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(54) **TACTILE FEEDBACK MAN-MACHINE INTERFACE DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

(63) Continuation of application No. 09/561,782, filed on May 1, 2000, now Pat. No. 6,275,213, which is a continuation of application No. 09/066,608, filed on Apr. 24, 1998, now Pat. No. 6,088,017, which is a continuation of application No. 08/565,102, filed on Nov. 30, 1995, now abandoned.

(51) **Int. Cl.**[7] **G09G 5/00**
(52) **U.S. Cl.** **345/156**; 345/702; 414/5
(58) **Field of Search** 345/156, 158, 345/157, 700, 701, 702, 703; 414/1–7; 901/32–34

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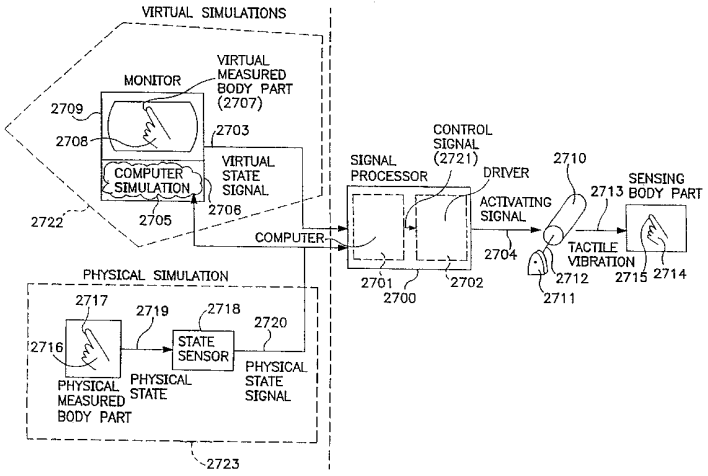
(57) **ABSTRACT**

A man-machine interface which provides tactile feedback to various sensing body parts is disclosed. The device employs one or more vibrotactile units, where each unit comprises a mass and a mass-moving actuator. As the mass is accelerated by the mass-moving actuator, the entire vibrotactile unit vibrates. Thus, the vibrotactile unit transmits a vibratory stimulus to the sensing body part to which it is affixed. The vibrotactile unit may be used in conjunction with a spatial placement sensing device which measures the spatial placement of a measured body part. A computing device uses the spatial placement of the measured body part to determine the desired vibratory stimulus to be provided by the vibrotactile unit. In this manner, the computing device may control the level of vibratory feedback perceived by the corresponding sensing body part in response to the motion of the measured body part. The sensing body part and the measured body part may be separate or the same body part.

18 Claims, 20 Drawing Sheets



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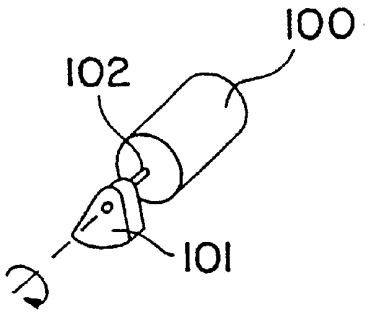

FIG. 1A

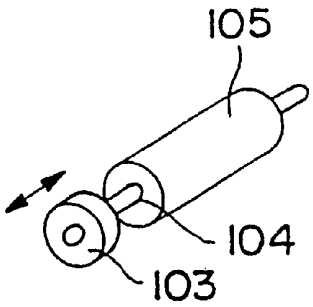

FIG. 1B

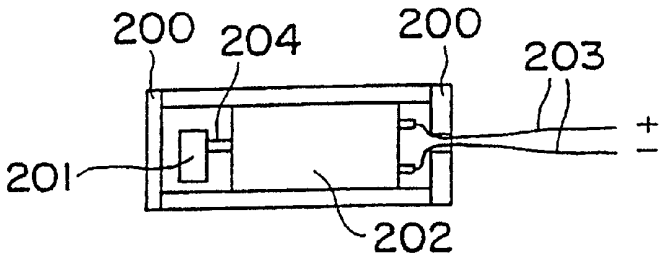

FIG. 2A

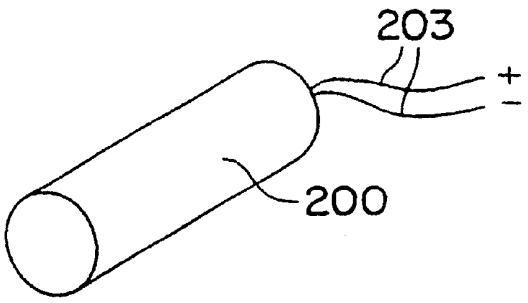

FIG. 2B

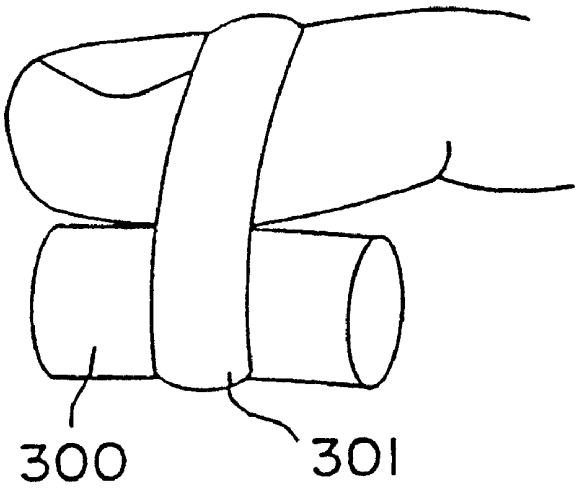

FIG. 3

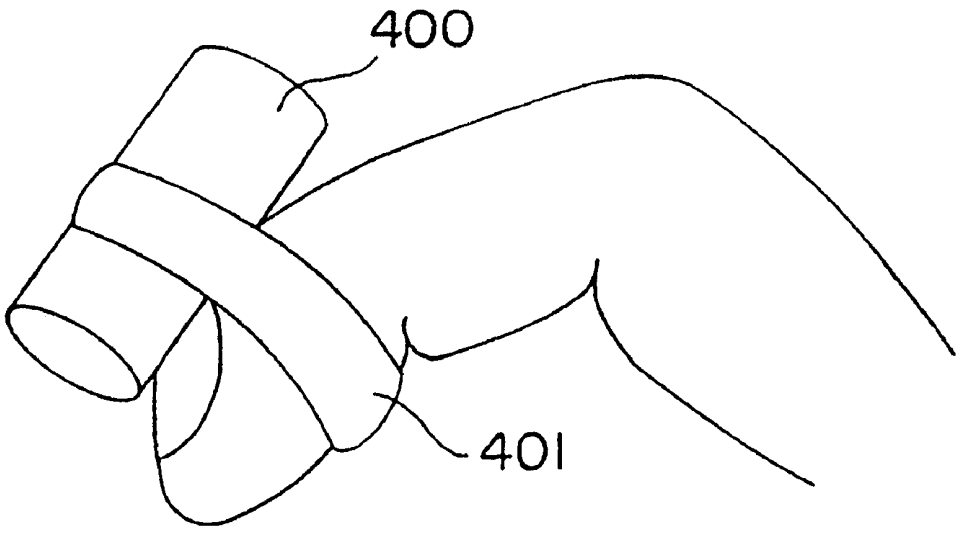

FIG. 4

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