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(19) **United States**(12) **Patent Application Publication****Watson**(10) **Pub. No.: US 2005/0151350 A1**(43) **Pub. Date: Jul. 14, 2005**(54) **VIBRATION CONTROL SYSTEM AND
IMPROVEMENTS IN OR RELATING TO
SKIS**(30) **Foreign Application Priority Data**

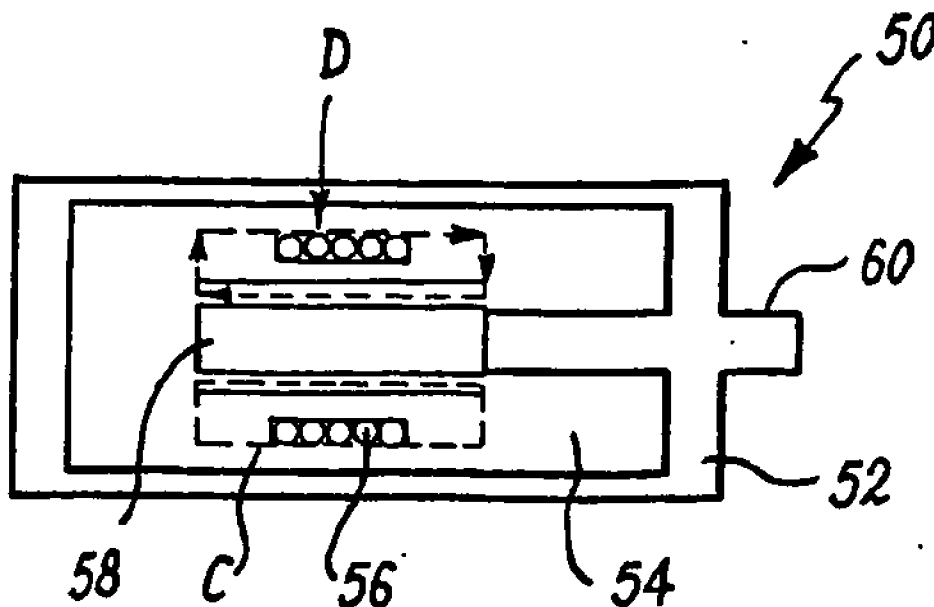
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(GB)**Publication Classification**

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Fleshner & Kim**Suite 1100****2325 Dulles Corner Boulevard****Herndon, VA 20171 (US)**(51) **Int. Cl.⁷** **A63C 5/07**(52) **U.S. Cl.** **280/602**(57) **ABSTRACT**

Vibration control systems are described which provide for the variation in stiffness and damping in a structure. The systems are based on the use of rheological fluid, with examples provided of magnetorheological fluid flex actuators and semi-active damping systems. An adaptive vibration control system is also described incorporating sensors, a signal processor and a power supply together with the fluid flex actuators and semi-active damping systems. Embodiments are described for use in and with skis.

(21) Appl. No.: **10/498,251**(22) PCT Filed: **Dec. 10, 2002**(86) PCT No.: **PCT/GB02/25551**

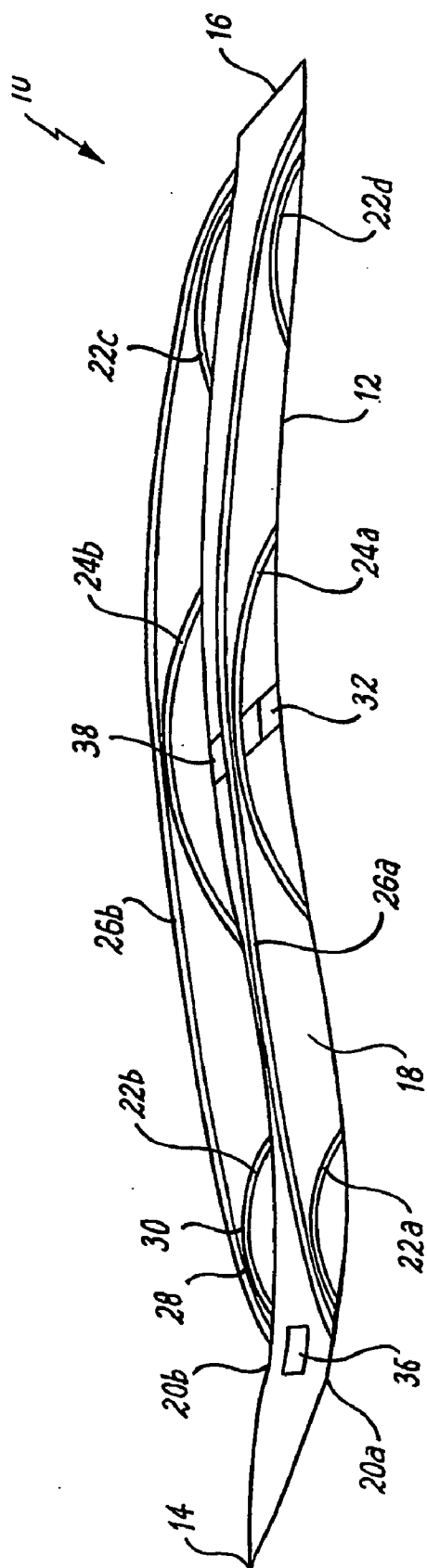


FIG. 1

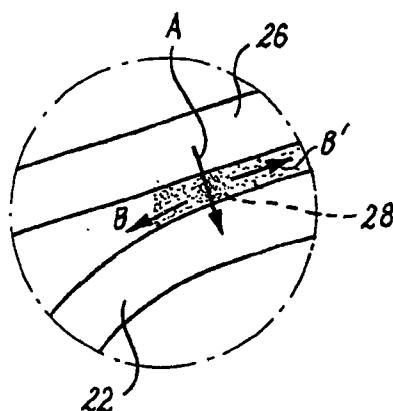


FIG. 2

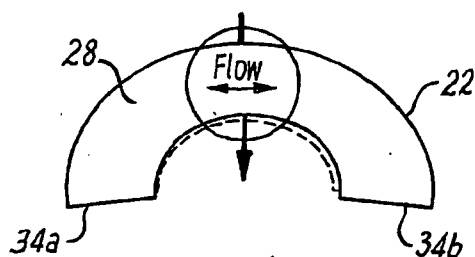


FIG. 4

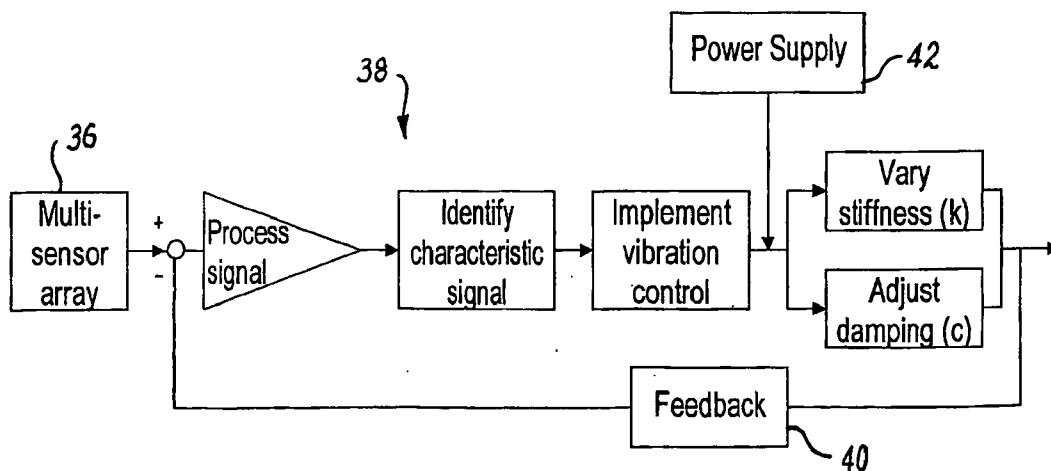


FIG. 6

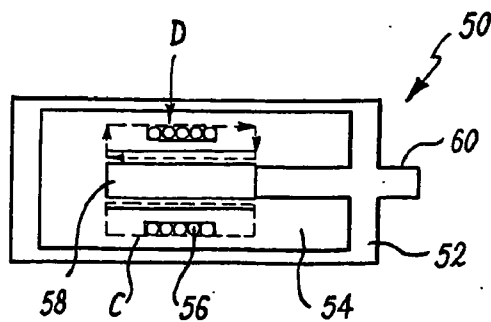


FIG. 3(a)

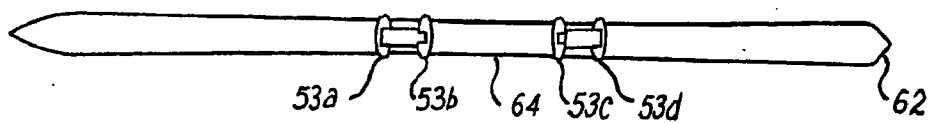


FIG. 3(b)

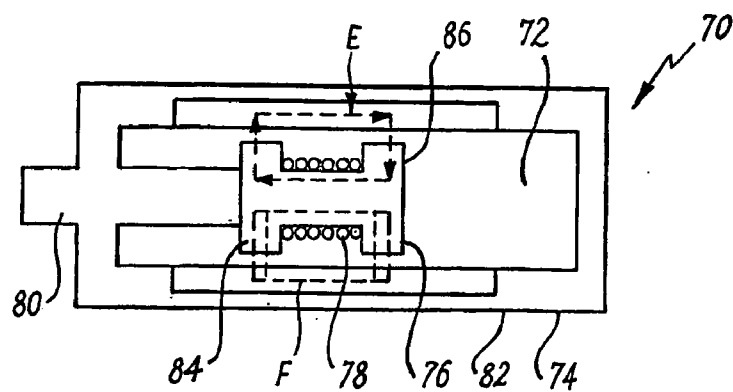


FIG. 5(a)

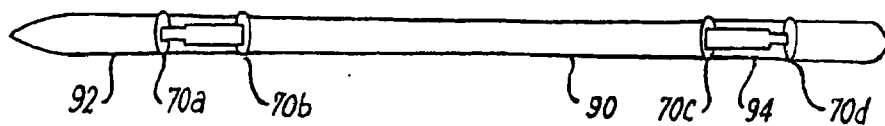
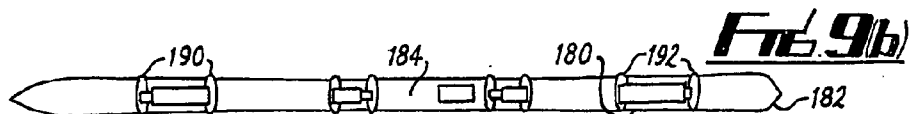
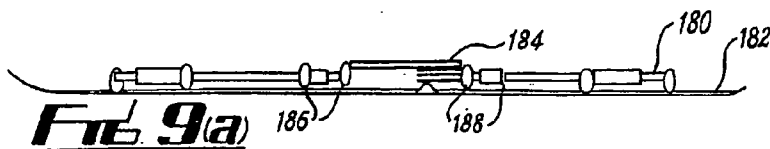
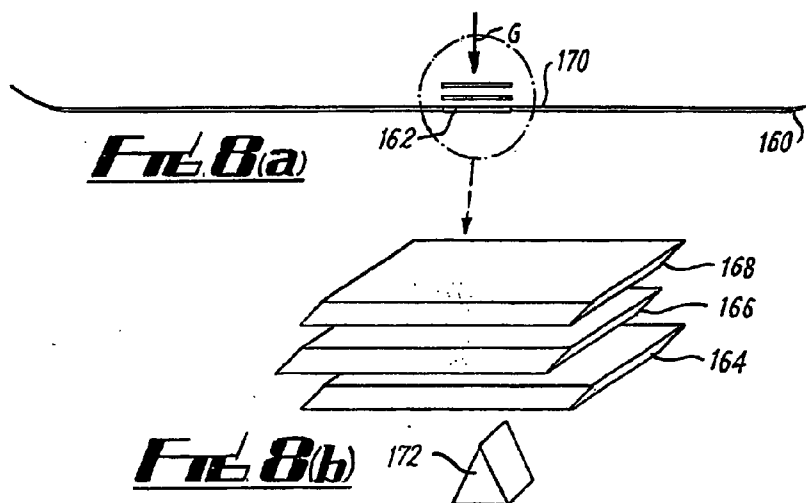
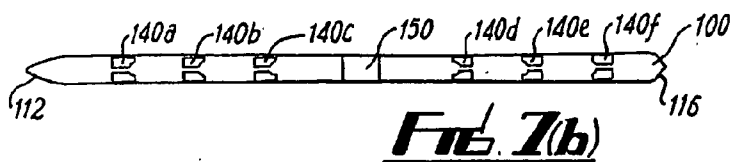
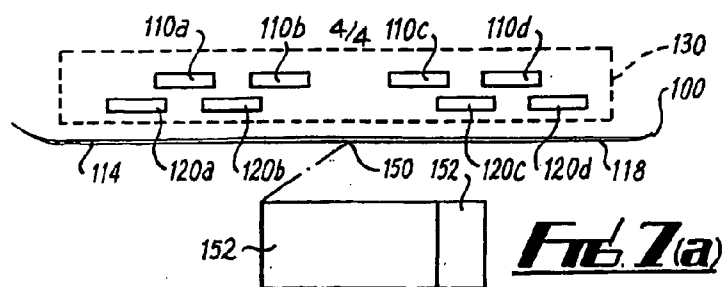


FIG. 5(b)



VIBRATION CONTROL SYSTEM AND IMPROVEMENTS IN OR RELATING TO SKIS

[0001] The present invention relates to vibration control systems and in particular, though not exclusively, to an adaptive control system to vary flex and damping in skis during use.

[0002] It is known that vibration of an object can be suppressed in objects manufactured with a calculated stiffness and damping. However, when the object is subjected to a range of operating conditions the frequency of vibration can vary i.e. the bandwidth increases. Objects having a fixed stiffness and damping cannot suppress vibration at varying frequencies and as a result the object is prone to vibration with deleterious effect.

[0003] An area where vibration reduces performance is in skiing. Vibration causes a ski to 'chatter' and so loose edge contact. Manufacturers have engineered skis by varying geometry, materials and construction techniques in an effort to suppress vibration, but such skis tend to be limited to use in certain environments. For example, male downhill race skiers use skis which have a high stiffness whereas recreational skiers have more flexible skis. It is recognised that it would be advantageous to provide a ski in which the stiffness and damping could be varied during use and so improve the handling of a ski in a range of environments.

[0004] It is an object of at least one embodiment of the present invention to provide a vibration control system which includes active flex control to vary the stiffness of an object during use.

[0005] It is a further object of at least one embodiment of the present invention to provide a vibration control system which includes a semi-active damping system to change the damping level so as to optimally counteract motion with a controlled resistive motion.

[0006] It is a yet further object of at least one embodiment of the present invention to provide a vibration control system which automatically adapts to surrounding conditions to provide active vibration control.

[0007] It is an object of at least one embodiment of the present invention to provide a ski including active flex control.

[0008] It is a further object of at least one embodiment of the present invention to provide a ski including a semi-active damping system.

[0009] It is a yet further object of at least one embodiment of the present invention to provide a ski having automatic adaptive control of stiffness and damping during use.

[0010] According to a first aspect of the present invention there is provided a vibration control system, the system comprising a structure including a chamber and a means for creating a variable applied field within the chamber, wherein the chamber is substantially filled with a rheological fluid which under the influence of the applied field causes a variation in the stiffness of the structure.

[0011] The rheological fluid may be an electrorheological fluid which undergoes a change in viscosity proportional to a change in electric field. Advantageously the rheological

fluid is a magnetorheological fluid which undergoes a change in viscosity proportional to a change in applied magnetic field.

[0012] Preferably the applied field is a continuously variable applied field.

[0013] Preferably, the means for creating a variable applied field comprises an electromagnetic coil. A variable power source may be applied to the coil.

[0014] The structure may include a first member having a first surface and a second member having a second surface, the surfaces being inner walls of the chamber and are arranged to face each other, wherein the rheological fluid is located therebetween such that in the presence of the applied field, a shear force is set-up between the surfaces by virtue of the fluid which varies the stiffness of the structure.

[0015] Alternatively, the structure may include a piston moveable within the chamber. Preferably the piston is an electromagnet such that the magnetic field strength may be varied within the chamber. More preferably, the piston is hollow providing a fluid flow path therethrough. Thus as the magnetic field strength is increased, the fluid particles in the piston align. This results in an apparent increase in viscosity that reduces the ability of the fluid to flow through the piston. Therefore by increasing the magnetic field, resistance to flow reduces the flex and hence increases the stiffness of the structure. The converse is also true. This vibration control system may be referred to as a resistive flow active flex system.

[0016] According to a second aspect of the present invention there is provided a vibration control system, the system comprises a mounting surface upon which is located a flexible hose, the hose having a first cross-sectional area filled with a rheological fluid and ends abutted to the surface.

[0017] The system provides semi-active damping as any flexing of the mounting surface will create a change in the cross-sectional area of the hose and cause the hose to act as a pump, while application of an applied field will cause the fluid to act as a valve. Consequently, an increase in field increases the fluid viscosity, the valve makes it more difficult to pump the fluid and thus more force is required to flex the hose, providing a damping effect.

[0018] The rheological fluid may be an electrorheological fluid which undergoes a change in viscosity proportional to a change in electric field. Advantageously the rheological fluid is a magnetorheological fluid which undergoes a change in viscosity proportional to a change in applied magnetic field.

[0019] Preferably the rheological fluid is 'Rheonetic Fluid' as produced by Lord Corporation, USA.

[0020] Preferably a plurality of hoses are located on the surface. More preferably the hoses are located symmetrically on the surface.

[0021] According to a third aspect of the present invention there is provided an adaptive vibration control system, the system comprising sensing means to determine one or more environmental characteristics, a signal processor to determine a controlling response to the characteristics and vibration control means responsive to the controlling response to counter vibration.

[0022] Preferably the sensing means is at least one sensor. More preferably the sensing means is a multi-sensor array. Advantageously the sensor array is a distributed array of PVDF piezo-sensors.

[0023] Preferably the signal processor identifies characteristic vibration patterns from the sensors. The signal processor may also include a control algorithm to identify the patterns. Preferably also the signal processor includes a feedback loop from the vibration control means to regulate the response.

[0024] Advantageously, the signal processor is a microprocessor. More preferably, the microprocessor is a proportional-differential-integral processor. Advantageously, the control algorithm is a fuzzy logic control algorithm to provide an intelligent control unit. Such an intelligent control unit with a fuzzy logic control algorithm programmed into the microprocessor may grade the vibration being monitored and control a graded response from the vibration control means.

[0025] Preferably the vibration control means comprises a vibration control system according to the first aspect. Preferably also the vibration control means comprises a vibration control system according to the second aspect. Advantageously the controlling response will determine the applied field.

[0026] Alternatively, the vibration control means comprises the vibration control system of the first aspect in combination with a direct shear mode semi-active damping system.

[0027] The direct shear mode semi-active damping system may comprise a fluid filled chamber which is acted upon by a piston to vary the characteristics of the fluid. More preferably, the fluid is a magneto-rheological fluid.

[0028] Advantageously, the piston is an electromagnet having a variable magnetic field strength. Thus in use, movement of the piston varies the magnetic field strength which in turn influences the alignment of iron particles in the fluid, the aligned particles being sheared as the piston moves.

[0029] Advantageously the adaptive vibration control system may be automatic. Alternatively the adaptive vibration control system may operate from a switch.

[0030] Preferably also the adaptive vibration control system includes a power supply located adjacent the system. More preferably the power supply is driven from vibration experienced by the structure. The power supply may include piezo material such that movement of the structure creates an electric signal.

[0031] Further, the adaptive vibration control system may include a user interface. The user interface may allow a user to provide the signal processor with data on one or more environmental characteristics. The user interface may comprise a wire or wireless connection to a remote device. The remote device may be a handheld device. More preferably, the remote device is a mobile PDA/phone.

[0032] According to a fourth aspect of the present invention there is provided a ski, the ski including a vibration control system according to the first aspect to vary stiffness in the ski.

[0033] Preferably the vibration control system is arranged fore and aft on the ski body. Advantageously the vibration control system is arranged longitudinally on the ski, on either side of a binding.

[0034] According to a fifth aspect of the present invention there is provided a ski, the ski including a vibration control system according to the second aspect to vary damping in the ski.

[0035] Preferably the vibration control system is arranged fore and aft on the ski body.

[0036] According to a sixth aspect of the present invention there is provided a ski, the ski including a vibration control system according to the first and second aspects to vary both stiffness and damping in the ski.

[0037] Preferably the vibration control systems are arranged fore and aft on the ski body. Advantageously the vibration control system according to the first aspect is arranged longitudinally on the ski, on either side of a binding.

[0038] According to a seventh aspect of the present invention there is provided a ski, the ski including an adaptive vibration control system according to the third aspect to provide adaptive control of vibration in the ski.

[0039] Preferably the sensor arrays are positioned at modal points on the ski. More preferably the sensor arrays are located at a fore and aft location in a body of the ski.

[0040] Preferably also the vibration control means are located at modal points on the ski. More preferably the vibration control means are located at fore and aft locations on a body of the ski. Advantageously the vibration control means according to the first aspect is arranged longitudinally on the ski, on either side of a binding.

[0041] Preferably the power supply powers the microprocessor and the variable magnetic field. More preferably the power supply comprises a layered piezo-ceramic. The piezo-ceramic may be located on the ski at a position where a skier's boot will rest. Thus the layered piezo-ceramic is configured at the point of maximum weight concentration to ensure it flexes as the skier moves. In this embodiment, power generation comes from the skier's movement over the ski, rather than the vibrating ski.

[0042] According to an eighth aspect of the present invention there is provided a chassis for mounting on a ski, the chassis including a vibration control system to control vibration of the ski in use.

[0043] By mounting the vibration control system on a chassis, the ski geometry can be varied as required.

[0044] Embodiments of the present invention will now be described, by way of example only, with reference to the following drawings in which:

[0045] **FIG. 1** is a schematic diagram of a ski according to an embodiment of the present invention;

[0046] **FIG. 2** is an exploded view of a portion of **FIG. 1** illustrating a vibration control system for varying stiffness according to an embodiment of the present invention;

[0047] **FIG. 3(a)** is an illustration of an alternative embodiment of a vibration control system for varying stiffness and **FIG. 3(b)** shows this embodiment mounted on a ski;

[0048] FIG. 4 is an exploded view of a portion of FIG. 1 illustrating a vibration control system for varying damping according to an embodiment of the present invention;

[0049] FIG. 5(a) is an illustration of an alternative embodiment of a vibration control system for varying damping and FIG. 5(b) shows this embodiment mounted on a ski;

[0050] FIG. 6 is a schematic diagram of an adaptive vibration control system according to an embodiment of the present invention;

[0051] FIGS. 7(a) and 7(b) are illustrations of an adaptive vibration control system mounted on a ski, according to an embodiment of the present invention;

[0052] FIGS. 8(a) and (b) are illustrations of a power supply for use on a ski according to an embodiment of the present invention; and

[0053] FIGS. 9(a) and (b) are schematic diagrams of a ski chassis, according to an embodiment of the present invention, mounted on a ski.

[0054] Reference is initially made to FIG. 1 of the drawings which depicts a ski, generally indicated by reference numeral 10, according to an embodiment of the present invention. Ski 10 has a conventional composite structure 12 providing a tip 14, tail 16, upper surface 18 and edges 20a,b. Mounted upon the upper surface 18, towards the edges 20a,b are four symmetrically positioned damping support bars 24a,b. The bindings (not shown) will be attached to the ski at the support bars 24a,b. This position will therefore bear the weight of the skier. Over the damping bars 22 and the support bars 24 are control rails 26a,b. The bars 22,24 and rails 26 are all arranged longitudinally on the ski 10.

[0055] Between the damping bars 22 and the control rails 26 is located a rheological fluid 28. Rheological fluids are well known and operate by increasing the viscosity of the fluid in response to an applied field. In the embodiment shown the fluid 28 is a magnetorheological fluid which undergoes a change in viscosity in response to a changing magnetic field. This arrangement of bars 22, rails 26 and fluid 28 provides a vibration control system in the form of an active flex control which can vary stiffness in the ski 10.

[0056] A first embodiment of the flex control system is illustrated with the aid of FIG. 2. FIG. 2 shows the interface between the damping bars 22 and the control rails 26. A magnetic field is applied between the bars 22 and rails 26 in the direction of arrow A. The magnetic field is applied via coils 30 (only one shown in FIG. 1) mounted on the rails 26. The consequent increase in viscosity of fluid 28 creates a shear force in direction BB'. The control rails 26 mechanically amplify the direct-shear mode and thus control the stiffness matrix (the inverse of side flex) of the composite 12 making up the ski 10. The direct-shear mode when applied reduces the movement of the bars 22 with respect to the rails 26. Vibration is thus controlled as the resultant change in stiffness alters the deflection of the ski 10 in response to impulses. Control can be varied by varying the amount of fluid 28 and the applied field. Thus at a high magnetic field the bars 22,24 and rails 26 will effectively 'lock' providing the ski 10 with a high stiffness. The arrangement shown in FIG. 2 provides active flex control to the ski 10 when the magnetic field is applied. The field is switched on via a

switch 32 located on the upper surface 18 of the ski 10 or via an adaptive vibration control system, described hereinafter with reference to FIG. 6.

[0057] In the preferred embodiment small volumes of fluid 28 are used which require small field strengths so that the ski 10 can be both lightweight and cheap to produce.

[0058] An alternative embodiment of the active flex control is shown in FIG. 3. In this arrangement actuators, generally indicated by reference numeral 50, provide the active flex control by a resistive flow concept. Each actuator 50, comprises a chamber 52 which is filled with a magnetorheological fluid 54. Within the chamber 52 is arranged an electromagnetic coil 56, in which passes a piston or slider head 58. The piston 58 includes a plastic sleeve 60, acting as a plunger. Further the piston has a hollow bore (not shown). In use the steel piston head 58 acts as an electromagnet and varies the magnetic field strength within the fluid filled chamber 52. Fluid 54 flows through the hollow bore. As the magnetic field strength is increased, the fluid particles in the piston align in the direction shown by broken line C by virtue of the magnetic flux path shown by arrow D. This results in an apparent increase in viscosity that reduces the ability of the fluid 54 to pass through the piston 58. Therefore, by increasing the magnetic field, resistance to flow reduces the flex, and hence increases the stiffness, of the ski to which the actuator is attached. The stiffness can be decreased by decreasing the magnetic field strength also. As the ski flexes, resistive flow reduces displacement of the piston sleeve 60.

[0059] FIG. 3(b) illustrates four active flex actuators 53a-d, located on a ski 62. The actuators are longitudinally arranged on the ski, in pairs, symmetrically about the binding position 64.

[0060] As the ski 10, 62 can vary its stiffness as described hereinbefore, conventional passive-damping techniques would be insufficient as the damping requirements will need to vary. Ski 10 incorporates a semi-active damping system, best illustrated in FIG. 4, to change the damping level and optimally counteract motion with a controlled resistive motion. This is achieved by applying the pressure driven flow mode of operation for controllable fluids.

[0061] Reference is now made to FIG. 4 of the drawings which illustrates a damping bar 22 as a vibration control system according to an embodiment of the present invention. The damping bar 22 has ends 34a,b which abut the upper surface 18 of the ski 10. Each bar 22 is made of a flexible hose. The hose is filled with fluid 28. The fluid 28 is sealed in the hose. When mounted on the ski 10, the hose has a uniform cross-section. The hose acts as a pump when flexed. Flexing creates a change in the cross-sectional area and the resulting restriction produces a pressure change which drives the fluid 28. When the magnetic field, described hereinbefore, is applied the viscosity of the fluid 28 increases. The fluid then acts like a valve making it more difficult to pump the fluid and therefore requiring more force to flex the hose. This damping arrangement of fluid filled hoses or fibres can be arranged along the length of the ski 10 to act against vibration.

[0062] Like the active flex control, the semi-active damping system can be constructed using small amounts of fluid 28 placed in fibres to reduce weight and cost of the ski 10.

[0063] A further embodiment of a semi-active damping system is shown in FIG. 5. The system comprises a damper, generally indicated by reference numeral 70, which acts in the direct shear mode of magnetorheological fluid to achieve semi-active damping. Damper 70 comprises magnetorheological fluid 72 filled chamber 74. A piston 76 is arranged within the chamber onto which is located an electromagnetic coil 78. The piston 76 thus acts as an electromagnet. The piston has a plastic sleeve 80 and is arranged within a steel sleeve 82. In use, vibration causes the plastic sleeve 80, to act as a plunger and force the piston 76 to move inside the sleeve 82. This increases the magnetic field strength in the magnetic flux path E and causes iron particles in the fluid 72 to align, F, between the ends 84,86 of the piston 76 and the steel sleeve 82. The aligned particles are sheared as the piston 76 moves. As the magnetic field increases the damping is increased.

[0064] Reference is now made to FIG. 5(b) which illustrates the dampers 70 mounted on a ski 90, in pairs. Fore-body damping occurs at a position 92 near the tip of the ski 90 while aft-body damping occurs at a position 94 towards the tail of the ski. Positions 92 and 94 are selected to be those regions of significant vibration on the ski when in use.

[0065] It will be appreciated by those skilled in the art that the active flex systems and the semi-active damping systems described hereinbefore can be used independently on a ski.

[0066] Reference is now made to FIG. 6 of the drawings which illustrates an automatic adaptive vibration control system for ski 10,62,90. A multi-sensor array 36 is located on a ski. The array 36 is made up of a distributed array of PVDF piezo-sensors. Though only one location for the array 36 is shown in FIG. 1 for ski 10, it will be appreciated that the sensors could be located across the entire structure of a ski 10. In a preferred embodiment the sensors are concentrated about regions of significant vibration i.e. modal points on the ski. The typical modal points are located in the fore and aft body structure of the ski, see FIG. 7(b) to be described hereinafter.

[0067] Signals from the sensors in the array 36 are input to a signal processing unit 38 which, using a stored algorithm, identifies a characteristic vibration pattern dependent on the environmental conditions and the handling of the ski 10. Unit 38 then determines a response proportional to the amplitude of the vibration which is transmitted to the coils 30 controlling the magnetic field strength. Thus the stiffness and damping can be controlled as described hereinbefore. A feedback loop 40 is also provided to enable the amount of actuator response to be regulated.

[0068] Reference is now made to FIG. 7 of the drawings which illustrates a ski, generally indicated by reference numeral 100, including an adaptive vibration control system to provide active flex control and semi-active damping, according to an embodiment of the present invention. Ski 100 includes a matrix structure into which is arranged a pattern of adaptive flex actuators 110a-d and semi-active dampers 120a-d. This may be termed a smart material 130. The smart material 130 is arranged longitudinally on the ski 100. At a point near the tip 112 is located a fore-body control point (FCP) 114 and at a point near the tail 116 is located an aft-body control point (ACP) 118.

[0069] Further on the ski 100 are arranged arrays of vibration sensors 140a-e. These sensors 140a-e are PVDF

piezo-sensors which convert vibrational movement to an electrical signal indicative of the amount of vibration experienced. These sensors 140a-e are positioned at positions, or modal points, where significant vibration is experienced by the ski 100. Thus they are located fore and aft on the ski towards each side.

[0070] Located centrally on the ski 100, at the position of the binding is an intelligent control unit 150. Control unit 150 is an advanced version of the adaptive control unit illustrated in FIG. 6. The unit includes a proportional-differential-integral (PID) microprocessor 152 on a microchip as the signal processor. A fuzzy logic control algorithm is programmed into the microprocessor 152, to grade the vibration being monitored by sensors 140 and control a graded response from the controls 110,120. This ensures the system operates within bandwidths of vibration and does not become unstable.

[0071] Also included with the intelligent control unit 150 is a control panel 152 which allows a user to input values representative of environmental characteristics into the microprocessor 152. For instance these may be the skiers weight, style, ability and snow condition. The control panel 152 may also include a main switch to enable and disable the unit 150. It will be understood that the control panel 152 may be remote from the unit 150. A cable to a switch located with the skier may, for example, be used. Alternatively the control panel may be a mobile telephone or a PDA (Personal Digital Assistant), providing the user with a wireless connection to the unit 150.

[0072] FIG. 6 also shows a power supply 42 used to drive the stiffness and damping vibration control systems. A similar power supply will be incorporated in the intelligent control unit 150 also. In the embodiments described hereinbefore this supply 40 would be the coils. Alternatively electromagnets could be used. The power supply 42 could also be replaced by a system such as piezoelectrics which are powered from the movement of the skis. FIG. 8 illustrates such a power generation system.

[0073] Referring initially to FIG. 8(a), mounted on a ski 160, at a point between the binding toe and heel piece, is a layered piezo-ceramic (PZT) 162. The layers 164,166,168 are parallel to an upper surface 170 of the ski 160 as illustrated in FIG. 8(b). Between the PZT 162 and the surface 170 is a raised section 172. The raised section 172 provides a small contact area with the PZT 162 compared to a large contact area on the ski 160. In use, a skiers weight is concentrated on the ski at the point shown by arrow G. This is directly on the PZT 162 and provides a point loading to increase strain through the layers of the PZT 162 to increase the output from the PZT 162 as the power supply 40. Thus the power is generated by the skiers movement on the ski.

[0074] A further embodiment of the present invention is shown in FIG. 9. FIG. 9 illustrates a ski chassis, generally indicated by reference numeral 180, which includes an adaptive vibration control system according to the present invention. The chassis 180 can be mounted on a ski 182 at the binding 184. Indeed the binding 184 may be mounted upon the chassis 180 via a binding mount provided as part of the chassis 180. The chassis comprises flex actuators 186,188 located at either side of the binding mount 184, semi-active dampers 190,192 at modal points towards the

ends of the chassis, a power supply mounted centrally with the control unit. These components are all as described hereinbefore with reference to FIG. 1 to 8. By locating the components on a chassis, this raised superstructure moves the rheological fluid away from the ski's neutral axis and thus mechanically amplifies any change occurring in the control elements. A further advantage to using a chassis is that it raises the binding off the ski and increases the swing weight or torque to put the ski onto its edge. This is regulated in competition and also has health implications in terms of knee damage. In using a chassis this can be designed to conform with regulations. A yet further advantage of incorporating a vibration control system on a chassis is that a single chassis can be interchanged between skis of varying geometry as required.

[0075] The principal advantage of the present invention is that it provides a vibration control system which, when incorporated into a ski, allows control of vibration and improves handling and skier performance by adapting physical properties of the ski.

[0076] A further advantage of the present invention is that it allows a single ski to be used for a variety of environmental conditions by varying the stiffness of the ski.

[0077] A yet further advantage of the present invention is that it provides a simple pump for semi-active damping control through use of a fluid filled flexed hose.

[0078] It will be appreciated by those skilled in the art that various modifications may be made to the invention hereindescribed without departing from the scope thereof. For example, while the embodiment shown is a ski, any object subjected to vibration over a wide bandwidth could be fitted with the vibration control system of the present invention. Additionally, the number of damping bars and shear-mode interfaces could be varied on an object.

1-39. (canceled)

40. A vibration control system, the system comprising a mounting surface upon which is located a flexible hose, the hose having a first cross-sectional area filled with a rheological fluid and ends abutted to the surface.

41. A vibration control system as claimed in claim 40, wherein the rheological fluid is an electrorheological fluid which undergoes a change in viscosity proportional to a change in electric field.

42. A vibration control system as claimed in claim 40, wherein the rheological fluid is a magnetorheological fluid which undergoes a change in viscosity proportional to a change in applied magnetic field.

43. A vibration control system as claimed in claim 40, wherein a plurality of hoses are located on the surface.

44. A vibration control system as claimed in claim 43, wherein the hoses are located symmetrically on the surface.

45. An adaptive vibration control system, the system comprising sensing means to determine one or more environmental characteristics, a signal processor to determine a controlling response to the characteristics and vibration control means responsive to the controlling response to counter vibration.

46. An adaptive vibration control system as claimed in claim 45, wherein the vibration control means comprises a structure including a chamber and a means for creating a

variable applied field within the chamber, wherein the chamber is substantially filled with a rheological fluid which under the influence of the applied field causes a variation in the stiffness of the structure.

47. An adaptive vibration control system as claimed in claim 45, wherein the vibration control means comprises a mounting surface upon which is located a flexible hose, the hose having a first cross-sectional area filled with a rheological fluid and ends abutted to the surface.

48. An adaptive vibration control system as claimed in claim 45, wherein the sensing means is at least one sensor.

49. An adaptive vibration control system as claimed in claim 45, wherein the sensing means is a multi-sensor array.

50. An adaptive vibration control system as claimed in claim 45, wherein the multi-sensor array is a distributed array of PVDF piezo-sensors.

51. An adaptive vibration control system as claimed in claim 45, wherein the adaptive vibration control system includes a power supply located adjacent the system, the power supply including a piezo material such that movement of the material creates an electric signal.

52. A ski, the ski including a vibration control system, the system comprising sensing means to determine one or more environmental characteristics, a signal processor to determine a controlling response to the characteristics and vibration control means responsive to the controlling response to counter vibration.

53. A ski as claimed in claim 52, wherein the vibration control means comprises a structure including a chamber and a means for creating a variable applied field within the chamber, wherein the chamber is substantially filled with a rheological fluid which under the influence of the applied field causes a variation in the stiffness of the ski.

54. A ski as claimed in claim 52, wherein the vibration control means comprises a mounting surface upon which is located a flexible hose, the hose having a first cross-sectional area filled with a rheological fluid and ends abutted to the surface.

55. A ski as claimed in claim 52, wherein the vibration control system comprises vibration control means comprising a structure including a chamber and a means for creating a variable applied field within the chamber, wherein the chamber is substantially filled with a rheological fluid which under the influence of the applied field causes a variation in the stiffness of the ski, and vibration control means comprising a mounting surface upon which is located a flexible hose, the hose having a first cross-sectional area filled with a rheological fluid and ends abutted to the surface to vary damping of the ski.

56. A ski as claimed in claim 52, wherein the sensing means is a multi-sensor array being a distributed array of PVDF piezo-sensors.

57. A ski as claimed in claim 52, wherein the sensing means is sensor arrays positioned at modal points on the ski.

58. A ski as claimed in claim 52, wherein the vibration control means are located at modal points on the ski.

59. A ski as claimed in claim 52, further comprising a power supply comprising a layered piezo-ceramic, and wherein power generation comes from a skier's movement over the ski acting on the piezo-ceramic.

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