

FOOT-GEAR.<sup>1</sup>

By JAMES MENNELL, M.D.

WHEN we look at the windows of any ordinary shoe shop of even moderate size we find them labelled "Ladies and Children" on one side and "Gents" on the other. Now why should this be so? "Children" and "Adults" one could understand, but "Ladies" and "Children" together, "Ladies" and "Gents" contrasted and divorced from one another can have no scientific justification. A human foot is a human foot—and one of the most wonderful works of the Almighty at that—be it male or female, nor do the marvels of its design include one pattern for men and another for women. Indeed we need a micrometer screw to distinguish between some of the bones of the skeleton of the male and female foot, while most of them are quite indistinguishable. There can therefore be no particle of scientific justification for the divorce of the two departments that deal with foot-gear. In other words we are the slaves of fashion and of the shoe manufacturer.

In the windows of one side of the shops we see shoes with relatively high heels and pointed toes, in the other we see them with relatively low heels and square toes. In the section of the first reserved for children we find a reversion to the low heel square toe variety again, but of different type. One can only meditate sadly on the changes that are supposed to take place in the human foot during adolescence to justify the change—possibly in a few months—from the children's type of foot-gear to one of the other types.

*The Sole.*—Few people will deny that the heel is narrower than the fore-part of the foot at the level of the heads of the metatarsals, and it is perfectly plain therefore that the general contour of any shoe to be accurate must be roughly triangular when seen from above, the angle at the heel being somewhat rounded (fig. 1). It is not by any means always found that even this elementary law of divergence of these lines is fulfilled adequately and the divergence of the two side lines of the shoe from the centre line of the foot is one that should receive far more attention than is apparently given to it.

The variation in shape and manufacture can easily be tested by placing a straight line between the centre of the heel and the forepart of the shoe running along the middle of the waist. In the tracing of the ordinary human foot this centre line usually passes through about the space between the second and the middle toe, but in many shoes that are made it is quite easy to establish that the design of the last is such that this line passes much too obliquely one way or the other, which means that there must be a very forcible strain upon the joints of the fore-part of the foot tending to swing it round away from the side which encounters pressure. The point where most of this particular pressure is felt is over the head of the first metatarsal

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on the inner side or the fifth on the outer. In choosing a shoe for a normal foot it is therefore wise to select one that has been built upon a last which gives the appearance, when viewed from the sole, of being thrown well in to the inner side at this point, provided the outer side is not thrown inwards to match (fig. 2).

We now come to the consideration of what should be done with the part of the shoe that concerns the foot in front of the metatarsal heads. We must remember in the first place that the laws of physics apply as much in the fitting of a shoe as in any other branch of life. When we raise the heel from the ground the sole of the shoe must of necessity assume a curve, and if the heel of the shoe remains in contact with the heel of the individual, the fore-part of the foot must of necessity slip forward on the surface of the sole (fig. 3). If it did not do so we should have in action the "three-ply system", and as you know this simply means that three very flexible pieces of wood when bound together become relatively rigid. The allowance that should be made for this sliding forwards is two boot sizes; this may

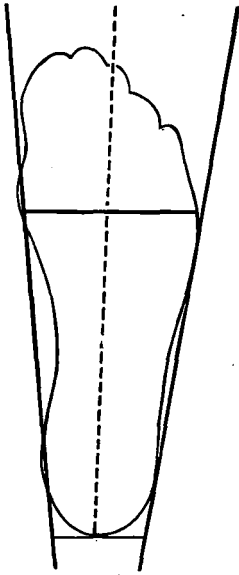


FIG. 1.—To show how the lines joining the sides of the heels to the sides of the metatarsal heads converge towards the heel. Note that although the tracing shows the contour of a foot that is fully serviceable and free from symptoms, it shows nevertheless signs of deformity due to inadequate foot-gear in the cramping of the big toe outwards and of the little toe inwards.

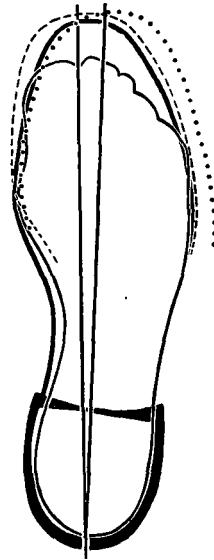


FIG. 2.—Tracings of three welts and the foot for which the shoes are provided. The firm lines show the outline of a plain walking shoe, the broken line that of a (supposedly) similar shoe, and the dotted line that of a golf shoe. The broken line shows the only good fitting. Note the swing away from the centre line of inner side of this shoe and compare it with that of the dotted line. The latter is a far larger shoe but it holds the whole foot in a faulty position.

sound excessive, but in practice it is no more than is essential.<sup>1</sup> Having made this allowance it is quite immaterial what happens beyond it, and the front of the shoe beyond the extreme limit of the essential space is a matter of indifference. Any shape is permissible provided always that the inner side of the shoe does not begin

<sup>1</sup> A boot-size in this country is  $\frac{1}{3}$  in.

to slope outwards until the front of the big toe is reached, and that any slope which is given on the outer side does not detract from the two boot-sizes which are left for the sliding forward of the little toe on the sole when it bends. There should therefore be no quarrel between the human foot and the pointed shoe, the only thing that matters is where the slopes of the point take place (fig. 4).

*The Heel.*—Now we must return to the question of the heel and whether the relatively high heel in the women's department, or the low heel of the men's department is the right and proper one. At first sight the temptation is to condemn the one and laud the other, but this simply ignores the one consideration

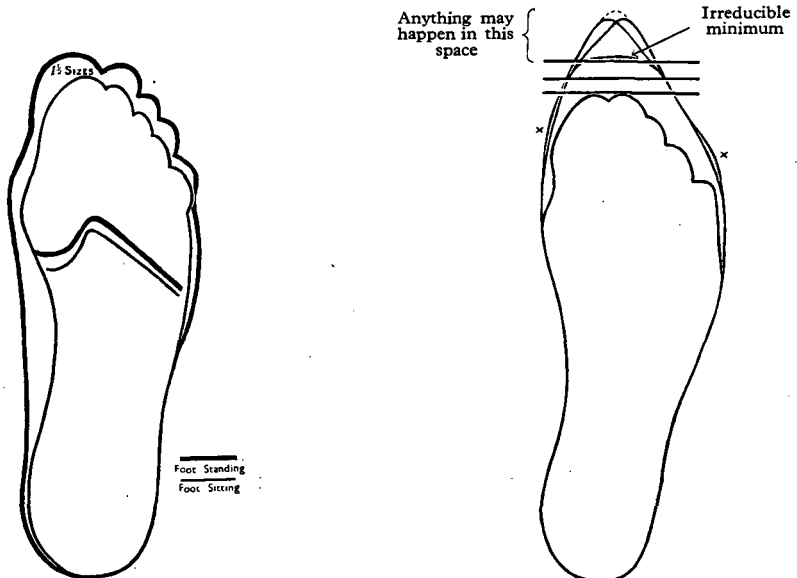


FIG. 3.—Sketch of a foot sitting and standing, showing outline of the back of the metatarsal heads. Note also increase of breadth. This foot is less deformed by foot-gear than that shown in fig. 1 on the outer side, but the big toe still shows signs of pressure. When the heel is raised the front of the toe shoots forwards on the sole to at least the extent of another two sizes— $\frac{2}{3}$  of an inch.

FIG. 4.—To show how a point may be added to an otherwise perfect shoe merely by increase of length. The only disadvantage is the liability to crease rather markedly, and, should the "break" occur at an unfortunate spot—it must occur somewhere—detrimental pressure on the toes may ensue. XX Two points at which the slope commonly begins prematurely. The outer of the two lines shows the correct contour.

on which alone the solution of this much-discussed problem depends. The point in question is nothing more or less than the elasticity of the calf muscles. If there is any relative insufficiency in this elasticity or in the length of the tendo Achillis, then it becomes obvious that, in order to place toe and heel on the ground together and to keep the leg vertical, something has got to stretch. That "something" is of course the structures in the sole of the foot. Bad as no doubt this may be for the intrinsic structures, the stretching forward of the fore-part must of necessity separate the head of the first metatarsal from the back of the internal malleolus round which passes the tendon of the flexor longus hallucis. If the slide forward of

the phalanx of the big toe is great, this muscle or its tendon may lack sufficient elasticity on the one hand or length on the other to allow the distal phalanx to dorsiflex in freedom. Indeed it is almost inevitable that it should be dragged down into the sole of the shoe until, as often happens, a definite hole is dug by the toe on the surface of the sole. Naturally if the sole is thin there is no substance into which the toe can "bed" itself and therefore the tendon becomes more and more strained.

Every normal foot in which the mobility of the joints is not destroyed will elongate to a certain extent when the weight of the body is placed upon it. The extent to which this happens varies considerably, a single boot-size is about the usual, one and a half sizes is not uncommon in a perfectly normal foot (as shown in fig. 3), but anything beyond this should be regarded as pathological.

These considerations lead us therefore to the consideration of the height of the heel required for an individual, be he male or female. The position may be summed up in few words; there are many men who will never know what it is to walk in comfort with less than two and a half inches of elevation at the heel, while some women (particularly those with a hallux rigidus) can never know comfort with any elevation above about three-quarters of an inch. It is utterly wrong therefore for

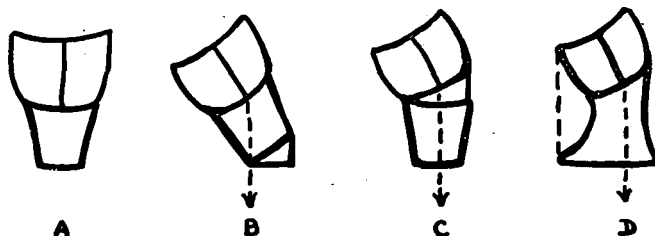


FIG. 5.—To show how the heel should be wedged on the inner side. The figures show the left heel seen from behind: (A) An ordinary heel of the "peg-top" type; (B) To show the effect of placing the wedge near the ground; (C) To show the effect of a corresponding wedge placed near the top of the heel; (D) To show how the lower part of the heel should be thrown out to the outer side to counteract the tendency for the foot to turn over to the outer side.

(From Mennell's "Physical Treatment". With acknowledgment to Messrs. J. & A. Churchill, Ltd.)

men to scoff at the relatively high heel of the shoes in the female shop, but equally many women would be well advised to adopt the relatively low heel in the men's shop. I do not wish this to be taken as being in any way a defence for the extravagantly high heel—i.e. anything above three inches—seen in the women's section, for which there can be no excuse; but for many people, whether male or female, anything up to two and a half inches of elevation may be of vital necessity to comfort.

*Heel-wedges.*—While on the question of heels it might be opportune to say one word about the wedging of a heel though I realize that this is a question of abnormal foot-gear rather than of the normal. In the first place I want to demonstrate to you the contrast between applying the wedge to the bottom of the heel and to the top. A glance at the line drawings will illustrate the point adequately. Under no circumstances should any elevation be made on the inner side unless the heel is thrown out to the outer side at the same time, so as to ensure that the centre of gravity of the body still falls through the centre of the heel of the shoe (fig. 5).

This leads on to the consideration of whether the sole should be wedged on the inner side or not. It seems to me that this prescription is often given without adequate consideration of the mechanical effect that it must produce. The longitudinal arch of the foot on the inner side is formed by the os calcis, the astragalus, scaphoid and first metatarsal. Anything that prevents the head of the first metatarsal from dropping downwards must of necessity tend to flatten the arch. On the other hand, if the heel is wedged upon the inner side and the sole is not raised, the tendency can only be to increase the arch and so relieve the structures in the sole of strain. It seems, therefore, that if we are to use the wedging of the sole aright, we should use it only for those cases in which restoration of mobility is impractical owing to pathological changes within the joints. To apply a sole wedge when we hope to maintain or to restore full mobility is calculated to defeat our main object in treatment.

Returning once more to the heel of the shoe, the "set" at which it is built is often of vital importance. The practice of turning inwards the angle of the heel at the forepart on the inner side is to invite the individual to evert the foot at every step that is taken. No last should ever be chosen in which the angle fails to touch the straight line drawn from the inner side of the heel to the inner side of the sole.

*Fitting.*—We now come to the consideration of the general type of shoe to be chosen by any individual. Attention has already been drawn to the danger of relying for selection of length on the measurement of the foot while sitting. It should be an invariable practice to measure it standing as well, as even if the length of the foot increases by only a length on standing, due allowance should be made. We then add the two boot-sizes necessary for the sliding forward of the front of the foot and finally any addition that may be necessary to allow for the shaping in front. We must add at least half a size to allow for a thin sock and the thickness of the shoe material. The question of breadth is as important as the question of length and again it is necessary to take the breadth standing and sitting. If a tape is placed around the foot at the level of the heads of the metatarsals, and the measurement is taken in the sitting and the standing positions consecutively, it is not at all an uncommon thing to find there is a difference in the two measurements of anything up to three-quarters of an inch (fig. 3). As, however, we have to supply a shoe of a length considerably in excess of the length of the foot, there is no necessity with a normal foot to do the same with regard to breadth. In fact if we do, it often leads to disaster and the shoe chosen is merely a sack. With one exception it is wise to choose from the point of view of breadth a shoe which is a quarter of an inch under the measurement of the breadth of the foot when standing. The one exception is when the patient is the victim of a hallux valgus with a bunion, and in this event the full measurement should be allowed and indeed something extra may be required.

*The Upper.*—We now come to the consideration of the "upper" and here I would remind you not to lay too much faith in the statement of size placed on any shoes in the ladies' department. It is by no means an uncommon event to find a shoe that is labelled five actually measures seven or even more when examined with the shoe-stick. Unfortunately there seems to be no general law in the trade governing the length which a shoe is stated to be in the ladies' department. In the men's

department the variation between the actual and the stated lengths is comparatively insignificant.

The shaping of the "upper" varies enormously according to the different lasts. In American shoes the depth of the front of the toe is usually maintained to the end of the shoe. In the eye of the English manufacturer this is not satisfactory, and it is customary to slope the front part of the shoe down gradually for a considerable distance. It is perfectly plain therefore that this practice must render the front part of a shoe so shallow that the big toe and second toe cannot find their way under this sloping roof. This extra length therefore is sheer waste. It is a particularly sad reflection that this fault is carried to extremes in the children's departments, and, wherever this slope is observed, due allowance must be made for it in estimating the effective length of the shoe.

For most of us a heel elevation of some sort is far more conducive to comfort than no elevation at all. Not long ago an attempt was made to popularize the heel-less shoe; it has not proved to be a success. If, however, we raise the height of the heel at all, the upper surface of the sole of the shoe must of necessity be on an inclined plane, and therefore there will be a tendency for the foot to slip forward down this inclined plane, thus tending to allow the heel of the foot to slip away from the heel of the shoe into the forepart. When this is allowed to take place it is obvious that we must be depriving the patient of the advantage of the extra length for which we have made provision in front. It is essential therefore for comfort that something should be provided to keep the heel back in the heel of the shoe. A narrow strap fixed with a button is totally inadequate and nothing less than two narrow straps fastened with buckles is in any way effective. This of necessity implies the instantaneous condemnation of the court or pump shoe for walking purposes. It is of course a matter of indifference what type of shoe is chosen if it is only to be worn while sitting at the dinner- or bridge-table; we are concerned to-day only with the consideration of foot-gear that will enable us to walk or to stand about without risk of injury. If no adequate provision is made to keep the heel of the foot back in the heel of the shoe, it is obvious that something must prevent the foot from sliding down the slope provided by the inclined plane, and the only thing which can prevent it is the meeting of the front part of the foot with an opposition from the front part of the shoe. This suffices to prevent any forward gliding whatsoever of the toes; but if this happens, i.e. if the toes run up against the front of the shoe, nothing can prevent them from bending at the proximal interphalangeal joints. This will involve dorsiflexion of the proximal phalanges at the metatarsophalangeal joints and this involves an undue exposure of the heads of the bones in the sole. There is no allowance made in the fore-part of any shoe for flexion to any marked extent of the interphalangeal joints, and, if it occurs unduly, corns over these joints and callosities under the sole are almost inevitable.

Just as we have spoken of the tendency of the English shoemaker to slope the front of the toe from above downwards to an undue extent, so too is the tendency observed to do the same thing on the outer side—again especially in the children's department. It not infrequently happens that a shoe, admirable in every other respect, possesses this fault, with the result that there is no adequate accommodation for the little toe. The further result is that a painful corn in this position is a



frequent occurrence. This fault is also one of the common causes of soft corns between the toes.

Often enough, and particularly when a lace-up shoe is selected, nothing can be found which will allow sufficient control of the heel of the foot in the heel of the shoe. A shallow pad of adhesive felt placed under the tongue will often solve the problem. Another very common fault in the designing of a shoe in this country, though this applies less to the American-made shoe, is the balance between the breadth of the heel at the back and the breadth at the level of the metatarsal heads. Very often the disproportion between the shape of our foot and the shoe that is offered us is absurd; but many of us require a relatively very narrow heel combined with a relatively broad front, a pattern which is often unobtainable from stock.

Finally, of course, when trying to select a pair of shoes it is necessary to measure both feet, as few of us are entirely symmetrical on both sides. In this event it is always wise to select shoes fitted to the larger foot and to make any necessary adjustment for the smaller one by wearing a cork in-sole or sock and a pad behind the supporting strap or tongue. Some retailers are willing to sell one shoe from one box and the other from another box, but it is not a common courtesy. It is also worthy of comment that to wear too short a sock or stocking is just as baneful as to wear too short a shoe.

#### CONCLUSION

The human foot is a perfect miracle of mechanical ingenuity and in the vast majority of people it should be perfect throughout life. With the exception of the victims of congenital abnormality or of gross disease or injury, a painless and perfect foot should be our heritage. Of this heritage we have been deprived by our foot-gear and I cannot help feeling that this evil thing is a reflection on the lack of co-operation between the shoe manufacturers, the anatomist and the medical man. The extent of the evil may be gauged by the extent to which chiropody has become a necessity in our civilized community; and the enormous variety of foot supports and foot-easers (often misappropriately so-called) which are to be found in every town and almost every village throughout the country bear an eloquent testimony to our foolishness in submitting to a tyranny, which is the direct cause of intense suffering in the feet, which is fatal for the all-important maintenance of a correct posture and which, most important of all, leads to irritability and bad temper.

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