A releasable ski binding device is disclosed whereby the release mechanism is electrically actuated by signals generated by a plurality of pressure sensors mounted in proximity to a ski boot. The binding device includes heel and toe engaging members and a solenoid actuated release mechanism having a learning system which automatically increases or decreases the pressure threshold point at which the release mechanism will be actuated. The device of this invention assures a skier that the ski binding will release only if excessive abnormal pressures are exerted and will not inadvertently release under conditions normal to the skier, even if the norm varies throughout the skiing day.
FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 8

FIG. 7
FIG. 5
FIG. 6
RELEASABLE SKI BINDING DEVICE

BACKGROUND OF THE INVENTION

1. Field
This invention is directed to a release system responsive to pressure changes and particularly to a ski binding release mechanism which is electrically actuated whenever abnormal stress and pressure levels are reached.

2. State of the Art
Most all of the release systems and especially the devices that are currently available to a skier are spring loaded mechanical type devices capable of releasing at predetermined set stress level points. In all such devices, the set release point will release the binding when a predetermined stress force is exerted on the binding, even if such stress force occurs when controlled skiing is in progress. As is recognized by all skiers, an early or unscheduled release can cause serious injury to the skier if he is not anticipating the release. In addition, various environmental conditions leading to an accumulation of ice or snow on the ski binding can hamper a normal release. These changes in the bindings release characteristics are obviously undesirable and are potentially dangerous to the skier.

It is therefore an object of this invention to avoid the above shortcomings which are now inherently present in mechanical type ski bindings. Another object is to provide a ski binding which is not susceptible to changes in the environment. Another object is to provide a releasable ski binding which is electrically actuated. Still another object of this invention is to provide an electrically actuated ski binding which will automatically adjust its release point over a relatively broad range to compensate for and correspond to the skier's capability and/or the particular skiing conditions. A still further object is to provide a device which has a built-in delay which prevents a release whenever a controlled force is applied to the ski binding even though such force may momentarily exceed its release threshold.

SUMMARY OF THE INVENTION

The release system and particularly the ski binding of this invention is unique in that it is capable of automatically adjusting its release threshold in response to past skiing stresses. With the device of this invention, the stresses or pressures exerted by a skier are measured by a plurality of pressure sensing elements mounted in tangential proximity to the ski boot or in proximity to either the heel or toe engaging members. As normal pressures or stresses are exerted by the skier, signals are transmitted from the sensing elements to a filter network or spring circuit. Portions of the signals transmitted from the pressure sensing elements are combined by electrical resolution prior to entering the short term delay or spring circuits. From the delay or spring circuits the signal passes to a learning level detector, which is continuously establishing a current voltage release threshold. The output from the learning level detector enters a voltage comparator which, when an abnormally high stress or pressure is exerted by the skier, transmits a signal, and if such signal exceeds the threshold value, the ski binding will release by the actuation of a solenoid contained therein.

Important features of this invention are that the release mechanism is adapted with a delay or filtering mechanism which will permit actuation of the solenoid only if the stress or pressure exerted by the skier continues for a predetermined period of time and a learning mechanism which automatically adjusts to a higher or lower release threshold based upon past skiing stresses. Both of these features, either alone or in combination, produce a release system which minimizes, if not avoids, unscheduled releases.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side perspective view with parts cut away for clarity showing generally a secured ski boot utilizing the ski binding of this invention.

FIG. 2 is a rear view of the heel plate taken along line 2—2 of FIG. 1.

FIG. 3 is a front view of the toe plate taken along line 3—3 of FIG. 1.

FIG. 4 is a top view of the toe engaging member taken along line 4—4 of FIG. 1.

FIG. 5 is a schematic diagram of the electrical circuit utilized in the ski binding device.

FIG. 6 is a schematic diagram showing a simplified circuit utilizing pressure and learning systems.

FIG. 7 is a diagrammatic side cross-section of a mechanical learning level detector.

FIG. 8 is a side cross-section of a typical pressure sensor.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, a toe plate 2 and a heel plate 4 are fastened to a ski boot 5 by means of screws 6. The toe plate 2 is "L" shaped and includes a horizontal member 8 which lays on the top surface 10 of the ski 11 and an elongated vertical member 12 extending upward from the horizontal member. A protuberance 13 (see FIG. 3) extends upward from the top edge of the vertical member 12. The heel plate 4 is likewise "L" shaped, having a horizontal member 14 and a vertical member 16 adapted with an annular shaped opening 18 (see FIG. 2).

The ski boot is held to the ski 11 by means of a toe member 22, which is mounted to the top surface of the ski 11 by screws 24. The toe member includes a vertical piece 26 to which are mounted a bottom horizontal member 28 and a top horizontal member 20 having a dimple 32. The dimple 32 of top horizontal member 30 overrides and engages the protuberance 13 of vertical member 12 of the toe plate 2 holding the toe portion of the ski boot firmly to the surface of the ski. As indicated above, the underside of the top horizontal member 30 has a slight indentation or dimple 32 for engaging the protuberance 13 located about midway between the ends of the elongated vertical member 12.

The heel portion of the ski boot is held in position by a solenoid piston 36 which, when deactivated, passes through the annular opening 18 of the vertical member 16 of the heel plate 4. The boot is released from the ski binding by actuating solenoid 40 which moves the solenoid piston 36 into its housing. Surrounding the solenoid is the binding housing 42 which contains the batteries and electronic components for operating the ski binding mechanism of this invention. Although the mechanical aspects of the ski binding device above disclosed are of the basic variety, it is evident that a more sophisticated system could be readily adapted to the release principles of this invention. For example, cable
release bindings and spring loaded toe and heel pieces could be easily modified to incorporate the electronic relay system hereinafter described.

Referring now to FIG. 5 it can be seen that a number of pressure sensors are positioned such that they are capable of measuring pressures or stresses from a number of directions. In addition, the number of sensors used could vary from four to as many as twelve and possibly even more. With four sensors, pressures exerted from the four basic directions; namely, up, down, right and left, can be easily detected. In addition, forces from an innumerable number of intermediate positions can likewise be detected and measured by introducing the signals received from the four basic directions into a combining circuit and then into a summing network prior to introducing this signal into the learning detector. The combining and summing network work in unison to resolve and integrate forces from two or more directions. In so doing, they provide a measurement of the resultant force which is then introduced into the learning detector.

Prior to introducing the signal into the learning detector, the signal passes through a delay time or filtering system which separates momentary high forces or pressures generated by sudden moves of the skier which creates a brief abnormal force. If this force should continue for less than a predetermined number of microseconds, such as would occur when the force is a result of a controlled, as opposed to an uncontrolled move, the time delay or filtering system will retain the impulse for a predetermined designated number of microseconds before sending it on to the learning level detector. This filter or time delay system minimizes, if not fully eliminates any possibility that the release mechanism will release during normal skiing operations, even when, for a brief period of time, the skier may exceed the pre-established release threshold.

When the signal passes through the filter or time delay system and enters the learning level detector, the learned release threshold level is either increased, decreased or held constant, depending on the intensity of the force reported by the pressure sensor. If the sensed force is greater than that previously experienced by the learned detector, the level or threshold of force retained within the learning detector (in the form of a voltage drop across a capacitor) is increased. The increase in voltage is a function of both pressure and time and will vary accordingly.

The difference between the sensed and learned signal is then passed from the learning detector to the threshold detector or voltage comparator. If the difference in pressure or stress, (i.e., that amount of stress above the learned level) as measured by an input voltage varies substantially above the stress or pressure difference value set in the comparator, a signal will be transmitted to a solenoid which, when actuated, releases the ski binding. However, if the difference in stress or pressure does not exceed the difference set into the comparator, a signal will not be transmitted to the solenoid and no release occurs.

In FIG. 5 four pressure sensors 70a, 70b, 70c and 70d are shown for detecting up, down, right and left pressures respectively. All of the pressure sensors are identical and include a variable impedance means actuated by pressure changes. Such a system can be schematically depicted by a variable resistor 71 and a fixed resistor 75 connected in series. A voltage of about 4.5 volts DC is continuously applied to the system by means of a battery now shown. The output from sensors 70a and 70b pass through a gated combination system 72a comprising a pair of diodes 73a and 73b while the output from sensors 70c and 70d pass through a similar gated combination system 72c comprising a pair of diodes 73c and 73d. Each pair of diodes steer the largest of the two signals received from each pair of sensors 70a and 70b and 70c and 70d to two junction points 74a and 74c respectively. The signals are then split with a portion of one feeding into a delay circuit 76a and the other portion to a delay circuit 76c. The remaining portions are combined in a second order combination circuit 78 which combines the output of two or more sensors of different directions of freedom to provide an algebraic sum output which is then fed into a third delay circuit 76b. The algebraic sum from the sensors may be weighted by altering the relative value of the resistors 80a, 80b and 80c of the combination circuit 78.

The output from the above three delay circuits are then introduced into three learning detectors 82a, 82b and 82c. The learning detectors are designed such that if a voltage is applied, for example, at point 84 and if this voltage is larger than the voltage applied across capacitor 86, a current will flow through the reverse diode 104, the capacitor 86 and the resistor 90 causing a voltage at point 92. This voltage is the difference between the voltage at point 84 and the voltage across capacitor 86. The voltage at point 92 is gated to the positive side of a voltage comparator 94 in a comparing system 93 through an isolation diode 107. The voltage at point 98 (same as voltage at point 92) is compared to the voltage set by the delta set control 100. If the voltage at point 98 exceeds the delta voltage, the solenoid will be actuated releasing the ski binding mechanism. If the voltage at point 98 does not exceed the delta voltage, the learning capacitor 86 will be charged through resistor 102 set by capacitor 86 and resistor 90. With this arrangement, capacitor 86 "learns" a time average of the peak voltage at point 84. Preferably the applied voltages will be in the neighborhood of about 3 to 6 volts DC. However, higher or lower voltages may be used if desired.

The voltage across the capacitor 86 will relax over a period of time (15-30 minutes) by discharging at normal leakage rates. If the voltage at point 84 reduces its peak below that of the capacitor 86, the capacitor will eventually discharge to the new peak average and stabilize. The reverse current diodes 104, 88 and 107 prevent discharge of the capacitor 86. The initial level set into the learning detector through a variable resistor 102 establishes the initial voltage across capacitor 86. Normally this is set at a minimum value to permit the learning mechanism to gradually increase the voltage across the capacitor. This will then set the release at a point of normal skiing stresses and pressures as independently determined by each skier's stress patterns. This allows the binding to release only when the normal skiing pressures are substantially increased as would occur when the skier runs into trouble or a fall is encountered. The learning mechanism 82a and 82c function in an identical manner to learning mechanism 82a. All outputs from the three learning detectors feed into a single comparator 94.

In FIG. 8 an inexpensive pressure sensor is shown comprising a top pressure plate 110 and a bottom pres-
sure plate 112. In between the two plates is a semicon- 
ducting material 114 such as paper saturated with dry 
India ink. The pressure plates also function as con- 
tactors for measuring the resistance of the carbon paper. 
When a pressure is exerted on the pressure plates the 
carbon in the ink is compressed causing a drop in resis- 
tance. Although paper impregnated with India ink and 
dried wherein the dried India ink comprises at least 
10% by weight on a dry basis of the paper and ink, is 
described as the sensing element in the pressure sen- 
sors, any semiconducting material capable of exhibiting a 
resistance drop or increase when a force or pressure is 
exerted thereon may be used. Any sensing element 
capable of providing an electrical response in which the 
response is a function of stress may be used.

In FIG. 7, a mechanical learning level detector is de- 
picted which functions in a manner analogous to the 
electronic mechanism hereinabove described.

As shown, when a force is applied to plunger 120, the 
force is sufficient to cause the plunger to contact a 
dashpot piston 122 and force the dashpot 124 against 
the learning rate spring 126 sufficiently far enough to 
cause the tip of the excess pressure control screw 128 
to contact the release trigger mechanism 130 activating 
the release mechanism and causing the binding to re- 
lease.

If the force applied is insufficient to cause release but 
is large enough to cause the plunger 120 to contact the 
dashpot 122 and push the dashpot mechanism in- 
wardly, then the dashpot 122 will contract at a prede- 
termined rate and the force applied by the plunger is 
diminished. Thus, a larger force on the plunger will be 
needed to release the binding. When there is an insufi- 
cient force on the plunger to cause contact with the 
dashpot, the dashpot will relax at a slow rate because 
of the dashpot spring 132. Thus the mechanism will 
learn the peak forces over a period of time. It will also 
relax to adjust itself to lower force levels. The excess 
pressure control screw 128 is used to adjust the pres- 
sure release difference in the same manner as the delta 
set control was used in the electronic mechanism. The 
minimum release pressure control 134 and maximum 
release pressure control 136 are used to limit the excu- 
sion of the dashpot and thus set the minimum and maxi- 
imum release pressures of the binding.

Referring now to FIG. 6, a simplified circuit is shown 
utilizing a pressure sensing system 140, a learning sys- 
tem 150 and a comparing system 160. The pressure 
sensing system includes a number of pressure sensing 
means depicted by four variable resistors 142, 144, 146 
and 148 respectively. However, it should be noted that 
the number of pressure sensing means used could be 
increased 20 to 40 fold without substantially changing 
the circuit shown. Although the pressure sensing means 
is preferably of the design shown in FIG. 8, more so- 
plicated systems may be employed.

The output from the pressure sensing system 140 
leads directly to a learning system 150 comprising, in 
series, a capacitor 152 and a resistor 154. This learning 
system may include diodes of the type shown in FIG. 5 
if a reduction in the normal rate of circuit leakage is de- 
sired.

The voltage output from the learning system 150 is 
transmitted to a comparing system 160 which includes 
a voltage comparator 162 and a variable resistor 164. 
The positive side of the comparator is connected to 
point 156 with the negative side connected to the vari-
}

able resistor 164. The voltage drop at point 156 is be- 
tween 3 to 6 volts and preferably about 4.5 volts DC.

The above described circuit is very similar to the cir- 
cuit shown in FIG. 5 except for the elimination of the 
gating systems. The learning system 150 has the ability 
to learn and accommodate relatively slow pressure 
changes. However, if the change in pressure is rela- 
tively substantial; i.e., varies substantially from that set 
in the delta voltage control (variable resistor 164), a 
response will be transmitted to a reporting system 170.

The above basic circuit arrangement could be incor- 
porated into an alarm system such as a burglar or fire 
alarm system. The pressure sensing cells could be 
placed in the flooring or along the support beams 
wherein changes in pressure (weight) could be de- 
tected. The advantage that this system would have over 
existing pressure detecting systems is that pressure 
changes resulting from changes in humidity, tempera-
ture or placement of furniture would be automatically 
compensated for by the learning system without in any 
way altering the system's sensitivity or causing a premu-
ture sounding of the alarm.

The above system could also be used as the sensing 
means for releasing the safety air bags now being used 
in automobiles. This system would avoid a premature 
release by learning and storing the stresses and pres-
sures detected during normal driving and would cause a 
release only when a substantial and unlearned pres- 
sure or stress is detected.

Other systems wherein a learning period would be 
desirable could readily incorporate the above release 
system.

While the invention has been described with refer- 
ce to certain specific embodiments, it is understood 
that changes may be made by one skilled in the art and 
would not thereby depart from the spirit and scope of 
the invention which is to be limited only by the claims 
appended hereto.

I claim:

1. A release system responsive to pressure changes 
comprising a pressure sensing means capable of trans- 
mitt ing a signal in response to a pressure change, a 
leaming level means for setting a variable pressure re-
lease threshold point, said threshold point being based 
only on past signals received from said pressure sensing 
means, and a release means actuated by a signal re- 
ceived from said pressure sensing means which exceeds 
said pressure release threshold point.

2. The release system of claim 1 including a means 
for resolving signals received from two or more pres- 
sure sensing means prior to relaying said signals to said 
leaming level means.

3. The release system of claim 2 including a time 
delay means for eliminating signals having a time pe- 
riod which does not exceed a set preselected time delay 
constant.

4. The release system of claim 1 including a compara-
tor means for receiving a signal from said learning level 
means and comparing said signal to a preselected value 
set in said comparator means.

5. The release system of claim 4 including a means 
for permitting the transmission of a signal to said re-
lease means when said signal from said learning level 
means exceeds said value preset in said comparator 
means.

6. In a ski binding release mechanism having a ski 
boot release means and a learning release system com-
prising pressure sensing means, capable of transmitting a signal in response to a pressure change, a learning level means for establishing a pressure release threshold point and means for permitting the transmission of a signal to said ski boot release means when a signal received from said pressure sensing means exceeds said variable pressure release threshold point.

7. The ski binding release mechanism of claim 6 wherein said ski boot release means includes a comparator means for receiving a signal from said learning level means and comparing said signal to a preselected value set in said comparator means.

8. An electronic circuit comprising a pressure sensing system capable of transmitting an electronic signal in response to a pressure change, a learning level system for establishing an electrical threshold point based on signals received from said pressure sensing system and means for transmitting a signal to a receiving means when said signal received from said pressure sensing system exceeds said electrical threshold point.

9. The electronic circuit of claim 8 including an electrical comparing system for comparing the signal received from said learning level system and permitting the transmission of a signal to said receiving means when said signal exceeds a value preset in said comparing system.

10. A method for detecting a pressure change comprising: converting said pressure change into a corresponding electrical response; establishing a variable pressure threshold point by assimilating the above electrical responses; and transmitting a signal whenever said electrical response exceeds said pressure threshold point by a preselected value.