

**A SUB-CHASSIS LIFTING MECHANISM
FOR OPTICAL DISC DRIVE**

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5 FIELD OF THE INVENTION

This invention relates the field of optical disc drives, and particularly to a sub-chassis lifting mechanism for optical disc drives.

10 BACKGROUND OF THE INVENTION

Optical disc drives and disc loading mechanism are generally well known to those skilled in the art. There are two major movements during the loading of an optical disc into an optical disc drive. The first is the
15 sliding movement of the loader tray into the drive. The second is the movement by which the optical reader is placed in position to read the disc. The second movement is often accomplished by pivoting up the tray, here referred to as the sub-chassis, which supports the optical reader from an lowered position to a raised position. Currently, a number of different
20 mechanism is used to raise and lower the sub-chassis. Many use gears or more complex devices for facilitating the movement and the timing of the movement of the sub-chassis.

In the recent years, many improvements have been made to the loading mechanism in general and to the sub-chassis lifting mechanism to
25 make the optical disc drive system more stable, reliable, less complex, cheaper, etc. Some of these improvements are detailed in, among others, US Patents #5,381,393 and #5,416,763. Despite the many improvements, the loading mechanism of the most current optical disc drives still employ

many similar components such as circular gears and belts for facilitating the loading process and for synchronizing the movements of the various parts.

Many of these current sub-chassis lifting mechanisms can include many components, some of which require some skill and labor to put
5 together, or complex schemes which require precise mating of parts. In the optical disc drive manufacturing industry where the drives are produced in high quantities, it is highly desirable to have a mechanism which uses the least number of components possible, and which is adapted for easy assembly. Hence, it would be desirable to have a sub-chassis raising
10 mechanism which further reduces the complexity, which is versatile, and which is highly adaptable for high-volume manufacturing.

OBJECT OF THE INVENTION

15 It is therefore the object of the present invention to provide a sub-chassis raising mechanism for an optical disc drive which reduces the complexity associated with the previous systems, and which can be more easily produced in a mass manufacturing setting.

20 SUMMARY OF THE INVENTION

The present invention is a sub-chassis lifting mechanism for an optical disc drive. The present lifting mechanism is generally adapted for pivoting type sub-chassis which rotates around a fixed axis and has 1-
25 degree of freedom. The preferred embodiment of the lifting mechanism includes an upper arm and a lower arm, both of which protrude out perpendicularly from a cylindrical main body and which extend out substantially in opposite directions from each other. The upper arm has a

rounded cavity at the end of the arm. The cylindrical body has a hole which extends through the length of the body and a wing segment which extends out from the side of the cylindrical body. On the face of the wing segment is slanted slit which is angled in relation to the axis of the cylindrical body.

- 5 The slanted slit has an upper end and a lower end, each having a rounded cavity. This unique shape and features described, allow the lifter to efficiently raise and lower the sub-chassis.

BRIEF DESCRIPTION OF THE DRAWINGS

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FIG. 1 is a perspective diagram illustrating the overall configuration of the present invention.

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FIG. 2A is a plan view of the bottom side of the loader tray with the gear bar in its first position.

FIG. 2B is a plan view of the bottom side of the loader tray with the gear bar in its second position.

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FIG. 2C is a perspective view of the bottom side of the loader tray with the gear bar removed.

FIG. 3 is a plan view of the chassis as the gear bar approaches the full in-position.

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FIG. 4A is a perspective diagram of the isolated gear bar.

FIG. 4B is a perspective diagram of the isolated gear bar showing a side opposite to side shown in FIG. 4A.

FIG. 5 is an isolated plan view illustrating the relationship between the gear bar and the lifter when the gear bar is in the second position.

FIG. 6 is an isolated plan view illustrating the relationship between the gear bar and the lifter before the gear bar is in the full in-position.

FIG. 7 is a perspective view of an optical disc drive with the tray loader in its fully out-position.

FIG. 8A is a perspective view of an optical disc drive and an optical disc with the tray loader in its fully in-position.

FIG. 8B is a perspective view of an optical disc drive and an optical disc with the tray loader in its fully out-position.

FIG. 9A is a perspective view of the loading mechanism with the gear bar in its fully out-position.

FIG. 9B is a perspective view of the loading mechanism with the gear bar in its second position.

FIG. 10A and 10B are perspective diagrams showing the two views of the lifter.

FIG. 10C is a side view of the lifter of FIG. 10A and FIG. 10B.

FIG. 11 is an exploded view of the sub-chassis illustrating how the nipple on the sub-chassis engages with the slanted slit in the lifter.

5 FIG. 12 is an exploded view of the chassis with the flexible ramp.

FIG. 13 is a perspective diagram of the lifter in FIG. 10A without a lower arm.

10 FIG. 14 is a perspective diagram of an alternative embodiment for the sub-chassis lifting mechanism

DETAILED DESCRIPTION OF THE DRAWINGS

The present invention is a sub-chassis lifting mechanism for an optical disc drive. The present lifting mechanism is generally adapted for pivoting type sub-chassis which rotates around a fixed axis and has 1-degree of freedom. FIG. 10A, 10B, and 10C illustrate the preferred embodiment of the lifting mechanism, or lifter for short. The lifter 30 includes an upper arm 31 and a lower arm 32, both of which protrude out perpendicularly from a cylindrical main body 33 and which extend out substantially in opposite directions from each other. The upper arm 31 has a finger 31a and a rounded cavity 31b at the end of the arm 31. The cylindrical body 33 has a hole 33a which extends through the length of the body and a wing segment 34 which extends out from the side of the cylindrical body 33. On the face of the wing segment 34 is slanted slit 35 which is angled in relation to the axis of the cylindrical body 33. The slanted slit 35 has an upper end 35a and a lower end 35b, each having a rounded cavity.

To properly engage the sub-chassis in the lowering and raising movements, the sub-chassis should have a extending member, or a nipple 65, as shown in FIG. 11, which is slidably fitted into the slanted slit 35. In addition, the hole 33a of the lifter 30 should be rotatably fitted onto a pole, or attached in some other manner, such that the lifter 30 can freely rotate. The structural relationship between the lifter 30 and the sub-chassis 60 is such that a clockwise movement (when looking down from above) of the lifter 30 would cause the nipple 65 to slide along the slanted slit 35 until the nipple reaches the upper end 35a of the slanted slit 35, where the nipple 65 is fitted snugly in the rounded cavity of the upper end 35a. This movement just described would, hence, raise the entire sub-chassis 60 as it pivots

upward. Conversely, a counterclockwise rotational movement of the lifter 30 would cause the nipple 65 to slide down along the slanted 35 until the nipple 65 reaches the lower end 35b, and the sub-chassis 60 would pivot downward.

5 When the sub-chassis 60 is fully raised and the nipple is in the rounded cavity at the upper end 35a, the sub-chassis 60 is locked into position. This is because the nipple rests on a relatively flat, rather than a slanted, bottom in the cavity, and so any force exerted by the nipple in the downwardly direction (the only direction possible since the sub-chassis has
10 only 1-degree of freedom) will exert the force only in a direction perpendicular to the plane of rotation of the lifter 30. Hence, the lifter 30 does not rotate and preventing the sub-chassis 60 from returning to the lowered position. This feature is important as it prevents the sub-chassis from inadvertently pivoting downward .

15 Because the lifter 30 has this self-locking feature, there is a need for a manual releasing mechanism for disengaging the sub-chassis from this locked position in the event that there is a problem with the motor or other parts of the mechanism. This releasing mechanism is provided for by the lower arm 32 of the lifter 30. As shown in FIG. 9B and 10B, when the lifter
20 30 is in the locked position, the angled end 32a of the lower arm 32, becomes disposed inside the opening 3. A small hole (not shown) is provided on the outside of the chassis 5 such that a small pin can have access to the angled end 32a. To manually release the sub-chassis from the locked position, one needs to push the angled end 32a through the
25 small opening. Although this manual release feature is highly desirable, it is not essential to the function of the overall loading mechanism, and hence can be eliminated if so desired. A lifter without the lower arm is illustrated in FIG. 13.

The rotational movement of the lifter 30 can be facilitated by having the upper arm 31 engage with another moving mechanism. While this moving mechanism can come in many forms, a linear bar is particularly suited to be used in conjunction with the present invention. The following
5 figures and description illustrate a preferred way of using the present invention in an optical disc loading mechanism. However, one of ordinary skilled in the art should understand that it is possible to utilize the present invention in manners different than the precise description contained herein.

FIG. 1 illustrates an optical disc drive with a loading mechanism
10 utilizing the present lifting mechanism. The optical disc drive is shown here with a standard optical reader 70 with a spindle turn table 72. The loading mechanism generally includes the chassis 5, loader tray 10, linear gear bar 20, lifter 30, motor 40, gear train 50, sub-chassis 60. To better illustrate the components of the present invention, the loader tray 10, which is usually
15 attached to the linear gear bar 20, and the gear bar 20 itself, have been removed from their normal configuration such that the features of the loading mechanism may be viewed more easily.

In the normal configuration, as shown in FIG. 7, the loader tray 10 and the chassis 5 are slidably mated such that the tray 10 can slide along
20 the chassis 5 with relative ease, and the gear bar 20 comes between the loader tray 10 and the chassis. To facilitate this mating scheme, the loader tray has a pair of channels 11, as better shown in FIG. 2A. These channels 11 are mated with thin guide strips 6 and 6a disposed on the chassis 5 as can be seen in FIG. 1 and FIG. 3. Each of the channels 11 terminates to a
25 closed end 11b and has an unblocked opening 11a in the front.

Two extreme positions are possible for the loader tray 10 in relation to the chassis 5: the fully in-position, FIG. 8A and the fully out-position, FIG. 8B. The fully out-position of FIG. 8B is the position where the tray 10 is in a

position where it most of its body is not overlapping with the body of the chassis 5. In this position an optical disc 80 can be loaded onto the tray. To prevent the tray 10 from actually disengaging from the chassis 5, a latch 7, shown in FIGS. 1 and 3, is provided on the chassis to catch an extended
 5 portion 12, shown in FIG. 1, of the tray 10. The fully in-position of FIG. 8A is a position where the body of the loader tray 10 is fully overlapped with the body of the chassis 5 and in position to allow the turn table 72 of the optical reader 70 to engage the disc 80. In the full in-position, the closed ends 11b of the channels 11, rest squarely against the guide strips 6a.

10 As shown in FIG. 2A and 2B, the gear bar 20 is attached to the bottom side of the loader tray 10. Two extreme position are possible for the gear bar 20 in relation to the loader tray 10: the first position and the second position. When the loader tray 10 is in its fully out-position, the gear bar 20 must be in its first position. However, when the loader tray 10 is in its
 15 fully in-position, the gear bar 20 is in the first position initially, and then moves to the second position, without the loader tray 10 changing its position. The first position is illustrated in FIG. 2A, and the second position is illustrated in FIG. 2B. The importance of these two positions will become apparent in the following description that illustrates the interaction among
 20 the gear bar 20, lifter 30, gear train 50 and the sub-chassis 60. For now, it is important to describe its structural relationship with the tray loader 10.

The structural details of the gear bar 20 are shown in Figs. 4A and 4B. The gear bar 20 has a long, rigid, linear body 21 with a thin panel 22 projecting out of the body 21. Along the length of the body 21 and adjacent
 25 to the thin panel 22 are gear teeth 23 which are designed to interact with other complementary set of gear teeth. At a back end 27 of the body 21 is a slanted arm 24 protruding out from the same side as the gear teeth 23. The slanted arm 24 has a cylindrical tip 24a which protrudes out perpendicularly

to the slanted arm 24. On the opposite side of the gear teeth 23 are two spaced-apart pegs 25 having an head 25a and a thinner neck portion 25b (the head 25a and neck 25b are better illustrated in FIG. 5). In between the pegs 25 is a flexible claw 26 having an sloping head 26a and a lateral fin 26b.

Now referring to Figs. 2A, 2B, and 2C, the gear bar 20 is slidably attached to a two thin panels, 13a and 13b, which are separated by a gap 13c, with the back end 17 of the gear bar 20 near the front end 2 of the loader tray 10. The two thin panels 13a and 13b each has an empty cavity with a rounded portion 14a and a elongated portion 14b. The rounded portion 14a is big enough to let the head 25a of the peg 25 fully through while the elongated portion 14b is narrow enough to prevent the head 25a from letting through but wide enough to accommodate the neck portion 25b of the peg 25. As such, the neck portion 25b of the peg 25 can slide along the elongated portion 14b of the thin panels 13a and 13b restricted only by the length of the cavity. Therefore, the entire gear bar 20 can slide along the thin panels 13a and 13b.

When the gear bar 20 is in the first position, as illustrated in FIG. 2A, the pegs 25 are at the elongated portion 14b of the cavity at an end opposite to the rounded portion 14a. In this position, the flexible claw 26 is in the gap 13c and positioned such that the lateral fin 26b is flush against a triangular stop 15. The triangular stop 15 essentially prevents the gear bar 20 from sliding along the thin panels 13a and 13b, and thus completely restricts the movement of the gear bar 20 relative to the loader tray 10. This blockage, however, can be moved if the flexible claw 26 is bent inward towards the gear body 21 such that the lateral fin 26b is no longer engaged against the triangular stop 15.

When the gear bar 20 is in the second position, as illustrated in FIG. 2B, the pegs 25 are at the rounded portion 14a of the cavity. In this position, the flexible claw 26 is substantially overlapped with the thin panel 13b such that the panel 13b is between the flexible claw 26 and the gear body 21, and the lateral fin 26b is flush against a rectangular stop 16. The rectangular stop 16 prevents the gear bar 20 from sliding forward, though the gear back may still slide backward towards the first position.

Now that the structural relationship between the gear bar 20 and the loader tray 10 has been established, the structure of the rest of the mechanism and its relationship with the gear bar 20 shall be described. FIG. 9A illustrates the loading mechanism (with the loader tray removed from the view) in the fully out-position. In this position, the sub-chassis 60 is in the lowered position such that the optical reading device 70 is sufficiently away from the path of the loader tray 10 (not shown in this figure) which needs to be slide into place. The sub-chassis 60, which supports the optical reading device 70, pivots along a fixed axis 62, and hence has only 1 degree of freedom. This limitation in the movement of the sub-chassis is important because it is resistant to excessive vibrational movement during an optical reading process, and hence facilitates overall stability of the overall system.

The raising and lowering of the sub-chassis 60 is accomplished by the lifter 30. Referring to FIGS. 9A, 10A, 10B, and 10C, the lifter 30 is mounted on a pole 4 which is fixed to the chassis 5. The hole 33a of the lifter 30 is fitted onto the pole 4 such that it is reasonable snug, but still loose enough for the lifter to rotate freely. The slanted slit 35 faces the sub-chassis 60 with the nipple 65 (shown in FIG. 11) of the chassis 60 inside the slanted slit 35. Both the lower and upper arms, 32 and 31 respectively, are slanted in relation to the plane defining the front side 8 of the chassis 5.

Still referring to FIG. 9A, the teeth 23 near the back end 27 of the gear bar 20 are engaged with the teeth of the gear train 50. The gear train 50 consists of a pair of cog wheels, a small wheel 51 and a large wheel 52, which are mated to rotate simultaneously. A motor 40 has a rotor 41 with
5 teeth which are mated with the teeth of the small cog wheel 51. Hence, the rotation of the motor rotor 41 (only visible in FIG. 1) causes the gear bar 20 to move linearly along the length its teeth 23. The configuration of the cog wheels and the motor is a well known in the art, and it should be understood that a number of variations are possible.

10 To initiate the movement of the tray loader 10 from the full out-position to the full in-position, the motor 40 is actuated to turn the cog wheels 51 and 52 which in turn move the gear bar 20. During this movement, the gear bar 20 is immovably fixed to the tray loader 10 as was shown in FIG. 2A and explained in detail above. Therefore, the tray loader
15 10 is forced to move in along with the gear bar 20. During the movement of the gear bar 20 from the full out-position to full in-position, the sub-chassis 60 remains stationary as nothing engages the lifter 30 to raise the sub-chassis 60. Indeed, it is very important that the sub-chassis 60 is not inadvertently raised during this movement because otherwise, the spindle
20 turntable 72 of the optical reader 70 may block the path of the incoming tray loader 10 which will result in a jam.

To ensure that such an undesirable result does not occur, the gear bar 20 is provided with the thin panel 22 which prevents the lifter from turning during certain periods. FIG. 6 is an illustration of the relationship
25 between the thin panel 22 and the lifter 30. Note that during this movement, the finger 31a of the lifter 30 is flush against the thin panel 22, and has no room to turn in a clockwise direction. Once the thin panel 22 is moved out of position however, such as in the full-in position, the thin panel 22 is no

longer engaged with the lifter 30, and hence, it is free to turn in a clockwise direction.

As the gear bar 20 and the tray loader 10 approach the full in-position, shown in FIG. 3 (tray loader not shown), the cylindrical tip 24a of the slanted arm 24 nears the rounded cavity 31b of the lifter's upper arm 31. When the gear bar 20 first reaches the fully in-position, the cylindrical tip 24a has just made contact with the cavity 31b. In this position, the tray loader 10 is fully overlapped with the chassis and can no longer move in any further as the end stops 11b of the channels 11, shown in FIG. 2A, are blocked by the guide strips 6a, shown in FIG. 1. In this position, the gear bar 20, which was initially prevented from sliding along the tray loader 10, is released from this fixed first position. As can be seen in FIG. 3, the releasing block 9 of the chassis 5 climbs over the sloping head 26a of the flexible claw 26 and causes the claw 26 to bend inward. This movement consequently causes the lateral fin 26b of the claw 26, shown in FIG. 4B, which was being blocked by the triangular block 15 of the tray loader 10, shown in FIG. 2A, to be unimpeded by the block 15. Now the gear bar 20 is ready to go into its second position.

The motor 40 continually turns the gear train 50 after the release of the gear bar 20 from the tray loader 10. So the gear bar 20 continually moves in while the tray loader 10 is stationary. During the gear bar's movement from the first position to the second position, the cylindrical tip 24a of the gear bar 20 is fully engaged inside the cavity 31b of the lifter's upper arm 31, as illustrated in FIG. 5. So as the gear bar 20 moves into its second position, it turns the lifter 30 in a clockwise direction, causing the sub-chassis to be raised to place the spindle turn table 72 of the optical reader 70 in position to clamp the optical disc 80. Once the gear bar 20 finally reaches its second position, shown in FIGS. 2B (showing gear bar's

position in relation to the tray loader) and 9B (showing gear bar's position in relation to the chassis), it is prevented from moving any further by the rectangular stop 16 which engages against the lateral fin 26b.

In this second position, a message is sent to the motor 40 to stop the movement by a sensor attached to the chassis and located right below the gear bar 20. As shown in FIG. 12, the sensor is a flexible ramp 45 which protrudes out above the bottom surface of the chassis 5. When the flexible ramp 45 is not engaged by the gear bar 20, it is in its raised position, the position shown in FIG. 12. When the gear bar is in place, but not in the second position, the raised surface 28, shown in FIG. 4A, presses down against the flexible ramp 45. The downward depression causes a message to be sent to the motor 40 to start the movement. When the gear bar 20 reaches the second position, however, the raised surface 28 no longer presses against the flexible ramp 45. Instead, the ramp 45 is allowed to be in its raised position as the hollowed portion 28a now engages the ramp. The movement of the ramp upward sends the message to the motor 40 that the movement is no longer necessary.

To move the loader tray 10 back out to the full out-position, the motor 40 reverses direction. The gear bar 20, which is in the second position, now slides along the loader tray 10 in the opposite direction until it is in the first position. This first movement causes the sub-chassis to be lowered as the cylindrical tip 24a of the gear bar 20, which is still engaged in the cavity, 31b, turns the lifter 30 in a counter-clockwise direction. Once in the first position, the sub-chassis 60 has completely lowered and the cylindrical tip 24a of the gear bar 20 is disengaged from the rounded cavity 31a of the lifter 30. The gear bar 20 is prevented from sliding any further relative to the loader tray 10 as the gear bar 20 is blocked by the front side 2 of the loader tray 10, as shown in FIG. 2A. Now the gear bar 20 and the loader tray 10

are forced to move together. As the motor 40 continually rotates, the gear bar 20 and the loader tray 10 move together until the tray loader 10 is in the full out-position.

5 The present invention has an advantage over the current lifting mechanism in that it can be rotated without the use of circular gears. Hence, in addition to avoiding extraneous components, it is easier to align the lifting mechanism during the assembly stage in the manufacturing process. Furthermore, present invention offers flexibility as many variations are possible for the upper arm 31 to engage another mechanism to facilitate
10 the rotational movement. In the simplest form, it is possible to have a lifter design as illustrated in FIG. 14 where the lifter 90 has only an extended member 92. Of course, though not shown, a lower arm of the type shown in FIG. 10A can easily be attached to the lifter 90 if the manual release feature is desired.

15 The present invention has been described in detail herein in accord with certain preferred embodiments thereof. The present invention included some components which do not have standard terms in the industry. Hence, to fully and clearly describe the details of the invention, certain descriptive names were given to the various components. Some examples
20 are rounded cavity, slanted slit, etc. It should be understood by those skilled in the art that these descriptive terms were given as a way of easily identifying the components in the description, and do not necessarily limit the invention to the particular description. For instance, the rounded cavity in the upper arm of the lifter need not be exactly round. Other shapes would
25 sufficiently serve the purpose, so long as they performs the function of catching a moving mechanism to rotate the lifter. Similarly, other components of the present invention having similar descriptive names may be replaced with other components which do not have the identical

descriptive features listed herein. Therefore, many such modifications are possible. Accordingly, it is intended by the appended claims to cover all such modifications and changes as falling within the true spirit and scope of the present invention.

CLAIMS**We Claim:**

- 1 1. A lifting mechanism for a sub-chassis in an optical disc drive, said
 2 sub-chassis having a nipple extending out, said lifting mechanism
 3 comprising:
 4 a main body;
 5 an arm extending out of said main body, said arm being adapted for
 6 engaging with a moving mechanism to create a rotational movement of said
 7 main body; and
 8 a slit disposed on said main body, said slit adapted for engaging said
 9 nipple on the sub-chassis;
 10 whereby, said rotational movement of the main body causes said
 11 nipple to slide along said slit to move said sub-chassis from a lowered
 12 position to a raised position and vice versa.
- 1 2. The lifting mechanism recited in claim 1 wherein said slit is disposed
 2 at an angle relative to said main body.
- 1 3. The lifting mechanism recited in claim 1 wherein said main body has
 2 a wing portion.
- 1 4. The lifting mechanism recited in claim 3 wherein said slit is disposed
 2 on said wing portion.
- 1 5. The lifting mechanism recited in claim 2 further comprising a rounded
 2 cavity at an end of said slanted slit.
- 1 6. The lifting mechanism recited in claim 5 wherein said rounded cavity
 2 has a flat bottom.
- 1 7. The lifting mechanism recited in claim 6 further comprising a second
 2 arm adapted for releasing said lifting mechanism from a locked position.



- 1 8. The lifting mechanism recited in claim 1 wherein said arm has a
2 cavity at an end.
- 1 9. The lifting mechanism recited in claim 1 further comprising a finger
2 attached to said arm.
- 1 10. The lifting mechanism recited in claim 1 further comprising a hole in
2 said main body adapted for enabling said rotational movement of said main
3 body.