SIGNAL REPRODUCING APPARATUS FOR USE IN OPTICAL DISC PLAYERS

This invention relates to signal reproducing apparatus for use in optical disc players.

In an optical disc player for reproducing an information signal recorded on an optical record disc, an optical head device is provided to read the information signal from a spiral track or concentric circular record tracks formed on the optical record disc. An example of such an optical head device is arranged as shown schematically in Figure 1 of the accompanying drawings.

The optical head device shown in Figure 1 is formed into an optical unit 10 which contains a semiconductor laser element 1, an objective lens 6, a photodetector 8 and other optical parts, and is movable in a direction of the radius of an optical record disc D on which, for example, a spiral record track is formed, as indicated by an arrow A. In the optical unit 10, a laser light beam generated by the laser element 1 is diffracted by a diffraction grating 2 to be divided into three beams, which for simplicity are represented with a single solid line in Figure 1, and each of the three laser light beams is directed to a polarising beam splitter 3 to pass through an analyzer plane 3a therein, and then enters a collimator lens 4. The laser light beam collimated by the collimator lens 4 passes through a quarter-wave plate 5 and enters the objective lens 6 to be focused thereby to impinge upon the disc D. The three laser light beams are so aligned to form a centre beam for reading an information signal from the spiral record track and for detecting a focusing condition of each beam on the disc D, and two side beams positioned on respective sides of the centre beam to be used for detecting a tracking condition of the centre beam in relation to the spiral record track on the disc D. At the spiral record track on the disc D, the three laser light beams are modulated in intensity and then reflected to form three reflected laser light beams.

The three reflected laser light beams from the disc D return through the objective lens 6 to pass through the quarter-wave plate 5. Each of the three reflected laser light beams having passed through the quarter-wave plate 5 has its plane of polarization rotated by ninety degrees in comparison with the respective laser light beam

incident upon the disc D.

The three reflected laser light beams having passed through the quarter-wave plate 5 pass through the collimator lens 4 into the beam splitter 3, and are reflected at the analyzer plane 3a to be guided through a light receiving lens 7 to the photodetector 8. Detection output signals obtained based on the centre beam and the two side beams respectively are derived separately from the photodetector 8.

As shown in Figure 2 of the accompanying drawings, a detecting portion 8A of the photodetector 8 provided for detecting the centre beam is composed of four photodetecting elements 8a, 8b, 8c and 8d, and a reproduced information signal and a focus error signal are obtained based on respective output signals of the four photodetecting elements 8a to 8d. The photodetecting elements 8a to 8d are disposed close to one another, and are so arranged that the photodetecting elements 8a and 8b are aligned substantially at a right angle to a direction corresponding to the tangential direction of the spiral record track on a plane in which the detecting portion 8A is disposed, and the photodetecting elements 8d and 8c are also aligned at substantially a right angle to the direction corresponding to the tangential direction of the spiral record track on the plane in which the detecting portion 8A is disposed. The centre beam reaching the detecting portion 8A forms a beam spot P on the photodetecting elements 8a to 8d thus arranged, and the photodetecting elements 8a to 8d produce respective output signals Sa, Sb, Sc and Sd each corresponding to a portion of the beam spot P formed on each of the photodetecting elements 8a to 8d.

For producing the reproduced information signal, the output signals Sa, Sb, Sc and Sd are summed by an adder 9 to produce an added signal Se as shown in Figure 2, and the added signal Se is used as the reproduced information signal, in the same manner as disclosed in, for example, United States patent specification US-A-4 079 247.

The information signal is usually recorded in the form of small pits arranged in the spiral record track on the optical record track, and therefore the centre beam is subjected to diffraction caused in response to each of the pits by a movement of the spiral record track relative to the centre beam irradiating the spiral record track resulted from the rotation of the disc D. Accordingly, in the beam

spot P formed on the photodetecting elements 8a to 8d by the centre beam, a diffraction pattern corresponding to each pit in the spiral record track moves, for example, in a direction T in Figure 2, that is, a direction from the photodetecting element 8a to the photodetecting element 8d or from the photodetecting element 8b to the photodetecting element 8c, at a speed corresponding to a moving speed of the spiral record track, and each of the output signals Sa to Sd varies in accordance with variations in the diffraction pattern moving in the beam spot P. As a result, phase differences arise between the output signal Sa of the photodetecting element 8a and the output signal Sd of the photodetecting element 8d, and between the output signal Sb of the photodetecting element 8b and the output signal Sc of the photodetecting element 8c, respectively, in response to the movement of the diffraction pattern in the beam spot P. The amount of each phase difference is determined by various factors including the moving speed of the spiral record track relative to the centre beam irradiating the spiral record track, the size of the detecting portion 8A, the size of the beam spot P formed on the detecting portion 8A and so on. Consequently, in the case where such phase differences are not negligible, there is a problem that a proper reproduced information signal cannot be obtained by merely adding the output signals Sa to Sd of the photodetecting elements 8a to 8d, respectively.

For the purpose of eliminating this problem, there has been proposed an improved signal processing circuit for producing a reproduced information signal based on the output signals Sa to Sd of the photodetecting elements 8a to 8d, as shown in Figure 3 of the accompanying drawings.

In the signal processing circuit shown in Figure 3, the output signals Sa and Sb derived from the photodetecting elements 8a and 8b, respectively, are added to each other in an adder 11 to produce an added signal Sa + Sb which is supplied to a phase shifter 13 operative to cause the added signal Sa + Sb to have a phase lag corresponding to the phase difference between the output signals Sa and Sd derived respectively from the photodetecting elements 8a and 8d, or between the output signals Sb and Sc derived respectively from the photodetecting elements 8b and 8c. The output signals Sc and Sd derived respectively from the photodetecting elements 8c and 8d are

added to each other in an adder 12 to produce an added signal Sc + Sd. Then, the added signal Sa + Sb subjected to the phase lag by the phase shifter 13 and the added signal Sc + Sd obtained from the adder 12 are added in an adder 14 to produce a reproduced information signal Si. This circuit arrangement results in the reproduced information signal Si being obtained by adding the output signals Sa to Sd, after each of the phase differences between the output signals Sa and Sd and between the output signals Sb and Sc has been eliminated, so that waveform distortion of the reproduced information signal Si is reduced and the signal to noise ratio of the reproduced information signal Si is improved.

When an optical disc player employing the optical unit 10 shown in Figure 1 and a signal processing circuit connected to the optical unit 10 is used for reproducing information signals from a double-faced optical record disc D' which has respective spiral record tracks on each side, as shown in Figure 4 of the accompanying drawings, the optical unit 10 is disposed to face the disc D' loaded rotatably on a disc driving table 15 and, for example, first an information signal recorded on a surface Da is reproduced and then another information signal recorded on a surface Db is reproduced. After reproduction of the information signal recorded on the surface Da has been completed, the optical unit 10 which has faced the surface Da is moved through a path detouring around the disc D' to face the surface Db for the reproduction of the information signal recorded on the surface Db, as shown in Figure 5 of the accompanying drawings.

In such a case, the disc D' is kept continuously on the disc driving table 15 during both reproductions, but the direction of rotation of the disc D' is changed to reverse between the reproductions. Therefore, the direction of movement of the spiral record track on the side of the surface Da in relation to the centre beam from the optical unit 10 incident upon the surface Da, and the direction of movement of the spiral record track on the side of the surface Db in relation to the centre beam from the optical unit 10 incident upon the surface Db, are opposite to each other. This results in each of the phase differences between the output signal Sa of the photodetecting element 8a and the output signal Sd of the photodetecting element 8d, and between the output signal Sb of the

photodetecting element 8b and the output signal Sc of the photodetecting element 8c, which arise in the signal processing circuit, being inverted between the reproductions and consequently the signal processing circuit having the phase shifter 13 and shown in Figure 3 is not available, so that waveform distortion of the reproduced information signal cannot be reduced and the signal to noise ratio of the reproduced information signal cannot be improved.

This problem may also arise in an optical disc player which employs the optical unit 10 shown in Figure 1, and a signal processing circuit connected to the optical unit 10, and constituted to reproduce selectively both information signals from optical record discs of two different types, such as a compatible optical disc player which is operative selectively to reproduce information signals from a video disc which has a diameter of approximately 30 cm and on which a television signal is recorded, and a compact disc which has a diameter of approximately 12 cm and on which a digital audio signal is recorded.

As shown in Figure 6 of the accompanying drawings, in a compatible optical disc player, a first disc driving table 21 on which a video disc VD is loaded and a second disc driving table 22 on which a compact disc CD is loaded are disposed separately and the optical unit 10 is provided between the first and second disc driving tables 21 and 22 to be movable linearly in a direction along an imaginary line passing through the centres of both of the first and second disc driving tables 21 and 22. The laser light beams emitted from the optical unit 10 forming the centre beam and the side beams are caused to impinge on one of the video disc VD and the compact disc CD rotated by the first disc driving table 21 and the second disc driving table 22, respectively, so as to read the information signal recorded on the video disc VD or the compact disc CD.

When the laser light beams from the optical unit 10 trace a spiral record tracks formed on the video disc VD and the compact disc CD, the optical unit 10 moves linearly along an opening 23 provided between the first and second disc driving tables 21 and 22 in a predetermined direction from one to the other of the first and second disc driving tables 21 and 22. The optical unit 10 having such a linear movement between the first and second disc driving tables 21

and 22 moves in the radial direction from the innermost radius to the outmost radius of the video disc VD and in the radial direction from the outermost radius to the innermost radius of the compact disc CD, or vice versa. The video disc VD and the compact disc CD are rotated in the same direction by the first and second disc driving tables 21 and 22, respectively.

Therefore, the direction of movement of the spiral record track on the video disc VD is relation to the centre beam from the optical unit 10 incident upon the video disc VD and the direction of movement of the spiral record track on the compact disc CD in relation to the centre beam from the optical unit 10 incident upon the compact disc CD, are opposite to each other. This results in each of the phase differences between the output signal Sa of the photodetecting element 8a and the output signal Sd of the photodetecting element 8d, and between the output signal Sb of the photodetecting element 8b and the output signal Sc of the photodetecting element 8c, which arise in the signal processing circuit, being inverted between the reproduction of the information signal recorded on the video disc VD and the reproduction of the information signal recorded on the compact disc Cd, and consequently the improved signal processing circuit having the phase shifter 13 and shown in Figure 3 is not available for the compatible optical disc player.

According to the present invention there is provided a signal reproducing apparatus for use in an optical disc player which uses a light beam, incident upon an optical record disc on which an information signal is recorded in a record track, to read the information signal from said disc, the apparatus comprising:

disc driving means for rotating said disc to move the record track on said disc in a predetermined direction;

optical head means including an optical arrangement for causing the light beam to impinge on said disc rotated by said disc driving means and receiving a reflected light beam from said disc, and at least first and second photodetecting elements which are so disposed that a beam spot is formed on said first and second photodetecting elements by the reflected light beam received by the optical arrangement and are aligned along a direction of movement of a diffraction pattern appearing in the beam spot in accordance with the movement of the

record track;

phase shifting means for varying the phase of at least one of first and second output signals obtained respectively based on detection outputs of said first and second photodetecting elements;

switching means for causing said first and second output signals selectively to pass through said phase shifting means in response to the direction of movement of the record track in relation to the light beam incident upon said disc; and

adding means operative to add one of said first and second output signals derived from said phase shifting means to the other of said first and second output signals so as to produce a reproduced information signal.

Thus an embodiment of the present invention may provide a signal reproducing apparatus for use in an optical disc player, operative to rotate an optical record disc on which an information signal is recorded and cause a light beam to impinge upon the optical record disc rotating at a predetermined speed so as to read the information signal from the optical record disc, by which a reproduced information signal with reduced waveform distortion and a superior signal-to-noise ratio can be obtained in both a first situation wherein the optical record disc is rotated clockwise in relation to the light beam incident upon the optical record disc and a second situation wherein the optical record disc is rotated counter-clockwise in relation to the light beam incident upon the optical record disc.

An embodiment of the present invention may provide a signal reproducing system for use in an optical disc player operative to rotate an optical record disc on which an information signal is recorded and cause a light beam to impinge upon the optical record disc rotating at a predetermined speed so as to read the information signal from the optical record disc, by which a reproduced information signal with reduced waveform distortion and a superior signal-to-noise ratio can be obtained when the optical disc player is used for reproducing information signals from a double-faced optical record disc which has respective record tracks on each side.

An embodiment of the present invention may provide a signal reproducing system for use in an optical disc player operative to rotate an optical record disc on which an information signal is

recorded and cause a light beam to impinge upon the optical record disc rotating at a predetermined speed so as to read the information signal from the optical record disc, by which a reproduced information signal with reduced waveform distortion and a superior signal-to-noise ratio can be obtained when the optical disc player is constituted to be a compatible optical disc player which is operative to reproduce selectively information signals from optical record discs of two different types, such as a video disc and a compact disc.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figure 1 is a schematic illustration showing an optical unit employed in an optical disc player;

Figure 2 is a schematic illustration showing a part of a photodetector in the optical unit of Figure 1, and one example of a previously proposed signal processing circuit;

Figure 3 is a schematic illustration shown the part of the photodetector shown in Figure 2, and another example of the previously proposed signal processing circuit;

Figure 4 is a schematic illustration showing a part of an optical disc player used for reproducing information signals from a double-faced optical record disc;

Figure 5 is a schematic illustration used for explaining the operation of the optical disc player used for reproducing information signals from the double-faced optical record disc;

Figure 6 is a schematic plan view showing a part of a compatible optical disc player;

Figure 7 is a schematic illustration showing one embodiment of signal reproducing apparatus for use in an optical disc player and according to the present invention;

Figure 8 is a schematic circuit diagram showing an example of

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phase shifter used in the embodiment of Figure 7;

Figure 9 is a schematic illustration showing a portion of another embodiment of signal reproducing apparatus for use in an optical disc player and according to the present invention; and

Figure 10 is a schematic illustration showing a portion of a further embodiment of signal reproducing apparatus for use in an optical disc player and according to the present invention.

The embodiment of Figure 7 is applied to, for example, an optical disc player in which the optical unit 10 shown in Figure 1 is provided, and three laser light beams comprising a centre beam and two side beams and generated by the optical unit 10 are caused to impinge on an optical record disc which is provided with, for example, a spiral record track formed thereon with an arrangement of small pits, and is rotated at a predetermined speed, so as to be modulated in intensity by the small pits in the spiral record track, and then reflected at the optical record disc to form three reflected laser light beams including a reflected centre beam and two reflected side beams.

The embodiment of Figure 7 includes a photodetector 8 which partially constitutes the optical unit 10 and comprises a detecting portion 8A for detecting the reflected centre beam and a pair of detecting portions 8L and 8R disposed to face each other with the detecting portion 8A between for respectively detecting the reflected side beams. The detecting portion 8A is composed of four photodetecting elements 8a, 8b, 8c and 8d which are disposed close to one another, and are so arranged that the photodetecting elements 8a and 8b are aligned at substantially a right angle to a direction corresponding to the tangential direction of the spiral record track on a plane in which the detecting portion 8A is disposed, and the photodetecting elements 8d and 8c are also aligned at substantially a right angle to the direction corresponding to the tangential direction of the spiral record track on the plane in which the detecting portion 8A is disposed. On the photodetecting elements 8a to 8d thus arranged, the reflected centre beam forms a beam spot P, and the photodetecting elements 8a to 8d produce respective output signals Sa, Sb, Sc and Sd each corresponding to a portion of the beam spot P formed on each of the photodetecting elements 8a to 8d.

The reflected centre beam irradiating the photodetecting elements 8a to 8d has been subjected to diffraction caused in response to each of the pits in the spiral record track which is moved in relation to the centre beam incident upon the optical record disc by the rotation thereof. Accordingly, in the beam spot P formed on the photodetecting elements 8a to 8d by the reflected centre beam, a diffraction pattern corresponding to each pit in the spiral record track moves, for example, in a direction indicated with an arrow F or R in Figure 7, that is, a direction from the photodetecting element 8a to the photodetecting element 8d or from the photodetecting element 8b to the photodetecting element 8c, or a direction from the photodetecting element 8d to the photodetecting element 8a or from the photodetecting element 8c to the photodetecting element 8b, at a speed corresponding to a moving speed of the spiral record track, and each of the output signals Sa to Sd varies in accordance with variations in the diffraction pattern moving in the beam spot P. As a result, phase differences arise between the output signal Sa of the photodetecting element 8a and the output signal Sd of the photodetecting element 8d, and between the output signal Sb of the photodetecting element 8b and the output signal Sc of the photodetecting element 8c, respectively, in response to the movement of the diffraction pattern in the beam spot P.

The output signals Sa and Sb obtained from the photodetecting elements 8a and 8b, respectively, are added to each other in an adder 31 to produce an added signal Sa + Sb, and the output signals Sc and Sd obtained from the photodetecting elements 8c and 8d, respectively, are also added to each other in an adder 32 to produce an added signal Sc + Sd. The added signals Sa + Sb and Sc + Sd are supplied to a switching block 33 which contains first and second switches 33A and 33B for extracting alternatively the added signals Sa + Sb and Sc + Sd. The first and second switches 33A and 33B are linked with each other and operated by a control signal Ss varying in response to a direction of movement of the spiral record track in relation to the centre beam incident upon the optical record disc.

When the direction of movement of the spiral record track in relation to the centre beam incident upon the optical record disc is such that the diffraction pattern corresponding to each pit in the

spiral record track moves in the direction indicated with the arrow F in the beam spot P formed on the photodetecting elements 8a to 8d by the reflected centre beam, the added signal Sa + Sb is picked out by the first switch 33A and the added signal Sc + Sd is picked out by the second switch 33B, and on the contrary, when the direction of movement of the spiral record track in relation to the centre beam incident upon the optical record disc is such that the diffraction pattern corresponding to each pit in the spiral record track moves in the direction indicated with the arrow R in the beam spot P formed on the photodetecting elements 8a to 8d by the reflected centre beam, the added signal Sc + Sd is picked out by the first switch 33A and the added signal Sa + Sb is picked out by the second switch 33B.

The added signal Sa + Sb or Sc + Sd thus picked up by the first switch 33A is supplied directly or through a phase shifter 34 to a switch 35. The phase shifter 34 is operative to cause the added signal Sa + Sb or Sc + Sd to have a phase lag corresponding to the phase difference between the output signals Sa and Sd derived respectively from the photodetecting elements 8a and 8d, or between the output signals Sb and Sc derived respectively from the photodetecting elements 8b and 8c, so that there is no phase difference between the added signal Sa + Sb or Sc + Sd subjected to the phase lag by the phase shifter 34 and the added signal Sc + Sd or Sa + Sb picked up by the second switch 33B.

The switch 35 is operated with a control signal So to extract selectively the added signal Sa + Sb or Sc + Sd picked up by the first switch 33A and the added signal Sa + Sb or Sc + Sd subjected to the phase lag by the phase shifter 34. The control signal So causes the switch 35 to extract the added signal Sa + Sb or Sc + Sd when the phase differences between the output signals Sa and Sd derived respectively from the photodetecting elements 8a and 8d and between the output signals Sb and Sc derived respectively from the photodetecting elements 8b and 8c are substantially negligible, for example, in the case where the optical record disc is of the constant angular velocity (CAV) type and the centre beam is incident upon an area close to the outermost radius of the optical record disc, and further causes the switch 35 to extract the added signal Sa + Sb or Sc + Sd subjected to the phase lag by the phase shifter 34 on other

occasions.

In the case of the optical record disc of the CAV type, a speed of movement of the spiral record track in relation to the centre beam incident upon the optical disc is relatively high in an area close to the innermost radius of the optical record disc, so that each of the phase differences between the output signals Sa and Sd and between the output signals Sb and Sc is relatively large and cannot be neglected, but is relatively low in an area close to the outmost radius of the optical record disc, so that each of the phase differences between the output signals Sa and Sd and between the output signals Sb and Sc is negligibly small. Therefore, by way of example, the control signal St is set to cause the switch 35 to extract the added signal Sa + Sb or Sc + Sd picked out the first switch 33A when the centre beam impinges upon an area including one hundred turns counted from the outermost turn of the spiral record track on the optical record disc.

The added signal Sa + Sb or Sc + Sd picked out the first switch 33A or the added signal Sa + Sb or Sc + Sd subjected to the phase lag by the phase shifter 34 thus extracted by the switch 35 is added to the added signal Sc + Sd or Sa + Sb picked out by the second switch 33B in an adder 37 to produce a reproduced information signal Si'. In this connection, the switch 35 and the added 37 constitute jointly a mixer for producing the reproduced information signal Si'.

With the arrangement described above, the reproduced information signal Si' is obtained from the adder 37 as a signal with reduced waveform distortion and an improved signal-to-noise ratio in both a situation wherein the optical record disc is rotated clockwise in relation to the laser light beams incident upon the optical record disc and another situation wherein the optical record disc is rotated counter-clockwise in relation to the laser light beams incident upon the optical record disc.

Figure 8 shows an example of a phase shift circuit which can be used as the phase shifter 34 of the embodiment of Figure 7. In this example, a signal supplied to an input terminal 50 is subjected to a phase lag in accordance with its frequency by a phase shifting circuit portion comprising a transistor 51, a capacitor 52 connected to a collector of the transistor 51, and a resistor 53 connected to an emitter of the transistor 51, and derived through a capacitor 54 and a

buffer transistor 55 of emitter-follower configuration to an output terminal 56.

Incidentally, in the embodiment of Figure 7, an added signal Sa + Sc resulting from addition of the output signal Sa of the photodetecting element 8a to the output signal Sc of the photodetecting element 8c performed in an adder 40 and an added signal Sb + Sd resulting from addition of the output signal Sb of the photodetecting element 8b to the output signal Sd of the photodetecting element 8d performed in an adder 41 are supplied to a subtractor 42 to produce a focusing error signal Sf which corresponds to the difference between the added signals Sa + Sc and Sb + Sd. Moreover, an output signal Sl of the detecting portion 8L for detecting one of the reflected side beams and an output signal Sr of the detecting portion 8R for detecting the other of the reflected side beams are supplied to a subtractor 43 to produce a tracking error signal St which corresponding to the difference between the output signals Sl and Sr.

Figure 9 shows a part of another embodiment of signal reproducing apparatus according to the present invention.

This embodiment is obtained by modifying the embodiment shown in Figure 7 to employ a pair of phase shifters 45 and 46 and a switching block 47 operating with a control signal Sx in place of the switching block 33, the phase shifter 34 and the switch 35 provided originally in the embodiment of Figure 7. Each of the phase shifters 45 and 46 is equivalent to the phase shifter 34, and the switching block 47 contains first and second switches 47A and 47B.

In the embodiment of Figure 9, the added signal Sa + Sb obtained from the adder 31 is supplied directly and through the phase shifter 45 to the first switch 47A in the switching block 47 and the added signal Sc + Sd obtained from the adder 32 is supplied directly and through the phase shifter 46 to the second switch 47B in the switching block 47. The first and second switches 47A and 47B in the switching block 47 are linked with each other and operated with the control signal Sx. The control signal Sx causes the first and second switches 47A and 47B to extract the added signals Sa + Sb and Sc + Sd, respectively, when the phase differences between the output signals Sa and Sd derived respectively from the photodetecting elements 8a and 8d

and between the output signals Sb and Sc derived respectively from the photodetecting elements 8b and 8c are substantially negligible. In the case where the phase differences between the output signals Sa and Sd and between the output signals Sb and Sc cannot be substantially negligible, the control signal Sx causes the first and second switches 47A and 47B to extract the added signal Sa + Sb subjected to a phase lag by the phase shifter 45 and the added signal Sc + Sd obtained from the adder 32 without passing through the phase shifter 46, respectively, when the direction of movement of the spiral record track in relation to the centre beam incident upon the optical record disc is such that the diffraction pattern corresponding to each pit in the spiral record track moves in the direction indicated by the arrow F in Figure 7 in the beam spot formed on the photodetecting elements 8a to 8d by the reflected centre beam, and further causes the first and second switches 47A and 47B to extract the added signal Sa + Sb obtained from the adder 31 without passing through the phase shifter 45 and the added signal Sc + Sd subjected to a phase lag by the phase shifter 46, respectively, when the direction of movement of the spiral record track in relation to the centre beam incident upon the optical record disc is such that the diffraction pattern corresponding to each pit in the spiral record track moves in the direction indicated with the arrow R in Figure 7 in the beam spot P formed on the photodetecting elements 8a to 8d by the reflected centre beam.

The signals thus extracted by the first and second switches 47A and 47B in the switching block 47 are added to each other in an adder 37 to produce the reproduced information signal Si'. Therefore, advantages the same as those obtained in the embodiment of Figure 7 are obtained in the embodiment of Figure 9.

Figure 10 shows a part of a further embodiment of signal reproducing apparatus according to the present invention.

This embodiment is also obtained by modifying the embodiment of Figure 7 to use a position sensor 60 and a disc discrimination signal Sv in place of the switch 35 and the control signal Sx provided in the embodiment of Figure 7. The position sensor is operative to detect a position on the optical record disc upon which the centre beam impinges, and produce a detection output signal Sp corresponding to the detected position, and the disc discrimination signal Sv indicates

a type of optical record disc, that is, the CAV type or the constant linear velocity (CLV) type.

In the embodiment of Figure 10, the phase shifter 34 is controlled by the detection output signal Sp and the disc discrimination signal Sv so as to prevent the added signal Sa + Sb or Sc + Sd picked out by the first switch 33A in the switching block 33 from having a phase lag when the disc discrimination signal Sv indicates the CLV type and the detection output signal Sp represents a position in an area close to the outmost radius of the optical record disc and, on other occasions, to cause the added signal Sa + Sb or Sc + Sd picked out by the first switch 33A in the switching block 33 to have a phase lag corresponding to the phase difference between the output signals Sa and Sd derived respectively from the photodetecting elements 8a and 8d or between the output signals Sb and Sc derived respectively from the photodetecting elements 8b and 8c.

Then, the added signal Sa + Sb or Sc + Sd derived from the phase shifter 34 is added to the added signal Sc + Sd or Sa + Sb picked out by the second switch 33B in the switching block 33 in the adder 37 to produce the reproduced information signal Si'. Accordingly, advantages the same as those obtained in the embodiment of Figure 7 are also obtained in the embodiment of Figure 10.

Each of the embodiments of Figures 7, 9 and 10 may preferably be applied to an optical disc player used for reproducing information signals from a double-faced optical record disc, as shown partially in Figure 4 or a compatible optical disc player which is constituted to be able to reproduce selectively both information signals from optical record discs of two different types, as shown partially in Figure 6.

In the case where one of the embodiments is applied to an optical disc player as shown in Figure 4, on which the double-faced optical record disc is loaded so that reproductions of information signals respectively recorded on first and second surfaces of the double-faced optical record disc opposite to each other are carried out selectively, the direction of rotation of the double-faced optical record disc is changed to reverse between the reproduction of the information signal recorded on the side of the first surface and the reproduction of the information signal recorded on the side of the second surface, and the switching block 33 in the embodiment of Figure

7 or Figure 10 or the switching block 47 in the embodiment of Figure 8 is controlled by the control signal Ss or Sx so that the added signal Sa + Sb subjected to the phase lag by the phase shifter 34 or 45 and the added signal Sc + Sd obtained from the adder 32 without passing through the phase shifter 34 or 46 are to be supplied to the adder 37 during the reproduction of the information signal recorded on the side of the first surface of the double-faced optical record disc and the added signal Sa + Sb obtained from the adder 31 without passing through the phase shifter 34 or 45 and the added signal Sc + Sd subjected to the phase lag by the phase shifter 34 or 46 are to be supplied to the adder 37 during the reproduction of the information signal recorded on the side of the second surface of the double-faced optical record disc.

Where one of the embodiments is applied to such a compatible optical disc player as shown in Figure 6, on which first and second optical record discs of different types are loaded substantially in a common plane so that reproductions of information signals recorded respectively on the first and second optical record discs are carried out selectively, the first and second optical record discs are rotated in the same direction, and the switching block 33 in the embodiment of Figure 7 or Figure 10 or the switching block 47 in the embodiment of Figure 8 is controlled by the control signal Ss or Sx so that the added signal Sa + Sb subjected to the phase lag by the phase shifter 34 or 45 and the added signal Sc + Sd obtained from the adder 32 without passing through the phase shifter 34 or 46 are to be supplied to the adder 37 during the reproduction of the information signal recorded on the first optical disc and the added signal Sa + Sb obtained from the adder 31 without passing through the phase shifter 34 or 45 and the added signal Sc + Sd subjected to the phase lag by the phase shifter 34 or 46 are to be supplied to the adder 37 during the reproduction of the information signal recorded on the second optical record disc.

CLAIMS

1. A signal reproducing apparatus for use in an optical disc player which uses a light beam, incident upon an optical record disc on which an information signal is recorded in a record track, to read the information signal from said disc, the apparatus comprising:
disc driving means for rotating said disc to move the record track on said disc in a predetermined direction;
optical head means including an optical arrangement for causing the light beam to impinge on said disc rotated by said disc driving means and receiving a reflected light beam from said disc, and at least first and second photodetecting elements which are so disposed that a beam spot is formed on said first and second photodetecting elements by the reflected light beam received by the optical arrangement and are aligned along a direction of movement of a diffraction pattern appearing in the beam spot in accordance with the movement of the record track;
phase shifting means for varying the phase of at least one of first and second output signals obtained respectively based on detection outputs of said first and second photodetecting elements;
switching means for causing said first and second output signals selectively to pass through said phase shifting means in response to the direction of movement of the record track in relation to the light beam incident upon said disc; and
adding means operative to add one of said first and second output signals derived from said phase shifting means to the other of said first and second output signals so as to produce a reproduced information signal.

2. Apparatus according to claim 1 wherein said phase shifting means is operative to cause one of said first and second output signals to have a phase lag corresponding to a phase difference between said detection outputs of said first and second photodetecting elements.

3. Apparatus according to claim 1 wherein said adding means including phase-shift restricting means for selectively disabling said

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phase shifting means.

4. Apparatus according to claim 3 wherein said phase-shift restricting means comprises additional switching means for picking out one of said first and second output signals directly and through said phase shifting means selectively.

5. Apparatus according to claim 4 wherein said additional switching means performs its switching operation in accordance with a position on said disc upon which the light beam impinges when said disc is of the constant angular velocity type.

6. Apparatus according to claim 1 wherein said disc is a double-faced disc having record tracks formed respectively on both sides of first and second surfaces thereof, said optical head means is able to move through a path detouring around the double-faced disc to face said first and second surfaces selectively for reproduction of each of information signals from record tracks formed on the respective sides of said first and second surfaces, a direction of rotation of the double-faced disc is changed to reverse between the reproduction of the information signal from the record track formed on the side of said first surface and the reproduction of the information signal from the record track formed on the side of said second surface, and said switching means is controlled so as to cause said first output signal to pass through said phase shifting means during the reproduction of the information signal from the record track formed on the side of said first surface and cause said second output signal to pass through said phase shifting means during the reproduction of the information signal from the record track formed on the side of said second surface.

7. Apparatus according to claim 1 wherein said optical disc player is constituted to be able to reproduce selectively information signals from first and second optical record discs of different types which are loaded substantially in a common plane on said optical disc player and rotated in the same direction, said optical head means moves along each of the radial directions of said first and second

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optical record discs to cause the light beam to trace selectively record tracks formed respectively on said first and second optical record discs for each of reproductions of the information signals from the record tracks formed respectively on said first and second optical record discs, and said switching means is controlled so as to cause said first output signal to pass through said phase shifting means during the reproduction of the information signal from the record track formed on said first optical record disc and cause said second output signal to pass through said phase shifting means during the reproduction of the information signal from the record track formed on said second optical record disc.

8. A signal reproducing apparatus for use in an optical disc player and substantially as hereinbefore described with reference to Figure 7 of the accompanying drawings.

9. A signal reproducing apparatus for use in an optical disc player and substantially as hereinbefore described with reference to Figures 7 and 8 of the accompanying drawings.

10. A signal reproducing apparatus for use in an optical disc player and substantially as hereinbefore described with reference to Figure 9 of the accompanying drawings.

11. A signal reproducing apparatus for use in an optical disc player and substantially as hereinbefore described with reference to Figure 10 of the accompanying drawings.

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