[0016] **FIG. 5***d* is a block diagram illustrating the interface between the user manipulable device and a computer according to an embodiment of the present invention;

[0017] **FIG. 6** is a sectional view of a tactile force feedback mechanism according to another embodiment of the present invention;

[0018] **FIG. 7** is a sectional view of a tactile force feedback mechanism according to another embodiment of the present invention;

[0019] **FIG. 8** is a sectional view of a tactile force feedback mechanism according to another embodiment of the present invention; and

[0020] **FIG. 9** is a sectional view of a tactile force feedback mechanism according to another embodiment of the present invention.

DESCRIPTION OF THE SPECIFIC EMBODIMENTS

[0021] FIGS. **1-5** show a mouse device **10** which includes a tactile force feedback (FFB) mechanism. It is understood that the present FFB mechanism may be implemented in other input devices, pointing devices, user manipulable devices, user interface devices, and the like. In the embodiments shown, the FFB mechanism produces a single axis tactile force feedback oriented generally perpendicular to the operating plane of the device. Of course, the mechanism may be modified to produce different feedback configurations without departing from the scope of the invention.

[0022] The FFB mechanism causes an inertial member **12** to move and produce tactile FFB. The inertial member **12** shown is an arm having one end attached to the upper case **16** of the mouse device **10**, for instance, by a fastener **14** as shown in **FIG. 5**. A key button plate **17** is also attached to the upper case **16**. Near the free end of the arm **12** is an actuatable member **18** and a contact member **20**, as best seen in FIGS. **1-4**. In a specific embodiment, the actuatable member is a permanent magnet **18**. The arm **12** is preferably flexible to permit the free end to move in flexion. The contact member **20** desirably is a resilient, deformable member which may include an elastomer material or the like. In a specific embodiment, the contact member **20** is an elastomeric O-ring, as shown in **FIG. 5**. The free end of the arm **12** is disposed in a structure which restricts its movement within a specific range. As shown in **FIG. 2**, the contact member **20** is movable between an upper limit or top side **22** and a lower limit or bottom side **24** in a structure connected to or formed integrally with the upper case **16**. The arm **12** is in a default or undeformed position in **FIG. 2** with the contact member **20** spaced between the upper limit **22** and lower limit **24**. **FIG. 3** shows the contact member **20** at the upper limit **22**, and **FIG. 4** shows the contact member **20** at the lower limit **24**.

[0023] The actuatable member **18** is actuated to produce movement of the arm **12**. In the specific embodiment shown, the permanent magnet **18** is caused to move up and down by attraction and repulsion generated by an electromagnet **30**. The electromagnet **30** typically includes a coil surrounding a metallic core. In a specific embodiment, the metallic core is circular cylindrical. The electromagnet **30** is desirably supported in a housing **32** which is fixed on the lower case **36** of the mouse device **10**. The electromagnet **30** is stationary on the device **10**, and the FFB is produced by movement of the inertial arm **12** as driven by the movable magnet **18**. It produces a magnetic field that may be fluctuated in both intensity and frequency to manipulate the permanent magnet **18**, for instance, in response to inputs from a host computer and in synchronization with the graphical interface. The position and frequency of the arm **12** as set in motion by the interaction between the electromagnet **30** and the permanent magnet **18** may cause the contact member **20** to strike only the top side **22**, only the bottom side **24**, both the top and bottom sides **22**, **24**, or neither. The striking of the device case by the contact member **20** imparts a tactile FFB felt by the user. In the case of no contact between the contact member **20** and the top and bottom sides of the device case, the mechanism creates a vibration within the device **10** without direct contact. This vibration is transferred through the inertial arm **12** to the point of attachment to the upper case **16** at the fixed end. The contactless vibration produces a different tactile FFB to the user from that generated by striking the device case.

[0024] The use of elastomeric material for the contact member **20** in striking the top side **22** and/or bottom side **24** may produce a more desirable (e.g., quieter and softer) tactile FFB than that produced by contact between a hard contact member and hard sides. In another embodiment as shown in **FIG. 5***a*, the contact member **20** includes an upper elastomer **20***a* and a lower elastomer **20***b* of different durometer to produce different FFB sensations. The upper elastomer **20***a* may impact the top side **22** imparting a sharper feel due to a higher durometer material, and the lower elastomer **20***b* may produce a softer and quieter impact to the bottom side **24** with a lower durometer material, or vice versa. The use of different materials creates a larger variety of tactile experiences to the user to support and simulate different graphical interfaces. In another embodiment shown in **FIG. 5***b*, the contact member **20**' may be made of a hard material, and is configured to strike an elastomeric top side **22**' and/or an elastomeric bottom side **24**'.

[0025] The configuration of the tactile FFB mechanism of FIGS. **1-5** is simple in structure and fits easily into the mouse device **10**. In an alternative embodiment as shown in **FIG. 5***c*, the arm **12** may be integrally formed with the key button plate **17** to form a unitary piece, for instance, by molding.

[0026] **FIG. 5***d* shows a block diagram illustrating the interface of the user manipulable device **10** and a computer **100** having a display **102**. The computer **100** typically is configured to accept an interface board **110** which includes the modules for electronically interfacing with the user manipulable device **10**. The interface board **110** may reside in an I/O slot of the computer **100**. The interface board **110** includes a microprocessor **112** which communicates with the computer **100**. The microprocessor **112** accesses force profile information from data storage **114** which is provided as a function of the coordinate position on the display **102**. The force profile information specifies the force to be applied by or to the force device of the user manipulable device **10**. The force typically is a function of the position of the cursor on the screen display **102** and a function of the particular screen display on which the cursor is being manipulated. For example, the force profile information may relate to the tactile responsiveness of the device **10** to the graphical user interface or screen display of the application. Based on the force profile information and the measured position of the