[0015a] According to a first aspect of the present invention, there is provided a Hooke's law disobeying spring system, including: a spring assembly interrelating one or more primary and one or more supplemental springs such that loading distortion of the assembly both distorts one or more of the primary springs and rearranges one or more loaded supplemental springs; wherein increasing assembly loading distortion increases the primary springs loading while rearranging the supplemental springs' to decrease their contribution to the assembly loading response, and decreasing overall assembly loading distortion decreases the primary springs loading while rearranging the supplemental springs' to increase their contribution to the assembly loading response.

[0015b] According to a second aspect of the present invention, there is provided a method of structuring a steady force spring-type load resistance, including the steps of: structurally interrelating one or more primary and one or more supplemental springs to meet an overall load with a combined level of resistance force when within their operating ranges; structuring the primary and supplemental springs' with a variable alignment of their respective load resistance force vectors such that the supplemental springs contribute more to the combined distortion resistance force when more aligned with the primary springs; wherein when an overall load increases the primary springs distortion, the also loaded supplemental springs alignments with the primary springs decreases, and when an overall load decreases the primary springs distortion the also loaded supplemental springs alignments with the primary springs increases.

[0015c] According to a third aspect of the present invention, there is provided a pneumatic inflation pressure corrector, suitable for use in a bounded volume of gas to be maintained at a selected level of gas inflation pressure, including: a gas-impermeable expandable envelope enclosing a variable size gas volume; an internal spring assembly and an internal gas pressure level forcing the envelope surface outward against encountered external gas pressure forcing the envelope surface inward, with the enclosed volume decreasing when there is more inward than outward forcing, the enclosed volume increasing when there is more outward than inward forcing, and the enclosed volume is unchanging when the inward and outward forcing is even; wherein the spring assembly outward forcing level decreases when the enclosed volume decreases and increases when the enclosed volume increases at rates of decreasing and increasing that match in magnitude and oppose in direction the internal gas pressure outward forcing's concurrent rates of increasing and decreasing, respectively, such that their combined outward forcing remains at a steady level as the enclosed volume increases or decreases.

[0015d] According to a fourth aspect of the present invention, there is provided a method of maintaining an inflation pressure level, including the steps of: structuring a gas-impermeable, expandable surface to contain a variable volume; disposing at least a portion of the expandable surface in direct contact with or in gas communication mediated contact with an inflated space; pressuring the surface outward with one or more spring forces so that the contained volume, increases when the inflated space pressure level is less than the outward pressure, decreases when the inflated space pressure level is more than the outward pressure, and is steady when the inflated space pressure level is even with the outward pressure.

[0015e] According to a fifth aspect of the present invention, there is provided an airborne infectant/pollutant facial protection system including: a gas-impermeable shield bordered by a resilient inflatable interface that collectively form a continuous seal with a wearer's face when a concave side of the shield faces the wearer and the system is applied to the wearer's face with the wearer's mouth, nose and eyes in a then bounded airspace; said interface inflation pressure corrected to maintain a steady level of pressure against the wearer's face and a steady force spring assembly providing the pressure correcting, and a divided airflow system wherein air enters the bounded airspace via ports in general proximity to the wearer's forehead and leaves the bounded airspace via ports in general proximity to the wearer's jaw and under chin.

[0015f] According to a sixth aspect of the present invention, there is provided a method of protecting a face from airborne infectants or pollutants including the steps of: arranging an at least partially arcuate, transparent, gas-impermeable shield to be bordered by a resilient inflatable interface and collectively configuring the shield and interface to form a continuous seal with a wearer's face such that a concave side of the shield faces the wearer's face and the wearer's mouth, nose and eyes are within an enclosed airspace bounded by the shield, the interface and their skin; correcting the pressure applied by the interface to the wearer's skin so that it is maintained at a steady level by a steady force spring assembly as the wearer's skin moves, and disposing an elastic, resilient soft air dam having a spiral cross-section resting shape with its concave spiral side facing downward and extending from side to side across the interior of the shield, wherein a less curled end of the dam is anchored, from side to side, to a vertical-when-worn-mid-section of the shield with the more curled end of the dam curving tightly enough to at least double back upon itself such that when the shield and dam are put on by the wearer, the wearer's face contacts the convex side of the dam.

[0015g] According to a seventh aspect of the present invention, there is provided a pressure compensator for maintaining a first inflated space's pneumatic pressure, including: a gas impermeable, size alterable enclosure of a first space, gas transfer ports through the enclosure to/from the first space and one or more force sensitive enclosure portions responsive to external pressure on and internal pressure from the first space's enclosed gas by increasing the first space's size when the internal pressure is greater than the external and decreasing the first space's size when the external pressure is greater than the internal; and a steady force spring assembly that exerts a steady force as it moves through its operating range, arranged to provide the external pressure on the force sensitive enclosure portions, such that as gas enters and/or exits the enclosure the spring assembly maintains a steady force on the enclosure so that its pneumatic pressure remains steady.

[0015h] According to an eight aspect of the present invention, there is provided an assembly that resists operating range distortion with a steady force level, including: one or more springs interrelated with one or more compensators; one or more interfaces transmitting external loads to the interrelated springs and compensators, said compensators modifying while translating the external loading from the interfaces to the springs; wherein said modifying matches the work done on the springs to the work done on the interface by altering the rate of distortion of the springs in inverse proportion to the rate of change of the force level of the springs' distortion resistance such that their product is steady.

[0015i] According to a ninth aspect of the present invention, there is provided an operational range constant force spring assembly, including: a spring assembly integrating one or more primary springs and one or more secondary springs so that their vector sum net loading resistance to overall assembly distortion comprises the assembly's overall loading resistance; wherein aggregate secondary and aggregate primary springs' distortion resistances input to the assembly distortion resistance in opposing directions and when the assembly distortion changes, all the springs' distortions change and the aggregate secondary and aggregate primary springs' distortion resistance changes are of the same sign and magnitude.

[0015j] According to a tenth aspect of the present invention, there is provided an operational range constant force spring assembly, including: a spring assembly integrating one or more primary springs and one or more secondary springs so that their vector sum net loading resistance to overall assembly distortion comprises the assembly's overall loading resistance; wherein aggregate secondary and aggregate primary springs' distortion resistances input to the assembly distortion resistance in aligned directions and when the assembly distortion changes, all the springs' distortions change and the aggregate secondary and aggregate primary springs' distortion resistance changes are of the same magnitude but opposing in direction.

[0016] The variable effective force expression of the variably unsheathed spring is intimately related to the various forms of Hooke's-Law-Disobeying (HLD) springs and spring assemblies disclosed m the present application's embodiments. A number of differing tactics are involved in realizing the embodiments of the present application, including a first tactic wherein one or more main, first, or primary forms of standard spring are interrelated with one or more effectively non-standard performing second, supplementary, or secondary spring elements. The interrelation is such that distortion/un-distortion of the one or more main springs also concurrently either or both distorts and/or undistorts the secondary spring elements and often also alters the effective rebound force being expressed by the secondary elements. Differing combinations of these approaches, as well as differing variations in execution techniques provide a wealth of variation in the number of manners (i.e. number of embodiments) of realizing the present invention.

[0017] Among the techniques which enable the constant (or near constant) force spring assemblies and methods are opposing compressions with extensions, opposing compressions with reversed compressions, arranging for compressions or extensions to become effective (or ineffective) progressively as the distortion progresses, arranging for the direction of expression of a compression (or extension) to be progressively redirected so that differing force components are effective upon the overall distortion of the spring assembly, and other means. While many of the embodiments described herein are referred to as compression springs, spring elements, and/or spring assemblies, it should be understood that the majority of these embodiments, sometimes with relatively modest and well-known modifications, are also able to function as or be replaced by extension springs, spring elements, and/or spring assemblies. Other objects and features will be in part apparent and in part pointed out hereinafter.

[0018] Among the specific uses of the present invention disclosed in the present application are systems and methods of ensuring correct, ongoing pressurization of a pneumatic tire from

inception of its pressurization and for a period afterward. Most of the embodiments work to inject additional material into the inflatable space of the tire interior to compensate for the air lost due to leakage over time. The additional material is sometimes air sourced from the atmosphere and compressed for injection into the tire interior, to occupy space within the tire interior and increase its pressurization, in other embodiments the additional material is an operative surface that usually constrains and is driven by the pressure of a volume of gas isolated from communication from the tire's interior volume, in addition to being driven by a spring mechanism having an effective variable spring constant.

[0019] In both forms of additional material intrusion into the tire interior volume, when the tire interior is at a correct pressurization, the re-pressurization operations are suspended, and when the tire pressure drops below a significant level the re-pressurization operations resume. Once correct pressure levels are regained, the operations again suspend, only to resume again when they drop below the significant level. The correct pressure levels maintained are determined by the construction and set-up of the gas re-pressurizing embodiments, and once installed are generally used essentially autonomously. Variations utilizing differing degrees of control and user involvement are also within the scope of the present invention, for situations in which greater involvement are preferable, including especially for indicating when the tire requires a re-inflating maintenance servicing.

[0020] The primary repressurization driving element(s) in a majority of embodiments of the present invention are compression resisting spring elements forming a spring mechanism with an overall effective spring constant. The spring elements can, both individually and collectively as the spring mechanism, assume active states when the tire interior is under pressurized relative to an acceptable target pressurization level, and inactive states when the tire pressurization is acceptable. Frequently, the inactivity is caused by the one or more spring elements being held in a disposition wherein they do not contribute their compression resistance to the pressurization of the tire interior, and once that disposition restraint is ended, those spring elements can then contribute again. Often, the disposition restraint is the interior pressurization level dependent such that the switching between active and inactive states is automatic and autonomous, and generally not heavily temperature dependent in operation or effectiveness since the spring elements usually keep a steadier spring constant over a large range of temperatures than a gas pressure based decompressing force.

[0021] For those embodiments where the additional material is gas, generally air, the resilient element becomes unrestrained when the tire interior pressurization fails below the target level. Once unrestrained, at least a portion of some of the spring elements decompresses until contact with an internal aspect of the tire side walls is contacted. As a wheel mounted the turns in operation, its sidewalls cycle through greater and lesser outward bowing each revolution, with the most outward bowing occurring adjacent the contact patch and the least outward bowing occurring at the top of the tire when the wheel and tire are bearing a load on their axle. Hence, the spring elements can be driven into compression, depending on the construction of the spring mechanism, by either sidewall bowing extreme, inward or outward. In general, when one bowing extreme disposition corresponds to compression of the spring mechanism, the other extreme corresponds to decompression of the spring mechanism. These two main extreme dispositions of the spring mechanism can be alternatively configured where either can correspond to a recovery stroke that sources and prepares gas, or a

pressurization stroke that compresses and injects gas into the tire interior. In both such configurations, the compression of the spring element or its decompression can be arranged to be a part of the recovery or the pressurization stroke, and all of these permutations fall within the scope of the present invention. In certain cases, there may be an energy efficiency advantage in having the spring mechanism be compressed by the less outward bowed sidewalls at the top of the tire where that part of the tire is less involved in efficiently transferring the vehicle motor power to the road.

[0022] In one embodiment of the present invention, resilient spring elements are compressed by the sidewalls being less bowed which also moves an injector into receiving gas to be pressurized, then when the sidewalls become more bowed the compressed resilient elements are released to apply their spring force to compressing the gas received and injecting into the tire interior. A number of these pressurizing and injecting spring mechanisms arranged symmetrically about the tire interior can operate continuously if desired so that even when only a minute amount of gas is injected in each cycle, a rolling the will execute so many cycles that pressurization recovery can be assured (since the present invention is intended to maintain proper pressurization, i.e. add small amounts of air, only once a tire has already been essentially filled from a pressurized source).

[0023] In other embodiments of the present invention, the additional material is an operative surface that occupies a portion of the inflatable interior of the tire that would otherwise be available to the tire's inflation gasses. The operative surface is a portion of a pressurization compensator that is configured to be responsive to the inflation pressure of the tire interior, in particular configured to become active automatically and autonomously whenever the tire pressurization falls below a target level. (In other circumstances, what was best described as a compensator in a first situation, is sometimes best described as a pressure stabilizer or a re-pressurizer in other situations.) Usually, the compensator incorporates one or more compressible/decompressible volumes whose size is at least partially dependent on the disposition of the operative surface such that the pressurization of the tire interior and that of the one or more compressible/decompressible volumes affect each other. The outward pressure of the operative surface is a combination of the compensator contained gas pressure and the spring mechanism's forcing, which add up to equal the tire inflation pressure when all are at a steady state.

[0024] In some embodiments, after set up, the amount of gas in the one or more compressible/ decompressible volumes is open to the atmosphere so that their internal pressure is relatively steady, while in others embodiments the compressible/decompressible volumes are closed at a selected pressure, so that their internal pressure thereafter basically varies from the starting point according to the ideal gas law in response to temperature and changes in sizes of the volumes. The gas pressure difference between the tire interior side and the compensator volumes' side of the compensator operative surface is supplied by the decompressive thrust of the at least partially compressed compensator spring mechanism. Hence, the greater the difference in the gas pressure on the two sides of the operative surface, the greater amount of force must be supplied by the spring mechanism, and lienee almost certainly the greater amount of weight required. In many applications, the difference in weight can be substantial because the tire interior pressurization can be a substantial amount greater than atmospheric pressure. The weight variation may also be of differing significance

when the compensator is integrated into a wheel's structure versus when the compensator is a separate, or aftermarket, piece of equipment (though normally still well secured to the wired).

[0025] Compensator embodiments of the present invention whose compressible/decompressible volumes are not supplied by the atmosphere have multiple variants. In one variant, the construction simplicity of a closed set of compressible/decompressible volumes is accompanied by the need for stronger spring elements to account for the greater difference in gas pressure on the differing sides of the operative surface. Other variants incorporate selectively closable valve(s) that when open allow gas communication between the tire interior and its inflation gasses and the interiors of the compressible/decompressible volumes. The selectively closable valve is normally pressure sensitive, directly or indirectly, and hence will allow pressurization of the compressible/decompressible volumes along with the tire interior when it is being inflated, up to the selected pressure. When the selected pressure is reached during the inflation the valves close and the tire interior is further inflated until it reaches its target pressure, while tire compressible/decompressible volumes contain a static amount of gas. When the valves close, the spring mechanism is at its uncompressed rest disposition wherein the combination of the gas pressure within the compressible/decompressible volumes and tire resistance to compression of the spring mechanism prevent any compression of the compensator until the tire interior reaches its target pressure.

[0026] At the target pressure, compressive movement of the operative surface is resisted by the gas pressure within the compressible/decompressible volumes combining with the spring mechanism's compression resisting force to drive the operative surface enough to equal the target pressure. At that point tire the interior is inflated with even more gas which temporarily raises the tire interior inflation pressure, until the compressible/decompressible volumes are compressed enough (winch increases the space available to the tire inflation gasses,) to bring the tire inflation pressure back down to the target pressure. The spring mechanism's variable effective overall spring constant is calibrated to diminish during compression by just the amount required to counterbalance tire increase in gas pressure due to reduced compressible/decompressible volumes and the linearly increasing distance of compression contribution to the spring force (spring force = [spring constant] [compression distance]). The variable overall effective spring constant diminishes just enough as the operative surface is compressively moved so that the increase in pressure within the compressible/decompressible volumes is balanced by a decrease in tire overall spring force exerted by the spring mechanism. The process is continued throughout the operative range of the compensator up to or near its maximum compression when the inflation is ended. Once the tire and compensator is then put in use, over time it will lose inflation gasses due to leakage. As it does, the compensator reverses the process that occurred during inflation which maintains tire the inflation pressure at the target pressure throughout its operative range, which can be large enough to account for multiple months of time and use based leakage.

[0027] By comparison, the constant compressible/decompressible volumes internal pressure approach is mechanically similar, but requires more of the spring mechanism since in many cases such as heavy vehicle tires the inflation pressure (normally 65-120 psi) is many multiples of atmospheric pressure (14.7 psi). Such an approach does enable the use of relatively simple constant force springs as elements of the spring mechanism. Because the

range of undesired the under inflation normally dealt with when using heavy vehicles, especially including cat 8 long haul semi-trucks, is often just a few psi or less in loss per month, using the closable valve enables the compressible/decompressible volumes to be filled with gas much more pressurized than the atmosphere. Hence, for these embodiments the spring mechanism must only compensate for 10 or 20 psi of lower pressure, and will thus be much simpler, lighter, and less expensive. Of course, almost any material with the requisite performance characteristics can serve as any aspect of the spring mechanism and/or the materials) that comprise the compressible/decompressible volumes.

[0028] In still other embodiments, the spring mechanism can itself comprise the operative surface of the compensator so that the entire compensator can be integrated within the wheel structure with a minimum of additional parts. Almost any geometry, multiplicity of parts (such as number of compressible/decompressible volumes or use of differing compensator constructions in the same embodiment), all fall within the scope of the present invention. Further variations can include selectably alterable, variable and/or steady, effective overall spring constants so that differing the inflation target pressures can be correctly maintained with the same compensator. Even further, this alterability can be controllable by accessible controls integrated within the wheel, or by a mechanism that is itself air pressure operated so that it can be manipulated with inflation gasses from their source.

[0029] Various embodiments of the present invention are able to provide effective answers to one or more of the above described needs and wants. These embodiments can operate in concert and/or individually, as well as in sub-combinations thereof. It should be understood that when or more embodiments of the present invention are discussed as a part of one or more of the representative embodiments of the present invention, the particular number of inventive embodiments present or not in that specific embodiment is not intended to be limiting but is rather merely illustrative. Unless specifically detailed herein, any and all embodiments of the present invention are able to be utilized in effective sub-combinations with any or all of the other embodiments of the present invention, regardless of the presence or absence of the detailing of that specific sub-combination herein.

[0030] A first embodiment of the present invention involves an inflatable interface that enables a soft, comfortable yet secure grip on the face. The interface is inflated with a constant pressure that stays constant even as a portion of the interface is moved or changes volume. One or more constant force spring assemblies are employed to manage the internal inflation pressure of the interface, such that as the pressurized volume is changed the spring assembly automatically compensates by its exertion of a constant decompression force throughout its operating range which in turn is exerted against a boundary of the inflated volume that pressurizes the interface. This constant pressurization compensation enables the interface to move in concert with a body part, such as the chin when the wearer is talking, all while exerting the same steady comfortable pressure against the chin's underside.

[0031] A second embodiment of the present invention involves a gas impermeable shield configured as a concave shape that can form a continuous seal with the inflatable compliant interface, such that when the shield and inflatable interface are pressed to a wearer's face the space enclosed between the shield, interface, and the wearer's face is isolated away from gas communication with the ambient environment. Due to the interface's compliance, the sealed

isolation of the space can be large enough to include the wearer's eyes, mouth, and nose without causing fit, comfort, or loss of seal issues due to a portion of the face moving, or due to the shield moving separately from the wearer's face's movement The shield can assume a wide array of configurations and forms, and can include a moveable diaphragm element to enhance speaking clarity.

[0032] A third embodiment of the present invention involves a soft air dam disposed so as to sub-divide the isolated space between the shield, interface, and the wearer's face. The air - dam sub-divides this isolated space into upper and lower zones, with the upper zone encompassing the eyes and their visual field, while the lower zone encompasses the wearer's nose and mouth. The dam usually is formed with a rest cross-section spiral shape with the convex side of the larger end of the spiral being disposed upward and forming a seal with a vertically middle portion of the shield form side to side. The dam is curled sufficiently tightly to at least double back on itself so that when the shield and dam are put on by a wearer, the convex side of the dam is pressed against the wearers face. When the wearer exhales, she concave side of the dam will be pushed by the contained exhalation pressure into a better seal with the user's face. When the wearer inhales, air from the upper zone is drawn downward so that its pressure on the dam's convex side tends to reduce its sealing pressure on the wearer's face and hence enables movement of the upper zone air to the lower zone.

[0033] A fourth embodiment of the present invention involves a zonal air flow created by restricting air flow inward to the shield/interface/skin enclosed space to only a first path while also restricting air flow outward from the shield/interface/skin enclosed space to only a second path. The first path (which like the second path can incorporate a multitude of individual passages that act collectively as a path) travels, in this instance, from one or more first path exterior vents to one or more first path channels leading to one or more first path ports to the shield/interface/skin enclosed space. The second path travels, in this instance, from one or more second path exterior vents to one or more second path channels leading to one or more second path ports to the shield/interface/skin enclosed space. The first path ports are located along the borders of the upper zone of the shield/interface/skin enclosed space while the second path ports are located along the borders of the lower zone. Hence air enters the shield/interface/skin enclosed space along the borders and specifically the upper borders of the upper zone, generally travels downward to the lower zone, and then leaves the shield/interface/skin enclosed space via the lower zone second path ports.

[0034] A fifth embodiment of the present invention combines the third and fourth embodiments so that the zonal flow' is an effectively one-way zonal flow. The air enters the shield/interface/skin enclosed space from the first path at the upper portion of the upper zone, flows downward under the air dam (but not upward past the darn) to the lower zone and then leaves the lower zone through the second path ports. An augmentation of the fifth embodiment can be used to direct the incoming air flow through the first path ports to impact upon the viewing field of the shield to dry that portion of the shield to reduce fogging. A further enhancement of this anti-fogging effect can be achieved by disposing a dessicant along the first path that the incoming airflow encounters.

[0035] A sixth embodiment of the present invention utilizes the first and second airflow paths to dispose the intake and exhaust vents rearward of the wearer's face, including behind the

ears or even behind the head so that to wearers can even speak in close proximity without either's breath being likely to be rebreathed by the other. An additional attribute of this embodiment is that the first and second paths can be disposed within rearward reaching arms that extend back from the interface and shield above the ears and around toward the back of the head similar to sunglass arms.

[0036] A seventh embodiment of the present invention involves an passive utilization of the wearer's exhalation air pressure to simultaneously drive air into the shield/interface/skin enclosed space upper zone to further prevent airflow from the lower zone to the upper zone. As the wearer exhales, the air dam of the shield/interface/skin enclosed space confines their breath to the lower zone and hence drives air out of the lower zone second path ports along the second path to its vents. At least a portion of the air traveling along the second path passes through a second path duct that contains members such as impellers that are driven to rotate by the passage of the exhalation air flow. The second path duct is interrelated with a first path duct through which at least a portion of the first path airflow passes. The first path duct contains similar members as the second path duct, which are rotated by the rotation action of the second path duct during exhalation, except when the rotation of the second path duct causes the rotation of the first path duct, the first path duct drives air to the shield/interface/skin enclosed space.

[0037] Other aspects objects and features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] Note: Figs. 1-17 are the same as Figs. 1-17 of the US provisional utility patent application 62/942403, filed on Dec. 2, 2019, titled “Pressurization-Stabilizing-Systems-and-Methods” and also invented by the inventor of the present application. These drawings and their brief and detailed descriptions of them are here by incorporated herein by reference and are a part of the disclosure of the present application.

[0039] Fig. 1 depicts a schematic cross-section view of an operating the and a first pressure compensator embodiment of the present invention.