

April 1, 1958

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2,828,555

FOOTWEAR

Filed Nov. 16, 1953

4 Sheets-Sheet 1

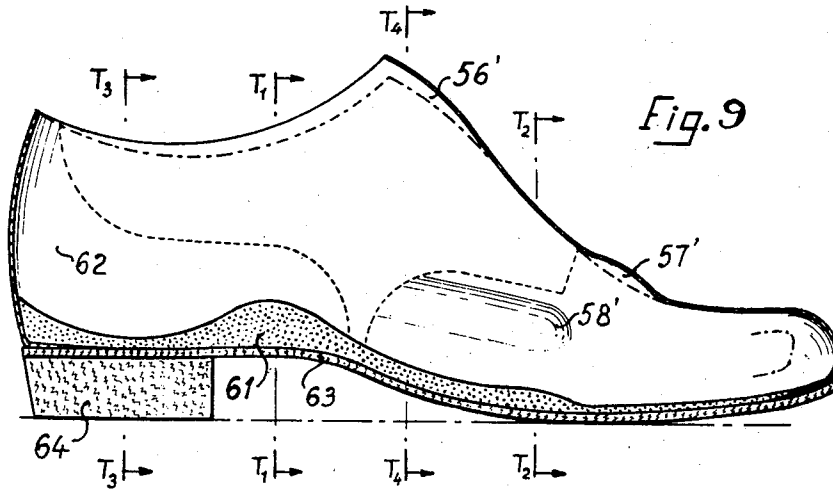


Fig. 9

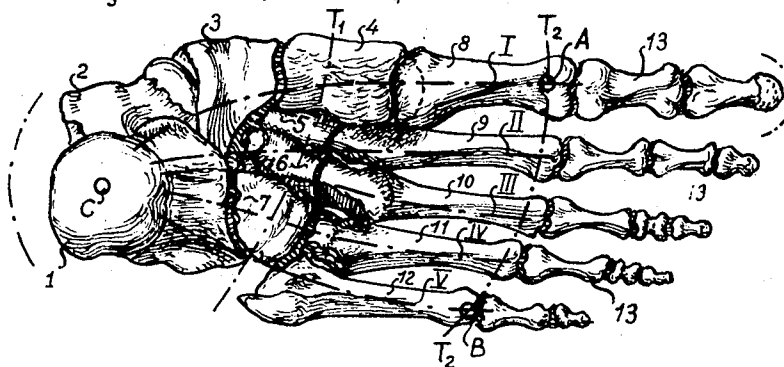


Fig. 1

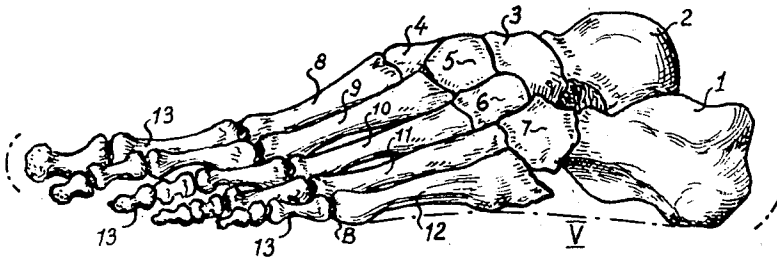


Fig. 2

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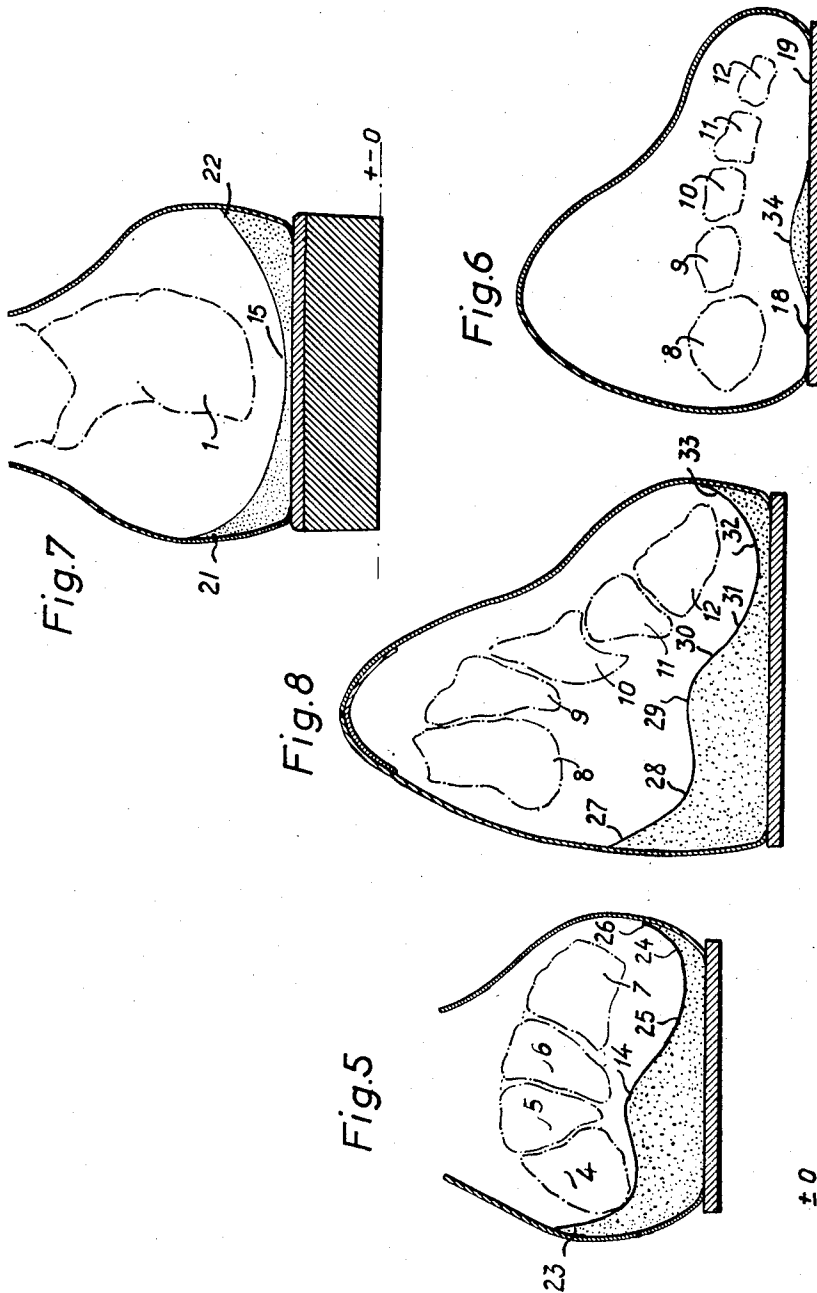
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Filed Nov. 16, 1953

4 Sheets-Sheet 3



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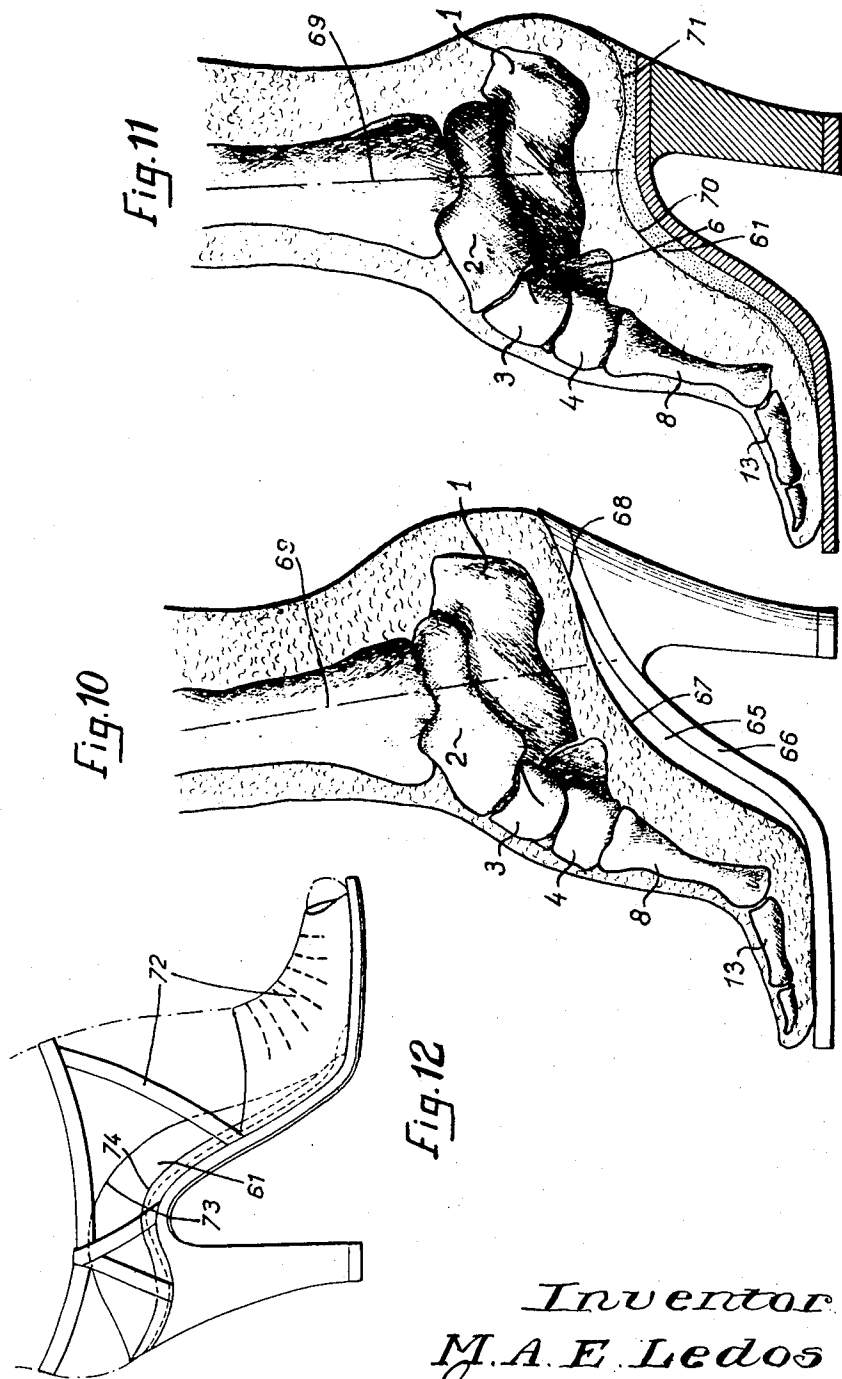
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FOOTWEAR

Filed Nov. 16, 1953

4 Sheets-Sheet 4



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2,828,555

FOOTWEAR

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Application November 16, 1953, Serial No. 392,418

Claims priority, application France December 24, 1952

4 Claims. (Cl. 36—71)

The present invention relates to footwear and has for its object to provide a foot support built into footwear and designed for proper posture and weight distribution.

In conventional footwear, the muscles holding the arches of the foot become weakened and strained and permit gradual breakdown, and flattening of such arches, so that the foot becomes more or less deformed and, as a result, the health and comfort of the wearer are affected.

The various bones and other elements of the foot tend to become displaced, with the result that certain portions of the foot are understrained, while other portions are overstrained and are subjected to excessive pressures. These excessive pressures on some parts of the foot cause the formation of corns, callouses and other deformities.

Orthopedic foot appliances have previously been proposed, having for their purpose to remedy foot deformities. Unfortunately, most of said orthopedic foot appliances devote their attention to correcting one part of the foot without supporting the entire foot, which results in increasing the strains on the various remaining arches and other supporting elements of the foot structure.

On the other hand, it has also been previously proposed to provide footwear with a foot-support more particularly for the plantar surface.

These known foot supports, however, merely constitute a kind of rigid or substantially rigid static base or moulding of the plantar surface on which the foot rests in normal standing position, but from which it becomes detached as soon as the user begins to walk.

Now, it is obvious that to provide a support adapted to walking conditions, which is the essential requirement to be met, it is not sufficient to adapt the support to the plantar surface, and that it is indispensable to consider also the dynamic conditions of walking so as to provide a support having mechanical properties adapted to such conditions.

It is a particular object of the invention to provide footwear having a foot support which will so elevate a point located on the centre line of the foot and in the region of the cuboid-scapoid joint thereof that this elevated region will correctly position the various arches of the foot in respect to each other and assure a proper distribution of the weight.

The invention will be better understood from the following detailed description, together with the accompanying drawings, submitted for purposes of illustration only and not intended to define the scope of the invention, reference being had for that purpose to the subjoined claims.

In these drawings:

Figs. 1 and 2 are elevational and sectional views, respectively, of the skeleton of a human foot.

Fig. 3 is a top view of a foot support according to the invention.

Fig. 4 is an axial sectional view along line III—III of

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Fig. 3 clearly showing the various longitudinal outlines of the foot supporting surface.

Figs. 5, 6, 7 and 8 are cross-sectional views along lines T1, T2, T3 and T4 of Fig. 3, respectively.

Fig. 9 is an axial vertical sectional view of a shoe according to the invention.

Figs. 10 and 11 are comparative views of a conventional lady's shoe and a lady's shoe according to the invention illustrating the advantages of the latter, Fig. 11 being an axial sectional view.

Fig. 12 is an elevational view of a lady's shoe according to Fig. 11.

As shown in Fig. 1, the human foot comprises twenty-six bones, and, in particular, the os calcis bone 1 by which the rear part of the foot is supported on the ground at C, the astragalus 2 on which is located the main articulation of the foot, the three cuneiform bones 4, 5 and 6, the scaphoid bone 3 which interconnects the latter with the astragalus, the cuboid bone 7 which bears directly on the os calcis bone, the five metatarsal bones the three first of which, 8, 9 and 10, respectively, are each articulated on one of the cuneiform bones and the fourth and fifth of which, 11 and 12, respectively, are both articulated on the suboid bone 7 and the phalangeal bones indicated at 13 which are each articulated on one of the metatarsal bones.

The human foot is supported on the ground at three main points, A, B and C, respectively, which are constituted by the heads of the first and fifth metatarsal bones, 8 and 12, and the base of the os calcis bone 1. These three main points may be considered as cross-braced by a structure comprising five longitudinal arches I, II, III, IV, V, respectively, and two transverse arches T1 and T2, respectively.

It is clearly shown, in the sectional view of Fig. 5 which is taken in the plane of the rear transverse arch T1, that the latter is constituted by an assembly comprising the three cuneiform bones 4, 5, 6 and the cuboid bone 7; the third or external cuneiform bone 6 constitutes the keystone of the whole structure. This structure does not rest directly on the ground but is supported at C through the scaphoid bone 3, the astragalus 2 and the os calcis bone 1. The rear transverse arch T1 also supports the five longitudinal arches I, II, III, IV, V so that if the external cuneiform bone 6 is properly supported, the whole assembly will be capable of ensuring its physiological functions without being subjected to stresses liable in time to cause permanent deformations of the system which could result in various complaints of the foot which may require orthopedic apparatus and which deprive the human foot of the natural properties with which it was originally designed and made.

As shown in Figs. 3 and 4, the foot support comprises a flat front portion 20 extending rearwards at 18 and 19 for supporting the head of the first metatarsal bone 8 and of the fifth metatarsal bone 12, respectively, of a foot, a concave rear portion 15 for supporting the heel of a foot above the plane of said front portion 20, and a forwardly and downwardly inclined arch supporting portion formed with a longitudinal median elevation extending forwardly to a point slightly ahead of the anterior arch T2 of the foot to provide support in the region and having its highest point positioned directly under the rear portion of the external cuneiform bone 6 so as to sustain the latter and the adjacent region of the cuboid-scapoid joint. The portion 14 of the foot support corresponding to this region is convex longitudinally and has a cross-sectional shape such that its top surface curves concavely from said median elevation to the inner longitudinal edge and to the outer longitudinal edge of the foot support,

said edges rising each from a point slightly behind the anterior transverse arch T2 to reach their greatest height substantially in the region of the rear transverse arch T1, the height of the inner edge being greater and the height of the outer edge being less than that of said median elevation.

The concavely curved transverse portions of the foot support are formed in such a manner that the lowest point of the inner concave transverse portion is higher than the lowest point of the outer concave transverse portion, said inner portion providing support for the longitudinal arch I, and said outer portion providing support for the longitudinal arch V of the foot the longitudinal median arch III of which is sustained by said median elevation of the foot support.

It will now be apparent that the top surface of the foot support is so designed that it effectively supports the bony structure of the inserted human foot in the normal position, that is, in the position in which the bones form natural longitudinal and transverse arches capable of taking up the stress placed on them by the body weight, and that it causes the greater part of the body weight to be distributed over the portion of the foot behind the rear transverse arch thereof to relieve the forepart of the foot from undue weight.

To facilitate the comprehension of the design of the various supporting portions of the foot support, there are shown in Figs. 5 to 8, four cross-sectional views along lines T1—T1, T2—T2, T3—T3 and T4—T4, respectively, of Figs. 3 and 4, the sections T1 and T2, respectively corresponding to the profiles supporting the rear and front transverse arches, respectively, while the sections T3 and T4 respectively correspond to a transversal plane containing point C located in the middle of the heel and to the mid-transversal plane of the foot.

A complete study of the supporting surface is given hereunder.

A. In the transversal direction (in the cross-sectional views of Figs. 5 to 8, line ± 0 indicates the ground level).

I. At the level of the heel (Fig. 7):

- (a) Nesting of the heel in a hollow 15.
- (b) Turning-up of the external and internal sides of the heel to permit nesting of the mid-portion thereof by means of upwardly-sloping cup edges 21, 22.

II. In a plane located at the first third of the foot length from the rear end (rear transverse arch), Fig. 5:

- (a) Internal lateral incurved reinforcement 23 for nesting the internal side of the foot in the astragalus internal lateral and scaphoid internal area.
- (b) Support ensuring a pressure at the level of the lower face of the scaphoid bone and astragalus-scaphoid internal joint.
- (c) Reinforcement 14 under the external cuneiform bone 6 at the level of the scaphoid-cuboid joint.
- (d) Slighter reinforcement 25 under the cuboid bone.
- (e) Reinforcement at the level of the inner side of the cuboid bone with beginning of the inclined plane of the external lateral nesting at 24.
- (f) External lateral nesting by an inclined plane and turning up of the antero-calcaneal and external cuboidal area 26.

III. Metatarsal region (Fig. 8):

- (a) On the internal side of the first metatarsal bone 8, internal lateral nesting 27 less elevated than at (a) II.
- (b) Under the first metatarsal bone 8, reinforcement slowly sloping down with respect to (b) II, at 28.
- (c) Under the second metatarsal bone 9, reinforcement 29 less protruding than at (c) II; same reinforcement under the third metatarsal bone at 30.

- (d) Under the fourth metatarsal bone 11, reinforcement substantially similar to (d) II at 31.
 - (e) Under the fifth metatarsal bone 12, reinforcement similar to (e) II at 32.
 - (f) External lateral nesting with inclined plane similar to (f) II at 33.
- IV. Metatarsal heads (front transverse arch, Fig. 6):
- (a) The lower face of the support is so shaped as to accommodate point A of the bearing triangle, the head of the first metatarsal bone 8 bearing flat on the supporting surface of the sole 18.
 - (b) Antero-metatarsal reinforcement 34 slowly sloping down from reinforcements (c) II and (c) III and extending across the mid third of the width of the front transverse arch with a maximum thickness at the level of the longitudinal axis of the foot.
 - (c) Accommodation of point B of the bearing triangle corresponding to the head of the fifth metatarsal bone 12 with shaping of the foot support similar to that provided for accommodating point A.
- V. Metatarsal-phalangeal articulation: Flat surface merging very smoothly into the antero-metatarsal reinforcement 34.
- VI. At one fifth of the foot length from the front end 35 turning up of the supporting sole to facilitate the action of the foot during walking (Figs. 3 and 4).

In the longitudinal direction (Fig. 4)

VII. On the internal edge:

- (a) Heel: rear turning up 36 for completing the nesting action of the cup-like recess.
- (b) Turning up along an inclined plane and lateral nesting of the heel.
- (c) At the level of external cuneiform bone, maximum internal lateral nesting 37 (internal area of the heads of the astragalus, scaphoid and external cuneiform bones).
- (d) Internal lateral nesting of slowly decreasing thickness 38 towards the head of the first metatarsal bone (zero level).
- (e) Upwardly sloping portion progressively increasing frontwards at 39 originating at one fifth of the foot length from the front end.

VIII. At the level of the internal longitudinal arch (I, Fig. 4), from the os calcis bone, through the internal face of the sustentaculum tali, the lower portion of the head of the astragalus, the lower portions of the scaphoid and external cuneiform bones, the base of the first metatarsal bone and its diaphysis, to the head of the first metatarsal bone:

- (a) At the rear of the heel, rear turning-up along an inclined plane and nesting at 40.
- (b) Under the heel inclined plane for internal lateral turning-up at 36.
- (c) At the level of the heads of the astragalus, scaphoid and external cuneiform bones, frontwardly increasing thickness at 41 reaching its top point at one third of the foot length from the rear end 42.
- (d) Reinforcement sloping down frontwardly at 43 to reach zero level behind the metatarsal-phalangeal joint of the big toe and to accommodate the bearing point A at 44.

IX. At the level of the second and third longitudinal arches (III, Fig. 4) from the os calcis bone, under the sustentaculum tali, the external cuneiform bone 6 and along the second and third metatarsal bones:

- (a) At the rear of the heel, rear turning-up along an inclined plane and nesting at 45.
- (b) Under the heel, the cup-like recess 15 suitably hollowed to nest the heel.

- (c) Progressive pressure of reinforcement 46 reaching its maximum value at the level of the bone 6.
- (d) Frontwards extension 47 of reinforcement 46 to form the antero-metatarsal reinforcement 34 which smoothly merges through an inclined plane into zero level, which is reached at the level of metatarsal-phalangeal joints of the second and third metatarsal bones.
- X. At the level of the fifth longitudinal arch, from the os calcis bone through the cuboid bone and along the fifth metatarsal bone (V, Fig. 4):
- (a) At the rear part of the heel, rear turning-up along an inclined plane at 48.
 - (b) Under the heel, external lateral turning-up along an inclined plane at 49.
 - (c) Reinforcement with an inclined plane for external turning-up and nesting at 50.
 - (d) Front inclined plane sloping down to reach zero behind the head of the fifth metatarsal bone to accommodate bearing point B at 51.
- XI. On the external lateral edge (Fig. 3), external lateral nesting from the heel to the metatarsal-phalangeal joint of the fifth metatarsal bone (16, 52).
- XII. Progressive turning up of the bearing surface on its whole front part from one fifth of the foot length, to facilitate the action of the foot during walking (35).

The above detailed description of the structure of the foot support, completed by the level or contour lines from zero to +45 of the diagram of Fig. 3, which lines are established with respect to the level of the ground, assuming that the foot is 24 cm. long and the shoe is provided with a 2 cm. high heel, clearly shows that the design of the entire foot support is perfectly adapted to the anatomy, physiology and functional requirements of the human foot.

The above described foot support may be made of a material which is not only elastically deformable, as already mentioned above, but offers, moreover, humidity absorbing properties.

A material having the following composition, has been found satisfactory, all proportions being established as a percentage of the weight of the gum:

Pure gum.	Percent
Oleic acid.....	5 to 10
Stearic acid.....	5 to 10
Zinc oxide.....	5 to 10
Magnesium carbonate.....	2 to 5
De-oxidising agent.....	1 to 2
Titanium oxide.....	5 to 10
Accelerator	1 to 3
Sulphur	2 to 3

this composition being completed by an aerating agent such as sodium bicarbonate in a proportion of 10% to 20% of the gum weight and by granulated or powdered cork in the proportion of 20% to 50% of the weight of the gum, to enable the composition to absorb moisture and to assist the foot support in keeping its shape.

In Fig. 9 are diagrammatically shown the elements of a shoe according to the invention comprising an insole 61 and uppers 62, the shoe assembly further comprising, as usual, one or more soles 63 and the heel 64.

It is to be noted that the outer outline of the uppers of the shoe according to the invention is higher than in a conventional shoe and is provided with bosses 56', 57' and 58'.

For comparison purposes, the outer profile of a conventional shoe has been shown in dotted lines.

In Fig. 10 is diagrammatically shown a high-heeled conventional and lady's shoe. Such a shoe has a number of drawbacks. First of all, a gap is formed at 65 between the sole 66 and the underside 67 of the foot. The supporting surface 68 of the shoe heel is inclined.

As a consequence of these two defects, the weight of the foot bears solely on the toes. This causes a considerable fatigue and, often, an acute pain at the level of the metatarsal heads. Furthermore, in normal standing position, as shown, that fraction of the weight of the body which is transmitted to the heel produces a strong pressure of the astragalus on the os calcis bone 1 and prevents the axis 69 of the leg from being angularly displaced beyond the forwardly inclined position shown in Fig. 10.

In contradistinction thereto, in footwear according to the invention (Figs. 11 and 12), in normal standing position, the underside of the foot fits along its whole length on the support 61 with a maximum pressure zone at 70 under the external cuneiform bone 6, by an elastic deformation of the median elevation portion 14 (see Fig. 5) provided under the external cuneiform bone 6. The heel of the foot nests in the recess at 71, and the weight of the body is evenly distributed on either side of axis 69 of the leg, thereby relieving the front of the foot. Furthermore, the orientation of the os calcis bone 1, which is more natural than in Fig. 10, permits the leg to have its axis substantially vertical, as shown in Fig. 11.

It will be seen that a lady's shoe according to the invention, as shown in Fig. 12, offers, besides the special advantages which have been just described, all the main advantages inherent in the footwear described above.

In Fig. 12 is shown a design of lady's shoe the uppers 72 of which are constructed according to the invention and which comprises a foot support 61 and its double lateral nesting 73, 74.

While the invention has been described with particular reference to preferred embodiments, it is not intended to limit the scope of the invention to said embodiments, nor otherwise than by the terms of the subjoined claims.

In particular, footwear forms or lasts designed according to the invention permit mass manufacturing of any type of footwear such as the usual heavy shoes, dress shoes, light and sports shoes, tennis shoes, high boots, half-boots and jack-boots, for ordinary or professional use.

What I claim is:

1. The combination with footwear having a heel, a sole and uppers, of an elongated foot support made of elastically deformable material and comprising a concave rear portion for supporting the heel of the wearer's foot above the plane of said sole, and a forwardly and downwardly inclined arch supporting portion having its bottom and inner and outer faces overlying areas of said sole and uppers, respectively, and its inclined inner and outer edges rising from a point slightly behind the anterior transverse arch to reach their greatest height substantially in the region of the rear transverse arch, said inclined inner edge being more elevated than said inclined outer edge, the portion of said arch supporting portion located in said region of the rear transverse arch being convex longitudinally and having a cross-sectional shape such that its top surface curves concavely from said inner and outer edges to a longitudinal median elevation extending forwardly to a point slightly ahead of said anterior transverse arch to provide support in the region thereof, said median elevation having its portion of greatest height less than that of said inner edge but of greater height than said outer edge, and said median elevation having its highest point positioned directly under the rear portion of the third or external cuneiform bone so as to support the region of the cuboid-scapoid joint to thereby provide support for said rear transverse arch in such a manner that not only all of the various arches will be correctly positioned with respect to each other, but also the body weight properly distributed over all the parts of the foot.

2. Footwear according to claim 1, in which said elastically deformable material has the following composi-

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tion, in which all proportions relate to the weight of pure gum:

Pure gum.	Percent	
Oleic acid.....	5 to 10	5
Stearic acid.....	5 to 10	
Zinc oxide.....	2 to 5	
Magnesium carbonate.....	2 to 5	10
De-oxidising agent.....	1 to 2	
Titanium oxide.....	5 to 10	
Accelerator.....	1 to 3	15
Sulphur.....	2 to 3	
Aerating agent such as sodium bicarbonate.....	10 to 20	
Granulated or powdered cork.....	20 to 50	

3. Footwear according to claim 1, in which said uppers have a shape and capacity adapted to accommodate the muscles and fleshy parts of the wearer's foot which are displaced with respect to the position they would occupy in conventional footwear, due to the presence of said foot support.

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4. Foot-wear according to claim 1, in which the inner concave transverse portion of said top surface of the foot support has its lowest point higher than the lowest point of the outer concave transverse portion of said top surface.

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