TUNABLE SHOE SOLE ENERGY ABSORBER

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ABSTRACT

A tunable shoe sole and heel energy storage device incorporating at least confronting upper and lower generally planar polymeric portions joined by a releasable fastener assembly. Cooperating post and recess retainers are preferably formed in the polymeric portions to capture and retain a plurality of reconfigurally removable, stackable, and replaceable energy absorbers. With the novel configuration of the energy storage device, a shoe may be customized and tuned for optimal energy absorption and release by arranging the quantity and location of the energy absorbers about the post and recess retainers. Preferably, the energy absorber is selected from the group of items that includes, for example, conical and coil springs, disc springs such as flat, conical, finger, curved, wave, and belleville disc springs and washers. The energy absorbers may be arranged in a series and or parallel manner to address foot impact loads experienced during business, casual, athletic, medicinal, recreational, athletic, and special purpose situations. Among other elements, the tunable shoe sole and heel energy storage device may further include a releasable fastener assembly that may have one or more fasteners such as, for example, hook and loop fasteners, cooperating bayonet-type guide posts and recesses, screws, adhesives, and combinations thereof. The polymeric upper and lower portion polymeric material is preferably either one of any of a number of suitable plastics such as elastomers and polyesters. In variations of the tunable shoe sole and heel energy storage device may be further adapted to be an insert that is compatible for use within a shoe.
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TECHNICAL FIELD

[0001] This invention relates to a customizable and tunable energy storage and return device having application in soles, inserts, and replacement elements for various types of shoes including, for example, but not limitation, dress, casual, medicinal, therapeutic, recreational, athletic, and special purpose shoe wear and components thereof.

BACKGROUND OF THE INVENTION

[0002] In the footwear industry, various attempts have been made to improve comfort of shoes and feet during use. Various types of springs, resilient materials, and disc springs have been incorporated in various arrangements and all with the intent to minimize shock loads to the anatomy of the wearer. Unfortunately, many shortcomings persist and there has been a long-felt need for a device that is suitable for use with any type of shoe, including, for example, athletic, casual, business attire, recreational, medicinal, therapeutic, and special purpose shoe wear. The prior art has sought to improve shoe comfort primarily by modifying the sole shoe in a way that has rendered the proposed solution incompatible for use with anything other than a specialized type of shoe, which results in manufacturing difficulties, increased production and end-user costs, and a one-size fits all lack of individualized suitability.

[0003] For example, a highly specialized shoe is described in U.S. Pat. No. 4,815,221 to Diaz, which is restricted to, among other limitations, a spring plate molded into the heel and or outsole portions of a shoe. A spring member containing shoe insert is illustrated by Ronen et al. in U.S. Pat. No. 5,042,175. Such constructions do not readily lend themselves to wide application and are incompatible for use with certain types of commonly used, off-the-retail-shelf types of shoes, especially business attire dress shoes.

[0004] What has been needed, but as yet unavailable, is a comfort improving device that is easy to use, inexpensive, uncomplicated, and convenient for not only incorporating into the most popular types of shoe wear, but which can also be used by consumers who may have a need to repair or replace a worn portion of a shoe sole and or heel and who would like to improve the comfort of the shoe. For example, many consumers purchase higher cost business attire dress shoe wear, which generally are not available with comfort enhancing features such those offered by the instant invention. Instead, such consumers are left to suffer with ineffective or limited capability cushioning materials that must be inserted in the shoe and which can drastically impair the proper fit of the shoe.

[0005] In each of the noted applications and situations, cumbersome and expensive shoe inserts of type shown in the prior art are generally undesirable because of the undesirable ramifications on proper shoe fit and comfort.

[0006] What has also been needed, is a device that not only easily accommodates a wide variety of readily available shoe wear, but which can also be optimized individually without undue effort to maximize shoe comfort in a cost-effective and easy to use manner. Moreover, the preferred apparatus should be easily adapted to perform well with any of the aforementioned types of shoes and in all of the likely uses thereof, including those described above and contemplated herein.

[0007] The present invention meets these and other needs by enabling the wearer of the shoe to overcome shoe comfort issues with a minimum of complexity and without adding any significant costs to cost of shoe repair and sole replacement, or for the purchase of inserts having capabilities beyond those of currently available products. The various embodiments of the present invention disclosed herein are readily adapted for ease of tunability, reconfigurability, and user optimization, simplicity of manufacture, low producibility costs in view of the prior art, and immediate compatibility with most common types of shoe wear presently in use.

SUMMARY OF INVENTION

[0008] In its most general sense, the present invention contributes a significant and useful advance to the field of art of shoes, and more particularly to shoe soles, by offering a new and innovative shoe sole energy absorption capability. The device according to the instant invention greatly minimizes the stresses experienced during standing, walking, and running because the inventive device can be tailored to the unique requirements of every type foot movement and impact profile. Moreover, the individual user can reconfigure the shoe sole and heel energy storage device to easily and efficiently adapt the cushioning and resilient benefits of the device to over-pronating arches as well as high and otherwise nominal or abnormal arches.

[0009] One of the preferred embodiments of the invention is directed to an adjustable and tunable shoe sole and heel energy storage device. The device preferably includes, among other elements, upper and lower generally planar polymeric portions, which are joined by a releasable fastener assembly and arranged to confront one another. The polymeric portions are formed to incorporate corresponding post and recess retainers adapted to receive a plurality of energy absorbers that are reconfigurably captured in the respective retainer assemblies. The absorbers are selected to be capable of absorbing mechanical energy from surrounding structure(s), to store that energy as a potential energy, and to subsequently release the stored energy. The absorbers are also selected to be removable, stackable, and replaceable so that the energy storage device can be tuned to accommodate the various modes of use. This is accomplished by arranging the quantity and location of the energy absorbers relative to the post and recess retainers.

[0010] In variations of the preceding illustrative configuration, the upper and lower polymeric portions are preferably formed from a polymeric material, and more preferably from a thermoplastic material, and more preferably from a thermoplastic elastomer, and even more preferably from a polyester or similar materials, and or from combinations, alloys, blends, and mixtures thereof. The polymeric portions can be preferably joined by the releasable fastener assembly, which can further incorporate fasteners such as hook and loop fasteners, cooperating guide posts and recesses having a bayonet connection, screws, adhesives, and combinations thereof. In modifications of any of the preceding exemplary configurations, the retainer posts are formed in the upper polymeric portion from a material that is preferably of a greater hardness than that of the polymeric upper portion material.

[0011] The most desirable type of energy absorbers are selected for their capability to minimize energy losses while
they absorb, store, and release mechanical energy that can be experienced during ordinary use of shoes in the form of impact loads during regular standing, walking, and running situations. Preferably, the energy absorber is selected from the group including conical and coil springs, and even more preferably from the group that includes disc springs which can be flat, conical, finger, curved, wave, and belleville disc springs and washers, and combinations thereof. Most preferably, belleville type disc springs are selected because of their extremely low cross-sectional profile and adaptability to be combined into parallel and series stacking configurations, which are useful to adapt the energy storage device to a variety of loading conditions.

[0012] Also, other alternatives include the energy storage device being configured as either a shoe insert that can be placed within the shoe during use, or the device being sized as a replacement for a portion of shoe sole or heel. In this latter configuration, the energy storage device may be modified, for certain appropriate and desirable situations, to have the polymeric upper and lower portions permanently joined and sealed together, instead of being releasably fastened, after the absorbers are arranged and installed. Here, the energy storage device is then affixed to a shoe sole and or heel. In similar variations, the energy storage device may be permanently joined together and shaped and sized for use as an entire replacement shoe sole. This modification also lends itself to having a leather and or high-friction material such as rubber being affixed to the lower surface of the lower polymeric portion, which improves the grip against and traction upon the ground.

[0013] In yet other variations of the preceding configurations and modifications the lower polymeric portion of the energy storage device is molded as a portion of the insole of a shoe. Alternatively, the upper portion may be molded into or as the lower portion of the outsole of a shoe, wherein in the latter variation a high-friction material may be added to improve traction.

[0014] The preceding variations, modifications, and alterations of the various preferred embodiments may be used either alone or in combination with one another as will become more readily apparent to those with skill in the art with reference to the following detailed description of the preferred embodiments and the accompanying figures and drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0015] Without limiting the scope of the present invention as claimed below and referring now to the drawings and figures, wherein like reference numerals, and like numerals with primes, across the several drawings, figures, and views refer to identical, corresponding, or equivalent elements, features, and parts:

[0016] FIG. 1 is a side and partial section view, in reduced scale, of a shoe sole and heel energy storage device according to the principles of the present invention;

[0017] FIG. 2 is a side exploded view and partial section view, in reduced scale and with certain structure removed for clarity, of the device of FIG. 1;

[0018] FIG. 3 is a planform top view taken along section line 3-3 in FIG. 2, in reduced scale, of an element of the device of FIGS. 1 and 2;

[0019] FIG. 4 is a detail view, in enlarged scale, taken about detail view line 4-4 of FIG. 2, of a portion of the device of instant invention;

[0020] FIG. 5 is a detail view, in enlarged scale and with certain structure removed, taken about detail view line 4-4 of FIG. 2, of a variation of the device of FIG. 2;

[0021] FIG. 6 is a detail view taken about detail view line 6-6 of FIG. 2, in enlarged scale, of a portion of the device according to the present invention;

[0022] FIGS. 7 through 10 are detail views taken about detail view line 6-6 of FIG. 2, in enlarged scale, of alternative configurations of a portion of the device according to the present invention; and

[0023] FIG. 11 is a planform view of another modification to the device shown in FIG. 1 and according to the principles of the instant invention.

**DESCRIPTION OF THE PREFERRED EMBODIMENT**

[0024] The shoe sole and heel energy storage device according to the present invention evinces a marked advance in the state of the art of shoe cushioning and fatigue minimizing articles. Of particular note and in contrast to the prior art devices, the instant invention is remarkably well-suited for use with business attire and dress shoes, as well as with the more commonly addressed problems associated with recreational, athletic, medicinal, and other special purpose shoe wear. In light of the now possible reconfigurability offered by the instant invention, the wearer is not limited by the prior art device because the novel and heretofore unavailable device may be easily and continually optimized to maximize comfort and efficacy for ever-changing anatomical and situational requirements.

[0025] With reference now to the accompanying figures and specifically to FIGS. 1 through 5, an adjustable and tunable shoe sole and heel energy storage device 100 is described. The device 100 preferably includes, among other elements, confrontingally arranged upper and lower generally planar polymeric portions 110, 120, which are joined by a releasable fastener assembly 130. Preferably, the fastener assembly 130 includes one or more types of suitable fasteners, including, for purposes of example but not limitation, hook and loop fasteners, shown in schematic representation generally in FIG. 2 by reference numeral 135. In the alternative or in combination therewith, the fastener assembly 130 may also further include cooperating guide bayonets 140 and receivers 145. In this variation, those with skill in the art will appreciate that the guide bayonet and receiver fastener 140, 145 can be adapted to have a releasable bayonet-type connection that can be configured to form a secure joint, but which can be pulled apart upon application of sufficient removal forces so that the device 100 can be reconfigured. The variations of the fastener assembly 130 that include the corresponding and cooperating guide bayonets and receivers 140, 145 are thus configured to resist relative planar type motion between the upper and lower polymeric portions 110, 120, which thereby minimizes shear induced abrasion and wear thereof.

[0026] In yet other modifications of the preceding arrangements, screws, releasable adhesives, and combinations thereof (not shown) can be employed either alone or in
combination with the preceding items to accomplish the capability of the fastener assembly 130.

[0027] The polymeric portions 110, 120 are further preferably adapted with a post 150 and recess 160 retainer element that is adapted to receive a plurality of energy absorbers 170 that are reconfigurably captured in the respective retainer assemblies 150, 160. As can be understood with reference now also to FIGS. 6 through 10, the energy absorbers 170 can be arranged relative to the retainer assemblies 150, 160 whereby the retainer post 150 can be situated to transfer loads, or mechanical energy, from the wearer and the upper portion 110, to the energy absorber 170 and the lower polymeric portion 120. In alternative configurations discussed in more detail below, the energy absorber 170 may be formed with a donut-type recess sized to receive the post 150 therethrough about the central recess so that the loads are transferred directly from the upper polymeric portion 110 to the energy absorber 170. See, for example, FIGS. 6-10. In this configuration, the retainer posts 150, if selected to be of the same material as that of the upper polymeric portion 110, will operate to augment the energy storage capability of the absorbers 170. Moreover, the guide posts 150 will serve the additional function of generally centering the energy absorber 170 within the retainer recess 160.

[0028] In yet additional variations of any of the preceding arrangements of elements and features, and with reference also now specifically to FIG. 10, a guide post 110′ is shown that is compatible for use with disc-spring-type energy absorbers 170, which do not have a centrally disposed recess for receiving the guide post 150′. Instead, the load forces pass through the polymeric upper portion 110′, through the guide post 150′ and into the energy absorbers 170, which in FIG. 10 are shown in a stacked arrangement.

[0029] The absorbers 170 are selected to be removable, stackable, and replaceable so that the energy storage device 100 can be tuned to accommodate the various modes of use in business dress, casual, recreational, therapeutic, and medicinal, and athletic applications. The device 100 is “tuned” or reconfigurably customized and optimized for maximized efficacy and comfort during use based upon the physical parameters and requirements of the wearer. As is evident with continued reference to FIGS. 1, 2, and 6 through 10, the energy absorbers 170 may be stacked in various configuration for purposes of tuning the shoe sole and heel energy absorbing device 100 to best suit the needs of the wearer. With specific focus being centered on FIGS. 6 through 10 and in comparison with FIG. 9, those having skill in the art can understand that the disc-type spring energy absorbers 170 can be arranged singly and stacked in “series” (FIGS. 7, 8, & 10) and in “parallel” (FIG. 9). In the parallel arrangement of FIG. 9, somewhat analogous to the capacitor of the electrical arts, the range of motion of deflection of the energy absorber 170 will be affected as a linear function of the combined thicknesses, while the reactive load force, or energy storage capacity of the absorber 170 will be effectively summed. In contrast, the series arrangement of the energy absorbers illustrated in FIGS. 7, 8, and 10 describes a configuration wherein the range of motion of deflection will be the sum of the deflections of the individual disc-springs that together form the energy absorber 170. Unlike prior art type foam cushioning articles, the energy absorbers according to the instant invention provide far greater life span and durability. Whereas prior art devices using only foam padding for cushioning benefits must be replaced often due to collapse of the foam, the energy absorbers 170 contemplated and illustrated herein have an extremely high fatigue life and will provide benefits for far longer periods of time. Additionally, the elements of the present invention can be used in conjunction with many types of prior art devices, including foam-type cushioning articles, for an even greater benefit to the end user.

[0030] The instant invention embodied in device 100 is well suited for use with energy absorbers 170 that have the form of coil and conical springs (not shown). However, it has been found that for most applications involving business-type dress foot wear, it is more preferable that the energy absorbers 170 be selected from the group of devices known to those with skill in the mechanical arts as “disc springs.” Disc springs can absorb, store, and release substantial mechanical energy while being formed with drastically smaller dimensional envelopes in comparison to coil and conical springs. Such disc springs can also be employed, for purposes of the instant invention, in combination with the coil and or conical springs for various applications that may require specialized shoe wear load environments.

[0031] The more preferable disc-spring-type energy absorber 170 has many specific configurations that may be compatible for use in the device 100 of the instant invention. The most commonly available disc springs include, for purposes of illustration without limitation, flat, conical, finger, curved, wave, and belleville-type disc springs and washers, and combinations thereof. There are many readily available sources for such disc-spring-type energy absorbers 170. However, various types of specialized disc-spring energy absorbers are more preferable for use with the device 100 since the physical dimensions and constant, intermittent, and cyclic loading and deflection characteristics must be properly defined so that the tunable shoe sole and heel energy storage device 100 can be properly configured for the wearer. One exemplary vendor of such well-defined disc springs includes, for example without limitation, McMaster-Carr Supply Company of Aurora, Ohio, USA, and having an internet address at: www.mcmaster.com.

[0032] In modified forms of the preceding illustrative embodiments and configurations, the upper and lower polymeric portions 110, 120 are preferably formed from any of a number of highly durable, tear and flex fatigue resistant, and flexible polymeric materials. More preferably, polymeric portions 110, 120 are formed from a thermoplastic material, and even more preferably from an thermoplastic elastomer such as, for example without limitation, a durable and high-strength polyester, and even more preferably from Hytrel™, which is an engineered thermoplastic that is available from DuPont, of Wilmington, Del., USA, and having an internet address of www.dupont.com. Various alternatives of the upper and lower polymeric portions 110, 120 can include combinations, alloys, blends, and mixtures of any of the preceding polymeric materials and equivalents thereof.

[0033] Alternative configurations of the preceding embodiments may incorporate any of the preceding exemplary configurations, wherein the retainer posts 150 are incorporated into or molded in the upper polymeric portion 110 from a material that preferably has a hardness that is
greater than that of the material of the polymeric upper portion material 110. For example, the upper portion can be made from any of a number of suitable metals or high-density polymers or thermoplastics, and combinations, alloys, blends, and mixtures thereof. In this exemplary alternative arrangement, the retainer posts 150 may be made even more durable when subjected to interaction with the respective energy absorbers 170.

[0034] With reference now directed specifically to FIGS. 1 through 3 in contrast to FIG. 11, it can be further appreciated that the preceding embodiments, alternatives, modifications, and variations thereof can be implemented in a shoe sole and heel energy absorber device, such as device 100 as shown in the various figures, which is configured as a device adapted to be inserted into shoe wear after tuning or to be incorporated or even molded into a specially designed recess in the sole and heel thereof. Alternatively, a modified form of the shoe sole 100 and heel device 100', see FIG. 11, can be sized and shaped for purposes of replacement of a portion of the sole “S” of a shoe. This latter modification is especially well-suited for use with business attire dress shoes that are typically characterized by soles having a thickness that relatively thin in comparison to many types of therapeutic, medicinal, recreational, and athletic shoe wear. Thus, the instant invention, unlike the devices of the prior art, has brought the heretofore unavailable benefits of the low-profile or relatively thin shoe sole and heel energy absorber invention to a consumer market segment that had previously been without the means to incorporate such capability with the more preferable and attractive shoe wear styles. In the past, very few options existed for obtaining relief from various foot fatigue and other maladies. Now, with the benefit of the instant invention, any shoe can be equipped with the tunable energy absorber capabilities.

[0035] In operation, the tunable shoe sole and heel energy absorber device 100, 100', 100", may incorporate a homogenous or mixed arrangement of energy absorber device 170, 170', 170", in the post and recess assemblies 150, 160, 150', 160'. For example, assuming the wearer of the shoe weighed about 200 pounds, and that the appropriate shoe size was about an American male size 10 business attire dress shoe. The shoe sole can be about 0.25 inches thick and about 4 to 5 inches wide across the side-to-side lateral dimension. Assuming also that the wearer would not be using the shoes for anything other than ordinary walking and standing, then for purposes of illustration an attempt can be made to prepare a suitable tunable shoe sole and heel energy absorber device 100', 100". Given that the 200 pound individual would be moving about while wearing the shoes, an approximation can made wherein a static load is derived or inferred that is comparable to the dynamic load imparted to the shoe sole as each foot strikes the ground under the entire weight of the individual. In sum, we roughly approximate using standard statics and dynamics “rule of thumb” mathematical techniques that the comparable static load is about 300 pounds, which is a point load that is distributed about either the heel “H” or the ball “B” of the sole of shoe “S”. (FIG. 11) Therefore, we assume that the shoe sole and heel energy absorber device 100', 100" must absorb, store, and release this amount of force or mechanical energy.

[0036] Referring to the data contained in the internet-based McMaster-Carr Supply Company catalog described hereinabove, a wave-disc-spring-type energy absorbers 170 is selected for incorporation as the energy absorber, such as McMaster item #9714K24 as shown on about page 3319 of the catalog. The characteristics of the #9714K24 absorber 170 is that it has an undeformed height of 0.030 inches. Therefore, for a replacement sole portion, device 100" must have a height of about 0.25". Assuming that about 0.010 inches of material is need to encapsulate the energy absorbers 170' in the upper (not shown in FIG. 11) and lower polymeric portions 120", there is an envelope of about 0.23 inches available for forming the post and recess retainer, within which the energy absorber stack will be captured. Therefore, it follows that each such retainer recess can accommodate between about 7 and 8 stacked wave-disc-spring-type energy absorbers 170, if item #9714K24 is employed. From the McMaster catalog, it is known that the fully deflected force of each individual disc spring is about 4.7 pounds each, it follows that a stack of 8 such disc springs arranged in parallel will develop about 376 pounds of force. Since the maximum outer diameter of the selected example spring is listed in the catalog to be 0.37 inches, and since we have assumed a lateral shoe sole width of about 4 to 5 inches, it follows that about 8 or 9 spring stack energy absorbers can be accommodated across the lateral width of the device 100" when sized to the example shoe. It can thus be appreciated by those with skill in the art that a suitable, tunable shoe sole and heel energy absorber device 100", 100" can be devised for even the most relatively thin shoe sole. It also follows, therefore, that similar constructions can be devised for shoes having greater sole thicknesses and lateral widths, which is the case for various types of recreational, medicinal, therapeutic, and specialized types of shoes. Once the initial construction of the desired shoe is selected, the arrangement and spacing of post and recess retainers 150, 160 and the selection of energy absorbers 170 is accomplished and tabulated for the expected comparable static loads so that a tuning database can be created for each shoe type, whereby a preliminary optimization can be defined and then further refined base upon feedback from the wearer. This action can be undertaken over several iterations and would be especially beneficial for athletics enthusiasts seeking to obtain optimum performance from the footwear used during competition.

[0037] More specifically, as can be appreciated by those with skill in the art, a performance conscious athlete can use any of the preceding embodiments to improve capability in certain circumstances. For example, a runner can employ the tunable shoe sole energy absorber to maximize the benefit of the present invention over the course of various training and competitive events. After a training session, for purposes of illustration, the runner can reconfigure and adjust the location, quantity, and arrangement of the energy absorbers 170 about the post and recess retainers 150, 160 to increase or decrease the spring force exhibited by the device 100 at any point or region over the sole S. Also, business, casual, military, and or recreational users can employ the instant invention to maximize comfort by using variations and modifications to any of the preceding embodiments. With reference now also to FIG. 12, it can be understood that the instant invention can be incorporated in a portion 180 and positioned on the heel H and configured to project outward therefrom to provide additional benefits. For further illustration, one of the additional benefits would be the experience to the user of reduced impact load-induced fatigue to feet, ankles, and knees during extended use. This type of
fatigue would be especially pronounced in, for example without limitation, military users who are forced to wear generally unforgiving boots during extended running, marching, and hiking of challenging terrain. The protruding portion 180 modification may also be used about the “ball” of the foot region of the sole for similar benefits.

Numerous alterations, modifications, and variations of the preferred embodiments disclosed herein will be apparent to those skilled in the art and they are all contemplated to be within the spirit and scope of the instant invention. For example, although specific embodiments have been described in detail, those with skill in the art will understand that the preceding embodiments and variations can be modified to incorporate various types of substitute and/or additional materials, relative arrangement of elements, and dimensional configurations for compatibility with the wide variety of shoe wear and soles that are available in the marketplace. Accordingly, even though only few embodiments, alternatives, variations, and modifications of the present invention are described herein, it is to be understood that the practice of such additional modifications and variations and the equivalents thereof, are within the spirit and scope of the invention as defined in the following claims.

1 claim:

1. A tunable shoe sole and heel energy storage device, comprising:

- confronting upper and lower generally planar polymeric portions joined by a releasable fastener assembly;
- corresponding post and recess retainers formed in the polymeric portions;
- a plurality of removable, stackable, and replaceable energy absorbers reconfigurably captured in the retainer assemblies; and
- wherein the energy storage device is tunable by arranging the quantity and location of the energy absorbers about the post and recess retainers.

2. A tunable shoe sole and heel energy storage device according to claim 1, wherein the releasable fastener assembly includes fasteners selected from the group including hook and loop fasteners, cooperating guide posts and recesses, screws, adhesives, and combinations thereof.

3. A tunable shoe sole and heel energy storage device according to claim 1, wherein

the polymeric upper and lower portion material is selected from the group including polymeric materials, thermoplastics, elastomers, polyesters, and combinations, alloys, blends, and mixtures thereof.

4. A tunable shoe sole and heel energy storage device according to claim 1, wherein the retainer posts are formed from a material having a hardness greater than that of the polymeric upper portion material and that is selected from the group including metals and high-density polymers, and combinations, alloys, blends, and mixtures thereof.

5. A tunable shoe sole and heel energy storage device according to claim 1, wherein the energy absorber is selected from the group including conical and coil springs, disc springs further selected from the group including flat, conical, finger, curved, wave, and belleville disc springs and washers, and combinations, and parallel and series stacks thereof.

6. A tunable shoe sole and heel energy storage device according to claim 1, wherein the lower polymeric portion is integrally molded to be a portion of the insole of a shoe.

7. A tunable shoe sole and heel energy storage device according to claim 1, wherein the energy storage device is further configured to be an insert compatible for use within a shoe and to be arranged therein in a confronting relationship with the bottom surface of the foot of a wearer.

8. A tunable shoe sole and heel energy storage device, comprising:

- confronting upper and lower generally planar and permanently sealable polymeric portions;
- corresponding post and recess retainers formed in the polymeric portions;
- a plurality of stackable energy absorbers captured in the retainer assemblies and having a selected arrangement therein; and
- wherein the energy storage device is tunable by arranging the quantity and location of the energy absorbers about the post and recess retainers, and wherein the energy storage device is further adapted to replace a portion of a shoe selected from the group including a portion of the sole and the heel.

9. A tunable shoe sole and heel energy storage device according to claim 8, further comprising:

an outsole portion carried from the lower polymeric portion and being selected from the group including leather and polymeric high-friction materials and combinations and arrangements thereof.

10. A tunable shoe sole and heel energy storage device according to claim 8, wherein

the polymeric upper and lower portion material is selected from the group including polymeric materials, thermoplastics, elastomers, polyesters, and combinations, alloys, blends, and mixtures thereof.

11. A tunable shoe sole and heel energy storage device according to claim 8, wherein the retainer posts are formed from a material having a hardness greater than that of the polymeric upper portion material and that is selected from the group including metals and high-density polymers, and combinations, alloys, blends, and mixtures thereof.

12. A tunable shoe sole and heel energy storage device according to claim 8, wherein the energy absorber is selected from the group including conical and coil springs, disc springs further selected from the group including flat, conical, finger, curved, wave, and belleville disc springs and washers, and combinations, and parallel and series stacks thereof.

13. A tunable shoe sole and heel energy storage device according to claim 8, wherein the upper polymeric portion is integrally molded to be a portion of the insole of a shoe.

14. A tunable shoe sole and heel energy storage device, comprising:

- a removable, stackable, and replaceable means for storing mechanical energy;
- a means for releasably and reconfigurably retaining the energy storing means;
- a means for defining the retaining means with posts and recesses formed about respective means for providing confronting upper and lower polymeric portions;
a means for releasably fastening the polymeric portion providing means; and

wherein the energy storage device is tunable by arranging the quantity and location of the energy storing means.

15. A tunable shoe sole and heel energy storage device according to claim 14, wherein the releasably fastening means includes means for fastening selected from the group including hook and loop fasteners, cooperating guide posts and recesses, screws, adhesives, and combinations thereof.

16. A tunable shoe sole and heel energy storage device according to claim 14, wherein the means for providing polymeric portions material is selected from the group polymeric materials, thermoplastics, elastomers, polyesters, and combinations, alloys, blends, and mixtures thereof.

17. A tunable shoe sole and heel energy storage device according to claim 14, wherein the post defining means of the retainer means are formed from a material having a hardness greater than that of the polymeric upper portion material and that is selected from the group including metals and high-density polymers, and combinations, alloys, blends, and mixtures thereof.

18. A tunable shoe sole and heel energy storage device according to claim 14, wherein the means for storing energy is selected from the group including conical and coil springs, disc springs further selected from the group including flat, conical, finger, curved, wave, and belleville disc springs and washers, and combinations, and parallel and series stacks thereof.

19. A tunable shoe sole and heel energy storage device according to claim 1, wherein the means for providing a lower polymeric portion is integrally molded to be a portion of the insole of a shoe.

20. A tunable shoe sole and heel energy storage device according to claim 1, wherein the energy storage device is further configured to be an insert compatible for use within a shoe and to be arranged therein in a confronting relationship with the bottom surface of the foot of a wearer.

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