

TITLE

Sound Button Unit

INVENTOR

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Background of the Invention

[001] The present invention relates generally to tires and, more particularly, to safety systems integrated within tires that generate audible signals during vehicle motion.

[002] In recent years, the proliferation of electric vehicles, hybrid vehicles, and other alternative drive technologies has introduced new safety challenges. Unlike conventional combustion engines, which naturally produce audible engine noise, electric drive systems operate in a quiet or nearly silent manner. While reduced noise levels can be advantageous in terms of comfort and environmental impact, they also create hazards for pedestrians, cyclists, and animals who may not perceive the approach of a moving vehicle in time to react. This risk is amplified in urban areas, residential neighborhoods, factory or warehouse environments, and other

settings where people and vehicles frequently share close spaces.

[003] Numerous efforts have been made to address this problem, such as external speakers or artificial sound systems mounted on vehicles. However, these solutions often rely on additional electronics, require external power, and may be prone to environmental damage, tampering, or system failure. They also do not necessarily scale well across different classes of vehicles, from passenger cars to industrial machinery, nor do they provide a standardized or mechanically reliable solution that integrates directly with the tire itself.

[004] Tires are in direct and constant contact with the ground surface during vehicle operation, and therefore represent a unique location from which consistent and predictable sound can be generated. Integrating a mechanical sound-generating device into a tire provides a passive, durable, and self-actuating means of creating audible signals. Unlike electronic sound generators, such a device does not require external power sources, wiring, or software control. Instead, it relies on the inherent cyclic motion of the wheel itself, ensuring that the audible signal is automatically produced whenever the vehicle is in motion.

[005] The present invention, referred to as the Sound Button Unit (Sound Button Unit), addresses these shortcomings by

providing a simple, robust, and versatile system embedded within the tire body. The Sound Button Unit comprises a band configured to carry multiple sound button modules, each biased to extend outward and generate sound upon contact with the ground. As the tire rotates, the modules cyclically depress and release, producing audible signals that warn nearby individuals of the vehicle's presence. The system can be adapted for use in pneumatic, tubeless, run-flat, solid, or airless tires, and can be manufactured using common materials and established fabrication processes already used in the tire industry.

[006] Because the Sound Button Unit is mechanically actuated and directly integrated with the tire, it offers durability, adaptability, and universality. It is not limited to any single material composition or specific class of tire. Instead, it provides a scalable safety solution applicable to a broad range of vehicle types, operating environments, and tire systems.

Brief Summary of the Invention

[007] The present invention provides an audible safety unit for tires, referred to herein as the Sound Button Unit (Sound Button Unit). The invention addresses the growing safety concerns associated with low-noise vehicles such as electric and hybrid vehicles, which can operate in near silence and pose hazards to pedestrians, cyclists, and animals who may not otherwise perceive the approach of a moving vehicle. By integrating a mechanically actuated sound-generating system directly into the structure of a tire, the invention ensures that an audible signal is automatically produced whenever the vehicle is in motion.

[008] In its broadest form, the invention comprises a band embedded within the tire body, and a plurality of sound button modules mounted to the band. Each sound button module includes a casing, a sound button, and a biasing element such as a spring that urges the sound button outward. When the tire rotates and the sound button makes contact with the ground surface, the sound button is momentarily depressed and then released, generating a characteristic audible signal. This cycle is repeated with each wheel rotation, producing a continuous or periodic sound that alerts surrounding individuals to the vehicle's presence.

[009] The invention is highly adaptable in terms of tire type and construction. In one embodiment, the band is embedded within a solid rubber tire, where it is permanently molded into the body of the tire during fabrication. In another embodiment, the band is positioned between a tread layer and a sealing or structural layer in a pneumatic or tubeless tire, such that conical apertures in the tread permit the sound buttons to extend outward for contact with the ground. A backing strip of rubber or other sealing material may also be applied to secure the band in place and protect any air chamber behind it. Key fit edges and wedges may be used to ensure the sealer layer is situated without the ability to defect by shifting. These methods of incorporation ensure that the Sound Button Unit can be implemented across a wide spectrum of modern tire systems without requiring fundamental redesign of the tires themselves or various tread designs. Some of the tire types in reference are Passenger Car (PC), Light Truck (LT), Trailer Biased (TB), Motorcycle (MC) and Industrial (ID), U and INCITY to name some that the Sound Button Unit is compatible with.

[010] The invention also provides protection at the level of the sound button module itself. Each sound button module is a discrete unit comprising a casing, a sound button, and a biasing element. The casing may be formed of metal, resin,

reinforced polymer, composite, or other suitable materials, and may include structural features such as recessed cradles for housing biased parts such as vsprings or anchoring structures to secure the sound button material. The sound button itself may be fabricated from various composites, rubber, resin, metal, elastomer, or combinations thereof. Reinforcement structures such as molded anchors or mesh reinforcements may be included to extend service life. Because the sound button module may be fabricated and distributed as an individual component, the invention anticipates that competitors may attempt to replicate the module apart from the band system. For this reason, the independent protection of the module itself forms a core aspect of the invention.

[011] The invention is further defined through a method of manufacturing. In one method, the band and its plurality of sound button modules are first assembled as a ring structure and then embedded into the solid tire body during tire fabrication. In the case of pneumatic or tubeless tires, apertures are provided in the tread layer to permit the sound buttons to protrude outward. In solid rubber tires, the Sound Button Unit can be molded directly into the tire during manufacture. Variations of the method include the use of adhesives, vulcanization, key-fit geometries, or mechanical fasteners to secure the band, as well as the addition of

sealing layers, wedges or backing strips to protect air chambers.

[012] The Sound Button Unit is not limited by material composition. The band may be formed of metals, alloys, resins, polymers, elastomers, or combinations thereof, and may be encased in a flexible coating such as synthetic rubber or like material as the tire its being fitted into. The biasing elements may be springs formed of steel, alloys, composites, or resilient polymers. The sound button itself may be formed of natural rubber, synthetic rubber, plastics, resins, or hybrid materials. The choice of materials may vary according to performance requirements, environmental conditions, manufacturing capabilities, and regulatory standards. Similarly, the methods of fabrication are not restricted, and may include molding, crimping, adhesive bonding, weaving of meshes, lamination, additive manufacturing, or other techniques.

[013] The invention is also adaptable across different environments and vehicle classes. Although particularly useful for electric and hybrid passenger cars, the Sound Button Unit can also be incorporated into motorcycles, bicycles, trucks, buses, forklifts, warehouse vehicles, airport ground equipment, and military vehicles. It may be applied to tires designed for road use, factory floors, airports, ports, or

industrial environments. In each of these contexts, the function remains consistent: the sound button modules provide a passive, mechanical, and self-actuating means of generating noise whenever the vehicle is in motion.

[014] Accordingly, the invention provides three levels of protection. First, the apparatus claim protects the complete unit comprising the band and sound button modules. Second, the module claim protects the sound button module itself as a sub-component. Third, the method claim protects the process of embedding the unit within various types of tires. Together, these claims ensure that the inventive concept is secured against replication in whole or in part.

[015] The Sound Button Unit therefore offers a novel, practical, and universal solution to the problem of silent vehicle operation. It requires no external power, produces no electronic waste, and is inherently reliable as it leverages the existing cyclic motion of the tire. By integrating sound generation directly into the tire structure, the invention ensures improved pedestrian, cyclist, and worker safety while remaining compatible with current tire manufacturing processes and materials.

Brief Description of the Drawings

Figure 1A is a perspective view of a section of the Sound Button Unit showing the band, exemplary locations of the sound button modules, and exemplary notches for securing the unit.

Figure 1B is a plan view of the outer face of the Sound Button Unit, showing exemplary positions of the sound button modules relative to the tread portion of a tire.

Figure 1C is a side view of the Sound Button Unit illustrating the band, flexible coating, and outwardly biased sound buttons.

Figure 1D is a sectional view showing the layered mesh substrate, flexible coating, and an example of a Z-seam connection for continuous mesh reinforcement.

Figure 2A is a sectional diagram showing the Sound Button Unit embedded within a pneumatic or tubeless tire, with apertures in the tread for sound button extension and an optional sealing layer behind the unit.

Figure 2B is a sectional diagram showing the Sound Button Unit embedded within a solid tire, without the need for a sealing layer.

Figures 3A and 3B are views of a sound button module, showing the sound button in the extended (open) position and the retracted (closed) position, respectively.

Figures 4A–4D are views of the sound button module components, including the casing, spring cavity, button cap, and optional reinforcement structures.

Figures 5A and 5B illustrate details of the mesh substrate, including seam construction and tie locations for securing layers of mesh.

Figures 6A–6C show multiple angles of the module casing, including the case top, case bottom, recessed cradle for the spring, and base plate.

List of Preferred Embodiments

- 1. Band**
- 2. Sound Button Module**
- 3. Notch**
- 4. Mesh**
- 5. Flexible Material**
- 6. Sound Button**
- 7. Spring**
- 8. Spacing**
- 9. Tread Face**
- 10. Tread Base**
- 11. Case**

- 12. Cavity**
- 13. Reinforcement Tree Anchor**
- 14. Ridge**
- 15. Plinth**
- 16. Trunk**
- 17. Branches**
- 18. Case Top**
- 19. Case Bottom**
- 20. Hole**
- 21. Recessed Cradle**
- 22. Ties**
- 23. Sealer Layer**
- 24. Sidewall**
- 25. Anchor**
- 26. Mesh Termination Points**
- 27. "Z" Seam**
- 28. Magnified Section**
- 29. Base Plate**
- 30. Cap**

Detailed Description of the Invention

[016] The following description refers to the accompanying drawings, in which like reference numerals designate like parts. The embodiments described herein are intended to illustrate the inventive concept and should not be construed as limiting. The scope of the invention extends to all equivalents performing substantially the same function in substantially the same way to achieve substantially the same result.

Figures 1A-1D: General Sound Button Unit Construction

[017] Figures 1A-1D illustrate embodiments of the Sound Button Unit (Sound Button Unit) positioned beneath the tread area of a tire. The Sound Button Unit comprises a band (1) formed from a mesh, flexible composite, or other substrate, submerged and encased in a flexible coating. A plurality of sound button modules (2) locations on the band and are where the apertures would be located in the tread area or contact patch in treadless tires encasing the Sound Button Unit. Notches or grooves (3) may be included along the band to assist in securing the unit within the tire body to avoid dislodgement or other defect.

[018] Figure 1B shows a plan view of the band covering a substantial portion of the tread area. The number and position of sound button modules (2) may be varied to suit different tread designs, traction patterns, hydro channel configurations or other design specifications. The invention is not limited to a particular module arrangement and may include circumferential, diagonal, or staggered layouts.

[019] Figure 1C shows a side view of the Sound Button Unit with sound buttons (6) biased outward. Each sound button is configured to retract when contacting a ground surface and return to its extended position upon release. This cyclical movement produces audible signals during tire rotation.

[020] Figure 1D illustrates a layered mesh (4) reinforced with ties (22) and joined using a Z-seam (27) or equivalent seam structure. The Z-seam allows continuous reinforcement when the band is formed from a single strip of mesh. Alternative seam patterns or multiple staggered joints may also be employed. The flexible coating (5) permeates the mesh structure, fully encapsulating it and leaving only the sound button modules exposed.

Figures 2A–2B: Tire Embodiments

[021] Figure 2A depicts the Sound Button Unit embedded within a pneumatic or tubeless tire. The band (1) with sound button modules (2) is positioned between a tread base (10) and a sealing layer (23). Apertures in the tread face (9) allow sound buttons (6) to protrude outward. A backing strip or sealing layer (23) may be applied behind the Sound Button Unit to prevent air leakage and to secure the unit. This embodiment demonstrates that the invention may be integrated during tire manufacture without altering fundamental pneumatic tire architecture.

[022] Figure 2B illustrates the Sound Button Unit embedded within a solid tire. In this configuration, no sealing layer is necessary, as there is no internal air chamber. The band (1) and modules (2) are molded directly into the tire body during fabrication. This embodiment is equally applicable to

airless or non-pneumatic tires, in which the band is permanently integrated into a solid or lattice structure.

Figures 3A-3B: Sound Button Operation

[023] Figures 3A and 3B show the operation of the sound button (6). In Figure 3A, the sound button is extended through the tread face (9) and the treads channel base (10), urged outward by a biasing element such as a spring which is omitted from this view for ease of drawing comprehension. In Figure 3B, the sound button is shown in its retracted position, having been pressed inward into its casing upon contact with the ground. This cyclical motion generates an audible signal as the button rapidly returns to its outward position. The retraction mechanism protects the tire and road surface from damage while ensuring consistent sound generation. The casing is to be of a height that is greater than the distance of protrusion of the Sound Button itself to avoid damage to the Sound Button Unit. A space (8) is pointed to and is located between the case top (18) and the case bottom (19) and is where the mesh is crimped into the casing. The figure also shows the location of the recessed cradle and the base plate (29) which is fitted under the case bottom (19).

Figures 4A-4D: Module Components

[024] Figures 4A-4D illustrate an embodiment of the sound button module. The casing (11) may be formed of metal, resin,

composite, or reinforced polymer. A recessed cradle (21) houses the spring (7) or other biasing element. The sound button (6) includes a sound button (6), and reinforcement elements such as a molded anchoring structure or internal tree (13) to prevent premature tearing or failure.

[025] Figure 4A shows the assembly in transparent view, highlighting the internal spring cavity (12) and anchoring structure (13). Figure 4B shows the sound button (6) with spring cavity (12), a hole (20) for anchoring the reinforcing tree (16), and a ridge (14) to prevent the sound button (6) from being ejected. The ridge (14) is also responsible for creating a secondary audio signal when the sound button is returned to its open position. Figure 4C shows a side view of the cap (30) in which the spring (7) fits into its cavity and also attaches to the sound button (6), and the reinforcing tree (13) , and Figure 4D illustrates the reinforcement tree (13), which may be replaced by a mesh insert, lattice, or other reinforcement. Materials for the button (6) may include synthetic rubbers such as SBR or SSBR, natural rubbers, resins, plastics, or hybrid composites as well as aggregates and additives to hone sound. The aggregates and additives may include metal flakes, types of rock, types of plastics or other substances for audio enhancement. The drawing also shows tree plinth (15) and the reinforcement trees anchor (25).

While the plinth and the anchor are both disc shaped the plinth (15) can be larger in circumference than the reinforcement trees anchor which must include a diameter which fits into the cylindrical cavity inside the cap (30). The diagram shows the approximate location of the anchor however it would not be seen considering it is inside the cap(30).

Figures 5A-5B: Mesh and Seam Details

[026] Figures 5A and 5B depict the mesh substrate (4) used to form the band. Seam details are shown, including Z-seam construction (27) which includes the end portions (26) of the wrapped mesh. Tie locations (22) for securing overlapping layers are shown, and should be included in construction before the coating is applied. The ties may be formed of rubber, polymer, resin, metallic wire or another material suited for proper functionality of the device. The mesh substrate may be woven, stamped, or molded, and may be formed of metal alloys, polymeric composites, or other durable materials. After the modules (2) are attached, the mesh is submerged and coated in a flexible coating (5) to fully encase and secure the structure. A magnified section (28) of the exemplary "Z" seam is shown as well and contains parts (26) mesh termination point, and the Z center which is pressed and fitted with machinery to create a smooth protrusion free seam prior to adding the flexible encasing material (5).

Figures 6A-6C: Module Casing Details

[027] Figures 6A-6C show different views of the casing (11) for the sound button module. The casing comprises a top portion (18) and bottom portion (19). The bottom portion may include a recessed cradle (21) for the spring (7), while the top portion includes an opening (20) through which the sound button (6) protrudes. A base plate (29) may be attached to reinforce the casing and provide a stable seat for the spring (7). The casing may be fabricated by stamping, molding, or machining, and may be secured to the band (1) by crimping the mesh between the top portion (18) and the bottom portion (19). Adhesives may be used prior to submersion in the flexible material to ensure the crimp is sealed and does not allow the flexible material to leak into the Sound Button prior to vulcanization.

Detailed Description of Embodiments

[028] The Sound Button Unit is not limited to any specific composition of materials. The inventive concept resides in the structure and arrangement of a band integrated with a plurality of sound button modules, and the functional relationship of these elements within a tire body. Accordingly, the Sound Button Unit may be fabricated from any

suitable materials capable of withstanding tire operating conditions. Non-limiting examples include metals, metal alloys, rubbers, elastomers, synthetic resins, natural or synthetic polymers, composites, ceramics, or combinations thereof. The materials may be selected according to cost, durability, wear resistance, manufacturability, and other design considerations, and may vary between the band, the casing of the sound button modules, the biasing elements, and the sound buttons themselves.

[029] The manufacturing process for the Sound Button Unit is also not restricted to a single technique. Suitable fabrication methods include molding (injection, compression, or transfer molding), extrusion, lamination, vulcanization, weaving of meshes or textiles, adhesive bonding, crimping, additive manufacturing (3D printing), or other known industrial processes. The band and modules may be fabricated with a variety of shapes patterns and dimensions and multiple sub-components, depending on the application, tread design and desired tire performance.

[030] The invention may be adapted for use across a wide range of tire types and vehicle classes. While particularly advantageous for electric and hybrid vehicles that operate with reduced noise signatures, the Sound Button Unit may also be incorporated into pneumatic tires, tubeless tires, run-flat

tires, solid tires, and airless or non-pneumatic tires. Applications are not limited to passenger automobiles, but may include motorcycles, bicycles, trucks, buses, industrial vehicles, warehouse vehicles, aircraft ground equipment, and military vehicles. The audible safety function may be desirable in diverse environments, such as city streets, highways, factory floors, airports, ports, or other settings where increased vehicle audibility improves safety.

[031] The embodiments described herein are illustrative rather than limiting. Variations in the dimensions, geometry, materials, and manufacturing processes are contemplated within the scope of the invention, provided the essential relationship between the band and the sound button modules are maintained. The invention therefore extends to all equivalents performing substantially the same function in substantially the same way to achieve substantially the same result. The Sound Button Unit is appropriate for many types of tire including pneumatic, radial, run flat, low pressure, camber, polyurethane, and foam filled tires to name some of the possible applications.

Functional Scope

[032] The embodiments described herein demonstrate the versatility of the Sound Button Unit in terms of construction,

materials, and methods of integration. The invention is not limited to any specific material composition, seam design, or button configuration. Rather, the essence of the invention resides in the combination of a band carrying a plurality of sound button modules that cyclically generate audible signals during tire rotation. Variations in geometry, number of modules, button size, material selection, and fabrication technique are all contemplated within the scope of the invention.

Use Cases, Applications, and Advantages

[033] The Sound Button Unit (Sound Button Unit) provides a passive, mechanically actuated audible signal whenever a tire rotates, enhancing situational awareness for pedestrians, cyclists, and workers. Because the Sound Button Unit is integrated at the tire contact patch, the point of ground contact produces a predictable actuation, speed-proportional, and does not depend on external electronics, wiring, power supplies, or software.

[034] **Urban and Residential Use.** Electric and hybrid vehicles operating at low speeds in dense environments benefit from increased audibility without adding external speakers or vehicle power drains. The Sound Button Unit produces a repeatable audible signature that scales with wheel speed, aiding detection during starts, stops, and turns.

[035] **Industrial and Warehouse Operations.** Forklifts, pallet movers, tow tractors, and automated guided vehicles (AGVs) often share space with personnel. Embedding the Sound Button Unit in industrial tires provides a durable, tamper-resistant signal that functions despite dust, humidity, or lighting conditions that can defeat visual indicators.

[036] **Airports, Ports, and Yards.** Ground service equipment and yard tractors benefit from an audible cue that carries in outdoor environments with variable ambient noise. Because the Sound Button Unit is mechanical, it remains effective in rain, fog, and low-visibility conditions.

[037] **Education, Campus, and Healthcare Zones.** Low-speed vehicles (carts, shuttles, maintenance fleets) can be fitted with Sound Button Unit tires to provide a gentle, consistent audio presence without the complexity of external acoustic systems.

[038] **Micromobility.** Bicycles, e-bikes, cargo bikes, scooters, and delivery robots can implement scaled Sound Button Unit embodiments to increase user presence in mixed traffic without rider action.

[039] **Military and Security Applications.** When desired, acoustic signatures may be tuned for specific frequency content or duty cycles for convoy spacing, formation

awareness, or zone entry alerts, while still preserving vehicle operability when electronic emissions are restricted.

[040] **Emergency and Utility Fleets.** Utility trucks, street sweepers, and refuse vehicles experiencing frequent low-speed maneuvers near personnel gain a predictable, speed-linked audible cue independent of sirens or beacons.

[041] **Roadway Construction.** Equipment fitted with the Sound Button Unit enhances worker safety in environments where line-of-sight is often obstructed and ambient noise is variable.

[042] **Compatibility Across Tire Classes.** The Sound Button Unit is compatible with pneumatic, tubeless, run-flat, solid, and non-pneumatic tires. The band and sound button modules may be incorporated during new tire manufacture or integrated into retread processes where permitted.

[043] **Vehicle Class Scalability.** Passenger cars, light trucks, heavy trucks, buses, motorcycles, bicycles, industrial vehicles, airport ground equipment, and specialized platforms can all adopt embodiments by selecting appropriate band dimensions, module counts, and materials.

[044] **Acoustic Signature Tuning.** The frequency content, amplitude, and temporal pattern of the audible signal can be adjusted by varying (i) the number of modules per circumference, (ii) circumferential spacing and phasing, (iii)

button cap geometry and mass, (iv) biasing element stiffness, (v) protrusion height relative to tread apertures, and (vi) casing resonance features. These parameters may be selected to produce tones, clicks, or patterned sequences, without limiting the invention to any one signature.

[045] **Speed-Proportional Output.** Because activation is tied to wheel rotation, signal periodicity naturally scales with speed. Embodiments may employ staggered phasing to maintain perceptibility over a wide speed range while avoiding tonal monotony.

[046] **No External Power.** The Sound Button Unit operates without tapping the vehicle electrical system. This reduces parasitic loads, simplifies integration, eliminates electromagnetic compatibility concerns, and allows operation during electrical faults.

[047] **Tamper Resistance and Durability.** Integration within the tire body and use of recessed casings reduce exposure to vandalism and environmental damage. The retractable, biased sound button avoids sustained scraping of road surfaces and mitigates button damage at impact.

[048] **Serviceability Options.** In some embodiments, modules may be replaceable during tire retread or service intervals. In other embodiments, modules are permanently embedded for

maximum robustness. The band may be continuous or formed of arcuate segments that assemble into a ring during manufacture.

[049] **Traction and Water Management.** Apertures for sound button passage may be located or shaped to maintain tread block function and hydrochannel continuity. Button geometry can be selected to minimize snow/ice packing and to self-clear debris during rotation.

[050] **Thermal and Wear Considerations.** Materials may be selected for heat resistance at highway speeds and for predictable wear. Button materials are allowed to abrade at a controlled rate so protrusion does not increase as tread depth decreases. Anchoring structures and internal reinforcement (e.g., molded trees, meshes, or lattices) promote cohesive integrity over service life.

[051] **Manufacturing Flexibility.** The Sound Button Unit may be integrated by molding, vulcanization, lamination, over-molding, adhesive bonding, crimping, or combinations thereof. Mesh seams may use Z-seams or staggered joints for continual mesh layering; flexible coatings may be applied by dip, spray, or flow processes. Additive manufacturing may be used for module or casing fabrication.

[052] **Material Flexibility.** Bands may use metallic or polymeric meshes, textiles, or composite lattices; casings may be metals, alloys, polymers, composites, or hybrids; biasing

elements may be metallic springs, elastomeric domes, cantilever beams, or equivalent resilient mechanisms; button caps may be rubber, elastomer, resin, metal, or combinations. Selection is driven by performance, cost, and manufacturability, not by any specific chemistry.

[053] **Redundancy and Fault Tolerance.** Multiple modules around the circumference provide functional redundancy: loss or fouling of individual modules does not eliminate audibility. Distributed loading reduces localized stress.

[054] **Integration With Electronic Systems (Optional).** Although the Sound Button Unit requires no electronics, embodiments may be combined with electronic audible systems for layered signaling. The mechanical baseline ensures audibility even if electronic systems fail or are powered down.

[055] **Regulatory Adaptability.** Because acoustic characteristics are set by mechanical parameters, embodiments may be tuned to satisfy diverse jurisdictional requirements for low-speed vehicle audibility or facility safety policies without limiting the invention to any one threshold.

[056] **Fleet Management Advantages.** Standardized acoustic patterns can aid fleet operators with by-ear recognition of vehicle approach in noisy depots, improving human-machine interaction without additional training.

[057] **Environmental and Sustainability Benefits.** Absence of electronic components reduces e-waste. Use of existing tire manufacturing workflows and materials minimizes process changes. Mechanical actuation avoids standby power consumption.

[058] **Cost and Retrofit Pathways.** Compared with externally mounted acoustic devices, the Sound Button Unit can reduce BOM complexity and installation time. In retreadable applications, bands and modules may be integrated during tread replacement where compatible with standards and safety practices.

[059] **Design Parameterization (Non-Limiting).** Engineers may specify module count per circumference, angular spacing, button cap thickness and stiffness, biasing rate, casing wall thickness, aperture diameter and fillet radius, and band thickness and mesh gauge. These choices are ordinary design tradeoffs to achieve target durability, audibility, and vehicle dynamics.

[060] **Balance and Ride Quality.** A circumferential band with uniformly distributed module mass supports tire balance. Where needed, counterweights or module phasing may be employed to maintain uniformity within typical tire balance tolerances.

[061] **Noise Quality and Comfort.** Acoustic spectra may be chosen to remain perceptible in typical ambient noise while avoiding harshness. Patterns (e.g., alternating module

spacings) can break up tonal peaks, yielding a polite yet noticeable signature.

[062] **Safety During Stationary States.** Because actuation depends on rotation, the Sound Button Unit remains inactive when the vehicle is stationary, reducing unnecessary environmental noise and focusing audibility when movement—and risk—exists.

[063] **Interoperability With Tread Designs.** The Sound Button Unit can be located to preserve tread design, block edges, and water evacuation. Aperture geometries and local reinforcement maintain tread integrity and wear performance.

[064] In sum, the Sound Button Unit supplies a durable, universal, and power-independent audible safety solution across diverse tires, vehicles, and environments, achieved through the functional combination of a band carrying outwardly biased sound button modules. Variations in geometry, materials, and manufacturing remain within the scope of the invention so long as this functional relationship is maintained.

Claims

Independent Apparatus Claim

1. An audible safety unit for tires, comprising: a band configured to be embedded within a tire body; and a plurality of sound button modules mounted to the band, wherein each sound button module includes a sound button biased to protrude outward from the band and generate an audible signal when cyclically pressed and released against a ground surface during tire rotation.

Dependent Apparatus Claims

2. The audible safety unit of claim 1, wherein the band is formed of a mesh substrate encased in a flexible material.

3. The audible safety unit of claim 1, wherein the sound button module comprises a casing, a sound button, and a spring biasing element.

4. The audible safety unit of claim 1, wherein the band is configured for embedding within a solid rubber tire.

5. The audible safety unit of claim 1, wherein the band is configured for embedding beneath the contact patch of a pneumatic or tubeless tire.

Independent Module Claim

6. A sound button module for generating audible signals in a tire, comprising:

a casing;

a sound button movably disposed in the casing; and

a biasing element that urges the sound button outward,

wherein the sound button retracts upon contact with a ground surface and re-extends when released, thereby generating sound.

Dependent Module Claims

7. The sound button module of claim 6, wherein the casing includes a recessed cradle for housing the biasing element.

8. The sound button module of claim 6, wherein the sound button is secured by a molded anchoring structure or mesh reinforcement.

9. The sound button module of claim 6, wherein the sound button is formed from rubber, resin, metal, or combinations thereof.

10. The sound button module of claim 6, wherein the sound button may include a reinforcement tree or stem to reduce premature wear of the sound button.

Independent Method Claim

11. A method of manufacturing a tire with an audible safety unit, comprising:

embedding a band with a plurality of sound button modules into a tire body;

and providing apertures in a tread portion of the tire through which sound buttons extend, wherein the sound button modules are biased to retract and extend during tire rotation to generate audible signals.

Dependent Method Claims

12. The method of claim 10, wherein embedding comprises molding the band into a solid rubber tire.

13. The method of claim 10, wherein embedding comprises layering the band between a tread portion and a sealing layer of a pneumatic tire.

14. The method of claim 10, wherein embedding further comprises applying a backing rubber strip to secure the band and seal an air chamber.

15. The method of claim 10, wherein the tread layers apertures are conical in shape allowing for the Sound Button to avoid defect from contact with the peripheral tread layer, allowing for unobstructed passage even when the Sound Button is in a levered position from contact with the grounds surface, due to the arc of the tire, trajectory of incoming Sound Button Modules from the motion of the vehicle.

Abstract

An audible safety unit for tires is disclosed. The unit comprises a band embedded within the tire body and a plurality of sound button modules mounted in the band. Each sound button module includes a casing, a sound button, and a biasing element urging the sound button outward. During tire rotation, the sound buttons cyclically depress and release upon ground contact, generating an audible signal that alerts pedestrians, cyclists, and animals to the vehicle's presence. The band may be molded into a solid tire or layered between a tread portion and a sealing layer of a pneumatic or tubeless tire, with apertures formed in the contact patch to permit sound button protrusion. A backing strip or sealing layer may be included for additional support. The invention requires no external power, is compatible with existing tire manufacturing processes, and provides a durable, passive, and universal safety solution for low-noise vehicles.