

The invention relates to a process for stopping a rotating disc-shaped recording medium.

CD-players or video disc players are for instance equipped with a loading- and unloading device, into which the recording medium, a compact disc or a video disc, is manually inserted and out of which it can again be removed by hand. After insertion, the disc is automatically brought into the play position. By means of a so-called STOP-key the user of the CD-player can at any time interrupt the playing of a disc. The disc is stopped and moved automatically into the unloading position, so that the user can remove it from the loading device for instance in order to be able to insert a different disc.

Before however the disc is brought from the play position into the unloading position, it should be braked as far as possible to a stop by the motor of the disc drive in order to avoid damage to its sensitive surface during the unloading process.

The rotational speed of a disc is however, not constant, because in a CD-player the system keeps constant, in contrast to a CAV system, the abbreviation for constant-angular-velocity, not the angular velocity, but as is usual in a CLV system - the abbreviation for constant-linear-velocity - the path velocity.

It can thus arise that the disc still rotates during the unloading process, either in the play direction or even in the reverse direction depending on whether it has been braked by the disc drive motor too little or too much. Further, because the mass and diameter vary from disc to disc and there are also small minidisks, it can happen that the disc is still turning during the

unloading process. However, as already mentioned, the sensitive surface of a disc, which is still rotating during the automatic unloading process, can be easily damaged.

Therefore, in order to make certain that the disc is actually stationary at the start of the unloading process, a short waiting time should be provided as a time safety delay between braking the disc and the unloading process so that the disc can run down. However, this provision has the disadvantage that it delays the unloading process.

A method for stopping a rotating, disc-shaped recording medium is known from EP-A-O 322 177.

The rotating, disc-shaped recording medium is braked by a first braking pulse. The time which elapses from the first braking pulse until the rotational speed of the rotating, disc-shaped recording medium has dropped to a predetermined value is measured; then a second braking pulse is generated and switched off after a period which has been calculated from the length of time previously measured.

It is, therefore, the object of the invention to provide a method for stopping a rotating, disc-shaped recording medium in such a way that the rotating recording medium is brought rapidly and reliably to a complete halt ready for unloading.

The invention achieves this object by the following method steps :

- a) the recording medium is braked by a first braking pulse

- b) when the rotational speed of the recording medium has dropped to a predetermined value $+N$, the time T is measured until the rotational speed of the recording medium reaches the opposite value $-N$
- c) when the rotational speed of the recording medium has reversed to the value $-N$, the polarity of the first braking pulse is reversed and
- d) after the time $T/2$ the thus-formed second braking pulse is terminated

A second solution according to the invention envisages repeating the method steps a) to c) several times and to form the mean value T_M from the measured times T , which pass each time at the reversal of the rotational speed, and to dimension the duration of the last braking pulse to $T_M/2$.

By this measure the duration of the last braking pulse, which brakes the recording medium to a complete stop, is determined more precisely than with the first solution according to the invention.

Moreover, according to claim 7, the invention provides an arrangement for performing the first-mentioned method.

Figure 1 shows an arrangement for performing the method according to the invention:

Figure 2 shows a pulse diagram for explaining the invention;

Figure 1 shows the drive motor M , which drives a compact-disc CD . A revolution counter DM , which

measures the rotational speed of the record CD, is connected to the input of a detector D, of which both outputs are connected to both inputs of a control circuit ST. The output of the control circuit ST is connected to the input of a braking pulse generator BG, of which the output is connected to the drive motor M.

For stopping the disc CD the braking pulse generator BG supplies a first braking pulse B1 to the drive motor M, whereby the disc CD is braked. As soon as its rotational speed has dropped to a predetermined value $+N$, the detector emits a first signal to the control circuit ST, which now measures the time T, which elapses until the detector D emits a second signal to the control circuit ST. Because the first braking pulse B1 of the braking pulse generator BG continues to be applied to the drive motor M, the disc CD is braked from the rotational speed $+N$ to a stop and then accelerated in the opposite direction of rotation. When the rotational speed of the disc CD has reversed to the value $-N$, the detector D emits a second signal to the control circuit ST. The control circuit ST, which has measured the time T between the first and the second signal of the detector D, now causes the polarity of the first braking pulse B1 to be reversed and the thus-formed second braking pulse B2 of reversed polarity to be terminated after the time $T/2$. By this measure the disc CD is safely and rapidly braked to a stop.

By the first braking pulse B1 the rotational speed of the disc CD is reduced to a stop; because, however, the first braking pulse B1 remains further, the disc CD is then accelerated in the opposite direction.

The invention is now based on the perception that the time $T/2$, which elapses until the disc has dropped from

a predetermined rotational speed $+N$ to zero, is the same as the time which elapses until the disc CD starting from being stationary is accelerated up to the same rotational speed in the opposite direction, and the same as the time which elapses until the disc is braked to a stop from the rotational speed $+N$ or $-N$. When the disc rotates with the rotational speed $-N$ in the opposite direction, a braking pulse of opposed polarity brakes the disc therefore in the time $T/2$ precisely to a stop.

An essential advantage of the method according to the invention is that the diameter and the moment of inertia of the disc are no longer relevant. Each disc is safely and rapidly braked to a stop every time independently of its diameter and its moment of inertia.

The invention is suitable for recording- and/or reproduction devices having a rotating disc-shaped recording medium such as for instance CD-players, video disc players, DRAW-disc-players or magneto-optical devices.



Claims

1. A method for stopping a rotating disc-shaped recording medium (CD) characterised by the following steps:

- a) the recording medium (CD) is braked by a first braking pulse (B1);
- b) when the rotational speed of the recording medium (CD) has dropped to a predetermined value $+N$, the time T is measured, which elapses until the rotational speed of the recording medium (CD) has reached the reversed value $-N$;
- c) when the rotational speed of the recording medium (CD) has reversed to the value $-N$, the polarity of the first braking pulse (B1) is reversed and
- d) after the time $T/2$ the thus-formed second braking pulse (B2) is terminated.

2. A method for stopping a rotating disc-shaped recording medium (CD) characterised by the following steps;

- a) the recording medium (CD) is braked by a first braking pulse (B1);
- b) when the rotational speed of the recording medium (CD) has dropped to a predetermined value $+N$, the time T is measured, which elapses until the rotational speed of the recording medium (CD) has reached the reversed value $-N$;
- c) when the rotational speed of the recording medium (CD) has reversed to the value $-N$, the polarity of



the first braking pulse (B1) is reversed;

- d) the steps a) to c) are repeated several times;
- e) from the measured times T the mean value T_M is formed;
- f) the duration of the last braking pulse is dimensioned to be $T_M/2$.

3. A method according to claim 1 or 2, characterised in that a detector (D) supplies a first signal to a control circuit (ST), when the rotational speed of the recording medium (CD) has reduced to the predetermined value $+N$ due to the first braking pulse (B1), and in that the detector (D) supplies a second signal to the control circuit (ST), when the rotational speed of the information medium (CD) has reached the opposite value $-N$ due to the first braking pulse (B1).

4. A method according to claim 2 or 3, characterised in that the control circuit (ST) measures the time T , which elapses until the rotational speed of the recording medium reverses from the value $+N$ to the value $-N$.

5. A method according to claim 4, characterised in that the control circuit (ST) controls a braking pulse generator (BG).

6. A method according to claim 5, characterised in that the control circuit (ST) at the time when the rotational speed of the recording medium (CD) has reached the value $-N$, causes a reversal of the polarity in the braking pulse generator (BG) of the first braking pulse (B1) and terminates the thus-formed second braking



pulse (B2) after the time $T/2$.

7. An arrangement for performing the method according to claim 1 having a drive motor (M) for turning a recording medium (CD), a revolution counter (DM) which measures the rotational speed of the recording medium (CD) and is connected to a detector (D), which is connected to a control circuit (ST), which is itself connected to a braking pulse generator (BG) which is connected to the drive motor (M) for the recording medium (CD), the detector (D) supplying a first signal to the control circuit (ST) when the rotational speed of the recording medium (CD) has dropped to a predetermined value $+N$ as a result of the first braking pulse (B1) characterised in that the detector (D) supplies a second signal to the control circuit (ST) when the rotational speed of the recording medium (CD) has reached the opposite value $-N$ as a result of the first braking pulse (B1), in that the control circuit (ST) measures the time T which elapses until the rotational speed of the recording medium has reversed from the value $+N$ to the value $-N$, and in that at the time when the rotational speed of the recording medium (CD) has reached the value $-N$, the control circuit (ST) causes a reversal of polarity of the first braking pulse (B1) in the braking pulse generator (BG) and terminates the thus-formed second braking pulse (B2) after the time $T/2$.