

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
16 March 2006 (16.03.2006)

PCT

(10) International Publication Number
WO 2006/028510 A1

(51) International Patent Classification⁷: **G06F 11/32**

(21) International Application Number:
PCT/US2005/010750

(22) International Filing Date: 29 March 2005 (29.03.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/932,961 2 September 2004 (02.09.2004) US

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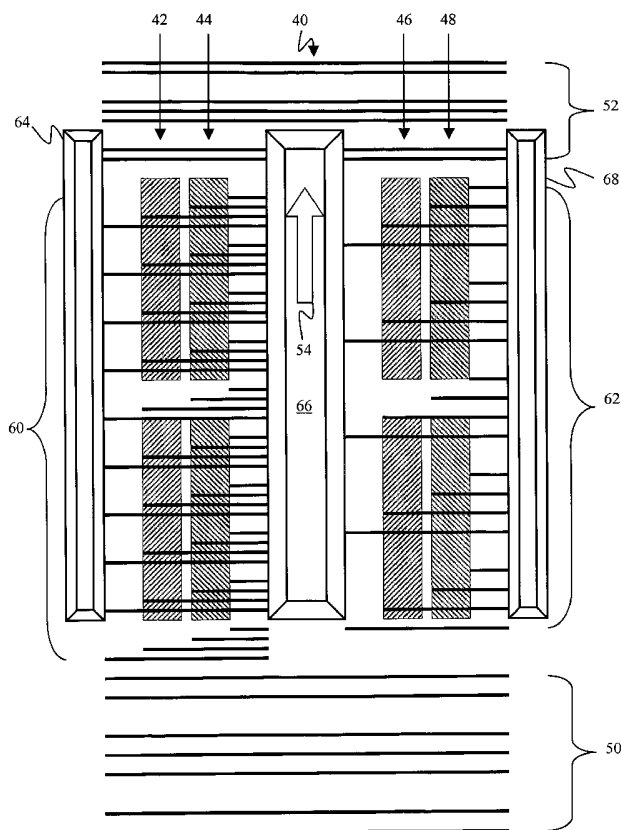
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Suite 1600, Greenville, SC 29601 (US).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU,
ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,

[Continued on next page]

(54) Title: RUMBLE STRIP FOR LOCATING TIRES



(57) Abstract: Methodology and apparatus are dis-
closed for transmitting position locating data to a tire
electronics device contained in a tire. The tire elec-
tronics device includes a vibration sensor and micro-
controller configured so that vibrations sensed by the
vibration sensor may produce corresponding signals
that may be recorded and analyzed to determine if the
vibrations occurred according to a predetermined se-
quence. Detection of the predetermined sequence of
vibrations may be used to trigger data transmission
from the tire electronics device that may be further
analyzed to determine the specific location of the tire
with respect to all other tires mounted on a vehicle.
Data may be transmitted to the tire electronics using a
variety of mechanical devices including permanently
or temporarily installed traffic lane devices.



FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO,
SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, ML, MR, NE, SN, TD, TG).

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Published:

— *with international search report*

UNITED STATES PATENT APPLICATION**TITLE: RUMBLE STRIP FOR LOCATING TIRES****PRIORITY CLAIM**

[0001] This application is a Continuation-In-Part of previously filed, commonly assigned, U.S. Patent Application entitled "MECHANICAL TRANSMISSION OF DATA TO AN ELECTRONIC DEVICE IN A TIRE," by Patrick Allan Tyndall, assigned USSN 10/932,961, filed on September 2, 2004, and which is incorporated herein by reference for all purposes.

FIELD OF THE INVENTION

[0002] The present subject matter concerns the transmission of data to tire electronics devices for use with vehicle tires. More particularly, the present subject matter concerns enhancements to such devices through the provision of mechanical data transmission methodologies that enable specific identification of individual tire mounting location.

BACKGROUND OF THE INVENTION

[0003] The incorporation of electronic devices with pneumatic tire and wheel structures yields many practical advantages. Tire electronics may include sensors and other components for relaying tire identification parameters and also for obtaining information regarding various physical parameters of a tire, such as temperature, pressure, tread wear, number of tire revolutions, vehicle speed, etc. Such performance information may become useful in tire monitoring and warning systems, and may even potentially be employed with

feedback systems to regulate tire or vehicle parameters. As such, it may be advantageous to be able to identify the location with respect to the vehicle of the reporting tire.

[0004] Yet another potential capability offered by electronics systems integrated with tire structures corresponds to asset tracking and performance characterization for commercial vehicular applications. Commercial truck fleets, aviation crafts and earthmover/mining vehicles are all viable industries that could utilize the benefits of tire electronic systems and related information transmission. Radio frequency identification devices (RFID) can be utilized to provide unique identification for a given tire, enabling tracking abilities for a tire. Tire sensors can determine the distance each tire in a vehicle has traveled and thus aid in maintenance planning for such commercial systems. The ability to identify specific tire location with respect to the vehicle may greatly reduce the work of maintaining a particular tire which may be especially important in multi-wheeled vehicles.

[0005] U.S. Patent No. 5,749,984 (Frey et al.) discloses a tire monitoring system and method that is capable of determining such information as tire deflection, tire speed, and number of tire revolutions. Another example of a tire electronics system can be found in U.S. Patent No. 4,510,484 (Snyder), which concerns an abnormal tire condition warning system. U.S. Patent No. 4,862,486 (Wing et al.) also relates to tire electronics, and more particularly discloses an exemplary revolution counter for use in conjunction with automotive and truck tires. Additional background information regarding RFID technology may be had by reference to co-pending, commonly owned U.S. Patent Application Serial Number 10/697,576, filed 10/30/03, entitled "Acoustic Wave Device With Digital Data Transmission Functionality" incorporated herein for all purposes.

[0006] In conventional implementations of RFID devices in tire-related applications, such devices typically store collected and previously recorded information for delayed transmission. The stored collected data may relate to tire parameters including tire pressure, tire temperature, speed, total number of revolutions, tire mounting location on a vehicle and other parameters as well as calculated data such as temperature at speed, miles at temperature, pressure variation over miles or time and other data of specific interest depending on exact usage of the RFID device. Previously recorded data may include a serial number or identification number for the tire with which a particular RFID device may be associated or other data such as manufacturing data including manufacturer and/or place, time and date of manufacture or other data related to the tire or RFID device per se.

[0007] Transmission of data from RFID devices may be initiated automatically or triggered manually. Manual triggering of a transmission from such an RFID device normally requires an operator to employ some form of interrogator device. Interrogator devices may be fixed (i.e., may employ drive-by antenna arrays) or handheld devices that will typically be configured to transmit a radio frequency (RF) signal that is received by an RFID device that interprets the transmitted signal as an instruction to begin data transmission. One advantage of using an RF field-generating interrogator resides in the fact that the RF field itself may be used as a power source for the RFID device. Alternative methods for triggering data transmission are known and include such as placing a permanent magnet in proximity to a tire electronics package to operate a mechanical or electrical switch to begin data transmission or physically removing a tire from its wheel to gain access to an electrical connector associated with the tire electronics and thereby gain access to stored data.

[0008] While various implementations of RFID devices in tire electronic systems have been developed, and while various combinations of information have been wireless relayed from tire or wheel assemblies using conventional technologies, no design has emerged that generally encompasses all of the desired characteristics as hereafter presented in accordance with the subject technology.

[0009] In accordance with the present subject matter, it is appreciated that certain advantages of piezoelectric materials have long been recognized. However, such technology is constantly improving, thus potentially affording applications that utilize piezoelectric materials with improved operating capabilities. Examples of relatively new advances in piezoelectric technology are provided in U.S. Patent Nos. 5,869,189 (Hagood, IV et al.) and 6,048,622 (Hagood, IV et al.), directed to composites for structural control. The presently disclosed technology concerns further advances in piezoelectric structure applications such that a piezoelectric power generating and sensing device can be integrated with a tire or wheel assembly for purposes of data transmission to associated RFID or other tire related data collection and storage devices. It should be appreciated, however, that although the principally discussed mechanism for data detection and transmission involves piezoelectric sensors, other types of mechanical vibration sensitive elements could also be employed. Thus the basic methodology illustrated involves the mechanical transmission of data through a tire or other housing or containment element. Moreover, the device or mechanism used for detecting the mechanical vibrations involved with such data transmission as well as the

devices and methods used to produce such mechanical vibrations are secondary in nature to the basic principles disclosed.

[0010] Currently pending and co-owned U.S. patent applications 10/143,535 and 10/345,040 disclose aspects of generating and harvesting electric power from a rotating tire's mechanical energy using piezoelectric materials. The present invention concerns further applications offered by the integration of such piezoelectric structures in a tire or wheel assembly. More particularly, such piezoelectric structures can be combined with additional features to provide an extremely simple and convenient methodology for automatically initiating information transfer to an RFID or other device mounted in association with a tire or wheel assembly in accordance with aspects of the present invention.

[0011] The disclosures of all of the foregoing United States patents and patent applications are hereby fully incorporated into this application for all purposes by reference thereto. While various tire electronics systems have been developed, no design has emerged that generally encompasses all of the desired characteristics as hereafter presented in accordance with the subject technology.

SUMMARY OF THE INVENTION

[0012] In view of the recognized features encountered in the prior art and addressed by the present subject matter, an improved methodology for transmitting data to an RFID device or other tire electronics based device has been developed. More particularly, according to the present subject matter, an improved methodology has been developed that provides extreme simplicity in the transmission of information to tire electronics device that incorporate, at least, motion sensitive elements.

[0013] According to certain aspects of the present subject matter, methodologies are provided for the transmission of information to tire electronics devices without requiring highly specialized interrogators or other forms of electronic equipment.

[0014] In accordance with other aspects of the present subject matter, methodologies are provided wherein information may be selectively transmitted to tire electronics devices at various selected times and places automatically as a vehicle passes through a designated area or along a designated path.

[0015] According to yet other aspects of the present subject matter, methodologies are provided that permit more-or-less permanent designation of specific areas or vehicle pathways as those at which data is to be automatically transmitted to a tire electronics device.

[0016] According to yet still other aspects of the present subject matter, portable devices are disclosed that permit easy and convenient temporary designation of specific locations as locations at which data is to be transmitted to a tire electronics device.

[0017] Additional aspects of the present subject matter are set forth in, or will be apparent to, those of ordinary skill in the art from the detailed description herein. Also, it should be further appreciated that modifications and variations to the specifically illustrated, referred and discussed features and elements hereof may be practiced in various embodiments and uses of the present subject matter without departing from the spirit and scope of the subject matter. Variations may include, but are not limited to, substitution of equivalent means, features, or steps for those illustrated, referenced, or discussed, and the functional, operational, or positional reversal of various parts, features, steps, or the like.

[0018] Still further, it is to be understood that different embodiments, as well as different presently preferred embodiments, of the present subject matter may include various combinations or configurations of presently disclosed features, steps, or elements, or their equivalents (including combinations of features, parts, or steps or configurations thereof not expressly shown in the figures or stated in the detailed description of such figures). Additional embodiments of the present subject matter, not necessarily expressed in the summarized section, may include and incorporate various combinations of aspects of features, components, or steps referenced in the summarized objects above, and/or other features, components, or steps as otherwise discussed in this application. Those of ordinary skill in the art will better appreciate the features and aspects of such embodiments, and others, upon review of the remainder of the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

[0020] Figure 1 illustrates a pneumatic tire incorporating a tire electronics device to which the present technology may be applied;

[0021] Figure 2 illustrates an exemplary methodology for transmitting data to a tire electronics device incorporated into a pneumatic tire wherein the tire is manually struck to transmit selected data;

[0022] Figure 3 illustrates a vehicle lane configured with a predetermined sequence of vibration inducing elements designed to transmit a predetermined data sequence to a tire electronics device;

[0023] Figure 4 illustrates an exemplary portable device that may be selectively placed at locations at which data is to be transmitted to tire electronics devices; and

[0024] Figure 5 illustrates another exemplary portable device that may be placed at locations at which data is to be transmitted to tire electronics.

[0025] Repeat use of reference characters throughout the present specification and appended drawings is intended to represent same or analogous features or elements of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] As discussed in the Summary of the Invention section, the present subject matter is particularly concerned with methodologies for transmitting data to a tire electronics device incorporated in a tire or wheel structure of a vehicle that enable specific identification of individual tire mounting location.

[0027] It should be noted that each of the exemplary embodiments presented and discussed herein should not insinuate limitations of the present subject matter. Features or steps illustrated or described as part of one embodiment may be used in combination with aspects of another embodiment to yield yet further embodiments. Additionally, certain features may be interchanged with similar devices or features not expressly mentioned which perform the same or similar functions.

[0028] Referring now to the drawings, Figure 1 illustrates aspects of a known tire monitoring system. Tire structure 10 may incorporate a tire electronics device 12 that may include condition-responsive sensors to monitor various physical parameters such as temperature or pressure within the tire or associated wheel assembly as well as vibration-responsive sensors to monitor vibrations induced from road related parameters or other

conditions. Tire electronics device 12 may be physically attached to an inner liner of tire 10, to the sidewall of the tire, to the crown of the tire or actually embedded in the tire structure. Such a tire electronics device 12 may include at least one RFID type device capable of storing and transmitting data accumulated from the various condition-responsive devices as well as data recorded in a memory portion of the tire electronics device during original manufacture or at some other time from an external data source.

[0029] Tire electronics device 12 may derive operating power from an onboard generator, batteries that may be replaceable or rechargeable (possibly by the onboard generator) or from external sources. It should be appreciated that, in accordance with the present technology, a tire electronics device may correspond to any of the variously known types of commercially available devices that include at least a power source, a microcontroller, a memory capable of storing data and programming instructions, a data transfer mechanism and at least one sensor responsive to induced vibration. Vibration responsive sensors may include various piezoelectric devices, accelerometers, and virtually any other type of device capable of generating or producing a signal based on induced vibration. It should further be appreciated that the present subject matter does not rely on the use of any particular type sensor but rather only on the concept of the production of a vibration induced signal.

[0030] The tire electronics device 12 of Figure 1 is typically interrogated by a data acquisition transceiver 14 that may be provided with both transmitter and receiver electronics to communicate with the tire electronics device 12. RF pulses 16 transmitted from the antenna 20 of the transceiver 14 to the electronics assembly in tire 10 may be used both to provide power to the tire electronics device 12 as well as to supply control or data signals. Such control or data signals may provide instructions to the tire electronics device 12 to either transmit its stored data or to perform some other desired task such as to store additional data or modify its operation in some predetermined manner.

[0031] Reference will now be made in detail to the presently preferred embodiments of the subject electronics assemblies and methodologies for their operation. Referring now to Figure 2, an exemplary alternative methodology for transmitting data to tire electronics device 12 contained within tire 10 in accordance with the present technology is illustrated. As previously mentioned, tire electronics 12 corresponds to a device including several functionally related portions including, among others, at least a vibration responsive sensor.

The present subject matter provides methodologies for employing such a vibration responsive sensor as a data transmission element in lieu of, or in addition to, data acquisition transceiver 14 of Figure 1 for certain of the functions normally performed by the data acquisition transceiver.

[0032] In normal operation, tire electronics device 12 is responsive to what may be considered random vibrations induced as a result of contact with a surface. Certain of these vibrations may, in fact, be cyclical in nature as, for example, resulting from tire rotation as the tire rolls along or over a surface. The present subject matter seeks to make use of the vibration sensing capability of tire electronics device 12 by providing the tire electronics device 12 with the capability to identify specific vibrational frequencies or sequences and to respond to such identified vibrations in predetermined manners depending on the frequencies or sequences identified and thereby provide an alternate and new form of tire electronics data transmission.

[0033] As illustrated in Figure 2, in order to take advantage of this new form of tire electronics data transmission, a baton 30 or other element may be held in an operator's hand and used to physically strike tire 10 in a predetermined sequence or at a predetermined repetition rate as suggested by arrows 32. Tire electronics device 12 may be programmed to monitor the various vibrations it is already capable of detecting to determine if it recognizes the predetermined frequency or sequence and, if so, acts in a predetermined manner depending on the frequency or sequence detected. Of course an operator may use any available item to strike the tire including his foot, giving new life to the old adage of "kick the tires" as you inspect a vehicle.

[0034] The recognition that an intentionally induced predetermined vibrational sequence may be used to communicate specific data to a tire electronics device gives rise to a number of possibilities. As a starting point, very simple data or commands could be transmitted to the tire electronics device 12 such as to query the device and trigger a radio frequency (RF) transmission from the tire electronics device 12. Other relatively simple commands might include striking a tire in a predetermined sequence immediately after the tire is mounted on a vehicle to convey to the tire electronics the tire's specific location on the vehicle.

[0035] With reference now to Figure 3, a more complex form of intentionally induced vibrational communications will be described. Representatively illustrated in Figure 3 is a

vehicle travel lane 40 corresponding to a single travel lane including four separate tire tracks 42, 44, 46, 48. Traffic lane 40 is sized such that tire tracks 42 - 48 respectively represent the left outer, left inner, right inner and right outer tire tracks of a single vehicle. That is, a single vehicle traveling in the direction of arrow 54 would pass over lane 40 in such manner that the left side tires of the vehicle would pass over tracks 42, 46 while the right side tires of the vehicle would pass over tracks 46, 48. In this configuration, all of the tires mounted in any one line but on different axles of a vehicle would be subject to the same sequence of induced vibrations resulting from passing over selectively configured groups 50, 52, 60, and 62 of vibration inducing discontinuities.

[0036] It should be noted that the selectively configured groups 50, 52, 60, and 62 of vibration inducing discontinuities might comprise sequences of protrusions, recesses or combinations thereof. The function of such groups of discontinuities is to selectively induce vibration into a tire passing over the discontinuities, and thus, it is important to the operation of the presently disclosed technology only that a vibration producing mechanism is provided without limitation as to the physical shape or structure of such vibration producing mechanism.

[0037] With specific reference to Figure 3, it will be observed that four separate groups 50, 52, 60, and 62 of selectively configured vibration inducing discontinuities are illustrated. Groups 50 and 52 each correspond to vibration inducing discontinuities that are configured such that all tires mounted on all axles of any vehicle passing through the traffic lane 40 are subjected to the same vibration inducing discontinuities. Groups 60 and 62 of the selectively configured vibration inducing discontinuities are shown as spaced differently from each other and thus expose tires passing over tracks 42 - 48 to selectively different vibrational sequences. Such representation is intended to illustrate that it is desirable that data transmitted to tire electronics contained in the various tires mounted on individual axles be different from one side of the vehicle to the other.

[0038] Numerous possibilities exist for the effective implementation of what may be described as mechanically encoded traffic lanes as illustrated in Figure 3. Such traffic lanes could be created along any desired travel surface by installation of any material that may be secured to the travel surface. Material might include asphalt or concrete or any other known road surfacing material. In this instance, the intentionally induced vibration discontinuities might resemble conventionally used, so called, rumble strip as are often placed on the edges

of roadways to alert drivers that their vehicle may be off the established travel lanes. Alternatively other materials may be used as may be convenient to any particular installation. Non-exhaustive examples include wood, plastic, metal or composite structures.

[0039] In another alternative, discontinuities may comprise recesses cut into the surface of a roadway as by sawing or other means in a manner similar to providing water runoff channels in a road surface. Suitable recesses might be created in newly laid asphalt or concrete roadway surfaces by impressing a suitably configured form into the roadway surface before the surface becomes firm. Other suitable mechanism for creating discontinuities in a traffic lane will become apparent to those of ordinary skill in the art in light of the present disclosure and given the understanding that any mechanism that will produce a controlled induced vibration may be used to carry out the information transmission methodology of the present technology.

[0040] Mechanically encoded traffic lanes have utility in many different areas involving vehicular traffic. Mechanically encoded traffic lanes could be created at various locations along prescribed travel routes so that tires electronics devices associated with vehicle tires passing over such lanes would be triggered to record such information as distance, time or speed at the particular location or to trigger context-sensitive transmissions of data at a weigh station or depot. In the context of different encoding schemes for different lanes along a traveled route, different data or instructions could be passed to a tire electronics device as a vehicle enters and then leaves a particular area.

[0041] Based on the previous discussions of the range of complexity of data transmissions possible using the presently disclosed technology, it should be evident to those of ordinary skill in the art that the exact number of vibration inducing discontinuities illustrated in the various figures are exemplary only. Any number of discontinuities may be used as may be necessary to encode the data to be transmitted. Moreover various encoding schemes may be employed as desired to insure accurate transmission of data. For example, where it may be important that data is accurately transmitted and received, an encoding scheme involving a checksum or some other form of data verification may be used. Alternative methodologies might include the transmission of the same data a predetermined number of times in a technique that requires detection of the same data the predetermined number of times before it is accepted. It may also be advantageous to design bi-directional codes such that the same information is transmitted to a tire electronics device regardless of

the direction a vehicle may take in passing over a mechanically encoded travel lane. All such variations are envisioned by the present subject matter.

[0042] With further reference to Figure 3, additional characteristics relating to the various groups 50, 52, 60, and 62 of vibration inducing discontinuities will be discussed. With respect to groups 50 and 52, these groups of vibration inducing discontinuities may correspond to specific codes that may be interpreted by a microcontroller associated with a vibration sensor as, respectively, start, beginning, or “wake-up” and stop or ending codes. As these codes would correspond to the same code for all tire-associated sensors, the vibration inducing discontinuities producing such codes extend across the entire travel lane 40 corresponding to all four tire tracks 42 - 48. Groups 60 and 62 of vibration inducing discontinuities, on the other hand, correspond to specific position related code sequences or vibrational frequencies that differ from track to track so that laterally spaced tires on any single vehicle axle will be exposed to differing code sequences or vibrational frequencies.

[0043] As illustrated in Figure 3, the individual vibration inducing discontinuities making up each of groups 60 and 62 correspond to a repeating sequence of discontinuities that differ in length and spacing along the left tire tracks 42, 44 as well as the right tire tracks 46, 48. Such a configuration insures that each tire in each track is exposed to a distinctly different array of vibration inducing discontinuities so as to produce in each tire mounted on the same axle of a vehicle, a distinctly different sequence of vibrations corresponding to a particular lateral position on a vehicle axle that may be detected and recorded by respective vibration sensors associated with each individual tire.

[0044] As a vehicle traverses travel lane 40 in the direction of arrow 54, each tire will sequentially be exposed to a start or “wake-up” sequence from group 50 of the vibration inducing discontinuities followed, in sequence, by unique codes or vibrational sequences for each tire track 42 - 48 and, finally, by a stop sequence produced by group 52 of the vibration inducing discontinuities. As individual tire sensors are exposed to and then respond to the stop sequence produced by group 52 of the vibration inducing discontinuities, the individual sensors may transmit their own unique identification along with vibrational data developed based on their individually experienced vibrational sequences induced from the vibration inducing discontinuities associated with the four separated tire tracks 42 - 48. Since the tires mounted on each axle will report in order of exiting the lane 40, each axle can be ordered with respect to every other axle on the vehicle by the arrival of information at a receiver (not

shown in Figure 3 but similar to transceiver 14 of Figure 1) in the cab or other convenient location on the vehicle. The information transmitted from the various tire-associated sensors may also be received by way of drive-by antenna systems 64, 66, 68.

[0045] To prevent potential transmitted data collisions, transmitters sending information may have a delay imposed corresponding proportionally to the frequency of the vibrations measured while driving over the vibration inducing discontinuities. Alternatively, several transmissions with random spacing between duplicate transmissions may be sent for data collision avoidance. Since each tire on any given axle has been exposed to a unique sequence of vibrational information with respect to all other tires on that axle and since information may be coded in, for example, increasing frequency from left to right, each tire on the axle can be uniquely identified and its location with respect to the vehicle determined.

[0046] The presently disclosed methodology for automatically identifying tire location on a vehicle represents a substantially improvement over previously known methods as there is no need for either complicated radio frequency switching systems or specific operator intervention to achieve the desired results.

[0047] With reference now to Figures 4 and 5, exemplary representations of portable traffic lane encoders 70 and 170 are illustrated. Portable traffic lane encoders 70 and 170 correspond to traffic lane 40 illustrated in Figure 3 and may be sized to correspond to a single traffic lane accommodating four separate tire tracks 72, 74, 76, 78 and 172, 174, 176, 178, respectively. Portable traffic lane encoders 70 and 170 may be manufactured using any suitable materials ranging from wood to plastic to metal. For example, with respect to portable traffic lane encoder 70, a base 100 might be provided in the form of one or more standard sheets of plywood while groups 150, 152, 160, and 162 of intentional vibration inducing discontinuities in the form of protrusions might be provided by selectively sized and positioned additional plywood portions that may be glued, nailed or otherwise affixed to the base 100 in a predetermined manner designed to correspond to a desired pattern. Assembly and direction markers such as arrow 84 may be applied to base 100 to insure proper lane directionality in cases where bi-directional coding is not used.

[0048] Such a portable traffic lane encoder 70 might find utility at a temporary installation such as randomly erected vehicle inspection or weigh stations or temporary depot areas where more permanent forms of intentional vibration inducing protrusions may be destructive to the road surface or cost prohibitive to install on a temporary basis.

Additionally, portable traffic lane encoder 70 may be used as the aforementioned form usable with freshly laid asphalt or concrete to produce recesses by laying the portable traffic lane encoder 70 “face down” in the still soft roadway material to produce recesses in the surface at locations corresponding to the protrusions illustrated.

[0049] Figure 5 illustrates an alternative arrangement of a portable traffic lane encoder 170 corresponding in every detail, and including equivalent reference numbers incremented by 100, to that of Figure 4 except that the illustrated protrusions of Figure 4 are replaced by recesses that may be provided by cutting holes into the material 200 from which the portable traffic lane encoder 170 is constructed. The recesses cut into material 200 may extend either partially or completely through material 200. Yet another alternative configuration may be provided by combining feature of the embodiments illustrated in Figure 4 and 5 by providing combinations of protrusions and recesses as discontinuities in the same traffic lane encoder. Such an alternative might be used to provide different aspects to an induce vibration signal that could result in additional encoding possibilities for the transmitted information.

[0050] While the present subject matter has been described in detail with respect to specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such embodiments. Accordingly, the scope of the present disclosure is by way of example rather than by way of limitation, and the subject disclosure does not preclude inclusion of such modifications, variations and/or additions to the present subject matter as would be readily apparent to one of ordinary skill in the art.

WHAT IS CLAIMED IS:

1. A method for automatically locating tires mounted on a vehicle, comprising the steps of:

providing a tire;

providing a tire electronics device, the tire electronics device comprising a
5 microcontroller portion, a memory portion, and a vibration sensor portion, the vibration
sensor portion producing signals proportional to sensed vibration;

associating the tire electronics device with the tire such that vibration sensor portion
of the tire electronics is responsive to vibration induced in the tire;

mounting the tire on a vehicle;

10 configuring the microcontroller portion of the tire electronics to monitor signals
produced by the vibration sensor portion and to identify one or more predetermined signal
sequences; and

inducing vibrations into the tire corresponding to a selected lateral tire mounting
position relative to the vehicle.

2. The method of claim 1, wherein the step of inducing vibrations into the tire comprises
the steps of:

designating a predetermined traffic lane over which vehicular traffic may pass;

providing a plurality of selectively spaced discontinuities at predetermined locations
5 along the predetermined traffic lane; and

passing the tires and associated tire electronics devices over the plurality of
selectively spaced discontinuities.

3. The method of claim 2, wherein the step of providing a plurality of selectively spaced
discontinuities comprises selectively affixing predetermined quantities of material at
predetermined locations along the predetermined traffic lane, whereby tires associated with
vehicles passing through the predetermined traffic lane will be subject to induced vibrations
5 at the predetermined locations.

4. The method of claim 2, wherein the step of providing a plurality of selectively spaced
discontinuities comprises selectively removing predetermined quantities of material at
predetermined locations along the predetermined traffic lane, whereby tires associated with
vehicles passing through the predetermined traffic lane will be subject to induced vibrations
5 at the predetermined locations.

5. The method of claim 3, wherein the step of providing a plurality of selectively spaced discontinuities comprises the steps of:

providing a base surface;

affixing a plurality of protrusion forming elements to selected predetermined portions

5 of the base surface; and

placing the base surface with affixed elements within the predetermined traffic lane.

6. The method of claim 3, wherein the step of providing a plurality of selectively spaced discontinuities comprises the steps of:

providing a base surface;

removing predetermined portions of material from a plurality of selected

5 predetermined portions of the base surface; and

placing the base surface within the predetermined traffic lane.

7. A tire electronics device comprising:

a microcontroller portion having an input portion;

a program memory portion coupled to the microcontroller portion;

a data memory portion;

5 a data transmission portion; and

a vibration sensor portion coupled to the input portion of the microcontroller portion

capable of producing signals representative of sensed vibration,

wherein the program memory portion is configured to provide program instructions to the microcontroller portion to enable the microcontroller portion to monitor signals produced
10 by the vibration sensor portion corresponding to one or more predetermined signal sequences, to record signals in the data memory portion and to selectively cause the data transmission portion to transmit information corresponding to recorded signals upon receipt of a predetermined vibrational signal sequence.

8. The tire electronics device of claim 7, wherein the data transmission portion comprises a radio frequency transmission device.

9. A tire and tire electronics device combination comprising:

a tire; and

a tire electronics device associated with said tire, said tire electronics device

comprising:

5 a microcontroller portion having an input portion;

a program memory portion coupled to the microcontroller portion;

a data memory portion;

a data transmission portion; and

a vibration sensor portion coupled to the input portion of the microcontroller portion

10 capable of producing signals representative of sensed vibration,

wherein the program memory portion is configured to provide program instructions to the microcontroller portion to enable the microcontroller portion to monitor signals produced by the vibration sensor portion corresponding to one or more predetermined signal sequences, to record signals in the data memory portion and to selectively cause the data transmission
15 portion to transmit information corresponding to recorded signals upon receipt of a predetermined vibrational signal sequence.

10. The tire and tire electronics device combination of claim 9, wherein the data transmission portion comprises a radio frequency transmission device.

11. A traffic lane encoder, comprising:

a base member having an upper surface and a lower surface; and

a plurality of discontinuities selectively formed along the upper surface of said base member in a predetermined coded sequence,

5 whereby the plurality of discontinuities will cause different predetermined sequences of vibrations to be induced into laterally displaced tires mounted on the same axle of any vehicles contacting the discontinuities in sequence.

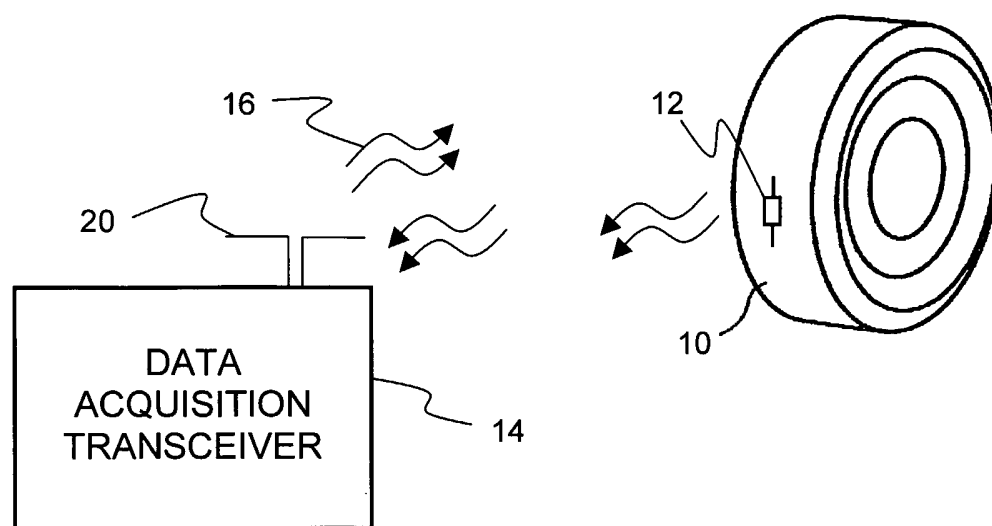
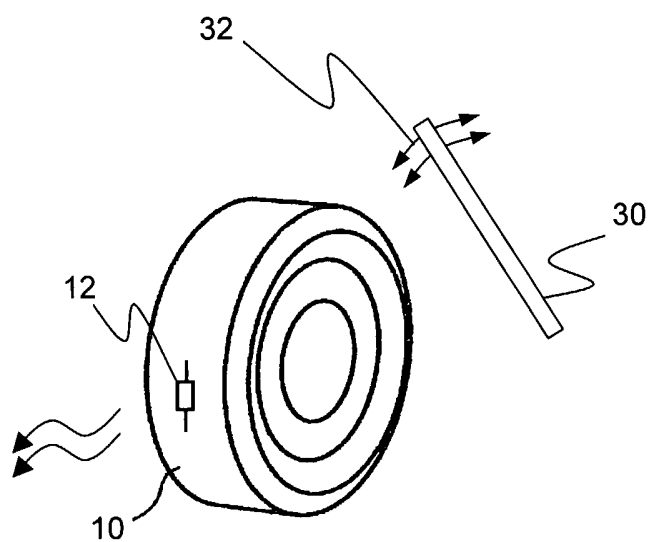
12. The traffic lane encoder of claim 11, wherein the plurality of discontinuities comprise four parallel sequences of discontinuities.

13. The traffic lane encoder of claim 12, wherein the plurality of discontinuities comprise beginning, ending, and central portions and the beginning and ending portions of each of the parallel sequences produce similar vibrational sequences.

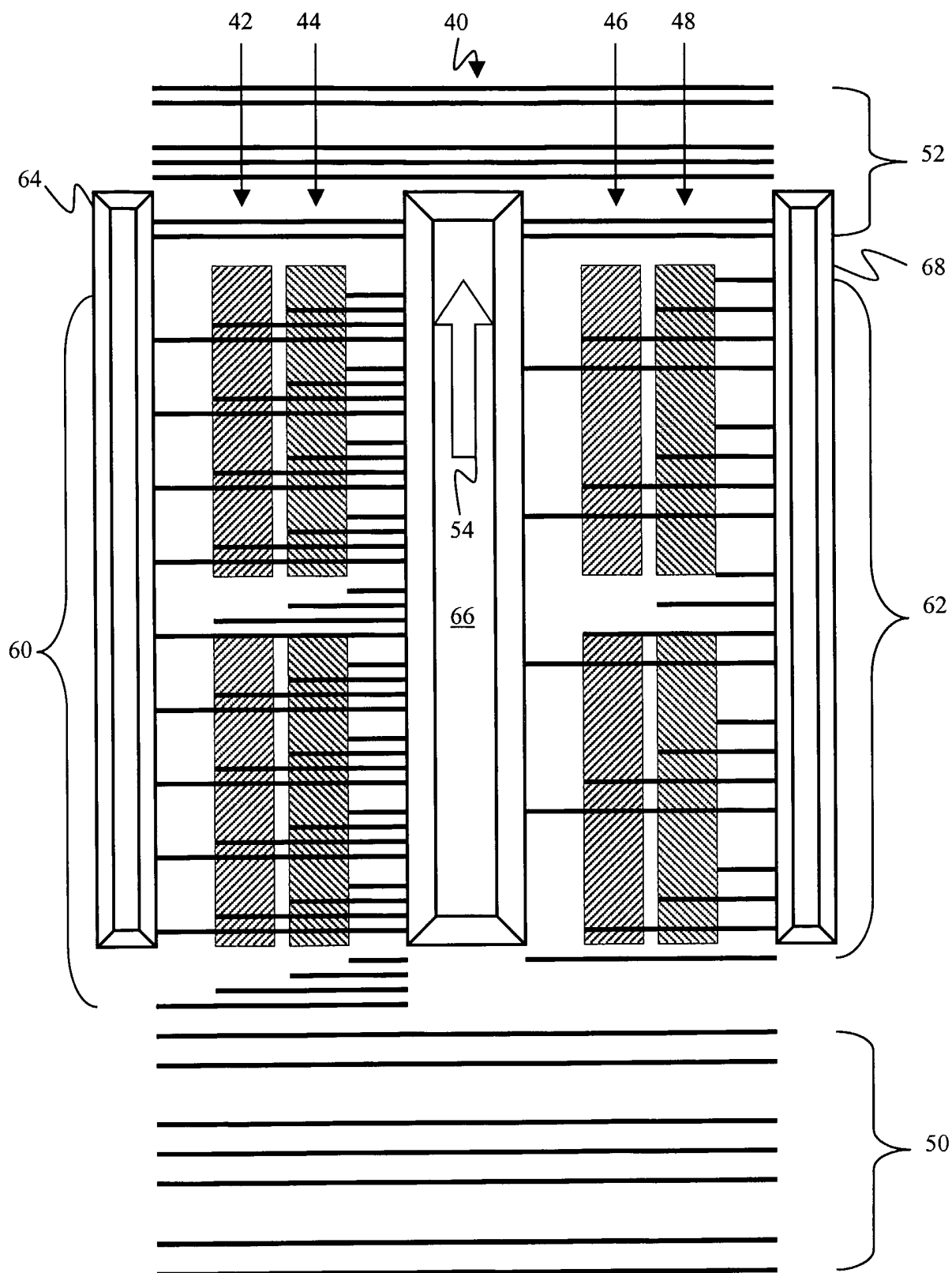
14. The traffic lane encoder of claim 11 wherein the discontinuities comprise a plurality of protrusions.

15. The traffic lane encoder of claim 11 wherein the discontinuities comprise a plurality of recesses.

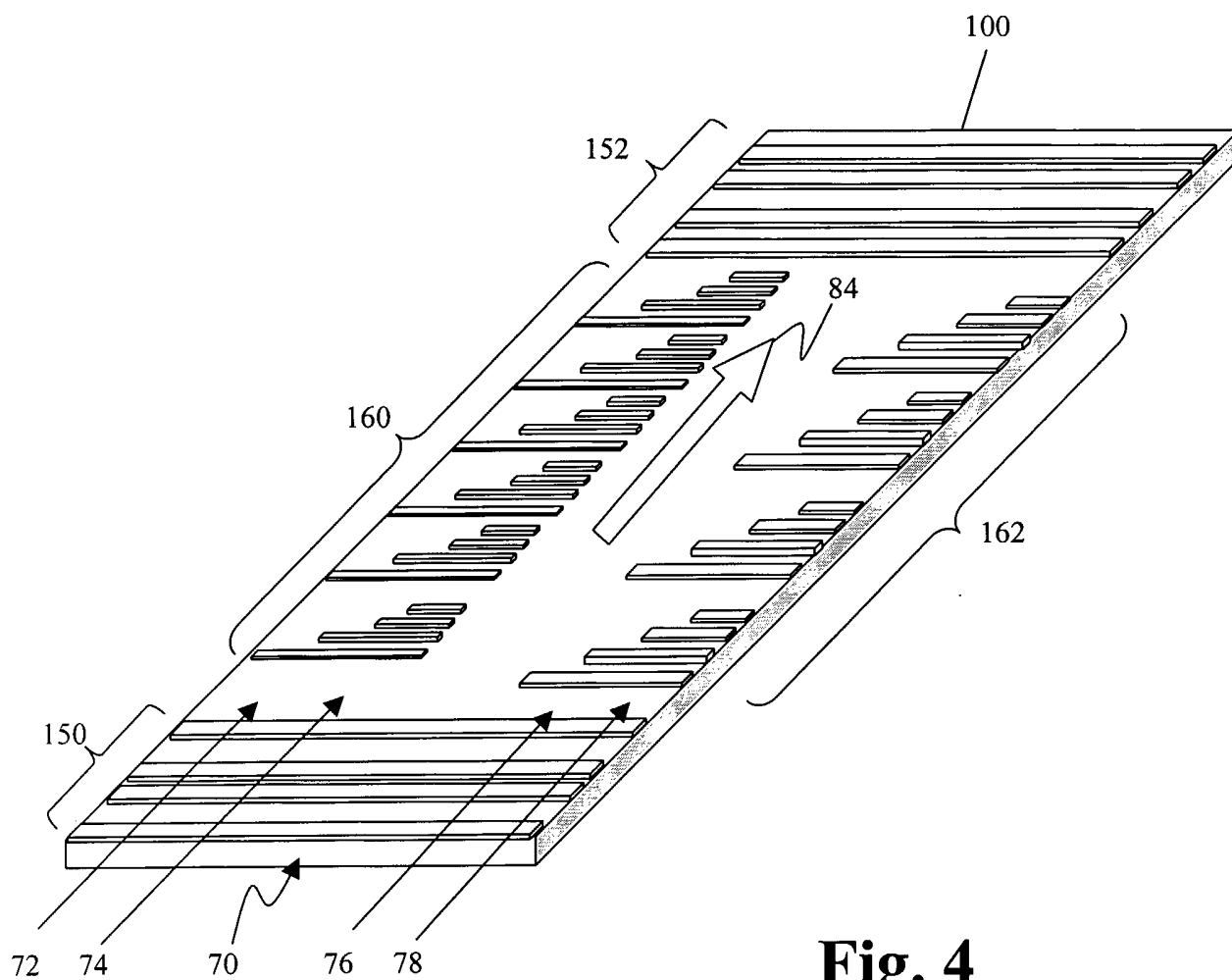
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**Fig. 1****Fig. 2**

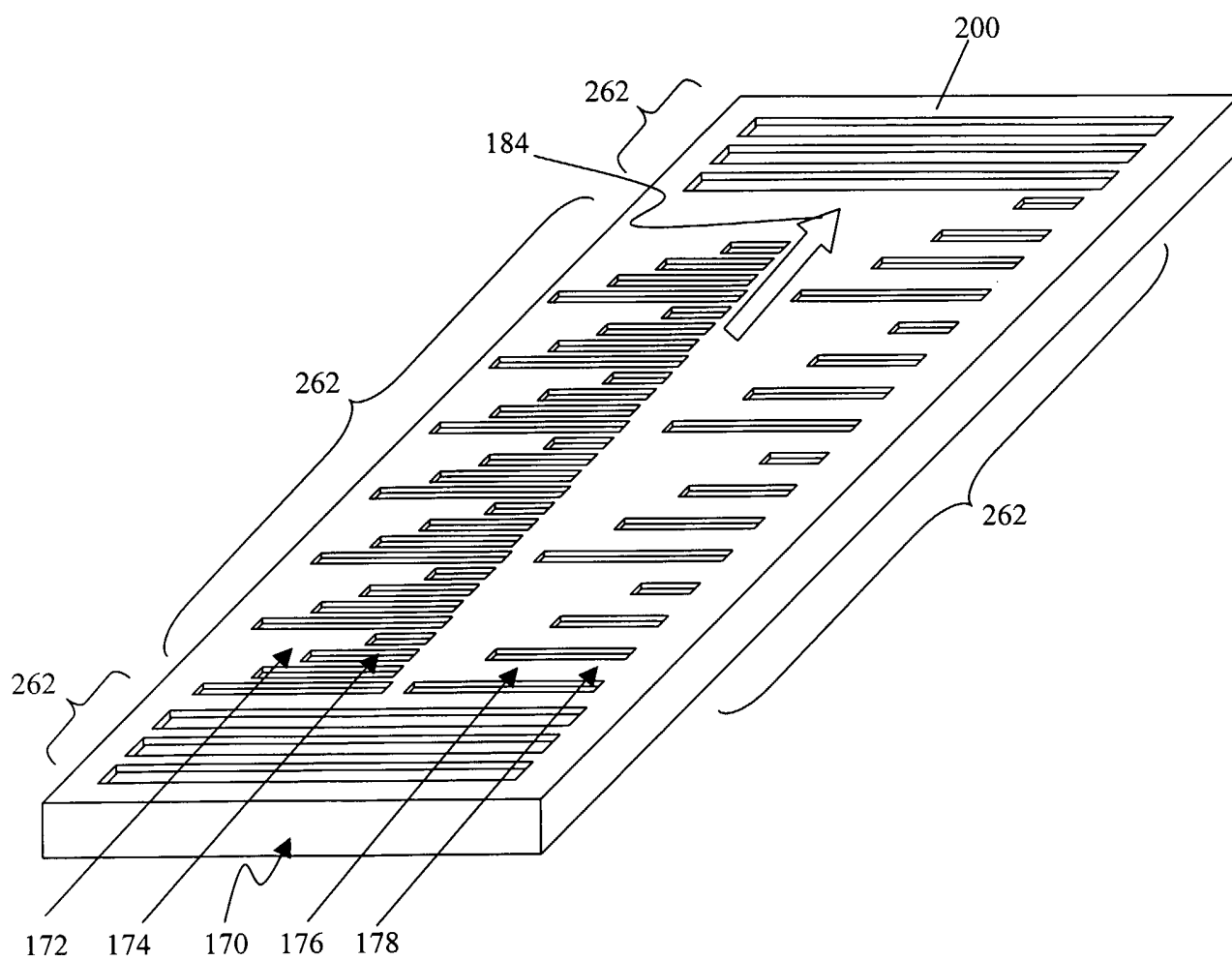
2/4

**Fig. 3**

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**Fig. 4**

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**Fig. 5**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US05/10750

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G06F 11/32

US CL : 702/182

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 702/182

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/0197604 A1 (Ogawa et al.) 23 October 2003 (23.10.2003), Figure 1	1-10
Y	US 5,477,453 (Harashima) 19 December 1995 (19.12.1995), column 3, lines 13-27	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:		"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

27 July 2005 (27.07.2005)

Date of mailing of the international search report

19 SEP 2005

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