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ALL-PURPOSE SKI BINDING

PHASE IV

MARCH 1962

THIS REPORT PREPARED
UNDER DEPARTMENT OF THE ARMY
CONTRACT NO. DA19-129-QM-1909 (OI 6013)

by

ARCTIC RESEARCH
CLARE, MICHIGAN

for

HEADQUARTERS QUARTERMASTER RESEARCH + ENGINEERING COMMAND, US ARMY
QUARTERMASTER RESEARCH + ENGINEERING CENTER
NATICK, MASSACHUSETTS

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FOREWORD

This report was prepared by Arctic Research under Department of the Army Contract No. DA19-129-QM-1909. It covers work performed in effecting design improvements in the All-Purpose Military Ski Binding developed under previous contracts Nos. DA19-129-QM-299, DA19-129-QM-1070 and DA19-129-QM-1634.

The project was conducted under the supervision of Mr. Charles W. Davis, Project Officer of the Support Equipment Branch, Mechanical Engineering Division, Headquarters, Quartermaster Research and Engineering Command, who maintained close liaison with the development work as it progressed and rendered active cooperation in expediting its performance. Valuable assistance on design problems was rendered by both Mr. Davis and Mr. J. W. Millard, Chief of the Mechanical Engineering Division of the Command.

ABSTRACT

This report describes improvements in the design of the Type I All-Purpose Military Ski Binding effected as a result of service experience gained through field tests conducted by the United States Army Arctic Test Board during the winter of 1960-61.

CONTENTS

INTRODUCTION

The adoption of the insulated, rubber, combat boot for use in cold climates made mandatory the development of a new type of ski binding specifically designed to accomodate this type of boot. Although hundreds of different types of ski bindings have been developed during the long history of skiing and a great many types are currently on the market, a survey of the work previously done in this field revealed that none of the designs developed in the past were capable of accomodating the new insulated boot. The consequent necessity for developing a new type of military ski binding is covered in detail in earlier reports on this subject listed in the Foreword.

Field tests conducted by the United States Army Arctic Test Board on the experimental all-purpose military ski bindings furnished for test the previous winter revealed some half-dozen desired modifications. These are summarized in the following quotation from the 13 June 1961 Test Board report:

> "DISCUSSION: The test binding was superior to the standard Balata binding in control, ease of mounting, durability and ease of adjustment although a lack of security of the quick release mechanism was noted. The sole plate of the test binding was too rigid for good cross-country performance. This heavy resistance to the vertical lift of the heel caused undue tiring of the individual on long cross-country marches. The lack of durability and reliability of the heel catch assembly indicated redesign is required to provide a positive durable downhill heel lock. A modified heel lock will be mandatory, and used, if the sole plate of the test binding is optimized for cross-country operations as recommended. The tendency of the test binding to catch on one another and the lack of security of the quick-release mechanism appear readily correctable."

To effect these improvements the following Statement of Work was prepared for Contract No. DA19-129-QM-1909:

> "Binding Design: The ski binding shall be of the design and construction evidenced in the Type I modified Balata Ski Binding (EX60-2), developed under previous contract DA19-129-QM-1634 with the following exceptions:

1. The heel catch assembly shall be of such design to secure the binding to the ski in the downhill position and to permit unrestricted, vertical movement of the heel in the cross-country position. The materials selected shall be such to insure durability under field operating conditions.

2. The quick release device used on the heel cup and toe piece shall be of such design to preclude accidental activation while traveling through wooded and bushy terrain and over medium and soft, crusted snow.

3. The toe assembly shall be of such design to prevent accidental engagement of skis during normal movement.

4. The sole plate shall be of such design to permit freedom of the heel while in the cross-country position, without undue fatigue to the individual.

5. The dacron webbing, used to adjust the quick release mechanism on the heel cup and toe piece, shall be of sufficient length to permit ease of adjustment for all sizes of boots, while wearing the arctic mitten set.

6. The screws, used to attach the binding to the ski, shall be of sufficient length to insure adequate attachment without extending through the running surface of the ski.

7. The toe piece and heel cup, together with adjusting straps, shall be of such design to result in a minimum of wear to the insulated footgear during normal use.

8. The rivets, used to attach the heel plates to the heel cup, shall be of sufficient size and strength to preclude failure during use."

The work done to achieve these objectives is described in the following section.

SUMMARY OF WORK PERFORMED

The performance characteristics of the experimental ski bindings evaluated in the previous winter's tests, and all possibilities for design improvement that could be brought to mind were thoroughly discussed with the Project Officer. A schedule listing the design improvements to be attempted, including a general outline of the most likely means for accomplishing them was prepared.

The work done under this schedule is described following under binding component sub-headings.

Heel Catch Assembly

In the interests of both economy and early delivery, the heel catch assemblies provided with the bindings furnished the previous winter were fabricated from materials which were either in inventory or available for prompt delivery from warehouse stocks. With particular reference to the aluminum channels used, it appeared from laboratory deformation tests that the relatively low strength 6063-T5 aluminum alloy channels available as standard warehouse items should provide adequate durability, and at least would serve to demonstrate the suitability of the general design of the component. However, inserting a 58" ski pole into the base channel slot through the hole in the sliding cover afforded approximately a 90 to 1 moment arm for prying action, which resulted in deformation of many of the covers in the field.

To correct this condition the slot for the ski pole tip was eliminated in the base plates of the new heel catch assemblies. Although the high leverage provided by the original design might prove useful in freeing an ice-coated catch, it was decided that this consideration was outweighed by the service life factor. In addition, the the new catches were fabricated from specially extruded 7075-T6 aluminum alloy having tensile, yield, and shear strength properties almost triple those of the 6063-T5 alloy.

Field test results also showed that the cold formed 7075-T6 flat spring used in the original heel catches was deficient in strength and durability. Accordingly, after a period of use, the heel catches sometimes moved to the downhill position (locked) during lunges.

Though time available for the work and the cost of fabricating special springs requiring individual tooling were inhibiting factors in developing the heel catch spring, after consultation with a number of spring fabricators it was decided to adopt a stainless steel spring for the application. The spring was redesigned to reduce stress concentrations and was fabricated from .0185" and .0220" 18-8 spring temper stainless steel, which was stress relieved after forming.

To provide a better grip for actuating the heel catch by hand the covers of the original catches were coated with abrasive filled Sonogrip paint. As a more durable and economical means for accomplishing this end, the sides of half of the heel catch covers furnished under the current contract were knurled. The remaining half were left smooth to facilitate field test evaluation of the advantage, if any, resulting from the extra knurling operation.

It was decided that the size and weight of the heel catch assembly could be reduced without adversely affecting performance characteristics and the new heel catches were accordingly reduced 2" in length from 6-7/16" to 4-7/16". Weight and cost were further reduced by using 3/8" square 2024-T4 aluminum alloy stock for the heel catch plug to replace the original, more complex brass plug, and by eliminating the 7/16" diameter spacer incorporated in the original design.

Since the previous winter's field tests had shown that the aluminum rivets used to fasten the plug to the heel catch cover became loose in service, they were replaced with stainless steel rivets in the new heel catches.

Although no failures of the 1/8" diameter heel catch pins were reported, these were improved by replacing the spring clips used on the ends with elastic stop nuts and by fabricating them from 303 CD annealed stainless steel rather than cadmium plated drill rod.

Quick Release Fasteners

It was found during the previous winter's field tests that the quick release strap fasteners sometimes opened accidentally in crusted snow or heavy underbrush due to the forward location of the release cup. While this problem could probably be best corrected by relocation of the release cup, a solution involving any major redesign of the purchased fastener was not feasible from the standpoint of either time or funds available. The most practical solution appeared to lie in increasing spring tension in the fastener. Accordingly, fasteners with a stronger torsion spring, requiring approximately 50% more pressure for release, were procured for the new bindings.

Since the field tests also revealed wear on the rubber insulated boots from abrasion of the quick release fasteners, 1-5/8" x 1-1/2" protective pads of 2-ply Barflex were riveted to the underside of the fasteners procured for the new bindings to reduce boot abrasion. (Detail reference: pp. 3, 4 + 5, Appendix III.)

Toe Piece Assembly

Service tests of the prototype all-purpose ski bindings during the two preceding winters demonstrated that the Dacron-reinforced, low-temperature butyl rubber sheet used in the toe piece and heel cup assemblies was in general better suited to the application than any of the other materials investigated. Nevertheless, the high elastic modulus imparted to the material by the Dacron cloth reinforcement, the compound curvatures of the boots, and the necessity for accommodating a wide range of boot sizes, precluded attaining a snug fit of the toe piece to the boots.

As can be readily appreciated the lack of a close fit to the boot tends to result in interference of the bindings in service and in wear of the edges of the toe pieces due both to such interference and to abrasion caused by crusted snow.

As recommended in the Arctic Test Board report (Deficiency No. 3, Annex B), consideration was given to readoption of a one-piece toe plate assembly similar to that provided for the 1959-1960 field tests. This was not considered feasible, however, primarily because positioning of the resilient Barflex strip either over or under the soleplate materially assists in gripping the sole plate and holding it in alignment with the heel catch.

The possibility of molding curved toe pieces which would better conform to the boot curvatures was investigated but rejected as being impractical from a production standpoint.

A considerable amount of effort was accordingly expended in attempting to obtain the optimum toe piece design in flat sheet for the full range of boot sizes. Details of this work are outlined in Appendix II, "Laboratory Notes - Experimental Toe Piece Designs". Modifications of the original prototype design which were finally adopted to improve the fit of the toe piece are summarized following:

1. The D-ring and Dacron strap were mounted at a 10° forward angle.

2. The toe piece body was decreased in width from 3" to 2-1/2", and all corners were rounded.

A further improvement in the toe piece assembly was achieved by mounting the D-ring directly to the toe piece body and eliminating the separate mounting strap. This simplified design provided both improved strength and production economy.

Heel Cup Assembly

As would be expected, difficulties similar to those encountered in the toe piece design also applied in designing a heel cup to provide the optimum fit for the various boot sizes. Details of the work performed on heel cup design modifications are outlined in Appendix III, "Laboratory Notes - Experimental Heel Cup Designs". The improvements effected in the heel cup design are summarized as follows:

1. The angle at which the fastener straps were mounted on the heel cup body was lowered 5° toward the horizontal. This provided an improved fit of the straps and quick-release fastener over the instep.

2. The hole provided in the rear of the heel cup to receive the heel catch plug was increased in diameter from 1/2" to 5/8".

3. The two wide notches in the bottom edge of the heel cup body were replaced by three narrower notches to facilitate assembly of the heel cup to the sole plate.

4. Harder, higher strength aluminum alloy rivets were used in assembly to the sole plate to achieve improved strength and durability.

Sole Plate

As an outgrowth of the 1960-61 winter's field tests it was decided that greater flexibility should be provided in the sole plate to reduce leg fatigue of the user in cross-country movement. A considerable portion of the total effort expended on design improvements under the current contract was directed toward the sole plate modification since a number of considerations were involved.

Foremost of these considerations was the likelihood that any increase in flexibility would involve a corresponding decrease in durability in service. It was believed that a sufficient increase in flexibility to provide optimum comfort in cross-country work would permit overbending the sole plate (beyond its elastic limit)--particularly in spills which are not infrequent occurrences in skiing. Since the degree of flexibility permissible in the sole plate from the durability standpoint was unknown and could be reliably determined only through actual service experience, careful study was given to physical properties of the material involved and to the stresses likely to be encountered in service.

A solution to the problem capable of providing any desired increase in flexibility, as well as increased durability if desired, was suggested by the Chief of the Mechanical Engineering Division of the Command. This would involve molding the sole plates in curved rather than flat form. In such a design the heel of the binding would be raised from the top surface of the ski when in a normal unstressed position. The weight of the user would hold the heel of the binding flush with the ski when standing and complete freedom of vertical heel movement, eliminating the extra energy requirement imposed by the flat sole plate design, would be provided for cross-country use.

Unfortunately, due to limitations of both time and funds, tapered sole plates molded in a curved form could not be provided for the prototype bindings fabricated under the current contract. Matched metal dies are required to mold these glass-reinforced, epoxy-resin laminates and tooling capitalization would not normally be considered economically feasible for quantities below 10,000 pieces or 5,000 pairs of bindings.

Other factors, in addition to that of durability, given due consideration in modifying the flat sole plate design are summarized following:

1. The only known failure of these sole plates occurred in the original design having a uniform thickness of 0.10" to 0.12". This sole plate cracked across the double row of fastener holes immediately behind the toe plate when the user fell forward in a spill. After the tapered sole plate was designed to provide a longer, more uniform bending arc no more failures were experienced. In fact, spills with the tapered sole plate have resulted in broken skis with no damage to the sole plate except for minor surface cracks around the fastener holes. Accordingly, it appeared that the strength and durability factor could be compromised to some (unknown and possibly only slight) extent in the interest of increased flexibility.

2. It had been considered previously that retention of the relatively stiff, tapered sole plate might permit simplification of the binding through elimination of the heel catch--required only for relatively high-speed downhill movement. Since the military requirement for downhill skiing capability is slight compared to the requirement for cross-country capability, the requirement for a heel catch with this relatively stiff sole plate is by no means absolute. On the other hand, the overriding requirement for cross-country capability appeared to preclude compromising cross-country performance. Provision of a flexible sole plate with a separate heel catch was considered to offer a more functional, though more complicated, over-all design. The heel catch would not only provide better downhill capability than a semi-stiff sole plate, but would also serve to protect the sole plate from damage in the higher speed spills that occur in downhill service.

3. Further consideration was given to the matter of ply lay-up (number and arrangement of isotropic and unidirectional fiberglas reinforced plies) as related to vertical flexibility and lateral stiffness, and it was decided that no alteration should be made in the basic type of lay-up adopted for the original design.

In the final analysis of the problem it was decided to make the following modifications in the flat tapered sole plate design:

1. Reduce the number of plies from 7 on the rearward end and 14 on the forward end to 6 and 12 respectively, and reduce the thickness from 0.070" and 0.140" to 0.055" and 0.110" to provide increased vertical flexibility. In arriving at this decision, the flexibility of sample sole plates in the following thicknesses were measured: 0.056" to 0.107", 0.062" to 0.117" and 0.070" to 0.136". The results of these laboratory tests are given in Appendix I.

2. Reduce the length of the sole plate one inch to twelve inches. This permitted accomodation of the complete range of boot sizes, including the small 5 X N cold wet boot, as well as reduction in the size, weight and cost of the component.

To further reduce the restriction on vertical heel movement imposed by the flat sole plate the toe plate design was modified as described following.

Toe Plate

The design of the aluminum toe plate was modified as follows:

1. Size was reduced from 4" x 2-3/4" to 3-1/4" x 1-3/4".

2. The one inch radius curve on the outer edges was discontinued in favor of a flat design.

3. Fastener hole spacing lengthwise of the ski was reduced from 2" to 1".

These modifications were made to provide greater vertical flexibility of the heel by adding one inch to the bending arc, to permit closer fit of the toe piece assembly to the boot and, at the same time, reduce the size, weight and cost of the component.

Dacron Webbing

To improve ease of adjustment of fastener strap length while wearing the Arctic mitten set, the tabs sewn on the ends of the Dacron webbing straps were increased in size from 1/2" wide by 3 plies thick to 1" wide by 4 plies thick.

Service Testing

To assist in evaluating various modifications in design considered during the course of the work, brief service tests were conducted on several occasions. The information derived from these tests is outlined in the following section.

CONCLUSIONS

On the basis of the information available to date it is believed that the objectives outlined in the statement of work have been essentially accomplished by the design modifications described in the preceding section.

With the exception of the sole plate, the strength of the binding has been materially increased and, at the same time, its weight has been reduced by 18% to 1126 grams (2.48 lbs.) per pair. Comparative weights are:

	Gms. per Pair
Current binding	1126
Previous all-purpose binding	1370
Standard Army Cable binding	1934
Army cross-country binding (Balata). . .	1150

Although time permitted but a few brief trials of the new binding in service, and these were limited to cross-country work, no significant deficiencies were observed in its performance. For comparative purposes the original all-purpose binding with the heavier sole plate was mounted on one ski and the current binding on the other.

The resistance to vertical heel movement imparted by the sole plate was still definitely noticeable in the new binding, but the improvement in flexibility was also readily apparent. The degree of restraint on the heel that can or should be tolerated is, of course, a matter of opinion, but there can be little doubt that, so long as a heel catch is provided for downhill use, even greater freedom of the heel for vertical movement would be desirable in the binding. It is believed, however, that any appreciable increase in flexibility of the flat sole plate, beyond that provided in the current design, would result in an unacceptable decrease in service life.

In this connection, if the importance of using the heel catch to secure the heel in downhill skiing is emphasized in training, greater protection will be afforded both sole plates and personnel. Severe spills, of course, occur much more frequently in high-speed downhill skiing where heel hold-down is essential to safe control.

To provide optimum freedom of vertical heel movement the toe plate assembly should be mounted as far forward on the sole plate as boot length will permit. As shown graphically on sheet 3 of Appendix I, restraint on the heel is 50% greater with the toe plate mounting in the short position than in the long position.

It is believed that both the flexibility and durability of the flat sole plate in the redesigned binding will be found adequate in service. Should it be considered after reviewing the past winter's service test results, however, that improvement on either or both of these factors is required, it is believed adoption of a curved sole plate could provide any desired degree of improvement.

Although the new binding does not provide a snug fit to the boots of either the heel cup or the toe piece assembly, significant improvements were attained and it is believed that both wear and interference have been reduced to an acceptable practical minimum with the reinforced flat sheet stock used.

Molding of these components is not believed economically feasible. A more promising possibility for improving their fit would appear to lie in procuring a knitted type of reinforcing fabric to give limited elasticity to the Barflex sheet stock. It is believed an increase in elasticity of from five to ten per cent would result in a snug fit of the toe piece assembly and a relatively close fit of the heel cup. The possibility of obtaining Dacron reinforcing material of this type is currently under investigation.

RECOMMENDATIONS

It is believed that the current all-purpose ski binding design meets the existing military requirements, so far as appears practicable at the moment, and its adoption to replace the present cable and balata types is recommended.

At the same time it is, of course, recognized that improvements can be made on the binding in the future based on additional service experience, the development of new materials and devices, and other unforeseeable factors. The most promising avenues of approach in effecting further improvements appear to lie in:

1. The possible adoption of a curved sole plate.

2. The possible procurement of Dacron reinforcing cloth in a more elastic weave for the toe piece and heel cup. If not currently available, it is believed such material can no doubt ultimately be procured.

3. Redesign of the quick-release strap fastener to reposition the pressure release point from its present exposed forward location, and to provide a lighter, more economical fastener.

It is recommended that particular consideration be given to these three possibilities in the light of information acquired from further service experience in the field.

On the basis of information acquired to date it would appear that the present heel catch should perform satisfactorily in the current field test phase of the project. At worst, if any deficiencies are revealed in service they should be readily subject to correction, e.g:

1. Galling of the aluminum channels is not expected in this type of service with the 7075-T6 alloy, but if it should occur, hard-coating is recommended to overcome it.

2. Spring tension can be varied in either direction should the desirability of such modification be indicated by results of the current field tests.

3. Should difficulties occur in actuating the heel catch due to icing, re-adoption of the slot originally provided in the base channel to permit the use of leverage with the ski pole is recommended as feasible with the 7075-T6 heel catch. It is hoped this will not be found necessary, however, as the ninety to one leverage involved would invite possible damage to either the ski pole or the heel catch. Further, if it is found no requirement for leverage exists, the possibilities will be enhanced for ultimate simplification of the heel catch design in the interest of production economy.

4. In view of the gripping points provided by the elastic stop nuts on the heel catch pin, and probable infrequent hand actuation of the catch in service, knurling of the heel catch covers is not recommended.

It is recommended that training or field manual instructions pertaining to the all-purpose ski binding stress that the binding be mounted so that the toe piece assembly is as far forward as boot length permits. This will provide maximum freedom of the heel in the vertical direction for optimum comfort in cross-country use.

In mounting the bindings positioning of the Barflex toe piece either over or under the sole plate appears permissible. Positioning the Barflex component over the sole plate, however, should effect a slight reduction in stress concentrations in the sole plate and is accordingly recommended.

It is also recommended that field instructions specify that the free ends of the Dacron straps should be tucked in between the binding and the boot when the smaller sized cold wet boots are mounted in the binding.

Further, it is recommended that training instructions stress the importance of using the heel catch to secure the heel in downhill service. Heel hold-down is essential to proper technique and control in downhill skiing. Further, in addition to reducing the number of spills, locking of the heel will prevent overbending and breakage of the flexible sole plate in such spills as do occur.

Assuming their desirability is substantiated through field test experience, it is recommended that the following details, not specified on drawings prepared to date, be included in procurement specifications:

1. Provision of a low temperature lubricant, equivalent to that used in prototype bindings, should be specified for the heel catch spring.

2. Impregnation of the Dacron webbing to provide water repellancy, equivalent to that provided in the prototype bindings, should be required.

3. Rounding of the inside edges of the heel cup at the fastener strap attachment points should be specified.

4. Provision should be made for smoothing the outer surface of the 5/8" diameter hole at the rear of the heel cup by sanding off excess Barflex stock at this point after assembly of the heel cup.

It is recommended that 303 CD annealed stainless steel be specified for the heel catch pin and the option of using cadmium plated drill rod as specified on Drawing No. SB5-A-143 be withdrawn. There is no appreciable difference in cost involved and the stainless steel pin, having better low temperature properties and no wearable plated surface, should prove more durable.

With reference to mounting fasteners for the binding, it is recommended that 430 stainless steel machine screws, mounted in tee-nuts pre-assembled in the ski, be used in place of wood screws for the following reasons:

1. The one-inch spacing of the mounting fasteners provided in the new aluminum toe plate design will make maintenance of sole plate alignment with the heel catch more difficult after prolonged service. The use of tee-nuts pre-assembled in the ski will result in more accurate initial alignment and permit a more secure mounting with less resultant wear at the sole plate mounting holes.

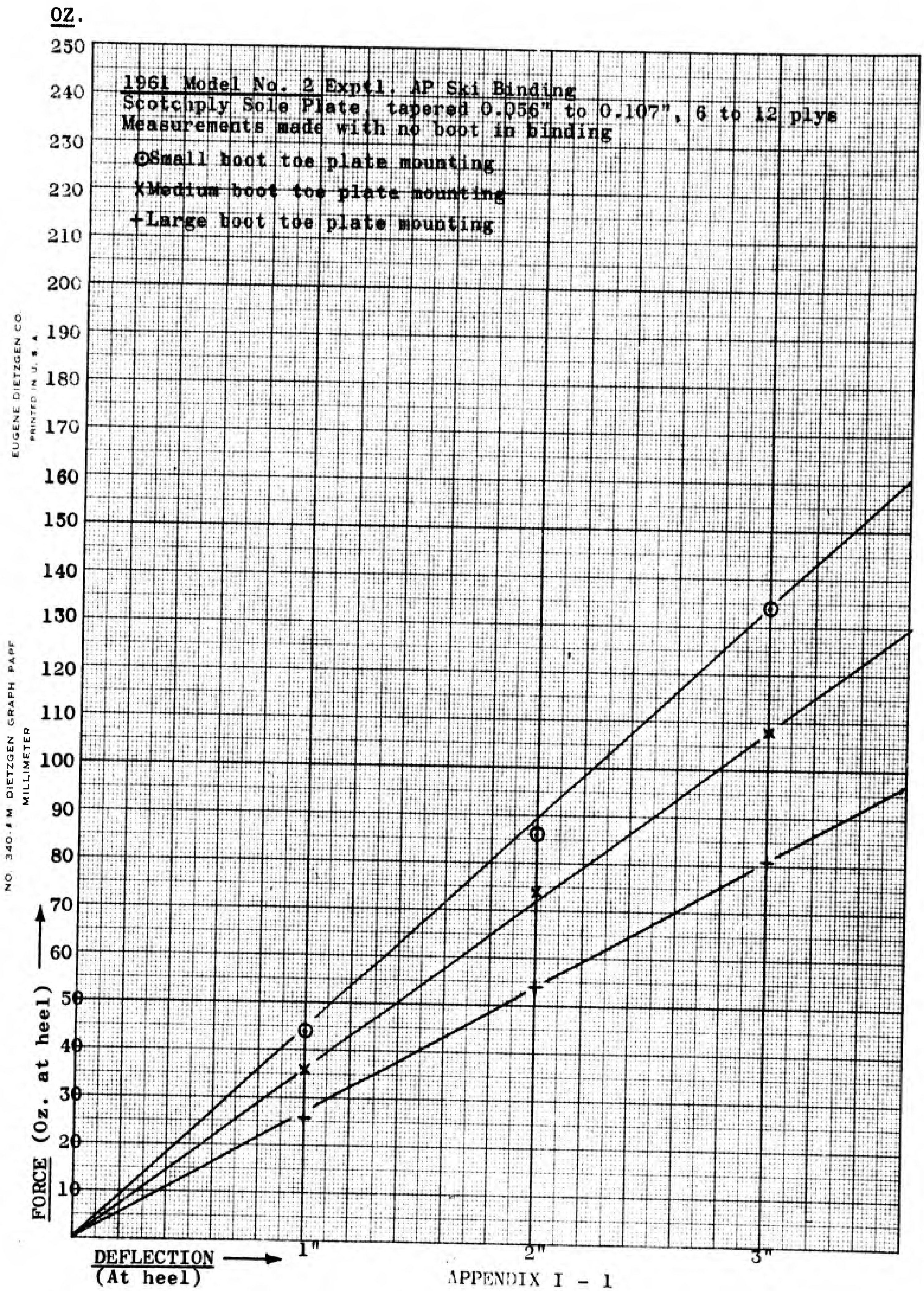
2. More uniform strength of attachment of the toe plate to the ski will be provided. Attachment with wood screws in the field by personnel not always skilled in the use of hand tools frequently results in insecure mountings, usually due to improper predrilling of the skis.

The use of white enamel coated brass rivet caps with the brass tubular rivets used in assembling the Barflex components would improve the binding from the standpoint of camouflage and general appearance. Their use would also at least double the material and labor cost of the operation, with no increase in the strength of the fastenings. Whether or not the increase in cost involved is warranted is believed a matter that can be best decided by the Command.

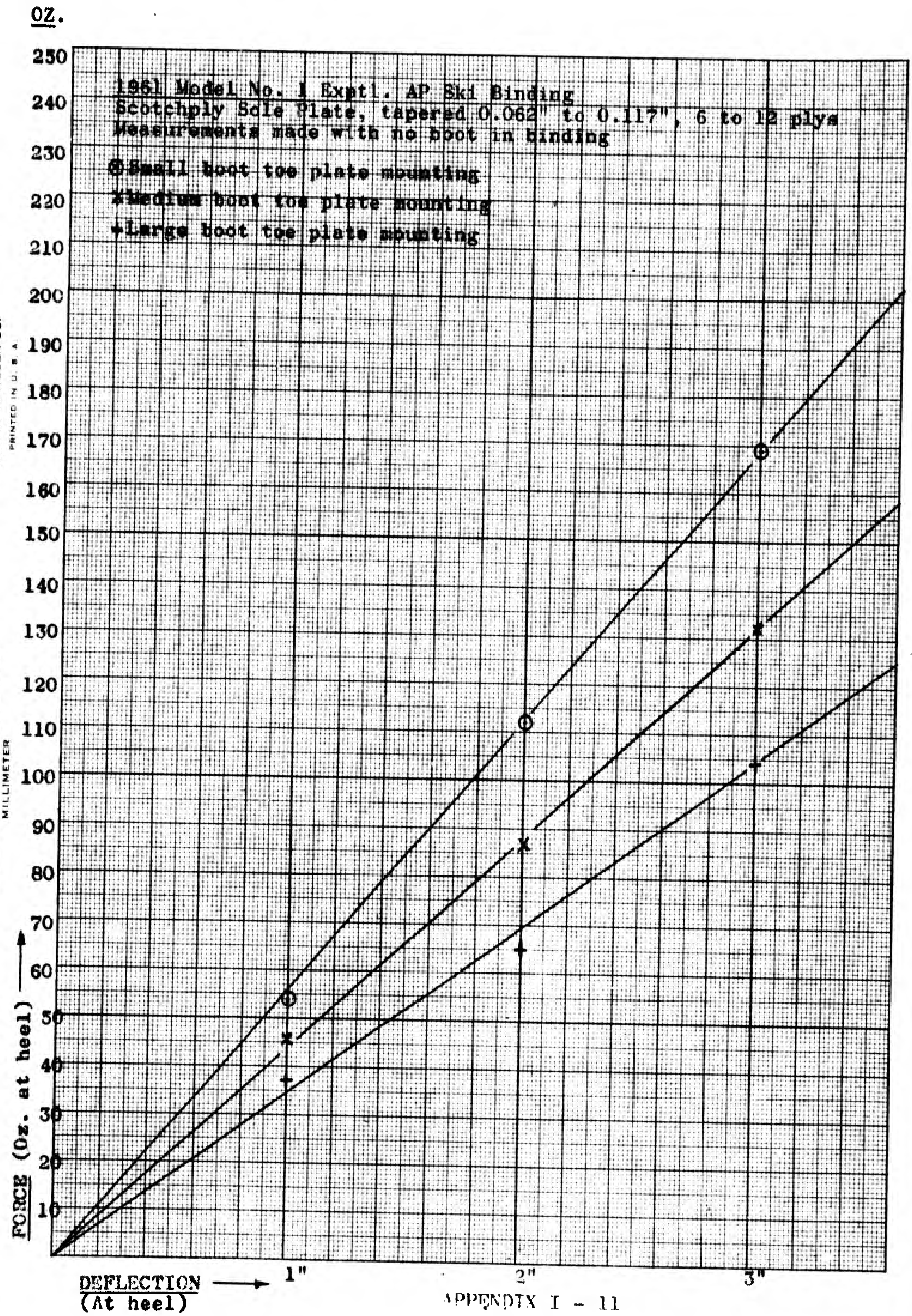
It is recommended that the ability of the binding to accomodate the size 15 W boot be verified, particularly with reference to Dacron strap lengths.

It is believed that 2024-T6 aluminum alloy would provide adequate strength for the heel catch channels and permit a reduction in procurement costs. The base price of 2024-T6 aluminum alloy is currently $0.90 per pound compared with a base price of $1.28 per pound for the 7075-T6 alloy used in the current binding.

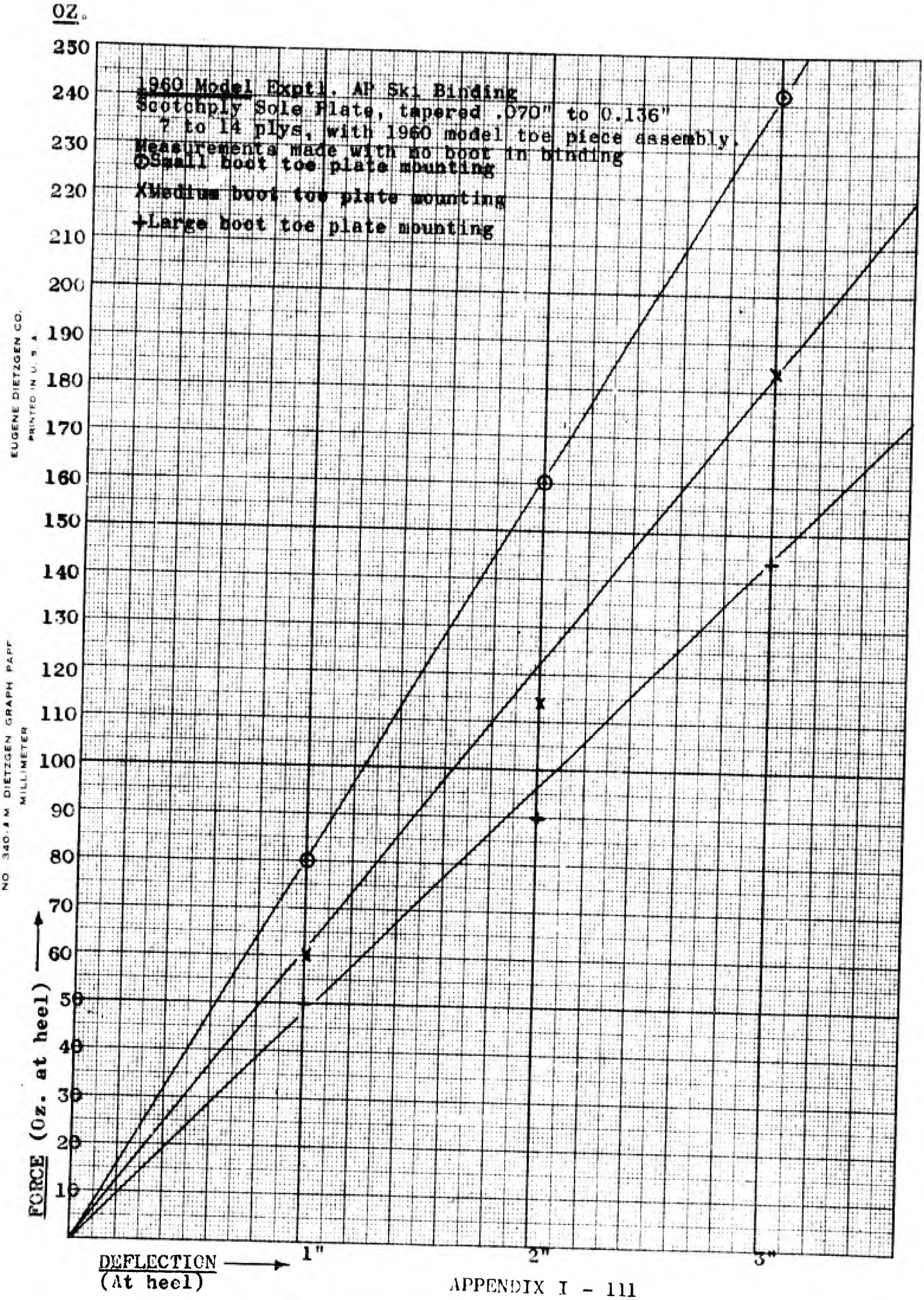
Assuming deformation of the present heel catch channels does not occur in service, it is recommended that partial procurement of the heel catch channels be made in the 2024-T6 alloy when the bindings are procured in production quantities.



OZ.
1961 Model No. 2 Exptl. AP Ski Binding
Scotchply Sole Plate, tapered 0.056" to 0.107", 6 to 12 plys
Measurements made with no boot in binding
⊙Small boot toe plate mounting
XMedium boot toe plate mounting
+Large boot toe plate mounting
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
FORCE (Oz. at heel)
DEFLECTION (At heel)
1"
2"
3"
EUGENE DIETZGEN CO.
PRINTED IN U. S. A.
NO. 340-# M DIETZGEN GRAPH PAPE
MILLIMETER



OZ.
1961 Model No. 1 Exptl. AP Ski Binding
Scotchply Sole Plate, tapered 0.062" to 0.117", 6 to 12 plys
Measurements made with no boot in binding
⊙Small boot toe plate mounting
×Medium boot toe plate mounting
+Large boot toe plate mounting
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
FORCE (Oz. at heel)
DEFLECTION (At heel)
1"
2"
3"
EUGENE DIETZGEN CO.
PRINTED IN U. S. A.
NO. 340-M DIETZGEN GRAPH PAPER
MILLIMETER



OZ.
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
1960 Model Exptl. AP Ski Binding
Scotchply Sole Plate, tapered .070" to 0.136"
7 to 14 plys, with 1960 model toe piece assembly.
Measurements made with no boot in binding
⊙Small boot toe plate mounting
XMedium boot toe plate mounting
+Large boot toe plate mounting
FORCE (Oz. at heel)
DEFLECTION (At heel)
1"
2"
3"
EUGENE DIETZGEN CO. PRINTED IN U.S.A.
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LABORATORY NOTES
DA19-129-QM-1909

EXPERIMENTAL TOE PIECE DESIGNS

No. 1 Exptl. Toe Piece Assy - As tentatively designed at Natick, 9-1/4" long x 3" wide x 2-ply Barflex, with 1/2" notched corners at rear and 1/4" notched corners in front. Barflex D-Ring strap and Dacron Tyclip strap both attached at 7-1/2° forward angle. 9" overall length of Dacron strap (after folding tab end) found slightly longer than needed for size 14 boot and much too long for both size 5R cold dry and size 5XN cold wet boot. Dacron Tyclip strap reduced to 8" overall length but still too long for use with small boots.

Appears that good fit to boot, particularly at front edges, cannot be obtained with 3" wide toe piece regardless of angle or positioning of straps since Barflex will not stretch and conform to compound curves of boots. Most likely solution would appear to lie in reducing width of toe piece.

No. 2 ETPA - Size of toe piece body reduced to 9-1/4" x 2-1/2". Both straps centered and fastened parallel to toe piece body in symmetrical design. Appears to fit all four sizes (14N, 9R, 5R, and 5XN) of boots better than 3" wide toe piece. Should fit better yet if straps were angled and moved forward as in No. 1 design as boot narrows toward front and straps tend to take forward angle naturally when tightened.

No. 3 ETPA - Same construction as No. 1 ETPA except narrowed to 2-1/2" width by removing 1/2" strip from rear edge.

Size 14 boot; Fits reasonably well but appears that forward angle of straps might best be increased to 10°, and possibly another 1/2" should be removed from rear and width decreased to 2".

Size 9 boot: Fit snug except for 1/8" gap in front at sole. Possibly 10° forward angle would reduce this. NOTE: This gap is affected by location of Tyclip over boot toe when fastening.

Size 5XN boot: Fit considered satisfactory except for slight gap in front. Forward angle appears O.K. for this small boot. Loose end of Dacron strap reaches 1-7/8" under ski when boot is secured in toe piece. Fastening this small boot requires extreme take-up of Tyclip on Dacron strap. If Barflex protective pad under Tyclip is allowed to extend beyond inside edge of fixed roller, take-up for small boot will be reduced.

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No. 4 ETPA - Same construction as No. 3 ETPA except narrowed to 2" width by removing 1/2" strip from rear edge.

Size 14 boot: Snug fit. Appears 10° angle might be an improvement and probably should move straps forward on toe piece body 1/8" to 1/4" if forward angle increased to 10°.

Size 9 boot: Good fit but 1/8" gaps at front edges - probably best reduced by moving straps forward 1/8" to 1/4". If this were done it appears 10° angle might throw Tyclip too far forward on boot toe. Possibly Dacron strap should be kept at present position and angle and Barflex strap moved forward 1/4" and kept parallel with toe piece? NOTE: With present construction size 9 boot fits well in position for smallest boots.

Size 5 boot: 1/8" gaps at front edges. For this boot it appears Barflex strap should be centered (as is) and left parallel with toe piece, and existing 7-1/2° angle on Dacron strap retained.

2" width toe piece gives best fit and strength would be adequate unless excess fraying occurs in service. Probably should compare fit with that of 2-1/2" wide toe piece having straps set at 10° forward angle.

No. 5 ETPA - Same construction as No. 3 ETPA except straps fastened at 10° angles.

Gaps between edges of toe piece and boot are not appreciably larger than with 2" wide toe piece. Main problem appears to lie in excess length of Dacron strap with small boots. Further, it appears corners should be rounded.

Solution to excess length of free end of Dacron toe strap with size 5XN cold wet and other small boots: In mounting set Tyclip adjustment for proper length of Dacron strap and tuck free end in front of toe piece between toe piece and boot; then shove Tyclip on D-ring. This should be a satisfactory answer to this problem considering that very few of these small boots are used. Better solution might be to make Barflex component of toe piece of one-piece construction and bring D-ring over about 3/4" (away from Tyclip). This would increase size adjustment about 3/4", and would eliminate interference of Barflex protective pad under Tyclip.

No. 6 ETPA - Construction similar to No. 5 ETPA except toe piece made in one piece with tab on left end to secure D-ring flush with left edge of toe piece, and corners rounded using 1/2" radius in rear and 1/4" radius in front and on end of D-ring tab. Dacron strap length increased to 9-1/4" after folding (12-1/4" total length).

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Fit appears acceptable with all boot sizes and is probably optimum with 2-1/2" wide toe piece. One-piece Barflex design pretty well eliminates possibility of loose end of Dacron strap getting under outside edge of ski when used with small boots. In general appears best design from standpoints of both function and adaptability to production. Rounded corners improve appearance.

No. 7 ETPA - Same construction as No. 6 ETPA except 7-1/2° forward angle used.

Fit believed not quite as good as with No. 6 ETPA but degree of forward angle does not appear to be too critical.

No. 8 ETPA - Construction similar to that used for No. 6 ETPA but width reduced 1/2" to 2" and D-ring tab and Dacron strap moved 1/4" toward front in effort to obtain optimum fit. Optimum fit for various boot sizes believed obtained unless width could be further reduced. This not believed feasible in view of the unknown extent of fraying that may be expected in service.

No. 9 ETPA - Same construction as for No. 8 ETPA but width increased 1/4" in rear to provide greater safety margin in view of fraying tendency in service.

Fit appears satisfactory with all boot sizes but is better with larger boots than with smaller. Might be necessary to tuck free end of Dacron strap between boot and toe piece (as mentioned previously) with size 5XN cold wet (black) boot, but it does not appear this will be necessary with the size 5R cold dry (white) boot.

NOTE: All toe-piece assemblies tested with new, smaller 1-3/4" x 3-1/2" aluminum toe plate and 12" long Scotchply sole plate.

Dacron straps should be fastened to toe piece body so that folds in tab end are on top when mounted on boot. If mounted in reverse position tab end can be drawn farther into Tyclip making it harder to grasp.

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EXPERIMENTAL HEEL CUP DESIGNS

No. 1 Exptl. Heel Cup Assy - Same upper and lower aluminum heel plates used as in 1960 model. Modified Barflex heel cup body, as discussed at Natick, by:

1. Lowering angle of fastener straps 5° (increased angle shown on Dwg. SB5-B140 from 45° to 50°).

2. Shortening Barflex strap 1" from 6-7/8" to 5-7/8" (final lengths), lengths before folding 8" x 7" respectively.

3. Lengthening Dacron strap from 10" to 12" (final lengths) and increased length and thickness of end tab to 1" long by 4 plys thick (length of new strap before folding 15").

Purpose of modifications:

No. 1 - Improve fit of straps to boot.

Nos. 2 x 3 - Raise free end of Dacron strap when binding is mounted on small, 5XN, cold wet boot, so that it cannot get under ski or between sole plate and ski in use. Get Tyclip assembly off center of boot for most commonly used boot sizes, 9, 10, and 11. When Tyclip is centered in front of boot, release cup assumes extreme forward position and would appear to be in optimum position for accidental release due to forward motion of boot against brush or loose chunks of snow or ice. Tab increased in size for easier grasping with Arctic mitten.

Remarks - New instep strap angle appears to provide optimum fit for all boot sizes. While heel cup is approximately 1/4" too wide for optimum fit to size 5XN boot, it is minimum allowable for size 14N boot. Ability of heel cup to accomodate 14W boot should be checked. Dacron strap length: appears long enough to accomodate size 14N boot; is not too long for size 5R cold dry boot; is about 1-1/2" too long for size 5XN cold wet boot, but free end of Dacron strap can be tucked between boot and that portion of strap between Tyclip and heel cup when this small boot is used.

No. 2 Exptl. Heel Cup Assy - Same construction as No. 1 EHCA except Barflex strap reduced 1" from 5-7/8" to 4-7/8" (final length) and Dacron strap lengthened 1/2" to 12-1/2" (final length after folding).

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Purpose of modification:

1. To move Tyclip further from center of boot on theory that this will reduce tendency toward accidental opening of Tyclip through forward motion of boot against brush, etc.

2. To remove free end of Dacron strap from area between sole plate and ski top when binding is mounted on small boot.

Remarks: Free end of Dacron strap now approximately 1/2" above top surface of ski with size 5XX cold wet boot, and dacron strap could be lengthened 1/2" to better accomodate size 11 boot. Tyclip cup now positioned in center of this small boot making Tyclip susceptible to accidental opening by pressure against any object impeding forward motion. With size 5R cold dry boot Tyclip is sufficiently off to one side to reduce liklihood of accidental opening. It appears that extension of heel cup vertical edges 1/2" toward front would improve fit with these small boots - if not with all boots.

With sizes 9 and 11 boots Tyclip is positioned far enough to side of boot to preclude accidental opening by pressure against the front of the assembly of any object impeding forward motion. If bindings are mounted so that Tyclips are positioned on the inner sides of the boots accidental opening would appear to be most unlikely with medium and large sized boots. Interference with Tyclip on opposite boot would also appear unlikely since boots narrow toward the heel. Should interference occur, however, it could be corrected by reversing the mountings left to right.

It appears that better fit of heel cup to boot could be obtained with larger boots as well by enlarging heel cup and extending vertical edges 1/2" toward the front. It would also appear that wear of boot by upper front corners of heel cup could be reduced by increasing height of heel cup 1/2" at the same time.

Positioning Tyclips off center of boot somewhat reduces convenience of operation of quick release with ski pole, but this effect would probably be negligible once user became accustomed to holding pole at proper angle for his particular boots. This possible disadvantage will have to be weighed against probable advantage in reducing tendency toward accidental opening of fastener. Increasing strength of spring and pressure required to open Tyclip may increase difficulty of opening fastener with ski pole more than

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repositioning of fastener, considering the resilience of the outer surface of the boot. Try and see when fasteners with stronger springs are received.

No. 3 Exptl. Heel Cup Assy - Same construction as No. 2 EHCA except height of heel cup increased 1/2" and width increased 1" (1/2" on each side).

Purpose of modification:

1. To reduce wear of boot by upper front corners of heel cup, (through increase in height).

2. To reduce boot wear by increase in height + width and to provide better fit to boots by increase in width.

Remarks: Increase in height of heel cup results in wide gap between upper part of heel cup and rear of boot with small boots. This opening would trap snow and this design does not provide an acceptable fit. Further, gap between front vertical edges of heel cup and boot is increased with a corresponding increase in susceptibility to fraying, trapping snow, and impeding forward movement.

No. 4 EHCA - Same construction as No. 3 EHCA except 1/2" strip removed from top of heel cup.

Remarks: This design too small to accomodate size 14 boot.

No. 5 EHCA - No. 4 EHCA design with following modifications:

1. Front edges of heel cup tapered back at lower corners to original bottom edge dimension to accomodate heel of size 14 boot.

2. Rounded upper front corners (1" of inside edge) to reduce tendency to wear boot.

3. Increased Barflex strap length 1/2" to 5-3/8" and decreased Dacron strap length 1/2" to 12".

4. Mounted Davis Aircraft Products' sample Tyclip having stronger spring and 2-5/8" x 1-1/2" Barflex protective pad on Dacron strap. Little noticeable difference in spring. Check this.

5. Increased depth of two notches in bottom of heel cup body to 3/4" (from 5/8") and used 3/8" radius at top of notch rather than 9/64" in effort to provide closer fit around sole plate curve and increase ease of assembling.

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Remarks: Heel of size 14 boot will not fit down snugly on aluminum heel plate, probably due to closer fit of Barflex to sole plate and heel plate as a result of notch modification. Heel cup does not fit as snugly as with original design and there is approx. a 1/4" gap at upper front corners of heel cup body as compared with approx. 1/8" with original design. It appears that the only way this gap could be reduced for the size 14 boot would be by widening the aluminum heel plates. These are already too wide for the small boots and it is believed the present 2-3/4" width constitutes the best compromise that can be reached.

This design does not fit the sizes 9R and 5R boots as well at the upper front corners as the original design, though the gap at these points with the size 5XN cold wet boot is approx. the same as with the original design.

The Barflex protective pad on the sample Tyclip decreases ease of adjustment of the Dacron strap to a noticeable extent and will have to be shortened.

The larger bottom notches appreciably increased ease of assembly of the heel cup but the closer fit of the Barflex Heel cup body around the sole plate, which also resulted, precludes adoption of this particular design. It appears that notch depth must be limited to 5/8". Possibly assembly ease could be improved without decreasing final heel cup width by adding a third notch and retaining the 5/8" depth.

No. 6 EHCA - 1960 design as shown in Dwg. #SB5-B-140, modified as follows:

1. Angle of straps lowered 5°.
2. Increased diameter of heel lock hole to 5/8" and lowered hole 1/8".
3. Raised all 9/64" dia. rivet holes 1/16".
4. Reduced width of two bottom notches to 7/8" and increased radius at top from 9/64" to 1/4".
5. Added triangular notch in center 5/8" wide at base and extending through 5/8" heel lock hole.
6. Increased length of Dacron strap to 16" (after folding).
7. Mounted D-Ring on upper front corner of heel cup body with three fasteners, eliminating Barflex strap.

Remarks: This simplified design would result in production economy and decrease incidence of accidental opening of quick release. A special D-Ring with more stock in rivet attachment area should, however, be provided.

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This design is not well suited to the Tyclip fastener since it is inconvenient to operate the quick release with the ski pole when the fastener is so near the heel. Further interchangeability between right and left hand is adversely affected since positioning of Tyclip on inner side could result in interference with opposite boot in walking.

No. 7 EHCA - Modified 1960 Heel cup design as follows:

1. Angle of straps lowered 5°.
2. Heel lock hole increased in dia. to 5/8" and lowered 1/8".
3. All 9/64" dia. rivet holes raised 1/16".
4. Reduced width at base of two bottom notches to 7/8" and added a third notch in center having a 5/8" width at base. Height of all notches 5/8" and radius at top 1/4".
5. Rounded inside edges of upper front corners of heel cup body.
6. Shortened Barflex strap 1" to 5-7/8" final length.
7. Lengthened Dacron strap from 10" to 12" final length and increased length + thickness of end tab to 1" long by 4 plys thick (length of strap before folding 15").
8. Decreased size of Barflex pad under Tyclip to 1-1/2" wide by 1-3/4" long and mounted front edge of pad flush with front edge of Tyclip.

Remarks: This design believed to offer a satisfactory fit for the full range of boot sizes with the possible exception of size 14W (not available for checking). Modification of the bottom notch design appreciably increases ease of assembly. Decreased size of Barflex pad under Tyclip restores former ease of adjustment of Dacron strap length. It is believed that the shortening of the Barflex strap moves Tyclip sufficiently off the center of the boot to reduce the incidence of accidental opening in service with the larger boots, and at the same time does not appreciably affect convenience of release with ski pole tip. It might be desirable to shorten the Barflex strap another inch, particularly if it is found the accidental release problem is not overcome through increasing torsion in the fastener spring.