Nov. 19, 1935. L. ROSENTHAL 2,021,467

ARCH SUPPORT

Filed Sept. 16, 1932

Fig. 1.

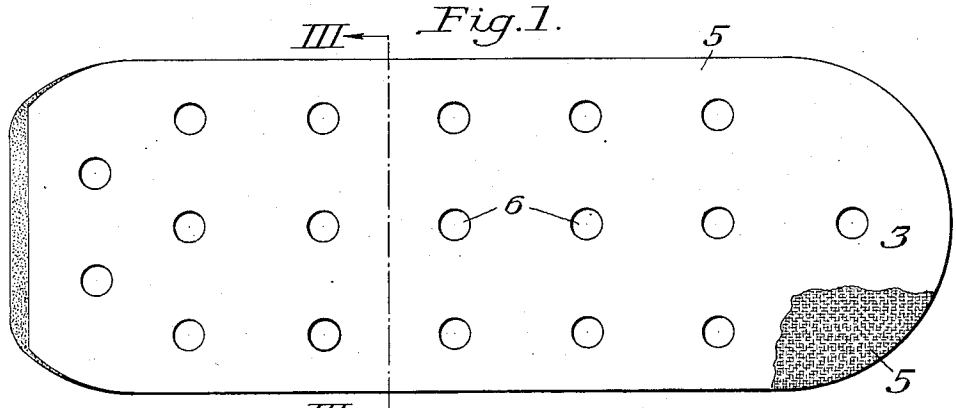


Fig. 2.

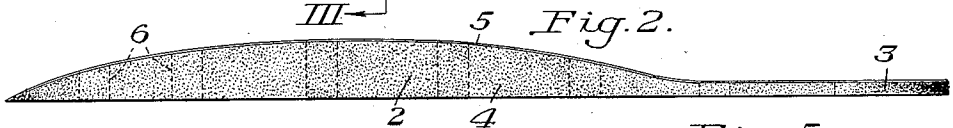


Fig. 3.

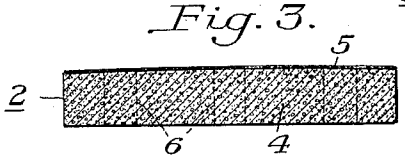


Fig. 5.

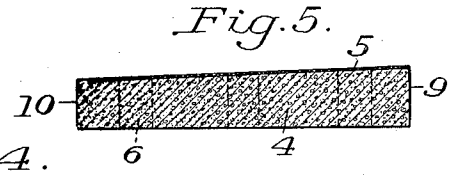


Fig. 4.

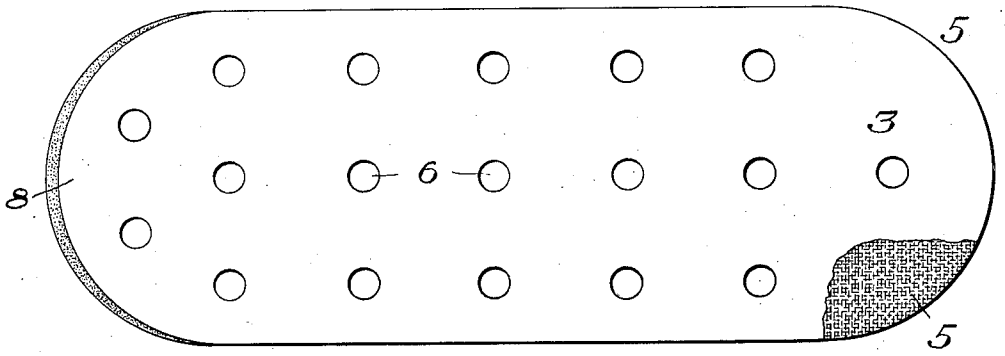
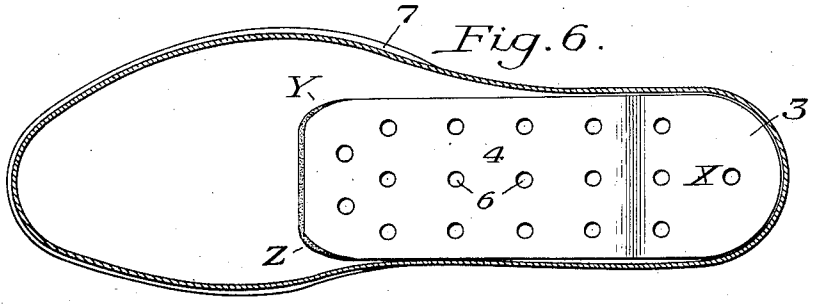


Fig. 6.



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2,021,467

ARCH SUPPORT

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Application September 16, 1932, Serial No. 633,436

3 Claims. (Cl. 36—71)

This invention relates to that class of devices intended for the correction or alleviation of those troubles which result from the weakening or breaking down of the arches of the feet. The present invention is to that particular type of support which is non-metallic and resilient.

It is of course well-known that the human foot is comprised of a great many small bones held in position by numerous muscles and tendons so arranged as to move with relation to one another in the act of walking and absorb the impact to which the foot is subjected in the shifting of the entire weight of the body from one foot to the other as occurs in the act of walking. In the arrangement of the bones there is an arch which extends longitudinally of the foot between the heel and the front of the foot, and there is a transverse arch, known as the metatarsal arch, which extends crosswise of the foot forwardly of the longitudinal arch and rearwardly of the toes.

The longitudinal arch must be considered as comprising two complementary arch structures, i. e., the inner arch and the outer arch. The latter is a true arch in a mechanical sense, while the former is a suspended structure maintained by muscles and tendons. It is also well understood that through natural weakness or various causes the muscle tissue weakens or the tendons stretch, allowing the various bones to move out of their normal relation, with the result that various foot and leg strains develop as well as unnatural fatigue.

In the act of walking with the foot in a normal condition, the heel first contacts with the ground, the weight then shifts forwardly along the outside of the foot, then the foot rolls inwardly, shifting the weight to the inner side of the metatarsal arch to that part of the foot which is commonly referred to as the "ball" of the foot, and as the foot lifts for the next step forward, the weight is on that portion of the foot in advance of the ball and including the large toe. This shifting of the weight by the forward, outward and inward roll brings the various bones and muscles into relative movement. When the bones of the foot structure are slightly displaced the foot cannot roll freely and comes down more or less flat, and such relative movement of the bones as does occur is strained and unnatural and produces fatigue, irritation and discomfort.

Various corrective devices have heretofore been proposed, the most commercially successful of which are rigid, being made of steel, and being much higher on the inside of the longitudinal arch than on the outside, the purpose being to throw the weight of the foot naturally to the outside of the foot and thereby approach a condition comparable to that obtained with the bones in a natural position. The objection to such a rigid structure, however, is that it does not permit of the natural movement of the bones relatively to one another, holding them in a more or less fixed position, with the result that the muscles become atrophied, and instead of being corrective, such devices in many cases aggravate weakness both by preventing the natural development of the muscles and preventing the proper free movement of the bones relatively to one another. As a matter of fact, such rigid devices destroy the suspended condition of the inner longitudinal arch by supporting it from below.

Other devices have been proposed, among them being the structure disclosed in my Patent No. 1,517,170, dated November 25, 1924, wherein the support is non-metallic, and therefore permits relative movement of the bones, tending in theory to overcome many of the objections of the rigid metal arch support.

The development of such devices, however, has been on the theory that the support should be thicker on the inner side of the foot than on the outer side, tending to throw the weight to the outside of the foot. This is the arrangement disclosed in my said patent above referred to. I have since determined that this is not sound, first, for the reason that it tends to shift the weight unnaturally to the outside of the foot, compelling the foot to walk upon an incline plane actually displacing the foot at the ankle,—a condition antagonistic to natural walking. This condition then tends to prevent the roll of the foot naturally toward the inside tread of the metatarsal arch; and secondly, it tends to offer greater resistance to the suspended inner longitudinal arch by support from below, and therefore correcting the outer longitudinal arch which may be properly restored to position by pressure from below.

Such an arrangement, while tending considerably to alleviate the effects of a weakened or broken down arch, does not create the proper corrective influences desirable for developing the muscles of the foot and overcoming the inherent weakness. After considerable experiment on a large number of patients I have determined that the most corrective, as well as the most alleviating results, are obtained by the use of a material in the manufacture of devices of this kind which

is highly elastic and flexible, but which is restrained from too much displacement, and which is either of substantially uniform transverse thickness, or is slightly higher on the outside of the foot than on the inside.

The present invention may be readily understood by reference to the accompanying drawing in which:

Figure 1 represents a plan view of a support embodying my invention;

Figure 2 is a side elevation of the support shown in Figure 1;

Figure 3 is a transverse vertical section in the plane of line III—III of Figure 1;

Figure 4 is a view similar to Figure 1 of a slightly modified shape of support;

Figure 5 is a view similar to Figure 3 showing a support which is higher at the outside of the foot than at the inside; and

Figure 6 is a somewhat schematic view showing the approximate location of the support of Figure 1 in a shoe.

Referring first to the construction shown in Figures 1, 2 and 3, the device comprises an integral mass of sponge rubber **2** having a relatively thin flat heel portion **3**, an arched supporting portion **4** which increases in thickness longitudinally from the heel portion to a point which corresponds substantially to the highest portion of the arch of the wearer and which then tapers off gradually to the front edge of the support, the length and curvature of the portion **4** corresponding generally to the length and curvature of the foot to which the device is applied. In order to secure the proper corrective action, the supports are made in different sizes. A section transversely of the support at any point between the heel portion and the extreme front portion shows the part **4** to be of substantially uniform transverse thickness, as indicated by Figure 3, which shows a typical cross-section through the part **4** of the arch support.

Vulcanized to the upper surface of the arch support is a layer of rubber impregnated fabric, which is substantially co-extensive with the support, and which is designated **5**. The fabric which I prefer to use and which is a commercially available material suggesting in appearance so-called "oil cloth", but which is impregnated with rubber, presents a smooth surface on which the foot can slide when the device is in a shoe, whereas the sponge rubber itself presents a friction surface which does not permit the foot to slide easily. Aside from providing a relatively slippery and non-absorbent surface, however, it does, through being vulcanized to the mass of sponge rubber, serve to hold the rubber somewhat in place. Being a fabric, it does not stretch or flow sidewise to an excessive amount the way sponge rubber will, thus serving to prolong the life of the support and serving to keep the support in condition where it will longer effectively provide the proper conditions for support. Being a flexible material, it of course permits of such distortion as is required to meet the movement of the foot in the act of walking. I prefer that this layer of vulcanized fabric be provided only on the top surface of the support for the reason that when located at the top of the support it provides a low friction surface and provides ample means to keep the sponge rubber closely to its shape. The bottom surface of the support, however, is preferably the surface of the sponge rubber. This provides a high friction surface for contact with the bottom of the shoe in which the support is placed, which serves to better hold the device in place in the shoe when the foot is being slipped into the shoe, and serves to better retain the device against creeping in the act of walking. Moreover, since the bottom of the support is the natural surface of the sponge rubber, a more natural "flow" or displacement of the rubber may occur in the act of walking than if the rubber were completely confined on both surfaces. It has the further advantage of permitting the circulation of air more readily through the mass of sponge rubber, tending to prevent the air from being trapped to too great an extent in any portion of the rubber.

Passing completely through the arch support, including the sponge rubber and the rubberized fabric on the top surface, are a number of relatively large holes **6** distributed more or less haphazardly over the area of the support and one arrangement of which is shown in Figure 1 of the drawing. These holes serve first to materially lighten the weight of the support as their total area represents a relatively large percent of the area of the support, and the support may be from 20 to 35% lighter than if the holes were not present. A second advantage of these holes is that in walking perspiration of the foot occurs, and the smooth surface of the rubberized fabric would tend to increase the sweating and moistening of the foot. By providing the holes, not only is ventilation obtained, but a more or less forced circulation of air is brought about by reason of the fact that the compression of the sponge rubber tends to create an air pressure in these holes, establishing a mild but definite circulation of air under the entire area of the foot, thus overcoming the objections incident to the use of a smooth rubber or leather surface on a device of this character. This effects the rapid evaporation of foot moisture.

A further advantage of the holes is that when the rubber is compressed together the air in the holes provides a support for the foot. Finally, the holes provide a space into which the rubber can be displaced or squeezed in the act of walking, tending toward better supporting action and preventing too great a compression of the rubber at any one point.

Figure 6 illustrates the manner of application of the support to the shoe. In this figure, **7** designates the shoe. The support sits in the bottom of the shoe with the heel portion **3** in the heel of the shoe, and with the supporting portion **4** extending over the shank of the shoe, the forward portion of the support terminating at about the widest point of the toe portion of the shoe. The support is the full width of the bottom of the shoe at the heel portion, and it has parallel sides so that forwardly of the heel portion it drops away from the outer side of the shoe, but remains close to the inner side of the shoe. In the act of walking, the load first comes on the heel in the neighborhood of the point marked X. Since the support tends to hold the outer longitudinal arch of the foot up in its normal place, the natural tendency of the wearer is for his weight to be thrown to the outside of the shoe. Consequently, it is unnecessary that the support be sloped outwardly for this purpose. Since the support is of uniform transverse width in the arrangement described, the rubber along the outside of the part **4** is compressed to a greater extent than is the rubber along the inside of the arch support. This is desirable, because it gives a substantial support from below to the outer

longitudinal arch and only a slight upward pressure to the suspended inner arch construction of the foot, and causes the wearer to naturally and instinctively roll his foot toward the inside of the foot as the step approaches completion. In other words, as the step progresses, the weight shifts from the point X partially along the outside edge of the arch support toward the point marked Y somewhat near the outside of the metatarsal arch. The greater compression of the rubber along the outside edge of the support serves to naturally make the walker "toe in" so that the weight shifts approximately to the point Z at the inner side of the metatarsal arch, and at this time the weight is then properly assumed by the foot at points X, Y and Z. The forward end of the support terminates just under the metatarsal arch.

The device, therefore, has the function, first, of holding the bones of the foot in a substantially normal position and has the further tendency to make the wearer "toe in", i. e., shift the weight from the point Y to the point Z when the step is completed and before the foot starts to bend for the next step. Since the device is of uniform width and is only as wide as the heel of the shoe, it does not give full support across the width of the foot at the front of the longitudinal arch, with the result that the shape of the support is such as to maintain the inner longitudinal arch suspended.

Where it is desirable to give some support to the anterior or metatarsal arch, the arrangement shown in Fig. 4 may be resorted to instead of the arrangement shown in Fig. 1. Generally, the two devices are similar and similar reference numerals have been used to designate the corresponding parts. The front edge of the support, instead of being straight across, is rounded, as indicated at 8, and tapers off slightly less gradually. By reason of the rounded part it is slightly longer, and the rounded part extends under the anterior arch between the points Y and Z, as indicated by the dotted lines in Figure 6, thereby lending support to the anterior arch.

In the arrangement which I have described, the support is of uniform transverse thickness across the portion 4. In the treatment of aggravated foot conditions I have found that in a sponge rubber device of this kind a benefit is derived from having the support slightly thicker along its outside edge than along its inside edge, this being contrary to the accepted way of designing arch supports. This is shown in Figure 5 wherein the structure is generally the same as that shown in Figure 3 and wherein corresponding reference numerals have been used to designate corresponding parts. In this figure, 9 designates the outer edge of the support, and 10 is the inner edge. At any point transversely of the arch supporting part 4 the support is slightly thicker along the outer edge, tapering down gradually toward the inner edge. As previously explained, the support extends under the entire arch of the foot and is thick enough to give support at any point of the main or longitudinal arch. It therefore naturally tends to hold the bones in a correct position so that there is a natural tendency for the weight to be thrown along the outer edge of the arch.

This tends to compress the outer edge of the support more than the inner edge, with the result that in the act of walking, the support is compressed to a point where the inside is really materially higher than the outside. By increasing the thickness of the outside edge of the support a greater resistance to compression is built up along the outer edge, tending first to give added support to the outside of the arch and tend to cause the wearer to "toe in" as he is walking.

By using sponge rubber as the material for the arch support, a greater degree of compressibility and flexibility is obtained than where the device is formed of solid rubber. Resilience, furthermore, is obtained through the fact that the porous rubber sponge traps the air and the cushioning effect is secured partially by the compressing of this entrapped air. Under the constant impact of walking, the expansion and compression of the air serves to keep the rubber from becoming compacted, whereas a sufficiently soft solid rubber body tends to become permanently distorted under the continued impact of walking. Furthermore, the sponge rubber is of substantially uniform porosity so that a given thickness of it always has about the same degree of resilience. The wearer therefore is not conscious of any localized areas of counter-pressure, the entire device feeling smooth and comfortable under the foot of the wearer.

The observed advantages of the invention are, principally, that the device, while supporting the bones of the foot in proper position, permits of their proper relative movement, and at the same time tends to cause the foot to roll and the walker to "toe in" in a natural way.

While it is normally as high or higher on the outer edge than on the inner edge, it compresses along the outer edge to a greater extent than along the inner edge in the act of walking, giving at a point in the act of walking the effect of a support which is higher on its inner side than on its outer side. That is, when the rubber is compressed on its outer edge and is under little compression at the inner edge, the support actually provides a support which slopes in use outwardly, but without unduly pressing up on the inner longitudinal arch. However, it creates a tendency for the foot to ultimately roll in onto the ball of the foot in the final portion of the step, rather than tending to hold the weight to the outside of the foot, as do present arch supports having the outside definitely lower than the inside. Because of the fact that it gives a natural movement to the walking and allows the proper relative shifting of the bones, the foot is properly exercised and the muscles are developed, so that minor defects can be naturally corrected and the effect of major breakdowns very materially alleviated.

I claim:

1. An arch support comprising an integral body of sponge rubber having a heel portion and having a supporting portion extending forwardly of the heel portion, the supporting portion having a longitudinally curved surface conforming to the arch of the foot, the arch supporting portion being slightly thicker along its outside edge than along the inner edge or intermediate portions.

2. An arch supporting device comprising an integral mass of sponge rubber having a relatively thin flat heel portion and an arch supporting portion extending forwardly from the heel portion, the arch supporting portion being arched longitudinally, the length of the arch supporting portion being sufficient to extend from the heel to a point under the anterior arch of the foot of the wearer, the arch supporting portion throughout the major portion of its length being

substantially equal to the width of the shoe in which the support is placed, the extreme forward portion of the support being of less width, whereby it extends partially under the center of the anterior arch of the foot of the wearer without lifting the parts of the foot at each side of the center of the anterior arch, the top surface of the rubber having a layer of rubberized woven fabric vulcanized thereto for holding the rubber in shape, certain portions of the arch supporting portion having holes therethrough of relatively large diameter providing for the displacement of the rubber, the circulation of air, and increasing the resilience of the support.

3. An arch support comprising a heel portion and an arch supporting portion extending forwardly of the heel portion, the arch supporting portion having the top thereof curved in a longitudinal direction, the curvature beginning at the heel portion and extending forwardly to the forward end of the support, the length of the supporting portion being such as to extend only approximately to the region of the anterior arch of the wearer's foot, the arch supporting portion comprising a mass of sponge rubber having a fabric layer vulcanized to the top surface thereof, the arch supporting portion being of gradually diminishing thickness from the outside toward the inside edge thereof.

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