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(54) **WIRELESS COMMUNICATION DEVICE**

DRAHTLOSE KOMMUNIKATIONSANORDNUNG

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Description

[0001] The present invention relates to a device capable of wirelessly communicating information, to a wireless system for wirelessly communicating force information with such a device and to a method of wirelessly communicating information.

[0002] Wireless communication devices are commonly used today to wirelessly communicate information about goods. For example, transponders may be attached to goods during their manufacture, transport and/or distribution to provide information, such as the good's identification number, expiration date, date of manufacture or "born on" date, lot number, and the like. The transponder allows this information to be obtained unobtrusively using wireless communication without slowing down the manufacturing, transportation, and/or distribution process. Antenna arrangements for such wireless communication devices are known, for example, from WO 02/093685 A1, being published after the priority date of the present application, which discloses a ball grid array antenna, or from US 2001/0020921 A1 which discloses a tunable antenna having separate radiator parts. The antenna known from WO 02/093685 A1 incorporates conductive antenna elements from an integrated circuit package, a circuit board to which the integrated circuit package mounts, and signal conducting connecting means between the integrated circuit package and the circuit board. The antenna known from US 2001/0020921 A1 includes separate radiator parts coupled to one another. The coupling between the parts is changed by rotating and/or displacing the parts with respect to one another such that the antenna exhibits a radiation pattern associated with a respective degree of a rotation and/or displacement to reach a tunability of the antenna.

[0003] Some goods involve environmental factors by design that are critical to their manufacture and/or intended operation. An example of such a good is a vehicle tyre. A tyre is designed to be placed under pressure to operate properly. Too little pressure can cause a tyre to be damaged by the weight of a vehicle supported by the tyre. Too much pressure can cause a tyre to rupture. Tyre pressure must be tested during the manufacturing process to ensure that the tyre meets intended design specifications. The tyre pressure should also be within a certain pressure limits during use in order to avoid dangerous conditions. Knowledge of the tyre pressure during the operation of a vehicle can be used to inform an operator and/or vehicle System that a tyre has a dangerous pressure condition. The vehicle may indicate a pressure condition by generating an alarm or warning signal to the operator of the vehicle.

[0004] A pressure sensor can be provided in the tyre and coupled to the vehicle using a wired connection. However, the tyre moves with respect to the vehicle during the vehicle's movement, and a wired connection may be susceptible to damage or a break thereby causing a failure in receiving pressure information from the pressure sensor. A wireless communication device may be more advantageous to place in a tyre to communicate tyre pressure. A pressure sensor can be coupled to a wireless communication device that is placed inside a tyre to wirelessly communicate tyre pressure without need for wired connections.

[0005] Such a wireless communication device including a separate pressure sensor is, for example, known from WO 99/29525 A1, corresponding to EP 1 037 755 A1 and disclosing an antenna for a radio transponder according to the preamble of claim 1. The communication device comprises a radio-frequency transponder including an integrated circuit chip and optional sensors in the chip or associated with the chip, wherein the integrated circuit chip of the transponder has at least the capacity to transmit data relating to tire or wheel identification. The antenna of this generic wireless communication device comprises a composite of an electrical conductor and a rubber matrix wherein the composite is capable of elongation. However, the additional cost of the wireless communication device in addition to the pressure sensor may be cost prohibitive.

[0006] Therefore, an object of the present invention is to provide a wireless communication device that can determine and communicate certain environmental conditions, such as pressure, without the use and added cost of a separate environmental sensor. The present invention relates to an antenna coupled to a wireless communication device that is comprised of a series of conductive elements that form a conductor when placed under a force. The conductor is coupled to a wireless communication device to provide an antenna so that the wireless communication device is capable of communicating at an operating frequency defined by the length and construction of the conductor. The wireless communication device, through its communication using the conductor as an antenna, acts as an indicator of force to an interrogation reader since the wireless communication device is not capable of communicating to the interrogation reader unless a force is placed on the series of conductive elements that form the antenna.

[0007] In one embodiment, the series of conductive elements are comprised of links that form a link chain. The link chain is coupled to the wireless communication device to form a dipole antenna. The wireless communication device and link chain are also attached to a flexible, resilient material. When a force is applied to the flexible material and/or the link chain, the links in the link chain form conductive connections with each other to form an antenna to be used by the wireless communication device for wireless communication.

[0008] In another embodiment, the series of conductive elements are comprised of hollow conductive spheres that join together using shaped links. The shaped links form conductive connections between the hollow conductive spheres when a force is applied to the hollow conductive spheres and/or a flexible material containing the hollow conductive spheres.

[0009] In another embodiment, the series of conductive elements are coupled to a wireless communication device that are placed on the inside of a tyre to act as a pressure indicator.

[0010] In another embodiment, the wireless communication device is coupled to a series of conductive elements that are attached to a load to act as a weight indicator.

[0011] In another embodiment, the wireless communication device is coupled to a series of conductive elements that is attached to an axle to act as a rotation speed indicator.

[0012] In another embodiment, the wireless communication device is coupled to a tuning ring, and the tuning ring is coupled to a series of conductive elements. The tuning ring acts as a first antenna to allow the wireless communication device to operate at a first operating frequency. The series of conductive elements acts as a second antenna when placed under a force to allow the wireless communication device to operate at a second operating frequency.

[0013] In another embodiment, the wireless communication device is coupled to a series of conductive elements that contains a moveable link. The series of conductive elements acts as a first antenna having a first length when the moveable link is not under a force to allow the wireless communication device to operate at a first operating frequency. The series of conductive elements acts as a second antenna having a second length when the moveable link is under a force to allow the wireless communication device to operate at a second operating frequency.

[0014] In another embodiment, the wireless communication device is coupled to a fixed conductor that is coupled to a series of conductive elements. The fixed conductor acts as a first antenna regardless of any force applied to the series of conductive elements to allow the wireless communication device to operate at a first operating frequency. The series of conductive elements couple to the fixed conductor to become one conductor acting as a second antenna when the series of conductive elements are under a force to allow the wireless communication device to operate at a second operating frequency.

[0015] In another embodiment, the wireless communication device is coupled to a series of conductive elements that includes a locking mechanism. The wireless communication device is capable of using the series of conductive elements as an antenna for wireless communication when the locking mechanism is engaged, locking the series of conductive elements in a conductive connection. The conductive connection remains even if the force is later removed from the series of conductive elements.

[0016] The interrogation reader may communicate information received from a wireless communication device using the series of conductive elements as an antenna to a reporting system located in close proximity to the interrogation reader, a remote system, or both.

[0017] Ways of carrying out the invention will now be described in detail, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram of an interrogation reader and wireless communication device system in the prior art;

Figure 2A is a schematic diagram of a chain coupled to a wireless communication device whose links are not under force;

Figure 2B is a schematic diagram of a chain coupled to a wireless communication device whose links are under force to form a conductor and a dipole antenna;

Figure 3 is a schematic diagram of one embodiment of hollow conductive spheres in a chain that are designed to form a conductor when under force;

Figure 4 is a flowchart diagram of an interrogation reader determining that a certain force or temperature threshold condition has been met at the wireless communication device when the interrogation reader receives successful communication from the wireless communication device;

Figure 5 is a schematic diagram of a chain coupled to a wireless communication device in a tyre that forms an antenna when the tyre is inflated to a certain pressure level;

Figure 6 is a schematic diagram of a chain coupled to a load and to a wireless communication device such that the chain forms an antenna when the load is above a certain weight;

Figure 7 is a schematic diagram of a chain coupled to an axle and to a wireless communication device such that the chain forms an antenna when the axle rotates above a certain speed;

Figure 8 is a schematic diagram of a chain and a tuning ring coupled to a wireless communication device such that the wireless communication device can operate at a first operating frequency using the tuning ring as a first antenna and can operate at a second operating frequency using the chain as a second antenna;

Figure 9 is a schematic diagram of a chain that has one moveable link coupled to a wireless communication device so that the wireless communication device can communicate at a first operating frequency when the chain forms a first antenna and can communicate at a second operating frequency when a force is placed on the moveable link to form a second antenna;

Figure 10 is a schematic diagram of a wireless communication device coupled to a fixed conductor to act as a first antenna to communicate at a first operating frequency and coupled to a chain to act as a second antenna to communicate at a second operating frequency when a force is placed on the chain;

Figure 11A is a schematic diagram of conductive elements in a locking mechanism that is in an unlocked position;

Figure 11B is a schematic diagram of conductive elements in a locking mechanism in a locked position wherein the conductive elements and locking mechanism form a conductor to be used by a wireless communication device as an antenna; and

Figure 12 is a schematic diagram of a reporting system.

[0018] The present invention is directed to an antenna coupled to a wireless communication device. The antenna is comprised of a series of conductive elements that do not form conductive connections with each other to form the antenna unless they are placed under a force, such as tension or compression. When the conductive elements are placed under a force, the conductive elements form conductive connections with each other to form a conductor.

[0019] This conductor is coupled to a wireless communication device to provide an antenna so that the wireless communication device is capable of communicating at an operating frequency defined by the length and construction of the conductor. In this manner, the wireless communication device, through its communication using the conductor as an antenna, acts as an indicator of force to an interrogation reader since the wireless communication device is not capable of communicating unless the series of conductive elements are under a force. The wireless communication device can be used in various applications as an indicator of force.

[0020] Before discussing the particular aspects of the present invention and the embodiments for providing a series of conductive elements to form a conductor and antenna when placed under a force, a brief discussion of interrogation readers and wireless communication devices follows.

[0021] Figure 1 illustrates a typical wireless communication device and communication system in the prior art. The wireless communication device 10 is capable of communicating information wirelessly and may include a control system 12, communication electronics 14, and memory 16. The wireless communication device 10 is also known as a radio-frequency identification device (RFID). The communication electronics 14 is coupled to an antenna 18 for wirelessly communicating information in radio-frequency signals. The communication electronics 14 is capable of receiving modulated radio-frequency signals through the antenna 18 and demodulating these signals into information passed to the control system 12. The antenna 18 may be internal or external to the wireless communication device 10. The antenna 18 may be a pole antenna or a slot antenna.

[0022] The control system 12 may be any type of circuitry or processor that receives and processes information received by the communication electronics 14, including a micro-controller or microprocessor. The wireless communication device 10 may also contain a memory 16 for storage of information. Such information may be any type of information about goods or objects associated with the wireless communication device 10, including but not limited to identification, tracking and other pertinent information. The memory 16 may be electronic memory, such as random access memory (RAM), read-only memory (ROM), flash memory, diode, etc., or the memory 16 may be mechanical memory, such as a switch, dip-switch, etc.

[0023] Some wireless communication devices 10 are termed "active" devices in that they receive and transmit data using their own energy source coupled to the wireless communication device 10. A wireless communication device 10 may use a battery for power as described in U.S. Patent No. 6,130,602 entitled "Radio frequency data communications device," or may use other forms of energy, such as a capacitor as described in U.S. Patent No. 5,833,603, entitled "Implantable biosensing transponder." Both of the preceding patents are incorporated herein by reference in their entirety.

[0024] Other wireless communication devices 10 are termed "passive" devices, meaning that they do not actively transmit and therefore may not include their own energy source for power. One type of passive wireless communication device 10 is known as a "transponder." A transponder effectively transmits information by reflecting back a received signal from an external communication device, such as an interrogation reader. An example of a transponder is disclosed in U.S. Patent No. 5,347,280, entitled "Frequency diversity transponder arrangement," incorporated herein by reference in its entirety. Another example of a transponder is described in U.S. Patent No. 6,501,435, entitled "Wireless communication device and method," incorporated herein by reference in its entirety.

[0025] It is readily understood to one of ordinary skill in the art that there are many other types of wireless communication devices and communication techniques than those described herein, and the present invention is not limited to a particular type of wireless communication device, technique or method.

[0026] Figure 1 also depicts communication between a wireless communication device 10 and an interrogation reader 20. The interrogation reader 20 may include a control system 22, an interrogation communication electronics 24, memory 26, and an interrogation antenna 28. The interrogation antenna 28 may be a pole antenna or a slot antenna. The interrogation reader 20 may also contain its own internal energy source 30, or the interrogation reader 20 may be powered through an external power source (not shown). The energy source 30 may include a battery, a capacitor, solar cell or other medium that contains energy. The energy source 30 may also be rechargeable. The interrogation reader 20 may also include a clock 23 that is coupled to and used by the control system 22 for changing clock cycles and timing operations and/or other timing calculations.

[0027] The interrogation reader 20 communicates with the wireless communication device 10 by emitting an electronic communication signal 32 modulated by the interrogation communication electronics 24 through the interrogation antenna 28. The interrogation antenna 28 may be any type of antenna that can radiate a communication signal 32 through a field 34 so that a reception device, such as a wireless communication device 10, can receive such communication signal 32 through its own antenna 18. The field 34 may be electro-magnetic, magnetic, or electric. The communication signal 32 may be a message containing information and/or a specific request for the wireless communication device 10 to perform a task or communicate back information.

[0028] When the antenna 18 is in the presence of the field 34 emitted by the interrogation reader 20, the communication electronics 14 are energized by the energy in the communication signal 32, thereby energizing the wireless communication device 10. The wireless communication device 10 remains energized so long as its antenna 18 is in the field 34 of the interrogation reader 20. The communication electronics 14 demodulates the communication signal 32 and sends the message containing information and/or request to the control system 12 for appropriate actions.

[0029] Turning now to aspects of the present invention, Figure 2A illustrates one embodiment of the antenna 18 for the wireless communication device 10. The antenna 18 is comprised of a series of conductive elements that form a link chain 40. The link chain 40 is coupled to the wireless communication device 10 to act as its antenna 18 when the link chain 40 is under a force, such as tension or compression. In this embodiment, two link chains 40 are coupled to the wireless communication device 10 at coupling points 41 to form a dipole antenna 18.

[0030] The link chain 40 is comprised of a plurality of individual links 42 that are circular in shape. The links 42 are constructed out of a conductive material, such as aluminum, cooper, or steel. The wireless communication device 10 and the link chain 40 are attached to a flexible material 43. The flexible material 43 is a resilient material that is capable of flexing, such as stretching or compressing, when a force is placed on the flexible material 43. The flexible material 43, being resilient, returns back to its original shape when a force is not exerted on it. The flexible material 43 may be constructed out of rubber, foam, or any material that is capable of being stretched or compressed and is resilient. Note that the flexible material 43 is optional, and force may be applied directly to the conductive elements to allow the wireless communication device 10 to act as a pressure indicator.

[0031] The force exerted on the flexible material 43 may be an external mechanical force, including gravity, or may be caused by the flexible material's 43 response to an environmental condition, such as temperature. The flexible material may be any type of flexible material so long as the material flexes.

[0032] The flexible material 43 illustrated in Figure 2A is not under a force. The links 42 are attached to the flexible material 43 so that the links 42 either (1) do not form a good conductive connection; or (2) any conductive connection whatsoever between each other when the flexible material 43 is not under a force. The wireless communication device 10 is designed to operate at a frequency that uses the link chain 40 as an antenna 18 when the link chain 40 is under a force. So even if there are some links 42 in the link chain 40 that are conductively connected to each other when the flexible material 43 is not under a force, the conductive length of the link chain 40 will be different than is intended for use by the wireless communication device 10 and/or the interrogation reader 20 for their designed operating frequency.

[0033] Figure 2B illustrates the same wireless communication device 10 and link chain 40 illustrated Figure 2A, discussed above. However in Figure 2B, the flexible material 43 is under a force; it is being stretched. This stretching causes the link chain 40 and its links 42 to stretch as well since the links 42 are attached to the flexible material 43. In this manner, the links 42 come into contact with each other to form a conductor that is coupled to the wireless communication device 10, at the couplings 41. When the links 42 form a conductor, the links 42 are continuously coupled to the wireless communication device 10 so that the wireless communication device 10 can use the links 42 as an antenna 18.

[0034] The links 42 in the link chain 40 may also be compressed by compressing the flexible material 43 to form a conductor. If the links 42 are compressed so that the links 42 come into conductive contact with each other, the links 42 will form a conductor than can also be used by the wireless communication device 10 as an antenna 18. Compression of the links 42 will create an antenna 18 that is used to communicate at a higher operating frequency than stretching of the links 42, since compression of the links 42 will form a conductor that is shorter in length than a conductor formed by stretching of the links 42.

[0035] Whether the flexible material 43 and/or the links 42 are stretched or compressed, the wireless communication device 10 is capable of communicating using the link chain 40 as the antenna 18 at the desired and designed operating frequency if the links 42 form a conductor. When the interrogation reader 20 receives a communication signal 32 from the wireless communication device 10, illustrated in Figure 2B, the interrogation reader 20 will know that such successful communication is indicative of a threshold force being applied to the flexible material 43 and/or the link chain 40.

[0036] Figure 3 illustrates another embodiment of the present invention wherein the antenna 18 is constructed out of different conductive elements than the links 42 illustrated in Figures 2A and 2B. The antenna 18 is comprised of two or more hollow conductive spheres 44 that are attached to the flexible material 43. The hollow conductive spheres 44 may be constructed of aluminum, steel, copper, or any other conductive material. The hollow conductive spheres 44 may be completely hollow or substantially hollow so long as the shaped links 48, discussed below, do not form a substantial conductive connection with the hollow conductive spheres 44 when the hollow conductive spheres 44 are not under a force.

[0037] Each hollow conductive sphere 44 contains two orifices 46. The orifices 46 are located on the left-hand side and the right-hand side of each hollow conductive sphere 44. Shaped links 48 are provided between each hollow conductive sphere 44 to connect the hollow conductive spheres 44 together to form a conductor when the hollow conductive spheres 44 are stretched. The shaped links 48 are constructed so that they have a narrow portion 50 in the central region of the shaped link 48 and wider portions 52 on each end of the shaped links 48. The wider portions 52 have a larger diameter than the diameter of the orifices 46. In this manner, the hollow conductive spheres 44 are free to move back-and-forth along the path of the shaped link 48 as force is exerted on the hollow conductive spheres 44. However, the hollow conductive spheres 44 cannot move farther apart than the length of the shaped link 48 since the wider portions 52 of the shaped links 48 are larger in diameter than the orifices 46.

[0038] When the flexible material 43 and/or the hollow conductive spheres 44 are under tension, the hollow conductive spheres 44 move apart from each other horizontally along the path of the shaped link 48 until the shape length 48 reaches the point where the diameter of its wider portions 52 reach the diameter size of the orifices 46. In this manner, a conductive connection is made between adjacent hollow conductive spheres 44 through the connectivity of the shaped links 48 to the adjacent hollow conductive spheres 44 through contact with the orifices 46.

[0039] The hollow conductive spheres 44 can also come into conductive contact with each other when the flexible material 43 and/or the hollow conductive spheres 44 are compressed together. In this manner, the hollow conductive spheres 44 move closer to each other in a horizontal direction along the path of the shaped link 48. Eventually, the shaped link 48 between adjacent hollow conductive spheres 44 will be totally inside the hollow conductive spheres 44, and the outside of adjacent hollow conductive spheres 44 will come into contact with each other to form a conductor.

[0040] Whether the flexible material 43 and/or the hollow conductive spheres 44 are stretched or compressed, the hollow conductive spheres 44 will create a conductor to form an antenna 18 when the stretching or compressing causes the hollow conductive spheres 44 to conductively contact each other to form a conductor. When the interrogation reader 20 receives a communication signal from the wireless communication device 10 using the antenna 18 formed by the hollow conductive spheres 44 forming a conductor, the interrogation reader 20 will know that such successful communication is indicative of a defined force being applied to the flexible material 43.

[0041] Figure 4 illustrates a flowchart diagram of the process executed by the interrogation reader 20 to determine if a wireless communication device 10 in the range of its field 34 is under a force. The wireless communication device 10 may use any antenna 18 that is a series of conductive elements that form a conductor when the elements are under a force, such as tension or compression. The wireless communication device 10 may use an antenna 18, such as a link chain 40 or hollow conductive spheres 44, as illustrated in Figures 2 and 3 and discussed above.

[0042] The process starts (block 60), and the interrogation reader 20 sends out a communication signal 32 through the field 34 to establish communications with any wireless communication device 10 in the range of the field 34 (block 62). If the interrogation reader 20 does not receive a modulated signal response back from any wireless communication device 10 (decision 64), this is indicative of one of two conditions; (1) there is no wireless communication device 10 present in the range of the field 34; or (2) a wireless communication device 10 in the range of the field 34 is not under a force such that the conductive element coupled to the wireless communication device 10 forms a conductor to form an antenna 18. In either condition, the interrogation reader 20 repeats by again sending out a communication signal 32 (block 62) in a looping manner until a modulated communication signal 32 response is received back from a wireless communication device 10.

[0043] If the interrogation reader 20 receives a response signal back from a wireless communication device 10 (decision 64), this is indicative that the wireless communication device 10 is under a force since the wireless communication device 10 is configured with an antenna 18 that does not form a conductor unless the antenna 18 is under a force. The interrogation reader 20 receives the communication from the wireless communication device 10 and takes any action necessary and/or designed to be carried out (block 66). The interrogation reader 20 repeats the process by sending out a communication signal 32 to determine if either the same wireless communication device 10 as was previously interrogated is still under a force and/or if another wireless communication device 10 is under a force (block 62).

[0044] As an example, the communication signal 32 received by the interrogation reader may include the identification of the wireless communication device 10. This identification may uniquely identify a good or article of manufacture that contains the wireless communication device 10. In this manner, the interrogation reader is capable of determining and/or reporting that the good is under a force. The interrogation reader 20 must be designed to operate at an operating frequency that is the same as the operating frequency of the wireless communication device 10 using the antenna 18 as it is under force. Various examples of applications that may use the present invention are discussed below and illustrated in Figures 5-12.

[0045] Figure 5 illustrates one application for use of the wireless communication device 10 and antenna 18 to indicate the pressure of a tyre 70. The wireless communication device 10 is coupled to a link chain 40, and both are placed in the inside 72 of the tyre 70. The inside 72 of the tyre 70 is comprised of a flexible material 43, namely rubber, that stretches and expands when put under pressure. As the tyre 70 is inflated under pressure, the antenna 18 components stretch or expand. If the tyre 70 is inflated to a threshold pressure, the links 42 form a conductor to provide an antenna 18 to the wireless communication device 10. At this threshold pressure, the wireless communication device 10 will be able to respond to an interrogation reader 20 communication signal 32 using the link chain 40 as an antenna 18.

[0046] The interrogation reader 20 is designed such that its receipt of communication by a wireless communication device 10 indicates that the tyre 70 has been inflated to a certain pressure. Note that other conductive elements, such as hollow conductive spheres 44, may also be used with this embodiment to form the conductor and antenna 18.

[0047] Figure 6 illustrates another application of the present invention wherein the wireless communication device 10 is designed to communicate with an interrogation reader 20 when an object or load 80 is above a certain threshold weight. The wireless communication device 10 is attached to a flexible material 43. The wireless communication device 10 is also coupled to a link chain 40 that is attached to the flexible material 43, like that illustrated in Figure 2, to provide an antenna 18. However in this embodiment, the link chain 40 is aligned in a vertical direction so that gravity is the force applied on the flexible material 43.

[0048] If the weight of the load 80 is sufficient to pull down on and stretch the flexible material 43 such that the links 42 form conductive connections with each other to form a conductor, the wireless communication device 10 will be capable of responding to an interrogation reader 20 communication signal 32 using the link chain 40 as an antenna 18. In this manner, the wireless communication device 10 and link chain 40 attached to the flexible material 43 form a weight indicator so that an interrogation reader 20 is capable of determining if the load 80 is above a certain threshold weight. Again, note that other conductive elements, such as hollow conductive spheres 44, may also be used with this embodiment to form the conductor.

[0049] Figure 7 illustrates another application of the present invention wherein the wireless communication device 10 is capable of communicating to an interrogation reader 20 if an axle 90 rotates above a certain speed. The wireless communication device 10 is coupled to a series of hollow conductive spheres 44 to form an antenna 18 when the hollow conductive spheres 44 form a conductor, as illustrated in Figure 3. The wireless communication device 10 and series of hollow conductive spheres 44 are attached to a flexible material 43. The axle 90 rotates in either a clockwise or counterclockwise direction. The series of hollow conductive spheres 18 is connected to the axle 90 at an attachment point 92.

[0050] As the axle 90 rotates, the centrifugal force of the rotation causes the hollow conductive spheres 44 to move outward from the axle 90 in the rotation path 94. Centrifugal force is speed divided by the radius of the rotating object squared. If the speed of rotation and therefore the centrifugal force goes above a certain threshold of speed, the hollow conductive spheres 44 will move apart along the shaped link 48 to form conductive connections with each other to form a conductor. In this manner, the wireless communication device 10 and the hollow conductive spheres 44 attached to the flexible material 43 form a speed indicator so that an interrogation reader 20 is capable of determining if the axle 90 is rotating above a certain threshold speed. Again, note that other conductive elements, such as links 42, may also be used with this embodiment to form the conductor.

[0051] In another embodiment, the series of conductive elements, such as a link chain 40 or series of hollow conductive spheres 44, may be used to indicate if a sufficient amount of pressure has been applied to a security strap. For example, the link chain 40 coupled to a wireless communication device 10 may be used as a securing strap for air-cargo pallets. The wireless communication device 10 cannot use the strap as an antenna 18 unless the strap has been secured with the correct amount of pressure. An example of straps that are attached to pallets to secure cargo is disclosed in International Patent Application No. WO 02/07084 entitled "Wireless transport communication device and method", and incorporated herein by reference in its entirety.

[0052] Figure 8 illustrates another embodiment of the antenna 18 wherein a tuning ring 100 is coupled to the wireless communication device 10 through the couplings 41. A link chain 40 is attached on each side of the tuning ring 100 at connection points 102. In this embodiment, two link chains 40 are coupled to the tuning ring 100 to form a dipole antenna 18 when the link chains 40 are under a force to form conductors.

[0053] The tuning ring 100 is used to improve the connection strains between the wireless communication device 10 and the link chain 40 so that a force applied to the link chain 40 exerts force on the tuning ring 100 rather than the wireless communication device 10. In addition, the tuning ring 100 allows the wireless communication device to communicate at two different operating frequencies. The tuning ring 100 always forms a conductive connection with the wireless communication device 10 to form a first antenna 18A regardless of the force, lack thereof, applied to the flexible material 43, the link chain 40, and/or the tuning ring 100. The tuning ring 100 provides the first antenna 18A so that the wireless communication device 10 is capable of operating at a first operating frequency. In one embodiment, the turning ring 100 is constructed to resonate at around about 2.45 GHz.

[0054] If a sufficient force is exerted on the link chain

40, the individual links 42 form conductive connections with each other to form a second, dipole antenna 18B. The link chain 40 forms an antenna 18B that is designed to operate at a different, second operating frequency than designed for the tuning ring 100. In this manner, the wireless communication device 10 is capable of communicating a second operating frequency when a force is exerted on the flexible material 43 and/or the link chain 40. In one embodiment, the link chain 40 is constructed to resonate at around about 915 MHz. Again, note that other conductive elements, such as hollow conductive spheres 44, may also be used with this embodiment to form the conductor.

[0055] Figure 9 illustrates another embodiment of the present invention that is similar to the embodiment illustrated in Figure 8. The wireless communication device 10 is capable of communicating at two different operating frequencies. However, this embodiment does not contain the tuning ring 100. A link chain 40 is coupled to the wireless communication device 10 that contains a moveable link 110 that is free to move about. This moveable link 110 will form a conductive connection with adjacent links 42 in the link chain 40 if a certain threshold force is applied to the link chain 40. The other links 42 in the link chain 40 are conductively coupled to each other regardless of the force applied to the link chain 40, or lack thereof.

[0056] The wireless communication device 10 is coupled to the link chain 40 to form a first antenna 18A of length L_1 when the moveable link 110 does not form a conductive connection with adjacent links 42. In this manner, the wireless communication device 10 is capable of operating at a first operating frequency as defined by the length L_1 and the construction of the first antenna 18A. In one embodiment, the length L_1 is approximately 30.6 millimeters so that the link chain 40 of length L_1 resonates at around about 2.45 GHz.

[0057] When a force is applied to the link chain 40 such that the moveable link 110 forms a conductive connection with adjacent links 42 in the link chain 40, a second antenna 18B of length L_2 is coupled to the wireless communication device 10. In this manner, the wireless communication device 10 is capable of operating at a second operating frequency as defined by the length and construction of the second antenna 18B when the flexible material 43 and/or the link chain 40 are subject to a certain threshold force. In one embodiment, the length L_2 is approximately 51.4 millimeters so that the link chain 40 of length L_2 resonates at around about 915 MHz. Again, note that other conductive elements, such as consecutive hollow conductive spheres 44, may also be used with this embodiment to form the conductor.

[0058] Also note that more than one moveable link 110 may be placed in the link chain 40 so that the link chain 40 has an upper and lower frequency range. For example, one moveable link 110 may be placed in the link chain 40 at a distance of 30 millimeters from the end of the link chain 40 so that the link chain 40 resonates at around about 2.5 GHz when a force is placed on the first moveable link 110. A second moveable link 110 may be placed in the link chain 40 at a distance of 31 millimeters from the end of the link chain 40 so that the link chain 40 resonates at around about 2.4193 GHz when a force is placed on the second moveable link 110. In this manner, the antenna 18 formed by the link chain 40 tunes itself with force.

[0059] Figure 10 illustrates another embodiment of the present invention wherein a wireless communication device 10 is capable of operating at two different frequencies using two different antenna 18 lengths. A fixed conductor 114 is coupled to the wireless communication device 10 to form a first antenna 18A. The fixed conductor 114 has a fixed length that does not change as force is applied. In this embodiment, two fixed conductors are attached to the wireless communication device 10 to form a dipole antenna 18A.

[0060] A series of metal spheres 112 are coupled to the fixed conductors 114. The metal spheres 112 are conductively coupled to each other regardless of force applied, or lack thereof. Hollow conductive spheres 44, illustrated in Figure 3, are connected on the ends of the metal spheres 112 such that the metal spheres 112 are connected in between the hollow conductive spheres 44 and the fixed conductor 114. The metal spheres 112 are coupled to each other regardless of force. The hollow conductive spheres 44 form a conductive connection with the metal spheres 112 to form a conductor if a certain threshold force is applied to the metal spheres 112. In this manner, the wireless communication device 10 is capable of communicating at a first operating frequency using the first antenna 18A if a certain threshold force is not applied to the metal spheres 112, since only the fixed conductor 114 will be coupled to the wireless communication device 10.

[0061] The wireless communication device 10 will communicate at a second operating frequency formed by the hollow conductive spheres 44 conductively coupled to the fixed conductor 114, through the metal spheres 112, to form a second, longer antenna 18B if a certain threshold force is applied to the metal spheres 112. Again, note that other conductive elements, such as links 42, may also be used with, this embodiment to form the conductor.

[0062] Figures 11A and 11B illustrate another embodiment of the present invention wherein an interrogation reader 20 is capable of ascertaining if a wireless communication device 10 has been subjected to a certain threshold force. A series of links 42 are coupled to the wireless communication device 10, as illustrated in Figure 3, to form the antenna 18. Figure 11A illustrates two locking mechanisms 115A, 115B in an unlocked position that are provided inline in the series of links 42 attached by a linking device 113. The locking mechanisms 115A, 115B are placed on the outside of two adjacent links 42. The locking mechanisms 115A, 115B are slanted outward and are designed only to move outward and return to their original position, but the locking mechanisms

115A, 115B will not move further inward than their resting position, as illustrated in Figure 11A.

[0063] As the links 42 are pulled outward on each side, the locking mechanisms 115A, 115B move outward, and the height of the locking mechanisms 115A, 115B lower. If a sufficient tension is exerted on the links 42, the links 42 will exert pressure on the locking mechanisms 115A, 115B thereby moving the locking mechanisms 115A, 115B outward. Eventually, the locking mechanisms 115A,115B will move outward such that the links 42 will clear the locking mechanisms 115A,115B and move to their outside, as illustrated in Figure 11B.

[0064] The locking mechanisms 115A, 115B are constructed out of a conductive material so that the locking mechanisms 115A, 115B form part of the conductor used by the wireless communication device 10 as an antenna 18 when in a locked position. When the locking mechanisms 115A, 115B are in a locked position, the links 42, by the force of the linking device 113 causing the links 42 to have force placed on them inwardly, are in conductive contact with the locking mechanisms 115A, 115B, thereby forming a conductor to be used by the wireless communication device 10 as an antenna 18 for communications to an interrogation reader 20.

[0065] Since the locking mechanisms 115A, 115B only become locked when a certain threshold force is applied to the links 42, the conductor is only formed when a certain threshold force has been applied to the links 42 at least once. Once this threshold force has been applied, the conductor stays formed even if the force is released due to the locking mechanism 115A, 115B keeping the links 42 from releasing, thereby breaking the conductivity in the conductor.

[0066] The interrogation reader 20, by receipt of communication from the wireless communication device 10 that includes the locking mechanisms 115A, 115B has knowledge that a certain threshold force has been applied to the links 42. If the wireless communication device 10 was not in range of the field 34 of the interrogation reader 20 at the time the threshold force was applied to the links 42, the interrogation reader 20 could still determine that the threshold force was applied to the wireless communication device 10 at some time in its past since the locking mechanisms 115A,115B stay locked, keeping the conductor formed. Again, note that other conductive elements, such as hollow conductive spheres 44, may also be used with this embodiment to form the conductor.

[0067] Figure 12 illustrates a block diagram of an information reporting configuration for the present invention whereby information received by the interrogation reader 20 from wireless communication devices 10 is communicated to other systems. The interrogation reader 20 may be coupled to a reporting system 120. This reporting system 120 may be located in close proximity to the interrogation reader 20, and may be coupled to the interrogation reader 20 by either a wired or wireless connection. The reporting system 120 may be a user interface or other computer system that is capable of receiving information about objects that contain wireless communication devices 10. The information may be used to track the objects or to store information concerning the objects in memory (not shown).

[0068] The reporting system 120 may also further communicate information from the wireless communication devices 10 to a remote system 122 located remotely from the reporting system 120 and/or the interrogation reader 20. The communication between the reporting system 120 and the remote system 122 may be through wired communication, modem communication or other networking communication, such as the Internet. Alternatively, the interrogation reader 20 may communicate information about the wireless communication devices 10 directly to the remote system 122 rather than first reporting the information through the reporting system 120.

[0069] Certain modifications and improvements will occur to those skilled in the art upon a reading of the foregoing description. It should be understood that the present invention is not limited to any particular type of component, including but not limited to the wireless communication device 10 and its components, the interrogation reader 20 and its components, the link chain 40, the links 42, the flexible material 43, the hollow conductive sphere 44, the shaped link 48, the tyre 70, the load, 80, the axle 90, the tuning ring 100, the moveable link 110, the metal spheres 112, the locking mechanisms 115A, 115B, the linking device 113, the fixed conductor 114, the reporting system 120, and the remote system 122. For the purposes of this application, couple, coupled, or coupling is defined as either a direct connection or a reactive coupling. Reactive coupling is defined as either capacitive or inductive coupling.

[0070] One of ordinary skill in the art will recognize that there are different manners in which these elements can accomplish the present invention.

Claims

1. A device capable of wirelessly communicating information, comprising: a wireless communication device (10); and a series of conductive elements (40) coupled to said wireless communication device (10) forming as an antenna **characterised in that**, the conductive elements are arranged in a manner that they do not form conductive connections with each other unless they are placed under force and the conductive elements are coupled together in such a manner that they form a conductor when said series of conductive elements (40) are under a force; wherein at least one conductive element (42, 44, 100, 110) in said series of conductive elements (40) is coupled to said wireless communication device to form the antenna for said wireless communication device (10) to wirelessly communicate information when said series of conductive elements (40) are under sufficient force to become conductive.

2. A device as claimed in claim 1, wherein said series of conductive elements (40) are comprised of two different series of conductive elements (40) coupled to said wireless communication device (10) to form a dipole antenna (18).

3. A device as claimed in claim 1 or claim 2, wherein said series of conductive elements (40) are flexible.

4. A device as claimed in any one of claims 1 to 3, wherein said force is comprised from the group consisting of a stretching force, a compression force, a rotation force, and an expansion force.

5. A device as claimed in any one of claims 1 to 4, wherein said series of conductive elements is a link chain.

6. A device as claimed in claim 1, wherein said series of conductive elements (40) are comprised of a plurality of hollow conductive spheres (44) each having two orifices (46) and a shaped link (48) confining the distance between each of said plurality of hollow conductive spheres (44), wherein said shaped link (48) has a narrow center (50) and wider outer edges (52) wherein said wider outer edges (52) are inside said orifices (46) and are larger in diameter than said orifices (46) so that said shaped link (48) creates a conductive connection between said hollow conductive spheres (44) when said hollow conductive spheres elements (44) are stretched.

7. A device as claimed in claim 1 or claim 6, wherein said series of conductive elements (40), especially a plurality of hollow conductive spheres (44), are placed inside a tyre (70) and said series of conductive elements (40), especially said plurality of hollow conductive spheres (44), form a conductor when the pressure of said tyre (70) reaches a threshold pressure level.

8. A device as claimed in claim 1 or claim 6, wherein said series of conductive elements (40), especially a plurality of hollow conductive spheres (44), are attached to an object (80) that stretches said series of conductive elements (40), especially said plurality of hollow conductive spheres (44), to form a conductor when said object (80) is above a threshold weight level.

9. A device as claimed in claim 8, wherein said series of conductive elements (40), especially said plurality of hollow conductive spheres (44), are attached to an air-cargo pallet.

10. A device as claimed in claim 1 or claim 6, wherein said series of conductive elements (40), especially a plurality of hollow spheres (44), are attached to an axle (90) that stretches said series of conductive elements (40), especially said plurality of hollow spheres (44), to form a conductor when said axle (90) rotates above a threshold speed.

11. A device as claimed in claim 10, wherein said axle (90) is on a vehicle.

12. A device as claimed in any one of claims 1 to 5, further comprising a tuning ring (100) coupled to said series of conductive elements (40) and coupled to said wireless communication device (10) so that the strain on said wireless communication device (10) caused by said series of conductive elements (40) being placed under force is reduced.

13. A device as claimed in claim 12, wherein said tuning ring (100) is arranged to act as an antenna apart from said series of conductive elements (40) so that said wireless communication device (10) is capable of operating at more than one frequency.

14. A device as claimed in claim 13, wherein said tuning ring (100) resonates at an operating frequency of about 2.45 GHz, and said series of conductive elements (40) resonates at about 915 MHz when under force.

15. A device as claimed in any one of claims 1 to 5, wherein said series of conductive elements (40) contains a moveable link (110) and wherein said series of conductive elements (40) forms a first conductor with a first operating frequency and forms a second conductor that is longer than said first conductor with a second operating frequency when a force is placed on said moveable link (110).

16. A device as claimed in claim 15, wherein the length (L_1) of said first conductor is about 30.6 millimetres and the length (L_2) of said second conductor is about 51.4 millimetres.

17. A device as claimed in claim 15 or claim 16, wherein said first conductor has an operating frequency of about 2.45 GHz and the second conductor has an operating frequency of about 915 MHz.

18. A device as claimed in any one of claims 1 to 5, wherein said series of conductive elements (40) contains two moveable links (110) in two consecutive conductive elements (42) that are arranged to form a first conductor when a first force is applied to the first of said moveable links (110) and a second conductor at a length greater than said first conductor when a second force is applied to the second of said moveable links (110) so that said series of conductive elements (40) has an frequency operating range between the operating frequency of said first conductor and said second conductor.

19. A device as claimed in claim 18, wherein the length of said first conductor is about 30 millimetres and the length of said second conductor is about 31 millimetres.

20. A device as claimed in claim 19, wherein said first conductor has an operating frequency of about 2.4193 GHz and said second conductor has an operating frequency of about 2.5 GHz.

21. A device as claimed in any one of claims 1 to 5, further comprising a locking mechanism (115A, 115B) adjacent to at least one conductive element (42) in said series of conductive elements (40) that is arranged so that it locks said series of conductive elements (40) to form a conductor when a sufficient amount of force is placed on said series of conductive elements (40).

22. A device as claimed in claim 21, wherein said series of conductive elements (40) is a link chain.

23. A device as claimed in claim 21, further comprising a conductor (114) that is coupled in between said wireless communication device (10) and said series of conductive elements (44) so that it forms an antenna (18) having a first fixed length to operate at a first operating frequency when said series of conductive elements (44) are unlocked and wherein said series of conductive elements (44) form an antenna (18) having a second length to operate at a second operating frequency when said series of conductive elements (44) are locked.

24. A device as claimed in claim 23, wherein said first operating frequency is about 2.45 GHz and said second operating frequency is about 915 MHz.

25. A device as claimed in any one of claims 1 to 5, wherein said series of conductive elements (40) are comprised of a material that expands in relation to temperature.

26. A device as claimed in any one of claims 1 to 5, wherein said series of conductive elements (40) are coupled to a temperature sensitive material (43) that expands in relation to temperature in such a way that said series of conductive elements (40) is caused to stretch in relation to temperature.

27. A device as claimed in any one of claims 1 to 5, wherein said series of conductive elements (44) contains two expansion points, that are arranged in such a way that said series of conductive elements (40) forms a first conductor with a first operating frequency at a first temperature and forms a second conductor that is longer in length than said first conductor with a second operating frequency at a second temperature.

28. A device as claimed in claim 27, wherein the length of said first conductor is about 30.6 millimetres and the length of said second conductor is about 51.4 millimetres.

29. A device as claimed in claim 28, wherein said first conductor has an operating frequency of around about 2.45 GHz and the second conductor has an operating frequency of around about 915 MHz.

30. A wireless communication system for wirelessly communicating force information, comprising: an interrogation reader (20) that generates a radiating field to communicate the force information; and a device according to one of the claims 1 to 29 wherein the device communicates with said interrogation reader (20) when said series of conductive elements (40) are under sufficient force to become conductive and when said series of conductive elements (40) is in the range of said field.

31. A system as claimed in claim 30, wherein said force is comprised from the group consisting of a stretching force, a compression force, a rotation force, and an expansion force.

32. A system as claimed in claim 30, wherein said series of conductive elements (40) are coupled to a temperature sensitive material (43) that expands in relation to temperature in such a way that said series of conductive elements (40) is caused to stretch in relation to temperature.

33. A system as claimed in claim 30, further comprising a reporting system (120) that receives the force information from said interrogation reader (20) that is interrogated by said interrogation reader (20) from said wireless communication device (10).

34. A system as claimed in claim 33, further comprising a remote system (122) that is arranged in such a way that it receives the force information from said reporting system (120) after the force information is received by said interrogation reader (20).

35. A system as claimed in claim 30, further comprising a remote system (122) that is arranged in such a way that it receives the force information from said interrogation reader (20) that is interrogated by said interrogation reader (20) from said wireless communication device (10).

36. A method of wirelessly communicating information from a device according to one of the claims 1-29,

comprising the steps of: providing a series of conductive elements (40) that do not form conductive connections with each other unless they are placed under force,
placing the series of conductive elements coupled together under a force to form a conductor; and communicating information using said series of conductive elements (40) as an antenna (18) when said series of conductive elements (40) is placed under a force to form said conductor.

37. A method as claimed in claim 36, wherein said placing comprises placing said series of conductive elements (40) coupled together under a force individually in a manner to form two conductors to form a dipole antenna (18).

38. A method as claimed in claim 36 or claim 37, wherein said placing comprises stretching said series of conductive elements (40) coupled together in a manner to form a conductor.

39. A method as claimed in claim 36 or claim 37, wherein said placing comprises compressing said series of conductive elements (40) coupled together in a manner to form a conductor.

40. A method as claimed in claim 36 or claim 37, wherein said placing comprises rotating said series of conductive elements (40) coupled together in a manner to form a conductor.

41. A method as claimed in claim 36, further comprising placing a force on a tuning ring (100) coupled to said series of conductive elements (40) and coupled to a wireless communication device (10) to reduce the strain on said wireless communication device caused by said series of conductive elements (40), wherein the method especially further comprises communicating at a first frequency using said tuning ring (100) as a first antenna and communicating at a second frequency using said conductor formed by said series of conductive elements (40) under force to form a second antenna.

42. A method as claimed in claim 36, wherein said placing further comprises placing said series of conductive elements (40) coupled together under a first force to form a first conductor length capable of operating at a first frequency in a first mode of operation, and placing said series of conductive elements (40) coupled together under a second force to form a second conductor length capable of operating at a second frequency in a second mode of operation, wherein especially said placing further comprises placing said first force on a first of said series of conductive elements (40) and placing said second force on a second of said series of conductive elements (40) that is located adjacent to said first of said series of conductive elements.

43. A method as claimed in claim 36, wherein said placing further comprises locking said series of conductive elements (40) coupled together when placed under said force, wherein said communicating further comprises communicating at a first frequency using a conductor (114) coupled between said series of conductive elements (44) and said wireless communication device (10) and communicating at a second frequency after locking said series of conductive elements (44) coupled together when placed under said force.

44. A method as claimed in claim 36, wherein placing a series of conductive elements (40) coupled together under said force to form a conductor comprises expanding said series of conductive elements (40) coupled together that expand in relation to temperature to form said conductor.

45. A method as claimed in claim 44, wherein expanding further comprises attaching said series of conductive elements (40) to a temperature sensitive material (43) that expands in relation to temperature and thereby causes said series of conductive elements to stretch in relation to temperature.

46. A method as claimed in claim 44 or claim 45, wherein said expanding comprises expanding said series of conductive elements (40) coupled together individually in a manner to form two conductors to form a dipole antenna (18).

47. A method as claimed in any one of claims 44 to 46, wherein said expanding further comprises expanding said series of conductive elements (40) coupled together under a first force to form a first conductor length capable of operating at a first frequency in a first mode of operation, and expanding said series of conductive elements coupled together under a second force to form a second conductor length capable of operating at a second frequency in a second mode of operation, wherein especially said expanding further comprises expanding a first of said series of conductive elements and expanding a second of said series of conductive elements that is located adjacent to said first of said series of conductive elements.

48. A method as claimed in claim 44, wherein said expanding further comprises locking said series of conductive elements coupled together when expanded.

49. A method as claimed in claim 43, wherein said communicating further comprises communicating at a first frequency using said conductor (114) coupled between said series of conductive elements (44) and said wireless communication device (10) and communicating at a second frequency after locking said series of conductive elements (44) coupled together when expanded.

50. A method as claimed in claim 36, further comprising reporting the force information that is interrogated by an interrogation reader (20) from said wireless communication device (10) to a reporting system (120), wherein the method preferably further comprises reporting the force information received by said reporting system (120) to a remote system (122).

51. A method as claimed in claim 36, further comprising reporting the force information that is interrogated by an interrogation reader (20) from said wireless communication device (10) to a remote system (122).

Patentansprüche

1. Vorrichtung, zum drahtlosen Kommunizieren von Informationen, umfassend: eine drahtlose Kommunikationsvorrichtung (10) und eine Reihe von leitenden Elementen (40), die an die drahtlose Kommunikationsvorrichtung (10) gekoppelt sind, die eine Antenne bilden,
dadurch gekennzeichnet, daß
die leitenden Elemente auf eine Weise angeordnet sind, daß sie keine leitende Verbindung miteinander bilden, wenn sie nicht einer Kraft ausgesetzt sind, und die leitenden Elemente auf eine Weise miteinander gekoppelt sind, daß sie einen Leiter bilden, wenn die Reihe von leitenden Elementen (40) einer Kraft ausgesetzt sind, wobei zumindest ein leitendes Element (42, 44, 100, 100) in der Reihe von leitenden Elementen (40) an die drahtlose Kommunikationsvorrichtung gekoppelt ist, um die Antenne für die drahtlose Kommunikationsvorrichtung (10) zu bilden, um drahtlos Informationen zu kommunizieren, wenn die Reihe von leitenden Elementen (40) einer ausreichenden Kraft ausgesetzt sind, um leitend zu werden.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß**
die Reihe von leitenden Elementen (40) zwei verschiedene Reihen von leitenden Elementen (40) umfasst, gekoppelt an die drahtlose Kommunikationsvorrichtung (10), um eine Dipolantenne (18) zu bilden.

3. Vorrichtung nach Anspruch 1 oder Anspruch 2, **dadurch gekennzeichnet, daß**
die Reihen von leitenden Elementen (40) biegsam sind.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, daß**
die Kraft in der Gruppe enthalten ist, die aus einer streckenden Kraft, einer Kompressionskraft, einer zentrifugalen Kraft und einer Dehnkraft besteht.

5. Vorrichtung nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, daß**
die Reihe von leitenden Elementen eine Gliederkette ist.

6. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, daß**
die Reihen von leitenden Elementen (40) eine Mehrzahl von hohlen leitenden Kugeln (44) umfassen, von denen jede zwei Öffnungen (46) und ein geformtes Bindeglied (48) aufweist, das den Abstand zwischen jeder Kugel aus der Mehrzahl von hohlen leitenden Kugeln (44) begrenzt, wobei das Bindeglied (48) eine enge Mitte (50) und breitere äußere Enden (52) aufweist, wobei die breiteren äußeren Enden (52) im Inneren der Öffnungen (46) sind und einen größeren Durchmesser aufweisen, als die Öffnungen (46), so daß das geformte Bindeglied (48) eine leitende Verbindung zwischen den hohlen leitenden Kugeln (44) erzeugt, wenn die hohlen leitenden Kugelelemente (44) gestreckt werden.

7. Vorrichtung nach Anspruch 1 oder Anspruch 6, **dadurch gekennzeichnet, daß**
die Reihen von leitenden Elementen (40), insbesondere eine Vielzahl von hohlen leitenden Kugeln (44), im Inneren eines Reifens (70) angeordnet sind und die Reihen von leitenden Elementen (40), insbesondere die Vielzahl von hohlen leitenden Kugeln (44), einen Leiter bilden, wenn der Druck des Reifens (70) einen Druckpegelschwellenwert erreicht.

8. Vorrichtung nach Anspruch 1 oder Anspruch 6, **dadurch gekennzeichnet, daß**
die Reihen von leitenden Elementen (40), insbesondere eine Vielzahl von hohlen leitenden Kugeln (44), an einem Objekt (80) befestigt sind, das die Reihen von leitenden Elementen (40), insbesondere die Vielzahl von hohlen leitenden Kugeln (44), streckt, um einen Leiter zu bilden, wenn dies Objekt (80) sich über einem Gewichtsschwellenwert befindet.

9. Vorrichtung nach Anspruch 8, **dadurch gekennzeichnet, daß**
die Reihen von leitenden Elementen (40), insbesondere die Vielzahl von hohlen leitenden Kugeln (44), an einer Luftfrachtpalette befestigt sind.

10. Vorrichtung nach Anspruch 1 oder Anspruch 6, **dadurch gekennzeichnet, daß**

die Reihen von leitenden Elementen (40), insbesondere eine Vielzahl von hohlen leitenden Kugeln (44), an einer Achse (90) befestigt sind, die die Reihen von leitenden Elementen (40), insbesondere die Vielzahl von hohlen leitenden Kugeln (44), streckt, um einen Leiter zu bilden, wenn die Achse (90) sich oberhalb eines Geschwindigkeitsschwellenwerts dreht.

11. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, daß**
die Achse (90) sich an einem Fahrzeug befindet.

12. Vorrichtung nach einem der Ansprüche 1 bis 5, ferner umfassend
einen Einstellring (100) gekoppelt an die Reihen von leitenden Elementen (40) und gekoppelt an die drahtlose Kommunikationsvorrichtung (10), so daß die Belastung auf die drahtlose Kommunikationsvorrichtung (10), die durch die Reihen von leitenden Elementen (40), wenn sie einer Kraft ausgesetzt sind, verursacht wird, vermindert wird.

13. Vorrichtung nach Anspruch 12, **dadurch gekennzeichnet, daß**
der Einstellring (100) angeordnet wird, um als eine Antenne neben den Reihen von leitenden Elementen (40) zu agieren, so daß die drahtlose Kommunikationsvorrichtung geeignet ist, bei mehr als einer Frequenz zu arbeiten.

14. Vorrichtung nach Anspruch 13, **dadurch gekennzeichnet, daß**
der Einstellring (100) bei einer Betriebsfrequenz von ungefähr 2,45 GHz schwingt, und die Reihe von leitenden Elementen (40) unter Belastung bei ungefähr 915 MHz schwingt.

15. Vorrichtung nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, daß**
die Reihe von leitenden Elementen (40) ein bewegliches Bindeglied (110) enthält und
dadurch gekennzeichnet, daß die Reihe von leitenden Elementen (40) einen ersten Leiter mit einer ersten Betriebsfrequenz bildet und einen zweiten Leiter bildet, der länger ist als der erste Leiter, mit einer zweiten Betriebsfrequenz, wenn eine Kraft auf das bewegliche Bindeglied einwirkt (110).

16. Vorrichtung nach Anspruch 15, **dadurch gekennzeichnet, daß**
die Länge (L_1) des ersten Leiters ungefähr 30,6 Millimeter und die Länge (L_2) des zweiten Leiters ungefähr 51,4 Millimeter beträgt.

17. Vorrichtung nach Anspruch 15 oder Anspruch 16, **dadurch gekennzeichnet, daß** dier erster Leiter eine Betriebsfrequenz von ungefähr 2,45 GHz hat und der zweite Leiter eine Betriebsfrequenz von ungefähr 915 MHz hat.

18. Vorrichtung nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, daß**
die Reihe von leitenden Elementen (40) zwei bewegliche Bindeglieder (110) in zwei aufeinander folgenden leitenden Elementen (42) enthält, die angeordnet sind, um einen ersten Leiter zu bilden, wenn eine erste Kraft auf das erste der beweglichen Bindeglieder (110) ausgeübt wird, und einen zweiten Leiter mit einer Länge, die größer ist als der erste Leiter, wenn eine zweite Kraft auf das zweite bewegliche Bindeglied (110) ausgeübt wird, so daß die Reihe von beweglichen Elementen (40) einen Frequenzbetriebsbereich zwischen der Betriebsfrequenz des ersten Leiters und des zweiten Leiters aufweist.

19. Vorrichtung nach Anspruch 18, **dadurch gekennzeichnet, daß**
die Länge des ersten Leiters ungefähr 30 Millimeter beträgt und die Länge des zweiten Leiters ungefähr 31 Millimeter beträgt.

20. Vorrichtung nach Anspruch 19, **dadurch gekennzeichnet, daß**
der erste Leiter eine Betriebsfrequenz von ungefähr 2,4193 GHz aufweist und der zweite Leiter eine Betriebsfrequenz von ungefähr 2,5 GHz aufweist.

21. Vorrichtung nach einem der Ansprüche 1 bis 5, ferner umfassend
einen Sperrmechanismus (115A, 115B) neben zumindest einem leitenden Element (42) in der Reihe von leitenden Elementen (40), der so angeordnet ist, daß er die Reihe von leitenden Elementen (40) arretiert, um einen Leiter zu bilden, wenn eine ausreichende Menge an Kraft auf die Reihe von leitenden Elementen (40) ausgeübt wird.

22. Vorrichtung nach Anspruch 21, **dadurch gekennzeichnet, daß**
die Reihe von leitenden Elementen (40) eine Gliederkette ist.

23. Vorrichtung nach einem der Ansprüche 1 bis 5, ferner umfassend
einen Leiter (114), der zwischen der drahtlosen Kommunikationsvorrichtung (10) und den Reihen leitender Elemente (44) gekoppelt ist, so daß er eine Antenne (18) mit einer festen Länge bildet, um bei einer ersten Betriebsfrequenz zu arbeiten, wenn die Reihen leitender Elemente (44) nicht arretiert sind, und **dadurch gekennzeichnet, daß** die Reihen von leitenden Elementen (44) eine Antenne (18) mit einer zweiten Länge bilden, um bei einer zweiten Betriebsfrequenz zu arbeiten, wenn die Reihen von leitenden Elementen (44) arretiert sind.

24. Vorrichtung nach Anspruch 23, **dadurch gekennzeichnet, daß** die erste Betriebsfrequenz ungefähr 2,45 GHz beträgt und die zweite Betriebsfrequenz ungefähr 915 MHz beträgt.

25. Vorrichtung nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, daß** die Reihen leitender Elemente (40) ein Material umfassen, das sich in Bezug auf Temperatur ausdehnt.

26. Vorrichtung nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, daß** die Reihen leitender Elemente (40) an ein temperaturempfindliches Material (43) gekoppelt sind, das sich in Bezug auf Temperatur auf eine solche Weise ausdehnt, daß die Reihen leitender Elemente (40) veranlasst werden, sich in Bezug auf Temperatur zu strecken.

27. Vorrichtung nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, daß** die Reihe leitender Elemente (44) zwei Dehnungspunkte enthält, die so angeordnet sind, daß die Reihe leitender Elemente (40) einen ersten Leiter mit einer ersten Betriebsfrequenz bei einer ersten Temperatur bildet und einen zweiten Leiter, der einer längere Länge hat als der erste Leiter, mit einer zweiten Betriebsfrequenz bei einer zweiten Temperatur bildet.

28. Vorrichtung nach Anspruch 27, **dadurch gekennzeichnet, daß** die Länge des ersten Leiters ungefähr 30,6 Millimeter beträgt und die Länge des zweiten Leiters ungefähr 51,4 Millimeter beträgt.

29. Vorrichtung nach Anspruch 28, **dadurch gekennzeichnet, daß** der erste Leiter eine Betriebsfrequenz von ungefähr 2,45 GHz aufweist und der zweite Leiter eine Betriebsfrequenz von ungefähr 915 MHz aufweist.

30. Drahtloses Kommunikationssystem zum drahtlosen Kommunizieren von Kraftinformationen, umfassend: einer Abfragelesevorrichtung (20), die ein ausstrahlendes Feld erzeugt, um die Kraftinformationen zu kommunizieren, und eine Vorrichtung nach einem der Ansprüche 1 bis 29, **dadurch gekennzeichnet, daß** die Vorrichtung mit der Abfragelesevorrichtung (20) kommuniziert, wenn die Reihen leitender Elemente (40) ausreichender Kraft ausgesetzt sind, um leitend zu werden, und wenn sich die Reihen leitender Elemente (40) in der Reichweite dieses Feldes befinden.

31. System nach Anspruch 30, **dadurch gekennzeichnet, daß** die Kraft in der Gruppe enthalten ist, die aus einer streckenden Kraft, einer Kompressionskraft, einer zentrifugalen Kraft und einer Dehnkraft besteht.

32. System nach Anspruch 30, **dadurch gekennzeichnet, daß** die Reihen leitender Elemente (40) an ein temperaturempfindliches Material (43) gekoppelt sind, das sich in Bezug auf Temperatur so dehnt, daß die Reihe leitender Elemente (40) veranlasst wird, sich in Bezug auf Temperatur zu strecken.

33. System nach Anspruch 30, ferner umfassend ein Berichtssystem (120), das die Kraftinformationen von der Abfragelesevorrichtung (20) empfängt, die durch die Abfragelesevorrichtung (20) von der drahtlosen Kommunikationsvorrichtung (10) abgefragt werden.

34. System nach Anspruch 33, ferner umfassend ein Fernsystem (122), das so ausgebildet ist, daß es die Kraftinformationen von dem Berichtssystem (120) empfängt, nachdem die Kraftinformationen durch die Abfragelesevorrichtung (20) empfangen werden.

35. System nach Anspruch 30, ferner umfassend ein Fernsystem (122), das so ausgebildet ist, daß es die Kraftinformationen von der Abfragelesevorrichtung (20) empfängt, die durch die Abfragelesevorrichtung (20) von der drahtlosen Kommunikationsvorrichtung (10) abgefragt werden.

36. Verfahren zum drahtlosen Kommunizieren von Informationen von einer Vorrichtung nach einem der Ansprüche 1 bis 29, umfassend die Schritte: Bereitstellen einer Reihe leitender Elemente (40), die keine leitenden Verbindungen miteinander bilden, wenn sie nicht einer Kraft ausgesetzt sind,
Anwenden einer Kraft auf die Reihe von leitenden Elementen, die miteinander gekoppelt sind, um einen Leiter zu bilden,
und
Kommunizieren von Informationen unter Verwendung der Reihe von leitenden Elementen (40) als eine Antenne (18), wenn die Reihe von leitenden Elementen (40) einer Kraft ausgesetzt ist, um den Leiter zu bilden.

37. Verfahren nach Anspruch 36, **dadurch gekennzeichnet, daß** das Anwenden einer Kraft das einzelne Anwenden einer Kraft auf die Reihe von leitenden Elementen (40), die miteinander gekoppelt sind, auf eine Weise umfaßt, um zwei Leiter zu bilden, um eine Dipolantenne (18) zu bilden.

38. Verfahren nach Anspruch 36 oder Anspruch 37, **dadurch gekennzeichnet, daß**
das Anwenden das Strecken der Reihe von leitenden Elementen (40), die miteinander gekoppelt sind, auf eine Weise umfaßt, um einen Leiter zu bilden.

39. Verfahren nach Anspruch 36 oder Anspruch 37, **dadurch gekennzeichnet, daß**
das Anwenden das Zusammendrücken der Reihe von leitenden Elementen (40), die miteinander gekoppelt sind, auf eine Weise umfaßt, um einen Leiter zu bilden.

40. Verfahren nach Anspruch 36 oder Anspruch 37, **dadurch gekennzeichnet, daß**
das Anwenden das Drehen der Reihe von leitenden Elementen (40), die miteinander gekoppelt sind, auf eine Weise umfaßt, um einen Leiter zu bilden.

41. Verfahren nach Anspruch 36, ferner umfassend
das Anwenden einer Kraft auf einen Einstellring (100) gekoppelt an die Reihe von leitenden Elementen (40) und gekoppelt an die drahtlose Kommunikationsvorrichtung (10), um die Belastung der drahtlosen Kommunikationsvorrichtung (10), die durch die Reihe von leitenden Elementen (40) verursacht wird, zu vermindern, wobei
das Verfahren insbesondere ferner umfaßt das Kommunizieren bei einer ersten Frequenz unter Verwendung des Einstellrings (100) als eine erste Antenne und Kommunizieren bei einer zweiten Frequenz unter Verwendung des Leiters, der durch die Reihe leitender Elemente (40) unter Krafteinwirkung gebildet wird, um eine zweite Antenne zu bilden.

42. Verfahren nach Anspruch 36, **dadurch gekennzeichnet, daß**
das Anwenden ferner das Anwenden einer ersten Kraft auf die Reihen von leitenden Elementen (40), die aneinander gekoppelt sind, umfaßt, um eine erste Leiterlänge zu bilden, die geeignet ist, bei einer ersten Frequenz in einer ersten Betriebsart zu arbeiten, und Anwenden einer zweiten Kraft auf die Reihen von leitenden Elementen (40), die aneinander gekoppelt sind, um eine zweite Leiterlänge zu bilden, die geeignet ist, bei einer zweiten Frequenz in einer zweiten Betriebsart zu arbeiten, wobei insbesondere das Anwenden ferner umfaßt das Anwenden der ersten Kraft auf eine erste der Reihen von leitenden Elementen (40) und das Anwenden der zweiten Kraft auf eine zweite der Reihen von leitenden Elementen (40), die neben der erste der Reihen von leitenden Elementen angeordnet ist.

43. Verfahren nach Anspruch 36, **dadurch gekennzeichnet, daß**
das Anwenden ferner umfasst das Arretieren der Reihe von leitenden Elementen (40), die aneinander gekoppelt sind, wenn sie einer Kraft ausgesetzt sind, wobei das Kommunizieren ferner umfasst das Kommunizieren bei einer ersten Frequenz unter Verwendung eines Leiters (114), der zwischen die Reihe von leitenden Elementen (44) und die drahtlose Kommunikationsvorrichtung (10) gekoppelt ist, und das Kommunizieren bei einer zweiten Frequenz nach dem Arretieren der Reihe von leitenden Elementen (44), die aneinander gekoppelt sind, wenn sie einer Kraft ausgesetzt sind.

44. Verfahren nach Anspruch 36, **dadurch gekennzeichnet, daß**
das Anwenden von Kraft auf eine Reihe von leitenden Elementen (40), die unter besagter Kraft aneinander gekoppelt sind, um einen Leiter zu bilden, umfaßt das Ausdehnen der Reihe von leitenden Elementen, die aneinander gekoppelt sind, die sich in Bezug auf Temperatur ausdehnen, um dien Leiter zu bilden.

45. Verfahren nach Anspruch 44, **dadurch gekennzeichnet, daß**
das Dehnen ferner umfaßt das Befestigen der Reihe leitender Elemente (40) an einem temperaturempfindlichen Material (43), das sich in Bezug auf Temperatur ausdehnt und **dadurch** die Reihe leitender Elemente (40) veranlaßt, sich in Bezug auf Temperatur zu strecken.

46. Verfahren nach Anspruch 44 oder Anspruch 45, **dadurch gekennzeichnet, daß**
das Dehnen das einzelne Dehnen der Reihe von leitenden Elementen (40), die aneinander gekoppelt sind, auf eine Weise umfaßt, um zwei Leiter zu bilden, um eine Dipolantenne (18) zu bilden.

47. Verfahren nach einem der Ansprüche 44 bis 46, **dadurch gekennzeichnet, daß**
das Dehnen ferner das Dehnen der Reihen von leitenden Elementen (40), die aneinander gekoppelt sind, unter einer ersten Kraft umfaßt, um eine erste Leiterlänge zu bilden, die geeignet ist, bei einer ersten Frequenz in einer ersten Betriebsart zu arbeiten, und das Dehnen der Reihen von leitenden Elementen (40), die aneinander gekoppelt sind, unter einer zweiten Kraft, um eine zweite Leiterlänge zu bilden, die geeignet ist, bei einer zweiten Frequenz in einer zweiten Betriebsart zu arbeiten, wobei insbesondere das Dehnen ferner umfaßt das Dehnen einer ersten der Reihen von leitenden Elementen und das Dehnen einer zweite der Reihen von leitenden Elementen, die neben der erste der Reihen von leitenden Elementen angeordnet ist.

48. Verfahren nach Anspruch 44, **dadurch gekennzeichnet, daß**
das Dehnen ferner umfaßt das Arretieren der Reihe

von leitenden Elementen, die aneinander gekoppelt sind, wenn sie gedehnt sind.

49. Verfahren nach Anspruch 43, **dadurch gekennzeichnet, daß**
das Kommunizieren ferner umfaßt das Kommunizieren bei einer ersten Frequenz unter Verwendung des Leiters (114), der zwischen der Reihe von leitenden Elementen (44) und der drahtlosen Kommunikationsvorrichtung gekoppelt ist, und das Kommunizieren bei einer zweiten Frequenz nach dem Arretieren der Reihe von leitenden Elementen, die aneinander gekoppelt sind, wenn sie gedehnt sind.

50. Verfahren nach Anspruch 36, ferner umfassend
das Berichten der Kraftinformationen, die durch eine Abfragelesevornchtung (20) von der drahtlosen Kommunikationsvorrichtung (10) abgefragt werden, an ein Berichtssystem (120), wobei das Verfahren vorzugsweise ferner umfaßt das Berichten der durch das Berichtssystem (129) empfangenen Kraftinformationen an ein Fernsystem (122).

51. Verfahren nach Anspruch 36, ferner umfassend
das Berichten der Kraftinformationen, die durch eine Abfragelesevorrichtung (20) von der drahtlosen Kommunikationsvorrichtung (10) abgefragt werden, an ein Fernsystem (122).

Revendications

1. Dispositif capable de communiquer sans fil des informations, comportant : un dispositif de communication sans fil (10) ; et une série d'éléments conducteurs (40) couplés audit dispositif de communication sans fil (10) formant une antenne, **caractérisé en ce que** les éléments conducteurs sont agencés de telle manière qu'ils ne forment pas des connexions conductrices les uns avec les autres à moins qu'ils ne soient placés sous une force, et les éléments conducteurs sont couplés ensemble de telle manière qu'ils forment un conducteur lorsque ladite série d'éléments conducteurs (40) sont sous une force ; dans lequel au moins un élément conducteur (42, 44, 100, 110) dans ladite série d'éléments conducteurs (40) est couplé audit dispositif de communication sans fil pour former l'antenne afin que ledit dispositif de communication sans fil (10) communique sans fil des informations lorsque ladite série d'éléments conducteurs (40) sont sous une force suffisante pour devenir conducteurs.

2. Dispositif selon la revendication 1, dans lequel ladite série d'éléments conducteurs (40) sont constitués de deux séries différentes d'éléments conducteurs (40) couplés audit dispositif de communication sans fil (10) pour former une antenne dipôle (18).

3. Dispositif selon la revendication 1 ou 2, dans lequel ladite série d'éléments conducteurs (40) sont souples.

4. Dispositif selon l'une quelconque des revendications 1 à 3, dans lequel ladite force est dans le groupe constitué d'une force d'étirement, d'une force de compression, d'une force de rotation, et d'une force de dilatation.

5. Dispositif selon l'une quelconque des revendications 1 à 4, dans lequel ladite série d'éléments conducteurs est une chaîne à maillons.

6. Dispositif selon la revendication 1, dans lequel ladite série d'éléments conducteurs (40) est constituée d'une pluralité de sphères conductrices creuses (44), chacune ayant deux orifices (46) et un maillon mis en forme (48) confinant la distance entre chacune parmi ladite pluralité de sphères conductrices creuses (44), dans lequel ledit maillon mis en forme (48) a un centre étroit (50) et des bords extérieurs plus larges (52), dans lequel lesdits bords extérieurs plus larges (52) sont à l'intérieur desdits orifices (46) et ont un diamètre supérieur auxdits orifices (46), de sorte que ledit maillon mis en forme (48) crée une connexion conductrice entre lesdites sphères conductrices creuses (44) lorsque lesdites sphères conductrices creuses (44) sont étirées.

7. Dispositif selon la revendication 1 ou 6, dans lequel ladite série d'éléments conducteurs (40), en particulier une pluralité de sphères conductrices creuses (44), est mise en place à l'intérieur d'un pneumatique (70), et ladite série d'éléments conducteurs (40), en particulier ladite pluralité de sphères conductrices creuses (44), forme un conducteur lorsque la pression dudit pneumatique (70), atteint un niveau de pression de seuil.

8. Dispositif selon la revendication 1 ou 6, dans lequel ladite série d'éléments conducteurs (40), en particulier une pluralité de sphères conductrices creuses (44), est fixée sur un objet (80) qui étire ladite série d'éléments conducteurs (40), en particulier ladite pluralité de sphères conductrices creuses (44), pour former un conducteur lorsque ledit objet (80) est audessus d'un niveau de poids de seuil.

9. Dispositif selon la revendication 8, dans lequel ladite série d'éléments conducteurs (40), en particulier ladite pluralité de sphères conductrices creuses (44), est fixée sur une palette de fret aérien.

10. Dispositif selon la revendication 1 ou 6, dans lequel ladite série d'éléments conducteurs (40), en particulier une pluralité de sphères creuses (44), est fixée sur un essieu (90) qui étire ladite série d'éléments conducteurs (40), en particulier ladite pluralité de sphères creuses (44), pour former un conducteur lorsque ledit essieu (90) tourne au-dessus d'une vitesse de seuil.

11. Dispositif selon la revendication 10, dans lequel ledit essieu (90) est sur un véhicule.

12. Dispositif selon l'une quelconque des revendications 1 à 5, comportant en outre une bague de syntonisation (100) couplée à ladite série d'éléments conducteurs (40) et couplée audit dispositif de communication sans fil (10), de sorte que la contrainte sur ledit dispositif de communication sans fil (10), causée par ladite série d'éléments conducteurs (40) placés sous une force, est réduite.

13. Dispositif selon la revendication 12, dans lequel ladite bague de syntonisation (100) est agencée pour agir en tant qu'antenne indépendamment de ladite série d'éléments conducteurs (40), de sorte que ledit dispositif de communication sans fil (10) est capable de fonctionner à plus d'une fréquence.

14. Dispositif selon la revendication 13, dans lequel ladite bague de syntonisation (100) résonne à une fréquence de fonctionnement d'environ 2,45 GHz, et ladite série d'éléments conducteurs (40) résonne à environ 915 MHz lorsqu'ils sont sous une force.

15. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel ladite série d'éléments conducteurs (40) contiennent un maillon mobile (110), et dans lequel ladite série d'éléments conducteurs (40) forment un premier conducteur ayant une première fréquence de fonctionnement, et forment un second conducteur qui est plus long que ledit premier conducteur, ayant une seconde fréquence de fonctionnement lorsqu'une force est placée sur ledit maillon mobile (110).

16. Dispositif selon la revendication 15, dans lequel la longueur (L_1) dudit premier conducteur est d'environ 30,6 millimètres, et la longueur (L_2) dudit second conducteur est d'environ 51,4 millimètres.

17. Dispositif selon la revendication 15 ou 16, dans lequel ledit premier conducteur a une fréquence de fonctionnement d'environ 2,45 GHz, et le second conducteur a une fréquence de fonctionnement d'environ 915 MHz.

18. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel ladite série d'éléments conducteurs (40) contiennent deux maillons mobiles (110) dans deux éléments conducteurs consécutifs (42) qui sont agencés pour former un premier conducteur lorsqu'une première force est appliquée sur le premier desdits maillons mobiles (110), et un second conducteur sur une longueur supérieure audit premier conducteur lorsqu'une seconde force est appliquée sur le second desdits maillons mobiles (110), de sorte que ladite série d'éléments conducteurs (40) a une plage de fréquence de fonctionnement entre la fréquence de fonctionnement dudit premier conducteur et celle dudit second conducteur.

19. Dispositif selon la revendication 18, dans lequel la longueur dudit premier conducteur est d'environ 30 millimètres, et la longueur dudit second conducteur est d'environ 31 millimètres.

20. Dispositif selon la revendication 19, dans lequel ledit premier conducteur a une fréquence de fonctionnement d'environ 2,4193 GHz, et ledit second conducteur a une fréquence de fonctionnement d'environ 2,5 GHz

21. Dispositif selon l'une quelconque des revendications 1 à 5, comportant en outre un dispositif de verrouillage (115A, 115B) adjacent à au moins un élément conducteur (42) dans ladite série d'éléments conducteurs (40), qui est agencé de sorte qu'il verrouille ladite série d'éléments conducteurs (40) pour former un conducteur lorsqu'une quantité suffisante de force est placée sur ladite série d'éléments conducteurs (40).

22. Dispositif selon la revendication 21, dans lequel ladite série d'éléments conducteurs (40) est une chaîne à maillons.

23. Dispositif selon la revendication 21, comportant en outre un conducteur (114) qui est couplé entre ledit dispositif de communication sans fil (10) et ladite série d'éléments conducteurs (44), de sorte qu'il forme une antenne (18) ayant une première longueur fixe pour fonctionner à une première fréquence de fonctionnement lorsque ladite série d'éléments conducteurs (44) sont déverrouillés, et dans lequel ladite série d'éléments conducteurs (44) forme une antenne (18) ayant une seconde longueur pour fonctionner à une seconde fréquence de fonctionnement lorsque ladite série d'éléments conducteurs (44) sont verrouillés.

24. Dispositif selon la revendication 23, dans lequel ladite première fréquence de fonctionnement est d'environ 2,45 GHz, et ladite seconde fréquence de fonctionnement est d'environ 915 MHz.

25. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel ladite série d'éléments conducteurs (40) sont constitués d'un matériau qui se dilate par rapport à une température.

26. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel ladite série d'éléments conducteurs (40) sont couplés à un matériau thermosensible (43) qui se dilate par rapport à une température, de telle manière que ladite série d'éléments conducteurs (40) sont amenés à s'étirer par rapport à une température.

27. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel ladite série d'éléments conducteurs (44) contiennent deux points de dilatation qui sont agencés de telle manière que ladite série d'éléments conducteurs (40) forment un premier conducteur ayant une première fréquence de fonctionnement à une première température, et forme un second conducteur qui est plus long en longueur que ledit premier conducteur, ayant une seconde fréquence de fonctionnement à une seconde température.

28. Dispositif selon la revendication 27, dans lequel la longueur dudit premier conducteur est d'environ 30,6 millimètres, et la longueur dudit second conducteur est d'environ 51,4 millimètres.

29. Dispositif selon la revendication 28, dans lequel ledit premier conducteur a une fréquence de fonctionnement d'environ 2,45 GHz, et le second conducteur a une fréquence de fonctionnement d'environ 915 MHz.

30. Système de communication sans fil pour communiquer sans fil des informations de force, comportant : un lecteur d'interrogation (20) qui génère un champ rayonnant pour communiquer les informations de force ; et un dispositif selon l'une quelconque des revendications 1 à 29, dans lequel le dispositif communique avec ledit lecteur d'interrogation (20) lorsque ladite série d'éléments conducteurs (40) sont sous une force suffisante pour devenir conducteurs, et lorsque ladite série d'éléments conducteurs (40) sont dans l'étendue dudit champ.

31. Système selon la revendication 30, dans lequel ladite force est dans le groupe constitué d'une force d'étirement, d'une force de compression, d'une force de rotation, et d'une force de dilatation.

32. Système selon la revendication 30, dans lequel ladite série d'éléments conducteurs (40) sont couplés à un matériau thermosensible (43) qui se dilate par rapport à une température, de telle manière que ladite série d'éléments conducteurs (40) sont amenés à s'étirer par rapport à une température.

33. Système selon la revendication 30, comportant en outre un système de rapport (120) qui reçoit les informations de force à partir dudit lecteur d'interrogation (20) qui est interrogé par ledit lecteur d'interrogation (20) à partir dudit dispositif de communication sans fil (10).

34. Système selon la revendication 33, comportant en outre un système à distance (122) qui est agencé de telle manière qu'il reçoit les informations de force à partir dudit système de rapport (120) après que les informations de force aient été reçues par ledit lecteur d'interrogation (20).

35. Système selon la revendication 30, comportant en outre un système à distance (122) qui est agencé de telle manière qu'il reçoit les informations de force à partir dudit lecteur d'interrogation (20) qui est interrogé par ledit lecteur d'interrogation (20) à partir dudit dispositif de communication sans fil (10).

36. Procédé de communication sans fil d'informations à partir d'un dispositif selon l'une quelconque des revendications 1 à 29, comportant les étapes consistant à : fournir une série d'éléments conducteurs (40) ne formant pas des connexions conductrices les uns avec les autres à moins qu'ils soient placés sous une force,

placer la série d'éléments conducteurs couplés ensemble sous une force pour former un conducteur ; et

communiquer des informations en utilisant ladite série d'éléments conducteurs (40) en tant qu'antenne (18) lorsque ladite série d'éléments conducteurs (40) est placée sous une force pour former ledit conducteur.

37. Procédé selon la revendication 36, dans lequel ledit placement comporte un placement de ladite série d'éléments conducteurs (40) couplés ensemble sous une force individuellement de manière à former deux conducteurs pour former une antenne dipôle (18).

38. Procédé selon la revendication 36 ou 37, dans lequel ledit placement comporte un étirement de ladite série d'éléments conducteurs (40) couplés ensemble de manière à former un conducteur.

39. Procédé selon la revendication 36 ou 37, dans lequel ledit placement comporte une compression de ladite série d'éléments conducteurs (40) couplés ensemble de manière à former un conducteur.

40. Procédé selon la revendication 36 ou 37, dans lequel ledit placement comporte une rotation de ladite série d'éléments conducteurs (40) couplés ensemble de manière à former un conducteur.

41. Procédé selon la revendication 36, comportant en outre l'étape consistant à placer une force sur une bague de syntonisation (100) couplée à ladite série d'éléments conducteurs (40), et couplée à un dispositif de communication sans fil (10) pour réduire la contrainte sur ledit dispositif de communication sans fil causée par ladite série d'éléments conducteurs (40), dans lequel le procédé comporte en outre particulièrement une communication à une première fréquence en utilisant ladite bague de syntonisation (100) en tant que première antenne, et une communication à une seconde fréquence en utilisant ledit conducteur formé par ladite série d'éléments conducteurs (40) sous une force afin de former une seconde antenne.

42. Procédé selon la revendication 36, dans lequel ledit placement comporte en outre le placement de ladite série d'éléments conducteurs (40) couplés ensemble sous une première force pour former une première longueur de conducteur capable de fonctionner à une première fréquence dans un premier mode de fonctionnement, et le placement de ladite série d'éléments conducteurs (40) couplés ensemble sous une seconde force pour former une seconde longueur de conducteur capable de fonctionner à une seconde fréquence dans un second mode de fonctionnement, dans lequel particulièrement ledit placement comporte en outre un placement de ladite première force sur un premier de ladite séries d'éléments conducteurs (40), et un placement de ladite seconde force sur un second de ladite série d'éléments conducteurs (40) qui est situé adjacent audit premier de ladite série d'éléments conducteurs.

43. Procédé selon la revendication 36, dans lequel ledit placement comporte en outre un verrouillage de ladite série d'éléments conducteurs (40) couplés ensemble lorsque placés sous ladite force, dans lequel ladite communication comporte en outre une communication à une première fréquence en utilisant un conducteur (114) couplé entre ladite séries d'éléments conducteurs (44) et ledit dispositif de communication sans fil (10), et une communication à une seconde fréquence après verrouillage de ladite série d'éléments conducteurs (44) couplés ensemble lorsque placés sous ladite force.

44. Procédé selon la revendication 36, dans lequel un placement d'une série d'éléments conducteurs (40) couplés ensemble sous ladite force pour former un conducteur comporte une dilatation de ladite série d'éléments conducteurs (40) couplés ensemble qui se dilatent par rapport à une température pour former ledit conducteur.

45. Procédé selon la revendication 44, dans lequel une dilatation comporte en outre une fixation de ladite série d'éléments conducteurs (40) sur un matériau thermosensible (43) qui se dilate par rapport à une température, et amène ainsi ladite série d'éléments conducteurs à s'étirer par rapport à une température.

46. Procédé selon la revendication 44 ou 45, dans lequel ladite dilatation comporte une dilatation de ladite série d'éléments conducteurs (40) couplés ensemble individuellement de manière à former deux conducteurs, afin de former une antenne dipôle (18).

47. Procédé selon l'une quelconque des revendications 44 à 46, dans lequel ladite dilatation comporte en outre une dilatation de ladite série d'éléments conducteurs (40) couplés ensemble sous une première force pour former une première longueur de conducteur capable de fonctionner à une première fréquence dans un premier mode de fonctionnement, et une dilatation de ladite série d'éléments conducteurs couplés ensemble sous une seconde force pour former une seconde longueur de conducteur capable de fonctionner à une seconde fréquence dans un second mode de fonctionnement, dans lequel en particulier ladite dilatation comporte en outre une dilatation d'un premier de ladite série d'éléments conducteurs et une dilatation d'un second de ladite série d'éléments conducteurs qui est situé adjacent audit premier de ladite série d'éléments conducteurs.

48. Procédé selon la revendication 44, dans lequel ladite dilatation comporte en outre un verrouillage de ladite série d'éléments conducteurs couplés ensemble lorsque dilatés.

49. Procédé selon la revendication 43, dans lequel ladite communication comporte en outre une communication à une première fréquence en utilisant ledit conducteur (114) couplé entre ladite séries d'éléments conducteurs (44) et ledit dispositif de communication sans fil (10), et une communication à une seconde fréquence après verrouillage de ladite série d'éléments conducteurs (44) couplés ensemble lorsque dilatés.

50. Procédé selon la revendication 36, comportant en outre un rapport des informations de force qui sont demandées par un lecteur d'interrogation (20) à partir dudit dispositif de communication sans fil (10) vers un système de rapport (120), dans lequel le procédé comporte en outre de préférence un rapport des informations de force reçues par ledit système de rapport (120) vers un système à distance (122).

51. Procédé selon la revendication 36, comportant en outre un rapport des informations de force qui sont demandées par un lecteur d'interrogation (20) à partir dudit dispositif de communication sans fil (10) vers un système à distance (122).

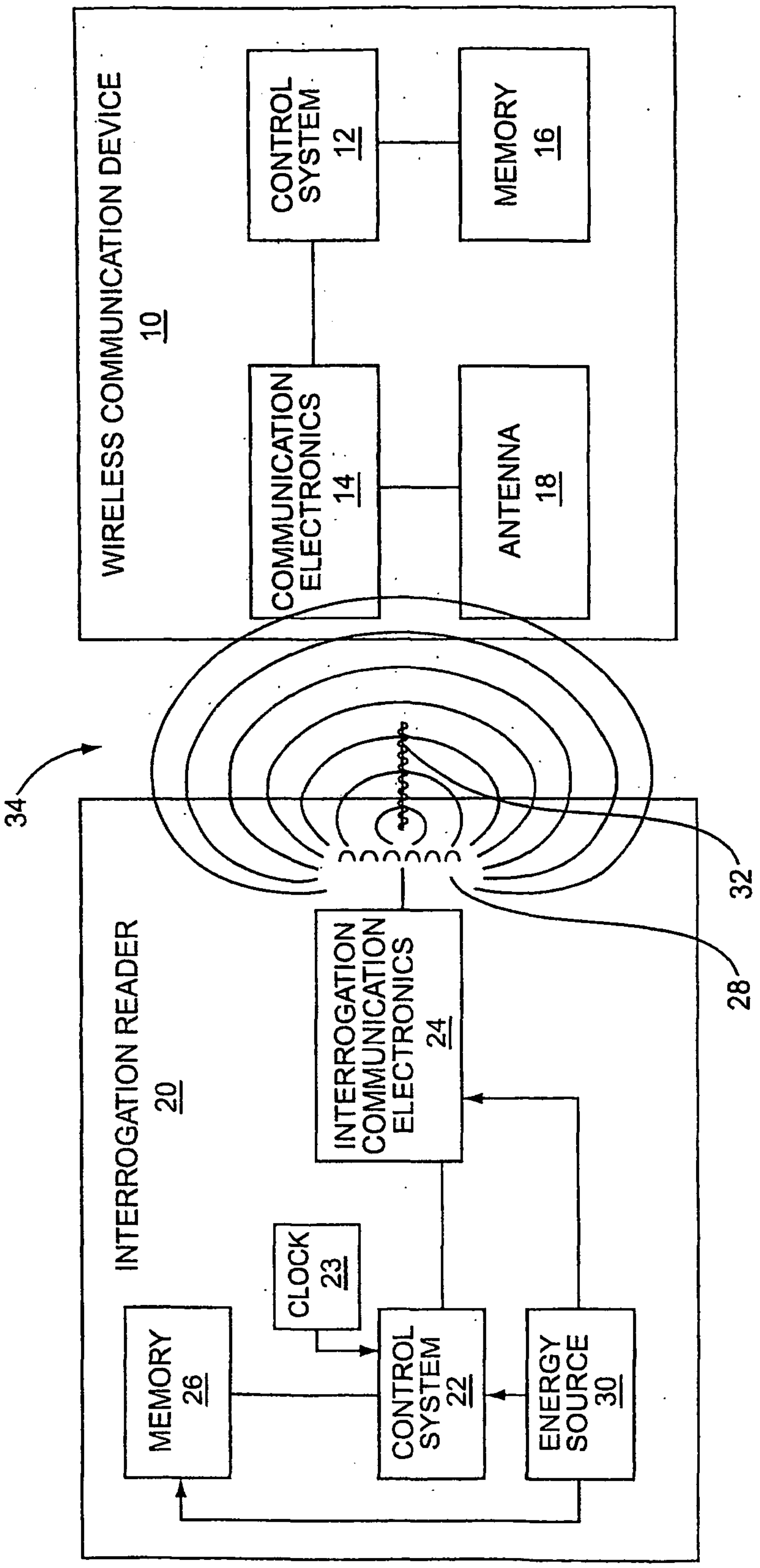

FIG. 1
PRIOR ART

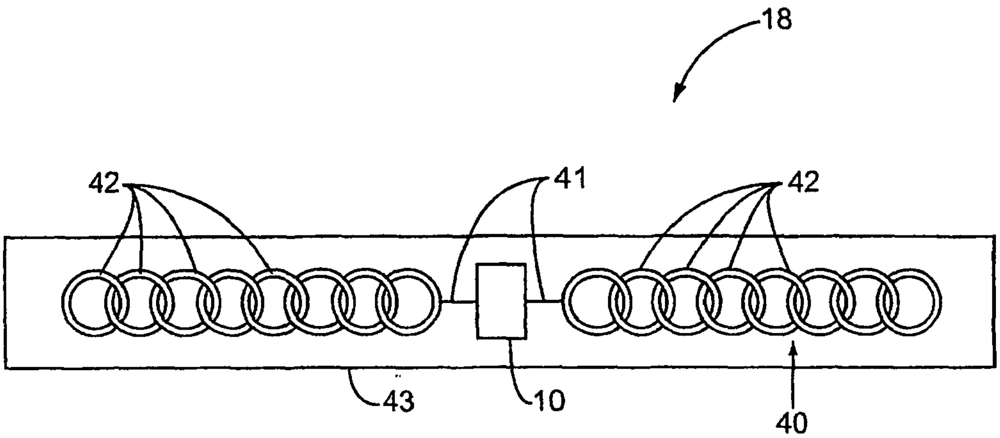

FIG. 2A

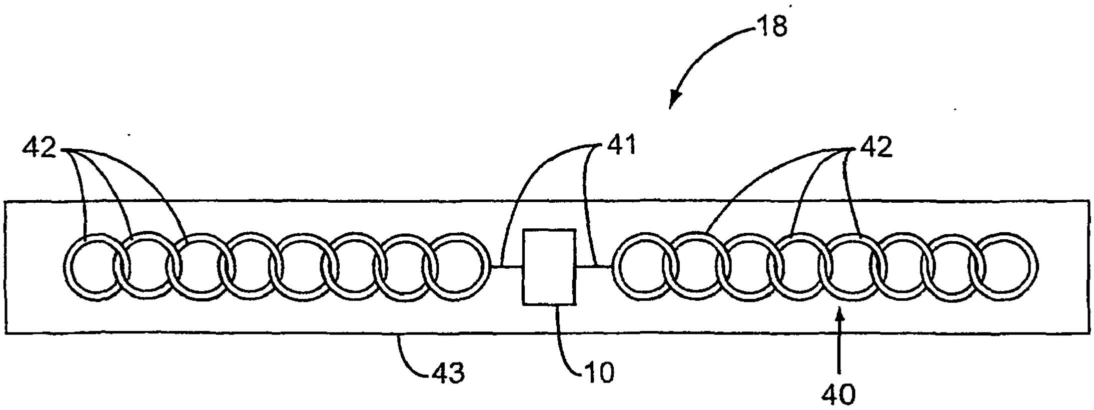

FIG. 2B

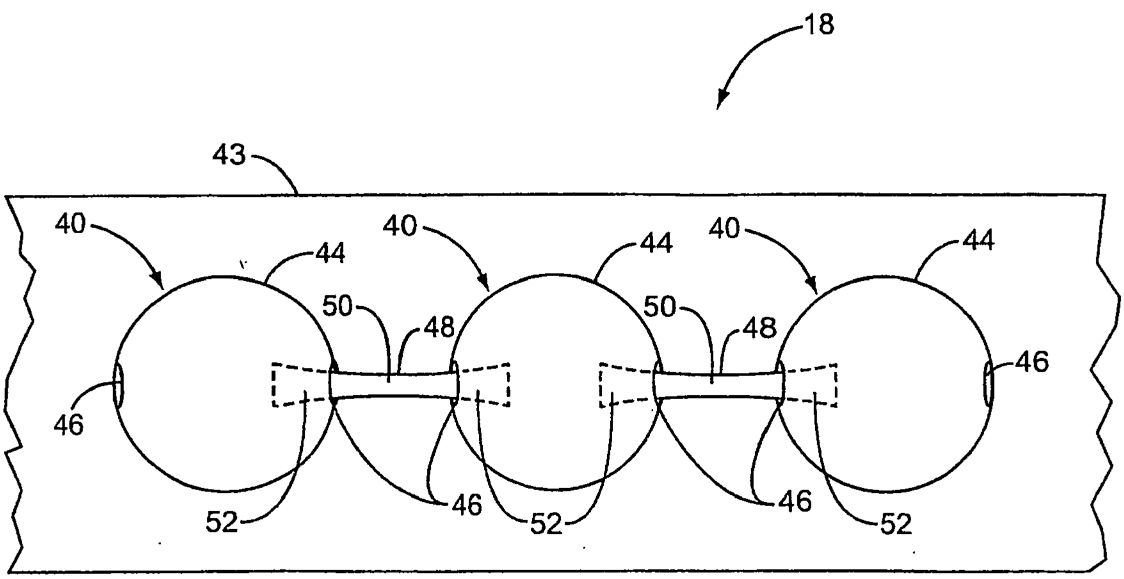

FIG. 3

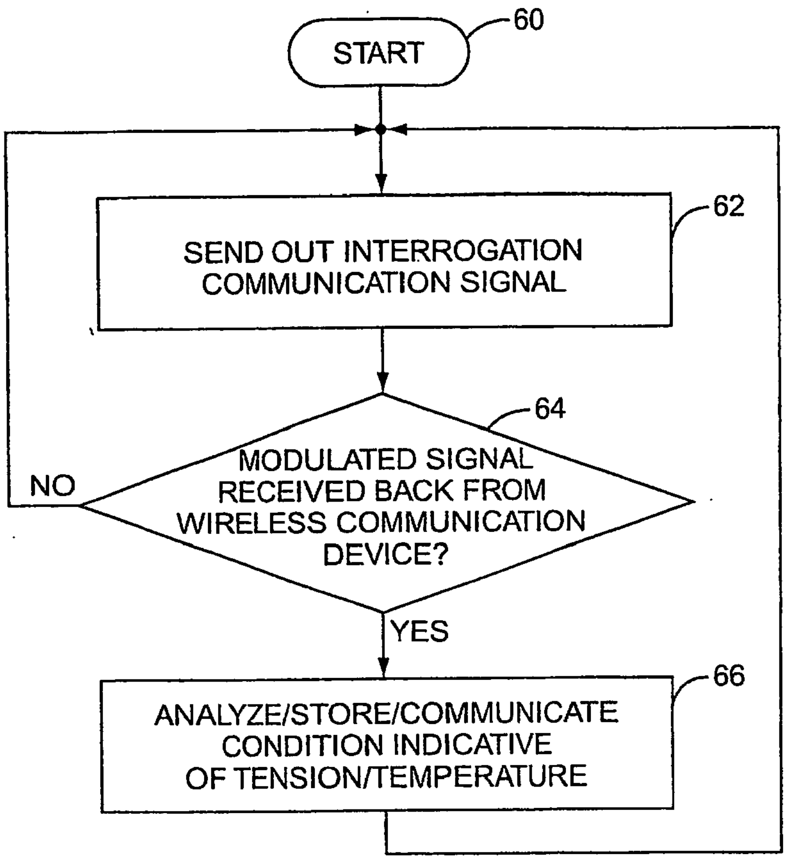
60
START
62
SEND OUT INTERROGATION COMMUNICATION SIGNAL
64
MODULATED SIGNAL RECEIVED BACK FROM WIRELESS COMMUNICATION DEVICE?
NO
YES
66
ANALYZE/STORE/COMMUNICATE CONDITION INDICATIVE OF TENSION/TEMPERATURE

FIG. 4

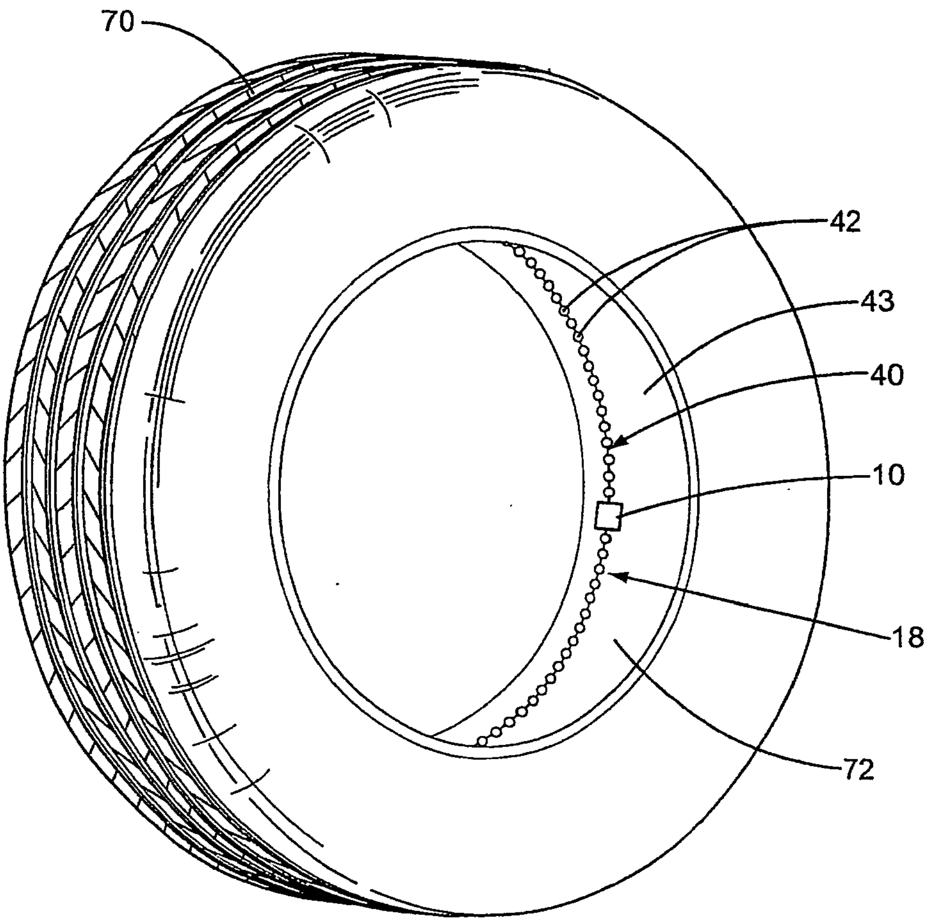

FIG. 5

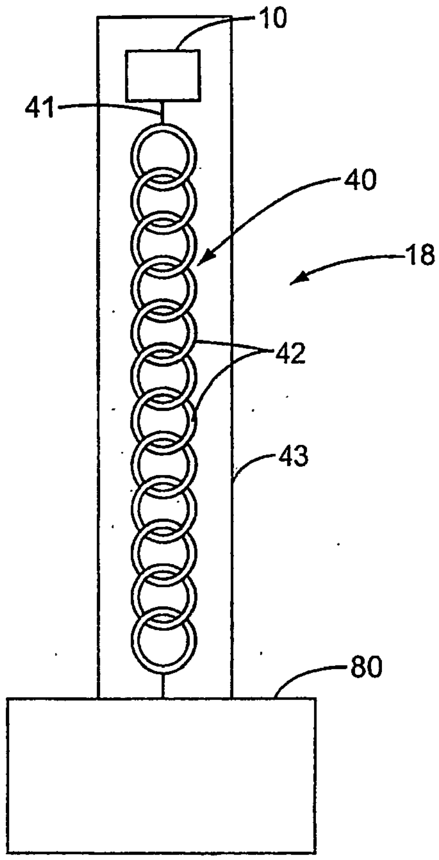

FIG. 6

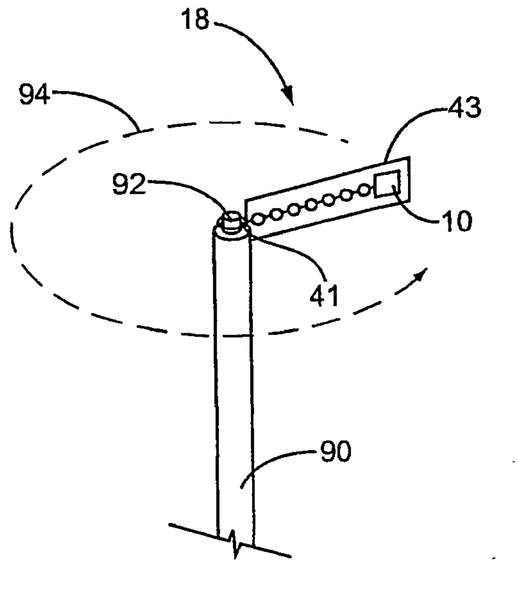

FIG. 7

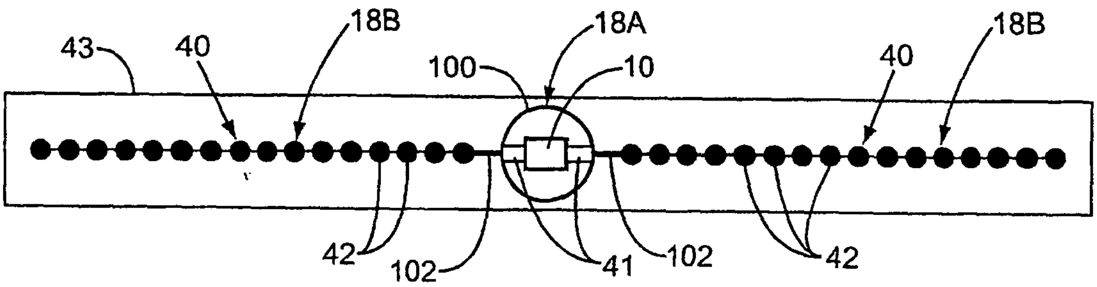

FIG. 8

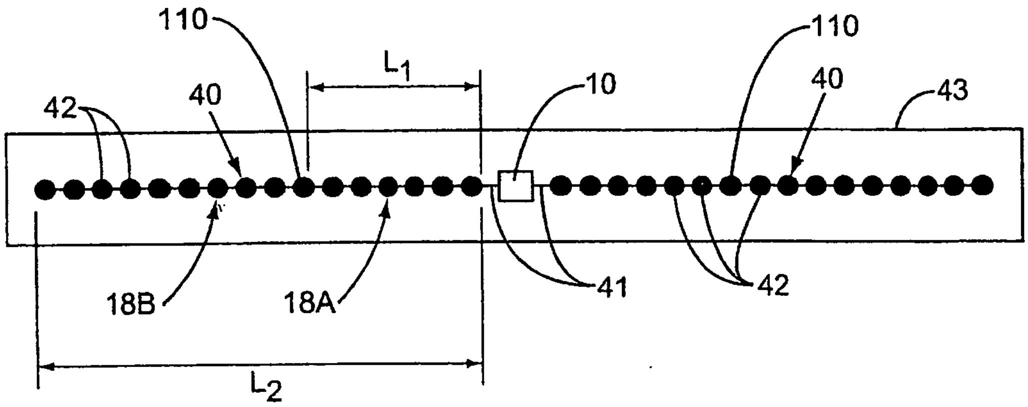

FIG. 9

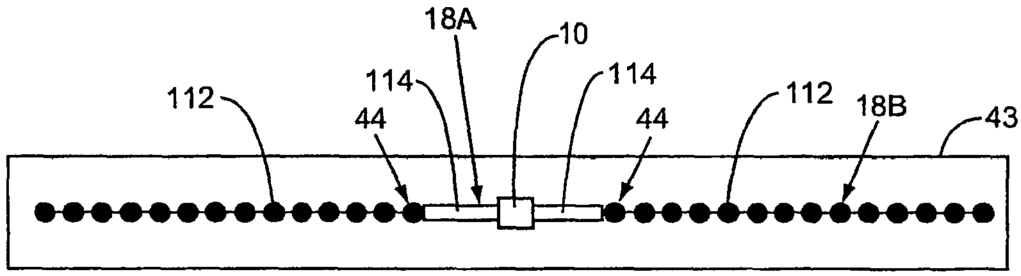

FIG. 10

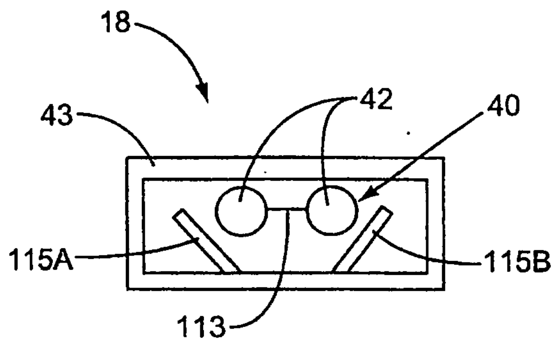

FIG. 11A

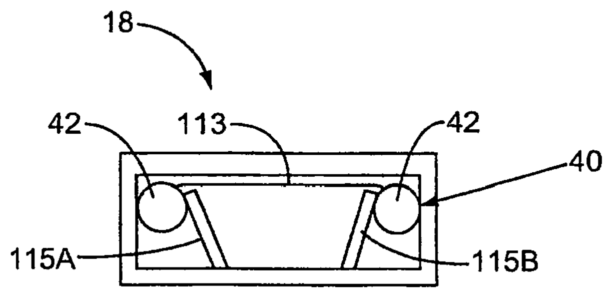

FIG. 11B

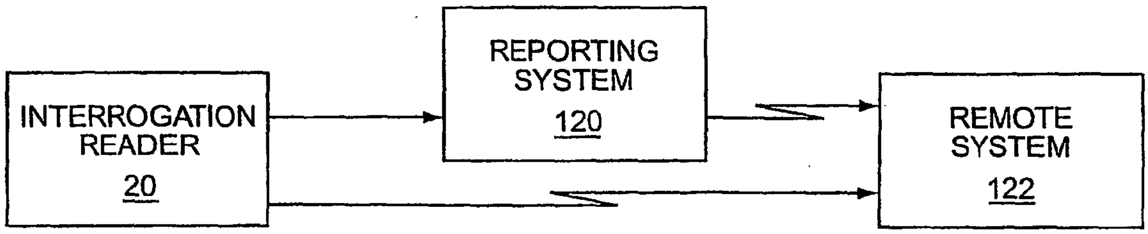
INTERROGATION READER
20
REPORTING SYSTEM
120
REMOTE SYSTEM
122

FIG. 12

REFERENCES CITED IN THE DESCRIPTION

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- US 6501435 B **[0024]**
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