pinned magnetic layer, the nonmagnetic electrically conductive layer, and the free magnetic layer in that order from below, the antiferromagnetic layer laterally extends from the layers laminated thereon, and a pair of hard bias layer, a pair of intermediate layers, and a pair of electrode layers are respectively laminated on a pair of metallic layers respectively deposited on the antiferromagnetic layers in the laterally extending regions thereof.

[0081] According to a seventh aspect of the present invention, a magnetoresistive-effect device includes a multilayer film including a free magnetic layer, nonmagnetic electrically conductive layers respectively lying over and under the free magnetic layer, pinned magnetic layers respectively lying over the one nonmagnetic electrically conductive layer and under the other nonmagnetic electrically conductive layer, each having a pinned magnetization direction, and antiferromagnetic layers respectively lying over the one pinned magnetic layer and under the other pinned magnetic layer, and a pair of hard bias layers, deposited on both sides of the multilayer film, for orienting the magnetization direction of the free magnetic layer perpendicular to the magnetization direction of the pinned magnetic layer, and a pair of electrode layers respectively deposited on the hard bias layers, wherein an intermediate layer, made of at least one of a high-resistivity material having a resistance higher than that of the electrode layer and an insulating material, is interposed between each of the hard bias layers and each of the electrode layers and the electrode layers extend over the multilayer film.

[0082] The antiferromagnetic layer is preferably made of a PtMn alloy. Alternatively the antiferromagnetic layer may be made of an X—Mn alloy where X is a material selected from the group consisting of Pd, Ir, Rh, Ru, and alloys thereof, or may be made of a Pt—Mn—X' alloy where X' is a material selected from the group consisting of Pd, Ir, Rh, Ru, Au, Ag, and alloys thereof.

[0083] According to an eighth aspect of the present invention, a magnetoresistive-effect device includes a multilayer film including a magnetoresistive-effect layer, a soft magnetic layer, and a nonmagnetic layer with the magnetoresistive-effect layer and the soft magnetic layer laminated with the nonmagnetic layer interposed therebetween, a pair of hard bias layers deposited on both sides of the multilayer film, and a pair of electrode layers respectively deposited on the hard bias layers, wherein an intermediate layer, made of at least one of a high-resistivity material having a resistance higher than that of the electrode layer and an insulating material, is interposed between each of the hard bias layers and each of the electrode layers and the electrode layers extend over the multilayer film.

[0084] The high-resistivity material, which fabricates the intermediate layer interposed between the hard bias layer and the electrode layer, is preferably at least one material selected from the group consisting of $TaSiO_2$, TaSi, $CrSiO_2$, CrSi, WSi, $WSiO_2$, TiN, and TaN.

[0085] Alternatively, the high-resistivity material, which fabricates the intermediate layer interposed between the hard bias layer and the electrode layer, is preferably at least one material selected from the group consisting of $Al_2O_3$, $SiO_2$, $Ti_2O_3$, TiO, WO, AlN, $Si_3N_4$, $B_4C$, SiC, and SiAlON.

[0086] The multilayer film preferably includes a central sensitive region which provides an excellent reproduction gain, exhibiting a substantial magnetoresistive effect and insensitive regions which are formed on both sides of the sensitive region, and provide a poor reproduction gain, exhibiting no substantial magnetoresistive effect, wherein the electrode layers deposited on both sides of the multilayer film extend over the insensitive regions of the multilayer film.

[0087] The sensitive region of the multilayer film is defined as a region which results in an output equal to or greater than 50% of a maximum reproduction output while the insensitive regions of the multilayer film are defined as regions, formed on both sides of the sensitive region, which result in an output smaller than 50% of the maximum reproduction output, when the magnetoresistive-effect device having the electrode layers on both sides only of the multilayer film scans a micro track, having a signal recorded thereon, in the direction of a track width.

[0088] The width dimension of the sensitive region of the multilayer film is preferably equal to an optical track width O-Tw.

[0089] It is another object of the present invention to provide a magnetoresistive-effect device which restricts a sense current from shunting to a hard bias layer while assuring sufficient insulation in an upper gap layer. To achieve this object, the present invention employs an intermediate layer, made of a high-resistivity material having a resistance higher than that of the electrode layer or an insulating material, interposed between each of the hard bias layers and each of the electrode layers, and the electrode layers extend over the multilayer film.

[0090] The intermediate layer of an insulator material interposed between the hard bias layer and the electrode layer reduces a sense current shunting into the hard bias layer (i.e., a current loss). With the electrode layer extending over the multilayer film, the electrode layer is connected to the multilayer film on the top surface thereof, thereby permitting the sense current to directly flow from the electrode layer to the multilayer film.

[0091] In accordance with the first through third aspects of the present invention, the electrode layer **210** overlaps the multilayer film **209**, but no intermediate layer is interposed between the electrode layer **210** and the hard bias layer **205**. To allow the sense current to effectively flow from the electrode layer **210** to the multilayer film **209**, the thickness hi of the electrode layer **210** relative to the multilayer film **209** must be increased to reduce the direct current resistance of the electrode layer **210** and to restrict the sense current from shunting to the hard bias layer **205**. In this case, a sharp step develops between the top surface of the electrode layer **210** and the top surface of the multilayer film **209**. When an upper gap layer **211** of an insulator material covers the electrode layer **210** and the multilayer film **209**, the upper gap layer **211** suffers a poor step coverage, and a film discontinuity occurs at the step. As a result, the upper gap layer **211** fails to provide sufficient insulation.

[0092] In accordance with the sixth through eighth aspects of the present invention, the intermediate layer of an insulator material is interposed between the hard bias layer and the electrode layer. The sense current is less likely to shunt from the electrode layer to the hard bias layer regardless of the thickness of the electrode layer. In contrast to the