[0021] One of the plurality of unit force patterns is like a horizontal straight line that force does not change from a predetermined value to provide a fixed force feel sensation.

[0022] Simply by selecting a horizontal linear unit force pattern that force does not change from a predetermined value with this constitution, a fixed force feel sensation can be easily obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] **FIG. 1** is a partial sectional view of an embodiment of the force feedback device of the present invention;

[0024] **FIG. 2** is a block diagram of the embodiment of the force feedback device of the present invention;

[0025] **FIGS. 3A** to **3**F are graphs of composite force patterns used in the embodiment of the force feedback device of the present invention;

[0026] **FIGS. 4A** to **4**D are graphs of unit force patterns used in the embodiment of the force feedback device of the present invention;

[0027] **FIGS. 5A** to **5**F are diagrams showing the line-ups of unit force patterns in the embodiment of the force feedback device of the present invention;

[0028] **FIG. 6** is a block diagram of a force feedback device of the prior art; and

[0029] **FIGS. 7A** to **7**C are graphs of generated forces of force patterns of the force feedback device of the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] A preferred embodiment of the force feedback device of the present invention will be described with reference to FIGS. **1** to **5**. **FIG. 1** is a partial sectional view of an embodiment of the force feedback device of the present invention, **FIG. 2** is a block diagram of the embodiment of the force feedback device of the present invention, **FIGS. 3A** to **3**F are graphs of composite force patterns used in the embodiment of the force feedback device of the present invention, **FIGS. 4A** to **4**D are graphs of unit force patterns used in the embodiment of the force feedback device of the present invention, and **FIGS. 5A** to **5**F are diagrams showing the line-ups of unit force patterns in the embodiment of the force feedback device of the present invention.

[0031] A base **1** is made from an insulating resin and annular with a hole **1***a* in the center.

[0032] A printed circuit board **2** is placed on the under surface of the base **1** to mount electric parts (not shown) constituting a control unit **12** required for the force feedback device.

[0033] An actuator **3** is an electromagnetic coil prepared by winding a coil round an iron core in a ring form, has a round hole **3***a* in the center and is mounted on the base **1**.

[0034] A driver **4** is made from an insulating resin and made up of a shaft portion **4***a*, a disk portion **4***b* and a ring portion **4***c*. The ring portion **4***c* projects upward from the periphery of the disk portion **4***b*, and the shaft portion **4***a* is formed perpendicularly to the disk portion **4***b* at the center of the disk portion **4***b*. The shaft portion **4***a* is rotatably fitted in the round hole **3***a* of the actuator **3**.

[0035] An armature **5** has an iron plate and is shaped like a disk having a round hole **5***a* in the center. One side of the armature **5** is mounted on the under surface of the disk portion **4***b* of the driver **4** through an armature return spring **6**. The other side of the armature **5** is opposed to the top surface of the actuator **3** through a space.

[0036] An engagement member **7** is made from an insulating resin, made up of a ring side wall **7***a* and a bottom plate **7***b* and is shaped like a vessel having an opening as the ring side wall **7***a* projects from the periphery of the disk-like bottom plate **7***b*. The side wall **7***a* of the engagement member **7** mates with the ring portion **4***c* of the driver **4** such that it surrounds the ring portion **4***c*, whereby the engagement member **7** and the driver **4** are connected to each other.

[0037] An operation shaft **8** is made from metal and fixed in the center of the bottom plate **7***b* of the engagement member **7** vertically. The operation shaft **8** has a large-diameter portion **8***a*.

[0038] A position sensor **9** is a rotary encoder for detecting rotation angle positions, has a cylindrical form and includes a rotor and a stator (not shown). The rotor is fixed to the operation shaft **8** and the stator is provided with a projection **9***a*.

[0039] A knob **10** as an operation unit is made from an insulating resin and has a cylindrical form and a shaft hole (not shown) in the center. The upper end of the operation shaft **8** is fitted in the shaft hole of the knob **10**.

[0040] A panel board **11** is made of a metal plate and has a coated surface and a hole **11***a*. The operation shaft **8** is inserted into the hole **11***a* of the panel board **11**, and the large-diameter portion **8***a* of the operation shaft **8** is in contact with the top surface of the panel board **11**. The projection **9***a* of the stator of the position sensor **9** is fitted in the unshown hole of the panel board **11** to fix the stator of the position sensor **9** to the panel board **11**. The position sensor **9** is sandwiched between the panel board **11** and the engagement member **7** in the axial direction of the operation shaft **8**.

[0041] A description is subsequently given of the operation of the force feedback device of the embodiment of the present invention.

[0042] When the operation shaft **8** is turned by rotating the knob **10**, the driver **4** is turned by the engagement member **7**. At this point, the operation shaft **8** turns the rotor of the position sensor **9** and supplies a signal indicative of the rotation angle of the rotor to the control unit **12** mounted on the printed circuit board **2**. The control unit **12** picks out different unit force patterns from the unit force patterns (unit **1**, unit **2**, unit **3**, . . .) stored in a first memory (ROM) **12***a*, selects the specified line-up pattern from the line-up patterns (pattern **1**, pattern **2**, pattern **3**, . . .) of the unit force patterns from a second memory (ROM) **12***b*, lines up the unit force patterns on the selected line-up pattern to form a composite force pattern and supplies it to the controller **12***c* of the control unit **12**.

[0043] The controller **12***c* gives an instruction to send a current corresponding to the composite force pattern to the actuator **3**. The actuator **3** which receives the current sucks