** is a partial cross-sectional view of a distal portion of a guidewire in accordance with an additional exemplary embodiment of the present invention.

[0013] **FIG. 4** is a schematic diagram of a system for detecting vulnerable plaque within a blood vessel, in accordance with an exemplary embodiment of the present invention;

[0014] **FIG. 5** is a partial cross-sectional view of a catheter in accordance with an additional exemplary embodiment of the present invention; and

[0015] **FIG. 6** is a diagrammatic representation of a system for detecting vulnerable plaque within a blood vessel, in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] The following detailed description should be read with reference to the drawings, in which like elements in different drawings are numbered in like fashion. The drawings which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of the invention. In some cases, the drawings may be highly diagrammatic in nature. Examples of constructions, materials, dimensions, and manufacturing processes are provided for various elements. Those skilled in the art will recognize that many of the examples provided have suitable alternatives which may be utilized.

[0017] **FIG. 1** is a plan view of a guidewire **100** in accordance with the present invention. Guidewire **100** comprises a first wire **102**, a sheath **106** disposed about first wire **102**, and a coil **120** comprising a plurality of turns **110** formed by a second wire **104**. In **FIG. 1** it may be appreciated that second wire **104** also includes a substantially straight portion **112**.

[0018] **FIG. 2** is a partial cross-sectional view of a distal portion of guidewire **100** of **FIG. 1**. In **FIG. 2**, it may be appreciated that a distal end **122** of first wire **102** and a distal end **124** of second wire **104** are coupled to form a junction **140**. In the embodiment of **FIG. 2**, junction **140** includes a tip member **142** disposed between distal end **122** of first wire **102** and distal end **124** of second wire **104**. In a preferred embodiment, tip member **142** comprises an electrically conductive material. Tip member **142** may be formed, for example, by depositing solder on the distal ends of first wire **102** and second wire **104**.

[0019] In a preferred embodiment, first wire **102** comprises a first material **134** and second wire **104** comprises a second material **136** which is different than first material **134**. In this preferred embodiment, first material **134** and second material **136** are selected so that an electromotive force is produced across junction **140**. In a particularly preferred embodiment, first material **134** and second material **136** are selected so that the amplitude of the electromotive force across junction **140** varies with changes in the temperature of junction **140**. For example, the relationship between the temperature of junction **140** and the electromotive force across junction **140** may be described by the relationship below for some material selections:

$$E=C_1\times T+C_2\times T^2+C_3\times T^3+C_4\times T^4+C_5\times T^5+C_6\times T^6+C_7\times T^7+C_8\times T^8$$

[0020] In the equation above, T represents the temperature of junction **140**, E represents the electromotive force across junction **140**, and C1 through C8 are constants. The values of the constants will vary depending upon which materials are selected as first material **134** and second material **136**. For example, one wire may comprise chromel and the other wire may comprise constantan. By way of a second example, one wire may comprise alumel and the other wire may comprise chromel. In a particularly preferred embodiment, the amplitude of the electromotive force produced by junction **140** varies with the temperature of a tissue proximate junction **140** (i.e., the temperature of junction **140** is effected by the temperature of tissue proximate junction **140**).

[0021] In the embodiment of **FIG. 2**, first wire **102** includes a body portion **144** and a profiled portion **146**. Profiled portion **146** of first wire **102** extends between body portion **144** and distal end **122** of first wire **102**. Beginning at body portion **144** and moving towards distal end **122** profiled portion **146** includes a first taper **148**, a first reduced diameter portion **154**, a second taper **150**, a second reduced diameter portion **156**, a third taper **152**, and a third reduced diameter portion **158**. In **FIG. 2**, profiled portion **146** of first wire **102** is shown in a somewhat foreshortened form for purposes of illustration. It is to be appreciated that **FIG. 2** is not necessarily to scale and is somewhat diagrammatic in nature. Various embodiments of first wire **102** are possible without deviating from the spirit and scope of the present invention.

[0022] In **FIG. 2**, it may be appreciated that sheath **106** is disposed between first wire **102** and second wire **104**. In a preferred embodiment, sheath **106** comprises a nonconductive material. Various non-conductive materials may be utilized without deviating from the spirit and scope of the present invention. Examples of materials which may be suitable in some applications include thermoplastic and non-thermoplastic materials. Examples of thermoplastic materials which may be suitable in some applications includes polyethylene (PE), polypropylene (PP), polyvinylchloride (PVC), thermoplastic polyurethane, polytetrafluoroethylene (PTFE), polyether block amide (PEBA), polyamide, and polyimide. Examples of non-thermoplastic materials which may be suitable in some applications include thermoset polyurthethane.

[0023] **FIG. 3** is a partial cross-sectional view of a distal portion of an additional embodiment of a guidewire **200** in accordance with the present invention. Guidewire **200** comprises a first wire **202** having a distal end **222** and a proximal end **226**. The proximal end **226** of first wire **202** is fixed to a distal end **262** of a third wire **260**. In the embodiment of

FIG. 3, first wire **202** and third wire **260** are fixed together by a first joint **272**. First joint **272** may comprise, for example, a solder joint, weld joint, and/or adhesive joint.

[0024] Guidewire **200** also comprises a second wire **204** and a fourth wire **266**. Second wire **204** forms a distal coil **230** having a plurality of turns **276**. In a similar fashion, fourth wire **266** forms a proximal coil **232** having a plurality of turns **278**. In the embodiment of **FIG. 3, a** plurality of turns **276** proximate a proximal end **282** of distal coil **230** are spaced apart to accommodate a plurality of turns **278** of proximal coil **232**. In a similar fashion, a plurality of turns **278** proximate a distal end **284** of proximal coil **232** are spaced apart to accommodate a plurality of turns **276** of distal coil **230**. In the embodiment of **FIG. 3**, the distal portion of proximal coil **232** has been turned into the proximal portion of distal coil **230** so that a plurality of turns **278** of proximal coil **232** are adjacent to a plurality of turns **276** of distal coil **230**. A second joint **274** connects second wire **204** of distal coil **230** to fourth wire **266** of proximal coil **232** over a plurality of turns. Second joint **274** may comprise, for example, a solder joint, a weld joint, and/or an adhesive joint.

[0025] A sheath **206** is disposed between third wire **260** and fourth wire **266** of proximal coil **232**. In a preferred embodiment, sheath **206** comprises a non-conductive material. Also in a preferred embodiment, sheath **206** is disposed about third wire **260** and extends longitudinally along substantially the entire length of third wire **260**.

[0026] A distal end **222** of first wire **202** and a distal end **224** of second wire **204** are coupled to form a junction **240**. In the embodiment of **FIG. 3**, junction **240** includes a tip member **242** disposed between distal end **222** of first wire **202** and a distal end **224** of second wire **204**. In a preferred embodiment, tip member **242** comprises an electrically conductive material. Tip member **242** may be formed, for example, by depositing solder on the distal ends of first wire **202** and second wire **204**.

[0027] In a preferred embodiment, first wire **202** comprises a first material **234** and second wire **204** comprises a second material **236** which is different than first material **234**. Also in a preferred embodiment, first material **234** and second material **236** are selected so that an electromotive force is produced across junction **240**. In a particularly preferred embodiment, first material **234** and second material **236** are selected so that the amplitude of the electromotive force across junction **240** varies with changes in the temperature of junction **240**. Also in a particularly preferred embodiment, the amplitude of the electromotive force produced by junction **240** varies with the temperature of a tissue proximate junction **240** (i.e., the temperature of junction **240** is effected by the temperature of tissue proximate junction **240**).

[0028] In a preferred embodiment, third wire **260** and fourth wire **266** each comprise an electrically conductive material. Examples of electrically conductive materials which may be suitable in some applications include stainless steel, tantalum, gold, titanium, and Nitinol. The word nitinol was coined by a group of researchers at the United States Naval Ordinance Laboratory (NOL) who were the first to observe the shape memory behavior of this material. The word nitinol is an acronym including the chemical symbol for nickel (Ni), the chemical symbol for titanium (Ti), and an acronym identifying the Naval Ordinance Laboratory (NOL).

[0029] The term "wire", as used in describing first wire **202**, second wire **204**, third wire **260**, and fourth wire **266** should not be mistaken as limiting these wires to elements having a circular cross section. The cross section of these wires may be any number of shapes. For example, the cross section of the wires could be rectangular, elliptical, etc. Likewise, the term "wire", as used in describing these elements should not be mistaken as being limited to metallic materials. In fact, these elements may comprise many metallic and non-metallic materials. Examples of non-metallic materials which may be suitable in some applications include conductive thermoplastic materials and a thermoplastic materials filled with conductive powder.

[0030] **FIG. 4** is a schematic diagram of a system **380** for detecting vulnerable plaque within a blood vessel, in accordance with an exemplary embodiment of the present invention. System **380** includes an elongate medical device **386**. Elongate medical device **386** may be, for example, a guidewire, a catheter, etc. Elongate medical device **386** includes a first wire **302** and a second wire **304**. A distal end **322** of first wire **302** is coupled to a distal end **324** of second wire **304** to form a junction **340**. A proximal end **326** of first wire **302** is coupled to a distal end **362** of a third wire **360** at a first joint **372**. In a similar fashion, a proximal end **328** of second wire **304** is coupled to a distal end **368** of a fourth wire **366**. A proximal end **364** of third wire **360** and a proximal end **370** of fourth wire **366** are each coupled to an instrument **388**.

[0031] In a preferred embodiment, first wire **302** comprises a first material **334** and second wire **304** comprises a second material **336** which is different than first material **334**. In this preferred embodiment, first material **334** and second material **336** are selected so that an electromotive force is produced across junction **340**. In a particularly preferred embodiment, first material **334** and second material **336** are selected so that the amplitude of the electromotive force across junction **340** varies with changes in the temperature of junction **340**. As shown in **FIG. 4**, instrument **388** is coupled to first wire **302** and second wire **304** via third wire **360** and fourth wire **366**, respectively. In a preferred embodiment, instrument **388** may be utilized to measure the amplitude of the electromotive force across junction **340**. In a particularly preferred embodiment, the amplitude of the electromotive force produced by junction **340** varies with the temperature of a tissue proximate junction **340** (i.e., the temperature of junction **340** is effected by the temperature of tissue proximate junction **340**).

[0032] **FIG. 5** is a partial cross sectional view of a catheter **405** in accordance with an exemplary embodiment of the present invention. Catheter **405** includes a shaft **403** defining a lumen **423**, and a balloon **409** disposed about shaft **403** proximate it's distal end. An optical fiber **425** is disposed within lumen **423** of shaft **403**.

[0033] In **FIG. 5**, catheter **405** is shown disposed within the lumen of a blood vessel **407**. In **FIG. 5**, balloon **409** is shown in an inflated state. When balloon **409** is in the inflated state, balloon **409** preferably contacts a wall **427** of blood vessel **407** and the flow of blood through the lumen of blood vessel **407** is occluded. Balloon **409** preferably also has a deflated state in which balloon **409** and catheter **405** have a low profile and blood flow through blood vessel **407** is not precluded.

[**0034**] In one method in accordance with the present invention, light of a selected wavelength passes through optical fiber **425**. The light is collimated by a lens **429** and is partially reflected by a partially reflecting surface **433** of a reflector **435**. After being reflected, the light impinges on a layer **437** of balloon **409**.

[**0035**] Layer **437** of balloon **409** preferably has temperature dependent optical properties. Various temperature dependent optical properties are possible without deviating from the spirit and scope of the present invention. For example, layer **437** may comprise a material which changes polarization at a defined temperature. By way of a second example, layer **437** may comprise a liquid crystal material which changes color as a function of temperature. Embodiments of the present invention have been envisioned in which layer **437** is encapsulated between an outer layer and an inner layer of balloon **409**.

[**0036**] A portion of the light **455** impinging on layer **437** is reflected by layer **437** to produce a light signal **439**. This light signal **439** passes through partially reflecting surface **433**. A portion of light signal **439** also passes through a filter **443** so that it illuminates a detector **445**. Detector **445** may comprise various light sensors without deviating from the spirit and scope of the present invention. Examples of light sensors which may be suitable in some applications include photodiodes, phototransistors, photovoltaic cells, and photoresistors.

[**0037**] Filter **443** is preferably adapted to differentially transmit light depending on the wavelength of the light. For example, if layer **437** turns red at a temperature a few degrees above 37° C., then filter **443** may be selected to transmit red light. In this exemplary embodiment, the signal produced by detector **445** will be higher when layer **437** turns red due to warming by vulnerable plaque.

[**0038**] During a procedure, reflector **435** may be rotated about a central axis **447**. Reflector **435** may also be pulled back along central axis **447**, preferably at a constant speed. The angular orientation and axial position of reflector **435** may be used to define the portion of blood vessel **407** which is being illuminated at any given point during the procedure. Thus, the position of any vulnerable plaque may be identified by observing variations in the signal from detector **445** and correlating those changes with the angular orientation and axial position of reflector **435**.

[**0039**] Embodiments of catheter **405** have been envisioned which include an ultrasonic transducer disposed within balloon **409**. A signal produced by this ultrasonic transducer may be utilized to produce an ultrasound image. The signals collected from detector **445** may be combined with the signal collected from the ultrasonic transducer so that each point in the ultrasound image is displayed with a temperature dependant color. The areas which are likely to include vulnerable plaque may be marked in the ultrasound image using a selected color.

[**0040**] **FIG. 6** is a diagrammatic representation of a system **580** for detecting vulnerable plaque within a blood vessel, in accordance with an exemplary embodiment of the present invention. System **580** includes a catheter **505** comprising a shaft **503** and a balloon **509**. Catheter **505** includes a first wire **502** having a distal end **522** coupled to a detector **545** and a proximal end **526** coupled to an instrument **588**. Catheter **505** also includes a second wire **504** having a distal end **524** coupled to detector **545** and a proximal end **528** coupled to instrument **588**. In a preferred embodiment, detector **545** produces a voltage which varies with the temperature of tissue located proximate balloon **509** of catheter **505**. In the embodiment of **FIG. 6**, detector **545** comprises a photodiode **549**. Detector **545** may comprise other detectors without deviating from the spirit and scope of the present invention. Examples of detectors which may be suitable in some applications include phototransistors and photovoltaic cells.

[**0041**] Catheter **505** of **FIG. 6** also includes an optical fiber **525**. A distal end of optical fiber **525** is coupled to a light source **553**. Light from light source **553** passes through optical fiber **525**, and is collimated by a lens **529**. This light is partially reflected by a partially reflecting surface **533** of a reflector **535** so that it illuminates a portion of a layer **537** of balloon **509**. Layer **537** of balloon **509** preferably has temperature dependent optical properties which may effect, for example, the wavelength and/or intensity of the light which is reflected by layer **537**. The portion of light **555** which is reflected by layer **537** forms a light signal **539**. This light signal **539** passes through partially reflecting surface **533**. A portion of light signal **539** also passes through a filter **543** so that it illuminates detector **545**.

[**0042**] Having thus described the preferred embodiments of the present invention, those of skill in the art will readily appreciate that yet other embodiments may be made and used within the scope of the claims hereto attached. Numerous advantages of the invention covered by this document have been set forth in the foregoing description. It will be understood, however, that this disclosure is, in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size, and arrangement of parts without exceeding the scope of the invention. The inventions's scope is, of course, defined in the language in which the appended claims are expressed.

What is claimed is:

1. A system for detecting vulnerable plaque within a blood vessel, comprising:

a first wire having a distal end and a proximal end;

a second wire having a distal end and an proximal end;

a voltage source coupled to the distal end of the first wire and the distal end of the second wire; and

a means for measuring voltage coupled to the proximal end of the first wire and the proximal end of the second wire.

2. The system of claim 1, wherein an amplitude of the electromotive force produced by the voltage source varies with a temperature of the voltage source.

3. The system of claim 1, wherein the voltage source comprises a photodiode.

4. The system of claim 1, wherein the voltage source comprises a phototransistor.

5. The system of claim 1, wherein the voltage source comprises a photovoltaic cell.

6. The system of claim 1, wherein the voltage source comprises a thermocouple junction.

7. An elongate medical device, comprising:

a first wire having a distal end and a proximal end;

a voltage source disposed proximate the distal end of the first wire; and

wherein the voltage source produces an electromotive force.

8. The elongate medical device of claim 7, wherein an amplitude of the electromotive force varies with a temperature of the voltage source.

9. The elongate medical device of claim 7, further including a second wire having a distal end and a proximal end.

10. The elongate medical device of claim 7, further including a second wire having a distal end and a proximal end; and

the distal end of the second wire being coupled to the voltage source.

11. The elongate medical device of claim 7, further including a second wire having a distal end and a proximal end;

the distal end of the second wire being coupled to the voltage source; and

the distal end of the first wire being coupled to the voltage source.

12. The elongate medical device of claim 7, further including a second wire having a distal end and a proximal end, and an insulator disposed between the first wire and the second wire.

13. The elongate medical device of claim 7, further including a sleeve disposed about the first wire.

14. The elongate medical device of claim 7, wherein the voltage source comprises a thermocouple junction.

15. An elongate medical device, comprising:

a first wire comprising a first material;

a second wire comprising a second material different from the first material;

a distal portion of the second wire being coupled to a distal portion of the first wire to form a junction; and

wherein the junction produces an electromotive force.

16. The elongate medical device of claim 1, wherein an amplitude of the electromotive force varies with a temperature of the junction.

17. The elongate medical device of claim 1, further including an insulator disposed between the first wire and the second wire.

18. The elongate medical device of claim 1, further including a sleeve disposed about the first wire.

19. The elongate medical device of claim 1, further including a second wire having a distal end and a proximal end, and an insulator disposed between the first wire and the second wire.

20. The elongate medical device of claim 1, further including a second wire having a distal end and a proximal end, and a sleeve disposed about the first wire.

* * * * *

专利名称(译)	用于检测易损斑块的方法和装置		
公开(公告)号	US20020111558A1	公开(公告)日	2002-08-15
申请号	US09/781741	申请日	2001-02-12
申请(专利权)人(译)	SCIMED LIFE SYSTEMS INC.		
当前申请(专利权)人(译)	BOSTON SCIENTIFIC SCIMED , INC.		
[标]发明人	KOKATE JAYDEEP Y DOBRAVA ERIC M URICK MICHAEL J		
发明人	KOKATE, JAYDEEP Y. DOBRAVA, ERIC M. URICK, MICHAEL J.		
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摘要(译)

公开了用于检测血管内易损斑块的装置和方法。根据本发明的系统包括第一导线，其具有连接到电压源的远端和连接到能够测量电压的仪器的近端。第二线的远端也耦合到电压源，并且第二线的近端耦合到仪器。由电压源产生的电动势的幅度优选地随着靠近电压源的组织的温度而变化。