

Dec. 11, 1962

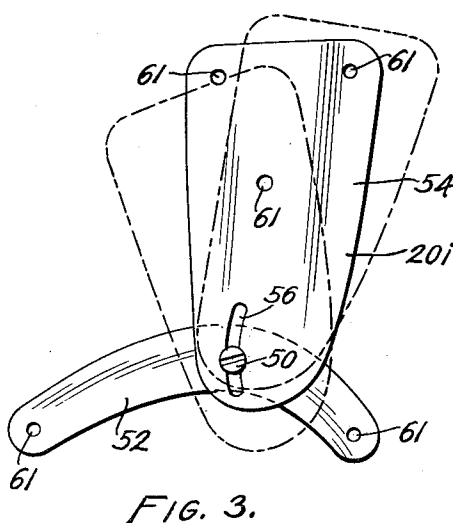
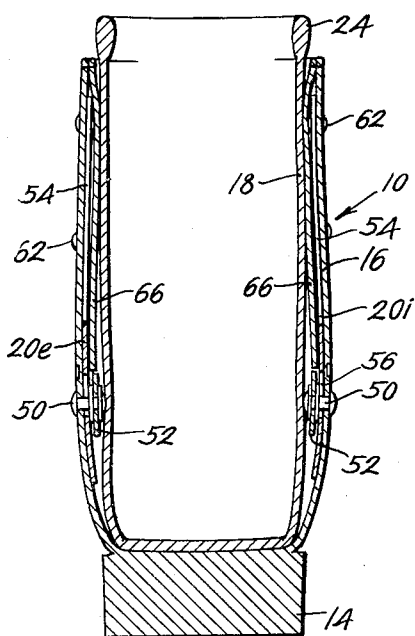
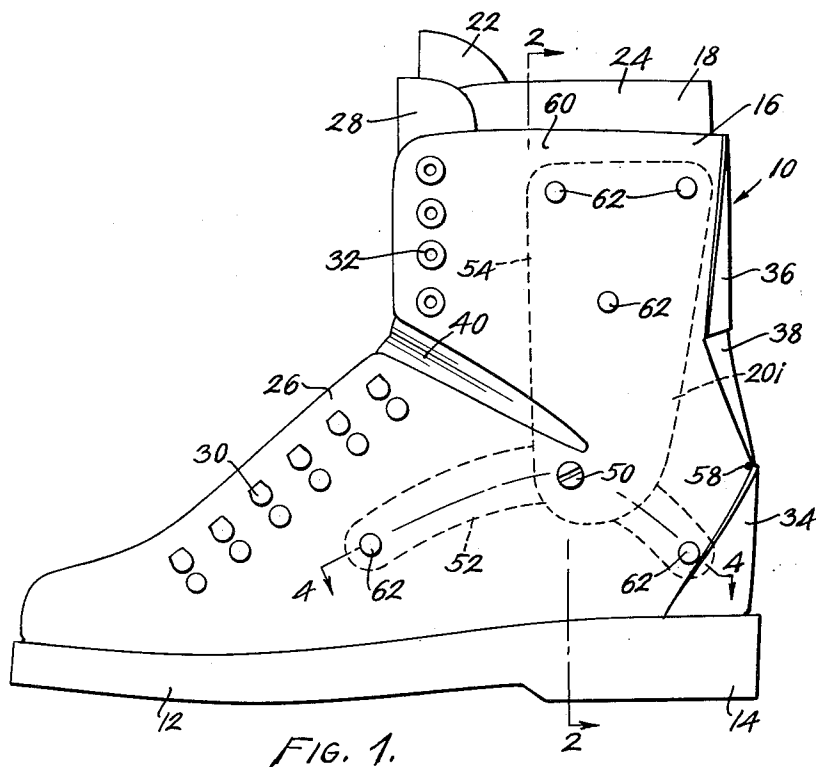
B. A. SCOTT ET AL

3,067,531

SKI BOOT

Filed March 15, 1961

2 Sheets-Sheet 1



INVENTORS
BRUCE A. SCOTT,
ROBERT R. ODEN,
DAVID J. LAWRENCE.

BY *Charles W. Dwyer & Wm. H. Moore*
ATTORNEYS

Dec. 11, 1962

B. A. SCOTT ET AL

3,067,531

SKI BOOT

Filed March 15, 1961

2 Sheets-Sheet 2

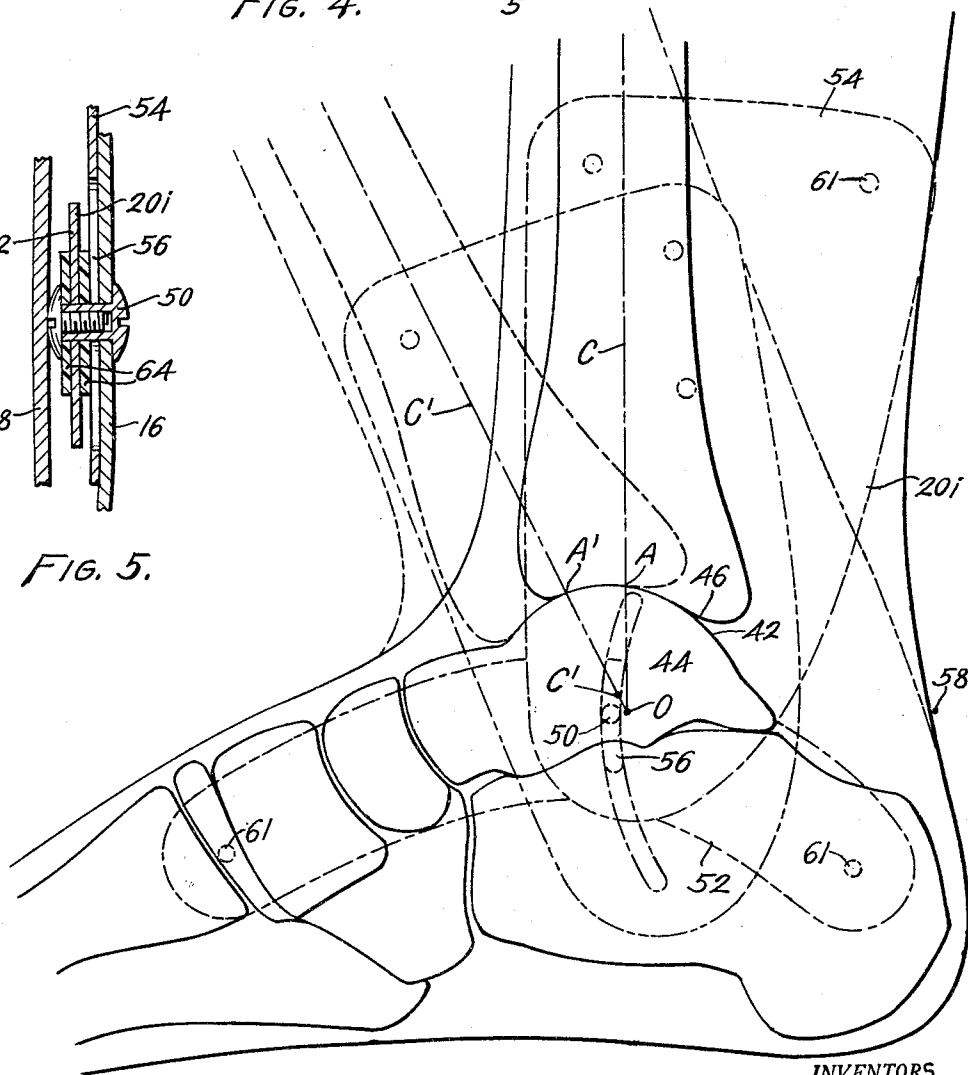
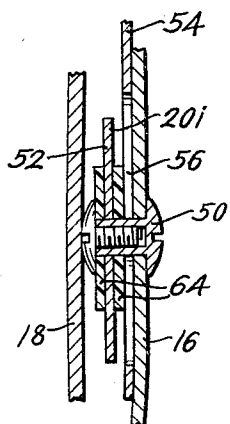
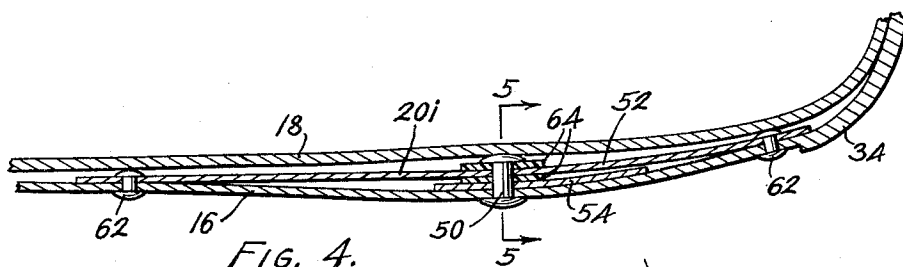


FIG. 6.

INVENTORS
BRUCE A. SCOTT,
ROBERT R. ODEN,
DAVID J. LAWRENCE.
BY *Andrew D. Langford & Moore*
ATTORNEYS

1

3,067,531
SKI BOOT

Bruce A. Scott, Denver, and Robert R. Oden and David J. Lawrence, Aspen, Colo., assignors to Aspen Boot, Ltd., Aspen, Colo., a corporation of Colorado
Filed Mar. 15, 1961, Ser. No. 95,923
16 Claims. (Cl. 36—2.5)

This invention relates to footwear and, more particularly to an improved ski boot characterized by the inclusion of a novel pair of hinge elements designed to resist and stabilize the ankle against lateral deflection while, at the same time, freeing the latter for longitudinal movement in cooperation with a carefully placed soft leather inset or gusset.

The design factors which influence the construction of sporting equipment such as, for example, the weight, length and balance of a shotgun, are known to have considerable bearing on the performance of the user; however, few instances exist where these factors are more significant than in the sport of skiing. Most skiers know, or at least should realize, that the control they are able to achieve bears a direct relationship to the fit of their boots and bindings, the latter elements providing the operative connection between the skier's body and the skis. A well designed pair of up-to-date safety bindings leaves little to be desired in terms of transferring the slightest movement of the boot to the ski; however, unfortunately, the present ski boots in all but very rare instances fail to measure up to the exacting criteria demanded of them if they are to transmit the motion of the foot to the binding and ski. In other words, with skis of the order of seven feet in length and more fastened to the boots by means of bindings, a fraction of an inch in movement of the foot results in several inches motion of the tip of the ski; whereas, if a substantial portion of this movement of the foot is lost inside the ski boot due to a poor fit, much of the desired control is lost and top performance becomes a practical impossibility. The failure of the prior ski boots to provide this tremendously important control function is, in large measure, a result of the fact that they are built up on standard lasts which may bear very little relation to the conformation of the foot of the actual wearer. A small percentage of people, of course, may have feet so ideally proportioned that they fit a boot fabricated on a standard last; however, this is undoubtedly an extremely rare phenomenon. In ordinary footwear, such differences as may exist are not too significant, but with ski boots this is not the case; yet, the same design criteria are generally used throughout the footwear industry.

Ideally, therefore, ski boots should be fabricated on lasts which comprise casts of the feet and ankles of each individual wearer. For all practical purposes, it is only when this is done that a substantially perfect fit of the type required to insure optimum control and comfort can be insured. For that matter, it has been found that the size and shape of an individual's feet, and therefore the boots, vary considerably and they are not mirror images of one another as is commonly suspected.

Another significant problem in ski boot design is that of lateral stability. For best performance, the ankle should remain substantially rigid insofar as bending to

2

one side or the other is concerned in order that the skis can remain properly edged and not side slip while executing difficult turns and the like. While rigid reinforcing elements of one type or another have been incorporated into the prior art ski boots on occasion, they have for the most part proven to be unsatisfactory for the purpose intended primarily because they were not designed with the anatomical characteristics of the foot and ankle or the comfort of the wearer in mind. Actually, if lateral stability alone were the problem, a suitable reinforcing member would call forth a relatively simple solution; however lateral stability cannot be divorced from the major difficulty that must be taken into account, namely, substantially unrestricted flexion of the ankle from an erect position to forwardly or rearwardly inclined ones which are the natural skiing attitude.

The previous attempts to design a suitable hinge providing both lateral stability and freedom of longitudinal movement have been very poorly received by knowledgeable skiers for several reasons. First of all their design was such that the axis of pivotal movement of the hinge did not correspond with that of the ankle thus creating stresses, strains and substantial discomfort rather than effecting a solution to the problem by reducing the foregoing. Secondly, the hinge units were so constructed that they utilized a fixed axis of pivotal movement when, in fact, such a construction causes the hinge to work against the compressive forces set up in the boot when the skier leans either forward or backward. Furthermore, the means usually provided for relieving the stresses in the boot leather were so designed and located that they were ineffective or else weakened the support the boot was intended to furnish.

It has now been found in accordance with the teaching of the instant invention that the critical axis of pivotal movement for hinge design purposes is not that of the ankle as was heretofore thought to be the case; but rather, the point on the heel of the boot itself at which the ankle-encircling leather portion bends when the wearer leans forwardly or rearwardly from an erect position. Bearing this fact in mind the boot described and claimed herein is so designed that the ankle-encircling portion thereof is forced to bend at a pre-determined point established between a reinforced heel cap topped by a weakened area. Then, the instep of the boot is provided with a dart inset with a soft leather gusset positioned and adapted to close or open offering very little resistance when the skier leans forward or rearward, respectively.

The hinge members are likewise designed to provide the maximum lateral stability coupled with substantially unrestrained movement in a longitudinal plane. The foregoing is accomplished by means of a two-part member having a fixed element attached to a movable element by a pin and slot coupling that provides a lost-motion connection therebetween. The fixed element of the hinge member is rigidly mounted alongside the arch of the foot encased within a portion of the boot that does not bend or otherwise move; whereas, the movable element is fixedly attached to the ankle-encircling portion of the boot for movement therewith from an erect to either a forwardly or rearwardly inclined position. The pin depends from the fixed element of the hinge and is preferably located on the locus of points defined by the axis of movement

of the tibia over the proximal articular surface of the talus as it is at this point that the least relative motion in the ankle joint is found. While it is not imperative that the pin be so located for satisfactory operation of the hinge, the interaction, stresses and counteracting forces existing between the ankle joint, boot and hinge are thus reduced to a minimum and it is, therefore, preferred.

The slot, on the other hand, is placed in the movable hinge element on an arc scribed about the axis of pivotal movement of the ankle-encircling portion of the boot that passes through the pin. With the pin located at some point intermediate the ends of the slot when the ankle-encircling portion of the boot is in the normal or erect position, then the movable hinge element can rock both forwardly and rearwardly thereon. The resulting hinge connection virtually eliminates stretching of the leather which, in time, would result in a poorly fitted boot. Also, by properly relieving the strain developed in the boot as the ankle bends forward, unsightly and uncomfortable folds cease to be a problem.

It is, therefore, the principal object of the present invention to provide a novel and improved ski boot.

A second object is the provision of footwear of the type aforementioned wherein the design approaches the ultimate in lateral stability without sacrificing comfort and utility.

Another objective of the instant invention is to provide a ski boot which is preferably custom-contoured to the exact requirements of the individual wearer by means of a molded last cast from each foot.

Still another object is to provide an improved hinge incorporating a lost-motion connection that more nearly compensates for the counteracting forces in the boot, ankle and hinge than any heretofore known in the prior art.

An additional objective is the provision of a ski boot incorporating a precisely-positioned soft-leather dart or gusset that cooperates with a weakened heel area to substantially eliminate strains, folds, stretching and other difficulties that tend to ruin the fit of the boots as well as cause much discomfort to the wearer.

Further objects of the invention claimed herein are to provide ski boots that are capable of giving the precise control over the movements of the skis that is so vital to expert skiers, boots that are scientifically designed to produce the ultimate in comfort and freedom of movement from an erect to a forwardly inclined position, and ones that are decorative, relatively light-weight, usable with any of the popular types of bindings, and adaptable to any size foot.

Other objects will be in part apparent and in part pointed out specifically hereinafter in connection with the description of the drawings that follows, and in which:

FIGURE 1 is a side elevation of a ski boot embodying the novel hinge element that forms a part of the subject matter of the present invention;

FIGURE 2 is a vertical transverse section taken along line 2—2 of FIGURE 1 showing the location of the hinge between the inner and outer boots;

FIGURE 3 is a side elevation of the hinge element alone in substantially the same position in which it is shown in dotted lines in FIGURE 1;

FIGURE 4 is a fragmentary section taken along line 4—4 of FIGURE 1 and to a slightly enlarged scale showing further details of the hinge;

FIGURE 5 is a fragmentary section to a further enlarged scale taken along line 5—5 of FIGURE 4 illustrating the details of the hinge-pin assembly; and

FIGURE 6 is a diagrammatic elevation illustrating the anatomical structure of the human ankle in an erect and forwardly inclined position along with the positions of the hinge element corresponding thereto and to the entire foot.

Referring now to the drawings for a detailed description of the ski boot of the present invention, the latter

having been designated in a general way by reference numeral 10, and in particular to FIGURES 1 and 2 for this purpose, it will be seen to include a sole 12 having a heel 14 attached thereto, an outer boot 16 and an inner boot 18, and a pair of hinge elements 20i and 20e attached in place between the inner and outer boots. The inner boot 16 is of conventional construction having an opening along the instep behind which is located an inner tongue 22 adapted to cooperate therewith in the usual manner to provide a substantially water-tight closure. A set of laces are seldom required on the inner boot although they may be provided if desired. The upper edge and tongue of the inner boot extend upwardly beyond the corresponding margin of the outer boot in the particular form shown and such projecting portion 24 is preferably folded over to provide a rolled edge or otherwise thickened in order that the boots not cut into the instep when the user leans forward.

The outer boot 16 is also equipped with an opening from the top thereof along the instep down to the toe providing a pair of flaps 26 adapted to overlie the side edges of the outer tongue 28. As would be expected, suitable fasteners comprising hooks 30 and eyelets 32 are provided along the edges of the flaps bordering the opening therebetween for the purpose of receiving a boot lacing that holds both the inner and outer boots tightly closed on the wearer's foot. As shown, the heel of the outer boot is reinforced by cap 34 and at the hook of the ankle as indicated at 36. Between these two reinforced areas lies a generally triangular-shaped opening into which is inset a thinner piece of leather 38 stitched to the inside. The latter inset, being of lighter weight leather, enables the ankle-encircling portion of the outer boot to bend forward more easily thus defining a weakened area in which the true axis of pivotal movement is located. A second soft leather dart or gusset 40 is provided in each flap extending generally from the instep toward the true pivot axis at the heel of the boot. This dart cooperates with the weakened area at the heel above cap 34 to enable the ankle-encircling portion of the outer boot to bend either forwardly or rearwardly without producing a fold in the heavy leather or otherwise causing strain or resistance to such movement. The width of gusset 40 is preferably such that the side edges thereof close when the lower leg is inclined forwardly about 30°. Ideally, some slack is provided in the soft leather gusset 40 in erect position to be taken up when the lower leg bends rearwardly about 30°.

The inner boot, outer boot and sole must, of course, be fabricated from a good grade of leather, preferably one that is relatively thick, pliable and will not stretch appreciably. As is customary in the construction of high quality ski boots, the sole will usually incorporate a steel shank so that it will not bend.

One of the most significant features of a well designed ski boot is the manner in which it fits the foot as has already been explained in considerable detail. Therefore, in the preferred embodiment of the instant ski boot, each is hand crafted from individual lasts cast of the wearer's feet. Ordinarily, this is accomplished by making a casting or mold of each foot with any one of several commercially-available molding compositions suitable for this purpose. Thereafter, the mold thus produced is used to make an exact replica of the skier's feet and angles. The manufacturer then uses these casts as lasts upon which the boots are constructed thereby insuring an exact fit. Obviously, the ski boots of the present invention can be fabricated on conventional lasts with substantial improvement being realized over the prior art boots due to the incorporation of novel hinge members 20; however, for best results, each boot must be individually tailored to the wearer's feet.

Before proceeding with a detailed description of the interior and exterior hinge members 20i and 20e, respectively, and the manner in which they are mounted with-

5

in the boot, it would be well to refer to FIGURE 6 wherein the factors that influence their design and location can best be set forth. To begin with, X-ray studies of the astragalus or ankle joint will reveal that the proximal articular surface 42 of the talus 44 is more nearly ellipsoidal with its major axis extending longitudinally than it is spherical. This means that the concave surface 46 of the tibia that slides on the talus moves about a constantly shifting center as the inclination thereof changes. In other words, if we consider line "C" the centerline of the tibia and point "A" on this line the point of tangency between the tibia and talus in erect position, the radius of curvature of the talus at this point would locate the center at "O." Now, when the tibia moves forwardly about 30° to the dotted line position of FIGURE 6 wherein the centerline occupies the position C' and the point of tangency is found at A', note that the center of the radius of curvature of the talus at this point has shifted upwardly and forwardly to C. The net effect of this shifting axis of pivotal movement of the astragalus can probably be ignored for most practical purposes as its maximum displacement between a full forward and full rearward lean will seldom exceed a quarter of an inch; however, in the preferred embodiment of the present invention, the fixed pin 50 of the hinge member should be located on or proximate to the locus of points defined by the shifting pivot axis of the astragalus, as shown, in order to reduce to a minimum the counteracting compressive and extensor forces existing in the hinge, the ankle and the boot.

The hinge pin 50 depends from the fixed element 52 of the hinge member 20 which is arched to follow generally the longitudinal arch of the wearer's foot terminating at the rear near the heel and at the front just behind the ball of the foot. At this point it will be well to mention that hinge member 20i which is found on the inside of the foot will be described in detail as it is more fully illustrated in the drawings; however, the same design criteria apply equally well to the outside or exterior hinge member 20e except, of course, for minor variations in shape to conform with the different contours of the ankle on the outside when compared with the inside and the fact that they are substantially mirror images of one another.

The movable hinge element 54 is attached to the pin 50 of the fixed hinge element 52 by means of an arcuate slot 56 which cooperates with the latter to provide a lost-motion connection. The radius of curvature of arcuate slot 56 is the distance between the center of pin 50 and the pivot point 58 on the heel located at the juncture between the heel cap 34 and the soft leather inset 38 as this is the axis upon which the ankle-encircling portion 60 of the boot bends when the lower leg is flexed either forwardly or rearwardly.

The extent of slot 56 lying above the pin 50 when the boot, hinge and ankle joint occupy the normal or erect position is such as to permit the lower leg and ankle-encircling portion of the boot to move forwardly about 30° from the vertical before the upper end of the slot contacts the pin as shown in dotted lines in FIGURE 6. Conversely, the length of slot 56 located below the pin is preferably such as to allow about a 30° rearward inclination of the lower leg and upper boot before the bottom of the slot contacts the pin. The above-described relative motion between the elements of the hinge is, of course, accomplished by fastening the fixed element securely to the counter and vamp of the boot and the movable element to the ankle-encircling portion thereof as will be explained presently in connection with other figures of the drawing.

In the particular form shown, the axis 58 about which the ankle-encircling portion 60 of the boot is designed to tilt is located in approximately the same horizontal plane as the hinge pin 50 which, in turn, coincides generally

6

with the axis of pivotal movement of the astragalus. Actually, axis 58 is positioned at that point on the heel of the boot which corresponds with the similarly located point on the heel at which the ankle joint appears to bend as indicated in FIGURE 6 by the dotted and full line configurations.

The shape of movable element 54 of the hinge member 20 is such as to provide a rounded lower end adjacent the pivot and a substantially square upper edge adapted to fit along the cuff of the boot. The front edge is almost vertical when the hinge member is in normal or erect position, whereas, the rear edge has a slight inclination upwardly and rearwardly. The cross section of the movable element is contoured to approximate the surface of the lower leg and ankle or maleolus it is designed to rest against and reinforce from between the walls of the inner and outer boot. Note that the slot and pin connection of the hinge member is displaced forwardly of the vertical centerline in order to overlie the locus of points defining the pivot axis of the astragalus.

Still with reference to FIGURE 6, it can be seen that the lost motion connection between the fixed and movable elements of the hinge member is located a substantial distance beneath the proximal articular surfaces of the talus and tibia which form the ball and socket connection at the ankle. This fact is of substantial importance in providing the maximum in lateral support and reinforcement for the ankle without sacrificing relatively free movement in a longitudinal plane. In other words, the movable hinge element bridges the ankle joint insofar as relative tiltable movement of the lower leg with respect to the foot is concerned and this would not be the case if the pin of the lost motion connection were raised to lie opposite the articulated surfaces of the astragalus.

The attention is now directed to FIGURES 1, 3 and 6 wherein it will be seen that with the fixed hinge element 52 permanently attached to the counter and vamp of the boot and the movable element 54 similarly attached to the ankle-encircling portion or cuff 60 thereof, as the lower leg bends forwardly relative to the foot, the movable element of the hinge must drop down relative to the fixed element if the former is to maintain its fixed position in the cuff. Hence, the need for the lost motion connection which allows the movable hinge element to drop downwardly at the same time the dart 40 at the instep is closing. If the hinge was not designed in this way, as the cuff 60 tilted forwardly, the movable element of the hinge would tend to resist this movement by trying to work its way out of the top of the boot.

The converse is also true, namely, that as the cuff or ankle-encircling portion of the boot bends rearwardly corresponding to a backward tilt of the lower leg relative to the foot, the movable element of the hinge becomes extended with reference to the fixed element if it is to occupy a fixed position in relation to the top of the boot. In this instance, the gap in the dart 40 widens causing the soft leather insert bridging same to stretch into an unfolded condition.

Specifically referring to FIGURE 3, both the fixed and movable elements of the hinge member are preferably fabricated from lightweight metal such as magnesium or an aluminum alloy. It has been found that an aluminum alloy 0.032 to 0.050 inch thick provides adequate reinforcement and strength without adding appreciable weight to the assembly. The movable hinge element is preferably located so as to cover or overlay the fixed element as shown. Obviously, the hinge pin 50 could depend from the movable element 54 with the arcuate slot 56 being located in the fixed element 52; however, this construction is somewhat less desirable as it would require substantial increase in the width of the fixed element to accommodate the slot and still maintain the required structural strength. Fastener openings 61 are provided at opposite ends of the fixed hinge element and

also in the upper end of the movable hinge element for the purpose of attaching the hinge to the leather of the boot.

Finally, the manner in which the hinge assembly 20 is installed within the boot will now be described in connection with FIGURES 2, 4 and 5 of the drawing. Both the fixed and movable hinge elements 52 and 54 are permanently mounted by means of rivets or other suitable fasteners 62 to the sidewalls of the outer boot 16 between the latter and inner boot 18. The hinge pin 50 provides a free sliding fit between the fixed and movable elements of the hinge assembly and also pierces the wall of the outer boot in the same manner as the rivets 62 thus providing additional fastening means. In the particular form shown, pin 50 is detachable and of the type commonly known in the art as a "Chicago Screw." Washers 64 separate the fixed and movable elements of the hinge and also the fixed element 52 from the head of the hinge pin. If these washers are fabricated from some self-lubricating material such as "nylon" they improve the action of the hinge and quiet its operation. In the preferred embodiment of the invention, the cuff or ankle-encircling portion 60 of the outer boot 16 is double-walled with inner wall 66 covering the inside surface of movable hinge element 54 as shown most clearly in FIGURE 2.

Having thus described the several useful and novel features of the ski boot of the present invention, it will be apparent that the many worthwhile objectives for which it was designed have been achieved. Although but a single specific embodiment of the invention has been illustrated in the accompanying drawings, we realize that certain changes and modifications therein may well occur to those skilled in the art within the broad teaching hereof; hence, it is our intention that the scope of protection afforded hereby shall be limited only insofar as said limitations are expressly set forth in the accompanying claims.

What is claimed is:

1. In a ski boot, a sole, a heavy leather upper including a vamp and counter attached to the sole and shaped to fit the foot, an integrally-formed ankle-encircling cuff providing a continuation of the upper and adapted to fit tightly around the ankle, said upper and cuff being slit longitudinally from a point adjacent the toe to the top thus cooperating with one another to provide a pair of laterally spaced openable flaps capable of being spread apart to receive the foot, a tongue attached in position to provide a substantially water-tight covering for the space between the flaps, fastening means interconnecting the flaps and adapted to close the gap therebetween for purposes of securing the foot tightly within the upper and cuff, each of said flaps having an elongate generally V-shaped cut therein opening onto the instep and extend rearwardly and downwardly therefrom to a point on opposite sides of the ankle proximate to the axis of pivotal movement thereof, a foldable soft leather insert attached in position to cover each of the V-shaped openings and cooperate with the latter to provide means adapted to relieve the compressive stresses occasioned by tilting the ankle-encircling cuff forwardly relative to the upper, and means comprising a weakened area in the heel spaced rearwardly from the axis of pivotal movement of the ankle joint thus defining a bending axis about which the ankle-encircling cuff tilts relative to the upper.

2. The ski boot as set forth in claim 1 in which a heel cap reinforces the counter with the upper margin thereof terminating adjacent the weakened area so as to cooperate with the latter in locating the bending axis.

3. The ski boot as set forth in claim 1 in which the soft leather insert covering the V-shaped opening is normally folded thus providing an expandable gusset that allows the ankle-encircling cuff to tilt rearwardly relative to the upper as well as forwardly.

4. The ski boot as set forth in claim 3 in which the

normally folded soft leather gusset will unfold to the extent required to permit the ankle-encircling cuff to tilt rearwardly relative to the upper through an angle of approximately 30°.

5. The ski boot as set forth in claim 1 in which the V-shaped openings in the flaps are of a width adapted to permit forward tiltable movement of the ankle-encircling cuff relative to the upper through an angle of approximately 30° before the gap between the angularly disposed edges thereof closes.

6. The ski boot as set forth in claim 1 in which the weakened area in the heel comprises an opening located immediately above the counter and a foldable soft leather insert attached in position to cover said heel opening.

7. The ski boot as set forth in claim 1 in which a pair of metal reinforcing plates shaped to conform with the inside and outside surfaces of the ankle are attached to opposite inside surfaces of the ankle-encircling cuff for movement therewith relative to the upper, each of said plates extending downwardly from the points of attachment thereof to the cuff into position alongside the axis of pivotal movement of the ankle joint, said plates being adapted to cooperate with one another to bridge the bendable joint between the cuff and upper in a manner to prevent relative tiltable movement therebetween from side to side while permitting substantially unrestricted relative movement in a longitudinal plane.

8. The ski boot as set forth in claim 6 in which a second pair of generally arcuate metal plates are attached between the vamp and counter of the upper on both the inside and outside of the foot conforming generally to the arch thereof while intersecting the lower extremity of the associated plate of the first pair thereof, and in which means comprising a pin and registering slot provide an operative connection between each of the arcuate metal plates and the associated plate of said first pair thus defining a pair of hinge elements.

9. The ski boot as set forth in claim 8 in which the pins depend from the arcuate plates of the second pair and are located approximately on the axis of pivotal movement of the ankle joint, and in which the slots are located in the plates of the second pair thereof in position to intersect the pins.

10. The ski boot as set forth in claim 9 in which the slots are arcuate about a radius determined by the distance between the center of the associated pin and the bending axis on the heel about which the ankle-encircling cuff tilts relative to the upper.

11. The ski boot as set forth in claim 9 in which the pin is positioned approximately intermediate the ends of the associated slot when the angle-encircling cuff is in its normal upright position relative to the upper.

12. The ski boot as set forth in claim 11 in which the slot is of a length to permit the plate of the first pair thereof to tilt both forwardly and rearwardly relative to the arcuate plate of the second pair through an angle of approximately 30° from its normal or mean position.

13. An ankle-supporting hinge for ski boots and the like which comprises, a generally arcuate rigid metal plate shaped to follow the arch of the foot at one side thereof from a point on the vamp near the ball to the counter forwardly of the heel while passing through the axis of pivotal movement of the ankle, a generally triangular rigid metal plate shaped to conform with the side of the ankle from an area on the lower leg downwardly to a point beneath the axis of pivotal movement of the ankle joint, said last-mentioned plate intersecting the first-mentioned plate at the axis of pivotal movement of the ankle joint, and a pin and registering slot operatively interconnecting the plates at their point of intersection to provide a slideable pivotal connection therebetween.

14. The hinge member as set forth in claim 13 in which the pin depends from the arcuate plate and is located on the axis of pivotal movement of the ankle joint.

15. The hinge member as set forth in claim 13 in which the slot is arcuately shaped about a radius determined by the distance between the center of the pin and a point on the heel defined by the intersection of a horizontal plane passing through the axis of pivotal movement of the ankle.

16. The hinge member as set forth in claim 13 in which the pin is located approximately intermediate the ends of the slot when the triangular plate occupies a substantially upright position relative to the arcuate plate.

5

10

975,820
1,441,677
2,444,428

548,245
1,193,946

References Cited in the file of this patent

UNITED STATES PATENTS

Azzara	Nov. 15, 1910
Golden	Jan. 9, 1923
Carrier	July 6, 1948

FOREIGN PATENTS

Canada	Nov. 5, 1957
France	May 4, 1959