United States Patent

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[54] RELEASABLE BINDING MECHANISM FOR SKIS

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[52] **U.S. Cl.** ..... **280/11.35 M**

[51] **Int. Cl.** **A63c 9/00**

[58] **Field of Search** ..... 280/11.35 M, 150 AB; 180/112; 294/83 AE

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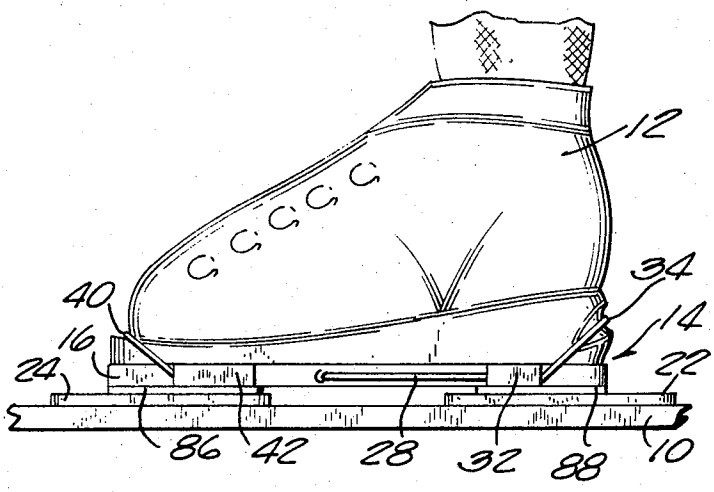
[57] **ABSTRACT**

A releasable binding mechanism for a ski including a boot support member resiliently mounted on the ski and a releasable cable means for securely holding the boot on the support member. A plurality of micro-switches mounted within the boot support member and adapted for actuation upon relative movement between the boot support member and the ski. An explosive charge and an electric igniter therefor adapted for energization when one or more of said micro-switches is closed. The gas pressure released upon ignition of the explosive charge actuates a cable release mechanism to thereby release the skier's boot from the ski.

13 Claims, 10 Drawing Figures



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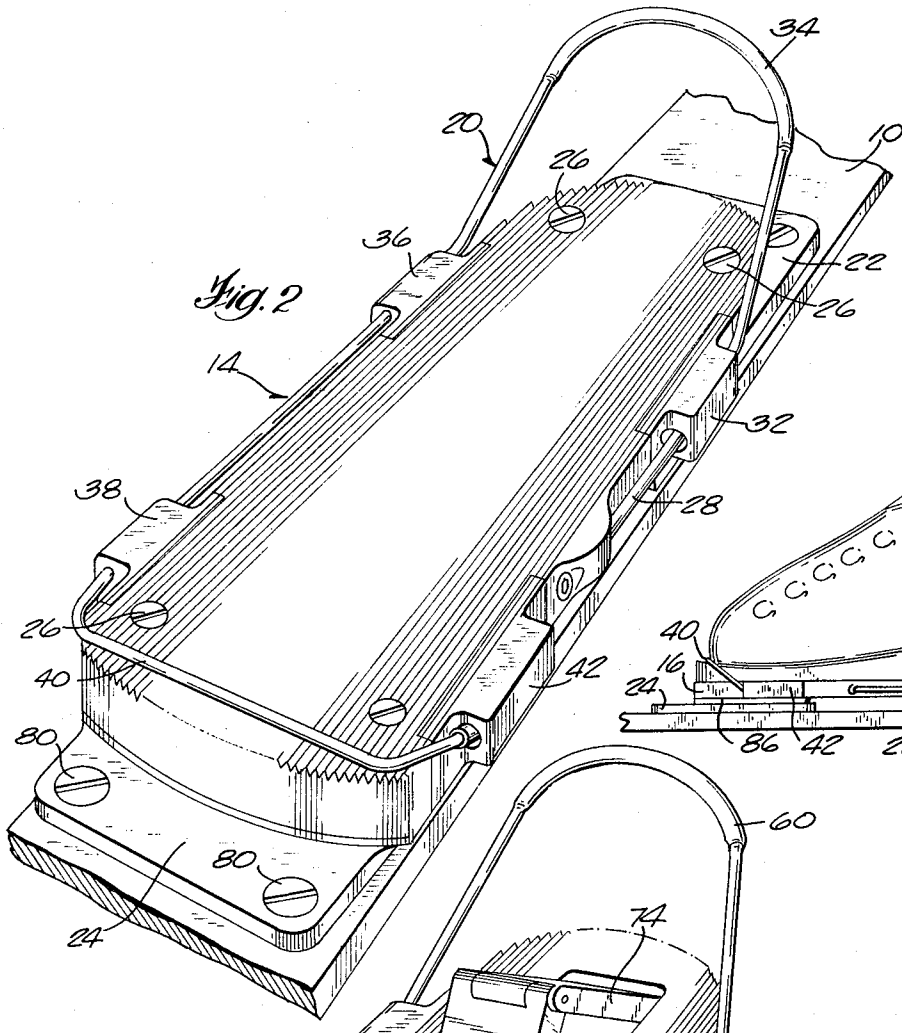

Fig. 2

Fig. 1

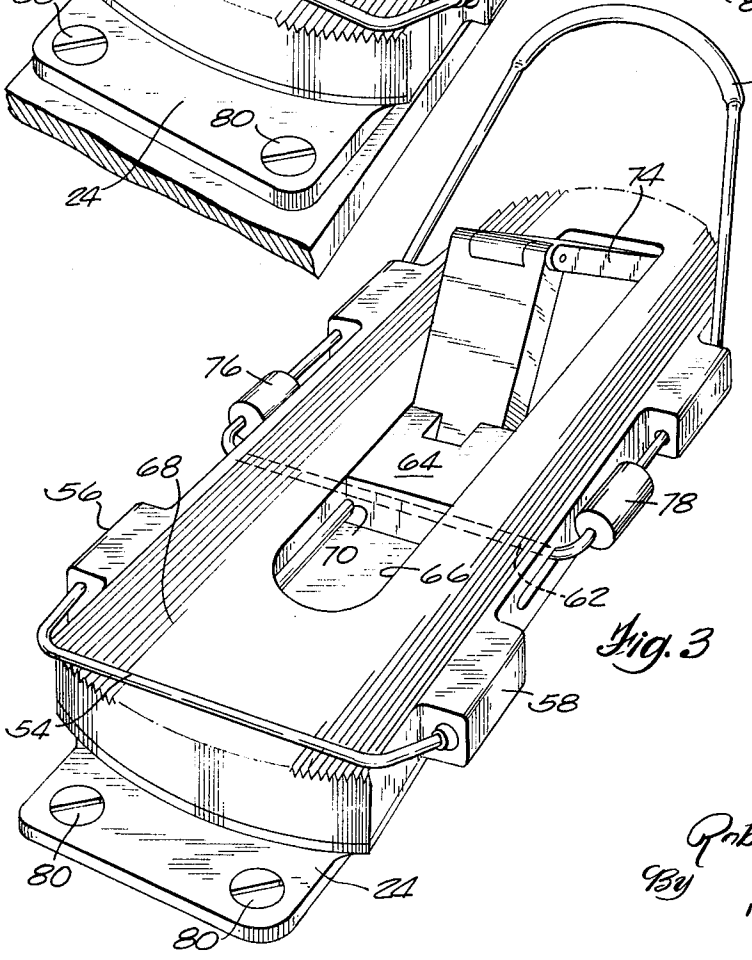

Fig. 3

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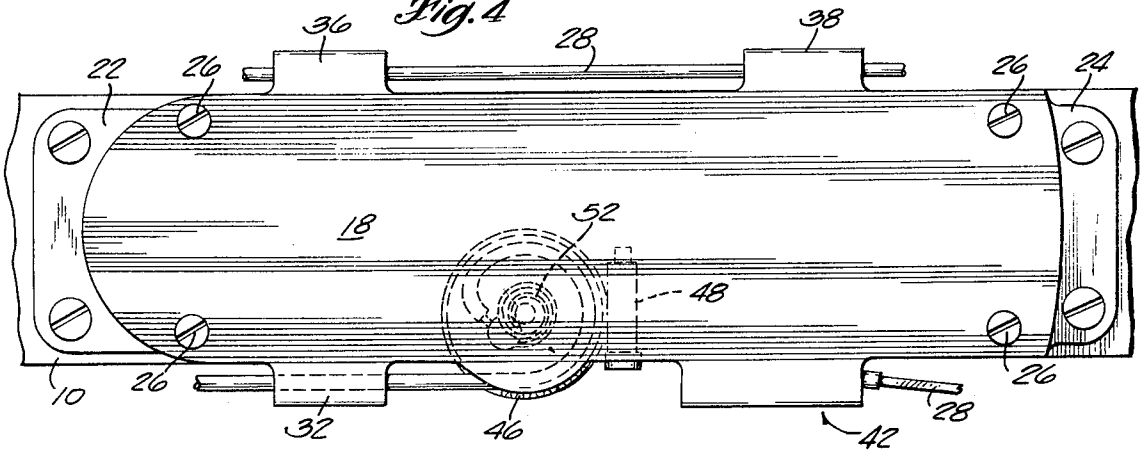
Fig. 4



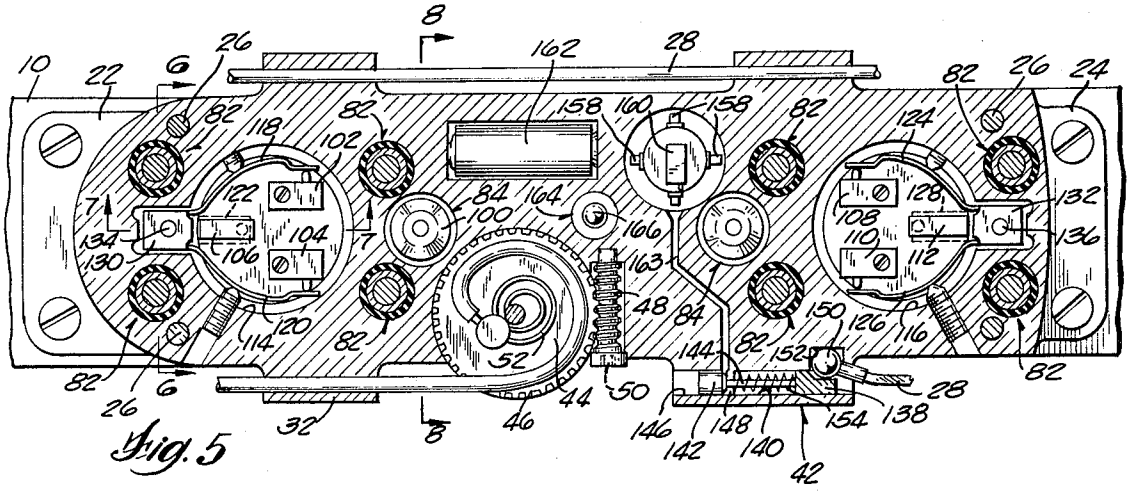


Fig. 5

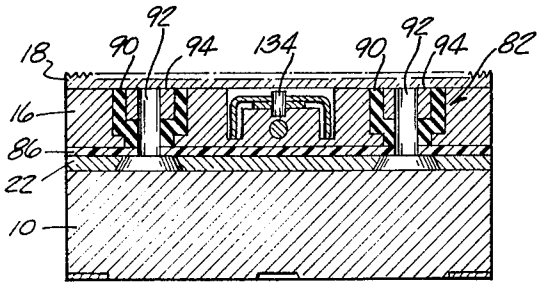


Fig. 6

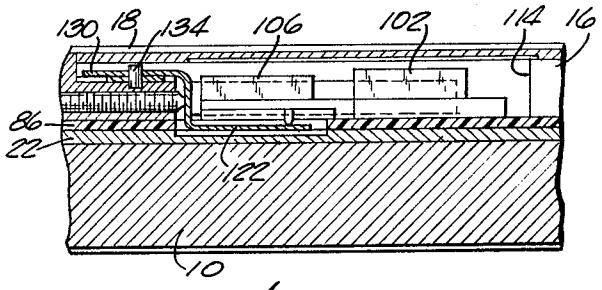


Fig. 7

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Fig. 8

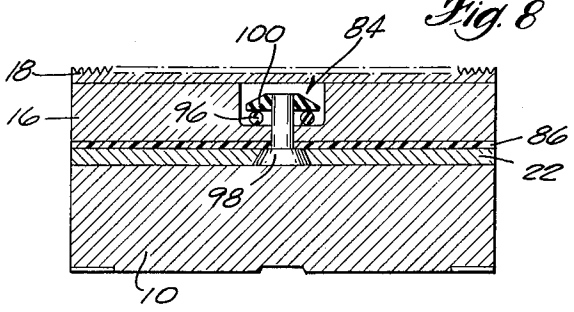


Fig. 9

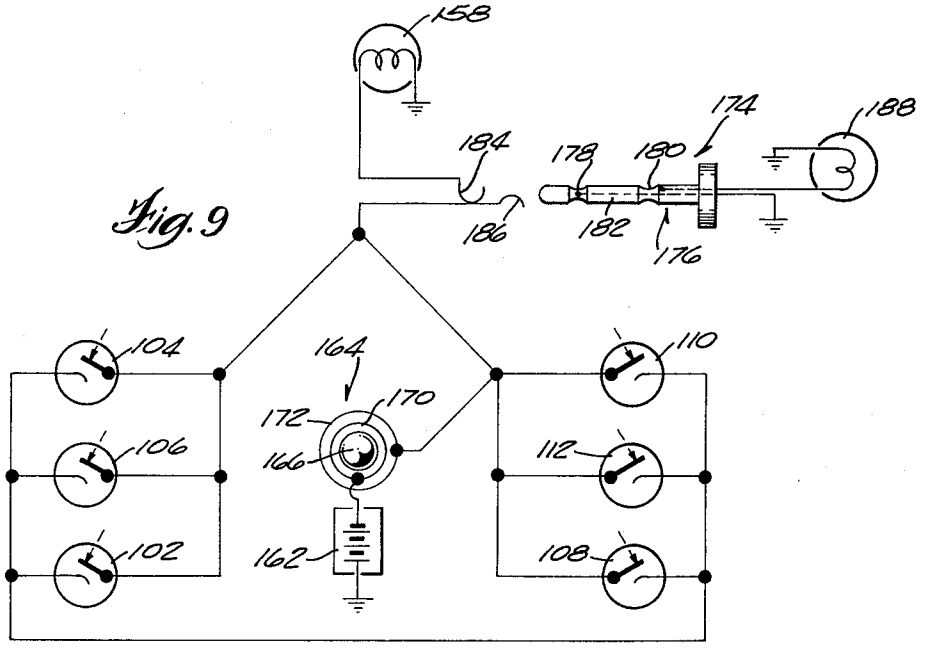
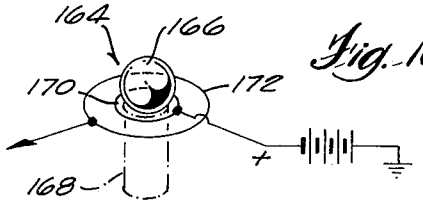


Fig. 10



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RELEASABLE BINDING MECHANISM FOR SKIS

BACKGROUND OF INVENTION

1. Field of Invention

This invention relates to an improved releasable binding mechanism for a ski or other similar device wherein it is desired to release the user from the device at predetermined stress levels.

2. Description of Prior Art

While there are a great variety of different types of releasable bindings for skis, all known prior mechanisms utilize some form of spring clamping force for holding the boot on the ski together with some type of a mechanical release mechanism for releasing the clamping means under conditions of abnormal stress.

In all such mechanisms "frictional forces" are the controlling variable. Since the environment of use involves wide ranges of temperature and moisture (including varying conditions of ice and snow), the frictional forces will also vary over a wide range and thus for any particular setting of the mechanism there may be a wide range of release characteristics depending on the variables of environment. Thus, if the binding is safe under one set of conditions, it may be very unsafe under other conditions such as icing for example.

Another shortcoming present in varying degrees in prior bindings is the inability thereof to sense all the various stress angles which the binding, to be fully safe, must be sensitive to. A still further problem of prior devices is the "release time" which, in the conventional mechanical clamping type release arrangements, is relatively slow, allowing high forces to build up in the skier's limbs before release is obtained. Ease of adjustment and ability to adjust the bindings for an infinite variety of anatomical conditions is a further problem.

As will be clearly apparent from the detailed description of the present invention which follows, the problems explained above are substantially reduced or eliminated by the improved releasable binding mechanism of this invention.

SUMMARY OF INVENTION

A releasable binding mechanism for a ski including a boot support member mounted on the ski and a resilient mounting means for mounting the boot support member thereon. The boot is held on the boot support member by any suitable holding means such as an adjustable cable. A strain sensing means such as a plurality of micro-switches is mounted within the confines of the boot support member and is adapted to sense stresses of predetermined magnitude set up in the resilient mounting means as a result of forces exerted on the boot support member. Also mounted and sealed within the boot support member is a releasing means adapted for energization from a source of electrical energy under the control of the micro-switches. The releasing means includes an explosive charge and an igniter therefor adapted, when energized, to release the holding cable.

Since the strain sensing means and release means are sealed within the boot support member, once the mechanism is set, its release characteristics will remain constant even under widely varying environmental conditions. Since the mechanism utilizes a source of electrical energy for energization of an explosive charge a very short "release time" is provided to release the binding at, or very close to, the exact instant at which the abnormal stress condition occurs. The plurality of micro-switches (or other suitable strain sensing means) can be positioned to detect forces in several directions and will thereby detect the full range of forces which are likely to be encountered between the boot and the ski. So-called "blind spots" are thus substantially eliminated in the detection area.

The arrangement of micro-switches or other strain sensing means also permits a very accurate tailoring of the mechanism, as far as its settings are concerned, to accommodate the almost infinite variety of anatomical variations encountered from individual to individual. Thus, the binding is safe for each individual user as opposed to prior bindings designed to handle a so-called typical skier.

DESCRIPTION OF DRAWINGS

FIG. 1 is a partial side elevation view showing the skier's boot clamped in operating position on the boot support member;

FIG. 2 is a perspective view of one embodiment of the releasable binding mechanism of this invention;

FIG. 3 is a perspective view of a second embodiment of the releasable binding mechanism of this invention;

FIG. 4 is a top plan view with portions broken away of the releasable binding mechanism shown in FIG. 2;

FIG. 5 is a top plan view of the same mechanism shown in FIG. 4 but with the top cover plate completely removed;

FIG. 6 is a sectional view taken along lines 6—6 of FIG. 5;

FIG. 7 is a sectional view taken along line 7—7 of FIG. 5;

FIG. 8 is a sectional view taken along line 8—8 of FIG. 5;

FIG. 9 is a partially schematic wiring diagram of the strain sensing and releasing means of the binding mechanism; and

FIG. 10 is a partially schematic wiring diagram of the accelerometer means used in the binding mechanism.

Referring to the drawings, FIG. 1 shows a ski 10 having a skier's boot 12 fastened thereto by a releasable binding mechanism 14 which incorporates one embodiment of the present invention.

The construction of binding mechanism 14 is best shown in FIGS. 2–8 which mechanism includes a platform or boot support member 16 having a cover plate 18 on which boot 12 is fastened by a releasable boot holding means 20. Also included is a pair of mounting plates 22, 24 on which platform member 16 is resiliently mounted as will be described in detail hereinafter. Cover plate 18 is removably mounted on platform member 16 by screws 26 and has a serrated top surface (FIG. 4) to provide a rigid couple between the boot sole and platform member 16 for maximum transmission of dynamic forces in use.

The releasable boot holding means 20 can take various forms. As shown in FIGS. 1, 2, 4 and 5, the means 20 is comprised of a flexible cable member 28 which extends rearwardly through a guide 32 on platform member 16, then is curved around 180° as at 34, then extends forwardly through guides 36 and 38, then is curved around 180° as at 40, and then extends rearwardly to a releasable holding mechanism 42 the construction and operation of which will be explained in detail hereinafter.

In the preferred embodiment, cable member 28 is made from a nylon covered steel cable and is adjustably mounted on platform member by means of a wheel member 44 having a peripheral gear portion 46 for engagement with a worm gear 48. Worm gear 48 is provided with a hexagonal pocket 50 at the exposed end thereof for actuation by a so-called "allen" type wrench of conventional design (not shown) for adjusting the tension in cable member 28. Reel member 44 may be provided with a coil spring member 52 to bias the reel towards its "tightened" position. As shown in FIG. 1, the front portion 40 of the cable is adapted for engagement with the toe of boot 12 and the rear portion 34 of the cable is adapted for engagement with the heel of the boot. As indicated previously, the tension in cable 28 when in its boot retaining position (FIG. 1) can be readily adjusted by means of the worm gear arrangement shown in FIGS. 4 and 5. It will be appreciated that this arrangement will facilitate use of the binding mechanism with ski boots of various size there being no necessity for remounting of the binding in the shop as is required with many of the conventional types of ski bindings currently on the market.

A second cable arrangement is shown in FIG. 3 wherein a so-called step-in action is provided. In the FIG. 3 embodiment, there is a front cable member 54 anchored in guide 56 at one end with the opposite end held by a releasable holding mechanism 58 of the type referred to in the FIG. 2 embodiment described above (see reference numeral 42). The heel of

the boot is held by a second cable member **60** having a transversely extending portion **62** engaged with a block member **64** slidably mounted in a cut-out portion **66** of platform member **68** and retained therein by tongue and groove joints **70** on opposite sides of the block. Block **64** is pivotally connected to a link member **72** which in turn is connected to a second link member **74** which in turn is pivotally connected to platform member **68** at the rear end of slot **66** therein. A pair of turnbuckle adjustment mechanisms **76** and **78** are provided to adjust the effective length of cable member **60**.

It will be appreciated by reference to FIG. **3** together with the above description that to operate the cable binding the user simply inserts the toe of the boot under front cable member **54** and then steps down on link members **72** and **74**. The downward movement of link members **72** and **74** will cause the rear cable member **60** to move into snug holding engagement with the heel of the boot to thereby secure the boot firmly on platform member **68** for skiing.

Mounting plates **22**, **24** are secured to the ski **10** by any suitable means such as screws **80**. Platform member is resiliently mounted on plates **22**, **24** by a plurality of mounting assemblies **82** and **84** (FIGS. **6** and **8**). A pair of Teflon plates **86**, **88** are positioned between platform member **16** and mounting plates **22**, **24** to minimize the frictional forces between the parts and to maintain such forces uniform under a wide range of environmental conditions.

Mounting assemblies **82** (FIG. **6**) are designed to permit relative vertical movement of platform member **16** with respect to the ski and to resiliently resist relative horizontal movement therebetween. As shown in FIG. **6**, each assembly **82** is comprised of a bushing **90** mounted on a stud **92** and held in place by a nut **94**. Bushings **90** are made from any suitable resilient material. In the disclosed embodiment, they are made of silicone rubber having a durometer hardness in the range of **50–60**.

Mounting assemblies **84** (FIG. **8**) are designed to permit relative horizontal movement of platform member **16** with respect to the ski and to resiliently resist relative vertical movement therebetween. As shown in FIG. **8**, assemblies **84** are comprised of O-ring members **96** held securely in place on studs **98** by nuts **100**.

The specific number and location of assemblies **82** and **84** may vary to some extent. In the disclosed embodiment, there are a total of eight assemblies **82**, four in the heel portion of member **16** and four in the toe portion of member **16**, and a total of two assemblies **84** located at spaced points on the longitudinal centerline of the binding mechanism.

The above-described combination of resilient mounting assemblies **82** provides a resilient mounting for platform member **16** on the ski which, under dynamic loading provides a double pivot in the horizontal plane disposed along the longitudinal axis, one pivot substantially under the heel and one substantially under the ball of the foot. Similarly, the above-described combination of resilient mounting assemblies **84** provides a resilient mounting for platform member **16** on the ski which, under dynamic loading, provides a double pivot in the vertical plane disposed along the longitudinal axis, one pivot substantially under the forward end of the platform member **16** and the other substantially under the rear end of the platform member.

A strain sensing means is provided to sense stresses of a predetermined magnitude set up in the resilient mounting means as a result of dynamic forces exerted on the platform member **16** by boot **12** as might occur when, for example, the skier experiences a bad fall.

In the disclosed embodiment, the strain sensing means is comprised of six micro-switches **102**, **104**, **106**, **108**, **110**, **112** fixedly secured to plates **22** and **24** as best shown in FIGS. **5** and **7**. The micro-switches are mounted in two clusters of three switches each in cut-out portions **114** and **116** of platform member **16**, such cut-out portions being located in the heel and toe portions of the member. The micro-switches are provided with cooperating actuator arms **118**, **120**, **122**, **124**, **126**, **128** which are constructed in the form of two integral members, each including three arms and having a common mounting portion **130** and **132** fastened to platform member **118** by any suitable means such as rivets **134** and **136**.

It is clear from the foregoing that since the micro-switches are fastened to the ski and the actuators therefor are fastened to the platform member **16** any relative movement between the platform and the ski will be reflected in a corresponding relative movement between the micro-switches and the corresponding actuators therefor. More specifically, actuator arms **118**, **120** and **124**, **126** (in combination with their corresponding micro-switches) are positioned to sense relative movement of platform member **16** with respect to ski **10** in a horizontal plane, whereas, actuator arms **122**, **128** (in combination with their corresponding micro-switches) are positioned to sense relative vertical movement of the platform member with respect to the ski.

It will be noted at this point that, although only one type of strain sensing means is disclosed herein, other types are contemplated. For example, as an alternative to the micro-switches referred to above, a plurality of so-called "strain gages" of suitable design may be employed. Such "strain gages" could be either a "resistance-wire" type or a "magnetic" type. For a detailed description of such types of strain gages, reference is made to "Electronics in Industry," 3rd Edition by George M. Chute, Chapter 32, Section 8 (beginning on p. 577) published in 1965 by McGraw-Hill, Inc. (Library of Congress Catalog Card Number 64–16842). The portion of the treatise referenced above is incorporated herein and made a part hereof.

A still further possible alternative to the micro-switches disclosed herein would be the use of a suitable crystal material having a characteristic wherein, if a mechanical force is applied across the crystal, a voltage will be produced. Such a characteristic is known as the "piezoelectric" effect of the material. In the present invention, such a "piezoelectric" material, together with a suitable amplification circuit could be used to sense stresses of a predetermined magnitude set up in the resilient mounting means as a result of dynamic forces exerted on the platform member **16** by boot **12**.

In completing the description of the binding mechanism, reference is now made to the means for instantaneously releasing the cable means when the strain sensing means described above senses a stress of a predetermined magnitude in the resilient mounting means as a result of a dynamic force being exerted on the platform member **16** by boot **12**.

In the preferred embodiment, this is accomplished by a releasing means **42** which is comprised of a sear member **138** slidably mounted in a first chamber **140** formed in the edge portion of platform member **16** as best shown in FIG. **5**. Sear member **138** is operatively connected to a piston member **142** by connecting rod **144**. Piston member **142** is slidably mounted in a second chamber **146** with the rod **144** passing through a wall **148** which serves to separate the two chambers. Cable member **28** is provided with a ball **150** fastened to the end thereof which, under normal skiing conditions is held in a detent **152** by sear **138** by the action of a compression spring **154**.

The above-described sear and piston assembly is actuated by a high energy source **156** which in the preferred embodiment is comprised of a combination explosive charge and igniter therefor commonly known in the art as a "squib." While the particular characteristics of the squib will vary with other design characteristics of the unit, one example of a squib which has been used with satisfactory results is a Type 1QB144 squib made by Atlas Chemical Industries, Inc., having an igniter drop of lead styphnate and a base charge of lead mononitroresorcinate. As shown in FIG. **5**, a plurality of squibs (four) **158** mounted on a rotatable cartridge member **160** are provided so that the binding mechanism can be repeatedly operated before it is necessary to install a new set of squibs.

Squibs **158** are energized from any suitable source of electrical energy such as a dry cell battery **162**. At this point, reference is made to FIG. **9** which shows a partially schematic electrical wiring diagram of a suitable detection circuit for energization of the squib **158**. As shown, sets of micro-switches **102, 104, 106** and **108, 110, 112** are connected in parallel with each other and in series with squib **158** and battery **162**. Thus, when any one of the six micro-switches is closed, the squib will be fired by electrical energy from battery **162**.

Referring back to FIG. **5**, when squib **158** is fired, the gas pressure produced thereby will be conducted through a passageway **163** to the underside of piston **142**, thus causing the piston and sear **138** to slide to the left in chambers **140** and **146** to thereby release ball **150** on cable **28** from detent **152**. The cable **28** thus released will release the skier's boot from the platform member **16**.

As a further refinement to the release mechanism described above, an accelerometer means **164** may be provided to detect a sudden deacceleration of the ski which may occur, for example, if a ski should strike a buried object in the snow head-on such as a large rock, tree stump, etc. The accelerometer means **164** may be mounted at any convenient location such as that shown schematically as a circle on FIG. **5**. The mechanism may be of any suitable design, such as that shown in FIG. **10** wherein a metal ball **166** is normally held at the end of a permanent magnet **168**. A pair of ring-shaped conductors **170** and **172** are concentrically mounted adjacent ball **166**. Conductors **170** and **172** are connected in series with battery **162** and squib **158** so that when ball **166** is displaced from the end of the magnet **168**, it will move into electrical contact with conductors **170, 172** to thus complete the circuit and fire the squib.

A further refinement of the present invention resides in a test means **174** (FIG. **9**) for easy and accurate adjustment of the mechanism to correlate the release characteristics of the mechanism with the characteristics of the user such as weight, age, skiing proficiency, etc. This is accomplished by a test probe means **174** shown in FIG. **9** which is comprised of a probe member **176** having a pair of contact portions **178** and **180** separated by an insulator portion **182**. The probe member is adapted for insertion through an opening (not shown) in platform member **16** for engagement with a pair of normally closed contact members **184** and **186** connected in series with squib **158** and battery **162**. Contact portion **178** is connected to ground, and contact portion **180** is connected to an indicator light bulb **188** (or volt meter) so that when the probe **176** is inserted between contact members **184** and **186**, the squib will be connected to ground and the light **188** will be connected in series with battery **162**. The mechanism is now in condition for adjustment of the strain sensing means (micro-switches) to preset the stress level at which the mechanism will release.

OPERATION

While various procedures may be employed for presetting the stress level at which the mechanism will release, the preferred procedure is as follows. The user, with his ski boots on, proceeds to place one boot on the platform member **16** and then to tighten the cable member **28** to the desired tension to securely hold the boot to the ski. The user, with the help of a person who preferably has been trained for the job, proceeds by trial and error to preset the micro-switches with the test probe means **174** installed in the mechanism. Such presetting of the micro-switches is accomplished by adjustment screws **190** (one for each actuating arm **118, 120, 122, 124, 126, 128**) as most clearly shown in FIGS. **5** and **7**.

The presetting adjustments are accomplished by actually applying force to the user's leg and ankle by twisting the ski in various directions to simulate the type of movements which the micro-switches are designed to detect. The setting will be determined by the amount of pain induced by the particular twisting action applied to the user. In other words, each switch will be set so that the indicator light will go on at the point when the force applied produces a threshold of pain beyond which the user feels an injury may occur. After the mechanism of the first ski is set, the ski is removed and the procedure is repeated for the second ski.

As an alternative to the "live" method of testing described above, the release levels can be set mechanically with the particular settings determined either by a special torque measuring device designed to actually measure the proper levels for an individual skier or by a formula based on the user's weight, age, skiing proficiency, etc.

In use, the binding mechanism operates as follows. Assume, for example, the skier is in a parallel christie to the left and the right-hand or down-hill ski strikes a rock buried in the snow, forcing the right edge of the ski to dig into the slope. In such event, platform member **16** will be moved slightly relative to the ski causing either or both of switches **102** and **108** (FIG. **5** to close. The closing of either of such switches will complete a circuit from battery **162** to squib **158** to thus ignite the explosive charge in the squib. The gas pressure thus produced will be conducted through passageway **163** to the underside of piston **142** causing the piston and sear **138** to slide to the left to thereby release ball **150** on cable **28** from detent **152**. The cable thus released will release the skier's boot from the ski and thereby prevent an injury which might otherwise occur. To restore the binding mechanism to operative condition for further use, ball **150** is re-engaged in detent **152** and a fresh squib is moved into operative position by rotating member **160**. The used squibs can be replaced at any convenient time and place.

It will be appreciated from the foregoing that the entire strain sensing means and release mechanism including the micro-switches, squibs, battery, etc., are all located within the confines of platform member **16** and are thus protected from the elements. This means, of course, that once the proper settings are made the release levels will remain constant irrespective of variables in the environment such as temperature, snow, ice, etc. Thus, it should be possible, for example, to set the release levels at the beginning of the skiing season and have them remain constant for the entire season.

It is also noted that by the use of a plurality of strain sensing means such as the micro-switches described above, together with the accelerometer means, substantially all conceivable types of stresses which would normally be encountered will be detected by the mechanism to thus provide maximum safety.

Another important feature is the substantially instantaneous release afforded by the combination of the micro-switches and the squib-actuated release mechanism. Finally, since most of the components are located inside the platform member, a very pleasing, clean, streamlined appearance results.

While the strain sensing means and releasing means for the cable are illustrated and described as being mounted on the ski, it should be appreciated that such sensing and releasing means may be either partially or wholly mounted on the boot.

I claim:

1. A releasable binding mechanism for a ski comprising the combination of:

a boot support member mounted on the ski;

a releasable boot holding means adapted to securely hold the boot on said support member;

a resilient mounting means for mounting said boot support member on said ski, said resilient mounting means adapted to permit slight pivotal movement of said boot and support member with respect to the ski about two pivot points, one pivot point located substantially under the heel of the skier's foot and the other pivot point located substantially under the ball of the skier's foot;

a strain sensing means mounted on the ski and adapted to sense stresses of a predetermined magnitude set up in said resilient mounting means as a result of pivotal movement of said support member with respect to said ski about either of said two pivot points; and

a releasing means operatively associated with said strain sensing means and adapted to release said boot holding means when said strain sensing means senses stresses in said mounting means above a predetermined level.

2. A releasable binding mechanism according to claim 1 in which said releasing means includes an explosive charge adapted when ignited to release said boot holding means.

3. A releasable binding mechanism according to claim 2 in which said releasing means further includes a slidably mounted piston member adapted for activation by the expanding gases produced by the ignition of said explosive charge.

4. A releasable binding mechanism according to claim 1 in which said strain sensing means includes a plurality of switches adapted for selective actuation in response to relative movement between said boot supporting member and the ski.

5. A releasable binding mechanism according to claim 4 in which said strain sensing means includes a test means for adjusting said switches to vary the stress level at which said switches will be actuated, said test means adapted to operatively disconnect said switches from said releasing means and to operatively connect said switch means to an indicator means.

6. A releasable binding mechanism according to claim 1 in which said releasing means includes a source of electrical energy and a high energy source, said source of electrical energy operatively associated with said strain sensing means, said high energy source adapted for energization by said source of electrical energy to release said boot holding means.

7. A releasable binding mechanism according to claim 1 in which said strain sensing means is adapted to sense both relative horizontal and vertical movement between said boot support member and said ski.

8. A releasable binding mechanism according to claim 1 in which said strain sensing means includes an accelerometer means adapted for actuation in response to abrupt changes in the speed of the ski.

9. A releasable binding mechanism for a ski comprising the combination of:

a boot support member resiliently mounted on the ski, said resiliently mounted support member adapted for slight pivotal movement with respect to the ski about two pivot points, one pivot point located substantially under the heel of the skier's foot and the other pivot point located substantially under the ball of the skier's foot;

a releasable boot holding means adapted to securely hold the boot on said support member;

a strain sensing means adapted to produce a pulse of electric energy whenever a slight pivotal movement occurs between said boot support member and the ski about either of said two pivot points; and

a releasing means adapted for energization by the pulse of electrical energy to release said boot holding means.

10. A releasable ski binding mechanism according to claim 9 in which said releasing means includes an explosive charge, said charge adapted when ignited to release said boot holding means.

11. A releasable ski binding mechanism according to claim 9 in which said strain sensing means includes a plurality of switches, said switches adapted for actuation in response to slight relative movement between said boot support member and said ski.

12. A releasable binding mechanism for a ski comprising the combination of:

a ski boot support platform means mounted on the ski, said platform means including a boot support surface on which the boot is positioned for releasable attachment to the ski, said platform means further including a sealed chamber means in the interior of said platform means;

a releasable boot holding means adapted to securely hold the boot on said support surface of said platform means;

a resilient mounting means for mounting said boot support platform means on the ski;

a strain sensing means including a plurality of strain sensors adapted to sense stresses of a predetermined magnitude set up in said resilient mounting means as a result of forces exerted on said support member by said boot, said strain sensors mounted in said sealed chamber means of said ski support platform means; and

a releasing means operatively associated with said strain sensing means and adapted to release said boot holding means when said strain sensing means senses stresses in said mounting means above a predetermined level.

13. A releasable binding mechanism according to claim 12 in which said resilient mounting means is adapted to permit slight pivotal movement of said boot and support platform means with respect to the ski about two pivot points, one pivot point located substantially under the heel of the skier's foot and the other pivot point located substantially under the ball of the skier's foot.

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