The invention relates to a method according to the preamble to the main Claim.

The method is concerned, in particular, with avoiding movements of the scanning system in unwanted directions during the radial scanning of compact discs with equipment which comprises a simple servo system without directional recognition logic.

It belongs to the state of the art that, in order to find any desired place on the disc rapidly, the tracks representing the difference between target and instantaneous position are first determined and preset as a desired value. For targets situated relatively far away, it is not sufficient just to carry out the search operation with the precision drive. In principle, the procedure is such that the coarse drive is switched over to rapid search, that is to say the coarse drive is accelerated and kept at high speed. At the same time, the control loop of the precision drive is interrupted. During the phase of movement which now takes place of the coarse drive (and of the entrained precision drive), the tracks traversed in the radial direction are detected and counted. As soon as the preset desired value (the track sought) is reached, the precision drive control loop is switched on again and the coarse drive is switched over from search mode of operation to control operation.

Search systems which work on this principle generally have a directional recognition logic, such as is described in GB-A-2 000 617, by means of which the direction of the precision and coarse drive relative to the disc to be scanned is ascertained. This device prevents tracks traversed in the wrong direction from being erroneously recognized as correct. In high-speed search systems, such movements which are wrong in

relation to the preset search direction only occur in the starting and landing phases. This is due firstly to the fact that the disc to be scanned has radial eccentricity as a result of the guiding or mounting of the disc and of manufacturing tolerances in the disc itself. In the starting or landing phase, in which the coarse drive system executes a relatively slow movement, it may happen that, depending on the instantaneous direction of the radial eccentricity of the disc, the resulting movement of the track catches up with or overtakes the movement of the scanner. In consequence, the resulting direction of movement in relation to the disc is the opposite of the preset direction. This can be seen from Figure 1. In search systems without directional recognition logic, no difference can be detected and tracks traversed in the wrong direction are erroneously evaluated as correct. As a result, however, a wrong target point is reached and corrections have to be made. This can lead to a considerable increase in the search time. The problem referred to is secondly due to the fact that there is a brief wrong direction of movement in the starting phase of the coarse drive. At the moment of starting, that is to say when the coarse drive is switched on and the precision drive is interrupted in its control loop, an erroneously oppositely directed movement may likewise occur depending on the instantaneous prior control of the precision drive. Since the coarse drive still practically does not make any movement in this first moment, this may lead to traversing a large number of tracks in the wrong direction. A great eccentricity at this moment reinforces the errors occurring and prolongs the time for finding the desired place of the track. Figure 2 shows this by way of example. If the instantaneous operating point of the precision drive does not lie in the zero point

of its range of movement, the error occurring with a corresponding jumping direction can be additionally increased as Figure 2 likewise shows.

EP.OS 0 090 379 may also be mentioned by way of example for this kind of search system.

Another solution can be seen from JP-A-58-57 637. Here an additional signal is given to the precision drive whereby the latter is deflected oppositely to the direction of movement of the coarse drive. This does not relate to the starting phase of a search operation. Accordingly, the problem posed is different from with the present invention.

Search systems with direction detectors or a directional recognition logic are at present reserved for top-of-the range equipment among CD players for reasons of cost. For simple search systems without directional recognition logic the facts given lead on the one hand to a considerable prolongation of the search times. On the other hand, in search systems with a very high search speed or with rapid, briefly occurring reciprocating movements of the precision drive, such as may occur in the starting phase, there are great difficulties in realizing the direction detectors which can only be overcome with a heavy expenditure on circuitry. This applies in particular when there is no pure hardware solution for the control of the search operation but there is a circuit variant supported by a microprocessor.

It was the object of the present invention to find a solution for a search system with servo-controlled, radial coarse and precision drives for the optical scanner of a CD player, which does not have any directional recognition logic, is relatively cheap to produce and renders possible rapid access times and which is

comparable, in the reliability of the correct track detection, with systems which work on the principle of direction detectors. At the same time, it is also required that out-of-true in the disc should not disturb the scanning.

According to the invention, this problem is solved in a method according to the preamble to the first Claim, by its characterising part. Claim 2 contains a circuit arrangement for carrying out this method. Further details and developments for carrying out the method can be seen from circuit arrangements according to the sub-claims and the following description.

The main advantage of the method according to the invention and the circuit details for carrying it out, apart from the little expense, is to be seen in that high search speeds with great initial acceleration or rapid phases of movement of the precision drive superimposed on the coarse drive, such as occur in particular in the starting phase, do not present any problems for the satisfactory operation of the method. Advantageously and surprisingly, high search speeds of the coarse drive actually have a positive effect. Disc wobble through eccentricity does not disturb search operations.

The invention will be described with reference to the drawing.

Figure 1 shows movement phenomena of an optical scanning system in the starting and search phase (state of the art);

Figure 2a shows courses of movement with unilaterally displaced operating point of the precision drive (state of the art);

Figure 2b shows movement of the coarse drive during this (state of the art);

Figure 3 shows courses of movement of an optical scanning system in the starting and search phase by

the method according to the invention;

Figure 4 shows an example of a solution of a circuit arrangement for carrying out the method, represented in the form of a block circuit;

Figure 5 shows a sequence diagram of the individual control signals from Figure 4 for a specific direction.

Reference has already been made to Figures 1 and 2 in the introduction for a better understanding of the state of the art.

By the method according to the invention, the precision control loop is not necessarily immediately opened on starting a search operation. Instead, various criteria are interrogated and the opening of the precision control loop is made dependent on the result of this evaluation.

It is characteristic of the method that the precision drive (and hence the optical scanner) is briefly deflected counter to the desired search direction. This is achieved in that the coarse drive is started while the precision drive is still holding the scanner in the instantaneous track. Only when the scanner has been deflected to a sufficiently great extent counter to the desired search direction is the control loop of the precision drive interrupted. As a result of the predeflection of the scanner, this can only move in a direction counter to this predeflection, that is to say in the search direction. If care is taken to ensure that the coarse drive already has a high speed at this moment, hunting of the scanner in its neutral position cannot have a disadvantageous effect. This can be seen from Figure 3. As Figure 3 likewise shows, the resulting total movement of the scanner remains positive and thus no tracks are traversed in the wrong (negative) direction.

In order to avoid such hunting phenomena, the precision drive control loop can be interrupted precisely in the zero position as shown in broken lines in Figure 3. What has a disadvantageous effect here is that depending on the jumping direction and radial eccentricity through out-of-true in the disc, the passage through zero must be awaited without previously switching on the coarse drive. This causes a prolongation of the access times. In addition, in precision drive systems, the operating point of which lies outside the zero line, this cannot be reached depending on the radial eccentricity of the disc and consequently cannot be used as a decision criterion.

Even with positions of the scanner in the starting phase of the search operation which have a favourable effect on the search direction, a minimum acceleration phase for the coarse drive should generally be adhered to with the precision drive control loop still closed. As a result of this, hunting phenomena or the radial eccentricity of the disc are prevented from having a disadvantageous effect on the desired direction of movement.

Figure 4 shows an example of a circuit arrangement for carrying out the method. Two adjustable detectors 8 and 9 are provided. Although here they are each associated with one search direction, they do not work as direction detectors but only as threshold detectors. A low-pass filter network 4, 5 produces the control signal URG for the detectors 8, 9 from the radial error signal URE which can be taken off directly at the radial actuator 3 of the precision drive system and at the output of the controller 2. This control signal URG is directly proportional to the amplitude of movement plotted as ordinate in Figures 1, 2 and 3. With the aid of these detectors 8, 9, the precision

drive control loop is switched off by means of the switch 1, via the changeover switch 10 which is switched by the control unit 14 according to the desired direction and selects the relevant detector output signal, and via the switch 11.

The delay element 12 shown in broken lines is only of importance when the threshold values (adjusters) 6 and 7 respectively of the detectors 8, 9 are selected so low that even a radial eccentricity occurring in playing operation actuates the detectors 8, 9. This delay time is related to the system and determined by the acceleration phase of the coarse drive 13 and is here preset as a constant. It guarantees that, in the case previously mentioned, no hunting movements of the precision drive and a superimposed radial eccentricity of the disc have a negative effect in the starting phase.

Figure 5 shows the sequence diagram of the individual control signals as they occur for a specific desired direction in the block circuit diagram of the circuit arrangement (Figure 4).

Claims

1. A method of track jumping to a desired track for a rotating information carrier scanned with an optical scanner, wherein the scanner is movable radially by a coarse drive (13) and a fine drive (3), wherein a servo circuit is present which controls the fine drive by means of a radial error signal U_{RE} and which is open during the track jumping caused by the coarse drive, and wherein, with the servo circuit open, the tracks traversed radially are counted without regard to the direction of the traversing, characterised in that during the track jumping, the servo circuit of the fine drive (3) at first remains closed if the coarse drive (13) is immediately set in motion (f in Figure 3) in accordance with the search direction fed in, and the servo circuit of the fine drive is only opened (j in Figure 3) in the event of criteria following as a result, in such a manner that, taking into account the acceleration and the search speed of the coarse drive (k in Figure 3) on the one hand and the eccentricity of the tracks (b in Figure 3) and the movement of the scanner (i in Figure 3) on the other hand, assurance is provided that the relative movement between information carrier and beam is not reversed after the start of the coarse drive.

2. A circuit arrangement for track jumping to a desired track for a rotating information carrier scanned with an optical scanner, wherein the scanner is movable radially by a coarse drive (13) and a fine drive (3), wherein a servo circuit is present which controls the fine drive by means of a radial error signal U_{RE} and which is open during the track jumping caused by the coarse drive, and wherein, with the servo circuit open, the tracks traversed radially are counted without

regard to the direction of the traversing, characterised by means which, during the track jumping, at first hold the servo circuit of the fine drive (3) closed if the coarse drive (13) is immediately (f in Figure 3) set in motion according to the search direction fed in, and which only open (j in Figure 3) the servo circuit of the fine drive in the event of criteria following as a result, in such a manner that, taking into account the acceleration and the search speed of the coarse drive (k in Figure 3) on the one hand and the eccentricity of the tracks (b in Figure 3) and the movement of the scanner (i in Figure 3) on the other hand, assurance is provided that the relative movement between information carrier and beam is not reversed after the start of the coarse drive.

3. A circuit arrangement according to Claim 2, characterised in that the opening of the servo circuit of the fine drive is triggered by the output signal of a detector of the radial error signal (U_{RE}), which has a fixed reference point, and this reference point may be zero or a level which is associated with the mid position (neutral position) of the fine drive.

4. A circuit arrangement according to Claim 2, characterised in that the opening of the servo circuit of the fine drive is triggered by the output signal of a detector (8, 9) of the radial error signal, the threshold of which detector is adjustable.

5. A circuit arrangement according to Claim 3 and/or 4, characterised in that a distinction is made between a forward and backward search direction as a result of the fact that two detectors (8, 9) are provided, one of which is associated with each of these search directions.

6. A circuit arrangement according to Claim 5, characterised in that a plurality of detectors or A/D converters are used.

7. A circuit arrangement according to Claim 2, characterised in that the control loop of the fine drive is only opened after the expiration of a fixed preset delay time.

8. A circuit arrangement according to Claim 7, characterised in that the extent of the delay time depends on system constants such as turntable unit and/or scanning unit used.

9. A circuit arrangement according to Claim 8, characterised in that the adjustable delay time is determined by the magnitude and direction of the radial eccentricity found in the starting phase of reproduction operation.

10. A circuit arrangement according to Claim 9, characterised in that the adjustable delay time is also determined by the jumping distance detected, in such a manner that it is reduced for short jumping distances and increased for long jumping distances.

11. A circuit arrangement according to Claim 2, characterised in that means are provided which ensure that a more favourable radial eccentricity with regard to the search direction is awaited.

12. A circuit arrangement according to Claim 2 and/or any one of the following Claims, characterised in that the opening of the fine drive control loop is only effected after the forcible removal of the scanning beam of light from the track, means being

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provided which ensure that the moment of opening of the fine drive control loop is additionally derived from the magnitude of the jumping distance.

13. A circuit arrangement according to Claim 12, characterised in that the closed-loop gain of the fine drive control loop is reduced during the starting phase of the coarse drive.