

Non-Hooke's Law Spring Constant Systems and Methods

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority from US provisional utility patent application 62/942403, filed on Dec. 2, 2019, titled "Pressurization-Stabilizing-Systems-and-Methods"; US
5 provisional utility patent application 62/979439, filed on Feb. 22, 2020, titled "Variable Spring Constant Systems and Methods"; and US provisional utility patent application 63/070267, filed on Aug. 26, 2020, titled "Airborne-Protection-Systems-and-Methods" and all also invented by the inventor of the present application.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

10 [0002] Not applicable.

BACKGROUND OF THE INVENTION

[0003] Field of the Invention

[0004] The present invention relates generally to resiliently distortable elements, and more particularly to those resiliently distortable elements that are used as springs or the equivalent and
15 varying applications of non-Hooke's Law performing springs.

[0005] Related Art

[0006] The present application hereby incorporates by reference the entirety of the disclosure of the US provisional utility patent application 62/942403, filed on Dec. 2, 2019, titled "Pressurization-Stabilizing-Systems-and-Methods"; US provisional utility patent application 62/979439, filed on Feb.
20 22, 2020, titled "Variable Spring Constant Systems and Methods"; and US provisional utility patent application 63/070267, filed on Aug. 26, 2020, titled "Airborne-Protection-Systems-and-Methods" and all also invented by the inventor of the present application.

[0007] Resilient distortable elements, and in particular springs, are a long known and heavily employed technology. In the ideal case, for a given operational range, the rebound force exhibited by
25 a spring that is distorted by a distance x is in the opposite direction of the distortion and has a

magnitude Kx where K is a characteristic constant of springs defined as the [spring rebound force] / [spring distortion distance]. Hence the rebound force expressed by a standard spring grows as the amount of the distortion grows.

[0008] While springs are immensely useful, there is also a need for other forms of rebound force expression, in as simple and reliable a package as a spring. For example, even in modern times the production of constant force machines, via complicated multi-part linkages and mechanisms, often including power and feedback sensors and sources, all presenting additional issues as well. The invention of even an approximation, much less an exact version, of a constant rebound force spring, compression or extension, would be immensely useful.

10 [0009] Pneumatic tires have enabled a land mobility revolution wherein it is now routine for anybody to be able to safely and comfortably travel at speed. Of course no technology is without weaknesses and one of the primary issues with pneumatic tires is the necessity of maintaining a correct level of pressurization that the tire is designed for. While advances in materials and construction have reduced the rate of gas leakage from modern pressurized tires' interiors, the ever
15 increasing performance and efficiency results demanded of tires are only heightening the value of proper pressurization to ensure that the tire performs as best as possible.

[0010] A number of approaches have been tried to address this issue, primarily by attempting to replace the lost inflation gas with an alternative gas, including often injecting more air into a tire to compensate for the lost air that leaked. Among the most common sources of the air tried are pre-
20 supplied compressed gas reservoirs and pump mechanisms that are externally powered or that attempt an energy scavenging and usually overall energy costing manner of taking atmospheric air and compressing and then injecting it into the tire's inflatable interior. Most all of these approaches, directly or indirectly, require energy sources, relatively complex sensors, and time intensive monitoring and/or installation & setup.

25 [0011] An approach to ensuring accurate, lasting tire pressurization preservation would have a number of optimal qualities in addition to the obvious attributes like low relative cost, light weight, and reliability of accurate performance. Among the key attributes would be autonomous pressure

level sensing and correction operation, “hands-free” pressurization maintenance set-up during a tire inflation procedure, minimal disruption of the integrity of a wheel the pressurized tire is mounted upon, and virtually no disruption of the tire or the current manner of physical interrelation between tires and wheels. In order to provide all of these attributes and more, the following invention is described and illustrated.

[0012] Certain workplaces, ambient environments and/or specific individuals have long been known to present exposure dangers. When workplace activities or conditions produces toxic substances that can damage an individual it may be necessary to protect their eyes, nose and mouth from exposure. Similar protection needs from airborne environmental pollutants and/or or infectious pathogens are also well-known. It is also known, especially but not only in health care settings, that in addition to guarding against potential risks to the wearer, a protection system may also need to protect against potential dangers spread by the wearer. These can range from excessive moisture for the conditions, such as an archaeological cave site that contains fragile artifacts, to infectious pathogens that an asymptomatic infectee could spread.

[0013] Broad varieties of face and breathing protection/filtering systems do exist, and are in increasing use in particular due to the emergence of the Covid-19 pandemic. These range from little more than loose, open weave cloth to safety glasses to welding helmets to surgical masks and plastic face shields. Some provide some filtering to the breath, but usually only at the N95 level or even less discriminating. Only a few provide eye protection at all, and even the shields are relatively immaterial against, for example, to an aerosolized virus that can exist at the sub 0.3 micron size as an airborne infectant for extended periods of time such that the air in the airspace becomes essentially an infectious agent itself. Scuba diving masks due often provide eye, nose, and mouth protection, but most are not well suited for extended wear (8+ hours) situations since their seals to the face are uncomfortable bordering on damaging when their use is extended. They also present a number of undesirable compromises for everyday wear. In medical settings, when required, the only option is often a \$1000/unit powered respirator mask with a hose extending from a shoulder borne powered, filtered fan enclosure.

[0014] What has become clear is that there is an unfilled need for a device that can provide a variety of forms of protection that are easy to use, comfortable over the long run, at a relatively affordable cost. Needs include complete isolation of the eyes, nose and mouth from the environment; respiratory air supply that is HEPA level filtered; respiratory exhaust that can be HEPA level filtered; sufficient wearing comfort to avoid physically based limitations on wearing endurance; passive operation that doesn't require a power source; affordable cost; ease of variation in size and arrangement to adapt to myriad heads/faces; and facilitation of spoken communication by the wearer. Wants include minimums of facial obstruction, both physically and visually; light weight; ease of start and end of use; ease of cleaning; ready replacement of filtering materials; simplicity of fashion and/or design customization; pleasing appearance individually and when worn; and ease of construction.

SUMMARY OF THE INVENTION

[0015] In lieu of paragraph 0015, and enabled by the incorporation by reference of the entire disclosure of US provisional utility patent application 62/942403, The entirety of paragraphs 0006 – 0019 of the '403 patent application, filed on Dec. 2, 2019, are hereby incorporated by reference as the opening paragraphs of the "Summary of the invention" portion of the present application.

[0015] The patent pending invention of the '403 application by the present inventor is in and of itself, a form of spring, when it is disposed in fluid contact with the gasses that inflate a volume with at least one moveable surface. Due to the pressure correction of the previous application, the moveable surface is then a (gas) spring surface that acts as a steady force (gas) spring. A gas driven piston and cylinder, with an interior in fluid communication with a pressure corrected gas volume, would be a constant force piston when that piston is used as a force expresser (or receiver). The variably sheathed spring element of the pressure corrector embodiment in the '403 application is the key to that device's non-Hooke's Law performance. The standard spring performing internal gas pressure and always unsheathed coil spring element of the pressure corrector operate as standard springs that function according to Hooke's Law when operating normally. The partially unsheathed spring adds the non-Hooke's behavior that combines with the standard springs to realize the constant force spring as an assembly.

[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 in 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
5 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
10 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)
15 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
20 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
25 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
5 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
10 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.

15 [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,
20 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 tire interior pressurization level dependent such that the switching between active and inactive states is automatic and autonomous, and generally not heavily temperature dependent in
25 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 falls 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 tire 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 tire 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 hence 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 wheel).

[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
5 volumes along with the tire interior when it is being inflated, up to the selected pressure. When the selected pressure is reached during tire inflation the valves close and the tire interior is further inflated until it reaches its target pressure, while the 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 the
10 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
15 point the tire interior is inflated with even more gas which temporarily raises the tire interior inflation pressure, until the compressible/decompressible volumes are compressed enough (which 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 the increase in gas pressure due to
20 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 the overall spring force exerted by the spring mechanism. The
25 process is continued throughout the operative range of the compensator up to or near its maximum compression when tire 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 the tire 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 tire 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 material(s) that comprise the compressible/decompressible volumes.

[0028] In still other embodiments, aspects of 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 tire 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 aspects of the present invention are able to provide effective answers to one or more of the above described needs and wants. These aspects can operate in concert and/or individually, as well as in sub-combinations thereof. It should be understood that when or more aspects 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 aspects 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 aspects of the present invention are able to be utilized in effective sub-combinations with any or all of the other aspects of the present invention, regardless of the presence or absence of the detailing of that specific sub-combination herein.

5 **[0030]** A first aspect 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
10 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.

15 **[0031]** A second aspect 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
20 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.

25 **[0032]** A third aspect 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 from 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, the 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 aspect 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 aspect of the present invention combines the third and fourth aspects 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 dam) to the lower zone and then leaves the lower zone through the second path ports. An augmentation of the fifth aspect 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 aspect 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 aspect 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 aspect 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 hereby 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 tire and a first pressure compensator embodiment of the present invention.

[0040] Fig. 2 depicts a schematic cross-section view of a first gas injecting spring mechanism according to the present invention.

[0041] Fig. 3 depicts a schematic cross-section view of a second gas injecting spring mechanism according to the present invention disposed within a tire interior section at the top of its revolution.

5 [0042] Fig. 4 depicts a schematic cross-section view of the second gas injecting spring mechanism according to the present invention disposed within a tire interior section at the bottom of its revolution.

[0043] Fig. 5 depicts a schematic cross-section view of a third gas injecting embodiment of the present invention.

10 [0044] Fig. 6 depicts a schematic cross-section view of a fourth gas injecting embodiment of the present invention.

[0045] Fig. 7 depicts a schematic cross-section view of an external air sourcing path for the gas injecting and/or static contained pressure embodiments of the present invention.

[0046] Fig. 8 depicts a schematic perspective view of a possible disposition of a first separable
15 pressurization compensator embodiment of the present invention.

[0047] Fig. 9 depicts a schematic cross-section view of a second form of spring mechanism and compensator embodiment according to the present invention.

[0048] Fig. 10 depicts a schematic cross-section view of a third form of spring mechanism and compensator embodiment according to the present invention.

20 [0049] Fig. 11 depicts a schematic cross-section view of a fourth form of spring mechanism and compensator embodiment according to the present invention.

[0050] Fig. 12 depicts a schematic cross-section view of a fifth form of spring mechanism and compensator embodiment according to the present invention.

[0051] Fig. 13 depicts a schematic cross-section view of a sixth form of spring mechanism and
25 compensator embodiment according to the present invention.

[0052] Fig. 14 depicts a schematic perspective view of a first separable compensator and spring mechanism embodiment according to the present invention.

[0053] Fig. 15 depicts a schematic cross-section view of variant interiors of the first separable compensator and a sheathed, over-coiled spring element embodiment according to the present invention.

[0054] Fig. 16 depicts a schematic perspective view of a sixth form of spring mechanism and compensator embodiment of the present invention.

[0055] Fig. 17 depicts a schematic expanded detail perspective view of a compressible/decompressible volume aspect of the sixth spring mechanism and compensator embodiment of the present invention.

[0056] Fig. 18 depicts a cross-section schematic view of a first Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0057] Fig. 19 depicts schematic views of a first resilient clover-spring element of a spring assembly portion of a second Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0058] Fig. 20 depicts schematic views of a second resilient clover-spring element of a spring assembly portion of a second Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0059] Fig. 21 depicts schematic views of a third resilient clover-spring element of a spring assembly portion of a second Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0060] Fig. 22 depicts schematic side views of a spring assembly portion of a second Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0061] Fig. 23 depicts a cross-section schematic view of a third Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0062] Fig. 24 depicts a cross-section schematic view of a fourth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0063] Figs. 25 & 26 depict cross-section schematic views of a fifth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention in less and more extended dispositions, respectively.

[0064] Figs. 27 & 28 depict cross-section schematic views of a sixth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention in more and less extended dispositions, respectively.

[0065] Figs. 29 & 30 depict cross-section schematic views of a seventh Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention in more and less extended dispositions, respectively.

[0066] Fig. 30 depicts a cross-section schematic view of an eighth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0067] Fig. 31 depicts a cross-section schematic view of a ninth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0068] Fig. 32 depicts a cross-section schematic view of a tenth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0069] Fig. 33 depicts a cross-section schematic view of an eleventh Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0070] Fig. 34 depicts a cross-section schematic view of a twelfth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0071] Fig. 35 depicts a cross-section schematic view of a thirteenth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0072] Fig. 36 depicts a cross-section schematic view of a fourteenth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0073] Fig. 37 depicts section schematic views of first, second, and third linear wave spring elements suited for incorporation in the fourteenth Hooke's-Law-Disobeying (HLD) spring embodiment.

[0074] Fig. 38 depicts a cross-section schematic view of a fifteenth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0075] Fig. 39 depicts a cross-section schematic view of a sixteenth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0076] Fig. 40 depicts a cross-section schematic view of a seventeenth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0077] Fig. 41 depicts a cross-section schematic view of an eighteenth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

5 [0078] Fig. 42 depicts a cross-section schematic view of a nineteenth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0079] Fig. 43 depicts schematic views of a resilient hoop-spring element of a spring assembly portion suitable for incorporation in a number of Hooke's-Law-Disobeying (HLD) spring embodiments.

10 [0080] Fig. 44 depicts a side detail schematic view of a twentieth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0081] Fig. 45 depicts a cross-section schematic view of a twenty-first Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0082] Fig. 46 depicts a cross-section schematic view of a twenty-second Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

15 [0083] Fig. 47 depicts a schematic view of a twenty-third Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0084] Fig. 48 depicts a schematic view of a twenty-fourth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

20 [0085] Fig. 49 depicts a schematic view of a twenty-fifth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0086] Figs. 50a & 50b depict schematic side and plan, respectively, views of a first resilient torsion-spring element of a spring assembly portion suitable for incorporation in a number of Hooke's-Law-Disobeying (HLD) spring embodiments according to the present invention.

25 [0087] Figs. 51 & 52 depict cross-section schematic views of a twenty-sixth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention in less and more extended dispositions, respectively.

[0088] Fig. 53 depicts a cross-section schematic view of a twenty-seventh Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention, in more and less extended dispositions.

[0089] Fig. 54 depicts a cross-section schematic view of a twenty-eighth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention, in more and less extended dispositions.

5 [0090] Figs. 55 & 56 depict cross-section schematic views of a pair of twenty-ninth Hooke's-Law-Disobeying (HLD) spring embodiments of the present invention in more and less extended dispositions, respectively.

[0091] Fig. 57 depicts a cross-section schematic view of a thirtieth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

10 [0092] Fig. 58 depicts a cross-section schematic view of a thirty-first Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0093] Fig. 59 depicts cross-section schematic views of a quartet of thirty-second Hooke's-Law-Disobeying (HLD) spring assembly embodiments of the present invention.

[0094] Fig. 60 depicts a schematic side view of a thirty-third Hooke's-Law-Disobeying (HLD)
15 spring embodiment of the present invention.

[0095] Fig. 61 depicts a schematic side view of a thirty-fourth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0096] Fig. 62 depicts a cross-section schematic view of a thirty-fifth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

20 [0097] Fig. 63 depicts cross-section schematic view of first and second modular variants of a thirty-sixth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0098] Figs. 64-68 depict cross-section schematic views of closely related third through seventh modular variants of a thirty-seventh Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

25 [0099] Figs. 69-72 depict schematic side views of closely related eighth through eleventh modular variants of the thirty-sixth Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention.

[0100] Fig. 73 depicts a schematic side view of a first embodiment of the present invention

[0101] Fig. 74 depicts a schematic overhead view of a second embodiment of the present invention.

[0102] Fig. 75 depicts a mostly frontal view of a third embodiment of the present invention.

[0103] Fig. 76 depicts a schematic cross-section view of a pressure correcting spring assembly suitable for incorporation into one or more embodiments of the present invention.

5 [0104] Fig. 77 depicts a schematic perspective view of first and second path ducts suited for inclusion in one or more embodiments of the present invention.

[0105] Fig. 78 depicts a schematic side view of an alternative interface embodiment including expanded views of two interface portions.

10 [0106] Fig. 79 depicts a schematic cross-section above down view of the alternative interface embodiment.

[0107] Fig. 80 depicts a schematic frontal view of an isolated shell and isolated interface liner as disposed in the alternative interface embodiment.

[0108] Fig. 81 depicts a schematic frontal view of aspects of the alternative interface embodiment in relation to aspects of a user' face/head.

15 [0109] Fig. 82 depicts a schematic perspective view of a sequential reel spring accumulating/constant force spring outputting embodiment of the present invention.

[0110] Fig. 83 depicts less and more extended pseudo-cross-section views of a pivoting main + modifying sub-spring embodiment of the present invention.

20 [0111] Fig. 84 depicts less and more extended pseudo-cross-section views of a sub-frame action-reversing main + modifying sub-spring embodiment of the present invention.

[0112] Fig. 85 depicts less and more extended pseudo-cross-section views of an extending/retracting sub-frame main + modifying sub-spring embodiment of the present invention.

[0113] Fig. 86 depicts less and more extended pseudo-cross-section views of a pulley sub-frame main + modifying sub-spring embodiment of the present invention.

25 [0114] Fig. 87 depicts less and more extended pseudo-cross-section views of an axially rotating sub-frame main + modifying sub-spring embodiment of the present invention.

[0115] Fig. 88 depicts less and more extended pseudo-cross-section views of a pneumatically enacted main + modifying sub-spring embodiment of the present invention.

[0116] Fig. 89 depicts less and more extended pseudo-cross-section views of a hydraulically enacted main + modifying sub-spring embodiment of the present invention.

[0117] Fig. 90 depicts a schematic pseudo-cross-section views of first and second constant force ring seal embodiments of the present invention.

5 [0118] Fig. 91 depicts a schematic pseudo-cross-section views of a third constant force ring seal embodiment of the present invention.

[0119] Fig. 92 depicts a schematic pseudo-cross-section views of a fourth constant force ring seal embodiment of the present invention .

[0120] Fig. 93 depicts a schematic pseudo-cross-section views of a fifth constant force ring seal
10 embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0121] In the present and other embodiments of the present invention when a spring element is shown or described as having one of a number of possible structural variations such as a circular cross-section, for example, any other form of spring construction variation that can perform similarly
15 or is not specifically unsuited, such as a coil spring having a rectangular cross-section substituting for a circular cross-section, is also included within the scope of the present invention.

[0122] Paragraphs 0039-0052 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 are hereby incorporated herein by reference at this point as a
20 detailed description of the drawings 1-17 of the 62/942403 application that were also incorporated herein by reference. These detailed descriptions of the drawings are hereby incorporated herein by reference and are a part of the disclosure of the present application.

[0123] Paragraphs 0039-0052 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
25 inventor of the present application are hereby incorporated herein by reference at this point as a detailed description of the drawings 1-17 of the 62/942403 application that were also incorporated herein by reference. These detailed descriptions of the drawings are hereby incorporated herein by reference and are a part of the disclosure of the present application.

[0124] Paragraphs 0039-0052 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 are hereby incorporated herein by reference at this point as a detailed description of the drawings 1-17 of the 62/942403 application that were also incorporated
5 herein by reference. These detailed descriptions of the drawings are hereby incorporated herein by reference and are a part of the disclosure of the present application.

[0125] Fig. 1 shows a schematic cross-section view of a vehicle loaded pneumatic tire and wheel 110. A wheel 111 has a conventionally mounted pneumatic tire 112 with an inflatable interior 114. The contact patch vicinity sidewall separation 118 is substantially wider than the sidewall separation
10 118 in the vicinity of the top of the tire. A not wheel integrated compensator's silhouette 120 shows potential compressed and uncompressed dispositions, and a representative compressible/decompressible volume 121 aspect of the compensator is seen to fit easily into the tire interior volume. A pair of dispositions 110b of a resilient shell 122 alternate form of a spring mechanism also serves to contain the gasses in the compressible/decompressible volume 121. The
15 shell 122 has an adjustable band 124 anchored to the wheel that allows variation in the target pressurization by allowing adjustments of a closable valve 126 that also determines the free extent of the shell 122. Expanding the band 124 by the extent 128 enables the shell 122 to reach up to the contour 130, which enlarges the contained volume 121 enclosed at the starting point of the compression of the shell 122, thereby enabling tailoring of the performance of the compensator 120.

[0126] Fig. 2 shows a first gas injecting spring mechanism 210 mounted upon a wheel 111. A primary spring element 212 has symmetrically configured sides 214 and widest point bends 216 when unrestrained. Rigid channels 218 restrain and guide the cycling middle extension 220 of the spring element 212 so that as the bends 216 are forced in by the sidewalls at 118, the extension 220 is
20 furthest drawn into the tire inflatable interior 114 and away from the wheel 111. When the tire sidewalls return to disposition 116 so that the spring element 212 relaxes which drives the extension 220 into a conduit 222 formed in the wheel 111. The cycling movement of the extension 220 into and out of the conduit 222 can be alternatively configured to compress and inject air into the tire interior 114 when on the out stroke as the sidewalls assume the disposition 118 and then draw air and prepare

for compression on the in stroke as the sidewalls assume the disposition 116; or in an alternative the in stroke can be configured to drive the compression and injection, while the out stroke would then be configured to drive the air drawing compression preparation.

[0127] Figs. 3 and 4 shows the two main dispositions 310 and 410 of a second gas injecting spring mechanism 310 in a tire interior 114 cross-section disposed adjacent the wheel 111. In the second gas injecting spring mechanism 310 the resilient spring element 312 is alternatively configured compared to the spring element 212. Bends 314 engage with the sidewalls, and channels 316, 318, and 320 guide the wheelward directed spring element's 312 movement toward and away from the channel 222. The range of the movement of the banded portion 322 reveals the differing dispositions of the spring element 312 and the range of movement into and out of the conduit 222.

[0128] Figs. 5 and 6 show a spring element portion 510 of a third gas injection embodiment 610 of the present invention. Adjacent the sidewall of a tire 112, a spring element 512 and extension 514 are outwardly biased to rotate about the center of the circular base 516 until the extension 514 contacts the sidewall in the disposition 518. The spring element 512 is then cycled back and forth as the side wall leaves and then reassumes its most bowed disposition 520, with the section 522 shuttling back and forth to and from the disposition 524. The spring mechanism extension 514 can also assume an anchored disposition 612 alongside the side wall, and then receive the side wall motion in an internal rotating ring 614. In either case the ring 614 engages with another gearing 616 that through a vane 618 draws air from the channel 620 past the one way valve 622 and on to compression and injection 624.

[0129] Fig. 7 shows one option for an external air sourcing pathway 710 wherein external air enters through the wheel external surface 711 into the wheel body 713 channel by passing through a debris and fluid filter 714. Further filtering 716 ensures only gas enters the conduit 718 which feeds the entering air stream 720 into a water trap 722. Due to centripetal force 724 in effect when the vehicle is in motion, the contained water 726 (from condensed water vapor) will separate from the contained air 728. An exhaust conduit 730 enables the accumulated water 726 to escape 732. Baffling 736 further ensures that only air transits conduits 738 and 740 (which in the case of the spring mechanism comprising the spring element 512 and the gearing 616, conduit 740 would then pass through valve

622 and feed the conduit 620). In the case of either the first 110 or second 210 gas injecting embodiments, the conduit 740 feeds conduit 742 which supplies air to a compression/injection hosting chamber 744 interior volume 745 and injection nozzle 746. When the pressure 114 in the tire 112 is at the target pressure level the valve 622 is closed preventing uptake of external air, and thereby preventing cycling movement through the conduit 222 due to vacuum pressure resistance. When the valve 622 is open, the compressed air portion 748 is compressed and injected 750 into the tire interior 114.

[0130] Fig. 8 shows a first installation disposition 810 shows a potential positioning of a separable compensator 812 relative to a wheel 111. Fig. 9 shows more and less compressed dispositions 910 of an operative surface first spring mechanism within and forcing outward an compressible/decompressible volume operative surface 912 that expands and contracts by movement of the free ends 914 to and from the dispositions 916, with a target pressure disposition similar to 918 in some embodiments. When a closable volume, with a closed valve (i.e. tire pressure above the selected value,) the differing enclosed volume magnitudes 920a and 920b will correspond to differing internal pressures though the amount of the gas contained is steady. The majority of the spring element 922 serves to maintain the positioning of the operative surface 912 at a particular disposition with curves 924 enabling resilience when being forced into a bent disposition 926.

[0131] Fig. 10 shows a second form of spring mechanism and compensator 1010 embodiment of the present invention wherein a spring element 1012 is also a compressible/decompressible volume operative surface that defines a contained volume 1014. A control rod 1016 has a plurality of adjustable clamps 1018 that can be moved to constrict or relax restraint of the compressive/decompressive movement of the operative surface 1012. Among other means, the clamps 1018 can be controlled by a knob 1020 and as simple a motion as rotation 1022 of the knob 1020.

[0132] Fig. 11 shows a third form of spring mechanism 1110 at three levels of compression/decompression 1110a, 1110b, and 1110c. The advantage of the third form of spring mechanism 1110 is that the enclosed spring element 1112 are very long so that the overall expansion of an operative surface enclosed volume from 1114 (most tightly packed), to 1114 and 1116 (less tightly packed), and

finally to all 1116 can increase the overall enclosed volume by a fraction equal to the length ratio of distances 1118 and 1120. Because the spring element has a great length the force reduction due to change from $k(\text{compression } x)$ to $k(\text{compression } x-\Delta x)$ is reduced because Δx is such a small fraction of the overall x . Hence, the long x helps to lessen the task of configuring an appropriately varying
5 spring mechanism.

[0133] Fig. 12 shows a wheel 111 integrated fourth compensator 1210 embodiment operative surface 1211, and spring mechanism 1212 that also serves as the compressible/decompressible volume operative surface, which is movable to dispositions 1213 and 1214. The lessened volume caused by the movement 1215 further constrains the contained air 1216 and thereby increasing its
10 pressure. A variable spring constant is produced by a flexible but not extendable linkage 1218 that is connected 1220 to a higher k supplemental spring element 1222. The hoops 1224 through which an operative portion of the supplemental spring element passes through transfer and add that operative portion's spring force to the overall effective spring force of the operative surface 1211, thereby raising the overall effective spring force of the spring mechanism even though the spring itself is
15 extending which reduces the decompression force of an average static k spring. As the surface 1211 expands, more and more of the spring element 1222 is unleashed from the rigid sheath 1226. The rigid sheath 1226 prevents the sheathed portion of the spring element 1222 from contributing to the overall effective spring mechanism's decompressing force. As the surface 1211 is decompressed more and more of the sheathed spring element 1222 is unsheathed which increases the overall
20 effective spring constant of the compensator 1210 spring mechanism.

[0134] Fig. 15 shows a fifth form of spring mechanism and compensator 1310 embodiment that are integrated into a wheel 111 and has similarities to aspects of the fourth spring mechanism and compensator 1210. A convoluted surface 1312 constraining a volume 1313 serves as both a spring element and an operative surface of a compressible/decompressible volume, and is expandable to
25 disposition 1314 wherein it will constrain the volume 1316. By virtue of its convolutions, the spring element 1312 is able to expand to constrain a greater volume 1316 with minimal extension of its length, and hence minimal diminishment of its effective overall contribution to the spring force of the spring mechanism 1312. The spring element 1312 is connected by a plurality of arrests 1318 to line

1320 which can constrain or limit the movement of the operative surface. The line 1320 can also have a resilient behavior that further alters the over effective spring constant. A closable valve 1324 can be included in variants which don't maintain the compressible/decompressible volumes at atmospheric pressure.

5 [0135] Fig. 14 shows a first separable compensator 1410 containing gas in the compressible/decompressible volume 1411 with an enveloping operative surface 1412, all disposed within the inflated volume 114 of a tire interior. The disposition of the operative surface 1412 is maintained by a framework 1414 and 1415 that is forced outward to resist compression by spring elements 1416, 1417, and in cases of a double wound spring mechanism, further crossing spring
10 elements 1418 (only partially shown).

[0136] Fig. 15 shows a cross-section view 1510 of the first separable compensator 1412. Due to visual complexity, the variable spring constant aspect of the spring mechanism of the first separable compensator was not included in Fig. 14 and is shown instead in Fig. 15 for clarity of illustration. A first spring element 1416 has coil portions 1512, 1514, and optionally one or both of portions 1522
15 and 1524 and/or portion 1516. Portion 1512 forms the basic contour defining of the compressible/decompressible volume 1411 contained within the operative surface 1412, and is what (as a group) that the operative surface 1412 is held by. The variable spring constant k of the overall cross-section 1510 of the spring mechanism is altered by changes in the degree of sheathing of the higher k coil portions 1516 and 1524. Sliding linkages such as 1520 and 1521 enable relative
20 movement of the coil portions while allowing their respective spring forces to contribute to the overall compression opposing spring force. Rigid, fixed trajectory sheaths 1518 and 1526 neutralize the spring force contributions of the sheathed portions of the coil portions 1516 and 1524. As those coil portions are unsheathed, they add their spring force resisting compression to the overall effective spring force of the spring mechanism as a whole, and due to their ability to have differing, and even
25 varying along their lengths, spring constant k 's they can provide a wide gamut of decompressive force shaping affects. In operation after setup, when the tire interior loses pressurization, the operative surface 1412 will expand. This unleashes more of either or both of coil portions 1516 and 1524 which are constructed to increase the overall effective spring constant of the compensator operative surface

1412 by an exactly compensation amount, when uncoiled a certain portion corresponding to a certain pressurization drop, to provide that level of pressurization force to the operative surface 1412 and thereby restore the target level of pressurization of the tire interior.

[0137] A virtually unlimited variety of forms of operative surfaces and spring mechanisms are available for use that fall within the scope of the present invention, including as simple as wheel circumnavigating coils forcing outward a resilient membrane (not shown). Fig. 16 shows a sixth form of a compensator 1610 wherein a tire interior 114 facing wheel 111 portion has affixed a symmetrically arranged plurality of “mushrooming” assemblies 1612 that extend and recede into the tire inflatable interior 114. The assemblies are anchored to rings 1614, which provide anchoring to the wheel 111, and space to dispose spring constant altering aspects analogous to sheaths 1518 and 1526 and coil portions 1516 and 1524. The exterior surface top 1616 of the assemblies 1612 is a near constant area “intrusion” into the space of the interior of the tire, and is hence easily altered by an integrated spring mechanism shown in Fig. 17.

[0138] Fig. 17 shows a schematic partial cut-away view of an individual compressible/decompressible volume subunit 1710 according to the sixth form of a compensator 1610. The sub unit 1710 is driven outward by a compressed spring 1712 which drives a gas impervious membrane 1714. Readily includable within the subunits 1710 are aspects of the variably unsheathable variable spring constant coil portions 1524 and sheaths 1516 to achieve the constant spring force needed to stabilize the tire interior pressure at the target level.

[0139] Fig. 18 shows a first Hooke’s-Law-Disobeying (HLD) spring assembly embodiment 1810 comprising dual helical main spring coils 1812 and 1814 having circular cross-sections 1816, wherein the forward projecting coil portions 1818 are mostly not visible. A series (or sequence, wherein the series versions are a number of connected, repeating units while the sequence versions include a number of disconnected repeating units, and both series and sequences can be used in the same embodiment,) of helical minor coils 1820 are disposed within the space internal of the main coils 1812/4. The “minor” coils are so named for their spatial relative size only, and not for their relative force contribution to the overall spring assembly rebound force, since it is quite possible to make a smaller coil with a much larger K (Hooke’s Law spring constant) than that of the main coils 1812/4.

The main coils 1812/4 are structurally interrelated together so that compression/expansion of one without the other is impossible. Similarly, the main coils 1812/4 and the minor coils 1820 are interrelated structurally so that compression/expansion of the main coils 1812/4 inherently also involves sheathing/unsheathing of the minor coils 1820 within a sequence of sheaths 1822. The sheathed ends of the minor coils 1820 are guided by friction reducing wheels 1824, as they move within the sheath interior passage 1826. The wheels 1824, in combination with the roller guides 1828, both constrain the minor coils 1820 to flattened dispositions 1830 within the passages 1826 (relative to their diagonal unflattened dispositions 1832 after emerging), and remove the portion of the minor coils 1820 in the sheaths 1822 that are past the rollers 1828 from contributing to the overall rebound force expressed by the assembled springs of the assembly 1810. Portions of the minor coils 1820 that never enter the sheaths 1822 are interrelated with the main coils 1812/4 such that their compression/extension also inserts/removes, respectively, the minor coils into/out from the sheaths 1822. As the main coils are compressed and hence progressively increase their contribution to the rebound force of the spring assembly 1810, the minor coils are progressively more and more sheathed and hence they contribute progressively less and less rebound force to the spring assembly 1820. Many well-known techniques enable the matching of the increase in the main coil's rebound force contribution to the minor coils reduction in rebound force contribution, so that the overall rebound force is steady, or even constant throughout the operative range of compression of the spring assembly 1810. The particular disposition of the sheaths 1822 as shown in Fig. 18 produces a constant rebound force from compression of the spring assembly 1810, while if the relative orientation of the minor coils 1820 and sheaths 1822 are reversed relative to the main coils 1812, a steady force extension spring assembly results.

[0140] Fig. 19 shows views of first and second resilient clover-spring elements 1910a/b of a spring assembly portion of a second Hooke's-Law-Disobeying (HLD) spring embodiment of the present invention. The clover-spring element 1910 is an endless leaf spring, with its particular shape designed to enable relatively easy compression/expansion in a number of differing dispositions (differing angles of inclination mostly,) so as to be securely in contact with an exterior retaining member, such as a cylindrical extending (in a direction perpendicular to the plane of Fig. 19,) border 1912. One rest

(uncompressed) disposition 1914 for the clover-spring element 1910 it expands in primarily one direction with broadened lobe 1916 that would normally be constrained by the interior surface 1918 which limited how far the element 1910 could expand in the direction 1920. Being constrained to the interior volume 1922, the element 1910 can expand by assuming differing angles of inclination
5 relative to the longitudinal axis of the cylinder 1912 seen in cross-section. When the element 1910 is parallel to the plane of Fig. 19, it is at its most compressed disposition 1924, and it moves between more and less compressed dispositions by altering its inclination via rotating as shown and described at 1926. The second resilient clover spring element 1910b differs in that it assumes disposition 1928 at its most compressed, and is constructed to preferentially decompress into the disposition 1930. It
10 should be understood that all of the spring elements in Figs. 19-21 are also functional as extension springs, and hence the overall effect of the second HLD spring embodiment 2210a/b (in [more and less compressed]/[less and more extended] dispositions, respectively,) which is constructed with the clover spring elements (1910, 2010, 2110) can be configured to be either or both a compression or extension steady force HLD spring.

15 [0141] Fig. 20 shows a third resilient clover spring element 2010 which differs primarily in being constituted of a closely wound helical coil 2012 formed into the clover shape and tempered for spring performance along the axis of the helical coil 2012, in addition to the overall shape 2010 spring resistance to compression. The clover form is retained by differential stiffness performance on one side of a coil than another in a region such as within the dashed circle 2014 wherein the side of the
20 coil on the inside of the curve is more stiffly coiled than the side of the coils on the outside of the curve. Fig. 21 shows one range of clover-spring compression/extension dispositions from least/most 2110 to an intermediate amount 2112 to a most/least disposition 2114, which are also differing dispositions assumed when the clover-spring elements are arranged in perimeter boundaries 2116, 2118, or 2120. It should be understood that the clover-spring elements themselves are standard
25 behaving springs, and hence they individually obey Hooke's law within the normal range of operation.

[0142] Fig. 22 shows shorter and longer dispositions 2210a and 2210b, respectively, of the second HLD spring assembly embodiment 2210, which is defined by a boundary bottom (as shown) 2211,

variable length sides 2212, and top (as shown) 2213. Within the interior 2114 of the boundary 2211-3, clover-spring elements 2116 are arranged into an accordioneing combination by hinges 2218. The widths 2220 and 2224 between the sides of the boundary define the horizontal components, X_1 and X_2 , respectively, of the clover-spring elements disposition, and of the expression of their rebound force, and can be held steady as the boundary changes extension, or can be allowed to vary. In many applications, it will be advantageous to keep it steady, and such will mostly be addressed here with standard well-known adjustments to be made in the cases where the width does vary. The vertical components 2222 (Y_1) and 2226 (Y_2) of each clover-spring elements' length 2228 (L_1) and 2230 (L_2) are defined by the amount of compression/extension of each clover-spring element. These dimensions define the angles of inclination 2232 (ϕ_1) and 2234 (ϕ_2) which also define the relative portion ($\sin \phi$) of a clover-spring element's rebound force that constructively adds to the overall rebound force in the Y direction whether longer 2236 (Y_1^{Tot}) or shorter 2238 (Y_2^{Tot}). The rebound force expressed by each clover-spring element involves horizontal and vertical components, with the vertical components adding constructively. Each individual clover-spring element's vertical contribution is defined by variations in the overall rebound force it is expressing in the L direction ($F = K \Delta L$), modified by the inclination factor ($\sin \phi$) which grows larger as clover-spring element's inclination becomes more vertical. At the same time the overall rebound force is growing smaller with increasing inclination, and it is a relatively easy task to match the two rates of change (since with a constant K , they both vary according to Y/L) so that each clover-spring element contributes a steady vertical rebound force as Y^{Tot} changes, which then add up to a steady rebound vertical force across differing vertical overall lengths for the second HLD embodiment 2210.

[0143] Fig. 23 shows a third HLD spring assembly 2310, which is partially defined by an accordioneing bellows 2312 having boundary delimitations 2314 and 2316, an interior 2318, and a bellows internal surface 2320. Dual helical coils 2322, 2324, and 2326 are intertwined with the exterior of the bellows 2312, so that the compression/extension (and their reverse actions) of the spring assembly 2310 is experienced by both the dual helical coils 2322 and the accordioneing internal assembly of clover-spring elements 2328 and hinges 2330 such as described in Fig. 22. The bellows is constructed to transition to and from 2332 more extended dispositions 2334 by compressing 2336

which would tighten the internal curves of the bellows, and expansion 2338 which loosens the curves of the bellows perimeter. Variations in HLD operation made available thus are those of the 2210 embodiment, in addition to the effects of compressing/extending the dual helical coil 2322, and constraints on the inclination evolutions of the clover-spring elements 2328 as the assembly 2310 changes length, such that not only can a spring assembly 2310 exhibit steady force rebounding throughout its loading, it can even express reverse Hooke's Law behavior in which the magnitude of the rebound force decreases as the spring is loaded.

[0144] Fig. 24 shows a fourth HLD spring assembly 2410 having significant similarities to the third HLD spring assembly 2310. A designated pushing/pulling end surface 2412 caps extendable sidewalls 2414 that have directing but relatively unimpeding (unless added to provide dampening,) expansion joints 2416 enabling space 2418 for movement of the sidewalls 2414. An internal bellows surface 2420 and in particular the intrusions 2422 restrict the manners of movement of a spring assembly disposed within the space 2424. Potentially, when included, augmenting materials 2426 such as compressible foams or inflation gasses are available to enhance the structural integrity and or dampen sound of the assembly 2410. The dual spring assemblies 2328 and 2330 are constrained by the internal surfaces 2420, in the present embodiment, so that its change in inclination also is augmented by the reduction of the *X* component of its disposition, whereby the net effective compression rebound force is not constant, but actually grows larger as the compression decreases.

[0145] Figs. 25 & 26 show a fifth HLD spring assembly 2510 in less 2510 and more 2610 extended, respectively, dispositions. A bellowing perimeter 2512 constrains a spring assembly of clover-spring elements 2328 and hinges 2330 within its interior 2513. Having a width limit 2514, when desired, for the greatest sideways reach 2516 of the bellows can be accomplished by constructing the bellows themselves to maintain certain shape characteristics, or by using resilient, elastic, or otherwise flexible bellows construction augmented by restraining strapping 2518 (elastic or not,) which serves to restrain 2520 the sideways reach 2516 available to the bellows. When more extended 2610 and, for example, rebounding from a compression the rebound force is impressed on the bellows perimeter 2512 due to the accumulated effects of extended clover-spring elements 2612 forcing a spring assembly end 2614 to extend further.

[0146] Figs. 27 and 28 show a sixth HLD spring assembly 2710 in more 2710 and less 2810 extended, respectively, dispositions. The assembly 2710/2810 is closely related to the assembly 2510 since it also encompasses a spring assembly 2328/2330 in its interior 2711, with the primary variations involving the perimeter end 2712 and its sides 2714 having the structural properties wherein it has shape memory as well as a selective degree of spring loading; and the hinges 2330
5 wherein it has shape memory as well as a selective degree of spring loading; and the hinges 2330 include a selective degree of torsional loading such that they can be chosen to effect a net compressing or expanding effect. The interior bellows surface bends 2716 restrict the horizontal space available to the assembled clover-spring elements 2328. When compressed 2810, the interior surface bends 2812 can be engineered to effect a variety of clover-spring element inclination effects,
10 which thereby enables a variety of HLD spring behaviors. Even more complex spring performance is enabled when varying spring effects of the perimeter sides 2714, varying spring effects of the hinges 2330, and/or varying spring effects of the assembled clover-spring elements 2328.

[0147] Figs. 29 and 30 show a seventh HLD spring assembly in more 2910 and less 3010 extended dispositions. Relatively rigid terminal bridges 2912 and 2914 are pivotally 2916 interconnected with
15 pairs of scissoring, interconnected loadable (compressible and/or extendible, standard behaving, linear extending springs,) linear spring elements 2918 and 2920 are pivotally interconnected at 2922 and 2924. Horizontal and vertical strappings 2926 and 2928 can be alike or differentially performing to provide a range of constraint options for the inclinations (and hence portion of unloading force contributing to the net total) of the springs 2918 and 2920 by their restraining action 2930/3012 on the
20 spring elements 2918 and 2920 combined dispositions. The interior 2930/ 3014 of the assembly 2910/3010 is generally able to be left open, assumes differing spatial dispositions, and can include various other equipment such as dampeners. Overall extension variations as great as 2934 to 3016 or more with HLD performance are enabled.

[0148] Fig. 31 shows an complexly multi-variably functional eighth HLD assembly 3110 that is
25 bordered by an enveloping strapping 3112 that rolls over pivots 3114 and ends at overlapped diverging ends 3116 that can be affixed, can be held/tensioned by a load, or can be allowed to run relatively free, but not slack. The interior of the assembly can utilize the strapping 3112 to maintain an envelope, and hence can utilize gas pressure 3117 for its spring properties as a spring element. In

addition, linear spring elements 3118, 3120, and 3122 can function as compression springs, extension springs, or a hybrid of both during differing points of extension/compression. Plus, pivots 3114 and rotational couplings 3120 can be loaded with various torsion effects to exert pivoting or extending forces, or both in a hybrid operation. Lastly, the vertical elements 3124 can also be variously
5 configured, so that the final assembled spring performance can assume a broad array of multiply evolving HLD spring functions.

[0149] Fig. 32 shows an extension-spring-driven compression-resisting ninth HLD spring assembly 3210. The pushing surface 3211 is formed by the extended length of a constant force coil to coil spring. Relatively rigid scissoring struts 3212 define an open interior 3214 and meet at pivoting links
10 3216 about which are disposed the spiral coils 3218 of constant force torsion springs 3220 and 3222. When near a 90 degree difference in inclination between the scissoring struts 3212, the assembly 3210 is close to a HLD constant force spring assembly, while at differing relative inclinations differing forms of HLD performance are exhibited.

[0150] Fig. 33 shows an supplemented dual helical coil tenth HLD assembly 3310 that has main
15 dual helical coils 3312 and 3314 having circular cross-sections 3316 and defining an open intra-coil space 3318. A supplementary sinusoidal (or alternative form) leaf spring 3320 is maintained in a disposition wherein its center line is bowed 3324 or straitened 3326 by its attachments 3328 to struts 3330 that are affixed to the helical coils at 3332. When the struts are in disposition 3331 due to the extending of the helical coils 3312, the sinusoidal leaf spring 3320, which is already compressed
20 along its center line 3324, makes an even greater contribution to the overall compression rebound of the assembly 3310 due to the greater net vertical compression rebound force exerted by the spring 3320 in the disposition 3322 versus when its center line is in the disposition 3324. An array of the supplementary springs 3320 can be disposed in a spiraling arrangement throughout the space 3318, with appropriate choices selected so as to enable the rising net decompression force of the spring 3320
25 to compensate for the lessening decompression force exerted by the coils 3312 as they decompress, so as to produce a steady decompression force throughout the operative range.

[0151] Fig. 34 shows a second supplemented dual helical coil eleventh HLD assembly 3410 which maintains an open interior 3412 while incorporating an array of supplementary progressively

unsheathing coiled leaf springs 3414 that slide in and out of sheaths 3416 via openings 3418 at the end of the sheath's initiator 3420. Among other arrangements, the array of springs 3414 can be spaced in a spiraling configuration of dispositions 3414-3416-3422-3424, etc. between adjacent helical coils 3312. In expanded detail of a coil 3424 in dashed circle 3426 seen from the side, the upper end of the unsheathed spring end 3426 is affixed 3423 to the helical coil 3312. The unsheathed coil portion 3426 contributes its uncoiling force to the spring assembly 3410 net vertical decompressive force. The opening lip 3428 divides the coil 3424 into an effective portion 3426 that contributes to the net assembly effective force and a bottom sheath portion 3428 restrained coil portion 3430 which does not contribute its uncoiling force to the assembly 3410 net effective force because it is held by the rigid sheath bottom 3432 when it is in the sheath interior 3434. Hence, as the helical coils 3312 are becoming less decompressed and hence contributing less decompressive force to the assembly net effective force, the coils 3414 are becoming progressively less and less sheathed, and hence are contributing progressively more and more decompressive force to the assembly 3410 net effective force. By selecting among the variable options for helical coil 3312 K's and the spring 3414 K's, for dimensional and number differences in the construction and number of the springs 3414, a wide gamut of HLD spring assembly 3410 performance is attainable, including near constant force throughout a compressive operative range. To turn the assembly 3410 into a constant force extension spring, the nature of the sheathed springs should be reversed, with the compression springs 3414 that are loaded by being forced more heavily coiled than their rest position being replaced by well coiled (at rest) leaf springs that are forced into more extended positions by the sheath 3422 top side. These extension opposing uncoiled spiral springs would be progressively unsheathed by a moving sheath (not shown) that would be shifted to less and less restraint of the spiral coil spring as the helical coils were less and less extended.

[0152] Fig. 35 shows a cross-section side view of a third supplemented dual helical coil twelfth HLD assembly 3510 wherein coils 3512 with circular cross-sections 3514 have an open central area 3516 which maintains an inter-coil spacing 3518 sufficient to dispose stagger-spaced rotating mounts 3520 (when rotated 90 degrees relative to the 3542 disposition) for linearly extendible/compressible springs 3522. between pairs of mirror disposed mounts 3520 is affixed a sinusoidal leaf spring 3522

that can be disposed variably including unloaded until loading of the coils 3512, or loaded in the direction of the loading of the coils 3512, or in the opposite direction. Limb 3524 affixes each end of spring 3522 to an outer perimeter ring 3526 which rotates in conjunction with an inner ring 3528 about the circular cross-section 3514 of the coils 3512. A strapping 3530 is attached at one end 3532 to and partially wraps around the inner ring 3528 while its other end 3534 extends to the 2nd coil 3512 to the right, being a dual helical coil 3512 these are adjacent coils from a single helix. Connections between the two helix coils are also an option (not shown) and essentially any pattern of connection between differing coils and/or differing helix are permissible as long as sufficient coil length is encompassed to allow a spring response by that length of the coils 3512. A second mount 3520 has one end of a strapping 3536 wrapped around its inner ring 3528 that is affixed at 3538 and has a second straight end 3540 that is affixed to the coil 3512 that the first mount is mounted about. The mounts 3520 are interrelated to the coil 3512 they surround by a rotatable connection wherein they are able to relatively freely rotate (except for dampening and other modifications,) while maintaining their centers coincident with the center of the coil 3512 that they mount, and while being able to translate forces the mounts 3520 experience back to their respective coils 3512. For a spring 3522 that is attached in a compressed disposition, as the coils 3512 are compressed/decompressed, the 3512-3512 intra-coil spacing decreases/increases. Because the spring 3522 is preloaded, the straps 3534 and 3540 stay taught throughout the compression range of the coils 3512. Due to the mirroring of the straps' (3534 and 3540) configurations, the rings 3528 rotate in opposite directions, so that in combination their rotations will increase or decrease the compression of the spring 3522. The fairly wide range of available inner ring 3528 and perimeter ring 3526 radii, and hence the availability of the wide range of difference in these radii enables broad ranges of variation, both positive and negative, in relative compression of the springs 3522 relative to the compression of spring assembly 3510. These enable a substantial variety of forms of force expression behavior of the "HLD-type" by the spring assemblies 3510.

[0153] Figs. 36 and 37 show cross-section side views of a fourth supplemented dual helical coil thirteenth HLD assembly 3610 and variant options 3710 for a supplemental sinusoidal leaf spring 3631, with coils 3612 having circular cross-sections 3614 and disposed surrounding an open central

area 3616. As shown, assembly 3610 is compressed/decompressed by decreases/increases, respectively, of the coil 3612 to adjacent coil 3612 spacing. Within the space 3616, an upper anchor 3618 and a lower anchor 3620 maintain descending 3622 and ascending 3624 props, respectively. An end piece 3626 is attached 3630, optionally detachably (not shown), to a sinusoidal linear leaf spring 3631 that extends upward (as shown in Fig. 36) to a fastening 3632. An optional extended opening 3634 extends vertically 3636 so that a modest range of coil 3612 compression can occur without affecting the spring 3631 (alternatively, an attachment 3630 can be used). An optional engagement end 3628 of the prop 3624 utilizes a hook bend 3638 to securely, though detachably, interconnect with the spring 3631, potentially by way of partial rotation as shown at 3640. Once compressed and arranged as shown in Fig. 36, compression of the helical coils 3612 as a group will, once the space 3636 is traversed, progressively extends the spring 3631. A number of compression and extension dispositions and pre-loadings for both the coils 3612 and the spring 3631 to combine force response effects to produce assemblies that can accomplish a wide range of HLD embodiments.

[0154] A first variant that is roughly steady in rebound force expression and a steadier second variant that produces approximately constant rebound force expression are two examples of the range of force balancing performance capabilities demonstrated by the variants of the assembly 3610. The differences between the roughly steady rebound force expression and the approximately constant force expression variant illustrate differing degrees of accuracy of the force balancing, and hence whether the force evolution through the operative range of overall compression or extension is suited for the task at hand. HLD springs will not display normal harmonic motion, and their specific performance in differing settings can be unpredictable and unintuitive. The roughly steady variant involves a longer (at rest) spring 3631 being pre-compressed, and inserted into place, so that compression and hence loading of the coils 3612 also unloads the spring 3631 that is pushing in the opposite direction. While these two springs do have opposed loading/unloading for rough balancing, achieving an exact balancing is more difficult, since the loading process is increasing in force magnitude while the unloading process is decreasing in force magnitude. The more nearly constant variant uses a shorter spring 3631 that needs to be uncompressed or stretched before incorporation in the assembly 3610, so that loading of the coils 3612 by compression also loads the spring 3631 by

extension, with the ever greater push by the spring 3631 on the coils 3631 to stay compressed, i.e. in the opposite direction of their natural rebound force, growing in magnitude as the coils 3631 rebound force grows in magnitude. The similar magnitude trajectories enable an easier flattening of the overall rebound force exhibited by the assembly 3631 when under compression.

5 [0155] Fig. 37 shows variations 3710 of the spring 3631 suited for use in the assembly 3610. A first spring 3631a with a more extended rest length than must be compressed for incorporation in the assembly 3601, and hence is useful for the roughly steady rebound force expression variant assembly 3610. An approximately constant rebound force expression variant assembly 3610 suited variant spring 3631b demonstrates optional range variations of the spring 3631 and the assembly 3631
10 performance variation consequences. A third spring 3631 variant 3712 has an intermediate length, with a pair of extended fastenings 3632 so that inception of either compression or extension HLD assembly 3610 performance is selectably delayable, after a period of standard spring performance.

[0156] Fig. 38 shows a fifth supplemented dual helical coil fourteenth HLD assembly 3810 whose coils 3812 also have a circular cross-section 3814, but are not tempered into forming a "spring effect"
15 due to moderate compression/decompression, and instead work much more like a very soft Slinky®. Their primary shape and disposition is too strong to be much displaced, so that they present a relatively low force requirement for movement along the longitudinal axis for moderate compression/decompression and hence a useful framework for guiding, combining, and translating forces applied to the coils 3812. A pair of variant manners of disposing constant force extension
20 springs and translating forces to/from them to the coils 3810 are shown. These include a first variant 3816 seen from the side wherein an upper descending arm 3816 overlaps a lower ascending arm 3820 with an uncoiled span 3822 of the constant force extension spring spanning between its pair of spiral coils 3824 and 3826 disposed on the end of the ascending and descending arms 3824 and 3826, respectively. This disposition of the constant force spring's extended span 3822 effects a constant
25 decompressive force on the coils 3812, throughout the operative range of the spring 3816. A second constant force extension spring 3824 is disposed on a first cross bar 3830 held by ascending struts 3828, and spans 3822 down to a second cross bar 3832 held by descending struts 3831. The descending struts 3831 are affixed 3834 to an upper coil while the ascending struts 3828 are affixed

3836 to a lower coil 3812. Compression of the assembly 3810 moves the upper descending strut 3831 in the direction 3838 until it reaches its lowest extent by assuming the disposition 3840 after traveling a distance 3842, and moves the lower ascending strut 3828 upward until it reaches its farthest extent 3844 after traveling the distance 3846. Throughout the movements of the bars 3830 and 3832
5 whether compressing or uncompressing the coils 3812, either or both variants of the constant force extension spring, as well as other variants of a constant force extension spring, will by use of the overlapping arms 3828 and 3831 or 3818 and 3820, exert a constant decompressive force on the coils 3812.

[0157] Fig. 39 shows a side views of a fifteenth HLD assembly 3910 that also employs a constant
10 force extension spring to effect a constant decompressive force with a differing force translation arrangement. Stationary extension spring coil mounting bar 3912 and moving coil mounting bar 3914 are interrelated by the constant force extension spring 3824. Rods 3926 provides interconnection of the assembly 3910 to other mechanisms, and by overlapping bar 3912, movement to dispositions 3928 and 3930/3932 provide translation of the constant force extension spring 3824 as a constant force
15 compression effect translated through the arms 2913 and 3926 throughout the range 3926.

[0158] Fig. 40 shows a side view of cooperative sixteenth HLD assemblies 4010 again utilizing constant force extension springs 3822/3824 to generate a constant force decompressive effect when combined with the assemblies 4010. A lower anchor bar 4012 and rectangular upward jog 4014 as well as a second connecting rod 4016 and third connecting rod 4018 are shaped to allow an upper
20 anchor bar 4012 and coil 3824 to be moved downward (and back upward) around the jog 4014. The voids 4022 and 4024 provide space for disposing the constant force extension springs 3822/3824 in a mostly planar disposition that this embodiment is intended to conform to. The available movement space 4024 allows the bar 4012 to translate to position 4026. By disposing the operative range of a second constant force extension springs 3822/3824 in the area 4028, and interrelating the rod 4018
25 and 4016, the springs 3822/3824 can be combined in force or in reach by adding the second (or third, etc.) spring 3822/3824 acting over the range of motion 4030.

[0159] Fig. 41 shows a side view of a cooperative seventeenth HLD assembly 4110 that again utilizes constant force extension springs 3822/3824 to generate a constant force decompressive effect

when combined with the assemblies 4110. First and second undulating armatures 4112 and 4114 both occupy a limited depth mostly planar space wherein bypasses 4116 and 4126 provide passages 4118 for armatures 4114 and 4124, respectively, to slide back and forth relative to each other. A bend 4120 of armature 4114 maintains the position of one end of the spring 3824/3822 while the other end's
5 force is applied 4122 to bend 4124 of armature 4112, such that the (near) constant extension rebound force expressed by the spring 3824/3822 enacts an anti-compressive effect on the intervening regions of the armatures 4112 and 4114 in between the dispositions of the springs 3824/3822. An optional variant to the assembly 4110 involves the inclusion of optional anchors 4128 that affix auxiliary "standard functioning" spring elements 4130 and 4132 between the armatures 4112 and 4114 as an
10 addition, or as a replacement for the springs 3822/3824, to achieve HLD spring assembly 4110 performance.

[0160] Fig. 42 shows a side view of an eighteenth HLD spring assembly 4210 that utilizes constant force extension springs 3822/3824 to generate a constant force compressive effect translated by gas pressure as a constant force compressive gas spring when combined with the assembly 4210. Bottom
15 and top end plates 4212 and 4214, respectively, and a flexible bellows 4216 envelope an inflation gas 4218. Outside of the operating dispositions 4220 of the bellows 4216 are constant force extension springs 3822/3824 maintained by supports 4222 for axles 4224 so that the contained gas 4218 is subject to essentially constant pressure due to movement up and down by end plate 4214 under forcing by the pair of springs 3822/3824. Outlet 4226 provide gas communication between the
20 assembly interior 4218 and a hose 4228 that can be connected in gas communication with essentially any gas spring, illustrated by a simple gas cushion 4230 example whose interior 4232 is in gas communication with the hose 4228, and if its exterior 4234 is sufficiently inelastic to maintain its shape if not its height, a top surface 4236 operates as a constant force spring.

[0161] Fig. 43 shows an ellipsoid spring element 4310 that operates as an endless leaf spring with
25 rolling wheels 4314 at the ends of its major axis and provides a standard spring performance profile when distorted into disposition 4316, for example. Fig. 44 shows schematic side views of a first shaped framework reciprocating nineteenth HLD spring assembly 4410 that utilizes the spring elements 4310. Structural non-spring framework 4412 have shaped internal surfaces 4414 designed

to coordinate differing specific orientations of the spring elements 4312 relative to the amount of decompression space made available at that orientation. Joining 4418 enables a sequence of frameworks 4412 and spring elements 4312 to be constructed, as well as modules having at least some sides, tops, and/or bottoms constructed of the mirrored frameworks 4412 and spring element 4312
5 combined into a module 4412/4312 building block exhibiting constant force compression response. Space 4420 is available for dampener disposition or other ancillary equipment. Rigid tether 4422 and hook 4423 offer a variety of options for varying the angle of the spring elements 4312 relative to their length, including those where the length does not change during rotation, and surface 4426 offers a variety of surface options for differential interactions with the wheels 4314. These combinations offer
10 a wealth of HLD spring capabilities by the assembly 4410, including steady force expression.

[0162] Fig. 45 shows a side schematic view 4510 of a twentieth HLD spring assembly comprising a module 4412/4312 reciprocating HLD spring interrelated with a helical coil 3312. Here, the module 4412/4312 orientation angle θ relative to a spring assembly length direction 4511 is directed by attachments 4512 of the rigid tethers 4422 to the coils 3312 resulting in a main decompression
15 direction 4513 for the spring element 4312. Rotating the module 4412/4312 unit 4514 as shown 4515 and combining produces 4517 the spring assembly 4610 shown in Fig. 46. Helical coils 3312 are affixed along their length 4612 to the modules 4514, so that the tethers are effectively attached 4614 to the helical coils 3312 as well. Hence, the full gamut of HLD spring assembly performance of the modules 4514 are available for combination with the standard spring performance of the coils 3312.

20 [0163] Fig. 47 shows a side view of a twenty-first HLD spring assembly 4710. A framework 4712 is formed to replicate the operative surface 4414 effect on the springs 4312, wherein framework 4712 represents an alternative form factor providing a fusion of some or all of the functions of coil 3312 and frameworks 4412. The framework 4712 can be tempered to provide a spring response itself, or can be conditioned to remain relatively unloaded as compression/expansion occurs. The frameworks
25 4712 are designed to provide differing functions at differing points along their extent, with straight portions 4714 providing transitioning positioning between operative spring 4312 reciprocating dispositions 4716. An alternative option of incorporating a dampener 4718 within some or all of the springs 4312 is available as well. An operative framework curve 4720 provides the analogue of the

surface 4414 for the springs 4312. Transition curves 4722 provide an option for integration of additional aspects in the framework 4712 by establishing the spaces 4724 for disposition of the optional aspects while maintaining separation from the reciprocating springs 4312. Non-operative framework sides 4726 interface when rows of two frameworks 4712 are disposed in facing
5 dispositions with an array of springs 4312 between them. These rows can be made as units until themselves, with attachments between the straight portions 4728 of adjacent rows enabling quick build up and tear down of tailored functional HLD spring assemblies 4710. The range of possible attachment point 4730 locations along the lengths 4728 enable an additional selectable degree of freedom to for the reciprocating springs 4312 to rotate faster or slower relative to the rate of relative
10 linear movement of the two frameworks 4712/4714 which provides still further manners of effecting the HLD performance of the assemblies 4710.

[0164] Fig. 48 shows a curtain arrangement twenty-second HLD spring assembly 4810 of cooperative frameworks 4812 and linking springs 4312. The frameworks 4812 are approximately an amalgam of facing frameworks 4712 with certain portions dropped and others fused. The result is a
15 series of frameworks 4812 that can themselves be configured into a unified spring behavior, or as just a sequence of stiff elements, both receiving and applying forces to a sequence of upper and lower springs 4312. As an assembly 4810, a near planar HLD spring behavior is available as a form of sheet. The same behavior can be accomplished as support or struts by, for example, bending the frameworks 4812 into triangles with the springs 4312 reciprocating along each relatively flat side of
20 the triangular strut (not shown). The frameworks 4812 incorporate transition zones 4814, spring 4321 reciprocation zones 4816, and dividing zones 4818. Any or all of the zones of one or more frameworks 4812, or some portion of the frameworks 4821 can be tempered to act as springs themselves, but even if not exhibiting spring like resistance to compression, they should be relatively stiff to efficiently transmit and/or aggregate forces. Some framework 4812 zone forms 4820 are
25 dictated by the requirements of the opposite side of the framework. Tether attachment points 4822 and 4823 to the frameworks 4812 can also be varied similarly to the twenty-first spring assembly 4710. The wheels 4824 experience and translate the compression rebound force from the spring 4312, and while the tether ends in dashed circle are shown as distinct and separately attached to the

framework 4812, they could instead be attached to each other (not shown) and not attached to the framework in the area 4826 at all and hence would yoke the two involved springs 4312 together. The dashed circle area 4828 view is turned 4830 (90 degree about the vertical axis) and expanded to show in greater detail three alternative options for the interaction between the wheels 4824 and the framework 4816. The framework 4816a has an I-Beam cross-section into which the wheel 4824a fits and is held by mechanical pressure. A second alternative 4832 has extensions to the framework 4816b that envelope the wheel sufficiently to ensure connection with or without mechanical pressure. A third alternative 4834 is a bare framework 4816c partially surrounded by a rolling semi-enveloping wheel 4824b.

10 [0165] Fig. 49 shows a modified curtain arrangement twenty-third HLD spring assembly 4910 of cooperative frameworks 4912 and linking springs 4312. Among the cardinal distinctions of the assembly 4910 as compared to the assembly 4810 are in the manner of interaction between the framework portion 4914 and the wheels and 4916. The dashed circle interaction area shown in greater detail at 4918 details a wheel and framework interaction that both structurally integrates the two but also provides structural integrity to the curtain as a whole. A box cross-section spring 4312 end 4920 incorporates in its right (as shown) side serving as an axle to a wheel 4922 with sprockets 4924 that fit into a sprocketed framework 4912 portion 4926 having motion guiding and securing sprocket holes 4928. The upper side of the box cross-section 4920 is secured in place by a rolling interaction guided by wheels 4930.

20 [0166] Figs. 50a and 50b show schematic views of aspects of a torsion spring component 5010 seen from the side 5010a and from above 5010b. Leaf spring bulge 5012 transitions to spread out (perpendicular to the plane of Fig. 50a) attachments 5014 and may be reinforced between a bulge top 5016 and a bulge shoulder 5018 by a brace 5020, all to enable modified spring behavior. The above view 5010b shows contours 5022 (and 5024, the farther side,) and relative thickening 5026 at the ends 5014 and thinning 5028 at the bulge 5012.

25 [0167] Figs. 51 and 52 show schematic cross-section views of more and less compressed, respectively, dispositions 5110 and 5210 of a first rotating variant and overall twenty-fourth spring assembly 5110/5210. First shaped helical coil 5112 cross-sections 5213 have broadened inner

(relative to coil whole,) and outer extents 5212 and are variously separated by the distance 5114 in the 5110 disposition and by the distance 5214 in the 5210 disposition. Intra-coil surfaces 5116 are specifically shaped to produce a desired interaction at 5118. Torsion loaded arms 5120 and 5122 are flexibly joined 5124 to positioner 5126 and 5128, which can be constructed also with the torsion

5 spring component 5010 to enable torsion based amplification 5010 of the turning effect produced when the coils 5112 change relative distances. A compressed sub-spring 5130 is held in a specified orientation by the arms 5120-5128, as seen in Fig. 52 wherein the sub-spring 5130 orientation determining positioner axis 5216 is at an angle θ to a reference direction which differs greatly from its position in Fig. 51. This difference in orientation of the positioner translates into an accompanying

10 reorientation of the sub-spring 5130. The sub-spring 5130 is a linear compression spring along its length, so that when its two ends are pressed together they press back as a standard spring with a constantly growing force that obeys Hooke's Law. The sub-spring 5130 presses on the surface 5116 to thereby add the amount of decompressive force with which it is loaded, to the decompressive force that the collective coils 5112 are loaded with. A variety of surface 5116 shapes are possible, from

15 those that accommodate a faster rotating sub-spring 5130, relative to the rate of increase of the distance 5114/5214 to accommodating slower rotation rates. Differing configurations and arms lengths of the sub-spring 5130 holding supports (e.g. 5120-5128 or 5010) can produce these turning rate differences. Of particular note is a turning rate and shape 5116 wherein the sub-spring 5130 remains at the same length throughout compression and decompression, so that the variation in its

20 contribution to the overall decompressive force being expressed by the spring assembly 5110 is determined by the horizontal (as seen in Figs. 51 & 52) component of its decompressive force. Since the spring 5130 does not change length, its turning does not present an energy barrier (outside of friction). The variations in available sub-spring 5130 materials and their performance variations, differences in the performance of the coils 5112, differences in the number of sub-spring 5130

25 incorporated, etc. enable a wide variety of HLD spring assembly 5110/5210 performance variations, including steady force compression.

[0168] Fig. 53 show schematic cross-section views of less and more compressed, respectively, dispositions 5310a and 5310b of a second rotating variant and overall twenty-fifth HLD spring

assembly 5310. An intra-coil distance 5312 (= 2.00 as shown) and coil height (= 2.28 as shown) are examples of the wide variations in construction of the spring assembly 5310 encompassed by the present invention. Widened ends 5316, shaped surfaces 5318 that interact and guide 5320 compressed intra-coil sub-spring 5322, and sub-spring 5322 turning supports 5324 and 5326 that
5 determine the angle of the spring 5322 (= 12 degrees to horizontal 5328 as shown). A center line 5330 shows that each support 5324 and 5326 are attached on one side to a coil 5316 and on the other side to the spring 5322, which ensures substantial turning. The outer surface 5332 is likely to be essentially the same as the inner surface 5418, while in the disposition 5410b the intra-coil distance 5416 has shortened (now = 1.83 as shown) and the angle 5426 has increased (now $\theta_2 = 38$ degrees as
10 shown).

[0169] Fig. 54 show schematic cross-section views of less and more compressed, respectively, dispositions 5410a and 5410b of a third rotating variant and overall twenty-sixth HLD spring assembly 5410. Distances 5412, 5414 and 5416 are directly analogous to the similar part number 5314 and 5312, respectively, of Fig. 53. Similar surfaces 5418 and 5419, supports 5420 and less bent
15 support 5324, coil to spring contact 5422, and coil axis 5424 at an angle 5426 (= 12 degrees and then 51 degrees as shown) as in Fig. 53 show some of the range of dimensional variation encompassed by the present invention.

[0170] Fig. 55 shows a section of a fourth rotating variant and overall twenty-seventh HLD spring assembly 5510 including a framework 5512 that may also be a helical coil exhibiting standard spring
20 performance. A strip of coil material is machined 5514 from the coils 5512 as is a stop 5516, with the majority of the coil material being formed into a coiled leaf spring 5518. Compressed from a relaxed disposition 5520 with a relaxed spring length 5522 to the length 5524, and retained 5526 near that length by the stop 5516. As the intra-coil distance 5528 changes, either or both the length of the coil 5518 and its angle of inclination 5530 (= 52 degrees to horizontal as shown) may change, wherein
25 increasing length 5524 reduces the decompressive force the coil 5518 is expressing, and increasing angle relative to horizontal increases the proportion of that decompressive force is vertical and hence additive to the coils 5512 decompressive force. There is then an interplay between the decreasing total spring 5518 decompression force and the increasing proportion of that force that is contributing

to the total assembly 5510 decompressive force, and accomplishing a constant force spring, for example, involves balancing the two. When the assembly 5510 is also itself a spring, in order to then accomplish the constant force balancing the total spring decompression from the springs 5518 must counterbalance both their own lessening decompression force as well as that of the coils 5510. Box 5 5532 details spring 5518 length and hence decompressive force expression variations.

[0171] Fig. 56 shows an alternative HLD spring assembly variant (of the assembly 5510,) and disposition 5610 wherein the coils 5612 have a substantially thinner construction, and hence may have much less or virtually no spring like resistance to compression, and hence are only active as frameworks. The inter-coil distance 5528 changes to 5614 with the accompanying increase in coils 10 5612 decompressive force 5534 (= +17% as shown). The transition region 5616 between the coils 5612 and the springs 5518 can be altered so that the rate of change of the angle 5617 of the springs 5518 varies as the spring assembly 5610 is shortened/lengthened. With alterations as described in 5618, among other alternatives, varying the functioning of the region 5616 when the coils 5612 are shortened/lengthened. At 5620 is a comparison of alterations in the angle of inclination 5530, and the 15 consequences for the vertical component of the decompressive force expressed by the spring 5518.

[0172] Fig. 57 shows a first combination spring assembly 5710 of standard or Hooke's Law Obeying (HLO) springs and HLD springs of varying forms that illustrate the range of functionalities that are accessible with the addition of the HLD springs to standard HLO springs. While the orientation of the assembly 5710 can in principle assume any disposition, for simplicity of illustration 20 only it will be discussed herein as oriented as shown in Fig. 57 with all directions described relative to such an orientation. An initial contact push plate 5712 pushes on a first HLO spring 5714 that pushes on a second push plate 5716. A pair of HLD springs 5718 are initially compressed, and their functioning is augmented by both pneumatic (for example) dampeners 5722 and repositioning elastic tethers 5724. These all rest on push plate 5726 that is initially at height 5728 on top of the upper 25 surface 5730. Optional inclusion of resilient and/or elastic membrane 5732 and/or bellows 5734, in combination with push plate 5726 and base 5736, enables interior volume 5735 to be gas or liquid filled to add their properties as spring contributors or dampeners to the assembly 5710. HLD assembly 5738 supports and resists alone the compression downward of push plate 5726 until it

reaches a height 5740 at which point the plate ends 5742 contact the push plate 5726 at 5744 and begin, when moving further downward, to also compress a pair of HLO springs 5746, which are supported by plates 5748 that rest on and compress springs 5750. The relative sizes and lengths of the springs shown are intended to also illustrate examples of the variations in spring strength (which
5 roughly encompasses the entire range of springs in existence,) as well as the range of differing dimensional and dispositional arrangements encompassed by the present invention.

[0173] Fig. 58 shows a second combination spring assembly 5810 of standard or Hooke's Law Obeying (HLO) springs and HLD springs of varying forms that illustrate further the range of functionalities that are accessible with the addition of the HLD springs to standard HLO springs. A
10 plate 5812 is forced against HLO springs 5813 and when it reaches the height 5814 also is forced downward against an HLD spring 5816 that is disposed within the contained volume of gas 5817 which also resists as a HLO gas pressure spring the downward movement of the plate 5812. An optional gas communication line 5818 enables the interior gas 5817 to connect 5820 with another gas volume (not shown) including one in which the pressure is compensator stabilized, which would then
15 enable the gas 5817 spring function to switch from HLO to HLD operation. All of the above described assembly 5810 portion presses down on plate 5822, which when it moves downward soon encounters resistance from larger, longer HLD spring 5824 until it reaches disposition 5826 when it also begins to feel resistance from shorter HLD spring 5828 and medium length, larger HLD spring 5834 (whose constant force responses are additive). When plate 5822 reaches disposition 5830, it
20 also then encounters resistance from the combination of medium long, smaller HLD spring 5832 and shorter, longer HLD spring 5836. At base are a pair of HLO springs 5838 upon which all of the above described assembly 5810 portions rest.

[0174] Fig. 59 shows first through fourth variants 5910, 5919, 5924, and 5930, respectively, of a twenty-eighth HLD spring assembly portion. The first variant 5910 includes a main framework
25 portion 5912 of a sinusoidal leaf spring with alternating voids 5914, and stiff counter-mounts 5916 extending across the majority of the voids 5914 to end branches 5918 between which are affixed a secondary sinusoidal leaf spring 5920. This arrangement enables counterbalanced effects upon the main spring portion 5912 and the secondary spring 5920, wherein when the portion 5912 is stretched,

the spring 5920 is compressed, and vice versa, through which various forms of HLD spring performance is achievable. The second variant 5919 has a pair of overlapping hoop secondary springs 5922 which only start interacting with each other or the portion 5912 after an initial period of compression or extension of the spring portion 5912. Hence, this variant starts out with HLO
5 functioning, and then transitions into a form of HLD function. A similar transitioning effect occurs with the concentric hoop springs 5926 surrounding the hoop springs 5928, which can be configured to overlap as well, wherein the springs 5926 are operative immediately, and the springs 5928 are operative after a degree of loading of the portion 5912. A fourth variant 5930 includes either a two stage mount and coil 5932/34 or an integrated mount and coil 5936 which can enable HLD
10 performance by, for example, stretching the spring portion 5912 and then curling up the ends of the mount and coil 5932/34 until they bypass each other and then releasing them so that they press on each other pushing the two sides of a bend of the spring portion 5912 apart, when the bend itself is attempting to assume a closer together disposition.

[0175] Fig. 60 shows a bent paired framework twenty-ninth HLD spring assembly 6010 comprising
15 complimentary frameworks 6012 and 6014 which can be independently sprung or not, as well as prespringing in different directions, and may also be, after tempering, affixed so that their operative action is a hybrid of the frameworks 6012 and 6014. For example, the framework 6012 can be compressed from its rest disposition and connected to the framework 6014 that is extended out from its rest position. The frameworks 6012 and 6014, attached or not, can also be fashioned into a form of
20 extending pseudo-helical coils 6016 and 6018. Additionally, a section of framework 6012 can be twisted and thereby functionally separated 6020 for fashioning and tempering into a tertiary spring portions 6022 of framework 6012 and complimentary tertiary spring portion 6024 of framework 6014. Differences in how the portions 6022 and 6024 are disposed when at rest, whether shorter 6028 or longer 6030 than the operative disposition, whether different or the same as each other, and whether
25 different or the same as either or both of the frameworks 6012 and 6014 enable a wide range of spring performance from HLO to HLD.

[0176] Fig. 61 shows paired looping frameworks thirtieth HLD spring assembly 6110 comprising a pair of mirror disposed undulating frameworks 6112 and 6114 which are both arranged in a semi-

helical overall 3-D arrangement with framework 6114 disposed immediately outside of framework 6112 as they traverse around the overall assembly 6110, and wherein the back side coils 6116 are shown partially washed-out. Each framework 6112 and 6114 are constituted of a series of upward and downward bends, connected by transition that are longer on one side than the other, so that the overall framework travels diagonally, and is then coiled as shown in Fig. 61. With tempering, the undulations become relatively irrelevant to the compression spring response of the whole assembly 6110. As arranged, the undulations are relevant to the disposition of sub-springs 6118 and 6120, which interact with each other within the shorter overlaps of the frameworks 6112 and 6114. As the assembly 6110 is compressed from its rest position, each coil of framework 6112 and 6114 will be getting closer to the next lower coil, which also means each framework 6112 and 6114 portion of a given coil will be getting closer and closer to a full overlap with each other, which also causes the shorter overlap in which the sub-springs 6118 and 6120 are disposed to become larger. By configuring the sub-springs 6118 and 6120 to have rest shapes 6118b and 6120b wherein they are compressed and attached to each other to assume the dispositions 6118 and 6120. As the sub-springs 6118 and 6120 are decompressed, their decompressive force, which serves to lengthen the assembly 6110, is lessened, as the decompressive force of the frameworks 6112 is heightened. Balancing these two crossing effects produces a steady force spring for a certain operating range.

[0177] Fig. 62 shows a dual leaf spring thirty-first HLD spring assembly 6210 includes dual leaf springs 6212 that when compressed can assume a disposition 6213 and are suited to be disposed between a load platform 6214 and an axle 6216. Rigid hoops' 6218 overlap 6220 maintains a compressed sub-spring 6222 that at rest assumes the disposition 6223 and when the springs 6212 are compressed assume the disposition 6221. The compressed sub-spring 6222 exerts a decompressive force that serves to compress the dual leaf springs 6212 and is lessened as the leaf springs 6212 are compressed 6213 and their inherent decompressive force rises. Balancing these two effects enables a steady or even constant force spring assembly 6210.

[0178] Fig. 63 shows a first modular endless leaf spring thirty-second HLD assembly 6310 and a second modular endless leaf spring assembly 6324/5. An endless hoop spring 6312 is roughly equivalent to a closed loop version of the leaf springs 6212, with similar parts and operational

dynamics. Assembly 6310 demonstrates how the modular assemblies 6310 can be linked, among other ways, and these linkages can also be shaped in 3 dimensions to fashion struts, boxes, and other structures which exhibit HLD spring performance as a structural component. Two dispositions of the second modular endless leaf spring thirty-third HLD assembly 6324 (more flattened) and 6325 (less flattened) shown in Fig. 63 also illustrate the basis of the modular spring 6324/5 HLD performance. Within the hoop spring 6312, a pair of slightly center offset rigid hoops 6326 and 6332 hold and orient a cross member 6330 to which a pair of springs 6328 are attached at opposite ends. As the hoop 6324 is compressed down to disposition 6325, hoops 6326 and 6332 turn the cross-member 6330 to disposition 6334 which stretches the springs 6328 which thereby exert a growing compressive force on the hoop 6324 while its inherent decompressive force is also growing. Balancing these forces produces a steady or constant force spring. When sufficient care in its construction is taken, the modular spring assembly 6324/5 exhibits a constant force spring to both compression and extension, and along both its major and minor axes.

[0179] Fig. 64 shows an essentially planar first variant of a third modular endless leaf/hoop HLD spring assembly 6410 that incorporates within its interior a symmetrically disposed pair of shuttling leaf springs 6412 that are straight at rest, and when forced into a curled disposition 6414 exert a straightening force. A pair of adjoined sleeves 6416 transition the leaf springs 6412 from straight to curled dispositions by receiving the straight end of the leaf spring 6412 at a straight receiving end 6418 and the curved end at a curved sleeve end 6420. When the straight portion of the spring 6412 encounters the internal surface 6422 the straight portion is curled and transitioned to the free curled portion 6414, which is attached to the hoop spring 6312 at 6221. The curled portion 6414 exerts a widening force on the spring 6312 at its minor axis. As the minor axis is shortened, the curled portion is reduced by the increase of the straight portion of 6412 and hence the minor axis extending force it exerts is reduced, which is a change in minor axis extending force in the opposite direction of the increase in minor axis extending force inherently rising due to the compressed spring 6312. Balancing these effects produces a modular, major and minor axis constant force rebound to compression or extension HLD spring assembly 6410.

[0180] Fig. 65 shows a second variant 6510 of the assembly 6410 which differs in that its sleeves 6416 straight end is now aligned with the spring 6312 minor axis and the shuttling springs 6412 are dimensioned longer and thinner with a greater proportion of their length comprising their curled portion 6514. If the spring 6312 in this variant is flexible enough, it is even possible for enough
5 spring 6512 to be enlarged enough for the spring 6312 minor axis to become its major axis. Fig. 66 shows a third variant 6610 of the assembly 6410 which differs in that its springs curved ends attachment points 6612 are fused, rather than pinned to the spring 6312, and hence are more difficult (requiring more force) to curl, so the sleeve curling portion 6616 is extended to facilitate this curling. Fig. 67 shows a fourth variant 6710 of the assembly 6410 with a substantially dimensionally altered
10 spring 6312b wherein the curled ends 6712 of the internal leaf springs are more abruptly transitioned to a curved disposition, which will cause the fourth variant to have a higher energy barrier to the transitioning process. Fig. 68 shows a rounded spring fifth variant 6810 whose hoop spring 6312c has a virtually round profile, so that its major and minor axes are not meaningfully distinguished. Balancing the effects described in regard to the first variant 6410, produces a modular, major and
15 minor axis constant force rebound to compression or extension HLD spring assembly from any of the variants.

[0181] Fig. 69 shows a first alternative version 6910 of the second modular endless leaf spring assembly 6324/5 having a main endless leaf spring 6912 that incorporates half coil leaf springs 6914 that are straight at rest and attached in a curled disposition at points 6916 to the spring 6912 at one
20 6914 end and to opposite cross-beam ends 6918 at the other 6914 end. Props 6920 press the spring 6912 at 6922, and are pivotally attached 6924 to the cross-beam between its ends 6918. Compression of the minor axis of the spring 6912 decompresses the springs 6914 and enables balancing such that the assembly 6910 will exhibit constant force resistance to compression or extension along either its major or minor axis.

25 [0182] Fig. 70 shows a second alternative version 7010 of the second modular endless leaf spring assembly 6324/5 having the endless leaf spring 6912 a pair of minor endless leaf springs 7012 in stretched dispositions attached at one end 7014 to the spring 6912 and extended under force to attach at the other end 7016 to cross-beam 7018 that is forced to turn by contact at 7018 with props 6920

when they are forced inward by compression of the spring 6912 along its minor axis. Compression of the minor axis of the spring 6912 decompresses the springs 7012 and enables balancing such that the assembly 7010 will exhibit constant force resistance to compression or extension along either its major or minor axis.

5 [0183] Fig. 71 shows a pair of fastened modular twisted wire HLD spring assemblies 7110 having a main endless leaf spring 7112 from which are twisted (or to which are attached) curled wire springs 7114 that are more straightened when at rest and which attach at their other end (& 7115 on the back side) to the outer extents of twisted wire cross-bar 7116. Depending inward from the spring 7112 are twisted wire (and hence relatively rigid) props 7118 and connecting the modules are a clasp twist
10 7120. The springs 7114 maintain the cross-bar 7116 pressed against the ends of twisted wire props 7118 which hence do not need to be attached to it. Compression of the minor axis of the spring 7112 decompresses the springs 7114 and enables balancing such that the assembly 7110 will exhibit constant force resistance to compression or extension along either its major or minor axis.

[0184] Fig. 72 shows a pair of fastened modular second twisted wire HLD spring assemblies 7210
15 having a main endless leaf spring 7112 from which are twisted (or to which are attached) curled wire springs 7212 that are more straightened when at rest, which cross the center line of the spring 7112 form, and which attach at their other end to the outer extents of twisted wire cross-bar 7116. Twisted wire mounts 7216 are attached to the cross-bar at 7218. Compression of the minor axis of the spring 7112 decompresses the springs 7212 and enables balancing such that the assembly 7310 will exhibit
20 constant force resistance to compression or extension along either its major or minor axis.

[0185] A first multipurpose embodiment 7310 of the present invention is schematically shown on a representative wearer in Fig. 73. The embodiment 7310 includes a head shell 7312, an inflatable interface 7314 and a gas impermeable shield 7316. The interface 7314 has a resilient bellows construction that contacts the wearer with a soft (silicone, for example) contact lining 7318 and is
25 outwardly bounded by the head shell at 7320. The dotted outlines 7322 trace the below the head shell 7312 disposition of the inflated interface 7314 as it travels around the wearer's face. The double line outline 7324 traces the interconnection between the shield 7316 and the shell 7312. The shield 7316 to shell 7312 interconnection is optionally configurable as a snap-on/off connection, as well as other

forms of removable closure, and can also be constructed as adaptable to interconnect with multiple different shield configurations such as shape 7326. A light diaphragm 7328 is movable 7330 in response to speech of the wearer to enhance the wearer's clarity of auditory expression. A spiral cross-section shaped soft air dam 7332 is affixed to a mid-portion of the shield 7316 with its concave side 7334 facing downward. A larger end of the air dam 7332 spiral is affixed to the shield 7316 from side to side all the way to its contact with the head shell bound 7320, while a smaller end is curled enough to double back on itself at 7336. The curled over portion 7336 of the spiral is pressed against the wearer's face in a side to side region 7338 that divides the upper zone behind the shield 7316 that encompasses the wearer's eyes from the lower zone that encompasses the wearer's nose and mouth.

10 The shape of the spiral end 7336 facilitates downward air flow 7339 by providing less sealing when the upper zone air pressure rises, and interrupts upward air flow (not shown) when the lower zone air pressure rises.

[0186] An upper interior side 7340 of the shield 7316 is kept unfogged by an incoming airflow 7342 directed against the interior side 7340 by the first path 7344 inflowing upper zone ports. An outward airflow 7346 exits from the lower zone of the shield/interface/skin enclosed space. The pressure within the interface 7314 is corrected to a constant pressure, even when its disposition or size is changing, by a steady force springs assembly driven pressure compensator 7348. An expanse of HEPA (or other) filter is frequently disposed at the second path ports 7350. In situations where the wearer may themselves be infectious, either knowingly or unknowingly, the filter at ports 7350 can be

15 important, while in situations where the only issue is outside contagion, such as industrial air pollution, the filter can be omitted. When a filter such as a HEPA filter is needed at ports 7350, they are arranged with extended air flow surfaces so as to ease movement of air through the filter. From the ports 7350 the second path 7352 travels upward through the shell 7312 until turning rearward and passing through the arms 7354 and eventually exiting rearward 7356 via the second path vents to the exterior. First path HEPA (or other) filtered 7358 vents 7360 receive exterior air 7362.

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[0187] Counterweight 7364 (when needed) balances the overall weight of this embodiment 7310 such that normal head motion does not tend to dislodge or move the PPE embodiment 7310, nor will it lean or pull unsymmetrically. An optional supplementary head strap 7366 can provide additional

support. Depending on the weight distribution in space of the embodiment 7310, the position of its un-counterweighted center of gravity is altered by the counterweight 7364 until it is located at a position 7368 where, when the embodiment 7310 is worn normally, the center of gravity 7368 is located vertically above the wearer's head's center of rotation 7370. Second and first ducts 7372 and 7374, respectively, through which at least a portion of second 7352 and first 7344 airflow paths, respectively, travel are interrelated such that rotation of airflow driven members in the second duct 7372 will induce rotation of similar but oppositely dispositioned airflow driving members in the first duct 7374. Thus, when the wearer exhales and forces air flow down the second path 7352 it forces rotation of the second duct 7372 that in turn forces rotation of the first duct 7374 which drives airflow through the first path 7344 ports and into the upper zone vicinity 7340 of the shield/interface/skin enclosed space. Additionally, a dessicant (not shown) can be disposed along the first path 7344 to dehumidify air entering the upper zone of the shield/interface/skin enclosed space.

[0188] An optional equipment, optional arrangements embodiment 74210 of the present invention is schematically shown in an overhead plan view on a representative wearer in Fig. 74. Among the optional variations illustrated are a variant shell 7312b having variations in thickness and disposition from the shell 7312 and the arm 7354b varying from the arm 7354; alternatively configured shields 7316b, 7316c, 7316d and 7316e that can be, among other things, specifically adapted to an individual wearer, or can be flattened to enhance visual acuity, or can be adapted for showing augmented reality displays, or enabling integration of auxiliary equipment that might have specific spatial availability needs; as well as varying potential paths for the lining portion 7318b as it crosses the forehead, or differing widths that may be required in the temple region lining 7318c. A bulb 7412 disposed at the rear of the arms 7354b provides available space for additional filtering or other modifications of the incoming airflow such as positive pressurization to enhance the protective effect, and can be configured to augment the shell 7312b hold on the wearer's head. Even greater room for augmentary functionalities is available by including compartments 7414 which can be made pivotal about the ends of the arms 7354b and/or lockable at 7416.

[0189] Variations that are complementary to individual style or appearance distinctions are seen in a mostly frontal view of a style adapted embodiment 7510 of the present invention shown in Fig. 75.

In the case of the embodiment 7510, specific shield shapes such as a chin following shield 7516d lower contour or a forehead following shield contour 7516e can be selected to complement the appearance of the wearer. Upper shell portion 7512a can be configured to enhance a wearer's brow line, a shell temple portion 7512b can be sculpted to enable the wearing of particular eyeglasses under the shield 77516, or to substitute the portions 7512b and 7512c for the eyeglass frame itself. Lower shell portions 7512d can be sculpted to enhance one's bone structure, or can be configured to obscure scars or highlight a tattoo or piercing. A mostly horizontally disposed air dam 7332b is connected at the mid-shield line 7514 and is more tightly spiraled so that it traces a thinner face contact region 7516 disposed in a potentially more appearance flattering location.

10 [0190] A steady pressure compensator 7610 aspect of the present invention is schematically shown in cross-section in Fig. 76. A casing 7612 is connected to a first end 7614 of a steady-force spring assembly 7615 that incorporates one or more compression springs. The assembly 7615 also incorporates a moveable (relative to the casing 7612 which the first end is affixed to,) second end 7616; moveable transfer member 7618; a pin trajectory slot 7620 formed in the transfer member 7618; 15 first and second pivotal forcing arms 7622 and 7624 that are pivotally interconnected at their lower ends by a pin 7626 that rides in slot 7620 (the pin 7626 is shown in 4 representative positions in the slot 7620 that correspond to the four solid and dashed line positions shown for the pivotal arm 7624); first arm upper pivot 7628 that rotatably interconnects the upper end of the first arm 7622 and an upward extension 7630 of the second end 7614; and a second arm upper pivot 7632 that rotatably 20 interconnects the upper extent of the second arm 7624 to the second end 7616. The top of the second end 7616 presses on a bellows 7634 that contains gasses that are usually air and enter or leave the bellows 7634 by a gas supply line 7636. The second end 7616 moves up and down in response to the gas entering or leaving causing the rising or dropping of the pressure of the gas contained within the bellows 7634 which is constructed to readily expand or contract in the vertical direction (as shown) in response to internal pressure and/or external forcing. A contracted bellows 7634b and raised second end 7616b illustrate alternative positions that correspond to a substantial reduction in the gas contained within the bellows 7634 which the spring assembly 7615 is still maintaining the selected steady gas pressure within. The steady pressure within the bellows 7634 is maintained by the steady

vertical force produced by the spring assembly 7615, as expressed by the second end 7616 pressing against the bellows 7634. The dimensional and geometric arrangements shown will produce a steady force response upward by the second end 7616 at each of the upper pivot heights Y_{1-4} 7638. As the heights 7638 are progressively assumed, the combinations of arms 7622, 7624, and transfer member 7618 (modified by slot 7620) compress the springs through the range of lengths L_{1-4} 7640. The respective heights Y_{1-4} 7638 are constant distance separated, while the corresponding separations of the spring lengths L_{1-4} 7640 are progressively smaller, so that the combination produces a constant force response. The exact relationships between any given set of Y_{1-4} 7638 and a corresponding set of L_{1-4} 7640 depends on a combination of factors including the original rest length of the springs, the percentage of that length the springs are originally pre-compressed to, the K decompression force constant of the springs, as well as the motion limitations of the spring assembly's geometry.

[0191] A pressure transfer duct assembly 7710 aspect of the present invention is schematically shown in Fig. 77. The duct assembly 7710 would typically be disposed within the arms 154 and would augment the airflow to the upper zone of the shield/interface/skin enclosed space and contribute to reducing fogging. Inner duct 7712 and outer duct 7714 that encircles the inner duct 7712 is one of many arrangements that fall within the scope of this invention, including side by side, separated and connected by a belt or gearing, or other forms of force transfer. In addition, the means by which the duct assembly 7710 interacts with the fluid passing through them can also assume a variety of forms such as impellers, ailerons, shaped internal surfaces, propellers, etc. while still remaining within the scope of the present invention. As an airflow 7716 is forced outward along inner duct 7712 by the wearer's respiration, it encounters angled vanes 7718 that are affixed to the inner duct 7712, and by force of the moving gasses reaction on those vanes the inner duct 7712 is rotated 7720 about its longitudinal axis. Attached to the inner duct 7712 external surface are impellers 7722 that lie within the outer duct 7714, and turn with the rotation of the inner duct 7712. The impellers 7722 are angled so as to drive incoming airflow 7724 to the end of the duct 7726 wherein it will be pushed through the upper zone ports of the shield/interface/skin enclosed space. Additional capabilities include arranging a filter element 7728 (with an internal passage 7730 for the

exhalation airflow 7716) and/or a dessicant containing passage 7732 for the airflow 7726 which is then a filtered and dried airflow 7734 prior to entering the shield/interface/skin enclosed space.

[0192] A second multipurpose embodiment 7810 of the present invention is schematically shown on a representative wearer in Fig. 78. The embodiment 7810 has much in common with the embodiment 7310, and where a part is the same in each, and that part is not also specifically numbered in Fig. 78, the part number for that part in Fig. 78 is the same as in Fig. 73. Rearward, over the ears and behind the head, extending arms 7812 have a resilient, porous surface structure that can have an ellipsoid cross-section shape and end in a spherical section 7814 form. The arms 7812 can be detachable, for ease of cleaning, and are often hollow to provide space to hold HEPA filters 7816 for cleaning the inward airflow path 7820 and HEPA filters 7818 for cleaning the outward airflow path 7822. The inward airflow enters the airspace behind the shield via ports 7824 disposed across the perimeter of the shell above the eyes where the shield and the shell meet. Similar outward airflow ports 7350 are disposed across the lower portion of the shell, where it meets the shield, through which air flows along to exit by path 7822, starting with exhalation-elevated pressure behind the shield forcing air outward through the ports 7350.

[0193] The wearer-shell interface 7828a/7828b/7828c of embodiment 7810 also differs from the embodiment 7310 in both its construction and its manner of operation and inflation/deflation. The 7828a portion of the interface forms the bridge between the forehead and temple of the user, for example, and the shell 7812, while the 7828b portion of the interface is typically disposed in the under-chin area of the wearer. The primary difference between the forehead area interface portion 7828a and the under chin area interface portion 7828b is the number of inflated layers 7832 between the shell and a face contacting liner 7830, with the under chin portion having more of the layers 7832. Alternatively (not shown) the same number of layers 7832 can be used with the inflated layers 7832 near the shell having an even greater normal (to the face) extent and accordingly lower surface area. Between each adjacent inflated layer is a layer of stiff slats 7834 that have small separations 7836 from each other. Hence the slats 7836 engender a pan-surface force response by each inflated layer 7832 to the forces exerted on it by the structures above and below. But, by being separated, they enable fairly close contour following by the interface 7828, such as head contour matching. The

inflated layers 7832 have varying cross-sections of relative extent normal to the wearer's face versus parallel. These variations alter its performance in regard to internal pressure change under compression. Due to the effect of the slats 7834, each inflated layer 7832 responds to the same amount of force exerted on the interface 7828, but that force is distributed across layers with differing surface areas to spread about that force upon. The inflated layer next to the liner 7830, and closest to the wearer, has the most surface area and hence has the smallest internal pressure rise due to compression by wearer relative movement. By the same token, the inflated layer 7836 closest to the shell 7812 has the smallest surface area and hence the greatest internal pressure rise. In this way the greater pressure rise is less incident on the wearer, since it is more focused on the shell, hence her comfort is improved. When the material spring properties of the inflated layers 7832 is compensated for, the interface 7828 as a whole is a relatively steady, near constant force, as expressed to the wearer, spring assembly.

[0194] The wearer-shell interface 7828 (7828a/7828b/7828c) of embodiment 7810 also can vary in construction in differing parts that interact with differing portions of the wearer's face. As shown earlier, the inflated layers 7836 that have a lesser surface area will experience a greater internal pressure rise, and hence are constructed with a greater extent normal to the wearer's face to accommodate the compression of that layer in that direction. In proximity to those areas of a wearer's face that move the most (lower jaw) the interface portion 7828b provides a greater freedom of movement by the doubling the inflated layer 7836, in comparison to the interface portion 7828a having a single layer 7836. Another closely related alternative embodiment (not shown) would be to combine the two (or more) inflated layers 7836 into a single inflated layer with a substantially greater extent normal to the wearer's face than parallel to it. This form of layer may need additional structural reinforcement depending on the application it is used for to avoid longitudinal bending and/or pinching. A representative assortment of inflated layer 7832 normal extents is shown in the 90 degree rotated 7840 view of a portion 7828c of the interface 7828 that only has three inflated layers 7832.

[0195] The shell 7812 also differs from the shell 7312 in how its interface 7828 is inflated and/or deflated. The region within the dashed circle 7842 is also shown, in a 90 degrees rotated 7843 cross-

section view in combination with the interface portion 7828a. A shunt 7844 supplies air from the inflow duct 7344 to a squeeze bulb 7846 that is compressible by the wearer. Airflow from the squeeze bulb 7846 is controlled by a one way valve 7848 the ensures a sufficient level of pressure in the air being injected by the squeeze bulb into the interface 7828 via a distributing manifold 7850.

5 The manifold 7850 would share the squeeze bulb 7846 forced air into each of the inflated layers 7812 via a pinch valve (not shown) in each layer that allows air in when its pressure is raised by the squeeze bulb 7846, but not back out. Hence, at rest each inflated layer 7812 will have about the same internal air pressure, which when worn will be often be in the general range of 0.2 or 0.3 psi above atmospheric pressure. A separate system (not shown in Fig. 78 because shown in Fig. 79) governs the
10 deflation of the interface 7828.

[0196] The top down schematic semi-cross-section view 7910a in Fig. 79 of embodiment 7810 illustrates a variety of geometric and other factors of the embodiment 7810, in addition to potential variants. Note again, please, that the embodiment 7810, shown in Fig. 79 again has much in common with the embodiment 7310, and where a part is the same in each and/or Fig. 78, and that part is not
15 also specifically numbered in Fig. 79 or 78, the part number for that part in Fig. 79 is the same as in Fig. 73 or Fig. 78. The rearward reaching arms 7812 are also shown in a 90 degree turned view wherein they are constructed of a soft enough material that their shape is somewhat indented by their pressure against the side 7915 of the wearer's head due to their front to rear disposition being inclined somewhat inward. Since the HEPA filters (not shown) will be entirely contained within the rearward
20 reaching arms 7812, they can also be made detachable at a connection 7916 that can enable fast attachment/detachment for cleaning and/or replacement. A spring-loaded one-way exit valve 7918 governs the air pressure within the interface 7828. By not opening until a selected pressure is reached, the valve 7918 ensures that the pressure within the interface, following inflation, is at least a particular level of pressure, and is not a substantially higher pressure. Hence, since that selected
25 pressure is relatively low, the interface 7828 can be substantially deflated simply by the wearer pressing the shell 7813 against their face so that the air is driven from the interior of the interface 7828 (and is not replaced since the squeeze bulb 7846 is not squeezed and hence the interface feed valve 7848 does not open.) A forehead portion 7920 of the shell 7812 has a particularly specific

geometry, both bridging between the two vertical sides and paralleling the approximately 20 degree to vertical inclination of the wearer's forehead. While the interface 7828 is not shown in Fig. 79, it is understood to span between the shell, for example portion 7920, and the face liner 7830, with more of the interface's disposition relative to a wearer can be seen in the dually rotated 7921 view 7910b.

5 [0197] The front schematic view 7910b of embodiment 7810 illustrates the relative positioning of the inflated layers 7836, their potentially modular construction, and the liner 7830 when worn. A portion 7922 of the liner 7830 is not seen as it passes under the chin. The front partial component view 8010 in depicted in Fig. 80 illustrates the spatial relationships between the various aspects of the shell 7312 and various portions of the interface liner 7830, with most of the interface 7828 not shown, including areas where the liner 7830 is not parallel to the line of sight of Fig. 90 such as below the
10 wearer's cheeks or along their forehead. The front relative dimension highlighting view 8110 depicted in Fig. 8110 demonstrates differences in relative spacing of the shell 7812 and the nearest portion of the wearer's face. A maximum vertical spacing 8112 and 8114 are sufficient to accommodate, optionally, a range of wearer face sizes including smaller spacings 8116 between the wearer's face
15 side and the shell 7812 larger under-chin spacing 8118. The space between the shield 7316 and the wearer's face can also assume a wide variety of side to side contours and/or configurations 8120.

[0198] A sequential reel spring accumulating, constant force outputting embodiment 8210 is shown horizontally for ease of illustration, but is normally operated at a 90 degree rotation to the view of Fig. 82 wherein a spindle 8212 is generally disposed vertically, with the reel springs stacked horizontally
20 up and down the spindle 8212. Rotating about the spindle 8212 are a series of one-way hubs 8214 that all hence only rotate about the spindle in the same direction 8215, counter-clockwise in the case of Fig. 82. Hubs 8214 can connect to a single reel spring 8216, or can be bridging hubs that are connected to a pair of reel springs 8216. The reel springs 8216 are one of two types: they either extend clockwise from the hub 8214, or counterclockwise. Both, however can be constructed to wind
25 up, and/or wind down by rotation in the same direction 8217 about the spindle. In a paired arrangement 8220 of such oppositely wound springs 8216, the springs 8216 are connected to each other by a peripheral bridge 8222 that moves each spring's outermost boundary 8223 in synchrony, but each spring is also riding on a different hub 8214, which are often bridging hubs 8218. In this

way, each spring pair 8220 is wound by rotation of one hub 8218 about the spindle 8212 and is unwound by rotation of the other hub 8218 about the spindle, in the same direction as the winding due to the other hub's rotation. These pairs 8220 can then be stacked atop a common spindle 8212 (or even separate spindles 8212 if needed) with the unwinding of one pair 8220 feeding the winding of the next. Optionally in such a stack 8220a,b,c each successive pair 8220 can have a differing force response from the next such as 4 windings of the first pair being equivalent to 1 winding of the next, for example. Thus, a stack can be configured that is both sensitive and efficiently accumulative of low and high levels of input forces and speeds.

[0199] Such a sensitive and efficient springs 8216 stack can also be interconnected via a checkable bridge hub 8224 that is both a one way hub and is also a checked hub, for example by use of a clutch, wherein when the constant force reel spring assembly 8226 is within its operating range, the bridge hub 8224 is free to transfer torque to the assembly 8226. But when the assembly 8226 has been torqued to the limit of its operating range, the hub 8224 is checked so that it cannot rotate about the spindle 8212. While the hub 8224 is checked the assembly 8226 is still operating feeding its constant force 8227 to a rotational load such as a generator 8229 (many generators work most efficiently at one particular force level or speed, which is why an assembly that supplies a constant exact force is beneficial). The checked hub 8224 receives force from the input/transfer assembly 8220 and receives a status input from a force differential sensitive one-way hub 8228. The hub 8228 receives input forces from opposing reel springs 8230 and 8232 components of the constant force assembly 8226.

When the assembly 8226 is in its their operating range (which occurs when both the springs 8230 and 8232 are in their operating range at the same time,) the hub 8224 is able to transfer force from the assembly 8220 to the assembly 8226. When the torque received by the assembly 8226 from the assembly 8220 has been too small (or too large,) one or the other of the opposing reel springs 8230 and 8232 will reach the end of their range which will either stop the assembly 8226 since it has exhausted its load energy, or will cause the output to the hub 8224 to check its movement about the spindle 8212 while the assembly 8226 provides a constant force output that unloads its accumulated work until it is again in operating range and the hub 8224 is then no longer checked. The opposing reel springs 8230 and 8232 both receive their input force from a spring-periphery connecting armature

8234 that is also interconnected with and receives its input force from the hub 8224. Both springs 8230 and 8232 are also connected at their axis to the hub 8228 which expresses their net force input as its output. The springs 8230 and 8232 can be made close to identical, with the “main” spring being more heavily wound by an increment, and the “sub” spring being oriented to wind and unwind with the armature in the same direction as the main spring does, but with its force in/out vectors in the opposite direction. Both springs 8232 forces are then aggregated by the hub 8228 into the constant output force 8227.

[0200] More 8310a and less 8310b extended dispositions of a constant force pivot-moderated main-spring/sub-spring assembly 8310 is depicted in Fig. 83. A helical main spring 8312 and a main spring modifying sub-spring 8314 are arranged to interrelate as an assembly 8310 that aggregates and expresses their combined spring force (when the assembly as a whole is compressed, wherein the assembly force is expressed as outward pushes by the left and right, as seen in Fig. 83, ends of the assembly 8310). A fulcrum support 8316 positions a pivot 8319 for cycling arm 8320 which interrelates guides 8322. Each end of the cycling arm 8320 has a wheel 8324 that rides in a passage 8326 in the guides 8322. The position 8328 of one guide 8322 is hence interrelated with the position of the other guide 8322, and via the props 8330, are also interrelated with the position of both ends of the main spring 8312 and the sub-spring 8314, so that when the main spring 8312 is more compressed 8310b, the sub-spring 8314 is less compressed, and vice versa 8310a. By appropriately varying the standard spring performance parameters of each of spring 8312 and 8314 the overall output decompression performance of the assembly 8310 can thus be made to be partially Hooke’s law obeying, partially Hooke’s law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the degree of construction precision.

[0201] More 8410a and less 8410b extended dispositions of a constant force reversing frameworks main-spring/sub-spring assembly 8410 is depicted in Fig. 84. A helical main spring 8412 and a main spring modifying sub-spring 8414 are arranged to interrelate as an assembly 8410 that aggregates and expresses their combined spring force (when the assembly as a whole is compressed, wherein the assembly force is expressed as outward pushes by the left and right, as seen in Fig. 84, ends of the

assembly 8410). First framework 8416 (at 8417) and second framework 8418 (at 8419) maintain the sub-spring 8414 in greater 8420 or lesser 8422 degrees of compression, depending on the degree of compression (8424 to + 8425) of the main spring. Hence, as the main spring 8412 is compressed the sub-spring 8416 is decompressed, and vice versa. By appropriately varying the standard spring performance parameters of each of spring 8412 and 8414 the overall output decompression performance of the assembly 8410 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the degree of construction precision.

[0202] More 8510a and less 8510b extended dispositions of a constant force gearing-moderated main-spring/sub-spring assembly 8510 is depicted in Fig. 85. A helical main spring 8512 and a main spring modifying sub-spring 8514 are arranged to interrelate as an assembly 8510 that aggregates and expresses their combined spring force (when the assembly as a whole is compressed, wherein the assembly force is expressed as outward pushes by the left and right, as seen in Fig. 85 ends of the assembly 8510). Gearing 8516 affixed to central portions of the main spring 8512 receive 8517 in housing 8518 geared 8519 frameworks 8520 and 8522 and inversely relate the relative movement of one framework 8520 with the other framework 8522 so that movement of the framework 8522 to the right relative to the gearing 8516 causes movement of the framework 8520 to the left, and vice versa. One end 8524 of the framework 8520 determines the degree of compression 8526 or decompression 8528 of the sub-spring 8514. Hence, when the main spring 8512 is more compressed 8510b, the sub-spring 8514 is less compressed, and vice versa 8510a. By appropriately varying the standard spring performance parameters of each of spring 8512 and 8514 the overall output decompression performance of the assembly 8510 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the degree of construction precision.

[0203] More 8610a and less 8610b extended dispositions of a constant force pulley-moderated main-spring/sub-spring assembly 8610 is depicted in Fig. 86. A helical main spring 8612 and a main spring modifying sub-spring 8614 are arranged to interrelate as an assembly 8610 that aggregates and expresses their combined spring force (when the assembly as a whole is compressed 8610a-8610b,

wherein the assembly force is expressed as outward pushes by the left and right, as seen in Fig. 86, ends of the assembly 8610). First and second frameworks 8616 and 8618, respectively, maintain pulleys 8620, cabling 8622 and cable extender 8624 so that the sub-spring 8614 is more extended 8626 to the distance 8628 when the cable extender 8624 is pushed closer to the right end of the main spring 8612, i.e. when the main spring 8612 is less extended (for example by the amount 8630 from a less compressed extension 8632), and vice versa. Hence, by appropriately varying the standard spring performance parameters of each of the springs 8612 and 8614, the overall output decompression performance of the assembly 8610 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the degree of construction precision.

[0204] More 8710a and less 8710b extended dispositions of a constant force rotating-cap-moderated main-spring/sub-spring assembly 8710 are depicted in Fig. 87. A helical main spring 8712 and a main spring modifying sub-spring 8714 are arranged to interrelate as an assembly 8710 that aggregates and expresses their combined spring force (when the assembly as a whole is compressed, wherein the assembly force is expressed as outward pushes by the left and right, as seen in Fig. 87, ends of the assembly 8710). First and second frameworks 8716 and 8718 are each attached to the first and spring 8712 at opposite ends, and in between their overlapping region 8719, a rotating cap 8720 spins about a central spindle 8722 so that when it spins one direction it moves closer to the left end of the assembly 8710b and when it spins in the other direction it moves closer to the right end of the assembly 8710a. The cap 8720 is spun by gearings (not shown) on its outer perimeter that interact 8726 with the first framework 8716, so that when the main spring is compressed (i.e. by 8727 from the less compressed length 8728), the cap 8720 is rotated which decompresses the sub-spring 8714 (i.e. to 8730 from the more compressed disposition 8731). Hence, by appropriately varying the standard spring performance parameters of each of spring 8712 and 8714 the overall output decompression performance of the assembly 8710 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the degree of construction precision.

[0205] More 8810a and less 8810b extended dispositions of a constant force pneumatically-moderated main-spring/sub-spring assembly 8810 is depicted in Fig. 88. A helical main spring 8812 and a main spring modifying sub-spring 8814 are arranged to interrelate as an assembly 8810 that aggregates and expresses their combined spring force (when the assembly as a whole is compressed, wherein the assembly force is expressed as outward pushes by the left and right, as seen in Fig. 88, ends of the assembly 8810). First and second frameworks 8816 and 8818 overlap 8819 between the two ends of the assembly 8810 within which is disposed the sub-spring 8814 whose degree of compression is determined by a pneumatic bellows 8820 which is more compressed 8822 when the assembly 8810 is more compressed 8810b. The bellows 8820 compression forces gas into the cylinders 8824 which extends pistons 8826 thereby compressing the sub-spring 8814, so that when the main spring 8812 is more compressed the sub-spring 8814 is less compressed. Hence, by appropriately varying the standard spring performance parameters of each of spring 8812 and 8814 the overall output decompression performance of the assembly 8810 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the degree of construction precision.

[0206] More 8910a and less 8910b extended dispositions of a constant force hydraulically-moderated main-spring/sub-spring assembly 8910 is depicted in Fig. 89. A helical main spring 8912 and a main spring modifying sub-spring 8914 are arranged to interrelate as an assembly 8910 that aggregates and expresses their combined spring force (when the assembly as a whole is compressed, wherein the assembly force is expressed as outward pushes by the left and right, as seen in Fig. 89, ends of the assembly 8910). First and second frameworks 8914 and 8916 each depend from opposite ends of the assembly 8910 and overlap in the intermediate region 8918 of the main spring 8912. First and second hydraulic main chambers 8920 are each attached at one of their ends to opposite ends of the assembly 8910, and a piston 8922 that determines the fill level of each chamber 8920 is attached to the framework at 8924 that depends from the opposite end of the assembly 8910 that that chamber 8920 is attached to. When the piston 8922 mostly empties chambers 8920, the fluid traverses tubing 8926 and fills chambers 8928 which presses sub-spring 8914 end plates 8930 closer together thereby compressing sub-spring 8914 whose compression resistance force is translated by the hydraulic fluid

to the ends of the main spring 8912 and hence the ends of the assembly 8910. Hence, when the main spring 8912 is more compressed 8910b, the sub-spring 8914 is less compressed, and vice versa 8910a. By appropriately varying the standard spring performance parameters of each of spring 8912 and 8914 the overall output decompression performance of the assembly 8910 can thus be made to be
5 partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the degree of construction precision.

[0207] A constant force spring first ring seal spring 9010 application comprises first 9012 and second 9014 canted ring springs. These ring springs are used to provide round seals with a greater
10 "sealing" force, and in such cases there is often benefits in having the force response of these reinforcing springs to be constant within their operating range. One such manufacturer, Bal Seal Engineering, Inc., produces such springs and quotes that their force response as being much flatter in the range where the force applied primarily varies the degree of canting of the spring loops, not constant but substantially closer. The doubled ring springs of embodiment 9010 shown, when
15 combined as described, do produce a constant force response within the prescribed operating range. The springs 9012 and 9014 operations when combined by the outer loops link 9016 anchored in detents 9018, become combinations of compression of the first canted spring 9012 with decompressions of the second canted spring 9014, and vice versa. Alternatively, anchoring 9020 from one side of the first spring 9012 to the far side of second spring 9014 also produces
20 combinations of compression of the first canted spring 9012 with decompressions of the second canted spring 9014, and vice versa. By appropriately varying the spring performance parameters of each of spring 9012 and 9014 the overall output decompression performance of the assembly 9010 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the
25 degree of construction precision.

[0208] A constant force leaf spring seal 9110 application comprises a first canted ring spring 9112 and a modifying interlaced combination leaf spring 9114. When at rest 9116, the spring 9012 is

relatively upward extended, i.e. less canted, while the spring 9114 is relatively compressed 9118, hence while spring 9112 is pressing upward less, the spring 9114 is pressing upward more. When the spring 9114 is more at rest 9120, the spring 9114 is more compressed 9122. A recess 9124 enables the secure insertion and hold of the spring 9114 within the center of the spring 9112. By

5 appropriately varying the spring performance parameters of each of springs 9112 and 9114 the overall output decompression performance of the assembly 9110 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the degree of construction precision.

[0209] A constant force spring third ring seal spring 9210 application comprises first 9212 and

10 second 9214 canted ring springs. An armature 9216 with detents 9218 inserted between the canted first 9212 and second 9214 springs maintains the springs relative positioning during compression/decompression cycling. In addition to a change in canting angle, each spring 9212 and 9214 alter their configuration, from more rounded and shorter (9222 & 9226) to less rounded and longer (9220 & 9224). As shown inn Fig. 92, the armature 9216 and the detents 9218 align the canted

15 first 9212 and second 9214 springs so that when the first spring 9212 is more compressed the second spring 9214 is less compressed, and vice versa. By appropriately varying the spring performance parameters of each of springs 9212 and 9214 the overall output decompression performance of the assembly 9210 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of

20 operation, depending on the degree of construction precision.

[0210] A constant force spring fourth ring seal spring 9310 application comprises first 9312 and second 9314 canted ring springs. The application 9310 is intended for use in constrained situations 9311 such as when operating between upper and lower situational boundaries 9309 as many spring ring seals do. Because the second ring spring 8214 is canted at an opposite angle to the canting of the

25 first ring spring 8212, the second ring spring 8214 is unable to expand beyond the inner border of the first ring spring 9312. In addition to a change in canting angle, each spring 9312 and 9314 alter their configuration, from more rounded and shorter (9320 & 9324) to less rounded and longer (9318 & 9322). As shown inn Fig. 93, when the first spring 9312 is more compressed the second spring 9314

is less compressed, and vice versa. By appropriately varying the spring performance parameters of each of springs 9312 and 9314 the overall output decompression performance of the assembly 9310 can thus be made to be partially Hooke's law obeying, partially Hooke's law reversing, or relatively steady, if not exactly constant, in force output throughout its range of operation, depending on the

5 degree of construction precision.

WHAT IS CLAIMED

1. A Hooke's law disobeying spring system, comprising:

a unified spring assembly including one or more primary and one or more supplementary springs,
said assembly interrelating the primary and supplementary springs such that

5 compression/decompression of the unified spring assembly compresses/decompresses one or
more of the primary springs and concurrently rearranges/de-rearranges one or more of the
supplementary springs while maintaining the primary and supplementary springs' effective (net
effect on the unified spring assembly) decompressive force vectors at least partially in the same
direction;

10 Wherein said rearranging alters the effective decompressive force exerted on the unified spring
assembly by the supplementary springs such that as the primary springs are more compressed the
supplementary springs effective force is lessened, and as the primary springs are decompressed
the supplementary springs' effective force is increased.

resilient

15 2. A Hooke's law disobeying spring system, comprising:

a unified spring assembly including one or more primary and one or more supplementary springs,
said assembly interrelating the primary and supplementary springs such that

compression/decompression of the unified spring assembly compresses/decompresses one or
more of the primary springs and concurrently compresses/decompresses one or more of the
20 supplementary springs while maintaining the primary and supplementary springs' effective (net
effect on the unified spring assembly) decompressive force vectors at least partially in opposing
directions;

Wherein said rearranging alters the effective decompressive force exerted on the unified spring
assembly by the supplementary springs such that as the primary springs are more compressed the
25 supplementary springs effective force is lessened, and as the primary springs are decompressed
the supplementary springs' effective force is increased.

3. A method of realizing a Hooke's-Law-diverging spring rebound-force effect, comprising:

arranging one or more first and one or more second springs so that when resilient distortion of one or more of the first springs occurs resilient distortion of one or more of the second springs is concurrent;

interrelating the first and second springs so that when said resilient concurrent distortion occurs, at

- 5 least a portion of the net rebound force exerted by one or more of the first springs is at least partially opposed by the net rebound force concurrently exerted by one or more of the second springs, such that when resiliently distorted the opposed portions of the first and second springs' rebound forces negate each other's contribution to the first and second springs' combined net rebound force.

- 10 4. A pneumatic tire inflation pressure maintenance system comprising:

a gas loss compensator operative when a pneumatic tire's inflation pressure is not in a selected range, the tire attaining a selected inflation pressure by holding a specified amount of gas within a tire carcass' inflatable volume disposed between a surface of a wheel the tire is mounted to and the interior surface of the tire carcass, with the tire dropping below the selected inflation

15 pressure when, due to gas loss, the amount of gas held is less than the specified amount;

said compensator incorporating one or more bias-able resilient elements assumes a first more biased disposition when the tire's inflation is in a selected pressure range and assumes a second less biased disposition when the tire's inflation is not in the selected pressure range, wherein said lessening the bias of the one or more resilient elements' causes a gas loss compensating

20 volume of material to encroach into the tire's present inflatable volume.

5. A pneumatic tire inflation pressure maintenance system according to claim 4, wherein the resilient elements operate cyclically by switching from a less biased to a more biased disposition, and then back again, repeatedly.

6. A pneumatic tire inflation pressure maintenance system according to claim 5, wherein the gas loss
- 25 compensating material is additional gas and the resilient elements' cycling drives both ingress and pressurization of a limited volume of air sourced from the atmosphere by the non-pressurizing portion of the cycles, and said cycles are at least partially driven by the oscillating disposition of an operating pneumatic tire's sidewalls.

7. A pneumatic tire inflation pressure maintenance system according to claim 5, wherein the gas loss compensating material is additional gas and the resilient elements' cycling drives both ingress and pressurization of a limited volume of air sourced from the atmosphere by the non-pressurizing portion of the cycles, and said cycles are stilled when the inflation pressure of the tire interior is above a selected level.
8. A pneumatic tire inflation pressure maintenance system according to claim 4, wherein the gas loss compensating material is a surface, bordering the tire's inflatable volume, that defines an expandable volume which constrains the volume available to the gas within the tire's inflatable volume, said surface also preventing gas communication between the expandable volume's interior and the tire's inflatable volume.
9. A pneumatic tire inflation pressure maintenance system according to claim 8, further comprising the expandable volume maintaining a steady internal pressure and the resilient elements' operation utilizes a compression spring mechanism having an effective variable spring constant k_x (at a compression distance x) of dimensions force/distance where x is the distance the spring mechanism is compressed relative to the spring mechanism's uncompressed free extent x_0 , and wherein the variable spring constant k_Δ (@ $x = \Delta$) or $k_{2\Delta}$ (@ $x = 2\Delta$) varies with the distance the spring mechanism is compressed (Δ or 2Δ) in accordance with the relationship $[k_\Delta] = 2 [k_{2\Delta}]$ so that the spring force resisting compression when x is $\Delta = (k_\Delta) (\Delta)$ and the spring force resisting compression when x is $2\Delta = (k_{2\Delta}) (2\Delta) = (\frac{1}{2} k_\Delta) (2\Delta) = (k_\Delta) (\Delta)$, the same force as when x is Δ .
10. A pneumatic tire inflation pressure maintenance system according to claim 4, wherein the gas loss compensating material is an expandable surface that defines an expandable volume, driven in part by a spring mechanism's bias to decompress, which constrains the volume available to the gas within the tire's inflatable volume; and in operation the spring mechanism has an effective spring constant defined in part by a variably constrained auxiliary spring portion that, as the expandable volume is progressively more compressed an accordant amount of the auxiliary spring portion is progressively more constrained into no longer contributing to the overall spring constant of the spring mechanism, and when the expandable

surface 1 less compressed disposition more and more of the auxiliary spring portion becomes unconstrained and then contributes to increasing the effective spring constant of the spring mechanism.

11. A pneumatic tire inflation pressure maintenance system comprising:

- 5 a pressurization compensator, disposed within the inflatable volume of a pneumatic tire mounted on a wheel, is defined by an expandable-compressible surface and occupies an expandable-compressible volume portion of the inflatable volume, said compensator including a spring mechanism that applies an outward bias to the expandable-compressible surface which combines with the expandable-compressible volume's internal gas pressure to apply a total expandable-compressible surface pressure to gas within the inflatable volume;
- 10

wherein said total expandable-compressible surface pressure is effectively unvarying across an operative range of magnitudes of the expandable-compressible contained volume.

12. A pneumatic tire inflation pressure maintenance system according to claim 11, further comprising that the molar amount of gas within the expandable-compressible contained volume is fixed so that

15 the external pressure of the contained gas varies inversely with changes in size of the expandable-compressible volume, and the expandable-compressible surface has an effective surface portion whose movement alters the expandable-compressible volume and is biased against compression by a spring mechanism having a variable effective spring constant;

- wherein the spring mechanism's effective spring constant varies by increasing or decreasing in
- 20 magnitude in proportion to the expandable-compressible contained volume's variations to compensate for changes in the external pressure of the expandable-compressible contained gas and changes in the decompressing force exerted by the spring mechanism such that the expandable-compressible surface maintains an effectively steady outward pressure throughout the volume variations.

25 13. A method of maintaining a pneumatic tire's inflation pressure comprising the steps of:

defining a pressure compensator's gas containing expandable-compressible volume by its containment within an enclosed expandable-compressible pressure compensator surface, said

surface having a volume varying effective surface portion driven outward against compression by a spring mechanism;

disposing the pressure compensator within a pneumatic tire's inflatable interior such the compensator's contained volume and the tire's interior cannot communicate gases and variations in the compensator volume correspond to inverse variations in the volume of the inflatable interior available to the tire's inflating gas; and

configuring the spring mechanism with a variable effective decompression spring constant that increases in magnitude as the amount of compression decreases, within an operative range of compensator compression and decompression, such that the spring constant variation induced increases in the spring mechanism's force during decompression are calibrated to compensate for both the drop in the compensator's internal gas pressure and the lessening of the spring mechanism's compression resting force when it is less compressed, such that the compensator exerts a stable

14. A method of maintaining a pneumatic tire's inflation pressure according to 13, wherein the effective spring constant variability involves a portion of the compression resisting elements of the spring mechanism being progressively unleashed as the compensator progressively expands, wherein said compression resisting progressively unleashed portion increases the overall spring mechanism's effective spring constant in accordance with the progress of the unleashing, so that the compensator overall outward pressure drop due to internal gas pressure reductions and spring mechanism decompression are balanced by the increases in the effective spring constant.

15. A method of maintaining a pneumatic tire's inflation pressure comprising the steps of:

disposing within or adjoining a pneumatic tire's inflatable volume a variable volume compensator having a bias-able spring mechanism, so that expansion or compression of the compensator reduces or increases, respectively, the volume available to the tire's inflation gas,

wherein the outward pressure exerted on the tire's inflation gas by a compensator surface is a combination of the decompression force exerted by the spring mechanism' decompression bias, distributed over the compensator surface area, and the pressure of the compensator

contained gas which varies inversely and proportionally to variations in the volume of the compensator interior, and when steady,

the compensator surface outward pressure is equal to the tire inflation pressure.

16. A method of maintaining a pneumatic tire's inflation pressure according to claim 15, further comprising the steps of:

configuring the compensator with a pressure sensitive valve that allows gas communication between the compensator interior and the inflatable volume of the tire, said valve closing when the tire inflation pressure reaches or exceeds a first selected magnitude, and reopening when the tire inflation pressure drops below the first selected magnitude, and

arranging the spring mechanism with a variable effective spring constant that increases as the spring mechanism decompresses, within a selected compression range, so that the spring mechanism contributes sufficient increasing force during decompression when the pressure sensitive valve is closed to balance the loss in outward pressure from the compensator interior contained gas during decompression.

17. A method of maintaining a pneumatic tire's inflation pressure according to claim 16, wherein said spring mechanism further comprises one or more partially sheathed spring elements, said spring elements contributing to the overall decompressive force exerted by the spring mechanism with their unsheathed portions and not contributing with their sheathed portions and the degree of sheathing, and hence degree of contribution to the overall decompressive force, of one or more of the one or more spring elements is responsive and at least partially proportional to the variations of the compensator's volume, which is responsive to the inflation pressure in the tire.

18. A pressurization stabilizer operative on the inflatable interior of a pneumatic tire to compensate for gas leakage induced depressurization, comprising:

A variably dimensioned compensating volume defined by an operative surface driven to expand

by a spring mechanism combining with the compensating volume's contained gasses' pressure;

a closable port enabling gas communication between the tire interior and the compensating

volume when open, wherein the closable port is open when the tire interior gas pressure is

below a selected degree, and closes when the tire interior gas pressure is above the selected degree;

one or more partially operative spring element aspects of the spring mechanism, said aspects having variable effective spring constant contributions to the spring mechanism's overall spring constant, wherein the more operative spring elements increase the overall spring constant more; and

a coupling between one or more of the spring elements and the operative surface so that as the tire's inflatable volume progressively decreases due to lower pressurization from gas leakage, but still has sufficient pressurization to close the closable port, and as an accompanying progressive expansion of the compensating volume occurs which moves the operative surface and due to the coupling progressively also increases the partially operative spring elements' operativity that then increases the effective overall spring constant of the spring mechanism.

19. A pressurization stabilizer operative on the inflatable interior of a pneumatic tire to compensate for gas leakage induced depressurization according to claim 18, wherein the rate of increase in the effective overall spring mechanism is calibrated so that it counterbalances the lower compensating volume gas pressure and the reduced compression of the already operative spring elements, both due to expansion of the compensating volume, said counterbalancing being selectably variable including being arranged to maintain a steady pressure by the operative surface on the tire inflatable interior's gasses throughout the expansion of the compensating volume.

20. A pressurization stabilizer operative on the inflatable interior of a pneumatic tire to compensate for gas leakage induced depressurization according to claim 18, further comprising said partially operative spring elements being partially sheathed spring members wherein only the unsheathed portion of the spring members contributes to the spring mechanism's overall spring constant, and the expansion of the compensating volume also unsheathes one or more of the partially sheathed spring members.

21. A method of adding air inflation to an operating pneumatic tire, comprising the steps of:
disposing a spring element at least partially in proximity to a tire sidewall interior surface and a wheel the tire is mounted upon so that it will cycle between a constrained first disposition when

the tire's sidewall interior surface is in a first configuration that occurs generally at the top of the tire and wheel's revolution, and a less constrained second disposition when the tire's sidewall interior surface is in a second configuration that occurs generally at the bottom of the tire and wheel's revolution, wherein the spring element stores potential energy when it is constrained by the tire interior first configuration and releases that energy when it is released as the tire interior assumes the second configuration;

establishing a pathway into the inflatable volume of the tire interior for communication of gasses, including atmospheric gasses, that progresses through the wheel and connects with a compressing mechanism driven by the energy released by the spring element that operates to inject pressurization stabilizing gasses into the tire interior, said spring element being non-operational when the tire inflation pressure is above a selected level to avoid unneeded energy costs.

22. A pneumatic tire inflation pressure establishment and maintenance method, comprising the steps of:

disposing an operative surface of an expandable pressure compensator in contact with a pneumatic tire's inflatable interior gasses, wherein when operative the compensator maintains an effectively constant outward pressure across its operative surface throughout its operative range of compression by combining a selectively isolated volume of pressurized gasses with an outwardly biased spring mechanism having an overall effective spring constant that increases as the compensator volume increases,

wherein the selective isolation occurs when a pressure sensitive valve is open to gas communication between the tire interior and compensator below a selected pressure level and is closed to said communication when the pressure is above the selected level;

establishing a gas inflation pressure within the tire interior by inserting gas while the valve is open with the spring mechanism in an uncompressed rest disposition until the tire interior reaches the selected pressure level when the valve closes, then

continuing tire inflation until the tire's inflation pressure reaches a target level above which the pressure is sufficient to progressively compress the compensator's spring mechanism and isolated volume, then still further inflating the tire, which remains at the target pressurization due to the progressive compression of the compensator, within the compensator's operative pressurization range, said compensator also protecting against over inflation; and maintaining the target pressurization level of the tire interior over time as the tire interior undergoes gas leakage with corresponding decompression of the compensator causing a tire interior re-pressurizing movement of the operative surface that restores the target level of pressurization of the tire interior by reducing the volume available to the tire inflating gasses, within the compensator's operative range.

23. A pneumatic tire inflation pressure establishment and maintenance method according to claim 22, wherein the selected pressure level is substantially above atmospheric pressure.

24. An airborne infectant/pollutant facial protection system comprising:

15 A transparent, gas-impermeable shield bordered by a resilient inflatable interface that are collectively configured 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; and an elastic, resilient soft air dam having a spiral cross-section resting shape disposed 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.

25. An airborne infectant/pollutant facial protection system according to claim 24, wherein said seal extends across the upper face generally above the brow ridge, then turns downward along the side of the face around and behind the eye socket and then below the cheekbone, then travels partially

forward to mid-cheek and then again turns downward until it crosses under the mid-jaw and continues up the other side.

26. An airborne infectant/pollutant facial protection system according to claim 24, and said seal's inflation pressure is compliant such that as when a skin contacting portion of the interface is moved
5 towards or away from the face, the inflation pressure within the interface remains steady.

27. An airborne infectant/pollutant facial protection system according to claim 26, wherein the seal's compliant pressure is accomplished by a Hooke's Law disobeying (HLD) spring assembly that exerts a steady force throughout its operating range and said steady force is either pressed against a border of the interface's inflatable volume or is pressed against a border of another inflated volume that is in
10 fluid communications with the interface's inflated volume so that the interface's inflated volume is rendered compliant when the another fluid volume is made compliant by the HLD spring assembly.

28. An airborne infectant/pollutant facial protection system according to claim 24, wherein when the facial protection system is worn the soft air dam presses against the wearer's face from side to side, generally contacts the wearer in the area above the mouth and nostrils but below the eyes, and is
15 sufficiently soft to closely conform to the wearer's face's topography.

29. An airborne infectant/pollutant facial protection system according to claim 24, wherein said soft air dam subdivides the enclosed airspace between the shield and the face into an upper zone that includes the wearer's eyes and a lower zone that includes the wearer's mouth and nostrils, with the concave downward cross-section shape of the dam confining exhalation gasses to the lower zone
20 even when its pressure rises higher than that of the upper zone, while the dam's convex upper surface allow gasses from the upper zone to pass to the lower zone when the upper zone's pressure rises above that of the lower zone.

30. An airborne infectant/pollutant facial protection system according to claim 29, further comprising first and second air circulation paths by which air enters or leaves, respectively, the
25 shield/interface/skin enclosed airspace, wherein the first path is restricted to one way air travel from the exterior into the enclosed airspace and the second path is restricted to one way air travel from the enclosed airspace to the exterior;

said first path involves exterior air entering via one or more vents and then traveling through one or more channels and then entering the enclosed airspace via one or more ports, while said second path involves air leaving the enclosed airspace via one or more ports and then traveling through one or more channels until exiting via one or more vents to the exterior, wherein the first ports
5 are open to only the upper zone of the enclosed airspace and the second ports can draw from only the lower zone of the enclosed airspace.

31. A method of protecting a face from airborne infectants or pollutants comprising 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
10 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; 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,
15 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.

32. A pressure corrected, inflatable interface, comprising:

20 a resilient boundary surrounding an inflatable boundary interior, said boundary being arrangeable spatially to conform to the general contours of a living body surface and form a seal with that surface when pressed upon it, wherein the boundary's interior inflation pressure can contribute force to the pressing of the boundary to the body surface when the interior is inflated above ambient pressure, and

25 the gas pressure within the interior is corrected to remain steady when the total enclosed volume of the interior is varied by movement of at least a portion of the boundary, said pressure correcting involving air pressurization by one or more steady force spring assemblies that push with a force that stays steady as their operating ends travel throughout their operating range, with this steady

force pushing on a part of the interior air space's boundary or on the boundary of another airspace that is pressure connected to the interior air space.

33. A pressure corrected, inflatable interface, according to claim 32, configured as a bridging element between an inanimate object and a living body surface wherein a first interface portion is affixed to the inanimate object and a second interface portion that is either itself in contact with or is affixed to a material that is in contact with a living body surface, with at least some portion of the pressure corrected inflated interior of the interface disposed in between the first and second interface portions, such that when either or both of the first and second interface portions are in motion the pressure expressed upon them both by the inflated interior remains steady.
34. A constant pressure compensator for correcting the inflation pressure of an inflated interface suited for contacting a living body, comprising:
- a moveable platen whose motion either alters the pressure within the interface's inflated interior volume directly by altering that volume or indirectly by altering the inflated volume of a separate inflatable space that is in gas communication with the interface's inflated interior, wherein the force with which the platen directly or indirectly presses against either the inflatable volume or space determines the gas pressure within the interface's inflatable interior; and
- one or more generally constant force spring assemblies arranged to impart the force that the platen exerts, wherein said assemblies express a generally constant force compression resistance throughout an operating range such that as the platen moves within that range the force that the spring assemblies express against the platen is relatively unchanging.
35. A constant pressure compensator for correcting the inflation pressure of an inflated interface suited for contacting a living body according to claim 34, wherein said spring assembly comprises first and second ends that are pushed apart by the spring assembly when in the operating range of separation of the first and second ends, and first and second pivot arms that are pivotally interconnected at their lower extents and collectively press upon one or more or compression springs that are compressed between one portion of the first end and the pivotal interconnection either directly or indirectly via a path shaping intermediary member, said first pivot arm's upper extent pivotally interconnected with the first end and said second pivot arm's upper extent pivotally

interconnected with the second end such that the compression springs' decompression force, moderated by the interconnected pivotal arms, is expressed upon the second end as a steady effective force that stays relatively unchanged as the second end moves closer or further from the first end.

36. An airborne infectant/pollutant facial protection system air circulation enhancement, comprising:

- 5 first and second one-way air circulation paths suited for use as a filtered air supply into and air exhaust out from, respectively, an enclosed air-volume, said volume suitably formed in between a mask and a wearer's face and enclosing the wearer's eyes, nose, and mouth; and
- first and second interrelated ducts that the first and second paths at least partially travel through, said ducts each containing air motion reactive members that rotate when air is blown through the duct,
- 10 wherein the first and second ducts' rotations are interrelated so that when exhalation drives air along the second path and through the second duct, the induced rotation of its reactive members induces rotation of the first duct's reactive members which drives air into the enclosed space along the first path.

37. An airborne infectant/pollutant facial protection system air circulation enhancement according to
- 15 claim 36, further comprising a dessicant containing chamber through which the first path passes such that the first path is suited for directing to initially impact on and reduce fogging of an eye shielding portion of a mask.