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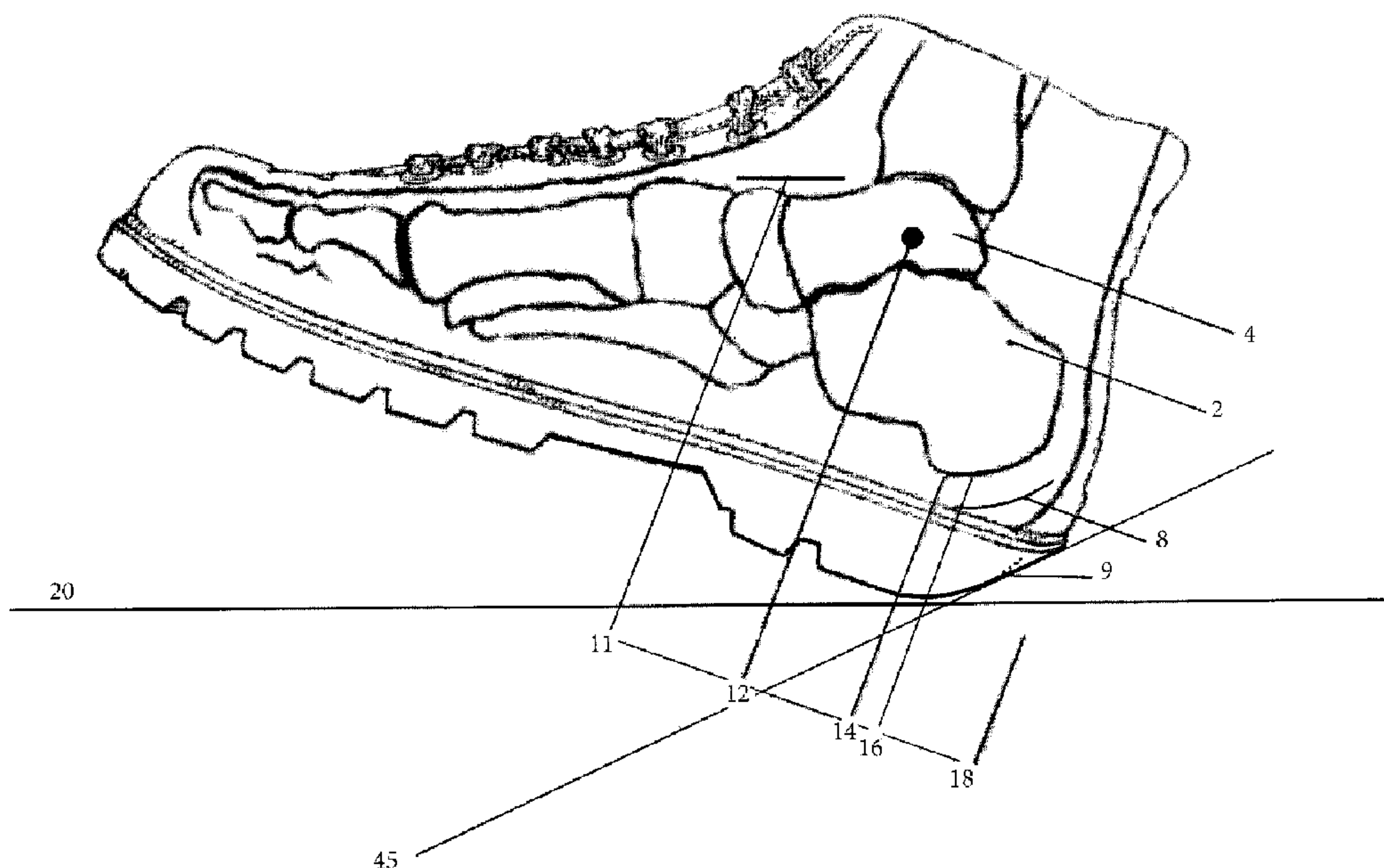
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(54) Titre : CONCEPTION DE TALON POUR CHAUSSURE CONCU DE MANIERE QUE LE LEVIER NATUREL DU TALON DU PIED DEMEURE RELATIVEMENT INCHANGE AFIN D'EMPECHER TOUTE AUGMENTATION DES FORCES DANS LA PHASE D'APPUI DU TALON DE LA LOCOMOTION BIPEDE. L'EFFET ETANT UNE ABSENCE DE PERIOSTITE TIBIALE, DE FASCIITE PLANTAIRE OU DE PATHOLOGIES CONNEXES INDUITES PAR LES TALONS DES CHAUSSURE

(54) Title: A HEEL DESIGN FOR FOOTWEAR DESIGNED SUCH THAT THE NATURAL LEVER ARM OF THE HEEL OF THE FOOT IS RELATIVELY UNCHANGED ENSURING NO INCREASE IN FORCES OF THE HEEL STRIKE PHASE OF BIPEDAL LOCOMOTION. THE EFFECT BEING NO HEEL OF FOOTWEAR INDUCED SHIN SPLINTS, PLANTAR FASCIITIS OR RELATED PATHOLOGIES



(57) Abrégé/Abstract:

A design of heel of footwear which reproduces the contacting portion, or minimally the key elements of the heel of the wearer in shape and placement in relation to the foot and function. That is a shape of heel in the footwear which does not imbalance the

(57) **Abrégé(suite)/Abstract(continued):**

natural functions of the foot in bipedal locomotion through addition of material outside the confines of the design, shape and measurements of the wearer's own heel in the sagittal plane. This design of heel will afford the wearer the grace, smoothness and ease of stride enjoyed while barefoot. The wearer of a shoe with such a shape of heel will not suffer from shocks and strains to the foot and supporting members caused by the shape of the heel of the shoe. These being the types of shocks and strains contributing largely to shin splints and plantar fasciitis and attendant pathologies.

ABSTRACT

A design of heel of footwear which reproduces the contacting portion, or minimally the key elements of the heel of the wearer in shape and placement in relation to the foot and function. That is a shape of heel in the footwear which does not imbalance the natural functions of the foot in bipedal locomotion through addition of material outside the confines of the design, shape and measurements of the wearer's own heel in the sagittal plane. This design of heel will afford the wearer the grace, smoothness and ease of stride enjoyed while barefoot. The wearer of a shoe with such a shape of heel will not suffer from shocks and strains to the foot and supporting members caused by the shape of the heel of the shoe. These being the types of shocks and strains contributing largely to shin splints and plantar fasciitis and attendant pathologies.

BACKGROUND—FIELD OF INVENTION

This invention relates to the *shape* of the heel of footwear, specifically the shape and proportions of the elements of the heel of the footwear in the sagittal plane in relation to the rest of the article of footwear and the heel of the wearer. Said structure being that which does not interfere with (allows) the natural strike point of the heel in walking/running and allows the natural controlled fall (roll, declination...) of the front of foot. Said structure does not contribute to shin splints or plantar fasciitis by adding to the natural forces exerted upon the foot and appending structures by increasing the lever arm of the wearer's heel.

BACKGROUND OF THE INVENTION—PRIOR ART

Previously the design of the heel of has generally been done with attention to style, cushioning, and some specialties such as the heel of a riding boot. Two medical problems have arisen. The first is known as Medial Tibial Stress Syndrome (MTSS), commonly called shin splints. The below quote by the Mayo Clinic staff says:

Shin splints are caused by excessive force (overload) on the shinbone and the connective tissues that attach your muscles to the bone. The overload is often caused by specific athletic activities, such as:

Running downhill

Running on a slanted or tilted surface

Running in worn-out footwear

Engaging in sports with frequent starts and stops, such as basketball and tennis

Shin splints can also be caused by training errors, such as engaging in a running program with the "terrible toes" — running too hard, too fast or for too long.

This is the generally accepted reasoning for the condition.

It is a fact that "*Shin splints are caused by excessive force (overload) on the shinbone and the connective tissues that attach your muscles to the bone.*"

The reasons above following this statement could be contributors to the problem.

There is a more basic and more important element.

Shin splints refers to the condition of painful shins during and/or after running or extended walking. The cause of this pain is damage to the muscles and attachments of the anterior lower leg or shins as they are commonly called. This is medically documented and will usually heal if running is ceased. Why does this happen? It would seem running is a natural thing to do for survival at least if not for pleasure. The foot is a highly functional, evolved, biomechanical device. It is well documented that persons living in areas of the world where they largely go barefoot there is little incidence of shin splints, plantar fasciitis or other gait related pathologies or symptoms.

First to explain the functioning of a foot in the gait cycle in normal action which would be bare foot. At the beginning of the heel-toe type gait cycle one lands on the ball of the heel Fig 2, and the foot rolls forward over the round portion of the heel which is delineated by the radius of the calcaneus Fig 1 point (7). This rolling motion disperses or spreads out some of the impact of the initial strike. It also allows a gradual loading from the first touch to full loading of body weight plus inertial forces. In this motion the anterior muscles of the shin control the attitude of the foot—they hold the front of the foot up through their attachments to the upper anterior foot bones (22) against the weight acting on the heel through the fulcrum of the calcaneus (2)-talus (4) structure pivoting on the talus (4)-tibia (6) joint. Point (12) is the approximate center of rotation of the foot around the tibia joint. The front of the foot would drop with a shocking splat on impact if not suspended by the shin muscles. This rolling action across the heel distributes the downward force of the body's weight while giving traction to the force generated by the leg muscles to contribute to forward motion. The shin muscles also act to absorb the shock of impact as they stretch with the force of impact. In actual heel strike walking or running there is not a great deal of movement of the foot in relation to the leg in the landing portion of the stride cycle. Under natural conditions the shin muscles hold the foot in place pulled up and under tension as the heel accepts the body weight being transferred from the opposite foot. This tension relaxes as the ball of the foot reaches the horizontal plane, and the foot takes on full body weight and then prepares for the push off portion of the stride cycle. Another important point in the cycle is that as the forefoot is closing with the horizontal surface, the toes are drawn up as the forefoot lowers in what is known as the Windlass mechanism. This is accomplished by muscles in the shin area as well. This pulling up of the toes tightens the plantar fascia (25) by pulling those tendinous tissues around the head of the metatarsals (26) in a manner somewhat like an old fashioned windlass. This pulls directly at the fascia anchor point (24) on the medial process of the tuberosity or posterior portion of the calcaneus just in front of the weight bearing ball shape. The tightening of the fascia draws up and tightens the arch of the foot in

preparation to accept full body weight. This happens as the knee moves over the foot and full body weight is applied. The foot takes the weight, the shin muscles relax and the foot flattens and begins to transfer to the push off position. The plantar connection with the forefoot is a major stabilizer of the calcaneus bone, which is bearing the weight of the body plus inertial forces.

It can be seen that in the landing portion of the stride cycle the muscles of the anterior portion of the lower leg do a dual function of suspending the forefoot under load and providing the tension to stabilize the arch of the foot and the calcaneus through the plantar fasciae. With each step the anterior or shin muscles are heavily loaded.

As can be seen in Fig. 2 when the foot first contacts at point (16) there is a given ratio of leverage between the attachment area of the shin muscles (11) and the area of the calcaneus that the contact forces act on, (7). (Point 8 is a radius delineated by the calcaneus and about half the distance between the calcaneus and the outer non-weight-bearing heel. It represents the moving point of contact of the outer heel, which is compressed by body weight in landing. 50% is an estimated average of heel pad compression under weight.) As the foot rolls forward on the round portion of the heel (barefoot) the leverage against the shin muscles decreases. The contact point moves forward to point 14 where the curve of the heel meets the horizontal and the foot is ready to accept full body weight. This means that as the body weight borne by the leading foot increases (the weight of the body is transferred to the front foot as it moves forward over the foot) the leverage against the shin muscles decreases. Another way in which the leverage is decreased in heel strike running/walking is that in taking a stride the forefoot is naturally lifted, to prepare for contact, pivoting the front of the foot upward in relation to the leg which in turn moves the heel downward and forward. This forward movement of the ankle shortens the lever arm lines (12-16, 17) at the time the foot first contacts giving a greater lever advantage to the shin muscles. Fig. 2, point (17) shows the lever extension of a bare foot contacting at a 45° angle. This is near the maximum inclination and at this inclination the foot would not be supporting much of the body weight, as it would be too far out in front. These are significant changes in lever advantage and are very important as the heel can be subject to forces of 3-4 times body weight on contact. The action of running and walking at length is a highly repetitive action. Any imbalance in forces acting on the foot is repeated possibly thousands of times in a given period of activity.

The aforesaid illustrates a workable system any footwear device should endeavor to complement. This means the optimum design for a shoe heel would be a shape closely duplicating the contact area of a barefoot with its point of contact corresponding to that of the bare foot of the wearer. The rounded heel takes advantage of the lessening lever arm. However any placement of the contact point near optimum will result in much less strain on the shin muscles.

So why does a natural motion like running or extended walking for some result in damage and pain in the shin muscles, connective tissue and bone? One of the only workable but not necessarily practical handlings, in running, for shin splints is to run barefoot. Another is to increase the strength of the shin muscles, another to learn to run landing only on the forefoot. Shoes have been designed to ensure landing only on the forefoot. Barefoot style shoes that fit closely to the foot have been found to help. These solutions work for some but the general populace wants to be able to walk or run in a normal fashion and needs and wants cushioning and protection in a shoe. If walking and running barefoot do not generally cause shin splints it follows that there is a problem with shoes.

Almost all running and walking shoes extend the heel rearward. It is customary for the heel of the shoe to extend downward from a point at the back of the wearer's heel plus the thickness of the shoe material often plus the welting. See Figure 3A. Many designs of shoes extend even further rearward. Even when the heel of the shoe is not extended rearward the strike point is moved rearward by the cushioning of the sole of the shoe. The strike point is far back of where the bare foot would strike.

In Fig. 3A, line 11-12 represents the lever arm the shin muscles pull against. Line (12-18) represents the counter lever arm of the calcaneus, which has body weight acting on it through the tibia talus joint. Line (16-18) represents the extension of lever arm caused by the heel of the shoe. This violates the natural amount of leverage the shin muscles work against when suspending and lowering the foot. It can easily be seen that the leverage working against the shin muscles in this shoe is nearly doubled and this is not at all an extreme example. Shoes and boots that extend rearward much more are common. According to experts the forces on impact can *be 3-4 times* (another ref says up to 11X) body weight. Extend the strike point of the heel rearward and the leverage ratio against the shin muscles is increased. The fairly conservative extension of the heel in Fig 3A increases the lever arm by almost 90%, almost doubling forces. A 200 pounder will go from 600-800 pound impact force to something approaching a ton. The shin muscles are overpowered and forced to extend by the impact and are damaged as a result. This is most pronounced in

activities like running or extended periods of walking where the repetitive action eventually damages the muscles and tendons of the shin area (bone damage can also occur from repetitive strain on the tendon attachments). People who land heavily or are overweight will suffer more from tendon strain.

An easy way to discover for yourself how this works is to put your bare foot out in front, toes up like you'd be landing on it while taking a stride. Push on your heel with your weight and feel the pull on the muscles of the shins. Next, put on your shoes and do the same action and feel the difference. You will feel the greatly increased pull on those shin muscles especially if body weight is applied as the forefoot nears the ground. They may not have the strength to hold the toes up.

Figs. 3A to 8A give examples of prior art that show this extension of the lever arm over that which occurs naturally.

It is this increase of leverage against the foot structure that causes the slapping or clomping sound of a walking shoe or boot that is often heard when the forefoot strikes the ground/floor hard. This is because of the shin muscles being over powered and the forefoot falling in an uncontrolled manner. This overpowering of the shin musculature is what causes the damage to them. This is noticeable shoes or boots with heels of poor design and hard soles. The sound is not heard so much in softer soled shoes but the damage to the body is still going on.

To increase cushioning the clearance between the foot and the sole must be increased. It is the function of cushioning to gradually decelerate the foot to remove the shock of a sudden stop of the foot hitting a hard surface. To have a more gradual deceleration the thickness of the cushion must be increased to have a greater range in which to accomplish the deceleration.

Any shoe design that raises the heel of the wearer needs to have the point of heel strike adjusted as any increase in height begins to move the strike point rearward of the natural strike point. Even barefoot type shoes with minimal thickness still make small additions to the dimensions and thereby to the lever arm of the actual bare foot. The wear layer of even this minimal type of shoe will extend the strikepoint of the heel rearward by its thickness—a consideration for the serious runner.

In a design where the contact point is relatively square as in Fig 3A the pivot point is maintained at the point of contact rather than moving forward as in a rounded heel. This makes for the worst lever disadvantage.

PROBLEM 2: Millions of runners and walkers suffer from plantar fasciitis. For some it is controllable, for many it prohibits them from walking, running or even enjoying life without pain. Plantar fasciitis involves pain and inflammation of a thick band of tissue and its connective points, called the plantar fascia, that runs across the bottom of the foot and connects the heel bone to the toes, Fig. 1 (24, 25). Its function is to help stabilize the bones of the foot. As one takes a step the toes are raised which tightens the fascia by pulling it around the head of the metatarsal bones (26) in what is called the “Windlass effect”. This pulls up the arch of the foot (also referred to as a truss) readying it to take the body’s weight. This not only stabilizes the foot but is another part of the system to gradually accept the load while using the muscles and tendinous tissues to absorb shock. This cycle occurs as the forefoot touches down and gradually loads as the knee passes over the foot and allows full transfer of the body’s weight.

The plantar fascia spans the five metatarsals and attaches to a single point (24) on the calcaneus. In fact it is the plantar fascia that plays a major part in holding the calcaneus in place as it bears load. An extended lever arm acting on the calcaneus, caused by shoe heel design will overload the plantar fascia. Most of the problems and pain in plantar fasciitis involve the attachment of the fascia to the anterior calcaneus, point (24). Heel spurs are a common malady. This is the focal point of all the loading of impact. The shin muscles suspend the front of the foot and toes. The plantar fascia connects this pulling force to the calcaneus.

This overloading of the calcaneus on the crucial point of contact lessens the stability of the foot structure and increases the likelihood of stride patterns deviating from the norm. Problems with weaknesses in structure will be magnified.

Another point which ties these two problems together is that the muscles working to pull the toes up in the “windlass effect” are anterior shin muscles. Here again is direct increased strain on those muscles through the plantar fasciae when the strikepoint of the heel is extended rearward.

There is a plethora of data available on how pronation, supination, improper arch heights and so on affect gait and structure. It is easy to see how these conditions can be exacerbated by overcoming the stability of the foot at the beginning of the cycle with an over-leveraged heel strike. The arch itself is supported by the plantar fasciae, which in turn are acted upon by the shin muscles.

It is plain to see that extending the lever arm of the heel will directly increase the forces acting on the plantar fascia.

Extending the lever arm of the calcaneus causes overloading which damages the fasciae, ligaments and their connections to the bones. It is also notable that a large number of those suffering from plantar fasciitis are runners, those whose work involves walking and those who are overweight. Extending the heel and increasing the forces acting on the plantar fasciae of an overweight person greatly increases the probability of damage. The repetitive action of running or extended periods of walking magnifies the problems caused by increased leverage on the calcaneus.

Prior Art Figs. 3A through 8A give examples of the lever arm of the calcaneus being increased by shoe heel design.

PRIOR ART

Many prior designs have mentioned reduction of shin splints in their claims. US patent 5,694,706, Penka discloses a running shoe with the no heel, the object being to force the wearer to land on the forefoot thus ensuring the anterior muscles are not loaded, the entire weight being handled by the calf muscles. This may be a viable system if one chooses to walk or run in this fashion.

This invention obviates the heel landing by design and does not interfere with my design for that reason.

US patent # 6,131,309, John Walsh mentions a need to correct abnormal pronation which can cause trauma, such as shin splints. His invention is a suspended heel carriage which allows movement of the heel and a different type of shock absorption. It does not address the problem of unnatural heel strike overloading the Medial tibial muscles and tissues or plantar fasciae.

US patent 4155180, Edward H Phillips—Roller Shoe, discloses a design of continuously rounded (front to back) sole of running shoe. He states: the rearward portion of the shoe is curved upward...This shape functions to relieve the runner of his tendency to land on his heel...thereby relieving heel shock. This design may work but necessitates a very thick rounded portion of shoe sole and is not the choice of all. In this design the heel is still extended rearward so that if one does land on the heel there will still be an overloading of the shin muscles as well as plantar fasciae.

US Patent 7,100,307, Footwear to enhance natural gait discloses a design of shoe with a round heel. This patent does have a heel design similar to that laid out herein but per drawings the radius of heel is not maintained but rather enlarged which moves the strikepoint rearward, increasing the lever moment against the shin muscles. This design is for a specific shoe as well and does not encompass all forms of footwear. The patent does not make any claim as to the radial design of heel in the sagittal plane to reduce shin splints or plantar fasciitis.

US patent Rosa discloses a shoe with a somewhat similar heel design but does not follow the formula of maintaining the radius of the heel and strikepoint of the bare foot. It in fact states the primary point of contact is on the rearmost part of the shoe which increases leverage against the shin musculature. It also does not make any claim of reducing the incidence of shin splints or plantar fasciitis.

EP 2319344 A1 by Stanislas Rio claims the risks of development of known related pathologies from the interaction of the foot heel and the footwear are minimized. His design is for a heel suspension and the heel of his design is conventional.

SUMMARY OF THE INVENTION

This invention has to do only with the rear part of the heel of an article of footwear which is the primary engaging unit in heel strike walking/running. The object of this shape of heel is to obviate the possibility of unusual shin muscle/ligament strain and plantar fasciae strain by maintaining the natural strike point of the heel of a bare foot. By maintaining the natural strikepoint, the lever arm of the heel and thus the loading is not increased.

This shape is only addressed in the sagittal view--that is fore and aft. This point is below the curve of the calcaneus bone at the approximate point it meets a parallel of the bottom of the foot as in Fig. 1 point (14) and following the radius of the contact area (8), rearward on inclination. This is the radius the heel follows under weight. This radius is defined by the radius of the calcaneus (7).

DRAWINGS--FIGURES

Fig 1 shows a sagittal view of a bare foot on a horizontal surface, bearing weight.

Fig 2 shows a sagittal view bare foot, inclined and contacting the horizontal at approximately 20°.

Fig 3A shows sagittal view of a foot within a shoe, inclined and contacting the horizontal plane.

Fig 3B is the shoe of Fig 3A with a modified heel.

Fig 3C is the shoe of Fig 3A with an example of another type of modified heel.

Fig 3D is the shoe of Fig 3A with a third type of modified heel.

Fig 4A shows sagittal view of a foot within a running style shoe, inclined and contacting the horizontal plane.

Fig 4B is the shoe of Fig 4 with a modified heel.

Fig 5A-8A show sagittal views of a foot within a shoe, inclined and contacting the horizontal plane.

Fig 5B-8B show sagittal views of a foot within a shoe with a heel modified per Detailed Description First Embodiment.

Fig 5C is the shoe of 5B with a lower heel.

Fig 6C shows a variation of 6B which conforms with alternative embodiment 3C.

Fig. 8C is an alternative embodiment of 8B.

Fig. 9 shows an example of a heel in which the contact point can be adjusted forward to reduce loading on foot and appended structure in the case of weakness or pathology.

DRAWINGS—REFERENCE NUMERALS

2. the calcaneus bone.

4. the talus bone

6. the tibia bone

7. the radius of the calcaneus which delineates the form of the heel.

8. the radius of the contact area which is the radius the heel follows under weight. This is approximately half the unloaded tissue thickness.

9. the radius of the contact area the heel follows under weight duplicated in the heel of the shoe.

10. radius 7 extended into a circle to illustrate the use of the back of foot as a marker for the placement of radius 9 in the shoe heel.

11. represents the approximate point on the top of the foot the shin muscles pull on—shows the point of leverage of the shin muscles.

12. the approximate point the foot pivots on.

14. the contact point of the heel when the forefoot has touched the horizontal. This point varies with thickness of heel tissue and shoe material but is always perpendicular to this point and is a point on line 14.

15. the contact point of a heel moved anterior for the purpose of lessening the load on foot structure in the case of pathology thereof.

16. the approximate contact point of the heel of a foot inclined in relation to the horizontal. About 20° in Fig. 2.

17. the point of contact of the foot were it to contact the horizontal at 45° .

18. the contact point of the extended heel of the shoe.

Line 11-12 represents the approximate lever arm of the shin muscles.

Line 12-14 represents the approximate lever arm of the calcaneus-talus under load which is pulling against the shin muscles and the plantar fasciae as the foot comes to rest.

Line 12-16 represents the approximate lever arm of the calcaneus-talus when the foot is contacting at an angle of 20° to horizontal.

Line 12-17 represents the approximate lever arm of the calcaneus-talus if the foot were to contact at an angle of 45° to the horizontal.

Line 12-18 represents the approximate lever arm of the calcaneus-talus when the foot is contacting through the extended heel of the shoe.

Line 16-18 represents the addition to the natural lever arm applied by the shoe heel.

Line 14-18 represents the addition to the natural lever arm applied by the shoe heel as the forefoot contacts.

20. represents the horizontal plane or ground.

21. adjustable portion of shoe heel.

22. slotted area to allow adjustment.

23. screw fasteners.

24. attachment area of the plantar fasciae to the calcaneus.

25. the plantar fasciae.

26. head of the first metatarsal.

27. the rear profile of the heel of Fig. 3D.

28. represents the approximate area the shin muscles pull on to raise the forefoot.

35. represents the horizontal (ground) if the heel meets it at a 35° angle.

40. represents the horizontal (ground) if the heel meets it at a 40° angle.

45. represents the horizontal (ground) if the heel meets it at a 45° angle.

DETAILED DESCRIPTION—FIRST EMBODIMENT—FIGS. 3B-8B

All embodiments of this design deal only with the shape of the heel in the sagittal plane that is, the side or profile view.

As seen in Fig. 1 the contact point of the radius of the heel when the foot is flat on a surface is point (14). This point is defined as the approximate point being vertically below the point where the lower posterior radius of the calcaneus (7) meets a parallel to the horizontal plane of a foot supporting weight on heel and forefoot. This point of the calcaneus meets the surface through the padding of the heel tissues and bears the weight of the standing body bearing on the heel.

As seen in Fig. 2 the contact point of the foot when it meets the ground surface at an angle is described by radius (8). This is the radius of the contact area, which is the curve the heel follows under weight. This curve ends at line 14. This curve or radius is approximately half the unloaded tissue thickness. This can also be described as the radius of the calcaneus plus approximately half the thickness of the heel tissue. A workable measure for this radius is approximately 14% of the total foot length. This radius can be positioned on the shoe heel by using a perpendicular aligned 0-2% anterior to the posterior most portion of the wearer's foot. This is given as a range because of differences in individual person's heels. It is also fine tuning in comparison to the gross additional leverage caused by most shoes prior to this design.

This radius is brought down perpendicularly to the ground plane until its lower part meets the intersection of line 14 with the bottom horizontal plane of the shoe heel.

This can be further refined by using the intersection of this radius (9) with a 45° plane as in figure 3B, line (45).

The 45° line from this intersection to the welt area of the shoe can be used as the demarcation line of the rear of the shoe heel, giving more space for material in the welt area. Material anterior to the 45° line will not increase leverage against the heel. This also gives a clean line to the back of the shoe for esthetic considerations. The 45° angle is chosen as the likely limit of inclination of the foot on contact. It is well beyond the average but there are some that walk or run in this manner.

A further definition of this shape of shoe heel is that no material shall extend posteriorly from the area described by the lower part of the radius and above the intersection of the radius and the 45° angle by that angle. This prohibition ensures no added leverage is applied to the wearer's heel by ground contact of the heel of the footwear. This definition can be changed to suit the chosen maximum angle of contact where it is determined that the maximum angle of contact will be different for shoes intended for a given activity. For example a jogging or walking shoe or one intended for someone with pathology could have a lesser maximum angle of contact. A shoe for certain sport activities may need a greater maximum angle of contact.

A heel of this design can be constructed with any of the various materials used in heel construction. The only requisite being that resilient type materials be of sufficient firmness or of a design to resist excessive deformation on contact that would move the contact point more than 1-2% of the entire foot length forward of that designated by point 14. If a fluid such as air or gel is used as part of the cushioning its confining structure must be such that will not allow deforming of the given design thus preventing the movement of the contact point forward or aft of that designated. These requisites are well within the knowledge and abilities of anyone knowledgeable in the art of modern shoe making and manufacture. Moving the contact point significantly forward of point 14 will bring the foot into a condition wherein the shin muscles having a lever advantage will momentarily halt the normal declination of the foot. This will cause a jolt, which is transmitted up the leg. Further as the body weight passes over the foot the shin muscles will then be overpowered and the foot will drop uncontrolled. Maintaining point 14 as the final contact point is the most important point in maintaining natural loading.

This design will work well with materials of little or no resilience such as the relatively solid heel of a boot or service shoe or dress shoe.

The design can be incorporated into attached or molded heels.

The point of contact and the radius of the contact area may be fine tuned to meet the exact needs of the wearer, for example in a shoe of one who does a lot of running or one who has some pathology or abnormality of the foot.

Each shoe in Figs. 3B through 8B show examples of the radial or rounded design.

OPERATION—FIRST EMBODIMENT—FIGS. 3B-8B

The point of final contact of the contact radius has been placed directly beneath point 14 and is defined as being that point of the radius of the calcaneus which meets with a horizontal plane parallel to that plane shared by the heel and forefoot of a weight bearing foot. A workable average measure is about 12% of the entire length of the foot forward of the rearmost part of the heel as shown in Fig.1. Making the heel of the shoe match the shape of the actual heel under load Fig. 1, radius (8) gives the best match to the natural strike zone of a bare foot. (Note: the center point of the calcaneus and the heel radius under load is forward of point (14) see circle (10). This is an important point in bringing the radius down in the shoe heel so that it is not placed too far back, as would be the case if the radius were aligned with the center perpendicular to point 14. If the radius of the wearer's (person's) heel under load is extended into a full circle (10) it can be seen to closely align with a perpendicular, generally about 0-2% of entire foot length forward of the back of the wearer's heel, Fig 1. This makes that perpendicular a useful orientation point in aligning the radius on the shoe heel.)

Use of a round contact area provides a more gradual loading. This also has the effect of dissipating forces over a larger area. The result of placing the contact point in this manner is no excess strain on the shins, no excess loading of the plantar fascia and a very nice lightness and smoothness to the impact of each step. This keeps all the forces generated by the heel strike landing in a range the body is naturally designed to cope with.

Use of the round contact area also allows the use of more material which will tend to hold the given shape better under load so that the contact point is not moved forward of point 14 under load.

As seen in Fig. 6B and 6C the design is easily applied to a heightened heel.

As seen in Fig. 5C the design works with a relatively low heel as well. With a low heel it is especially important to ensure the rear welt area is free of material that could contact the ground on heel strike.

DETAILED DESCRIPTION—ALTERNATIVE EMBODIMENT Fig. 3C.

One can simply use point 14 as the strikepoint as has been borne out in testing. Fig 3C shows the shoe heel is simply cut off at point 14 as seen in the sagittal view.

OPERATION—ALTERNATIVE EMBODIMENT Fig. 3C.

This shape has been tested and has been found to give similar comfort and ease of stride with no strain on shin muscles. It will slightly alter the natural loading cycle making it less gradual than with a rounded heel. This could possibly cause more strain on certain muscles after many strides as in distance running. It works fine with harder materials but likely not hold its shape as well with resilient materials. It is not an esthetic design and would likely look odd or suspect to the average consumer. It would also be subject to wear moving the contact point forward much more quickly. One could make almost any shape work in this embodiment as long as it has point 14 as the contact point, has no material posterior to the 45° angle or chosen maximum angle and supports the weight of the wearer.

DETAILED DESCRIPTION—ALTERNATIVE EMBODIMENT Fig. 3D.

Fig. 3D shows the shape of the rear of the shoe heel is simply a straight line from pt.14 to the welt area of the shoe (27) as seen in the sagittal view. This design adheres to the rule of no material posterior to that shown in Figure 3B. The shape in this embodiment can also be varied as long as it has point 14 as the contact point, has no material posterior to the 45° angle or chosen maximum angle that will contact the ground and supports the weight of the wearer.

OPERATION—ALTERNATIVE EMBODIMENT Fig. 3D

This shape has been tested and has been found to give similar comfort and ease of stride with no strain on shin muscles. This shape is a compromise between the round design of Fig3B and the square of Fig.3C. It gives similar advantages to the square cut design, will wear better, deform less with resilient materials and will look more acceptable to the average consumer. It is extremely simple to shape, mold or cut.

DETAILED DESCRIPTION—ALTERNATIVE EMBODIMENT Fig.8B.

Fig. 8B shows a runner with a resilient shock absorbing member(s) between the upper outsole and a leaf member meeting with the supporting surface (ground). The leaf and shock-absorbing member are curved in accordance with the design at the rear, the curve beginning at pt. 14. The curve is cut

short of the bottom of the shoe to allow compression of the shock-absorbing member. The bottom member can also be formed as simply as ending its length at point 14.

OPERATION—ALTERNATIVE EMBODIMENT Fig.8B.

This design gives the same advantages of maintaining the contact area of a bare foot that is given by the round heels of the 3B-7B series while allowing the use of cylindrical shock absorbing members. These shock-absorbing members could also be replaced by coil springs of a similar size. This particular design would have 2 shock absorbing elements side by side. Only one is seen in the sagittal view. A similar design could be made with a single or pluralities of shock absorbing member and or spring(s).

This design may also be formed of a leaf spring, which forms the lower leaf and is incorporated into the upper outsole, Fig 8C. Said leaf spring design could also incorporate any of the shock absorbing and coil springs elements described above.

DETAILED DESCRIPTION—ALTERNATIVE EMBODIMENT Fig. 9

As it is the musculature of the shin area that suspends the forefoot and takes up some of the force of impact as well as controlling the fall of the foot, it may be found that for therapeutic purposes in cases of weakened or damaged musculature the strike point may be adjusted forward of the natural point to compensate for such weaknesses. That is a heel contact point formed anterior to point (14) or a heel with an adjustable contact point that can be designed to adjust for that purpose. Thus effectively shortening the lever arm of the heel of the wearer. This may be applied to Plantar fasciitis and related conditions as well.

OPERATION—ALTERNATIVE EMBODIMENT Fig. 9

This moving of the contact point forward can be attained by simply cutting or molding a special shoe heel with the contact point moved forward to a degree suited to the individual.

A variation of adjustable strike point heel can be made in which the strike point is adjustable for the exact need of a particular person and then moved rearward toward the natural strikepoint as that person's pathology reduces. Thus allowing the structure of the foot to gradually strengthen and attain normal function.

In Fig. 9 the lower portion of the shoe heel is a formed as a separate piece (21). It is attached to the main body of the shoe by screws (23) which are located in slotted channels (22) to allow adjustment forward and back. This allows the main contact point, (14a when moved), to be adjusted forward of the normal strikepoint (14).

In adjusting the strikepoint forward it is necessary to adhere to the rule of no material projecting to the rear which will increase heel leverage at any point of the heel strike. In designing this heel and the shoe it may be determined that one who has a foot pathology may not need the room for a great deal of inclination on contact. For example a person with chronic shin splints may only need a maximum inclination of 30° on heel strike which will allow more clearance for material at the rear of the shoe.

CONCLUSIONS, RAMIFICATIONS AND SCOPE

The reader will see that applying this design of shoe heel to any footwear design will allow the wearer the advantages of cushioning, protection and esthetics given by footwear without the damaging effects of poor heel design. If one considers the size and weight of a body in comparison to the size and structure of the ankle and heel it is easy to see that a small member carries a large load. This load is magnified greatly in running. As this structure has been formed over ages of evolution it is therefore deemed of proper design by survival alone. One should take great care before introducing modifications to the operation of the foot.

Fig. 2 shows the lever arms of the calcaneus and the supporting shin muscles and Fig. 3A the extension of the calcaneus lever arm given by a common shoe heel. It is very simple to see that any shoe heel that extends this lever arm upsets a balanced system. This will result in damage to that system—minimally to the shin muscles, the plantar fasciae and their attachments.

Maintaining the natural contact radius of the heel as in Fig. 3B will not upset the balance of the natural system and will not cause undue damage to the components of that system. Just being relatively close in design to that set out herein will keep most feet in a tolerable range of stress. This design can be applied to any footwear. The design allows the use of cushioning without changing foot leverage. Even a flip-flop sandal increases the leverage of the calcaneus structure by the thickness of the sole wrapping around the heel with each stride. One could even walk with grace in a platform boot if the heel were cut to this design.

It is not contemplated that there is any material or type of heel or heel cushioning or suspension currently used that couldn't be used while conforming to this design. In heightened heels the contact area of the heel need only conform with that set out herein and the same advantages will be realized. No special manufacturing techniques are necessary, only the shapes of molds or cuts of material need be changed.

The wearer of footwear with this heel design will instantly realize an ease of motion and gait similar to walking barefoot.

This improvement on design of a running shoe or walking shoe or boot for that matter will prevent or greatly lessen the problem of shin splints and or plantar fasciitis for most and alleviate the problem for those who already suffer from shin splints/plantar fasciitis. This concept can be carried further to any other type of footwear. The more one walks the more important the point of heel strike becomes. Also the heavier the person, the more important this point of correct leverage in footwear.

It is also an important consideration for one with any of the various foot pathologies. It would be proper to correct the strikepoint of the heel before addressing other foot and related pathologies. It is quite possible that many other foot pathologies arise from the excess forces caused by increased leverage on the heel at contact.

NB. The strikepoint is referred to as point 14. Radius 8 is the preferred strikepoint. This is the radius formed by the progression of the strikepoint from first contact at the maximum inclination of that contact to the point it meets the horizontal that being point 14. Radius 8 does extend the strikepoint rearward as it comes into contact with the ground but the foot does not support a great deal of weight during this part of the stride unless the person moves in a very clumsy manner in which case it is even more important to not extend the strikepoint rearward. It is important to understand that in a bare foot the contact point moves forward as the heel contacts and rolls forward until the foot is fully contacting. This forward movement of the contact point increases the lever advantage of the supporting shin muscles as the body weight borne by the foot increases with forward motion. This allows the shin muscles to do their function of supporting and controlling the suspension of the rear foot as well as absorbing some of the shock of impact. As long as this natural progression of leverage is not interfered with a healthy body is not unduly plagued by shin splints. 14% of overall foot length as the radius of the heel is a workable estimate of a normal average. It could be slightly more or less depending on the individual. If one looks at the difference this makes in leverage it is seen to be minor when compared to the gross additions to leverage caused by shoe heels that do not conform to the measures of the wearer's foot itself.

Patent Application of

Larry Macdonald

for

Footwear heel designed to *prevent* additional forces acting against the wearer's heel caused by the footwear. The intention of the design being to alleviate shin splints, plantar fasciitis and associated medical problems caused or worsened by said additional forces and to promote ease of gait and grace in heel and toe walking/running, that is bipedal locomotion wherein the strikepoint of the leading foot is the heel.

Footwear heel design to allow natural movement of foot in heel and toe / walking running.

Use of heel design to alleviate a medical condition of the foot, specifically shin splints/plantar fasciitis.

Cross reference to related applications: NA

In this paper shoe and footwear are used interchangeably.

Sagittal plane refers to the plane of the side view of the body, profile is also used with the same meaning.

Heel in reference to footwear means the ground contacting rear portion of an article of footwear, that portion which supports the heel of the wearer.

Ground refers to the surface being tread upon.

Stride cycle refers to the motions gone through by a foot and leg in bipedal locomotion, walking or running.

CLAIMS

The Embodiments Of The Invention In Which An Exclusive Property Or Privilege Is Claimed Are Defined As Follows:

1. A shape/form in the sagittal plane of the posterior ground contacting portion of the heel of footwear in which the shape of said footwear heel will not cause unnatural strains of the foot and appending structures brought about by footwear heel induced increases in leverage applied to the heel of the wearers foot in the sagittal plane comprising:
 - (a) said heel of predetermined raised structure of which the rear ground contacting portion of said shape is formed in profile beginning at a point which is vertically aligned with the point of contact (Fig 1, point 14) of the radius of the calcaneus of the wearer's foot with a horizontal plane parallel to the plantar surface of said prone, weight-bearing foot, and
 - (b) said shape of heel of footwear is capable of bearing the weight and forces of the heel of the wearer and can be the primary contact point in heel strike type bipedal locomotion, and
 - (c) said shape of heel of footwear being such that no portion of said heel or shoe structure extends posteriorly to the contact point (14) in a manner that will significantly add to the natural leverage of the wearer's heel by contact with the ground at any point of the stride cycle.
2. A shape/form of heel of footwear of Claim 1 comprising:
 - (a) the shape of lower rear of said shoe heel approximately conforming to the shape of a wearer's heel under load and aligning vertically with the wearer's heel such that the natural lever arm of the wearer's heel is unchanged through the surface contacting portion of the stride cycle, and
 - (b) said shape being further defined as the approximate radius of the calcaneus of the wearer plus the thickness of the heel tissue while compressed as in bearing the load of the body in a stride, and
 - (c) said shape of wearer's heel under load being brought down to the base of footwear heel, perpendicularly to the plane of the plantar aspect of the foot, merging with the underside horizontal plane of the footwear heel at line (14) so that said shape of wearer's heel

under load in the sagittal view is reproduced in the heel of footwear under the wearer's heel (Fig 3B, point 9), and

- (d) said shape of footwear heel having no material projecting posteriorly which would alter the lever arm of the wearer's heel by contact with the ground while bearing load in the stride cycle.

3. A shape/form of heel of footwear of Claim 1 comprising:

- (a) A line in the sagittal view which continues approximately from the designated contact point (14) at the base of the shoe heel to the back of the shoe welt area such that it does not cross posteriorly a line of predetermined maximum angle of contact of the heel with the horizontal plane and drawn through said point of contact.

4. A shape/form of heel of footwear of Claim 1 comprising:

- (a) the heel of the footwear formed of separate elements such that the lower ground engaging element is of the form of a leaf hinged by a flexible portion to the midsole/outsole below the general area of the arch of the foot, and
- (b) the upper plantar portion of said shoe heel is supported beneath, variously by means of cylindrical or other shapes of resilient material or coil spring or springs or combination(s) thereof, and
- (c) the rear portion of said ground engaging element is confined posteriorly by the limitations described in Claim 1 and where its rear portion has an upturning portion such as a radius of the proportions and placement of that of the heel described in claim 2 the rear upwardly turning portion is cut short to allow upward movement of said element in shock absorbing/energy return motions.

5. A shape/form of heel of footwear of Claim 1 comprising:

- (a) said heel of the footwear formed of a separate element consisting of a leaf spring of "V" shape, the point of the "V" acting as a hinge and situated below the general area of the arch of the foot, one section or arm of the "V" constituting the lower leaf member and the upper arm being affixed or formed to or into the outer sole of the heel of the shoe such that the lower arm of the "V" contacts the ground, bends with weight and thereby absorbs shock and provides energy return and,

(b) said leaf spring may be additionally equipped with shock absorbing or other spring elements.

6. A shape/form of heel of footwear of Claim 1 comprising:

- (a) a heel of footwear with an adjustable point of contact wherein the contact point is made able to be moved anterior to that of Claim 1 to shorten the lever arm acting against the wearer's heel thereby providing a lessening of the loads to the foot and appending structures to give relief in the case of various types of injury or weakness in portion or portions of said structure such as medial tibial muscles, and
- (b) said shape continues posteriorly to meet the rear welt area of the shoe in a manner such that no portion of said heel structure will substantially add to the natural leverage of the wearer's heel by contact with the ground at any point of the stride cycle, and
- (c) said shape being moved anteriorly by cutting, molding at manufacture or cutting or other various means of reshaping after manufacture.

7. A shape/form of heel of footwear of Claim 6 comprising:

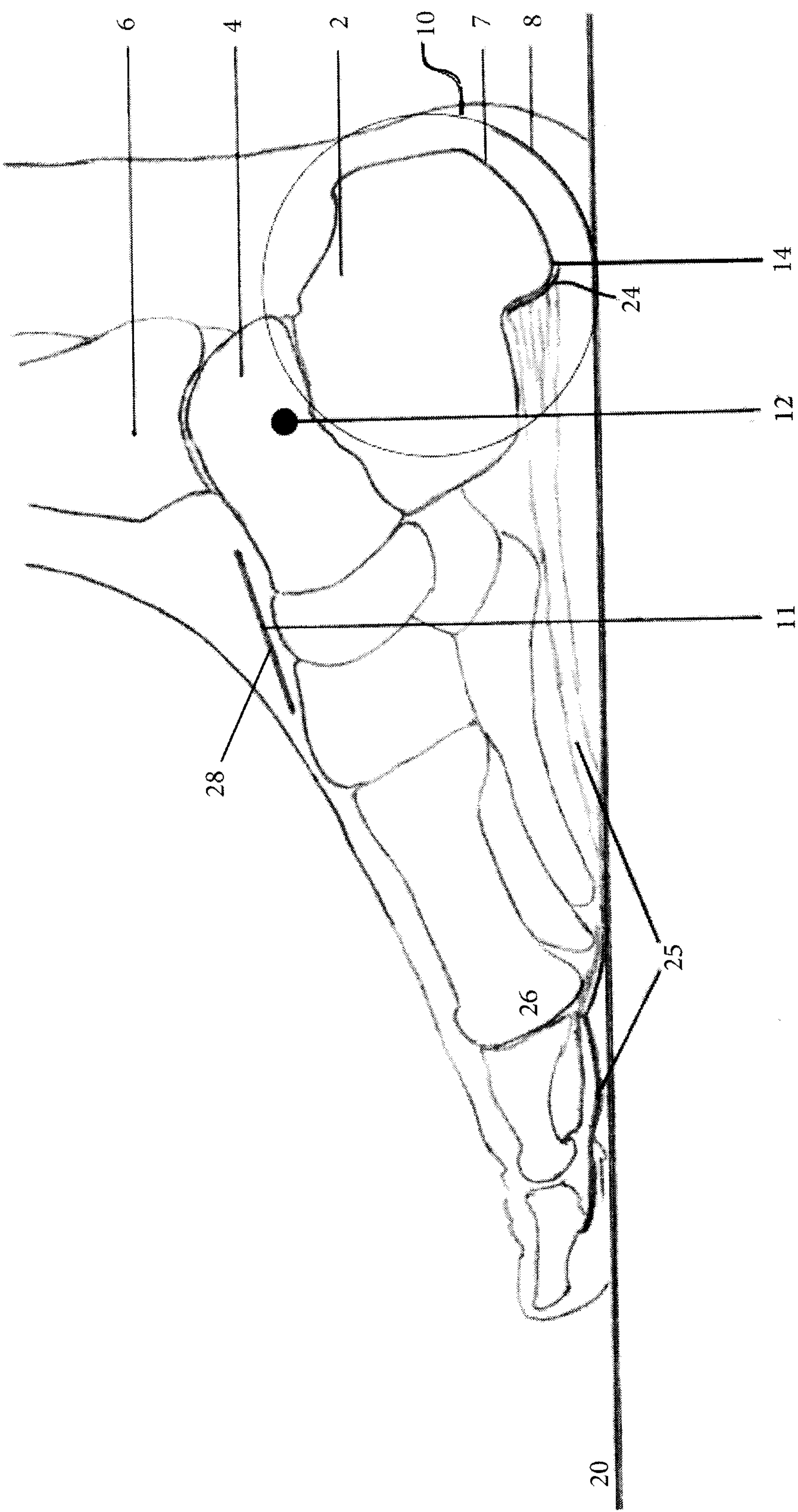
- (a) a lower section of the heel which is formed separately from the main body of the heel such that it is able to be adjusted anteriorly and posteriorly, and
- (b) said section is affixed by various means to the main body of the heel so it may be adjusted then fixed at a suitable setting, one means of affixing being screws through the movable section into the main body of the heel with slotted channels in the lower movable section aligned sagittally to allow adjustment, and
- (c) the shape of the entire rear of the heel of the footwear including the rear portion of the shoe is formed such that no material projects posteriorly in a manner that it could increase leverage against the heel by contact with the ground at any portion of a normal stride cycle.

CLOSING STATEMENT

It can be seen that the simplicity of this design/shape is reproducing the shape and position in the sagittal view of the natural contacting portion of the unshod heel in the heel portion of the shoe while providing an area posterior to this shape clear of material that could interfere with the natural

heel strike in the stride cycle. Alternatively the same effect may be achieved by using the point where the contact radius first meets the horizontal as the strikepoint and similarly keeping the area to the rear free of interfering material.

The preferred point of contact to prevent overloading of the shin muscles by extending the contact posteriorly is that radius defined as the radius of the heel under load. Any heel design/shape which approaches this point will gain in advantage by affording less change in leverage applied to the heel. It can be seen that if a shape is relatively close to that given here it will provide similar benefits to the claimed structure in proportion to how closely it approaches said structure. The above claims give examples of common use of this shape or profile of heel.



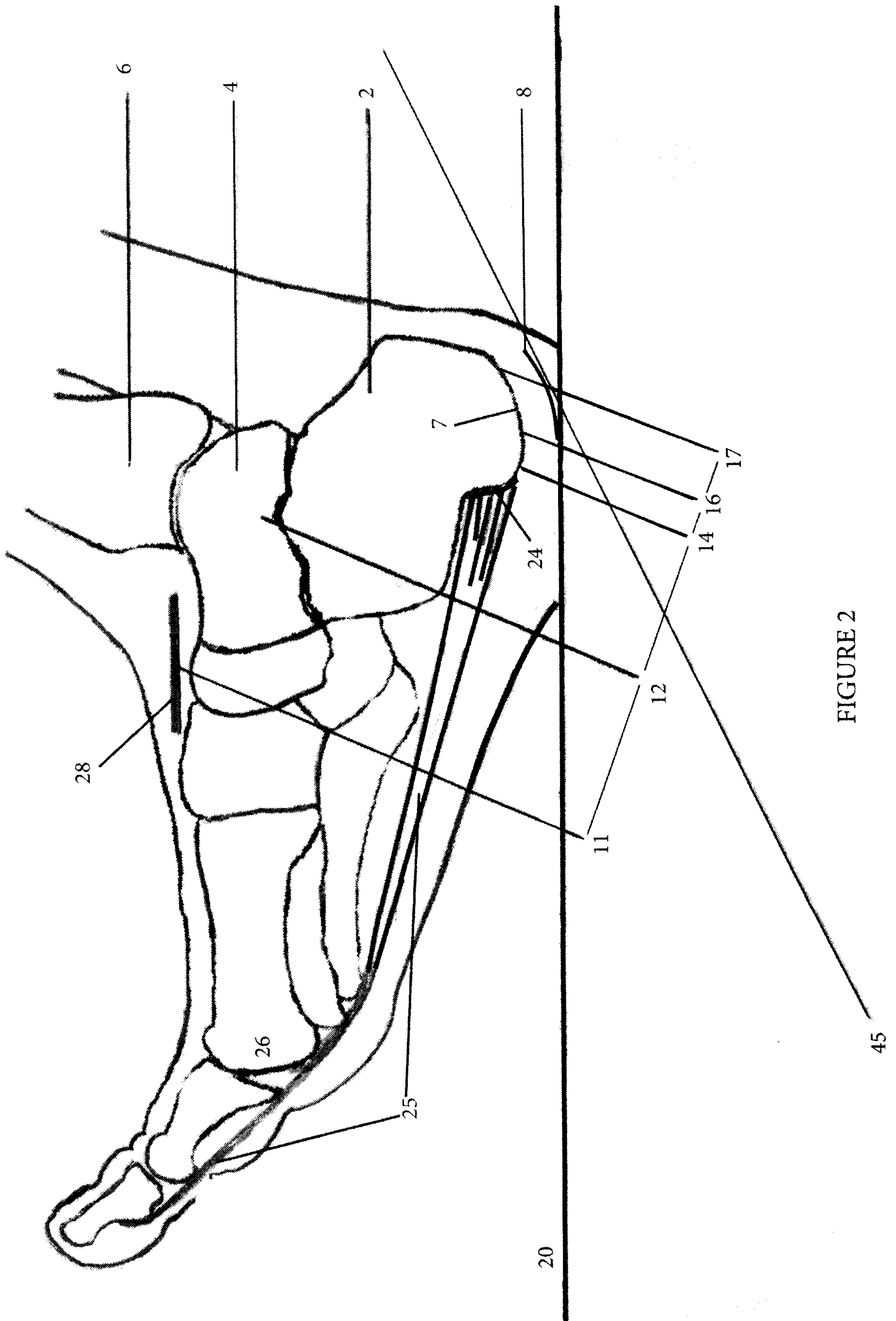


FIGURE 2

PRIOR ART

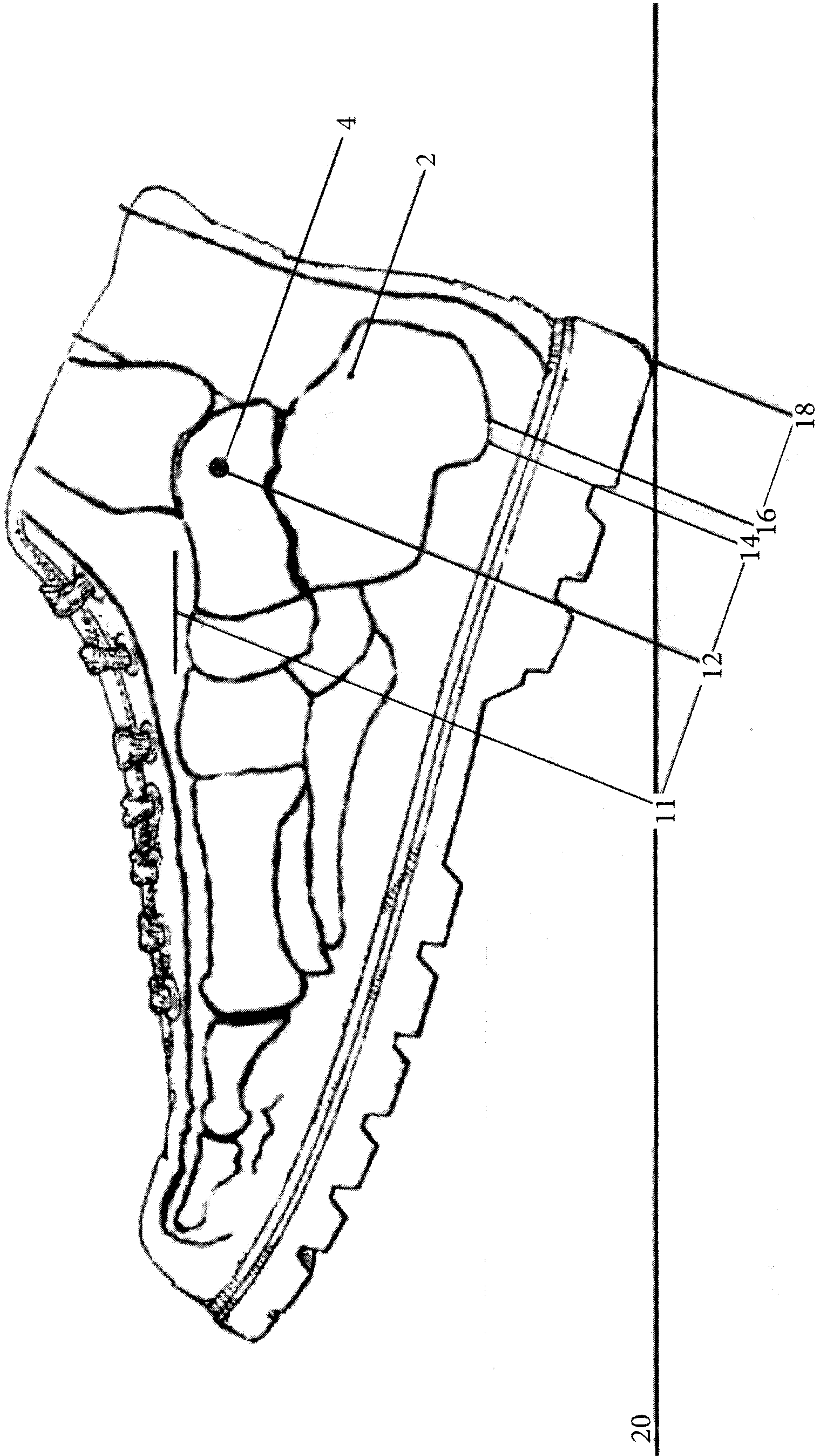
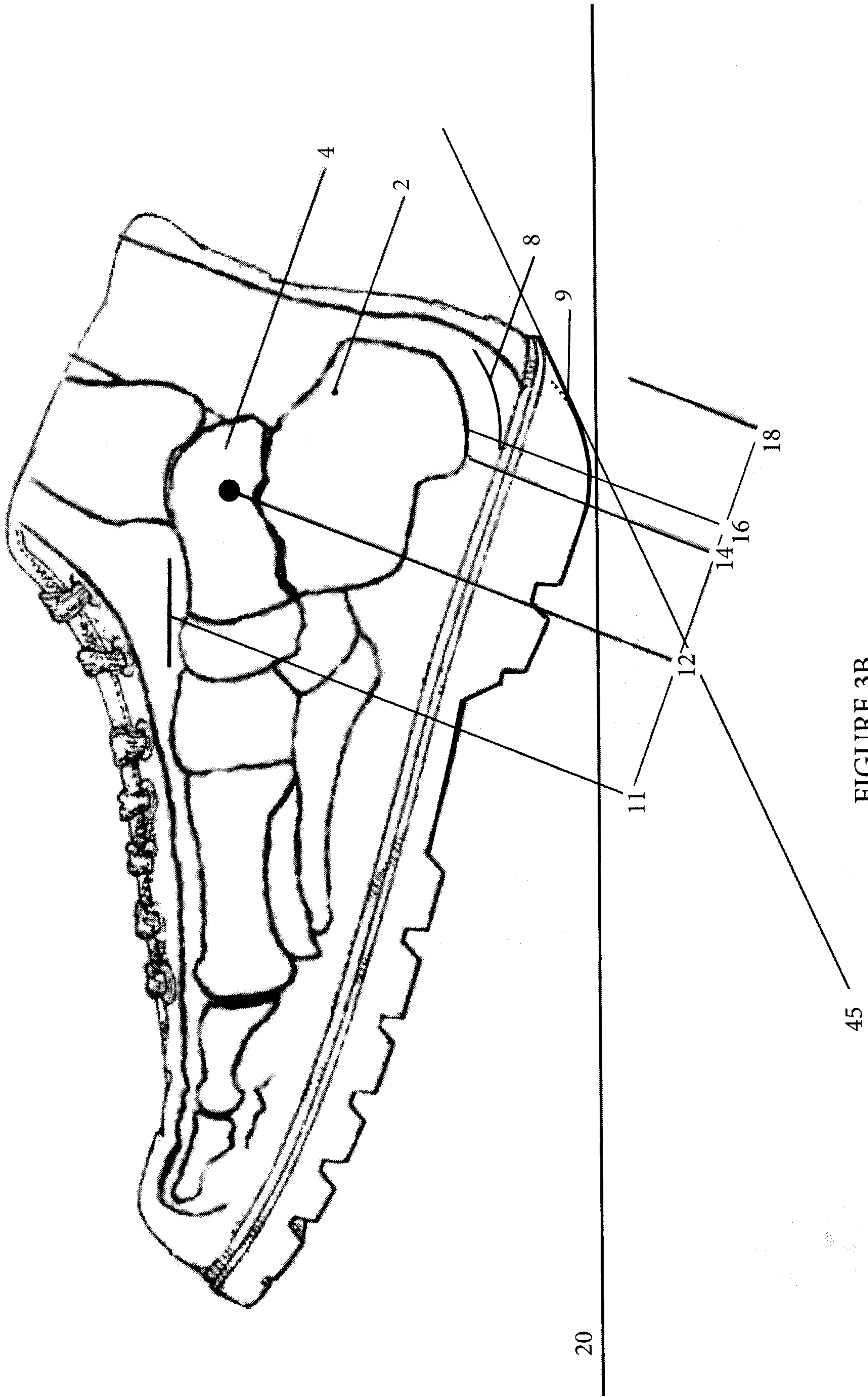


FIGURE 3A



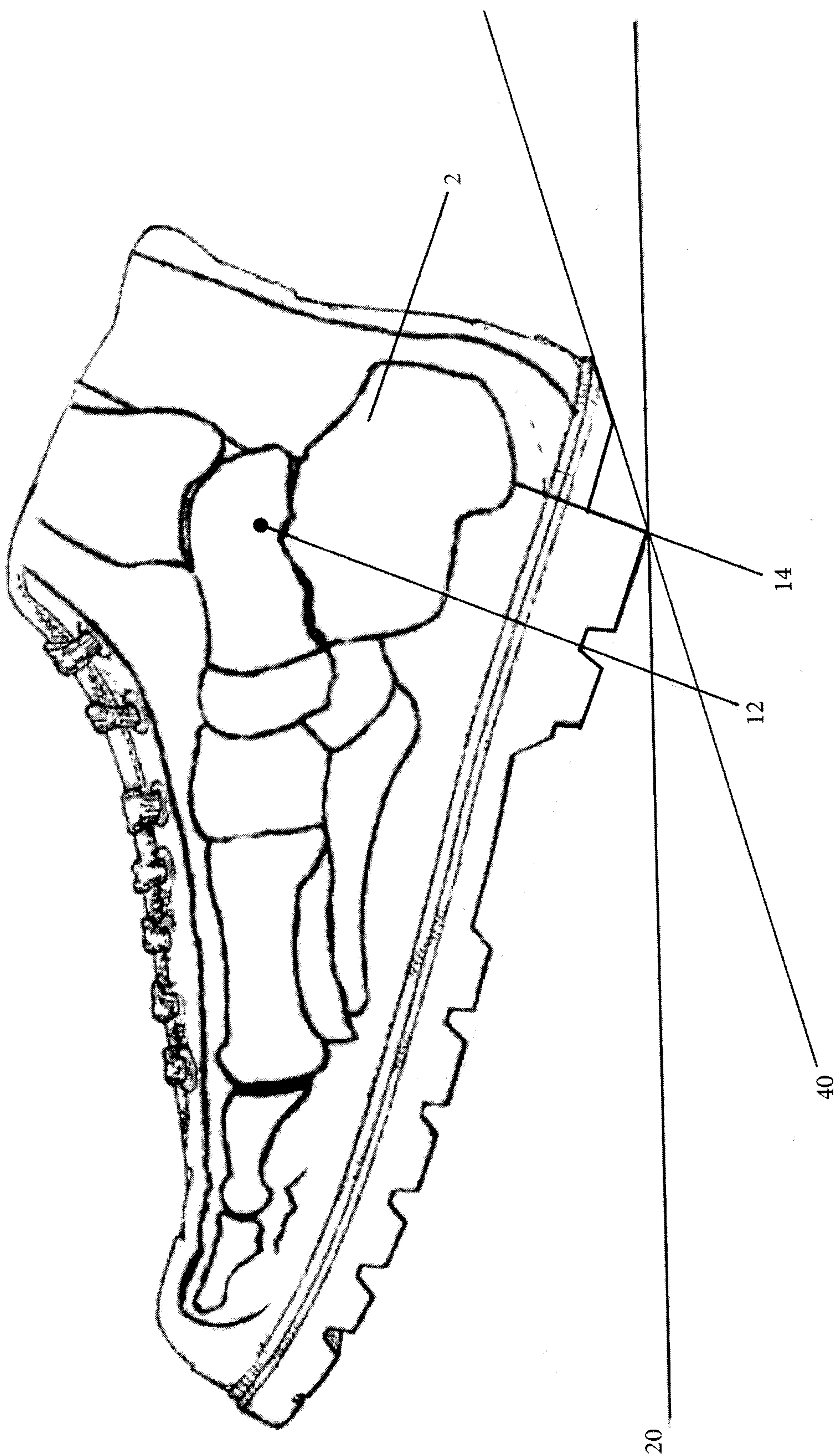


FIGURE 3C

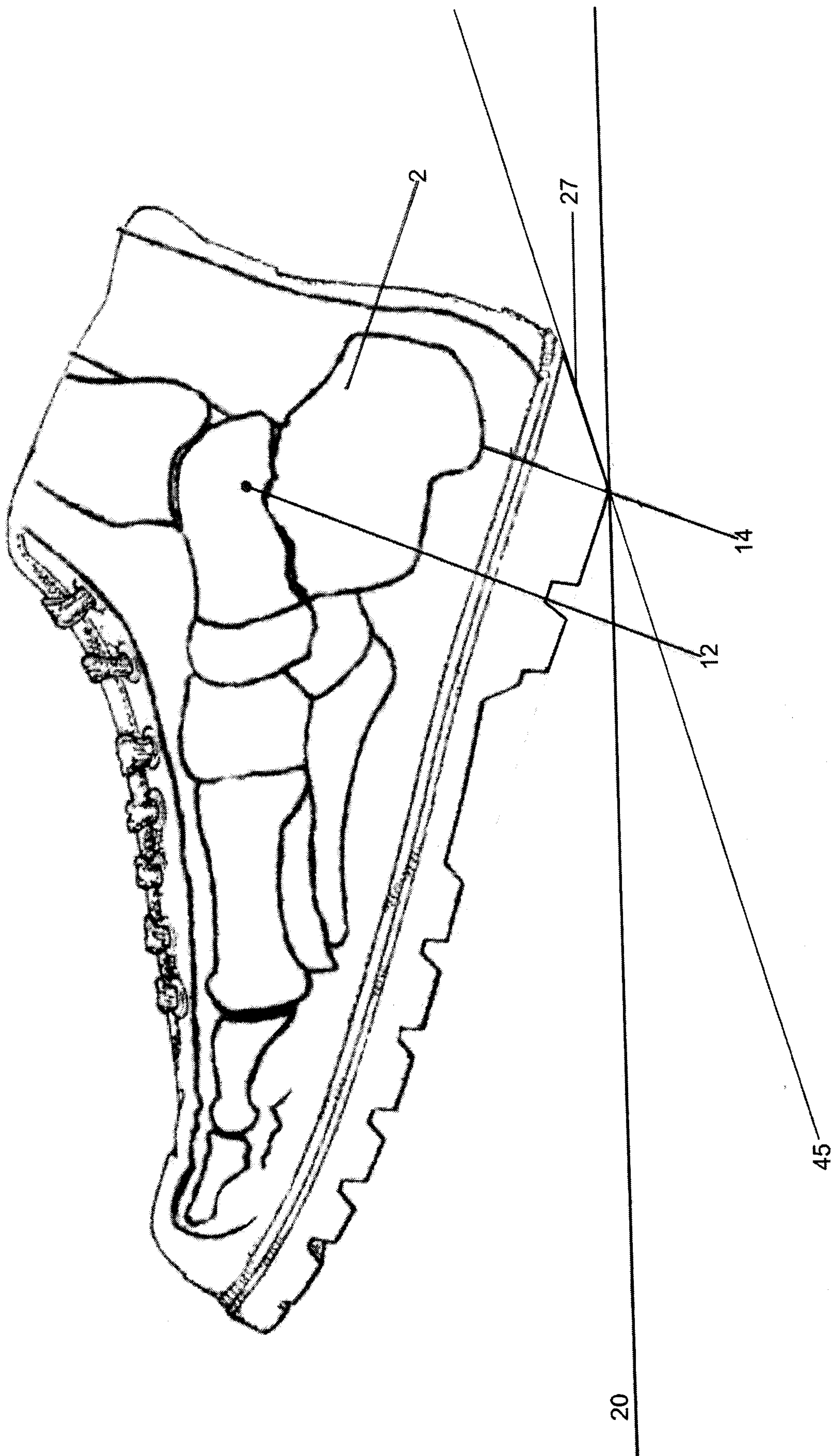


FIGURE 3D

PRIOR ART

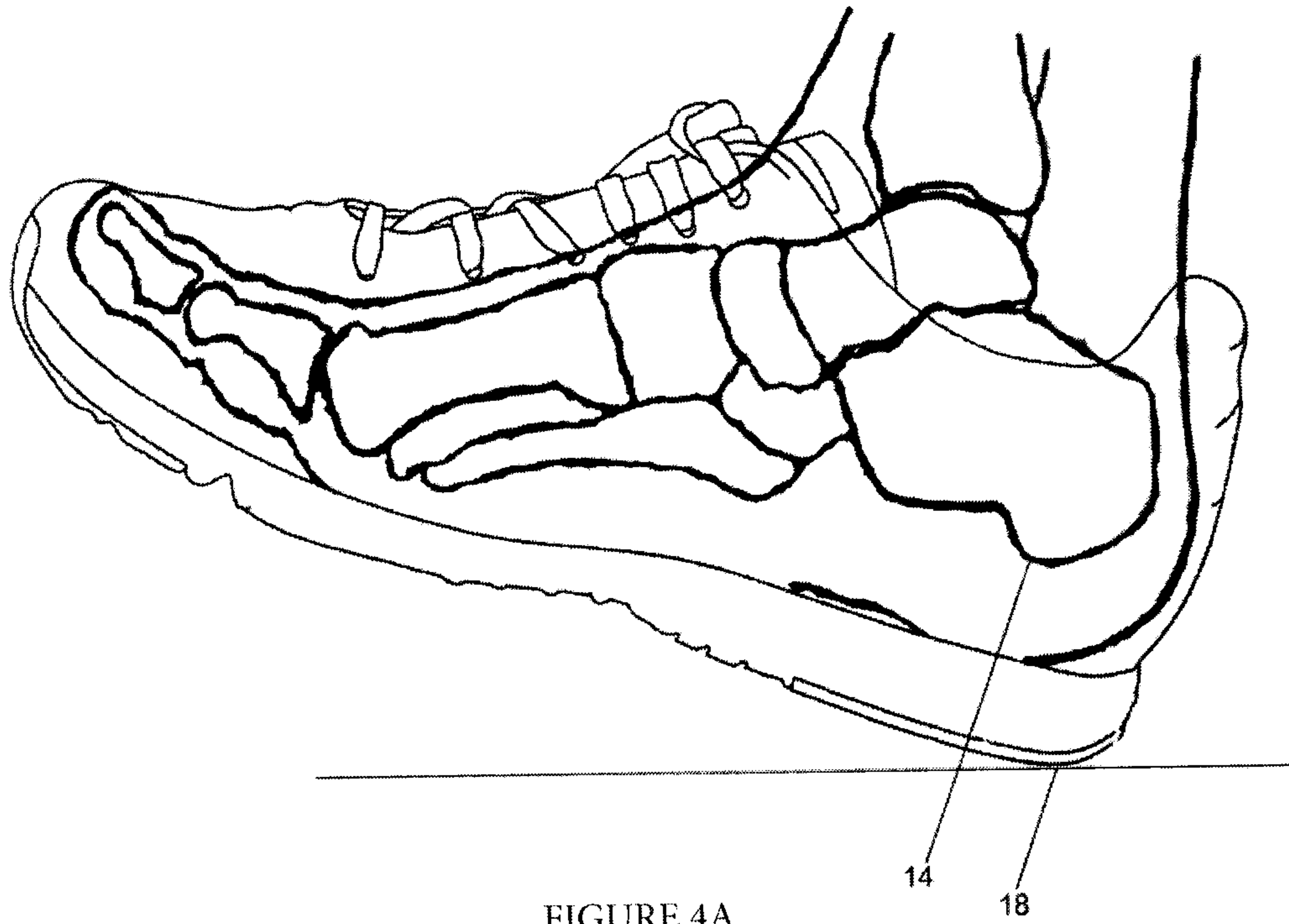


FIGURE 4A

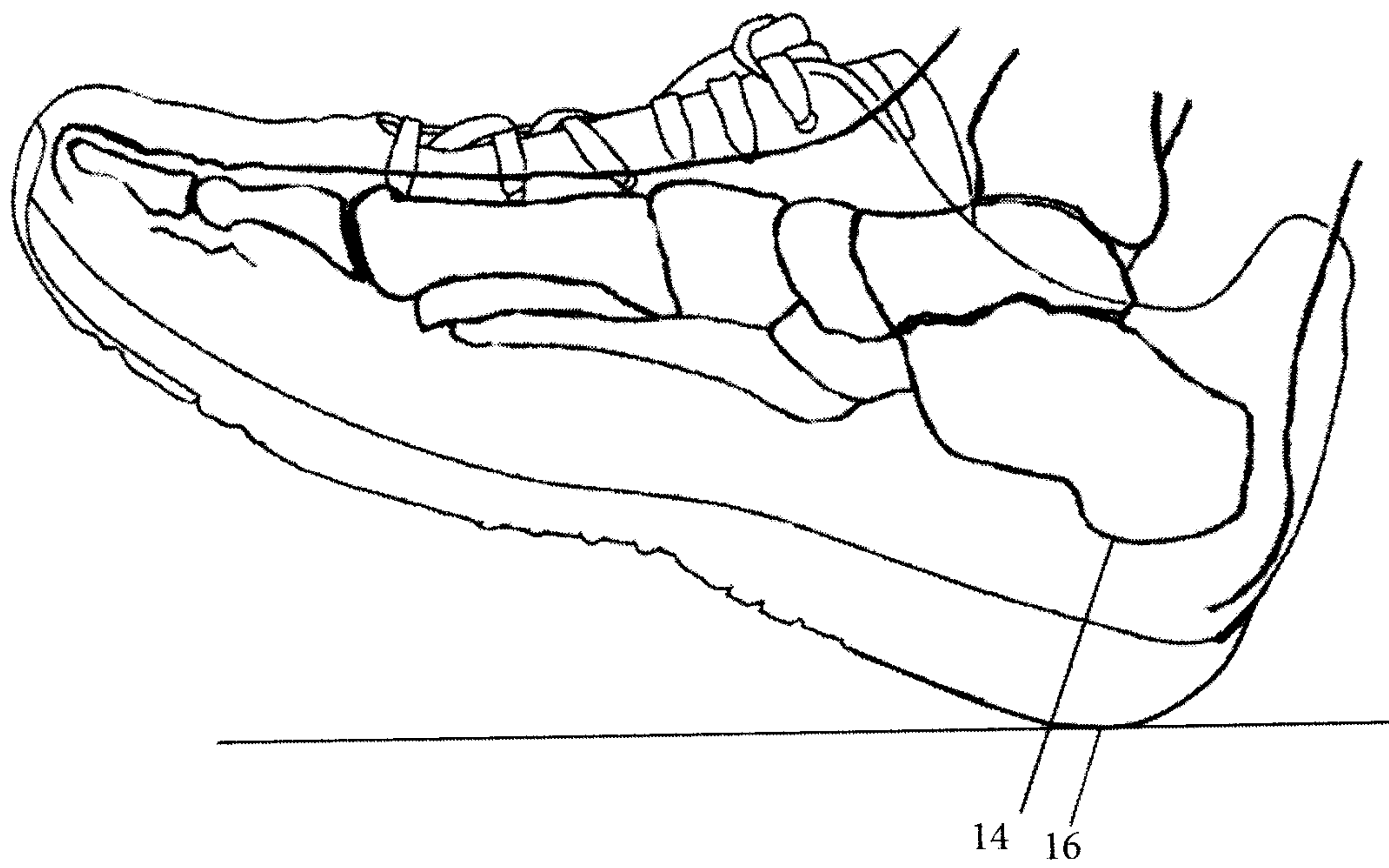


FIGURE 4B

PRIOR ART

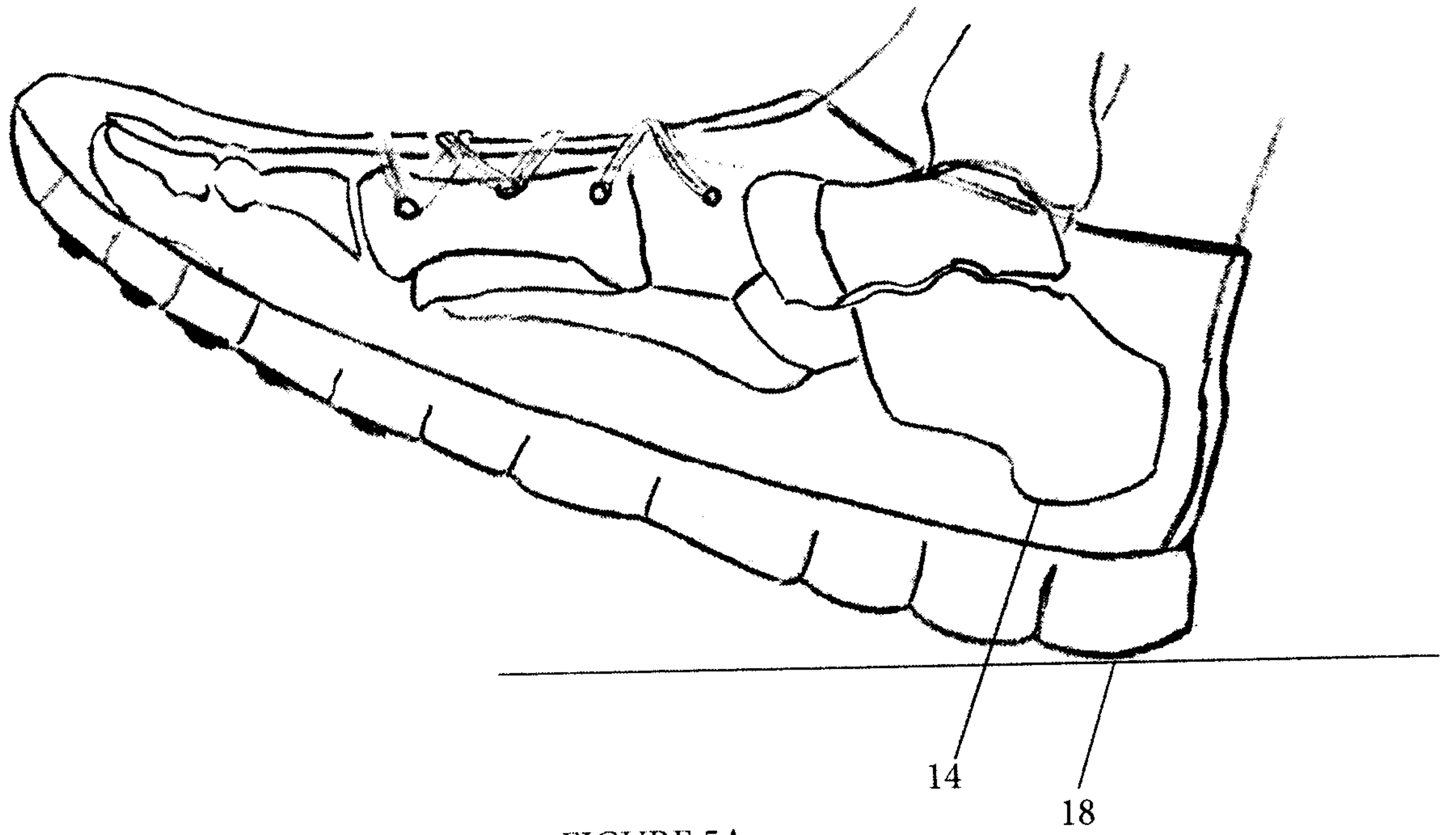


FIGURE 5A

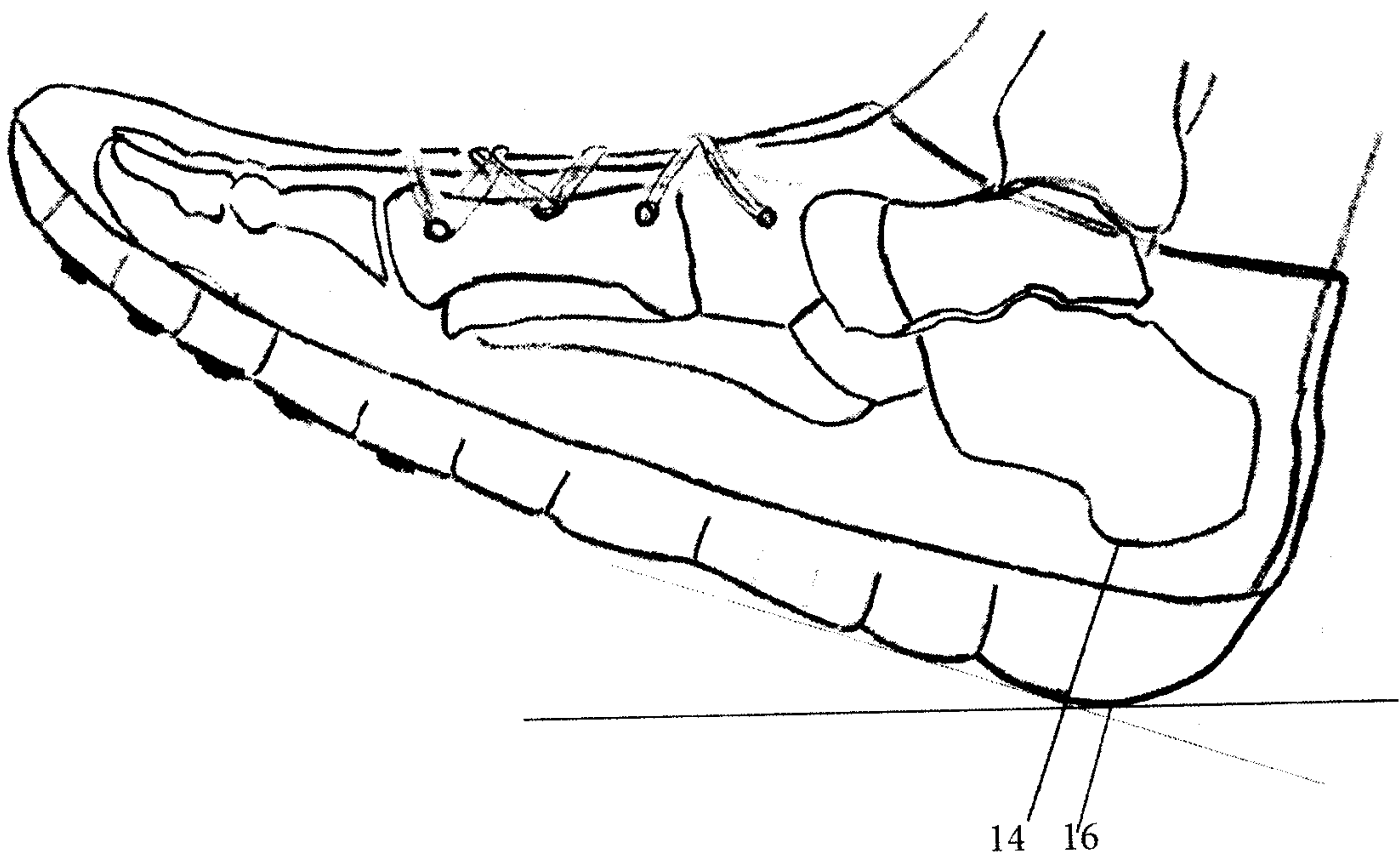


FIGURE 5B

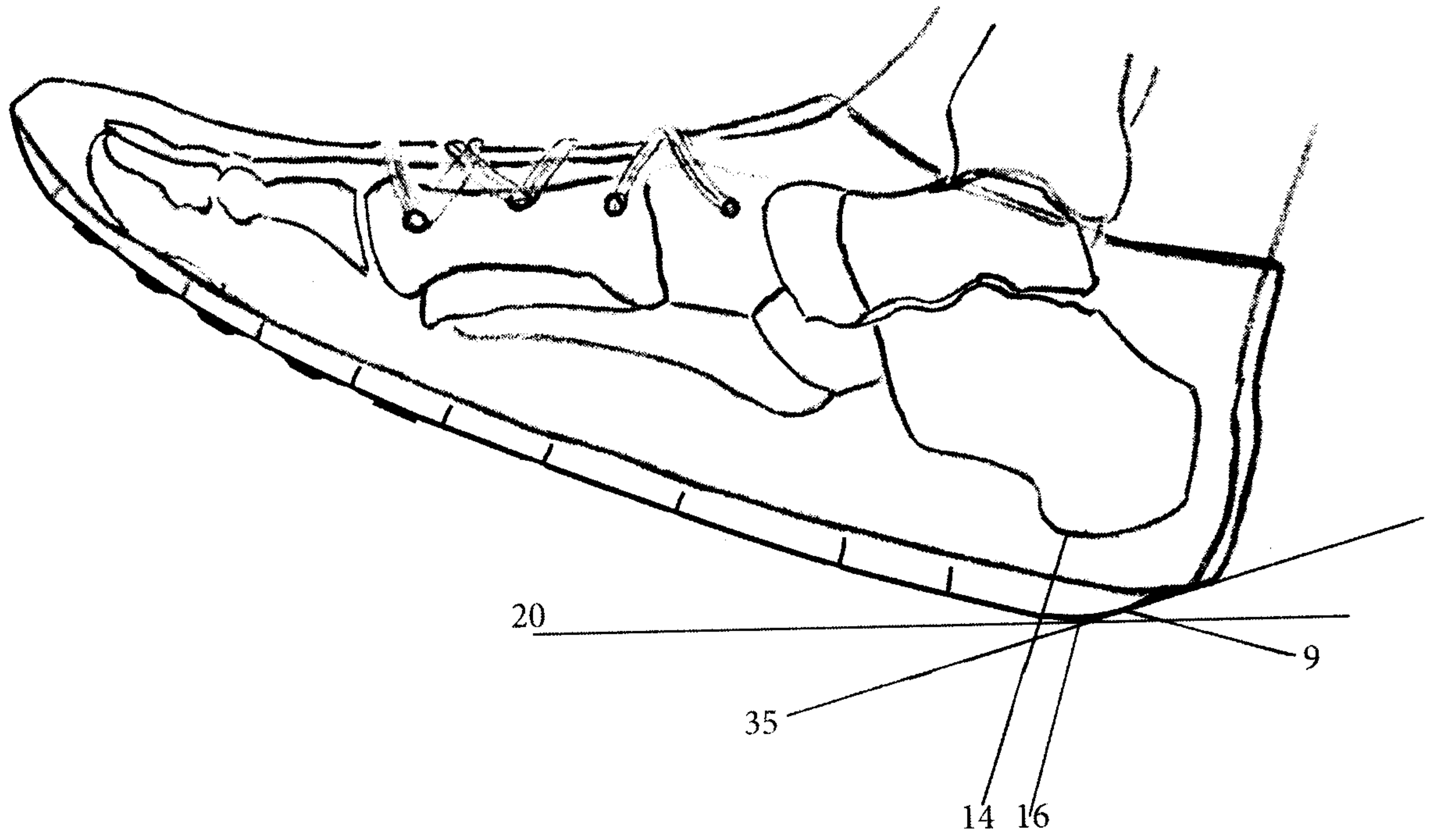


FIGURE 5C

PRIOR ART

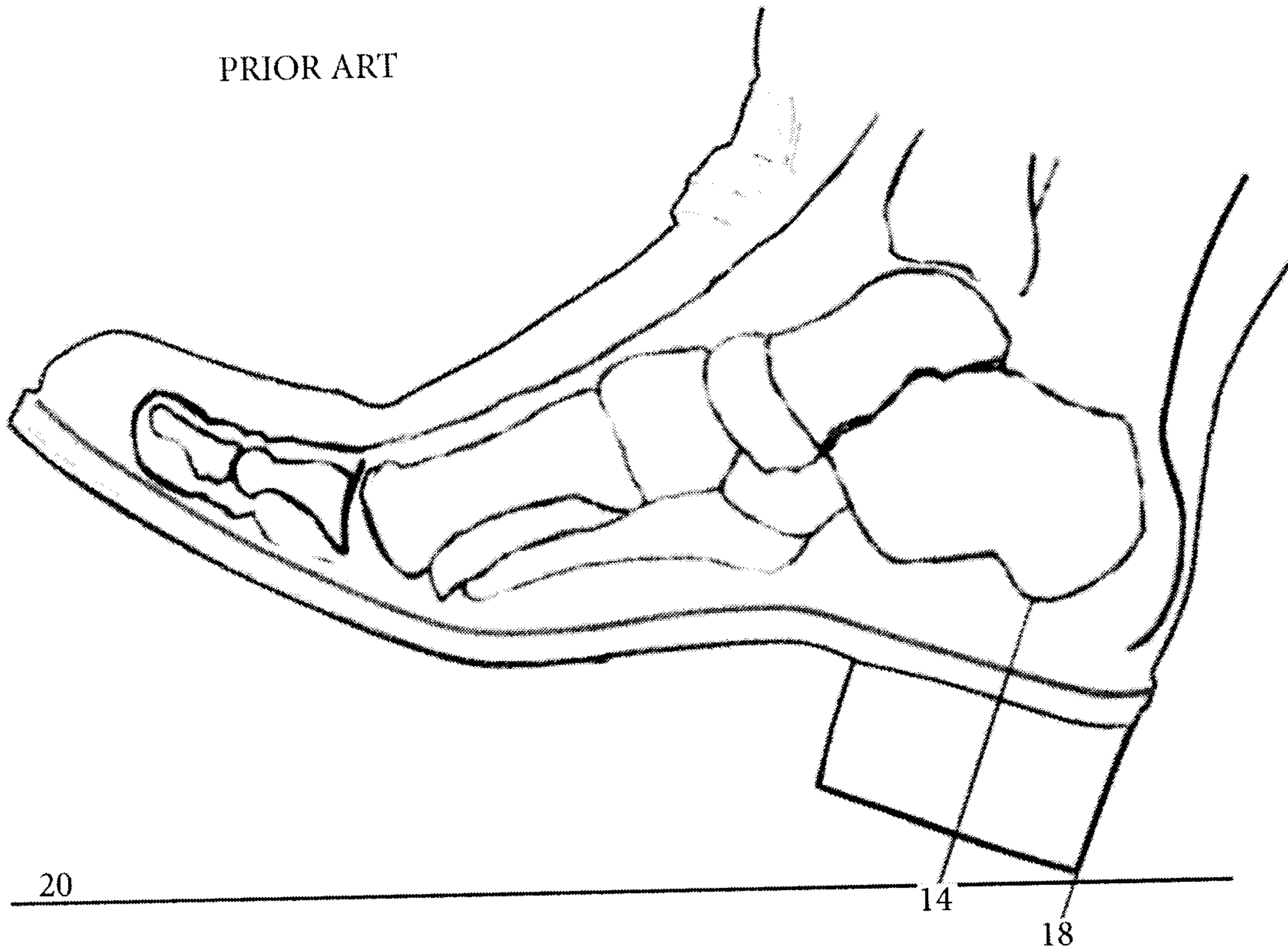


FIGURE 6A

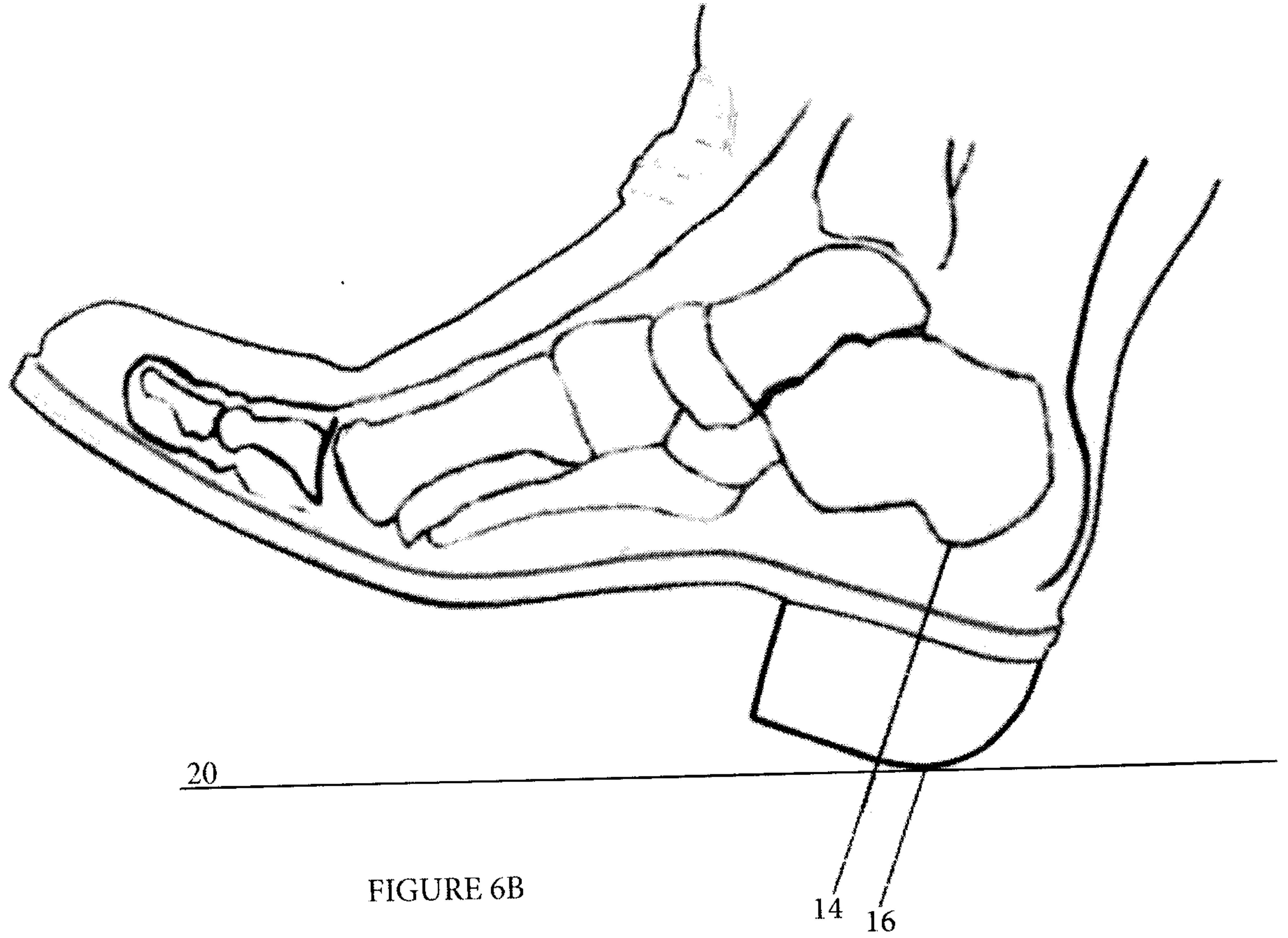
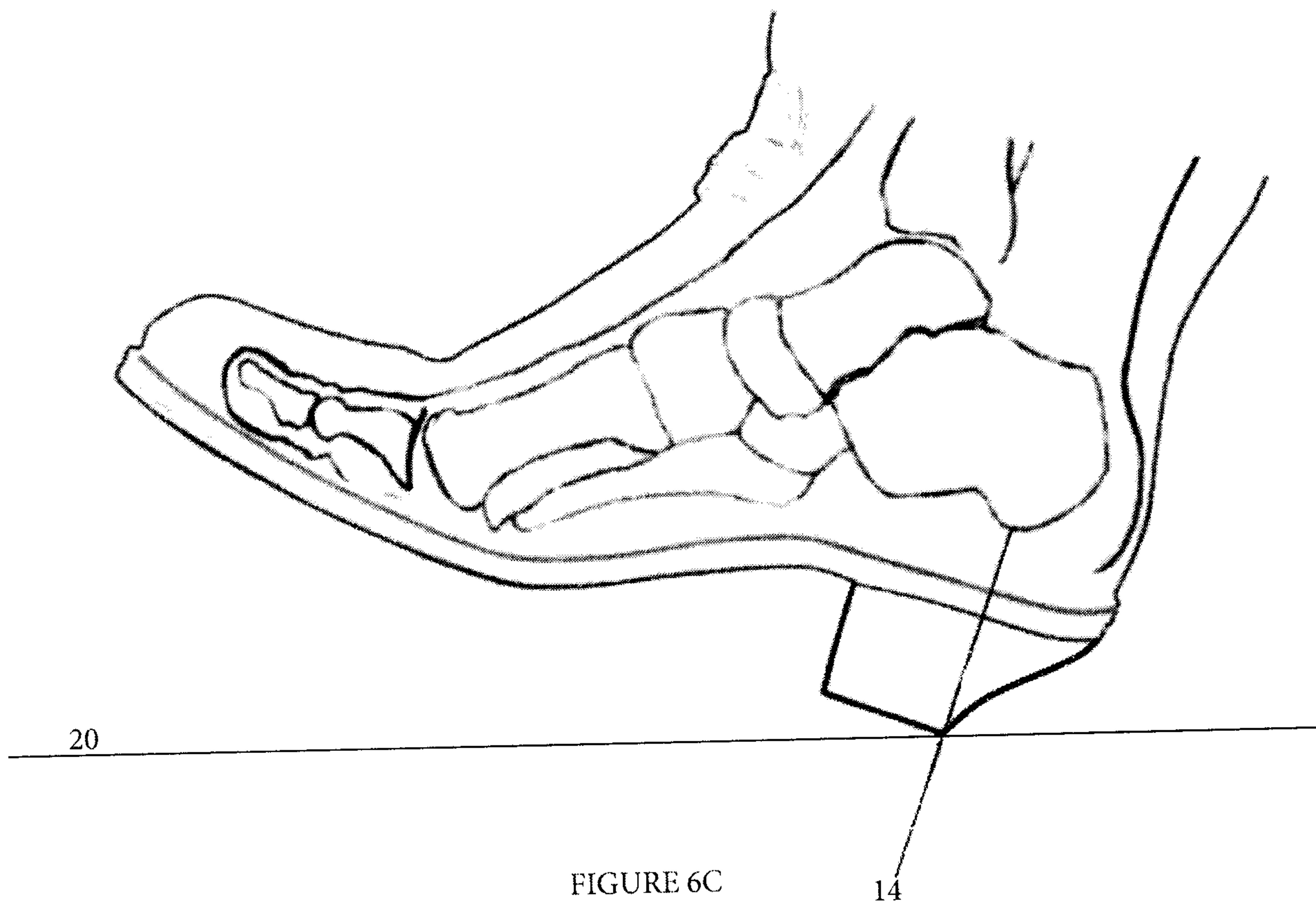


FIGURE 6B



PRIOR ART

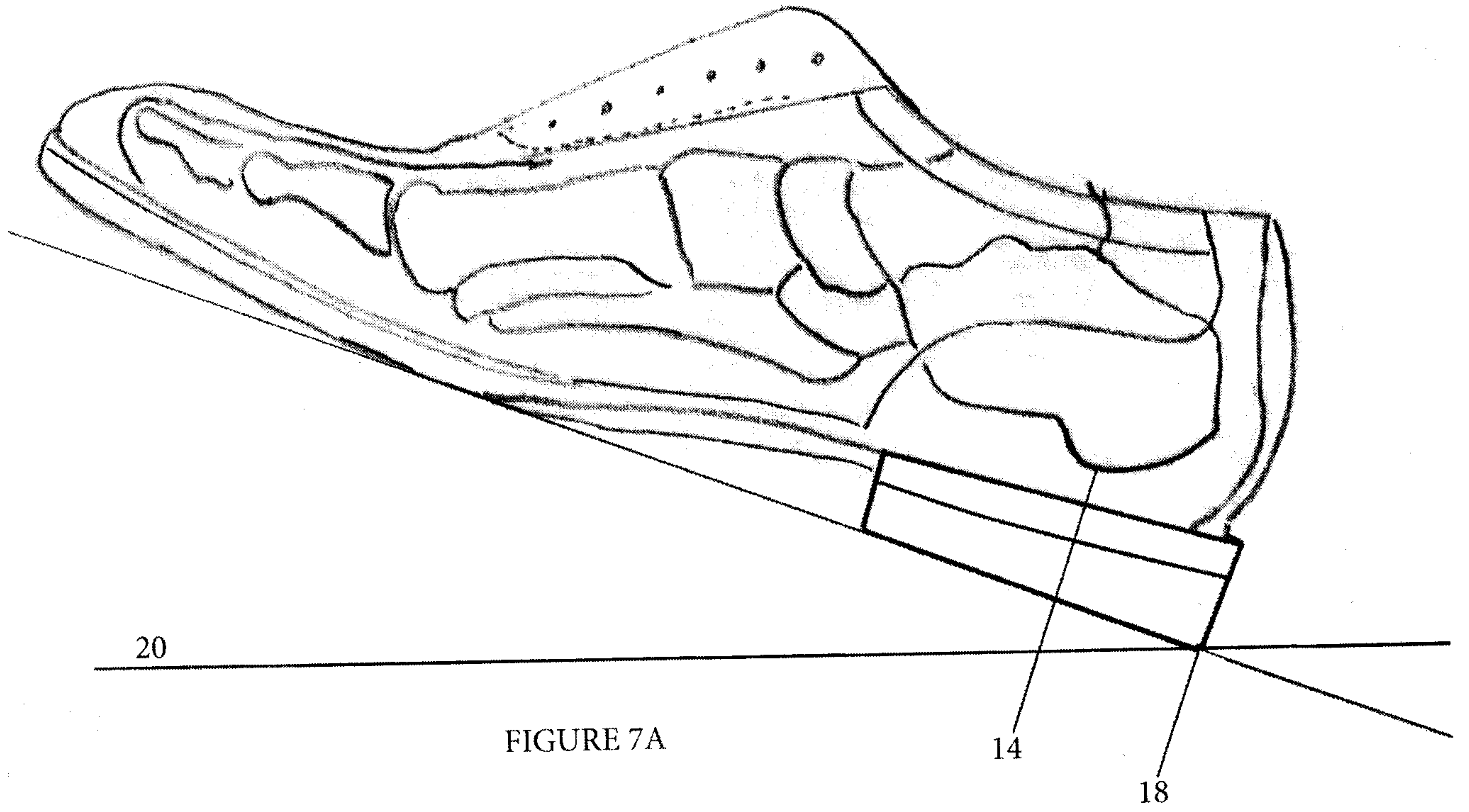


FIGURE 7A

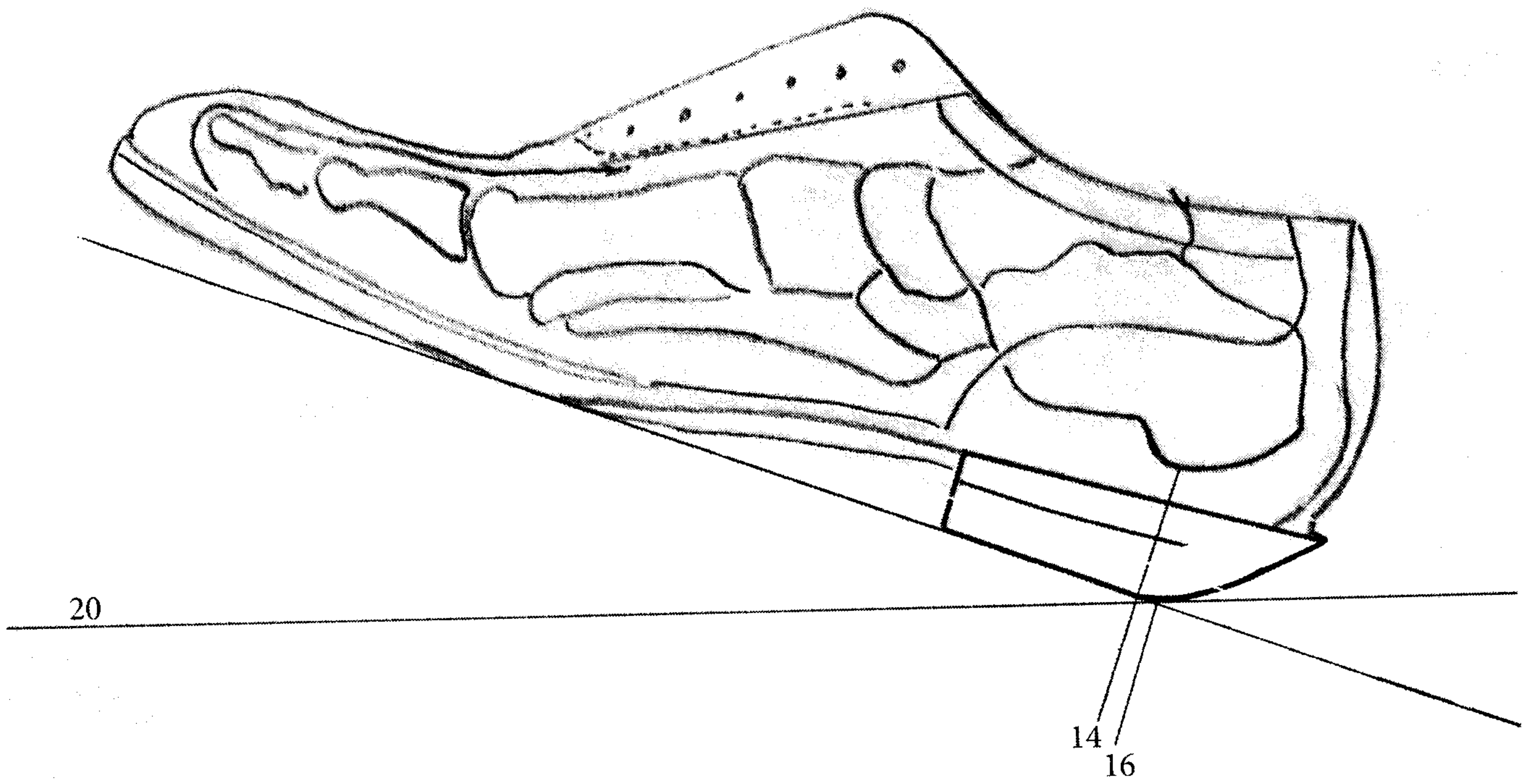


FIGURE 7B

