May 17, 1966 R. H. BECKMAN 3,251,077

SPRING ASSEMBLY

Filed March 3, 1964 2 Sheets-Sheet 1

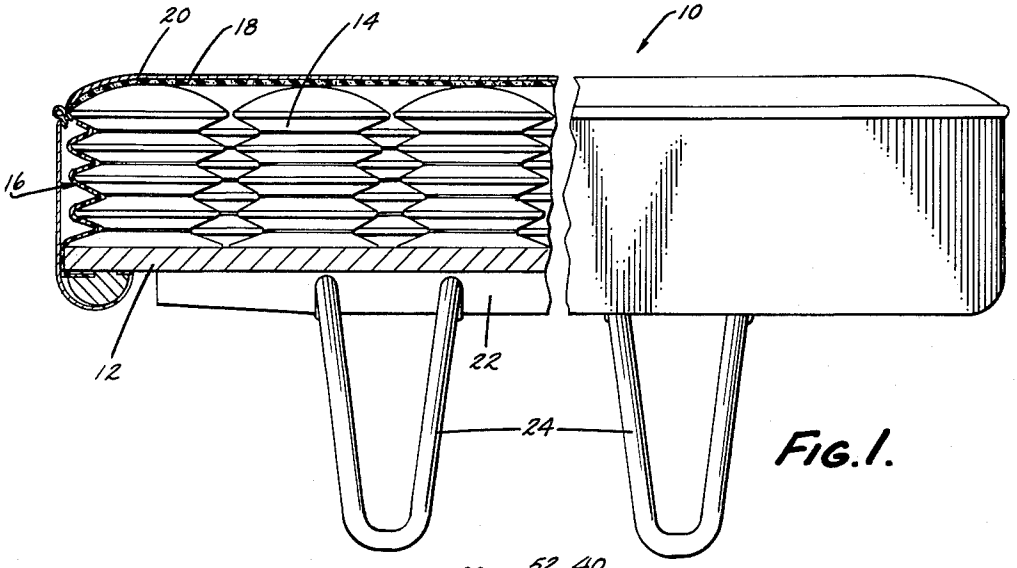


FIG. 1.

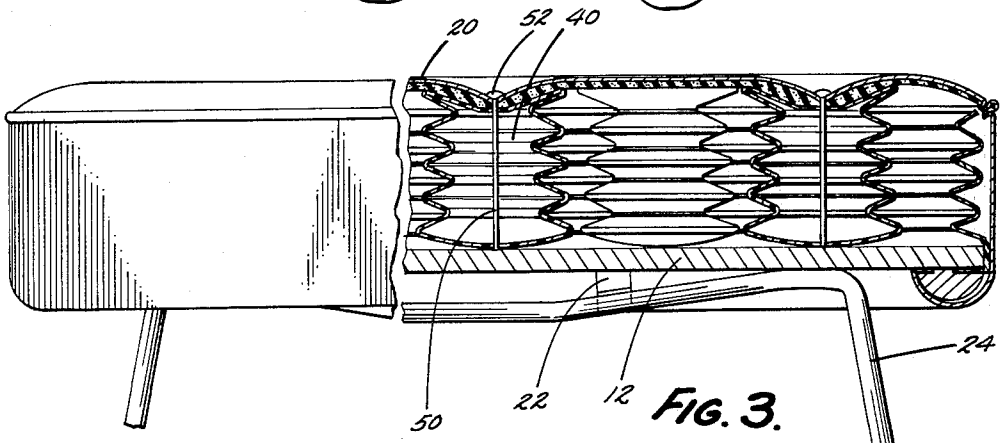


FIG. 3.

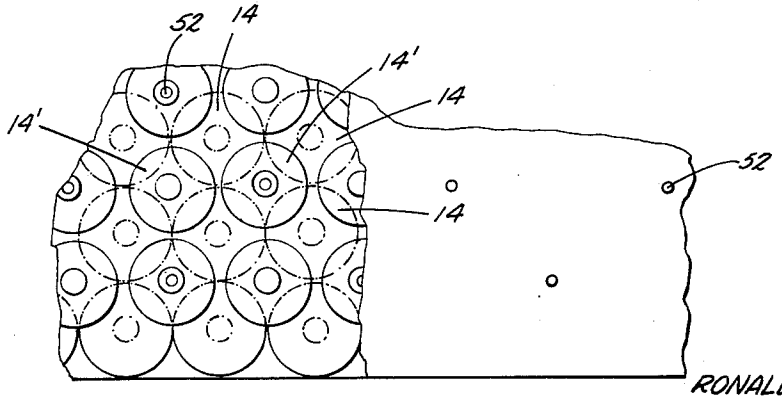


FIG. 2.

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May 17, 1966 R. H. BECKMAN 3,251,077

SPRING ASSEMBLY

Filed March 3, 1964 2 Sheets-Sheet 2

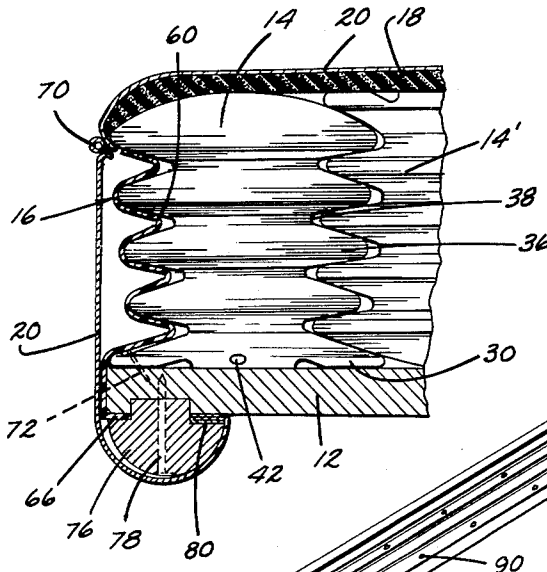


FIG. 4.

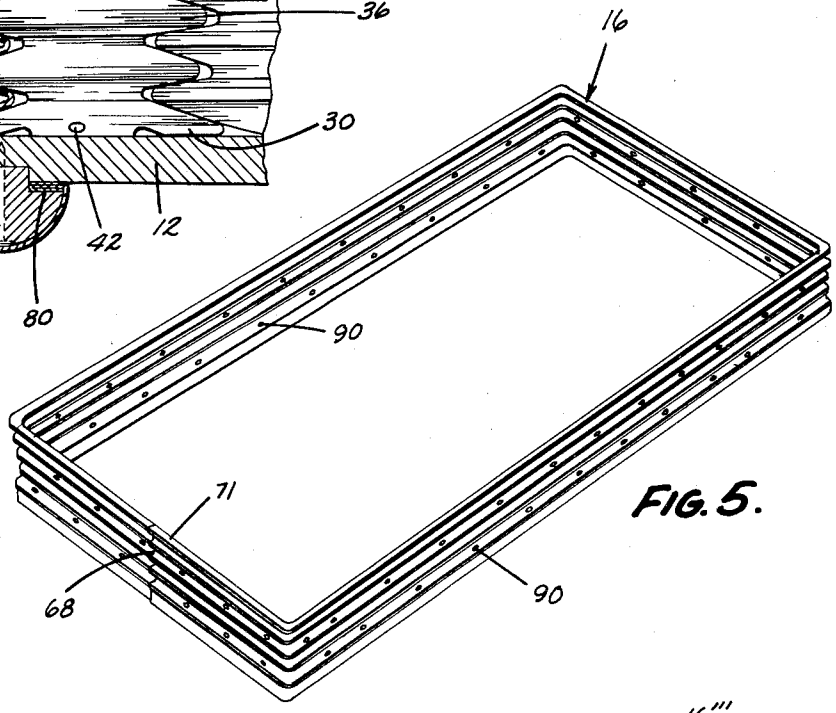


FIG. 5.

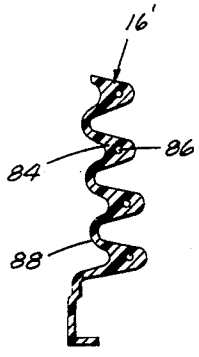


FIG. 6.

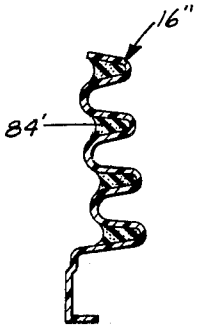


FIG. 7.

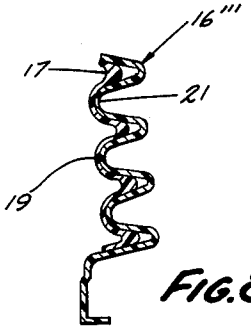


FIG. 8.

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3,251,077

SPRING ASSEMBLY

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Filed Mar. 3, 1964, Ser. No. 348,927
4 Claims. (Cl. 5—353)

This invention relates to a resilient load supporting assembly, and more particularly to a vented, bellows spring cushioning assembly, especially for furniture, mattresses, cushions, automotive and general transportation seating.

In quality furniture and mattresses, the edge of the article must provide firmness and support of the same or greater magnitude than the remainder of the article. In mattresses, this provides the person with a sense of security, since the edge does not "give" too readily. If the edge provides inadequate support, the marginal portion of the mattress will tend to assume a downward, outward slope allowing the person to roll off the mattress. If adequate support is built into this area, it serves as a retainer for the person. Seating furniture with this edge support prevents the sitter from sliding off the articles too readily, and supports the thighs of the sitter. At the same time the edge must not be hard and unyielding because this creates an area of rigidity and refusal which tends to interfere with circulation and creates discomfort.

In the manufacture of coil spring mattresses, great effort is expended in the form of hand labor to tie the edge springs to the other springs, and to reinforce the edge coil springs with heavier construction or reinforcing wires. The necessary hand labor and parts to achieve this feature are extensive and expensive. On many conventional structures, such as those formed of foam material, such edge support is not even possible.

Without edge firmness, if not initially downwardly sloped at the edges, the decorative cover sheet, pad and supporting spring structure progressively acquire an increasing degree of downward slope at the edges over a period of time. This edge sag is caused by permanent set and displacement of springs. The edge of a seat is subjected to more concentrated and more frequent body loads than the remainder of the seat. The edge is used no matter where a person sits on the seat. Sloping of the edge not only creates wrinkles and ridges in the cover pad and cover sheet, but also in the skirt around the cushion edge. The article thereby loses the aesthetic appeal created by sharp lines and neat contour, and acquires a tired, worn appearance, in addition to its ineffective physical support.

Incorporation of bellows springs into an assembled article does not eliminate the need for firm edge support without rigidity. Rather, the outermost bellows must not only be supplemented with vertical support, but also the periphery of the article of furniture must be bound into an integrated unity by the edge supporting means.

Another significant feature of quality furniture is that of zonal firmness variation over selected zones of each article. Those zones supporting the greatest load concentrations should provide increased resistance to deflection as contrasted to adjacent zones. Firmness variation of any extent in conventional resilient load supporting articles is possible with coil spring assemblies only after extensive hand labor to tie the springs together in complex fashion. Integration of the coil springs into an integral structure retaining the edge springs from bulging is achieved only with elaborate cross ties extending from side to side of the cushion. In medium and lower priced articles the cost of such special constructions is prohibitive.

Heretofore, no known structure was capable of achieving firm edge support and at the same time permitting

controlled zonal firmness variation in selected areas of the edge portions. The only truly firm edge support heretofore, has been characterized by excessive refusal or rigidity, thereby providing insufficient surface resiliency, not to mention controlled firmness variation.

There is a distinct difference between constructions which effect firm resistance to expected loads where the resistance arises from a stiff member characterized by high refusal closely adjacent the surface and those where the surface is relatively soft and the resistance is offered by the underlying fundamental structure of the unit. In the former, comfort is sacrificed because the structure creates an area of concentrated refusal to conform to body contours. In the latter, comfort is achieved because the soft, cushioning surface permits the limited surface conformity required for comfort. Yet stability and full support are provided because the underlying structure provides it. This invention provides the latter type of construction with the added feature that no area of resistance concentration can be detected. In other words, it telegraphs its presence. The structure effects a spreading of the area of resistance so that the transition from maximum to minimum support is gradual and the outline of contour of the area of high resistance cannot be defined by the user. If the basic substructure utilizes a rigid unyielding member to attain resistance, its presence or sharp outline cannot be concealed except by use of such depth of surface cushioning that its effectiveness is largely if not totally eliminated. Therefore, it is imperative that the basic substructure be itself characterized by yield and at least some degree of ability to conform to the contour of the load applied.

Therefore, an object of this invention is to provide a flexible load support, especially for furniture and mattresses, having a unique bellows spring construction, incorporating a relatively inexpensive, readily attached, edging reinforcing strip to supply optimum edge support qualities.

The strip forms a girdle band integrating the assembly into a cooperative unit. The edges of the support are firmed vertically with controlled firmness, but without uncomfortable rigidity. The edge portions of the article thereby do not sag prematurely. The outermost springs are safeguarded from excessive deflection under load. The outermost springs, moreover, are retained in cooperative relationship with adjacent springs, rather than bulging out of the assembly to form an ineffective and unsightly condition.

It is another object of this invention to provide a cooperative bellows springs assembly having edge support as well as controllable zonal firmness variation not only over the entire surface of the article, but also over the reinforced edge. Each article is imparted with custom-made qualities to suit particular pre-selected desired zonal characteristics, without edge rigidity. The edge band intermeshes with the bellows springs, causing the outermost springs to have comparable cushioning qualities to the remainder of the intermeshed springs. Thus, there is a smooth transition and blending of support qualities between the main body of the article and its edge. The bellows springs can be intermeshed to varying degrees to achieve complete and accurate control of article firmness. The reinforced edge can be as firm as the remainder of the article, or more so, merely by the simple attachment of one strip of plastic of controlled physical properties and intermeshed to a controlled depth with adjacent springs, to achieve top quality characteristics at low cost, and with ease of construction. The strip can be fabricated of known materials by known rapid methods, in a continuous manner. The springs need not be tied together. Only a portion of the springs need be secured to

the support panel. The entire assembly has the simplest of attachment features, adaptable to mass production with a minimum of hand labor, yet providing tailor-made qualities to suit the ultimate use.

These and several other objects of this invention will be apparent upon studying the following specification in conjunction with the drawings, in which:

FIG. 1 is a fragmentary, side elevational partially sectioned view of an article of furniture incorporating one form of this invention;

FIG. 2 is a fragmentary, plan view of the article illustrated in FIG. 1;

FIG. 3 is an end elevational, partially sectioned view of the article illustrated in FIG. 1;

FIG. 4 is an enlarged fragmentary, sectional side elevational view of a portion of the article illustrated in FIGS. 1 through 3;

FIG. 5 is a perspective view of the novel edge reinforcing and retaining strip around the assembly in FIGS. 1 through 4;

FIG. 6 is a fragmentary enlarged sectional view of a second form of the edge strip or band;

FIG. 7 is a fragmentary, enlarged, sectional view of a third form of the edge band; and

FIG. 8 is a fragmentary enlarged sectional view of a fourth form of the girdle band.

Basically, the load support device comprises a support surface or panel, a plurality of vented resilient bellows springs secured in a pattern on the panel, preferably intermeshed, to create a multiple cushioning effect, a peripheral edge reinforcing band having undulations intermeshed with the outermost bellows springs to effect vertical edge support, and serving as a spring retainer, and a flexible cover sheet and pad, enveloping the springs and reinforcing means, with the sheet being secured to the panel.

Referring specifically to the drawings, the novel load support assembly **10** is there shown in the form of an article of furniture. The inventive portion includes a support panel or surface **12**, a plurality of vented bellows springs **14** and an undulated edge support strip **16** intermeshed with the peripheral edges of the outermost bellows springs. It also includes an overlying pad **18**, preferably of foam material, and a cover sheet **20** enveloping the assembly.

The assembled structure is mounted on a suitable base including platform supports **22** and legs **24**, when used as furniture. Whether or not a base is used, and the choice of a particular base construction and/or style will depend upon the use of the article, and its surroundings. This particular base shown is only for illustrative purposes.

The panel **12**, if unsupported, is designed to be rigid. Suitable materials are plywood, heavy steel mesh similar to that used to sort gravel, criss-crossed slats, a plastic laminate board, or many others. If the panel is supported at spaced locations, its rigidity may be less, provided it has sufficient rigidity when supported to preserve the conformation of the article.

The springs can be attached to the support surface by many various types of attachment means. One possibility is the tufted construction with tension ties and tufting buttons illustrated in FIG. 3.

Each of the vented bellows springs is preferably slightly tapered from one end to the other, i.e. the outer diameter of each bellow is slightly smaller than that of the adjacent bellow, except, in some instances, the lowermost bellow (FIG. 4). The larger diameter end of the spring includes a dome or convex configuration. The opposite end of the spring has an opening in its central portion. The larger lowermost bellows **30** provides a generally continuous surface and an excellent engagement between upright bellows **14** and adjacent intermeshed inverted bellows **14**. These inverted bellows **14** (FIG. 3) are arranged in a pattern with the upright bellows so that each inverted bellows **14** is surrounded and intermeshed with four upright bellows **14** (FIG. 2), and each upright bellows **14** is surrounded by and intermeshed with four inverted bellows.

Each bellows springs consists of a series of stacked, inter-connected, individual bellows **36**. Each bellow **36** (FIG. 4) is composed of two outwardly converging legs having an arcuate outer juncture forming a hinge. The hinge is biased to a partially open attitude with an angle between the legs preferably greater than 50°. These legs may be forced toward each other by a load force on the bellows springs, causing the hinge angle to decrease temporarily. Total deflection is chiefly dependent, therefore, upon the number of bellows in the spring, and the angle of separation of the bellows legs.

Each bellows is integrally connected with the two adjacent bellows at the radially inner extremities of the legs to form inner junctures **38**. The diameter of each inner juncture is the root diameter of that portion of the spring, while the diameter of the outer juncture is the main diameter of that spring portion.

The bellows collectively form a hollow interior chamber **40**. This chamber is freely vented to the atmosphere externally of the spring by suitable vents **42**, for example, in the lower bellows. The vents, however, may be located elsewhere in the spring as may be found to be expedient. This venting is important in order to prevent significant pneumatic interference with the controlled hinging wall action of the resilient bellows. This control is achieved during fabrication of the springs.

While each of the bellows springs is shown to be generally circular in configuration, i.e. a tapered column, each can conceivably be of polygonal cross sectional configuration also. Further, each spring does not have to be tapered like that shown.

The bellows springs are preferably blow-molded from a resilient polymer such as a thermo-plastic material having resilience and memory sufficient to be compressed and to re-expand repeatedly to its orginally configuration and size without significant permanent set. The material should also be adapted to forming by a blow-molding process since this process effects a superior spring. A preferred material is a low density polyethylene. Other olefins such as polymers of ethylene ethylacrylate mixtures or a mixture of propylene and polyisobutylene, and other like materials could be used.

The blow-molding process of spring formation is preferred due to the relatively low cost of the dies, and the rapidity and accuracy of the process in reproducing identical springs. Blow-molding gives desirable physical characteristics to the springs as the plastic is forced radially outwardly into the dies. The blow-molding creates a thicker wall adjacent the inner junctions and a relatively thinner wall at the outer juncture hinges due to the characteristic of blow-molded articles to decrease in wall thickness with increasing radial distance from the central parison being blown. Consequently, the hinges at the outer junctures essentially comprise a series of flexible, cooperative, peripheral, spaced resilient supports.

The slightly tapered configuration has been found to be advantageous to obtain optimum intermeshing of the bellows between inverted and upright springs, and to obtain maximum compression displacement for the spring height and number of bellows. The taper should not be too great since the bottom of the spring then becomes too small, causing the spring to become top-heavy. The stability of the structure would also be lessened.

The thicker walled inner junctures constitute the most rigid portion of the bellows construction. Therefore, when each spring is compressed singly, the inner junctures flex only after the outer junctures have flexed considerably. This creates a unique double-action, since the initial compression or partial deflection of the spring is "soft," and occurs readily under a relatively light load, with flexure of the outer, thin, arcuate hinges. This is followed by a second partial depression, due to flexure

about the inner junctures, but only under a substantially greater load.

More specifically, if each tapered spring is compressed individually, the largest diameter juncture i.e., the uppermost hinge is the first to react. This is because the wall thickness of the hinge is the least on this bellow. After this uppermost bellow is deflected a small amount, resistance to further deflection becomes equal to the initial resistance to deflection of the adjacent bellow. Then, the next or second largest bellow begins to compress until its resistance increases to equal that of the third bellow. This sequential compression continues down to the smallest bellow which has the thickest outer juncture. Thereafter, the spring begins to compress about the inner junctures which are substantially thicker and, therefore, offer greater resistance. The area about the largest diameter inner juncture begins to compress first and this sequential action continues down to the juncture of smallest diameter. As a concrete illustration, springs of the novel construction, mounted on a panel to form a mattress, but not intermeshed, would readily compress the initial amount under the weight of a body. Then localized springs would be compressed under "bony" parts of the body such as a hip, but with substantially greater resistance to deflection. This effect creates good comfort, yet without abrupt bottoming. This double-action is reduced considerably between intermeshed springs due to a normalizing effect to be discussed hereinafter, but is believed to be present even then to some extent depending upon the degree of intermeshing, to provide optimum comfort when balanced with other characteristics. It will be noted that when the springs are not intermeshed, each spring acts singly except for load distribution by the cover sheet.

In use, when a load is applied to a focal point anywhere on the flexible cover sheet of the resilient load supporting device **10**, the load is distributed over several of the bellows springs. If the novel springs are not intermeshed, distribution must take place solely due to flexing of the non-stretching cover sheet. However, the springs are preferably intermeshed due to the unique interaction resulting. When so intermeshed, the forces created by a load are actually transmitted laterally between springs in an area, i.e. radially out from the area of concentrated load application. This interaction causes the major load distribution. This will occur even in the absence of any load distributing effect of the flexible covering sheet. A relatively small zone of reaction is involved, compared to conventional coil spring structures. Yet the zone is sufficiently large to prevent discomfort caused by concentrated resistance to depression, or caused by abrupt bottoming. This zone of reaction assumes the form of a gradually varying concavity since the springs being deflected or compressed, deflect and tip adjacent springs lesser and lesser amounts to provide optimum form fitting and cushioning characteristics. The degree of reaction is graduated outwardly in all directions from the focal point of the load. As the springs are compressed, the air in the chambers is vented freely through openings in the springs, and in the panel if necessary. The important thing is that there is insignificant pneumatic resistance to interfere with the controlled cushioning effect obtained by the flexing of the hinge arc and intermeshed bellows.

Experimentation with the intermeshed springs has shown the surprising result that the total support capacity of a plurality of the springs is far greater than the expected additive support capacity of the individual springs. Upon closer study of the novel assembly, it was determined that the total resilient support effect is due to at least three individual effects.

The first effect involves the expected cumulative resistance to deflection of the several springs due to individual hinge resistance to flexing under load. The second effect involves the frictional resistance between bellows of adjacent springs as they extend radially outwardly with compression and slide together. The third effect, and perhaps the most important, is caused by an interference fit between the springs, and involves the necessity of the compressed bellows, and especially the arcuate outer ends, to bulge radially outwardly into the adjacent grooves, in spite of their increasing resistance to this action as the springs are squeezed further together, causing the free arcuate ends to constantly decrease in size. Each of these resistance forces increases markedly with each increment of further compression. All of these factors cooperate to achieve the final result. Consequently, an explanation of each factor, taken separately, is really incomplete. This is especially true with respect to the second and third factors which are closely interrelated. However, for purposes of providing a detailed explanation, each will be described briefly.

Regarding the first factor, as any one or a few springs are compressed under a concentrated load, the compressed bellows immediately contact and depress adjacent springs. Since each spring can tilt somewhat, as one side is depressed by another spring, the opposite side will only partially depress as the spring tilt occurs. The next spring will tilt also and be depressed a lesser amount. This continues until the effect is dissipated over the zone of reaction. Of course, the cover sheet also causes partial distribution of the load.

Since the legs of each bellow engage the legs of two straddling bellows of each adjacent spring, and since axial compression of a spring causes radial expansion, these legs must slide over one another during compression, producing the second effect above. The frictional drag resulting causes total deflection to be less than would normally be expected from the additive effect of the springs since total resistance to deflection is greater. Moreover, after partial compression and deflection has occurred, further deflection requires an increasingly greater force because the pressure between the rubbing, sliding legs becomes even greater, causing the frictional resistance to sliding to be greater. This increasing resistance factor occurs over the total deflection of the spring.

The third interference fit reaction mentioned above still further increases this changing resistance to deflection due to the steadily decreasing portion of the outer juncture arcuate hinge remaining free to bulge into the cooperative groove of the adjacent spring. More specifically, as the outer arcuate hinge moves radially outwardly from the position shown in phantom when the spring is expanded, to the position shown in solid where the spring is partially compressed, the free arc length or size has decreased substantially. This decrease continues as each bellows is squashed, and must bulge into smaller and smaller sections of the groove. The resistance to further radial expansion therefore increases markedly requiring greater axial load to achieve another increment of spring deflection. This important effect supplements the two effects previously noted, to provide a spring with optimum qualities, with initial deflection occurring readily, and with each additional increment of deflection requiring a greater-than-proportionate force. Hence, the multiple action effect occurs.

The three effects taken together cause the several individual untied springs to react in a unitary fashion, with dissipation of the applied force occurring laterally, radially outwardly from the point of concentration. The lateral force distribution moreover occurs between all levels of adjacent springs, rather than just across the tops of the springs.

The amount of the double-action, referred to with respect to the compression of each spring, that remains in the intermeshed assembly, depends upon the degree of intermeshing. If the bellows are only slightly overlapping, a significant double-action effect remains, with the outer junctures deflecting first, and the inner junctures deflecting significantly only after substantial spring compression.

With full intermeshing, however, the thinner, highly flexible, outer junctures are adjacent the thicker, slightly flexible, inner junctures of adjacent springs so that flexing of the outer junctures tends to force some flexing about the inner junctures, producing an over-all normalizing effect. This further integrates the individual springs into a cooperative whole with substantially different, and highly advantageous characteristics.

The degree to which the springs are intermeshed controls not only the amount of compression which can occur before interaction is effective, but the degree to which interaction is effective in restraining the action of the individual spring. Thus, by the simple expedient of varying the degree of intermesh, the effective resistance of the assembly to a given load can be varied as required. This can be done throughout an entire assembly or it can be varied in selected zones to produce an almost endless pattern of load resistance variation. Thus, in a single assembly the resistance can be varied from that characteristic of springs acting as individual components which bottom relatively quickly to areas where the springs are so tightly intermeshed that compression is effectively limited to only a small portion of the total axial length of the spring. It will be understood that such variations are readily incorporated in the assembly without costly tooling, manual labor or significant increase in material costs. An article of furniture can be assembled with greater resistance to deflection in zones of weight concentration, and lesser resistance to deflection in varying degrees in other zones.

The cushioning effect or resistance to compression of each zone can be varied in another way, that is, by inserting springs of different wall thickness. This thickness is varied by altering the amount of material in the unblown parison introduced into the mold cavity, by varying the parison wall thickness or the parison diameter, or both.

The tapered configuration also prevents the thicker inner junctures from piling up one upon another to unnecessarily limit maximum compression. In the tapered structure, these inner junctures are slightly radially displaced from each other to prevent their premature accumulation upon compression of the spring.

If it is desired to form a tufted surface on the article, tension ties **50** having tufting buttons **52** engaging cover sheet **20** may be extended through the inverted hollow springs **14'**. The ends of the tension ties are suitably anchored to panel **12** by suitable means such as staples. These ties may be used simply for decorative purposes, or they may be used to place the bellows under a slight compressive load. By accurately controlling the length of the ties, they may be used to establish a pre-determined thickness for the assembly, and to maintain a tight fit between the pad and cover and the springs.

The degree or depth of intermeshing may be widely varied in selected zones of the article. This is dictated by the spacing of the springs. Since this directly and significantly alters the multiple cushioning effect, accurate control of the cushioning firmness of different zones readily can be achieved. Since the resistance to flexing of the individual spring is proportional to the cube of the wall thickness, variation and control of the article's firmness can also be obtained by use of springs of different wall thicknesses in selected areas. Substantial and accurate control of the wall thickness of the springs can be effected when using the blow-molding process. The variations possible using the combination are almost endless. Thus, wider spacing plus springs of thinner wall used in a particular zone of an article can be made to produce an extremely soft cushioning effect. Close spacing combined with thick walled springs can be made to produce a zone of great firmness. These wide variations in resistance or yield characteristics can be readily and economically provided in the same article. For example, the use of tight intermeshing and thick walled springs along the edge margins of a mattress or cushion can give the desired degree of firmness to provide comfort without creating a sharply defined area of rigidity characterized by lack of yield.

Wrapped around the periphery of the article, and more specifically around the exposed side of the outermost springs, is an edge reinforcing and spring retention strip **16**. This plastic girdle band may conceivably be extruded, molded, die or vacuum formed on a continuous basis into a configuration having elongated undulations **60**. These undulations **60** are spaced to seat into or intermesh with grooves of the springs between adjacent bellows. The strip may be formed of any of several suitable materials, such as a vinyl polymer, a polymer of ethylene, or others. The band should have considerable firmness of controlled amount, transversely of its longitudinal dimension, to provide vertical cushion edge support with resistance to compression equal to or greater than other portions of the cushions. This is especially important in the intermeshed bellows springs construction since the outer edges of the outermost springs are not intermeshed, and therefore will otherwise offer far less vertical support. The springs would not only compress too readily on the outer edge, but would also tend to tilt outwardly because of lack of lateral support. This produces instability along the marginal portions of the article. This would therefore create a feeling of insecurity to one lying near the edge of a mattress. Also, in seating cushions, thigh support would be insufficient and may even give the user the uncomfortable feeling of being tipped off the article. This increase in resilient firmness along the edge is determined by the physical characteristics of the material selected, by the thickness of the material, by the amount and nature of supplemental filling in the outwardly facing grooves between the inwardly directed undulations **60**, and by the degree of intermesh of the band with adjacent springs.

The lower edge **66** of strip **16** is preformed to wrap about and under the peripheral edge of panel **12** and to be secured in place by any suitable means, such as by the molding strip **76**. The lower skirt of the band may pass under or over the molding strip. If it is passed over the strip, the use of strip **76** serves to eliminate any sharp bend in the material which might become a source of structural weakness. It also serves a decorative purpose by giving an appearance of fullness to the edge structure when no cover sheet is used. It also helps to conceal the purely mechanical structures beneath the platform **12**.

It should be noted that this reinforcing band not only provides vertical support to the edge, but also retains all of the springs in cooperative intermeshed relationship and prevents displacement or protrusion of any springs out of the article by tilting or cocking. By so doing, it binds and integrates the springs and panel into a cooperative assembly. It therefore serves at least a dual function.

The plastic strip is preferably formed as a continuous ribbon and later severed into sections of lengths to encompass the articles concerned. The band may be attached by wrapping it around the springs and securing the abutting ends **68** and **71** together by plastic fusion, bonding or other equivalent means. To anchor the outermost springs (as in FIG. 4) while wrapping the strip around, suitable staples **72** can be used to tack the bottom bellows **30** of the springs to panel **12**. It will be recognized that when ties **50** are not used, all or selected ones of the springs may be secured to platform **12** by staples **72**. Other equivalent means may be employed for this purpose, such as bonding.

The girdle band ordinarily includes vents **90** to allow smooth exit and entrance of air between the springs (FIG. 5). This is especially important when cover sheet **20** includes a side skirt as shown, since trapped air between the springs as well as in them, would cause pneumatic interference with the mechanical spring action. The skirt of the cover sheet should also be vented.

In addition, or alternatively, panel **21** may include vents to accommodate exhaust of air from between the springs as well as in them. The venting action should be downwardly and/or sideways, and not upwardly, for obvious reasons.

Enveloping the springs, the reinforcing strip, and the edges of panel **21** is a decorative covering sheet **20**, of fabric, plastic or other flexible material having a conventional bead construction **70**. This cover sheet or laminate can be widely varied to suit the situation. Both the edge **66** of band **16** and the edge of cloth cover **20** may be secured beneath the panel by the molding strip **76**. This strip may be interfitted in a groove in the bottom of panel **12** and secured thereto by suitable means such as nails **78**. The opposite side edges secures the plastic and cloth edges to the panel to retain them securely. Since the band **16** is preformed with the lower edge having an L configuration, there is no tendency for it to pull free of the molding strip. The cloth edge is provided with a conventional U-shaped clip edge **80** to prevent the cloth from gradually pulling free of the molding strip.

The girdle band **16** may be modified in several ways for reasons of aesthetics or performance. For example, as illustrated in FIG. 6, the outer elongated concavities of band **16'** can be filled with fillets **84**. These are preferably formed integrally with the strip and may include elongated shrink cavities **86** according to conventional molding techniques. The band would then be compressed vertically only by hinging action around the outer extremities **88**. Its firmness, i.e. resistance to compression would be greater than the form in FIG. 1. Also, its maximum compressibility would be less since the accumulation of fillets, one upon the other, would limit compression. A girdle band such as band in FIG. 6 could also comprise a decorative dress for the edge of the article, thereby eliminating the need for a fabric cover skirt. Upon maximum compression of strip **16'**, further pressure would result in no further "give."

With strip **16''** in FIG. 7, however, the foam fillets **84'** in the outer concavities allow limited compression of the strip even after pressure has caused abuttment between the undulations. The foam material would compress to a limited degree even while the initial compression of the strip is occurring under load. This band should be covered with a dress skirt since foam normally is not too attractive.

In FIG. 8 is another form of strip **16'''**. The basic portion of this strip is the same as that in FIG. 1, but is covered by a reinforcing and dress layer **17**. Layer **17**, of a resilient material such as plastic which is compatible to strip **16'''**, has bulges protruding partially into the outer concavities of the strip, and intermediate webs **19** bonded or adhered to the outer convexities **21**. The cooperative action therebetween under a compressive load creates a variable intermeshing effect with increasing resistance to further compression, similar to that between bellows of adjacent intermeshed springs.

Other variations of the band configuration are also possible. This provides exact control over firmness and maximum compression. The inner undulations formed by the convexities and adjacent grooves or concavities in all of these various forms of the girdle band are adapted to intermesh with the bellows and grooves of the outermost bellows springs. This both retains the springs in a cooperative relationship with each other and integrates the band into the assembly, so that the edge firmness is not rigid, but a continuation of the controlled zonal firmness of the remainder of the article.

Assembly

In the manufacture of the novel assembly, the bellows springs are mass-produced by blow-molding from a thermo-plastic material. During fabrication, the wall thickness is controlled by the quantitiy of plastic introduced into the die cavity. This is done by control of parison wall thickness and diameter. They are then arranged in a pattern on panel **12** as illustrated in FIG. 2. Each upright bellows spring is surrounded by four inverted springs, and vice-versa. The edge springs are secured by staples **72**. If the tufting ties **50** are not employed, some or all of the other springs are similarly secured. The peripheral retention and edge support strip **16** is then wrapped around the springs with its undulations placed into intermeshing engagement with the grooves between the bellows of the outermost springs. The ends of the reinforcing strip are secured together to form a band that integrates the assembly. The lower edge **66** of the band **16** is seated about the panel to anchor it.

The cover **20** with its bead construction **70** is then placed over and around the springs and edge reinforcer. The foam pad **18** may be bonded to the back of cover **20** or may be applied independently thereof. Molding strips **76** are then loosely nailed to the bottom of the panel. The edge of the cover, with clamp **80** in place, is then wrapped around the bottom of the panel and underneath the inner edge of molding strip **76**. The strip is then nailed tightly against panel **12** to secure the assembly. The tufting is then applied, including buttons **52** and ties **50**, with the latter being stapled on their lower ends to panel **12**.

The foam pad **18** may vary in thickness e.g. from one-half to two inches. It eliminates "feel" of the springs by the person, and also prevents visible "telescoping" of spring configuration to the decorative surface in an unsightly manner. Conceivably, the foam pad may be bonded directly to the springs to anchor it. The cover sheet then need only overlie the foam pad, allowing the edge band **16** to serve as dress for the sides.

If the support is to be made into an article of furniture, a base such as legs **24** and base frame **22** is attached by any suitable means. If the structure is to be used as a mattress on a conventional bed frame, then no additional base frame is required unless the platform **12** is not rigid. Dimensions, including length, width and thickness will differ to suit various purposes.

It will be realized that, during use, when a load is applied at a focal point to compress the bellows springs, hollow chambers **40** are exhausted freely to the atmosphere, so that the hinging structure of the walls and the sliding effect between interfitted bellows serve as the sole support means for the load. As indicated previously, the intermeshing of the springs may be deep or shallow to vary the firmness or cushioning effect desired. The cover sheet and foam pad also serve to distribute the load in a graduated manner from the focus of load application through a transition zone of reaction. The zone of reaction involves several springs, and yet, is relatively limited because the springs are not literally tied together. The size of the zone of reaction is much smaller, for example, than that of a conventional coil spring assembly where the coils are all tied together by wires, etc. The vented bellows springs are, therefore, more responsive to conform to the shape of the person. The zone of reaction is transitional in nature in all directions away from the focus of the load. Certain of the springs can tilt slightly as needed to conform to the shape assumed by the cover sheet and foam pad under the load. The edge strip prevents distortion or tilting of the edges. It also adds vertical edge support. It will be readily seen that the structure is simple for the beneficial results achieved. The assembly requires little hand labor. All parts are durable and can be formed of materials having long life. In effect, each article formed is the equivalent of a custom-made item specifically tailored for its ultimate use, while still being a low-cost, mass-produced item. The commercial potential of the invention is, therefore, truly remarkable.

In addition to the possibilities of variation mentioned specifically above, additional minor variations and modifications will readily occur to those in the art upon studying the principles taught in the foregoing disclosure. These obvious modifications are deemed to be part of this invention, which is to be limited only by the scope of the appended claims and the reasonably equivalent structures to those defined herein.

I claim:

1. A resilient load supporting device comprising: a plurality of vented resilient bellows springs secured in a pattern; said springs being enveloped within flexible enclosure means; an undulated polymeric band girdling the pattern of springs, and intermeshed with the bellows of the outermost springs to provide edge support and peripheral spring retention, said band being compressible under load but having resistance to compression to effectuate edge firmness to the device.

2. A resilient load supporting device comprising: a support panel; a plurality of vented, resilient bellows springs secured on said panel; each of said springs having several bellows; the bellows of said springs being intermeshed with each other to create a multiple cushioning effect therebetween; and a resilient reinforcing strip means around the periphery of the device, having several elongated undulations intermeshed with the bellows of the outermost springs to provide resilient vertical edge support of the device, and to hold said springs in intermeshed relationship with each other and with said strip.

3. The device in claim 2 wherein said strip means is attached to said panel; a foam pad overlies the ends of said springs opposite said panel; and a flexible cover sheet envelopes said pad and springs.

4. An article of furniture, comprising: a panel supported on a base; a plurality of vented resilient bellows springs secured in position on said panel; said springs being generally tapered from one end; a portion of said springs being inverted; each of said springs having several bellows, with those of said inverted springs being intermeshed with the bellows of the upright springs to create a multiple cushioning effect; and elongated polymeric girdle band extending around the periphery of said article and having several undulations protruding inwardly of said article in intermeshing engagement with the bellows of the outermost springs for vertical edge support and for spring retention; said band being compressible under load but having resistance to compression to effectuate edge firmness to the device; and flexible cover means enveloping said springs and band.

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