each of the free magnetic layers, permitting the width dimension T45 of the sensitive region E to be enlarged.

[0314] As shown in FIG. 11, the protective layer 15 is deposited where the multilayer film 201 has no electrode layers 91 and 91 formed thereon. The electrode layers 91 and 91 are connected to the second free magnetic layer 87 with no protective layer 15 interposed therebetween.

[0315] This arrangement presents a smaller electrical resistance than the arrangement in which the electrode layers 91 and 91 are deposited on the protective layer 15, improving the characteristics of the magnetoresistive-effect device.

[0316] A multilayer film 202 of a spin-valve type thin-film device of a twelfth embodiment of the present invention shown in FIG. 12 has the inverted version of the multilayer film 201 of the spin-valve type thin-film device shown in FIG. 11. Specifically, referring to FIG. 12, a second free magnetic layer 87, a nonmagnetic material layer 86, a first free magnetic layer 85, a nonmagnetic electrically conductive layer 84, a second pinned magnetic layer 83, a nonmagnetic material layer 82, a first pinned magnetic layer 81, an antiferromagnetic layer 80, and a protective layer 15 are successively laminated on a substrate 10.

[0317] Referring to FIG. 12, the hard bias layers 89 and 89 are magnetically coupled with neither of the first pinned magnetic layer 81 and the second pinned magnetic layer 83. This arrangement prevents the magnetization directions of the first pinned magnetic layer 81 and the second pinned magnetic layer 83 aligned in a direction parallel to the Y direction, from varying under the magnetic field applied by the hard bias layers 89 and 89. The characteristics of the magnetoresistive-effect device are thus improved.

[0318] Referring to FIG. 12, the first pinned magnetic layer 81 and the second pinned magnetic layer 83, having different magnetic moments, are laminated to each other with the nonmagnetic material layer 82 interposed therebetween, and function as a single pinned magnetic layer P. Referring to FIG. 12, the first pinned magnetic layer 81 and the second pinned magnetic layer 83 are manufactured of the same material with thicknesses thereof made different so that the two layers have different magnetic moments.

[0319] As shown in FIG. 12, the first pinned magnetic layer 81 is deposited on and in contact with the antiferromagnetic layer 80, and is subjected to annealing in the presence of a magnetic field. An exchange anisotropic magnetic field takes place through exchange coupling at the interface between the first pinned magnetic layer 81 and the antiferromagnetic layer 80. The magnetization direction of the first pinned magnetic layer 81 is thus pinned in the Y direction. When the magnetization direction of the first pinned magnetic layer 81 is pinned in the Y direction, the magnetization direction of the second pinned magnetic layer 83, separated from the first pinned magnetic layer 81 by the intervening nonmagnetic material layer 82, is pinned to be antiparallel to the magnetization direction of the first pinned magnetic layer 81. The direction of the sum of the magnetic moments of the first and second free magnetic layers 81 and 83 becomes the magnetization of the pinned magnetic layer P.

[0320] The first free magnetic layer 85 and the second free magnetic layer 87, having different magnetic moments, are laminated with the nonmagnetic material layer 86 interposed therebetween, and function as a single free magnetic layer F.

[0321] The first free magnetic layer 85 and the second free magnetic layer 87 are manufactured of the same material with thicknesses thereof made different so that the two layers have different magnetic moments.

[0322] In the spin-valve type thin-film device shown in FIG. 12, again, the first free magnetic layer 85 and the second free magnetic layer 87, which are in a ferrimagnetic state with magnetization directions thereof being antiparallel, namely different from each other by 180 degrees, achieve the same effect, which can be provided by the use of a thin free magnetic layer F. This arrangement reduces the saturation magnetization of the entire free magnetic layer F, causing the magnetization of the free magnetic layer F to easily vary, and thereby improving the magnetic field detection sensitivity of the magnetoresistive-effect device.

[0323] The direction of the sum of the magnetic moments of the first free magnetic layer 85 and the second free magnetic layer 87 becomes the magnetization direction of the free magnetic layer F.

[0324] The hard bias layers 89 and 89 are magnetized in the X direction (i.e., the direction of the track width), and the magnetization direction of the free magnetic layer F is aligned in the X direction under the bias magnetic field in the X direction given by the hard bias layers 89 and 89.

[0325] The two end portions of the free magnetic layer F, having disturbed magnetization directions, present a poor reproduction gain, and become insensitive regions unable to exhibit no substantial magnetoresistive effect.

[0326] In twelfth embodiment again, the sensitive region E and the insensitive regions D and D of the multilayer film 202 are measured using the micro track profile method. Referring to FIG. 12, the portion, having the width dimension T48, of the multilayer film 202 is the sensitive region E, and the portions, each having the width dimension T49, are the insensitive regions D and D.

[0327] In the sensitive region E, the magnetization direction of the pinned magnetic layer P is pinned correctly in a direction parallel to the Y direction, and the magnetization direction of the free magnetic layer F is correctly aligned in the X direction. The pinned magnetic layer P and the free magnetic layer F are thus perpendicular in magnetization direction. The magnetization of the free magnetic layer F varies sensitively in response to an external magnetic field from the recording medium. An electrical resistance varies in accordance with the relationship between the variation in the magnetization direction of the free magnetic layer F and the pinned magnetic field of the pinned magnetic layer P. A leakage magnetic field from the recording medium is thus detected in response to a variation in voltage due to the electrical resistance variation. However, those which directly contribute to the variation in the electrical resistance (i.e., the reproduction output) are a relative angle made between the magnetization direction of the second pinned magnetic layer 83 and the magnetization direction of the first free magnetic layer 85. These magnetization directions are preferably perpendicular with a sense current conducted in the absence of a signal magnetic field.

[0328] The electrode layers 91 and 91 formed on both sides of the multilayer film 202 extend over the multilayer