July 9, 1968 S. P. CRANE ETAL 3,391,413

SPACER SHEET AND CUSHION

Filed March 4, 1965 2 Sheets-Sheet 1

Fig. 1

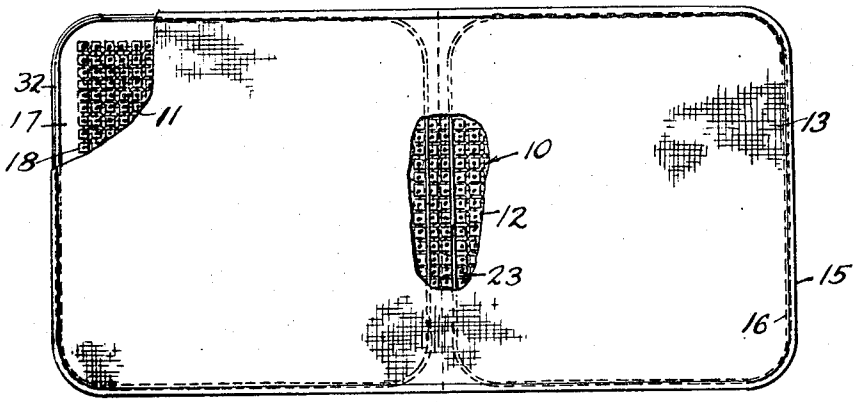


Fig. 2

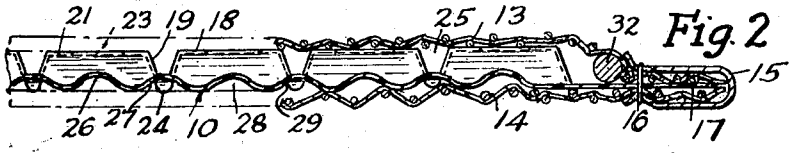


Fig. 3

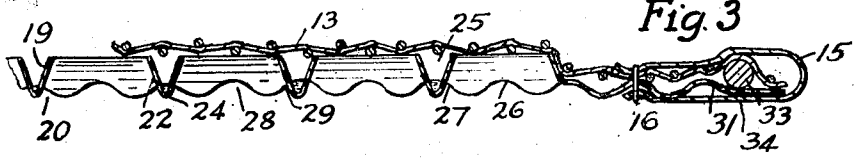


Fig. 4

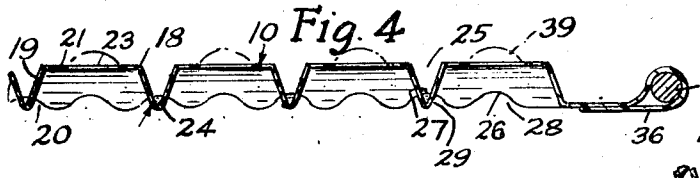


Fig. 6

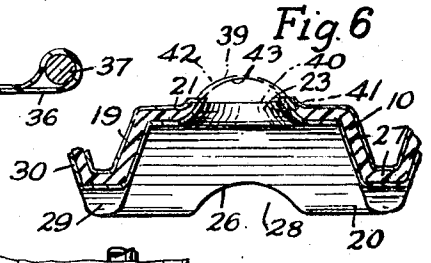
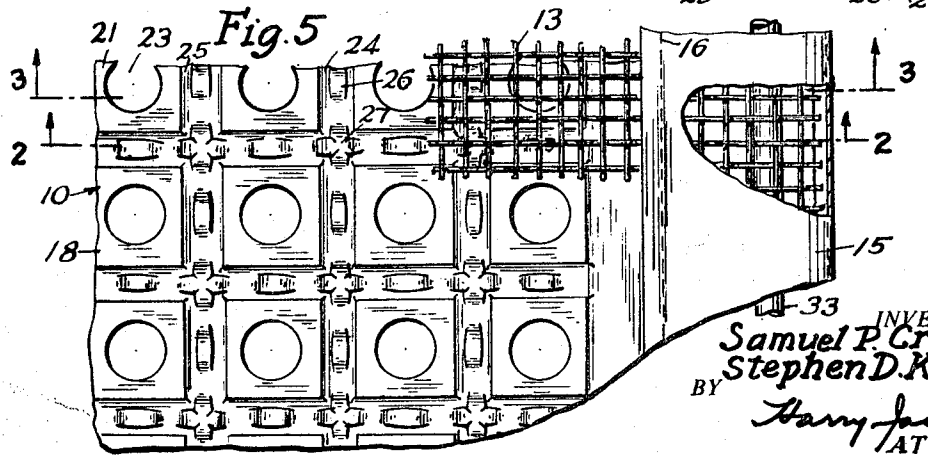


Fig. 5



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SPACER SHEET AND CUSHION

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Fig. 7

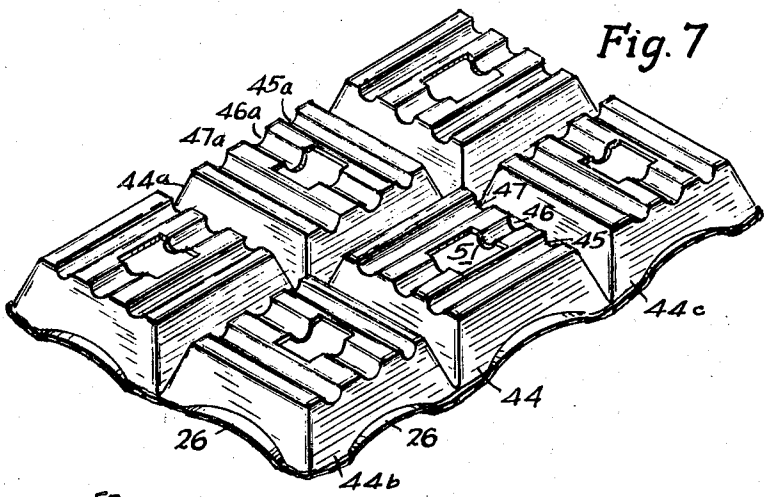


Fig. 8

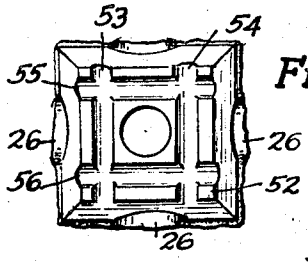


Fig. 9

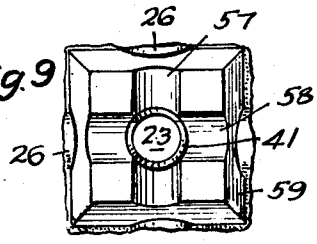


Fig. 10

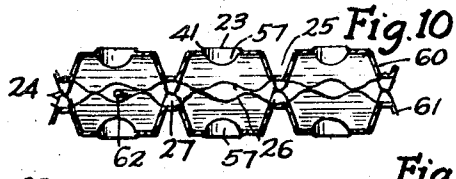


Fig. 11

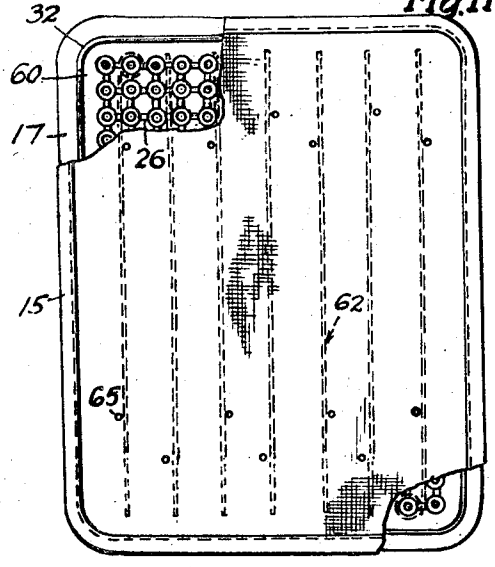
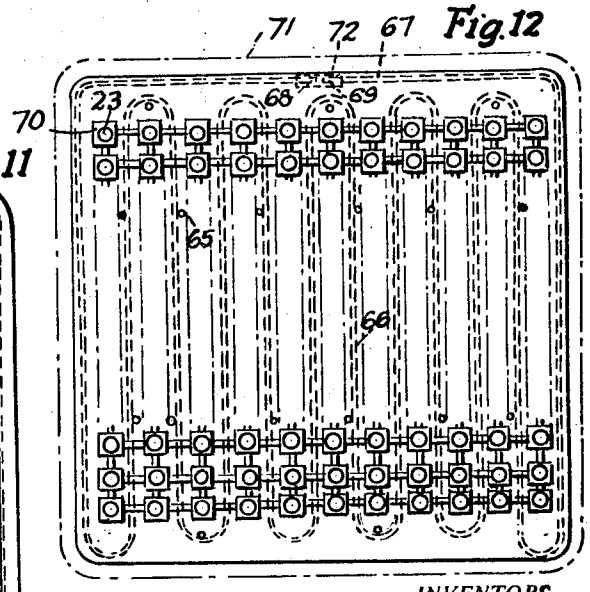


Fig. 12



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SPACER SHEET AND CUSHION

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19 Claims. (Cl. 5—347)

ABSTRACT OF THE DISCLOSURE

A plastic ventilating sheet has hollow spaced apart projections which have openings in the top and are also open at the bottoms. The projections are arranged in rows with separating troughs between them. The interiors of the projections communicate with each other through upraised portions of the troughs and are vented to the atmosphere. When used as a ventilating cushion, a reinforcing wire frame is included. Mesh covers are optional as are linear wire spring members which take out whatever slack in the sheet results from stretching of the sheet under load.

This invention relates to plastic spacer sheets adapted for use as the spacer element of ventilating seat pads, cushions, packing material and the like, and relates particularly to that type of such elements as is formed with integral spacing projections, from one or more sheets of relatively thin plastic material.

One object of the invention is the provision of intercommunicating channels and passages in a plastic spacer sheet for the circulation of air around all surfaces of and throughout the spacer cushion in which the sheet is used, without adversely affecting the spacing cushioning and supporting properties of the unit to any material extent, thereby to attain maximum ventilation consistent with adequate strength of the spacer elements with the use of a minimum quantity of material.

A further object of the invention is the provision of a ventilating spacer sheet provided with closely arranged slightly tapered protuberances having the bottom edges of the side walls thereof merging into the bottom edges of the adjacent protuberances and being embossed or corrugated, to provide not only adequate top areas for the comfortable support of the load, such as a sitter, and bottom areas for operative engagement with a support such as the upholstered seat or other cushion support of an automobile, chair, bed or the like, with the use of a minimum thickness of plastic sheet, but also providing trough-like channels for ventilating the spaces between the upper parts of the protuberances and the embossment or corrugations at the bottoms thereof for ventilating the interiors of the protuberances.

A still further object of the invention is the provision of a spacer employing the plastic spacer sheets singly or in pairs in abutting or nesting arrangement, and with the protuberances projecting upwardly or downwardly, to control the extent of the area which comes into engagement with the object to be supported and that area which engages the support, the unit being employed in the spacer with or without open mesh covers and edge binding tape.

Another object of the invention is the provision of a one-piece plastic spacer sheet metallized by a metallic coating thereon to dissipate or conduct away the heat generated by the body of the sitter, thereby to attain increased cooling by circulating air or to divert heat from entrance into and retention in the plastic material of the sheet.

Still another object of the invention is the provision of means for compensating when necessary and to a greater or lesser extent, for the unsightly appearance and discomfort of the seat spacer, resulting from permanent stretching and consequent loosely ruffled undulated and distorted appearance of the thin plastic sheet in contrast to its normal generally flat state, the unpleasant wavy appearance being assumed by the sheet when it is subjected to more or less prolonged use, said means taking the form of a spring or springs operative to restore the stretched sheet to as nearly its flat or initial state as is possible.

A still further object of the invention is the provision of a plastic sheet having hollow protuberances thereon and usable as a spacer, a substantial number of the protuberances having a top wall provided with a perforation, the wall thickness being least at the edge of the perforation whereby the inner periphery of the top wall yields under the pressure of the user, sufficiently to prevent uncomfortable pressure by lack of support of the user's body at the perforation and objectionable concentration of pressure at the edge of the perforation.

A further object of the invention is the provision of a spacer element formed of a pair of similar suitably shaped plastic spacer sheets connected together to provide adequate supporting areas at the top and bottom surfaces of the element, and with a suitable spring optionally arranged to operate over the major part of the area of the element either to stiffen the element enough to serve as a yieldable cushion or pad, or to permit the element to flex freely under load and then to return it to its initial generally flat state when unloaded.

Various other objects of the invention will appear from the following description and from the drawing, in which

FIG. 1 is a plan view of one form of a seat ventilating spacer having a back portion and a seat portion, parts of the front or top cover having been removed to show the interior spacer unit.

FIG. 2 is a fragmentary vertical sectional view of a slightly modified form thereof taken on a line corresponding to the line 2—2 of FIG. 5.

FIG. 3 is a similar view of a modified form of the spacer wherein the top walls of the protuberances have been completely eliminated from the spacer sheet, a single open mesh cover is used and a corrugated marginal portion provided on the sheet, the section being taken on a line corresponding to the line 3—3 of FIG. 5, but with the top walls of FIG. 5 omitted.

FIG. 4 is a similar view of another modified form of the spacer wherein the mesh covers and edge tape of FIGS. 2 and 3 have been eliminated, and the stiffening frame is heat sealed in place at the margins of the sheet, the domed protrusions which are removed to form the openings in the top walls of the protuberances being shown in dash dot lines.

FIG. 5 is a fragmentary plan view of that form of the spacer shown in FIG. 3 but with perforated top walls on the protuberances as in FIG. 4.

FIG. 6 is a vertical sectional view through the axis of a typical protuberance, on a greatly enlarged scale, showing a metallic heat conducting coating on each face of the sheet, and a rim-like thinned remnant of the removed spacer protrusion.

FIG. 7 is a fragmentary perspective view of a modified form of spacer wherein the top walls of the protuberances are corrugated and perforated.

FIGS. 8 and 9 are top plan views of other modified forms of the protuberances showing corrugated top walls.

FIG. 10 is a fragmentary vertical sectional view of a modified form of a spacer element such as that employed in a ventilated seat pad or cushion, wherein a pair of abutting spacer sheets are employed to provide maximum height and top and bottom bearing areas, showing also one form of the sheet-flattening spring optionally used between the sheets.

FIG. 11 is a plan view of a modified form of the ventilating seat spacer or cushion showing a spacer element similar to that of FIG. 10 but having substantially cylindrical protuberances and a series of flat strip flattening springs held against substantial displacement by the heat sealed areas connecting the spacer sheets.

FIG. 12 is a similar view of a modified form of the spacer element wherein the protuberances are separated and the flattening spring is a relatively thick wire effective to stiffen the element and to form a border frame.

While the invention has been shown in FIG. 1 as applied to a one-piece plastic spacer sheet, for both the back portion and the seat portion of a ventilating spacer, it will be understood that it is equally applicable to separate sheets for said portions as in FIG. 11, that the usual open mesh for fabric covers may optionally be used on one (FIG. 3) or both (FIG. 2) faces of the spacer element or entirely omitted, (FIG. 4); that one or both faces (FIG. 6) or selected areas of the sheet may be metallized; that the modified details of corresponding parts of the various embodiments of the invention herein disclosed may be combined or interchanged or substituted one for the other in an obvious manner.

As shown in FIGS. 1 and 2, the spacer pad **10** is long enough for the back portion **11** and the seat portion **12** and is covered on both faces thereof by the open mesh fabric covers **13** and **14**. Said covers are taped or finished along the edge portions thereof with the folded binding tape **15** which is held in place by the usual stitching **16** passing through the tape, the covers and the margin, **17** of the plastic spacer sheet.

Said sheet is preferably vacuum formed or molded of quite thin plastic sheet material of uniform thickness, such as polyethylene or the like. The material and thickness of the sheet are selected to give the desired supporting properties to the protuberances as **18** formed therein while permitting the sheet temporarily and while under pressure to conform to the shape of the seat or other support on which it rests. Each of the protuberances is illustrated as being relatively small and in the form of the frustum of a hollow square pyramid or other geometric solid, being shown in FIGS. 1–5 as having four flat side walls as **19** and being completely open at the bottom **20**. Even though the plastic sheet is quite thin when used in ventilating spacers, it is sufficiently rigid to support that portion of the weight of the sitter applied thereto, but is preferably intended to yield somewhat under such weight in order to have a slight cushioning function. It will be understood that for heavier duty, the thickness of the sheet and the dimensions of the protuberances are greatly increased and that the shape of the hollow protuberances may be varied throughout a considerable range such as conical, polygonal and cylindrical, (FIG. 11) provided that the supporting properties of the side walls are retained.

Still referring to FIGS. 1–6, top wall **21** partially closes the top of each protuberance except the protuberances **22** of FIG. 3, which latter are completely open at the top for maximum ventilation. It will be understood that in the design of ventilating spacers, a compromise becomes necessary between the volume of the ventilating space and the extent of the supporting areas in operative engagement with the body of the sitter. The open top protuberance **22** of FIG. 3 sacrifices some of its top constituting the supporting or bearing area for the person's body, to attain maximum ventilation and relies on the close arrangement of the protuberances to attain adequate body supporting areas. In such case, the thickness of the plastic sheet in which the protuberances are raised, should be slightly increased to maintain the required rigidity of the side walls, and the height of the protuberances may be increased as well, even though such increase in height would thin the side walls of the protuberances when the sheet is vacuum formed.

The top wall **21** has an opening **23** therein of any desired size and shape to ventilate the interior of the protuberance. The side walls **19** preferably are imperforate and converge upwardly from the bottom **20**, and the bottoms of the protuberances merge as at **24** to become integrally connected and to close off the trough-like channel **25** formed between adjacent protuberances. Since the protuberances are preferably arranged in two intersecting sets of parallel rows, the linear bottoms **24** of the channels **25** also become arranged in intersecting rows as best seen in FIGS. 1 and 5. Preferably, the maximum width of each channel **25** which occurs at its top, is less than the minimum width of the protuberances and may equal or even be less than the height of the protuberance in most cases.

To aid in ventilating the interior of each protuberance, communication between such interiors is provided.

This has been done by embossing or providing upstanding bosses as **26**, **27** in, or corrugating the bottoms **24** of the channels **25**. While any desired number of the bosses may be used and may take a variety of different positions, sizes and shapes, they are upraised from the material of the spacer sheet to a height less than the height of the protuberances to avoid complete blocking of channel **25**, and are preferably of generally partly cylindrical shape. As shown, the rib-like bosses **26** are arranged in the channels between adjacent protuberances symmetrically across the center lines of the rows of protuberances, while the cross shaped bosses **27** are similarly arranged where the channels intersect at the corners of adjacent protuberances as best seen in FIG. 5.

Dissipation of the accumulated heat transferred from the body of the sitter occurs by reason of air circulation, not only over the outer or upper surface of the sheet through the channels **25**, but also through the interiors of the protuberances, all of which communicate through the passages **28**, **29** and the like underneath the bosses **26**, **27**. To aid in eliminating the generated heat if desired, or shielding against the heat, a coating **30** (FIG. 6) of suitable heat-conducting metal such as copper, aluminum, tin, alloys, or the like is optionally applied to either or both upper and lower surfaces of the sheet as shown at selected areas thereof where most effective. The metallic coating is in any suitable form, such as foil, plating, vapor deposit, paint or the like, and prevents the heat from entering the plastic sheet to a substantial extent and from being retained by the sheet.

The marginal areas **17** of the spacer sheet, except that of FIG. 3, are preferably flat and devoid of protuberances. Resting relatively freely between the stitching **16** for the folded edge binding tape **15** and the nearest row of protuberances, as shown in FIGS. 1 and 2, is the stiffening frame **32** of the usual substantially rectangular wire type. In that form of the invention wherein the side walls **19** of the protuberances yield somewhat under the load thereon, the frame may be quite close to the stitching in a manner well known in the art, without exerting damaging stresses upon the stitching. The angle between the channel walls changes under load sufficiently to conform to the shape of the adjacent part of the sitter's body, and thereby absorbs some of the load and counteracts to some extent the tendency of the spacer sheet to become concave upwardly under the load and reduces the amount of movement of the stitching toward the border frame.

In FIG. 3 only the upper mesh cover **13** is shown. The marginal area **31** is illustrated as corrugated and hence transversely expandible in two perpendicular directions, thereby also permitting the border frame to be arranged quite close to the stitching without adverse effects. However, as shown, the border frame **33** is arranged outwardly of and between the stitching **16** and the bend **15** of the binding tape and preferably close to said bend, in which case the corrugations in the area **31** become less important. For maximum ventilation, the top wall **18** has been shown as completely removed to open the top

of the protuberance completely. Such open top may be provided in any of the various forms of the spacer sheet shown herein.

In FIG. 4 which is the most economical of the various forms of the invention, the spacer sheet **10** and the border frame are the only elements of the spacer. The marginal area of the sheet is initially relatively wide and extended as at **36** and is folded preferably downwardly and inwardly on itself and around the frame **37** on to the under face of the marginal area and there heat sealed to said under face. The stitching, binding tape and covers may consequently be entirely omitted.

As indicated in FIG. 4 and more clearly shown in FIG. 6 in which the thickness of the sheet **10** and of the metallic coating have been greatly exaggerated for clarity of illustration, a thinned dome-like blister **39** is formed in the top wall **21** during the vacuum forming of the protuberance **18**, the substantially thinned base of the blister surrounding the opening **23**. To expose said opening to the access and passage of air from the exterior of the protuberance, the major part of the dome is removed by suitable cutting or grinding tools along a plane **40** preferably slightly above and parallel to the upper surface of the top wall or coplanar with said surface. There remains optionally after such removal a low rim **41** surrounding the enclosed opening **21**. The outer surface of the rim **42** tapers upwardly and inwardly as does the inner surface **43** because the entire wall of the blister including the rim **41** is considerably thinned out during the formation of the blister. Such thinning aids in the operation of cutting off or otherwise removing the excess dome material. The inner peripheral part of the top wall **21** varies in thickness which is least at the edge of the perforation **23** whereby said wall part yields readily enough to reduce the pressure upon the body of the user.

The sheet **10** has been shown in a position in which the wall **21** is uppermost in the spacer and the channel edges **24** are at the bottom of the sheet. It is intended, however, that the sheet may be used, if desired, and where occasion requires, in the reversed position, that is, with the wall **21** at the bottom and the edge **24** uppermost. Such arrangement of the sheet is advantageous where the larger bearing area of the sheet must be arranged at the under face of the spacer instead of at the upper face.

As has been indicated, the sheet may be of any required thickness for its intended purpose and the protuberances may also be suitably dimensioned for the required purpose, whether for the spacer element of a ventilating seat spacer, or the resilient inner unit of a cushion or for packing fragile articles or as holders for such articles. In most cases, the plastic sheet is quite thin and flexible for purposes of economy, and may readily be provided with stiffening means and with finished marginal portions in the manner heretofore described. The sheet may also be used in combination with other similar sheets or other types of stiffeners as will soon be described. The protuberances themselves may also be variously shaped where additional rigidity or ventilation is desired, and the embossment at the bottoms of the channels **25** as well as the marginal areas of the sheet may vary considerably in arrangement and dimensions as may be found to be commercially acceptable and convenient.

In that form of the protuberances shown in FIGS. 7–9, the top walls have been grooved or corrugated in different ways to provide additional ventilation and add to the rigidity of the main parts of said walls over that of the flat type.

In FIG. 7 the center lines of the grooves **45, 46, 47** in the top wall of the protuberance **44** are parallel and extend in a direction at substantially right angles to the similar grooves **45*a*, 46*a*, 47*a*** in the top wall of the adjacent protuberances **44*a*, 44*b*, 44*c*** and the like, the grooves in effect producing a corrugated top wall on the protuberance which increases the volume of the ventilating space though at the expense of the top bearing area.

The opening **51** in the top wall has been shown as substantially square but obviously may be of any desired shape. Obviously, also the grooves in the top walls of an entire row of protuberances may extend in the same direction throughout the row and in a perpendicular direction in the adjacent rows. The direction of the grooves may also be varied in the different rows or in different individual protuberances as may be found desirable.

In the top protuberance wall **52** of FIG. 8, a first set of two grooves **53, 54** is made to extend in one direction across the wall and a second similar set of two grooves **55, 56** extends across in a perpendicular direction and intersects the first set at right angles in the same wall. Another modification is shown in FIG. 9 wherein two relatively wide and deep grooves **57, 58** in the protuberance **59** intersect at right angles.

Where bearing areas of substantial extent are required both at the top and bottom surfaces of the spacer element, or greater height and ventilating volume are required than is provided by a single spacer sheet a pair of such sheets are used as shown in FIG. 10. The sheets may be arranged in various positions such as bottom to bottom as shown or they may be nested in relatively reversed position in an obvious manner. The upper sheet **60** of FIG. 10 is right side up and is shown with the corrugations **57** only therein, with the low rim **41** around the opening **23**, and with the channel bottom edges **24** lowermost. The other sheet **61** is in an upside down or reversed position with the "bottom" edges **24** uppermost and with the corrugations **57** extending in the same direction as those in the upper sheet **60**. It will be understood that the lower sheet may instead be arranged in a position not shown, but turned 90° in the same plane from the position shown so that the corrugations **57** thereof are perpendicular to those in the upper sheet, as will now be obvious. The under sheet may be arranged in a position moved toward the left or right, a distance equal to half the widh of a protuberance so that the side walls thereof enter the interior of the protuberance above said walls in the upper sheet, for nesting purposes. While the nesting arrangement decreases the volume of the ventilating space provided by the combined sheets owing to the decrease in overall height of the assembly, greater strength is attained and the large bearing areas are retained on both faces of the assembly.

It frequently happens that when the thin sheet is used in a ventilating spacer and is made of such plastic as polyethylene, repeated or prolonged sitting on the spacer stretches the sheet permanently beyond its elastic limit to such an extent that it becomes wavy, ruffled, undulated or wrinkled between the stitched margins. To aid in returning such stretched sheet to its initial substantially flat or generally planar form, a suitable set of springs **62** preferably of light round wire or of flat strip form is arranged between the sheets such as **60** and **61** as best seen in FIG. 11. The springs comprise substantially parallel coplanar bars or lengths. The springs may be arranged in any convenient position, as between the bosses **26** of the adjacent sheets **60, 61** of FIG. 10 or the channels **25** may be shaped or other channels provided to receive the springs; or the protuberances or the walls thereof illustrated as cylindrical for purposes of example may be shaped to permit the springs to be fitted or forced into place between the sheets.

When the load on the sheets is released, the distorted sheets return substantially to or near the initial general planar or less distorted form thereof under the urge of the springs even though the sheets have been stretched appreciably. To secure the sheets together so that the sheets return as a unit with the springs to their original plane and at the same time to retain the springs in place, selected adjacent areas of the sheets are heat sealed together at points preferably close to the spring as at **65**.

In cases where the plastic sheets are used for cushions or the like, as shown in FIG. 12, the one piece sinuous spring **66** may, if desired, be so constructed as to take part of the load on the cushion. It need not be of one piece, but may be made of a number of separate strips. As shown, the spring **66** is prolonged to form the three-sided stiffening border frame **67** having straight or suitably shaped sides. The ends **68**, **69** of the spring are preferably arranged at the rear edge of the cushion and connected by the ferrule **72**. The square protuberances **70** may be somewhat spaced apart to provide spaces for the reception of the spring. While no covers or finished margins are shown for the sheet and spring assembly of FIG. 12, the edge portions of the sheets may be finished in any well known manner, such as in FIGS. 2 and 3 or as in FIG. 4, the edges being indicated by the dash-dot outline **71**.

While certain specific forms of the invention have herein been shown and described, various obvious changes, some of which have been mentioned, may be made therein without departing from the spirit of the invention defined by the appended claims.

We claim:

1. A flexible plastic spacer sheet having a multiplicity of hollow upstanding protuberances separated by troughs therebetween, each of a number of said protuberances having an opening in the top thereof, parts of the troughs between adjacent protuberances being upraised to extend into the adjacent walls of adjacent protuberances and to form passages thereunder communicating with the interiors of said adjacent protuberances.

2. The spacer sheet of claim **1**, the sheet having a relatively thin surface coating of metal.

3. The spacer sheet of claim **1**, each of the protuberances being in the form of the frustum of a square hollow pyramid, the walls of the protuberances being sufficiently rigid to support the weight of a sitter without collapse and sufficiently resilient to yield slightly under such weight.

4. The spacer sheet of claim **1**, a multiplicity of the protuberances being completely open at the top and each of the protuberances having upwardly converging side walls yieldable to a limited extent under the weight of a sitter.

5. The spacer sheet of claim **1**, a multiplicity of the protuberances having corrugated top walls.

6. In a ventilating spacer unit, the spacer sheet of claim **1**, the sheet having corrugated marginal areas, and a frame on said areas in outward spaced relation to the protuberances.

7. In a spacer unit, the spacer sheet of claim **1**, a stiffening frame in outward spaced relation to the protuberances, a woven open mesh cover for at least one face of the spacer sheet covering the frame and the sheet, a binding tape folded about the edge portions of the sheet, and stitching through the inner edges of the folded tape, through the cover and through the sheet.

8. In a spacer, a first flexible plastic sheet according to claim **1**, the tops of the protuberances being provided with substantially parallel corrugations, the sheet having a marginal portion, a second similar sheet arranged with the center lines of the corrugations thereof at substantially right angles to the center lines of the corrugations of the first sheet, said sheets having contacting areas thereof connected together to form a spacer.

9. In a spacer, a pair of plastic sheets each according to claim **1**, the sheets being connected together and spring members arranged between the sheets and extending throughout the major portion of the area thereof and urging said sheets into a position corresponding to the position assumed by the sheets and the spring members when the members are unstressed.

10. In a spacer unit the spacer sheet of claim **1**, a stiffening frame at the margins of the sheet, and an extended marginal portion of the sheet folded inwardly around the frame and heat sealed to the margin of the sheet to hold the frame to the sheet.

11. The spacer unit of claim **9**, the sheet having a surface coating of metal.

12. In a ventilating spacer, a spacer of a relatively thin sheet of flexible plastic material, said sheet having a multiplicity of upstanding protuberances therein, the protuberances being arranged in intersecting rows, each of the protuberances being open at the top and bottom thereof and being arranged sufficiently close to all of the surrounding protuberances to form relatively narrow continuous rows of intersecting trough-like channels each of lesser maximum width than the width of the adjacent protuberances, and embossed areas at the bottoms of adjacent protuberances reducing the effective height of said channels at said areas and joining the spaces below said areas to the interiors of said protuberances.

13. In a ventilating spacer, a spacer unit of a flexible sheet of relatively thin plastic material having upstanding spacing protuberances therein, each of a number of the protuberances having an opening in the top thereof and having a marginal area free of said protuberances, a wire frame arranged to rest on said area and means engaging the upper part of the frame to hold the frame down on said area, the protuberances having side walls and each terminating in a base portion integrally joined to the base portion of the adjacent wall of the adjacent protuberance, said base portion having an upstanding area embossed therein of lesser height than that of the protuberance and of lesser length than that of said base portion.

14. In a ventilating spacer, a spacer sheet of relatively thin plastic material having a multiplicity of hollow protuberances upraised from the remainder of the sheet and each having a corrugated and perforated top wall and imperforate side walls and being completely open at the bottom thereof, the respective side walls being joined to the adjacent side walls of the adjacent protuberances, and stiffening means for the marginal portions of the sheets.

15. The ventilating spacer of claim **14**, a second spacer sheet similar to the first mentioned sheet, the second sheet being heat sealed to said first sheet in reversed position relatively to said first sheet and in bottom to bottom contact therewith.

16. The spacer of claim **8**, and a normally planar spring between the sheets and held in place by said areas, said spring urging said sheets toward a generally planar normal position when moved from said position by a load thereon.

17. The spacer of claim **16**, the spring being of a single length of wire and having a marginal frame and a plurality of substantially parallel integrally connected bars within the frame.

18. A flexible plastic spacer sheet having a multiplicity of similar protuberances each having upstanding walls of the material of the sheet, and being open at the bottom thereof between the bottoms of said walls and having an opening at the top thereof between the tops of said walls, said bottoms of the walls being joined to the bottoms of the walls of adjacent protuberances by the material of the sheet to form imperforate troughs arranged in intersecting rows, parts of the troughs between adjacent walls being upraised to extend into said walls and to form passages thereunder each communicating with the interior of at least two adjacent protuberances.

19. A plastic sheet having multiple protuberances each in the general form of a hollow truncated geometric solid, a substantial number of said protuberances having top walls provided respectively with perforations, the protuberances being separated by troughs therebetween, and passages in the troughs providing communication between adjacent protuberances thereby to vent the interiors of the protuberances and the under face of the sheet.

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