Oct. 7, 1958 W. H. ASHTON ET AL 2,854,974

PAD

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Fig. 1.

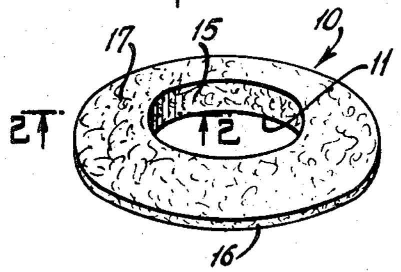


Fig. 2.

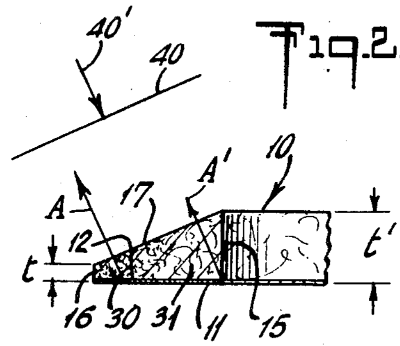


Fig. 3.

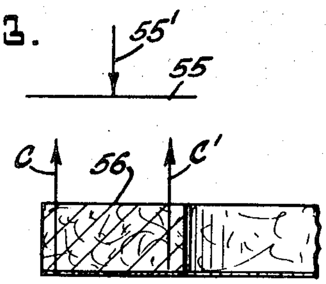


Fig. 4.

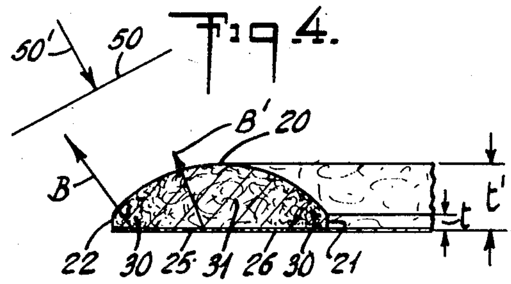


Fig. 5.

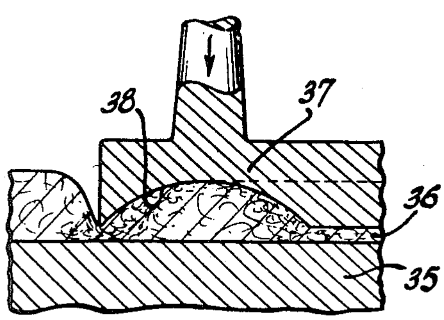
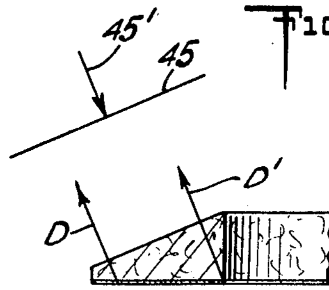


Fig. 6.



INVENTORS:
WILLIAM H. ASHTON
JOSEPH N. MASCI
BY
ATTORNEY

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PAD

William H. Ashton, Philadelphia, Pa., and Joseph N. Masci, Metuchen, N. J., assignors to Johnson & Johnson, a corporation of New Jersey

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5 Claims. (Cl. 128—153)

This invention relates to foot produtcs in the form of a pad, such as corn pads, which are intended to relieve localized pressures on the foot and thereby relieve irritation.

Many types of felt pads are used in the care of the foot. The function of pads is either to relieve pressure or to obtain support. They are used under the longitudinal and metatarsal arches for support and as relief or curvative aids in the healing of corns, bunions, bunionettes and other growths. The pads can be either permanently or temporarily applied to the interior of the shoe, or they can be secured to the foot in the right place. The pads are generally anchored in place in the shoe or on the foot by means of a suitable adhesive especially designed to meet the needs and perform the desired function.

Felt corn and bunion pads are presently available on the general consumer market. They are anchored to the site by either a pressure-sensitive or remoistenable adhesive. The pads are died out of flat felt stock resulting in square corners between the top surface of the pad and the side surface. They are usually round or oval.

Chiropodists, orthopedic surgeons, and their associates, do not generally use the conventional round or oval pad having vertical edges. This is because the edge is too hard or the profile wrong for their therapy. These specialists have found that conventional consumer felt pads can cause rather than relieve pressure irritation. Hence, it has been the practice for physicians to prepare specially their own pads so as to translate the pressure of the shoe away from the corn or bunion area. This has been achieved by buffing or cutting the thick felt to produce a skived or tapered edge. The tapered edge may also be obtained by building up the article from thin layers laminated together. The process used has been a hand operation in every case and has been tedious, expensive, and limited to use by skilled persons. Further, although certain partial relief has been obtained by use of the skived-edge corn pads, this relief has not been to the extent desired and the need has been felt to obtain still further dissemination and decentralization of localized stresses on the foot in the area of irritation.

One object of the invention is to produce felt pads which afford greater decentralization and spreading of stresses away from localized spots of irritation as compared with prior art pads.

Another object of the invention is to provide a valuable economical process for producing a pad having skived or tapered edges.

A further object is to devise a process adaptable to a high degree of automaticity. A still further object is to produce pads, preferably foot pads, having a very high degree of resiliency.

The products of the present invnetion are pressure-relieving pads adapted to be used adjacent the human body, the pads having tapered edges. The pads are formed from a mat or felt of certain fibers of textile length described more fully below. The invention pads have the additional and essential property that the density of

the pad, expressed as weight of fibers per unit volume, is greater at the tapered edges than at thicker central portions of the pad.

In manufacture of corn pads and other pressure-relieving pads adapted to be used adjacent the body, the qualities of resiliency, elasticity and abrasion resistance are quite important. Pads made of felt must be composed of fibers which inherently have the right combination of these properties. According to the invention, the requisites of pad resiliency, elasticity and abrasion resistance are fulfilled.

The invention may be conveniently understood by reference to the attached drawing in which the reference numbers designate corresponding parts in the several figures.

Fig. 1 is an isometric view of an oval shaped corn pad.

Fig. 2 is a sectional view of a portion of a pad taken along plane 2—2 of Fig. 1, the plane being perpendicular to the bottom surface of the pad.

Fig. 3 is a sectional view similar to Fig. 2 of a prior art corn pad.

Fig. 4 is also a sectional view similar to Fig. 2 of another product of the invention.

Fig. 5 is a view illustrating molding of the invention pad, the drawing showing only the portion of the pad and mold corresponding with the section 2—2 of Fig. 1.

Fig. 6 shows a section of another type prior art corn pad.

Reference number **10** designates the body of a corn pad generally circular, e. g. oval shape, and having adhesive mass **11** applied to its bottom flat surface **12**. Pad **10** has a vertical internal edge **15**, a short vertical outside edge **16**, and a sloping or skived top surface **17**.

In Fig. 4 the invention corn pad is shown as having a slightly modified cross scetion, that is, instead of the triangular cross section, the corn pad is provided with an oval shaped top surface. In the Fig. 4 pad both internal vertical surface **21** and external vertical surface **22** are small and of approximately the same dimensions. Adhesive mass on the bottom surface **25** is shown at **26**.

The notable characteristic of the invention fibrous pads is that the edge portions **30** in both the trapezoidal and the rounded top pads have greater fiber density than the central portions **31**. Generally, this fiber density varies inversely as the thickness "*t*" of the pad at any point, i. e. the smaller edge thickness "*t*" to the larger central thickness "*t'*." This increased fiber density near the edge portions of the pad is important in the pad function since it has less compressibility and hence greater resistance to compressive stresses as will be more fully explained below.

Referring to Fig. 5, there are shown a fixed support **35** and a continuous web of batting or felt material **36** which is the material of which the invention pads are made. Web **36** is made of staple fibers of synthetic polymer described above and has substantially uniform weight per unit area. Mold or plunger **37** has the shape of the top rounded surface **20** of the pad shown in Fig. 4. Means not shown are provided for heating mold **37** and support **35** to the temperature level required to cause permanent setting of the fibers in the web. Preferably web **36**, before it arrives at the point where mold **37** is lowered, is moistened to a predetermined water content sufficient to provide the amount of steam which will facilitate molding of the web when the heated member **37** is lowered onto the heated support **35**. The lower edge portions of mold cavity surface **38** compress corresponding parts of web **36** more than the higher central portions of the cavity surface. Since the web has a uniform weight per unit area, the more highly compressed parts of the web will have a higher unit density. The heat causes the fibers to set in the shape of the mold. After the molding operation, plunger **37** is raised and web 36 moved along the dieing out operations not shown in registry with the molding operation designed to produce a corn pad having a cross section as shown in Fig. 4 and a central opening as shown in Fig. 1. Molds of corresponding shape are utilized for preparation of pads having cross section shown in Fig. 2, and of course various other shapes may be made according to need with suitably designed molds.

The advantages of the invention corn pad become particularly apparent from consideration of the forces to which the pad is subjected in use. The skived or tapered pads heretofore made by cutting or abrading pads having rectangular cross sections are illustrated in Fig. 6. Vector arrows D and D' indicate schematically the direction and magnitude of force which results against member 45 when it is pushed against the pad in use by force 45'. It is seen that the amount of force on opposite edges of the bottom surface of the pad (adjacent the body) are about equal and are inclined at an angle to the vertical. The equality of the forces is obtained partly by reason of the conformity of the pad to the shoe and the foot of the wearer. Further the fiber density at the left side of the pad is the same as the fiber density at the right side of the pad. Therefore, the left side will not tend to bear any more of the total force than the right side, and the right side may even bear a greater proportion due to the tendency of the high point of the pad in this zone to resist selectively any incidental force applied directly vertically. Whatever advantages may have been obtained by reason of skiving the edges as shown in Fig. 6, it would be desirable to increase the proportion of the total stress D borne by the outside edge of the pad, as compared with the stress D' borne by the internal portion of the pad.

Referring to Fig. 2, the plane 40 represents the surface of the shoe or other object applying force to the body, and the arrow 40' represents the magnitude and direction of application of the force which bears directly against upper surface 17 of pad 10. Vector arrows A and A' represent the direction and magnitude of resistance force to force 40' at the outside and inside margins of the pad, respectively. Force 40' tends to compress the fibers in pad 10, and the fibers resist this compression. However, the fiber density is graded from high density at zone 30 of the left side of the pad, to lower density in zone 31 of the right side of the pad. In zone 30 the fibers, being already compressed, resist more strongly than does zone 31 further compression. Hence, it is seen that force A is substantially greater than A' which indicates that the stress or resistance force borne by the pad is disseminated and dispersed from the sensitive area being protected which is near the center of the pad, that is, near vector force A'.

In Fig. 4 the force is applied to upper surface 20 of the pad from an inclined plane 50, as shown. Here the resistance force B from the edge of the pad 30 is shown by the direction and length of the vector arrow, while the resistance force B' at the center of the pad is also shown by the other vector arrow. Due to the greater density of the pad at point 30, this portion tends to share more than its normally proportionate part of the total force 50', and hence arrow B is longer than arrow B', indicating a shift of force and stress away from the more sensitive areas of the body being protected at the right side of the drawing.

In Fig. 3 we have a conventional type corn pad having a square cross section. The force here 55' is applied from a horizontal surface 55 bearing directly against upper surface 56. Resistance forces C and C' are equal since the fiber density of the pad is the same at the right and left ends of the pad. The square cross section pad, of course, suffers from the objection of nonconformity which the skived pad is designed to cure. Further,

no shifting of stress to the left, away from the sensitive area of the body being protected, has been obtained.

To provide the stress-relieving properties of the invention padding as described above, the fiber density of the edge portions of the pad should be substantially greater than that of center portions. Generally the ratio of the fiber density, edge to central, will be at least about 2:1, preferably at least 5:1. When pads are made by compressing a sheet of uniform weight, the thickness ratio, i. e. the ratio of edge thickness "t" to central thickness "t'," will be the inverse of the density ratio, since the pad, according to the procedure described above, is made by compressing such sheet to different degrees at different points thereby to produce the different densities. However, the density is not limited to this inverse ratio feature since it is possible to obtain the advantageous high density edge feature of the invention by other methods.

Materials which are particularly suitable for invention pads are certain synthetic polymers, these being polymers (including copolymers) of acrylonitrile, polymers (including copolymers) of polyethylene, and polyesters of polyhydric alcohols and polybasic acids, specifically, polyethylene glycol-terephthalic acid esters and their derivatives. Polyacrylonitrile is made and sold under the trademark "Orlon," and polyethylene glycol terephthalate is made and sold under the trademark "Dacron." Fibers of these polymers have been found to have inherently the resiliency, elasticity and abrasion resistance desired for body protective pads, and hence can be used alone without incorporation of such conventional corn pad fibers as wool.

The molecular weight of the polymer in each case should be sufficiently high to provide a fiber having a melting point high enough to suit the requirements at hand. The melting point of the polyester fiber may be about 480° F.; the temperature at which the polyacrylonitrile begins to stick, about 455° F.; and the melting point of the polyethylene, about 230–250° F. The fibers are stretched during manufacture so that they have internal stresses which when the fibers are heated above a certain setting temperature will be relieved resulting in change of shape, usually shrinking of the fibers. The polymer fibers become entangled with one another and adjacent fibers and hence shape is retained permanently by the molded pad. Whatever may be the mechanism of the action taking place in the heating operation, the fibers take a permanent shape, and the shape of the products made up by the fibers may be controlled by the amount of pressure and the shape of the mold used for the heat-setting operation. The fibers in the pad of the present invention have been previously set by molding to the desired tapered shape and the internal stresses relieved so that the pads remain permanently tapered or skived. The pads are preferably subjected to heat and pressure as described above, suitably although not necessarily in direct contact with steam, at temperatures within the range 180° F. to 250° F. The temperature at which heat setting and strain relaxation take place will determine the temperature to which the material may thereafter be heated without suffering any change in shape.

The fibers prescribed can be used alone, in combination with one another, or in combination one or more with wool, cotton, cellulose or other filler. In the felt products of the invention many combinations and arrangements of fiber content are possible. Due to the greater abrasion resistance, loftiness and resilience of the polymer fibers described above, wider limits are possible depending upon the properties desired in the finished article. Generally, however, felts or battings having a thickness in the approximate range 0.05 to 0.25 inch, and a weight in the range 2.0 to 64 ounces per square yard are suitable. The felt or batting in order to be suitable for the invention products from the standpoint of resiliency as indicated below should have the polymer fibers described above present in content within the range 50% to 100%, and any filler fiber should be present in an amount not more than 50%.

As stated above, in the manufacture of a body protective pad, fiber resiliency is of great importance. The resiliency, in order to afford proper cushioning effect and resistance to stretch should be in the approximate range 70–100%. Resiliency is measured on a meter manufactured by Federal Products Corporation, Model 59B-11, having a dial micrometer with 1/1000" readings and circular presser foot area of 1 square inch (1.129" diameter). Before test the felt is conditioned for at least 24 hours at 70° F. and 65% relative humidity. Approximately 2 inches square are cut from the felt, and the determinations are carried out in a constant temperature room. The initial thickness, T_0, is measured with a ten ounce load applied for ten seconds by the instrument. Then an additional 1.5 pounds are added to the ten ounce load for one minute, and the reading T_s is taken. After the one minute load period the total weight (10 oz. plus 1.5 lbs.) is removed and the sample allowed to recover its initial thickness for a period of one minute. Then the final thickness T_1 is measured using the 10 oz. load for 10 seconds. Resiliency is taken as T_1 minus T_s. Percent resiliency is taken as

$$\frac{T_1-T_s}{T_0-T_s}\times 100$$

Three determinations are made for each sample, and the results averaged for each of initial thickness and percent resiliency.

Standard individual filament deniers of the fibers of the invention are satisfactory and are of the order of 0.5 to 3 denier. Felts used to fabricate pads anchored to the foot fall into the low range of ounces per square yard, e. g. 2.0 to 24.0, whereas those used under the foot, on the shoe, or on other parts of the body, tend to fall in the higher range of about 20 to 64 ounces per square yard. Thicker pads, of course, may be utilized for applications on other parts of the body. A formulation having particularly suitable properties in the manufacture of corn pads consists of 50% polyacrylonitrile fiber, 50% polyester of terephthalic acid and ethylene glycol, the felt having a weight of 20 ounces per square yard and a thickness of 0.18 inch.

The preferred fibers described above have heat-set binding properties, that is, they hold together adjacent fibers by entwining themselves around or entangling with such adjacent fibers, thereby exerting a chain type holding action. According to a modification of the invention, fibers are employed which bind by virtue of their coalescent properties activated by heat, which is another type of heat-setting; for example, vinyl chloride-vinyl acetate copolymer (85–15), polyvinylidine chloride, ethyl cellulose or cellulose acetate fibers, may be blended with fibers of wool or other felt-forming material. Blending of the felt-forming fiber is necessary to impart the desired resiliency, elasticity, and abrasion resistance. The felt is molded under pressure and high temperature to activate the binder fibers by softening and causing them to adhere to adjacent fibers, and thereby retain the felt in its compressed condition, i. e. with edge portions having greater density than central portions as specified above. Generally the limits of coalescent bonding fiber content will be substantially lower than the minimum 50% content of polyacrylonitrile, polyethylene and polyester stated specifically above, i. e. approximately 5–25%.

Another modification suitable for producing the protective pads of the invention having denser marginal portions and less dense central portions, is replacement of the coalescent binder fibers with an equal amount of (1) adhesive powder interspersed between the fibers of wool or other felt-forming material, or (2) with a heat-activatable adhesive such as vinyl acetate emulsion, carboxymethyl cellulose, or urea or melamine-formaldehyde resin, impregnated onto the felt fibers. In each case the pad is molded with heat into its final shape at which time the adhesive properties of the binder become effective and retain the pad permanently in the desired shape.

One suitable process having a high degree of adaptability to automatic operation has the following stations: (1) feeding; (2) wetting; (3) molding; (4) application of adhesive mass; and (5) dieing. The felt, suitably of the entangling bonding fiber type, is fed into the unit on long rolls of the proper width. It is then wetted with water spray or with water vapor. The wetted felt is then drawn into the molding station described above which is heated to temperature above 212° F. and is of the continuous multiple type unit molding equipment. This station sets the felt to the shape of the mold by applying a pressure of 500 pounds per square inch, relieving the strains as described above, and the heat is so regulated that the molded forms leave the station substantially dry. The continuous molded sheet then passes to the adhesive station where either pressure-sensitive adhesive mass or remoistenable glue is applied. This sets immediately and the sheets are died out under the proper registration with the molded forms to eject the molded articles. The molding pressure is controlled to produce (from the 0.18 in. thick, 20 oz. felt described above) a pad having an edge thickness of 0.031 in. and a maximum thickness in central portions of 0.125 in. The local fiber density at such edges is 0.48 oz. per cubic inch, while the local fiber density at the central portions is 0.12 oz. per cubic inch.

For a batch operation a plate mold was prepared with four recess units having dimensions approximating a standard round corn pad but with tapered edges as illustrated in Fig. 4. A felt made of 100% fibers of polyester of ethylene glycol terephthalic acid ("Dacron"), the fibers being 3 denier, the felt having a thickness of 0.134 inch and weighing 19.2 ounces per square yard, was placed on the plate mold and covered with a piece of 80 x 80 cloth containing about 300% water. The device was placed in a press the top plate of which was at a temperature of about 300° F. The press was closed until the gage pressure was 8000 pounds and held thus for 15 seconds. The pressure was then released and the molded sheet removed from the plate. Individual corn pad shapes are found to be permanently molded in the flat sheet. These forms were died out to produce corn pads of form having a cross section illustrated in Fig. 4.

The process stations may be combined where practicable, or their order altered when necessary. For example, the wetting can be combined with the molding station and the molded sheet died out and adhesive applied to the individual pads. The adhesive station can be altered in various ways depending on the type of mass and anchorage desired. The molded sheet stock may be passed through an operation which calenders a pressure-sensitive adhesive onto the sheet at a temperature below the mold temperature, thus retaining the molded forms in the desired shape. As a further alternative, hot melt remoistenable adhesive may be applied directly to the molded sheet as it leaves the molding station. Further, double-gummed tapes may be ironed onto the sheet of molded felt, or pressure-sensitive mass can be solvent spread or transferred onto the felt. If desired, a double faced pressure-sensitive tape can be anchored to the article, the one mass designed to adhere to the felt, and the other to the skin or shoe.

It will be apparent that pads of the present invention may be used for other purposes in connection with the body than on the feet. The process and product of the invention are applicable to articles designed for cushioning effect, such as knee pads, shoulder pads, helmet liners, and supporters of various kinds. Very special pads with tails or anchor strips can be died and heat pressed into a permanently set form. The adhesive surface, if such is supplied, may be on the top (e. g. for application to the shoe) or the bottom surface (for application to the foot). Hence, the invention is not to be limited to the specific instances and illustrations presented above.

The claims are:

1. A substantially annular body pad having edge portions, central portions, a substantially flat bottom surface, and a top surface which tapers from the central portions which are relatively thick to the edge portions which are relatively thin, the pad having comfortable resiliency, elasticity, and abrasion resistance and is constructed of felted staple fibers bonded together throughout the pad, said pad having uniform weight per unit area and its fiber density being inversely proportional to its thickness, said pad having edge portions and central portions, the density ratio of said edge portions to said central portions being at least 2:1, and the resiliency of said pad being in the range of about 70 to 100%.

2. A body protective pad as of claim 1 wherein the fiber mixture includes 5 to 25% of heat-activated bonding fibers and the said mixture is bonded together by heat-setting.

3. A foot pad of claim 2 constructed of heat-set staple fiber of a synthetic polymer of the group consisting of polyacrylonitrile, polyethylene and a polyester of polyhydric alcohol and polybasic acid, and having an adhesive layer secured to its bottom surface.

4. A body-protective pad of claim 3 having maximum thickness in the approximate range 0.05 to 0.25 inch and weight in the approximate range 2.0 to 64 ounces per square yard.

5. A foot pad of claim 4 wherein the density ratio is at least 5:1.

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