

DISC CHANGER

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a disc changer, particularly but not exclusively to a disc changer that stores a plurality of discs therein, transports a disc selected from a plurality of discs, and performs recording and/or reproducing an information signal on the disc. In the specification, the wording of "recording/reproducing an information signal on a disc" refers to "at least one of recording an information signal on a disc and reproducing an information signal from a disc" as an abbreviated form of expression.

Description of the Related Art

[0002] A conventional disc changer normally has a plurality of trays housed within a casing, with each tray arranged to carry an optical disc. In one known type, the disc changer includes a single selected tray or a main tray with a selected sub tray and by depressing an eject button the main tray carries the sub tray to move from a standby position within the casing to protrude outward to a disc exchange position for inputting or exchange of a disc. A disc can then be placed on the sub tray which, upon receiving a suitable signal, together with the main tray carries the disc into the standby position. At the standby position, the sub tray departs from the main tray to carry the disc to a storage rack within the casing which can hold a plurality of disc to be played. With this configuration, only one disc can be input or exchanged at a time, and to load a disc or replace a disc, each of the rest of the trays have to be ejected individually transported by the main tray. This can greatly inconvenience an end user since, more often than not, after keeping the discs inside the disc changer for a period of time, the user would not be able to remember the correct arrangement of the discs inside the disc changer and to find out, it will be necessary to inspect the contents of each tray.

[0003] Another known type of disc changer has a number of sub-trays arranged on a main tray and the main tray is used to transport all the sub-trays to a disc exchange position. However, it is necessary to have a main tray which increases manufacturing costs of the

disc changer and loading and replacement of disc are still inconvenient. Further, returning of each tray to its standby position within the casing is inefficient.

With the above-described two types of conventional disc changers, changing all the discs is inconvenient and requires a long time. Further, it is not possible with a single instruction to find out the titles of the discs or check which trays are empty.

[0004] A further problem with a conventional disc changer is that it uses a complicated configuration to select a tray and drive the tray from a disc standby position to a disc recording/reproducing position. This is because the driving mechanism needs to perform an operation in which a tray is selected and the driving mechanism is aligned with the a selected tray before the driving mechanism can drive the selected tray to the recording/reproducing position. Note that the driving mechanism cannot engage to the selected tray, or constrain the movement of the selected tray, while the tray is between the disc standby position and the disc exchanging position, since this would inhibit the movement of the tray to and from the disc exchanging position before the tray is driven to the recording/reproducing position.

[0005] Further, some conventional disc changers set a default position for the mechanism for driving trays to the recording/reproducing position at a position where the tray driving mechanism does not engage any of the trays. With this configuration, the loading time for the disc changer is higher because the tray driving mechanism needs to start the tray selection operation from the default position (which is not the position of the selected tray) before it can drive the tray to the recording/reproducing section. Still further, a large space is provided in a conventional disc changer to accommodate the tray drive gear and tray drive rack. This is needed because these parts move vertically in a up/down direction following the recording/reproducing section. Thus, the height and size of the disc changer will increase since these parts cannot be placed within the space within which the tray drive rack moves.

SUMMARY OF THE INVENTION

[0006] The present invention has been developed in view of the aforementioned technical problems and aims to provide a new and useful disc changer device. A preferred embodiment of the invention is a disc changer capable of ejecting all trays from the

standby position to a disc exchange position where the discs can be exchanged, and capable also of closing the trays one by one from the top tray to bottom one. Further, the preferred embodiment makes it possible to check directly and visually the discs stored inside the disc changer automatically with a single button operation.

One of the preferred objectives of the present invention is to provide a disc changer with a tray driving rack unit requiring a low number of parts and having a simple design to perform the operation of driving a tray between the disc recording/reproducing position and the disc standby position. is the preferred embodiment is a disc changer with a tray driving rack unit which moves in a horizontal direction and has no need to move in a vertical direction. The tray driving rack unit is able to drive a tray catch lever which can be aligned to a selected tray without constraining the movement of the selected tray from the disc standby position to the disc exchanging position. The preferred embodiment is furthermore a disc changer with a tray drive rack and a transverse slide plate that can trigger each other to carry out load and unload operations.

[0007] According to a first expression of the present invention, there is provided an optical disc changer for performing at least one of the operations of reproducing information from an optical disc or for recording information thereto, the disc changer comprising:

- a turntable;
- a recording/reproducing unit operative to perform at least one of the operations of recording and/or reproducing an information signal on an optical disc placed on the turntable;
- a plurality of trays for carrying respective optical discs, the trays being arranged in parallel;
- a housing for receiving the plurality of trays; and
- a tray driving rack unit operative to drive a selected one of the trays from a standby position to a recording/reproducing position in which the disc is carries is placed onto the turntable;
- the tray driving rack unit having a first portion for translation transverse to the plane of the trays for selection of one of the trays, and a second portion for translating the

first portion of the tray driving rack unit parallel to the plane of the trays towards or away from the recording/reproducing unit.

An alternative expression of the invention is a disc changer for storing a plurality of discs, transporting a disc selected from the plurality of discs, and performing recording/reproducing information signal on the disc, the disc changer comprising: a plurality of trays which respectively can be loaded with discs, can be moved substantially in a horizontal direction parallel to main surfaces of the discs, and are stacked substantially in a vertical direction perpendicular to the main surfaces of the discs; a tray driving gear unit capable of shuttling the trays between a standby position in which the trays are stored in a mechanical chassis as a housing of the disc changer and a disc exchange position in which the trays are protruded outward from the mechanical chassis thereby the discs can be put on the trays and removed from the trays; a gear driving mechanism driven by an electrical motor to generate driving force for driving the tray driving gear unit; a tray triggering unit capable of locking/unlocking the trays in the standby position, the unit capable of pushing all trays to engage with the tray driving gear unit after unlocking the trays and capable of driving the trays outward from the mechanical chassis toward the disc exchange position; a recording/reproducing unit for recording and/or reproducing information signal on a disc placed on a turntable; and an elevation unit capable of moving the recording/reproducing unit with the turntable in a vertical direction to align the recording/reproducing unit to a tray and place a disc on the tray onto the turntable; wherein there is provided a tray driving rack unit for driving the tray between the disc standby position and the recording and/or reproducing position, and the tray driving rack unit is formed by separate parts.

The tray driving rack unit includes a tray drive rack and a tray catch lever to move the tray to travel between the disc standby position and the disc recording/reproducing position. The tray drive rack moves a second play lever and then a first play lever to trigger a transverse slide plate to complete the clamping operation.

[0008] In one preferred embodiment of the present invention, the tray drive rack has a long shaft profile where the tray catch lever hole is inserted. The gear rack of tray drive rack is engaged and driven by a second play gear to move between the disc standby

position and the disc recording/reproducing position. The movement of tray drive rack will also move the tray catch lever.

[0009] According to the embodiment, tray drive rack moves in a horizontal direction. It is provided within a mechanical chassis, and specifically at a low position within the mechanical chassis. With this configuration, the tray drive rack is able to have a stable and constant support. This ensures a stable movement of the tray between the disc recording/reproducing position and the disc standby position especially when the tray contains a disc. The tray drive rack moves in the horizontal direction and is not required to move in a vertical (up/down) direction when the tray is selected. This reduces space required to accommodate the tray drive rack because extra space is not required to permit it to undergo up/down movement. Thus, the space over the tray drive rack can be used for other purpose such as mounting of gears, and/or the overall size of the disc changer, especially disc changer height, can be reduced.

[0010] In one preferred embodiment of the present invention, the tray catch lever is supported on the recording/reproducing section (UD base: Up/Down base) and moves on it. There is a catch profile on top of the tray catch lever, and the catch profile is used to pull the selected tray between the disc standby position and the disc recording/reproducing position. The actual driving force is transmitted from the tray drive rack to the catch lever. A shaft profile of the tray drive rack is inserted into a center hole of the tray catch lever, in order to provide a driving source which drives the tray between the disc standby position and the disc recording/reproducing position. The recording/reproducing section brings the tray catch lever into alignment with the selected tray in an up/down direction during the tray selection operation. There is no need for any additional driving gear train for the tray selection operation.

[0011] According to the embodiment, two parts (the tray catch lever and the tray drive rack) are used to drive the tray. This permits the height of the shaft profile to be reduced by half. This configuration will remarkably facilitate the control of the straightness of the parts. In the present design the tray catch lever may be mounted on the recording/reproducing section and supported on the UD base in a stable manner. This configuration provides a stronger construction to the driving mechanism. The recording/reproducing section can align the tray catch lever with a selected tray by a

vertical movement with a constant pitch and in a more accurate manner. In order to achieve a good contact but less friction force generated during a tray driving operation, a round smooth surface ring profile may be formed inside the cavity within the tray catch lever. The round smooth surface ring profile contacts the shaft profile of the tray driving rack. Furthermore, the outer surface of the tray catch lever also has similar round ring surface which touches a wall of UD base.

[0012] In one preferred embodiment of the present invention, the tray catch lever rotates away from tray's hook profile when it is driven by the tray driving rack to the disc standby position, and when the tray driving rack moves the tray catch lever backward in the direction of the disc recording/reproducing position, the tray catch lever rotates into tray's hook profile and drives the tray.

[0013] According to the embodiment, by using a cam profile on the UD base and a cam profile of the tray catch lever, the tray catch lever can be made to rotate and move away from the tray once the tray is moved to the disc standby position. This configuration creates, at the disc standby position, a condition in which the tray catch lever is not engaged with the tray's hook. The tray can be driven not only to the disc recording/reproducing position, but also be driven from the standby position to the disc exchanging position at any time, even when the tray catch lever is aligned to the selected tray.

[0014] In one preferred embodiment of the present invention, the tray catch lever can perform an "over stroke" when the tray reaches the recording/reproducing position. That is, when the tray hits to stopper (which functions as a recording/reproducing position stopper), the tray drive rack can still move further. This ensures a tray stopping position where the tray will always stop before the tray drive rack stops.

[0015] Note that it is important that the disc stops at the centre of the turntable when the tray stops at the recording/reproducing position, in order to have a stable and accurate disc clamping operation. For this reason, the movement of the tray from the disc standby position to the recording/reproducing position benefits from the over stroke design. This will ensure that the tray can hit the stopper and stop at well-defined position in the recording/reproducing position. With the separation of the tray drive rack and the tray catch lever, the tray drive rack can move further after the tray hits the stopper. At this

time, the tray catch lever can rotate by some angle in order to avoid stressing the shaft profile of the tray drive rack.

[0016] In one preferred embodiment of the present invention, a simple trigger construction is used to achieve a gear engagement between the tray drive rack and the transverse slide plate. A second play lever is rotated to push a first play lever when the tray drive rack reaches the disc recording/reproducing position. A boss profile of the first play lever is then pushed to the transverse slide plate to engage to the second play gear. The second play lever is fixed to the mechanical chassis while the first play lever is fixed on the UD base.

[0017] According to the embodiment, the first play lever is fixed on the UD base in order that it can move with the recording/reproducing section and have a stable connection to the transverse slide plate. The second play lever which has a long shaft profile is fixed to the mechanical chassis in order to ensure a stable connection between the tray drive rack and the first play lever. An opening of the first play lever slides on the second play lever when the recording/reproducing section operates to select a tray in a vertical movement direction. With these configurations, a transfer motion between the tray drive rack and the transverse slide plate can be done with minimum force loss during a loading or unloading operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Fig. 1 is a perspective view showing a disc changer according to the present embodiment in a state that all trays are opened;

Figs. 2(a) to 2(e) are schematic side views of the disc changer showing various operations of the trays and a recording and/or reproducing unit of the disc changer;

Fig. 3(a) is a plan view of the disc changer according to the embodiment;

Fig. 3(b) is an enlarged perspective view of a part of a disc tray;

Fig. 4 is a side view of the disc changer shown in Fig. 3(a);

Fig. 5 is a sectional view of the disc changer taken along line L5-L5 in Fig. 3(a);

Fig. 6 is a plan view showing a detail of tray opening mechanism of the disc changer;

Fig. 7 is a bottom view of Fig. 6 focusing the tray triggering unit;

Figs. 8(a) and 8(b) are plan views of a focused part of the disc changer showing a moving process of the trigger slide plate for triggering trays;

Figs. 9(a) to 9(c) are plan views of the trigger slide plate showing a moving sequence thereof for triggering trays and locking/unlocking trays in a standby position;

Fig. 10(a) is an explanatory drawing showing various locations of a boss portion of the trigger slide plate;

Fig 10(b) is a side view of the trigger slide plate;

Figs. 11(a) to 11(c) are plan view of a tray driving gear unit showing engagement and disengagement thereof to the tray;

Figs. 12(a) to 12(d) are explanatory drawings showing a sequence of a motion of a tray lock lever;

Fig. 13(a) is an exploded view of a tray driving gear unit;

Fig. 13(b) is a perspective view of a complete assembly of the tray driving gear unit;

Fig. 14 is a perspective view of the tray driving gear unit and a gear mechanism for driving it;

Figs. 15(a) to 15(h) are explanatory drawings showing a sequence of “RESET” the tray driving gear unit;

Fig. 16 is a side view of the tray driving gear unit with trays at standby position;

Fig. 17 is an enlarged perspective view of the tray driving gear unit with trays at standby position;

Figs. 18(a) to 18(d) are explanatory drawings showing a sequence of the tray driving gear unit for driving trays one by one from top to bottom;

Fig. 19(a) is a top view of the disc changer;

Fig 19(b) is a side view showing the tray driving gear unit which engages with trays;

Figs. 20(a) to 20(c) are side views showing a sequence of closing the top tray from the disc exchange position to the disc standby position;

Fig. 21 is a plan view showing a total layout of a driving (gear) mechanism in the disc changer according to the embodiment;

Fig. 22 is a plan view showing the details of a main part of Fig. 21;

Fig. 23 is a perspective view showing a gear engagement around a switching gear.

Fig. 24 is a perspective view showing a gear engagement around a function gear.

Figs. 25(a) and 25(b) are schematic side views showing a first gear train changing system by a switching gear;

Figs. 26(a) and 26(b) are schematic side views showing the second gear train changing system by a function gear;

Fig. 27 is a perspective view of a function lever and a function gear in an assembly condition;

Fig. 28(a) is a plan view showing a cam gear;

Fig. 28(b) is a perspective view showing the outer profiles at the lower side of the cam gear;

Fig. 29 is a block diagram for explaining a switching mode of the driving mechanism in the disc changer;

Fig. 30 is a plan view showing a gear train of a tray open/close system in the disc changer;

Figs. 31(a) to 31(d) are plan views showing the sequence of tray opening operation which mainly controlled by cam gear;

Figs. 32(a) and 32(b) are perspective views showing a trigger gear and a trigger slide plate;

Fig. 33 is a plan view showing a gear train of elevation system in the disc changer;

Fig. 34 is a perspective view showing the components of the elevation unit;

Fig. 35 is a side view showing a step-like cam profile on a right side UD rack;

Figs. 36(a) and 36(b) are perspective views respectively showing the recording/reproducing section at an upper most position and a lower most position;

Fig. 37 is a plan view showing a gear train of tray play/stock system in a disc changer;

Figs. 38(a) and 38(b) are plan views showing the movement of driving trays between the disc standby position and the recording/reproducing position;

Fig. 39 is a perspective view showing the components of the tray driving rack unit; Fig. 40(a) is a perspective view showing an assembled state of the tray driving rack unit;

Fig. 40(b) is an enlarged perspective view showing a substantial part of the tray driving rack unit;

Fig. 41(a) is a perspective view showing an assembled state of the tray catch lever and the tray drive rack;

Fig. 41(b) is a plan view showing the assembled state of the tray catch lever and the tray drive rack;

Fig. 41(c) is a sectional view taken along line L41-L41 in Fig. 41(b);

Fig. 42 is a perspective view showing the tray drive rack and the tray catch lever engaging with a tray;

Fig. 43(a) is a plan view showing the tray drive rack and the tray catch lever engaging with a tray;

Fig. 43(b) is a sectional view taken along line L43-L43 in Fig. 43(a);

43(c) is an enlarged sectional view showing a fitting portion of the tray catch lever to the long shaft of the tray drive rack;

Fig. 44(a) is a plan view showing the tray driving rack unit assembled to UD base;

Fig. 44(b) is a sectional view taken along line L44-L44 in Fig. 44(a);

Fig. 44(c) is an enlarged sectional view showing a fitting portion of the tray catch lever to the guide slot of the side wall of UD base;

Figs. 45(a) to 45(d) are enlarged plan views showing a moving sequence of a tray catch lever to drive trays from disc standby position to the recording/reproducing position;

Figs. 46(a) to 46(d) are enlarged plan views showing a sequence of an operation of tray driving rack unit;

Fig. 47(a) is a bottom view of the tray before it stopped at the recording/reproducing position by a stopper on UD base;

Fig. 47(b) is an enlarged bottom view of the tray catch lever in Fig. 47(a);

Fig. 48(a) is a plan view of the tray when it stopped at the recording/reproducing position by a stopper on UD base;

Fig. 48(b) is an enlarged plan view of the tray catch lever in Fig. 48(a);

Fig. 49(a) is a bottom view of the tray when it stopped at the recording/reproducing position by a stopper on UD base;

Fig. 49(b) is an enlarged bottom view of the tray catch lever in Fig. 49(a);

Fig. 50(a) is a plan view of the tray in a condition where the tray catch lever moves further after tray is stopped at the recording/reproducing position;

Fig. 50(b) is an enlarged plan view of the tray catch lever in Fig. 50(a);

Fig. 51(a) is a bottom view of the tray in a condition where the tray catch lever moves further after tray is stopped at the recording/reproducing position;

Fig. 51(b) is an enlarged bottom view of the tray catch lever in Fig. 51(a);

Fig. 52 is a side view showing a clamper unit in an unclamping condition;

Fig. 53 is a side view showing the clamper unit in a clamping condition;

Fig. 54 is an enlarged plan view showing a locking system for trays at disc standby position;

Fig. 55(a) is a plan view of a tray lock lever;

Fig. 55(b) is a perspective view of the tray lock lever.

Fig. 56 is a diagram showing a relationship between cam gear positions and locking types of the tray;

Fig. 57(a) to 57(c) are enlarged plan views showing tray lock levers in locking trays at standby position;

Fig. 58 is a perspective view of the disc changer from front side in a state trays are locked at stand by position;

Fig. 59 is a perspective view of the disc changer from rear side in a state trays are locked at stand by position;

Fig. 60 is a plan view showing a locking mechanism at the recording/reproducing section.

Figs. 61(a) and 61(b) are perspective views showing a first lock lever and a second play gear in a lock condition;

Fig. 62(a) and 62(b) are a plan view and a perspective view showing a first lock lever as a locking device;

Fig. 63(a) and 63(b) are a plan view and a perspective view showing the first lock lever;

Fig. 64(a) is a plan view showing a locking condition of the first lock lever.

Fig. 64(b) is a plan view showing an unlocking condition of the first lock lever;

Fig. 65 is a perspective view showing a condition where the cam gear rotates to a position for unlocking the first lock lever;

Fig. 66 is a plan view showing a second lock lever as a locking device in the changer mechanism;

Fig. 67 is a perspective view showing a second lock lever and a second UD gear in an unlock condition;

Fig. 68(a) is a plan view showing a locking condition of the second lock lever;

Fig. 68(b) is a plan view showing an unlocking condition of the second lock lever;

Fig. 69 is a plan view of a cam gear explaining an operation thereof when it rotates in a clockwise and a counter-clockwise direction;

Fig. 70 is a perspective view show a condition where the cam gear is rotated to a position for unlocking the second lock lever;

Fig. 71 is a perspective view showing another locking system that prevents a movement of the recording/reproducing section when one of the tray is at the recording/reproducing position; and

Fig. 72 is a locking system summary table at recording/reproducing section.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanied drawings.

[0020] Fig. 1 is a perspective view showing a disc changer 1 according to the present embodiment in a state that all trays T are opened. As shown in Fig. 1, the disc changer 1 is provided with a plurality of trays T. In the embodiment, the disc changer 1 is provided with five trays T (labeled T1-T5), but in other embodiments there may be a different number of trays T. Each tray T is capable of carrying a disc D thereon. The disc D may be a large disc Da having a larger diameter of 12 cm or a small disc Db having a smaller diameter of 8 cm depending on user's requirement, for example. The disc changer 1 is

also provided with a generally box-like shaped mechanical chassis 3 which serves as a housing or an outer frame body thereof.

Each tray T can be stored within the mechanical chassis 3 in a state that they are stacked in a substantially vertical direction perpendicular to a main surface of the disc D, and can be moved in a substantially horizontal direction parallel to the main surface of the disc D.

[0021] Figs. 2(a) to 2(e) are schematic side views of the disc changer 1 showing various operations of the trays T and a recording/reproducing section 70 of the disc changer 1. As shown in the drawings, the disc changer 1 is provided with, as tray positions, three different positions which are different in horizontal direction to each other. That is, a disc exchange position X in which the tray T protrudes outward from the mechanical chassis 3, a standby position Y in which the tray T is stored in the mechanical chassis 3 and a recording/reproducing position Z in which the tray T is correctly positioned to interact with the recording/reproducing section 70. The recording/reproducing position Z is set at near a back in the mechanical chassis 3, and the standby position Y is set at near an entrance of the mechanical chassis 3.

[0022] Among the Figs. 2(a) to 2(e), Fig. 2(a) shows a RESET state. In this RESET state, all the five trays T except for the highest level tray T1 are stored and aligned with one another at the standby position Y. The recording/reproducing section 70 is movable in a vertical direction, and is shown in Fig. 2(a) at its highest position. The highest level tray T1 is stored at recording/reproducing position Z.

[0023] Fig. 2(b) shows a series of disc exchanging states. In the state shown in Fig. 2(b-1), all trays T are moved to the disc exchange position X at once. It will be noted that the discs D (Da or Db) can be put on the trays T or removed from the trays T by moving the trays T one by one from top to bottom, as shown in the sequence of images 2(b-1) to 2(b-5).

[0024] Fig. 2(c) shows a series of recording/reproducing states. In each of these states, a specified tray T is moved to the recording/reproducing position Z from the standby position Y and is stopped there, thereafter a recording or reproducing signal on the disc D on the specified tray T is started. The disc D which is to be performed the recording or reproducing signal thereon can be exchanged by exchanging the specified tray T. With

respect to Fig. 2(c-1), the arrangement of the trays T is the same as the RESET shown in state Fig. 2(a), because the highest tray T1 is located to the recording/reproducing unit 70. The sequence of images Fig. 2(c-1) to Fig. 2(c-5) show how the trays T are successively moved to the recording/reproducing position Z.

[0025] Moreover, Fig. 2(d) shows a series of disc exchanging states during the recording and/or reproducing operation, for example a disc exchanging while tray T1 is at the recording/reproducing position Z. Fig. 2(d-1) shows the disc changer 1 in the same configuration as Fig. 2(c-1) in which all the discs D are in the disc exchange position X. In the state shown in Fig. 2(d-2), except for the tray T1 which supports a disc D during the recording or reproducing operation, all trays T (T2-T5) are positioned at the disc exchange position X, and in the sequence of images 2(d-2) to 2(d-5) the trays T are closed one by one from top to bottom, so that a disc D can be put on and/or removed from each tray T (T2-T5) when that tray T is the uppermost one at the disc exchange position X.

[0026] Fig. 2(e) shows in Fig. 2(e-1) to 2(e-5) a series of images which are respective fully-open states of the trays T during the recording and/or reproducing operation. In each of these states a single specified tray T is at the recording or reproducing position Z, and all the other trays T are positioned at the disc exchange position X. A disc D can be put on the corresponding tray or removed from it when the tray T is in the disc exchange position X, while the disc D on the specified tray T in the recording or reproducing position Z is experiencing the recording or reproducing operation.

[0027] The whole configuration of a disc changer 1 according to an embodiment of present invention which performs the above-described operations will be explained in accordance with Figs 3 to 5.

[0028] Fig. 3(a) is a plan view of the disc changer 1 according to the embodiment, Fig. 3(b) is an enlarged perspective view of a part of a tray T, Fig. 4 is a side view of the disc changer 1 shown in Fig.3, and Fig.5 is a sectional view of the disc changer 1 taken along line L5-L5 of Fig. 3(a).

[0029] As shown in Figs. 3 to 5, each tray T has a large diameter step Ta and a small diameter step Tb on the upper surface. Thereby, a selected one of large disc Da and a

small disc Db having different diameters (12 cm and 8 cm) to each other can be loaded on the tray T.

In the tray T, grooves Tc are formed on both right and left sides at the back, a gear rack Td is formed on one side (the left side, for example), a step up surface Te is formed on the left side at the back in rear portion of the tray T. Also, as shown in Fig. 3(b), a rib Tf is formed on the left side at the back in rear portion of the tray T, underneath the rack Td. Further, an opening of a hook profile Tg is formed on the left side of the rear portion of a tray support.

[0030] A plurality of (e.g. five) trays T are separately arranged in parallel while being stacked substantially in a vertical direction, that is, perpendicular to the main surfaces of the discs D. Moreover, as shown in Fig. 3, the trays T are supported by guide ribs 3a provided inside on the right and left sides of the mechanical chassis 3, so that the trays T can move substantially in a horizontal direction (lateral direction), that is in parallel with main surfaces of the disc D.

[0031] The trays T are moved by a tray driving gear unit 20 provided on the left side of the mechanical chassis 3, between the disc exchange position X and the standby position Y. A tray driving rack unit 60 is provided on the left side rearward of the trays T. The tray driving rack unit 60 is mounted on an UD base 5, moves and aligns itself to a specified tray address, and transfers trays T to the recording/reproducing section 70. It is to be noted that Figs. 3 to 5 show a state in which the highest level tray T1 (the first tray) is located at the disc exchange position X.

[0032] The disc recording/reproducing section 70 is provided behind the trays T located at the standby position Y. The disc recording/reproducing section 70 is supported by a left guide rib 3b and a right guide rib 3c which are formed on the sides of mechanical chassis 3, and is moved in a up and down direction (vertical direction) by an elevating unit 30 which will be discussed later.

A triggering unit 50 (shown in Fig. 4, and described in more detail below with reference to Fig. 31) is provided on the left side of the disc changer 1, and moves in a direction parallel to the left side surface of the mechanical chassis 3 to push the trays T so as to engage them with the tray driving gears unit 20. Further, there is provided a driving mechanism 100 (described below with reference to Fig. 21) composed of a motor for

driving each part, gear trains, a plunger unit for switching between gear trains, and a detection switch, under the trays T located at the standby position Y.

[0033] As mentioned above, the tray driving gear unit 20 is located on the left side of the mechanical chassis 3, and an open switch lever 27 for detecting trays T to be driven toward the disc exchange position X is provided at the vicinity of the tray driving gear unit 20. A gear cover 28 is mounted to cover a predetermined part of the top of the mechanical chassis 3, including the top of the tray driving gear unit 20 and the open switch lever 27. Thereby, longitudinal (vertical) axes of the tray driving gear unit 20 and the open switch lever 27 are correctly and stably positioned in relation to each other. Moreover, a top cover 4 is mounted on the top of the mechanical chassis 3 to increase the stiffness of the mechanical chassis 3 and to protect it from dust.

[0034] Fig.6 is a top view showing a detail of the tray opening mechanism of the disc changer 1. The tray opening system includes the trays T, the tray driving gear unit 20 capable of driving trays T from the standby position Y to the disc exchange position X, and a trays triggering unit 50 having a trigger slide plate 52. The trigger slide plate 52 is moved by a trigger gear 51 and a cam gear 114 to lock/unlock trays T at standby position and push all trays T to engage them with the tray driving gear unit 20. The trigger slide plate 52 moves by sliding at the side of mechanical chassis 3, while a boss portion 52c on the trigger slide plate 52 moves to follow cam profiles 3d on both the top and bottom of mechanical chassis 3.

[0035] Fig. 7 is a bottom view of a portion of the section of the disc changer 1 shown in Fig. 6, focusing on the tray triggering unit 50. As shown in Fig. 7, the trigger gear 51 with a gear rack 51b is connected to the cam gear 114 by a boss 51a is fitted into a groove 114b (see Fig. 6) of the cam gear 114. When the cam gear 114 is rotated, the boss 51a is driven in accordance with a profile of the cam groove 114b, thereby the trigger gear 51 is rotated around a supporting boss 51c. Thus, a gear rack 51b on the trigger gear 51 which engages with a rack profile 52b of the trigger slide plate 52 will push the trigger slide plate 52 to move in forward direction, and then push trays T at a trigger rib Th (see Fig. 8(b)).

[0036] A tray lock lever 53 is arranged between the trays T and the trigger side plate 52. The tray lock lever 53 is provided with a locking profile 53a (a convex part, for example)

for locking trays T at standby position Y. The locking profile 53a controls the trays T at the standby position by contacting surfaces Tk and Tm of a recess formed on the side of the trays T.

[0037] Figs. 8(a) and 8(b) show a moving process of the trigger slide plate 52 for triggering trays T. Boss shaped portions 52c are provided on the top and the bottom of the trigger slide plate 52. The boss portion 52c is fitted into a cam groove 3d formed on the top and the middle of the mechanical chassis 3. The cam groove 3d includes three moving paths P1-P3 for the boss portion 52c of the trigger slide plate 52.

A moving path P1 is a "HOME" path for the boss portion 52c of the trigger slide plate 52, a moving path P2 is a "TRIGGER" path P3 and a moving path P2 is a "TRANSITION" path located between the "HOME" path P1 and the "TRIGGER" path P3.

[0038] Fig. 8(b) shows the boss portion 52c of the trigger slide plate 52 in the "TRIGGER" path P3, the driving rib 52a of the trigger slide plate 52 is touching the trigger rib Th of the tray T, and ready to push trays T to move towards the tray driving gear unit 20.

[0039] Figs. 9(a) to 9(c) show a moving sequence of the trigger slide plate 52 for triggering the trays T and locking/unlocking the trays T in the standby position Y. Fig. 9(a) shows the trigger slide plate 52 at "HOME" position. A first protrusion profile 52e is touching a rib 53b protruding from the tray lock lever 53, thereby a movement of the tray lock lever 53 in arrow F or arrow E direction is prevented. The locking profile 53a is touching the surfaces Tk and Tm, thereby trays T are "locked" at the standby position Y. When the boss portion 52c of the trigger slide plate 52 moves to the "TRANSITION" path, the first protrusion 52e moves away from the rib 53b, as shown in Fig. 9(b). However, the tray lock lever 53 will remain in the same condition as Fig. 9(a).

[0040] This is due to a function of a plastic spring 53d of the tray lock lever 53. The plastic spring 53d does not allow the tray lock lever 53 to rotate in the direction of the arrow E and urge the tray lock lever 53 towards the direction of the arrow F if a bending force is applied on the plastic spring 53d. Before the driving rib 52a of the trigger slide plate 52 reaches so as to touch the surface Th of a recess formed on tray T as shown in Fig. 9(c), the second protrusion 52d already pushes a convex part 53c of the tray lock

lever 53 to another level. Thus, the tray lock lever 53 rotates in direction of arrow E and “unlocks” trays T.

[0041] Fig. 10(a) explains the various locations of the boss portion 52c of the trigger slide plate 52 from a “HOME” position Q1 to a “TRIGGER” position Q3 and from a “TRIGGER” position Q4 to a “HOME” position Q7. At a neutral-line position, trigger slide plate ribs 52f are in no stress condition. The stress increases as the boss portion 52c of the trigger slide plate 52 travels from the “HOME” position Q1 to the “TRIGGER” position Q3 through a "TRANSITION" position Q2. Fig 10(b) shows a side view of the trigger slide plate 52.

[0042] At the “TRIGGER” position Q3, the trigger slide plate 52 starts to push trays T to engage them with the tray driving gear unit 20. At end of moving sequence, the opening of the cam profile allows the boss portion 52c to release the stress trigger slide plate ribs 52f and return to the neutral condition. Thus, the boss portion 52c of the trigger slide plate 52 can return to “HOME” position following the other path to avoid its profile overlapping with the trays T when the trays T return from the disc exchange position X to the standby position Y.

[0043] At the “HOME” position Q7, bending stress start to increase on the trigger slide plate rib 52f at the opposite direction (towards the left). At a position Q8, the stressed trigger slide plate ribs 52f is released after the trigger slide plate 52 moves to an opening on the cam profile and return to its origin position (“HOME” position).

[0044] Figs. 11(a) to 11(c) show the engagement and disengagement of the tray driving gear unit 20 with the tray T. At an initial condition (when the trays T are at standby position Y, before they are triggered by the trigger slide plate 52), the gear rack Td is not engaged with the tray driving gear unit 20. After the trays T are triggered by the trigger slide plate 52, the trays T move forward and the gear rack Td will engage with the tray driving gear unit 20. Thus, all trays T will be driven forward at the same time to the disc exchange position X.

[0045] For the return condition, the gear rack Td leaves the tray driving gear unit 20 when it reaches the standby position Y. The tray lock lever 53 will be pushed away by trigger rib Th as shown in Fig. 12(b), at the time that the last gear tooth of the gear rack Td leaves the tray driving gear units 20, and the tray lock lever 53 rotates into the recess

of tray rib as Fig. 12(a). The contact of the locking profile 53a and a surface Tj of the recess create an inter-lock effect to prevent trays T from moving towards the disc exchange position X after reaching the standby position Y. After all the trays reach to the standby position Y, the first protrusion 52e of the trigger slide plate 52 will be pushed to the lock lever rib 53b and aligns and locks the trays T at the standby position Y as shown in Fig. 9(a).

[0046] Fig. 13(a) is an exploded view of the tray driving gear unit 20. The reference numeral 24 denotes a top tray drive gear which drives the upper most tray T1, the reference numeral 22 denotes a tray drive gear which drives trays T (T2-T4) other than the upper most tray T1 and the lower most tray T5, the reference numeral 25 denotes a bottom tray drive gear which drives the lower most tray T5. Further, the reference numeral 23 denotes a plastic ring located between two drive gears adjacent to each other which enables the drive gear 22, 24 or 25 to have a dummy turning, and the reference numeral 21 denotes a shaft gear fixed to a shaft 21s which holds all drive gears 22, 24, 25 and the plastic rings 23. Top drive gear 24 is fitted to the shaft 21s in a tight fitting condition and rotates as one solid body with it. Fig. 13(b) shows a complete assembly of the tray driving gear unit 20. As seen from Fig. 13(b), the plastic ring 23 is provided with stopper ribs 23a, 23b, the top tray drive gear 24 is provided with stopper ribs 24a, 24b.

[0047] Fig. 14 is a perspective view of the tray driving gear unit 20 and a gear mechanism for driving it. As shown in Fig. 14, the shaft gear 21 of the tray driving gear unit 20 is engaged with a tray relay gear 112 which is driven by the cam gear 114. When cam gear 114 rotates in a clockwise direction, the shaft gear 21 is driven to rotate in the same direction. The top driving gear 24 also rotates in the same direction.

It is to be noted that a metal spring 26 having protrusions 26a is provided at a vicinity of tray driving gear unit 20. And, the protrusions 26a of the metal spring 26 are touching to side portions of tray drive gears 22 and 25, thereby friction force is provided to the tray drive gears 22 and 25 so that they are held in position before they are driven by actual force from a electric motor 116 (described in more detail below with reference to Fig. 21).

[0048] Figs. 15(a) to 15(g) show a “RESET” operation of the tray driving gear unit 20. The “RESET” is to rotate all tray drive gears 22, 24 and 25 with the same rotational

speed, as if they were one solid gear which has a plurality of layers of drive gears 22, 24 and 25 capable of engaging a plurality of trays T. In this explanation, only the top tray drive gear 24 and the adjacent lower level tray drive gear 23 are explained because the “RESET” sequence for the following tray drive gears is the same. Figs. 16 and 17 show the tray driving gear unit 20 after driving all trays T to the standby position Y.

[0049] In order to drive the trays T to the disc exchange position X, the tray driving gear unit 20 needs to rotate in a clockwise direction in the drawings. A tray relay gear 112 which is driven by the cam gear 114 rotates to turn the shaft gear 21. Referring to Figs. 14 and 15(a), as the top tray drive gear 24 rotates together with the shaft 21s in the clockwise direction, a side surface of the stopper rib 24b on the top tray drive gear 24 will contact a side surface of the stopper rib 23a (level 1) on the adjacent lower level plastic ring 23 after about 1 round of rotation. Top tray drive gear 24 and the plastic ring 23 rotate together and continue the second rotation, until a side surface of the stopper rib 23b (level 1) of the plastic ring 23 contacts to a side surface of the stopper rib 23a (level 2) which is located 2 levels lower than top tray drive gear 24.

[0050] Figs. 15(e) and 15(f) are the top and isometric views of the tray driving gear unit 20 without the top tray drive gear 24. When a stopper rib 23a of the second level plastic ring 23 rotates, it touches the stopper rib 22b on the next tray drive gear 22. This tray drive gear 22 now will rotate in the same direction and speed with top drive gear 24. The rotation continues until the bottom tray drive gear 25 starts to rotate, at this time the tray driving gear unit 20 is completely “RESET” as shown in Fig. 15(g). In this condition, all gear teeth are aligned with each other and rotate as one solid body gear.

[0051] Fig. 16 is a side view of tray driving gear unit 20 with trays T at standby position Y. And, Fig. 17 is an enlarged perspective view of tray driving gear unit 20 with trays T at standby position Y. As explained above, the metal spring 26 having protrusions 26a is provided at a vicinity of the tray driving gear unit 20. The protrusions 26a of the metal spring 26 are touching side portions of the tray drive gears 22 and 25, thereby friction force is provided to the tray drive gears 22 and 25 so that they are held in position before they are driven by actual force from the motor 116.

[0052] Figs. 18(a) to 18(d) show the operation of the tray driving gear unit 20 for driving trays T to disc standby position Y, one by one from top to bottom. Top tray drive gear 24 tightly fitted to the shaft 21s at this time also starts to rotate among all tray drive gears.

In order to drive trays T from the disc exchange position X to the standby position Y, the tray driving gear unit 20 needs to rotate in a counterclockwise direction in the drawings. This time, the side surface of the stopper rib 24a after the first rotation will contact the side surface of the stopper rib 23b (level 1) of the plastic ring 23, thereby the tray T is driven from the disc exchange position X to a half-way position between the disc exchange position X and the standby position Y, because number of plastic ring 23 used between the tray drive gears is two. The second rotation continues until the stopper rib 23a (level 1) contacts the stopper rib 23b (level 2). Top tray T1 is now completely driven to the standby position Y. The second tray T2 will start to move when the stopper rib 23a (level 2) rotates and pushes the stopper rib 22b on the lower tray drive gear 22.

[0053] Fig. 19(a) is a plan view of the disc changer 1, where the top tray T1 has been driven by the top tray drive gear 24 to the standby position Y and the second tray T2 is waiting for rotation of tray driving gear unit 20 to move from the disc exchange position X to the standby position Y. Fig 19(b) shows the tray driving gear unit 20 which engages with trays T. Top tray T1 moves to the standby position Y and disengages from the tray drive gear 22 and other lower level trays T are at the disc exchange position X. Closing of trays T will be performed from top to bottom.

[0054] Figs. 20(a) to 20(c) are side views showing a sequence of closing the top tray T1 from the disc exchange position X to the disc standby position Y. Fig. 20(a) shows a state in which all trays T are positioned at the disc exchange position X. It is to be noted that the tray driving gear unit 20 is to rotate as one body when it drives trays T to the disc exchange position X.

Fig. 20(b) shows a state in which the top tray T1 is closed to half way between the disc exchange position X and the disc standby position Y. It is performed by a first rotation of the tray driving gear unit 20. Fig. 20(c) shows a state in which the top tray T1 is fully closed to the disc standby position Y. It is performed by a second rotation of the tray driving gear unit 20. Thereafter, the second tray T2 will start to move, if the tray driving gear unit 20 continues to rotate.

[0055] The plastic rings 23 in this design are useful for reducing the size of the tray drive gears 22 by providing dummy rotation to the drive gears. A first tray drive gear will rotate to close a tray T just after the tray T disengages from the first tray drive gear, and a stopper rib of the first tray drive gear will hit a stopper rib of the plastic ring 23, so that a second tray drive gear is rotated. This means that the first tray drive gear will rotate by a degree of $(360-2\theta)$ (where angle θ is an angle corresponding to a width of a stopper rib, as shown in Fig. 15(h) to drive the tray to disc standby position before the second tray drive gear starts to rotate to drive a second tray T2.

[0056] If there were no plastic rings 23, the PCD (pitch circle diameter) of drive gears of “D₁” for a tray ejection stroke of “y” would be given by the formula (1).

$$D_1 = [y/\pi] \times [360/(360-2\theta)] \text{ --- (1)}$$

Since plastic rings 23 are used, the PCD (pitch circle diameter) of drive gears of “D₂” for a tray ejection stroke of “y” will be given by the following formula (2). In this case, a tray ejection stroke of “y” will consist of a stroke achieved by a tray drive gear 22 and a stroke achieved by a plastic ring 23.

$$y = \pi D_2 [(360-2\theta)/360] + \pi D_2 [(360-2\theta)/360] = 2\pi D_2 [(360-2\theta)/360]$$

$$D_2 = [1/2] \times [y/\pi] \times [360/(360-2\theta)] \text{ --- (2)}$$

$$D_2 = [1/2] D_1$$

Therefore, by using plastic rings 23 (dummy rings), the PCD of tray drive gear 22 can be reduced by 1/2.

[0057] If “n” pieces of plastic rings 23 were used (as they might be in other embodiments of the invention), the PCD (pitch circle diameter) of drive gears of “D_n” for a tray ejection stroke of “y” would be given by the following formula (3).

$$y = \pi D_2 [(360-2\theta)/360] + n \{ \pi D_2 [(360-2\theta)/360] \} = (1+n) \pi D_2 [(360-2\theta)/360]$$

$$D_n = [1/(1+n)] \times [y/\pi] \times [360/(360-2\theta)] \text{ --- (3)}$$

$$D_n = [1/(1+n)] D_1$$

With more plastic rings 23, the diameter of tray drive gear 22 can be reduced more.

[0058] Next, a driving mechanism of the disc changer 1 will be explained.

Fig. 21 is a plan view showing a total layout of a driving (gear) mechanism 100 in the disc changer 1 according to the embodiment. Fig. 22 is a plan view showing the details of a main part of Fig. 21.

[0059] In Figs. 21 and 22, a reference character Z denotes a disc recording/reproducing position, a reference character Y denotes a disc standby position and a reference character X denotes the disc exchange position. Also, a reference numeral 100 denotes a gear mechanism of the disc changer 1 located at the disc standby position Y.

[0060] In Figs. 21, 22 and 23, a reference numeral 116 denotes an electric motor which provides driving power to the gear mechanism. The driving mechanism 100 includes a motor pulley 115, a belt 121, a pulley gear 101, a first relay gear 102, a second relay gear 103 and a third relay gear 104. The second relay gear 103 is provided on a back side of the pulley gear 101. The driving mechanism 100 also includes a switching gear 105, a long gear 106, a function gear 107, a first UD gear 108, a second UD gear 109, a first play gear 110 and a second play gear 111. Further, the driving mechanism 100 includes a main drive gear 113, a cam gear 114 and a tray relay gear 112. All the drive gears are located inside the mechanical chassis 3.

[0061] Fig. 23 is a perspective view showing a gear engagement around a switching gear 105. Switching gear 105 always engages to the third relay gear 104 and an up/down movement of the switching gear 105 is performed by sliding along the third relay gear 104. Each switching gear tooth 105a has a taper surface for easy engagement to a long gear 106 and a main drive gear 113. The main drive gear 113 has a coining profile 113a on each gear tooth for easy engagement to the switching gear 105.

[0062] Fig. 24 is a perspective view showing a gear engagement around a function gear 107. Function gear 107 always engages to the long gear 106 and an up/down movement of the function gear 107 is performed by sliding along the long gear 106. Each function gear tooth 107b has a taper surface for easy engagement to a first UD gear 108 and a first play gear 110. The first play gear has a coining profile 110a on each gear tooth for easy engagement to the function gear 107.

[0063] Figs. 25(a) and 25(b) are schematic side views showing a first gear train changing system by a switching gear 105. As shown in Fig. 25(a), the switching gear 105 is supported by a plunger lever 126. When an electric current is applied to a plunger unit

117, the plunger unit 17 pulls the plunger lever 126 by using a moving core 118, and in this way the switching gear 105 will be lifted up to engage with the long gear 106. On the other hand, when no electric current is supplied to the plunger unit 117, the switching gear 105 will be pushed down by a coil spring 119 and engaged with the main drive gear 113, as shown in Fig. 25(b).

[0064] The operation of the driving mechanism 100 when the switching gear 105 is at the lower position is to drive the functions of a tray open/close system or selection system (play/stock driving / elevation driving). On the other hand, the operation of the driving mechanism 100 when the switching gear 105 is at the upper position is to drive the functions of a tray play/stock system or an elevation system.

[0065] Figs. 26(a) and 26(b) are schematic side views showing the second gear train changing system by a function gear 107. As shown in these drawings, the function gear 107 is supported by a function lever 125. The round end portion 125a of the function lever 125 moves following to the outer profiles 114e and 114f at the lower side of the cam gear 114. When cam gear 114 rotates and plan profile 114e is touching the round end portion 125a of the function gear 107, the function gear 107 is lifted up by the function lever 125. At this time, the function gear 107 is engaged with the first UD gear 108 which will drive the elevation system. Fig. 26(b) shows a flat surface 114f of the cam gear 114 touching the round end portion 125a. In this state, the function gear 107 is pushed down by the function lever 125, and the function gear 107 is engaged with the first play gear 110 which will drive the tray play/stock system.

[0066] Fig. 27 is a perspective view of a function lever 125 and a function gear 107 of the disc changer 1 in an assembly condition. Function lever 125 has a hook portion 125b which holds a gear body 107a of the function gear 107. With the configuration, function lever 125 can always hold the function gear 107, and the function gear 107 can move in a vertical direction by a motion of the function lever 125.

[0067] Fig. 28(a) is a plan view showing a cam gear 114. And Fig. 28(b) is a perspective view showing the outer profiles 114e and 114f at the lower side of the cam gear 114. As shown in Fig. 28(a), the gear teeth 114a of the cam gear 114 are engaged with the main drive gear 113 and the tray relay gear 112. The cam gear 114 has cam

grooves 114b, 114c and 114d to create the rotational movements of the trigger gear 51, the first lock lever 93 and the second lock lever 94.

The outer profile 114e and 114f at the lower side of the cam gear 114 is used to change the state of function lever 125. The flat surface profile 114e allows the function gear 107 to engage to perform an elevation driving function and the flat surface profile 114f allows the function gear 107 to engage to perform a tray play/stock function. The cam gear 114 also has a sensor profile 114g for sensing changes of electronic sensor signal for indicating the tray T condition when opening or closing.

[0068] In order to achieve single motor driving, the driving mechanism 100 of the disc changer 1 has a switching mode as explained by a block diagram shown in Fig. 29.

Power supplied from electric motor 116 is directed to the different gear train systems (an elevation system, a tray play/stock system and a tray open/close system) by using the switching gear 105 and the function gear 107. The level of both gears is changed by using the plunger unit 117 and the flat surface profiles 114e and 114f of the cam gear 114.

[0069] Fig. 30 is a plan view showing a gear train of a tray open/close system in the disc changer 1. This gear train drives trays T between the disc exchange position X and the disc standby position Y.

[0070] When the disc changer 1 operates to drive the gear train of tray open/close system, a driving source gear train will connect to the main drive gear 113. The driving source gear train is to connect the driving source from the electrical motor 116 all the way until the switching gear 105. The gear train is from cam gear 114, tray relay gear 112 and then to tray driving gear unit 20 through a shaft gear 21. The tray driving gear unit 20 is designed such that it can drive all trays T from the standby position Y to disc exchange position X at once.

[0071] Figs. 31(a) to 31(d) are plan views showing the sequence of tray opening operations which are mainly controlled by cam gear 114. The tray open/close system includes the triggering section 50 and tray driving gear unit 20. The triggering section 50 comprises a trigger gear 51, a trigger slide plate 52 and a tray lock lever 53. When the disc changer 1 is operated to drive the tray open/close system, the cam gear 114 rotates in clockwise direction to move a tray T to disc exchange position X (open), or rotates in

counter clock-wise to move a tray T to disc standby position Y (close). In the case of opening the trays T, at the time the cam gear 114 rotates, the tray driving gear unit 20 rotates to "RESET" all the drive gears in order to rotate as one body, and the cam profile 114b at the same time pushes the trigger gear 51 to rotate to drive the trigger slide plate 52.

[0072] Fig. 31(a) shows the state at the instant that the tray open/close system starts to move. The tray lock lever 53 in this state locks all trays T and tray drive gear unit 20 is not engaged with the trays T. Figs. 31(b) and 31(c) show states in which the cam gear 114 is being driven by the gear train of tray open/close system and the rotation of the cam gear 114 will move the trigger slide plate 52 through a trigger gear 51. During the movement of the trigger slide plate 52, it unlocks the tray lock lever 53 to release the trays T. Fig. 31(c) shows a state in which the trays T are pushed to engage the tray driving gear unit 20. Fig. 31(d) shows a state in which all trays T are driven to the disc exchange position X by the tray driving gear unit 20. The tray T closing is carried out by reversing the tray opening operation. Trays T will close one by one from top to bottom.

[0073] Figs. 32(a) and 32(b) are perspective views showing the trigger gear 51 and the trigger slide plate 53. In the state shown in Figs. 32(a) and 32(b), a boss 51a (see Fig. 7) of trigger gear 51 is inserted into a cam groove 114b of cam gear 114 and driven by a profile of the cam groove 114b. The cam groove profile 114b on cam gear 114 is the control path for the trigger gear 51 movement. Gear teeth 51b on trigger gear 51 constantly engage a rack gear 52b of the trigger slide plate 52. The trigger gear 51 rotates around its supporting boss 51c which is held by a boss 120a of a pitch plate 120. A boss 51a of the trigger gear 51 is moved by the cam groove 114b. Thus, when the cam gear 114 rotates, a motion of cam groove 114b is transmitted to the trigger slide plate 52 by trigger gear 51 and allows the trigger slide plate 52 to move in a linear way.

[0074] Fig. 33 is a plan view showing a gear train of an elevation system in the disc changer 1. This gear train operates in order to move the recording/reproducing section 70 in vertical direction and then align it to specific a tray T.

[0075] When the disc changer 1 is operated to drive the gear train of the elevation system, the driving source gear train transfers the driving source from electrical motor 116 to a long gear 106, a function gear 107, a first UD gear 108 and a second UD gear 109. The

driving source gear train transfers the driving source from electrical motor 116 to all the way until switching gear 105. The gear train of the elevation system then will drive an elevating unit 30 for moving the recording/reproducing section 70 in vertical direction. [0076] Fig. 34 is a perspective view showing the components of the elevation unit. A right side UD rack 32 and a left side UD rack 31 are connected to each other by one connection lever 33. The elevation unit is used to move the recording/reproducing section 70 in a vertical direction by connecting to the gear train of the elevation system. The driving source is transferred by gear teeth 109a of a second UD gear 109 to a gear rack 32b of the right side UD rack 32. There is a step-like cam 32a and 31a on each UD rack 32 and UD rack 31. The step-like cams 32a, 31a have a cam profile similar to steps in a side view.

[0077] The cam profiles of the step-like cams 32a and 31a direct the movement of the recording/reproducing section 70. The bosses 5a provided on the side of a UD base 5 sit in the cam profile 32a, 31a of UD racks 32, 31 and they are supported by left guides 3b and a right guide rib 3c of the mechanical chassis 3. When the UD racks 32, 31 are moving linearly forward or backward, the recording/reproducing section 70 moves in vertical direction. UD rack 32 is connected to UD rack 31 to create synchronous movement by means of the connection lever 33. A boss 32c of the right side UD rack 32 is fitted into a slot 33a of the connection lever 33. Also, a boss 31b of the left side UD rack 31 is fitted into a slot 33b of the connection lever 33 on the opposite side.

[0078] Fig. 35 is a side view showing the step-like cam profile 32a on the right side UD rack 32. The step-like cam 32a has horizontal portions 32a-1 to 32a-5 which correspond to the positions or levels of the recording/reproducing section 70 that align to tray T. The level of 32a-1 to 32a-5 is determined by an electrical sensor using the sensor profile 32d.

[0079] Figs. 36(a) and 36(b) are perspective views respectively showing the recording/reproducing section 70 at an upper most position (for tray T1) and an lower most position (for tray T5). For elevating the recording/reproducing section 70 to the upper position, the right side UD rack 32 is driven by the gear train of elevation system in the forward direction. This movement will be transferred, by the connection lever 33 supported pivotally by the boss 120b of the pitch plate 120, to the left side UD rack 31. Consequently, the left side UD rack 31 will move in the rear direction. For moving the

recording/reproducing section 70 to the lower position, the moving direction of both UD racks 32, 31 are opposite to the above.

[0080] Fig. 37 is a plan view showing a gear train of the tray play/stock system in a disc changer 1. This gear train drives trays T between the disc recording/reproducing position Z and the disc standby position Y.

[0081] When the disc changer 1 operates the drive gear train of the tray play/stock system, the driving source gear train transfers the driving source from electrical motor 116 to a long gear 106, a function gear 107, a first play gear 110 and a second play gear 111. The gear train of the tray play/stock system then will drive a tray driving rack unit 60 which is capable of moving trays T between the recording/reproducing position Z and the disc standby position Y.

[0082] Figs. 38(a) and 38(b) are plan views showing the movement of driving trays T between the disc standby position Y and the recording/reproducing position Z.

After the recording/reproducing section 70 is aligned to a selected tray T level, the tray T can be driven between the disc recording/reproducing position Z and the disc standby position Y by the tray driving rack unit 60.

[0083] Fig. 39 is a perspective view showing the components of the tray driving rack unit 60. The tray driving rack unit 60 has a tray catch lever 61, a first play lever 62, a second play lever 63, a tray drive rack 64 and a transverse slide plate 65. When there are no trays T at the recording/reproducing position Z and all trays T are at the standby position Y, the gear train of tray stock/play system is connected by the second play gear 111 to the tray drive rack 64 through the gear engagement of a rack gear 64a and gear teeth 111a of the second play gear. When the second play gear 111 rotates in the clock-wise direction, tray T is driven to recording/reproducing position Z.

[0084] Fig. 40(a) is a perspective view showing the assembled state of the tray driving rack unit 60, and Fig. 40(b) is an enlarged perspective view showing a substantial part of the tray driving rack unit 60. Further, Fig. 41(a) is a perspective view showing the assembled state of the tray catch lever 61 and the tray drive rack 64, Fig. 41(b) is a plan view showing the assembled state of the tray catch lever 61 and the tray drive rack 64, and Fig. 41(c) is a sectional view taken along line L41-L41 in Fig. 41(b).

[0085] As shown in Figs. 40(a) and 40(b), the tray catch lever 61 is inserted into a guide slot 5g formed in a side wall 5w of the UD base 5, and guided by the guide slot 5g. The tray drive rack 64 is mounted on the mechanical chassis 3 and moves in a horizontal (front to back) direction between the disc recording/reproducing position Z and the disc standby position Y. Also, the tray catch lever 61 can move in vertical (up/down) direction by an up/down movement of the UD base 5 between the level of tray T1 and the level of tray T5. The tray driving rack unit 60 uses the tray drive rack 64 and the tray catch lever 61 to move the tray T between the disc standby position Y and the disc recording/reproducing position Z. The tray drive rack 64 moves the second play lever 63 and then the first play lever 62 to trigger the transverse slide plate 65 to complete the clamping operation by the clamper unit 10.

[0086] The tray drive rack 64 supported on the mechanical chassis 3 moves in a horizontal direction at the lowest level in the mechanical chassis 3. With this configuration, the tray drive rack 64 is able to have stable and constant support. This ensures a stable movement of the tray T between the disc recording/reproducing position Z and the disc standby position Y especially when the tray T contains a disc D. Although the tray drive rack 64 moves in the horizontal direction, it is not required for the tray drive rack 64 to move in a vertical (up/down) direction when the tray T is selected. This reduces the space needed to accommodate the tray drive rack 64 since it is not required to provide extra space for up/down movement of the tray drive rack 64. Thus, the space over the tray drive rack 64 can be used for other purposes, such as mounting of gears. Alternatively, the size of the disc changer 1, and especially disc changer height, can be reduced.

[0087] As shown in detail in Fig. 40(b), when the recording/reproducing section 70 (UD base 5) is positioned at the level of the uppermost tray T1, an opening 62a provided on the first play lever 62 will move by sliding on a shaft 63b of the second play lever 63 during tray selection. The shaft 63b has a smooth surface to achieve a smooth sliding between the opening 62a and the shaft 63b during the tray selection by the recording/reproducing section 70.

[0088] Further, as shown in Figs. 41(a) to 41(c), the tray catch lever 61 has a thru-hole 61a and the tray drive rack 64 is provided with a long shaft 64b. This long shaft 64b is

inserted into the thru-hole 61a, and the tray catch lever 61 is thereby supported by the long shaft 64b. Tray catch lever 61 is moved in horizontal (front to back) direction by a horizontal movement of the tray drive rack 64. The gear rack 64a of tray drive rack 64 is engaged with the second play gear 111 and driven by it to move between the disc standby position Y and the disc recording/reproducing position Z. The movement of tray drive rack 64 will also move the tray catch lever 61.

[0089] Fig. 42 is a perspective view showing the tray drive rack 64 and the tray catch lever 61 engaging with trays T in disc standby position Y. Further, Fig. 43(a) is a plan view showing the tray drive rack 64 and the tray catch lever 61 engaging with trays T in disc standby position Y, Fig. 43(b) is a sectional view taken along line L43-L43 in Fig. 43(a), and Fig. 43(c) is an enlarged sectional view showing a fitting portion of the tray catch lever 61 which is connected to the long shaft 64b of the tray drive rack 64.

[0090] As explained above, the tray catch lever 61 is supported on the recording/reproducing section 70 (UD base 5: Up/Down base) and moves on it. There is a catch protrusion 61b on top of the tray catch lever 61, and the catch protrusion 61b is used to pull a tray T to travel between the disc standby position Y and the disc recording/reproducing position Z. The actual driving force is transmitted from the tray drive rack 64 to the catch lever 61 through the long shaft 64b of the tray drive rack 64. UD base 5 brings the tray catch lever 61 into alignment with the selected tray T in an up/down direction during the tray selecting operation. . There is no need of any additional driving gear train for the tray selection operation.

[0091] As clearly shown in Fig. 43(c), a round ring protrusion 61c is provided on an inner surface of the thru-hole 61a of the tray catch lever 61, in order to maintain the contact between the outer surface of the long shaft 64b of the tray drive rack 64 and the inner surface of the thru-hole 61a of the tray catch lever 61. The round ring protrusion 61c has a smooth surface. By this configuration, it is possible to achieve a good contact without excessive frictional force being generated during a tray driving operation. Further, a round ring protrusion 61d having a smooth surface is provided on an outer surface of the tray catch lever 61.

[0092] Fig. 44(a) is a plan view showing the tray driving rack unit 60 assembled to UD base 5, Fig. 44(b) is a sectional view taken along line L44-L44 in Fig. 44(a), and Fig.

44(c) is an enlarged sectional view showing the fitting portion of the tray catch lever 61 connected to the guide slot 5g of the side wall 5w of UD base 5.

[0093] As explained above, the tray catch lever 61 is inserted into the guide slot 5g formed in the side wall 5w of the UD base 5, and movement of the tray catch lever 61 in the horizontal direction is guided by the guide slot 5g.

As clearly shown in Fig. 44(c), the round ring protrusion 61d provided on an outer surface of the tray catch lever 61, and maintains a good contact to the side wall 5w of the UD base 5, so that a contact with minimum friction is achieved. Further, a pair of rounded protrusions 5e having smooth surface are provided on upper inside edges of the guide slot 5g. The tray catch lever 61 is supported by the rounded protrusions 5e. By this configuration, it is possible to achieve a good sliding contact without excessive frictional force being generated during a tray driving operation in which the tray drive rack 64 drives a tray T between the disc standby position Y and the disc recording/reproducing position Z.

[0094] According to the embodiment, two separate parts (the tray catch lever 61 and the tray drive rack 64) are used to drive the tray T. These two parts make it possible for the height of the shaft profile to be reduced by half. This configuration remarkably facilitates the control of straightness of the parts. With the separated design for tray catch lever 61, the tray catch lever 61 is mounted on the recording/reproducing section 70 and supported on UD base 5 in a stable manner. This configuration provides a stronger construction to the driving mechanism. The recording/reproducing section 70 can align the tray catch lever 61 to the selected tray T in a vertical movement with a constant pitch and in a more accurate manner.

Furthermore, the outer surface of the tray catch lever 61 also has a round ring surface which touches a wall of UD base 5.

[0095] Figs. 45(a) to 45(d) are enlarged plan views showing a sequence in which the tray catch lever 61 moves to drive trays T from the disc standby position Y to the recording/reproducing position Z. Fig. 45(a) shows a state in which the tray catch lever 61 is away from tray T at the disc standby position Y. The UD base 5 supports the tray catch lever 61 as it moves in a vertical direction to align itself with the tray T which needs to be driven to the recording/reproducing position Z.

[0096] The tray drive rack 64 moves backward when the second play gear 111 rotates in a clock-wise direction as shown in Figs. 45(b) and 45(c), and as this happens the boss 64b on tray drive rack 64 pulls the tray catch lever 61 thru the hole 61a. As the tray catch lever 61 moves backward, the catch profile (concave portion) 61b rotates to fit into hook profile Tg of the tray T. The rotation of tray catch lever 61 is due to the cam groove 61c on the lower surface of tray catch lever 61 and a small boss 5b on UD base 5. The rotation of tray catch lever 61 is caused by the cam groove 61c fitted to the small boss 5b. Subsequently, the tray T will be moved to the disc recording/reproducing position Z by tray driving rack unit 60 as shown in Fig. 45(d).

[0097] Figs. 46(a) to 46(d) are enlarged plan views showing a sequence of an operation performed by the tray driving rack unit 60. Fig. 46(a) shows an initial position when the tray drive rack 64 and the tray catch lever 61 are positioned in the disc standby position Y. In this state, the second play gear 111 engages the rack gear 64a of tray drive rack 64, and the rack gear 65b of transverse slide plate does not engage the second play gear 111. Fig. 46(b) shows how a boss 64c of the tray drive rack 64 is moved into an opening 63a of the second play lever 63 before the end of movement of tray drive rack 64. When tray drive rack 64 continues to move backward, the second play lever 63 will be pushed by the boss 64c of tray drive rack 64 and rotates, and the boss 63b of the second play lever 63 pushes the opening 62a of the first play lever 62.

Further, a boss 62b of the first play lever 62 which is inserted into a cam profile 65c of the transverse slide plate 65 rotates and pushes the taper surface of the cam profile 65a. Transverse slide plate 65 is pushed to move to the right and the first gear tooth of the rack gear 65a will engage the gear teeth 111a of the second play gear 111 as shown in Fig. 46(c). The driving source will now be transferred to the transverse slide plate 65, and this slide plate 65 is driven to the right until it detects a switch that marks the completion of disc clamping operation as shown in Fig. 41(d).

[0098] The operation for driving the tray from disc recording/reproducing position Z to disc standby position Y is the reverse of the above. The driving source will be transferred from the second play gear 111 to transverse slide plate 65. The cam profile 65a of the transverse slide plate 65 triggers rotational motion of the first play lever 62, and then the second play lever 63 which will pull the tray drive rack 64 to engage to the second play

gear 111. Tray drive rack 64 will pull tray catch lever 61 that hooks to tray T. When tray T reaches the disc standby position Y, the tray catch lever 61 will come out from hook profile Tg and rotates in a counter clock-wise direction back to its original position. The rotation is same achieved by cam groove 61c and the boss 5b of the UD base boss 5 as shown in Fig. 45(b)

[0099] Figs. 47(a) and 47(b) to Figs. 51 (a) and 51(b) show a sequence in which the tray T moves from the standby position Y to the recording/reproducing position Z. Fig. 47(a) is a bottom view of the tray T before it is stopped at the recording/reproducing position Z by a stopper 5d on UD base5, and Fig. 47(b) is an enlarged bottom view of the tray catch lever 61 in Fig. 47(a). Also, Fig. 48(a) is a plan view of the tray T when it has been stopped at the recording/reproducing position by the stopper 5d on UD base5, and Fig. 48(b) is an enlarged plan view of the tray catch lever 61 in Fig. 48(a). Further, Fig. 49(a) is a bottom view of the tray T when it has been stopped at the recording/reproducing position by the stopper 5d on UD base5, and Fig. 49(b) is an enlarged bottom view of the tray catch lever 61 in Fig. 49(a). Still further, Fig. 50(a) is a plan view of the tray T in a condition where the tray catch lever 61 moves further after tray T is stopped at the recording/reproducing position Z, and Fig. 50(b) is an enlarged plan view of the tray catch lever 61 in Fig. 50(a). Still further, Fig. 51(a) is a bottom view of the tray T in a condition where the tray catch lever 61 moves further after tray T is stopped at the recording/reproducing position Z, and Fig. 51(b) is an enlarged bottom view of the tray catch lever 61 in Fig. 51(a).

[0100] As shown in Figs. 48(a) to 49(b), when the tray T hits the stopper 5d at the recording/reproducing position Z, the tray T will stop at the position where the center of the tray T is aligned with the center of the turn table 9.

As shown in Figs. 47(a) to 48(b), the tray T moves in direction parallel to long sliding rib 5p. And as shown in Figs. 48(a) to 51(b), the tray drive rack 64 moves further after tray T is stopped at the recording/reproducing position Z (this is referred to here as an "over stroke" configuration), and it will also try to move the tray catch lever 61. As the tray T is stopped at the recording/reproducing position Z, the tray catch lever 61 will rotate in a direction along with a rib 5r. With this condition, the tray T can always stop at

an accurate position, and the tray catch lever 61 and tray drive rack 64 will not be stressed or bent by the over-stroke.

[0101] As explained above, the tray catch lever 61 rotates away from tray's hook profile Tg when it is driven by the tray drive rack 64 to the disc standby position Y, and when the tray drive rack 64 moves the tray catch lever 61 backward to the direction of the disc recording/reproducing position Z, the tray catch lever 61 rotates into tray's hook profile Tg and drives the tray T.

[0102] According to the embodiment, by using a cam profile of UD base 5 and a cam profile 61c of the tray catch lever 61, the tray catch lever 61 can rotate and move away from the tray T once the tray T is moved to the disc standby position Y. This configuration creates, at the disc standby position Y, a condition in which the tray catch lever 61 is not engaged with the tray's hook Tg. Tray T is not just able to be driven to the disc recording/reproducing position Z, but can also be driven from the standby position Y to the disc exchanging position X at any time, even when the tray catch lever 61 is aligned to the selected tray T.

[0103] Also, according to the embodiment, the tray catch lever 61 can be put into the over stroke configuration when the tray T reaches the recording/reproducing position Z. When the tray T hits the stopper 5d corresponding to the recording/reproducing position Z, the tray drive rack 64 can still move further. This ensures that the tray T will always stop before the tray drive rack 64 stops.

[0104] The exact location within the recording/reproducing position Z at which the tray T stops is important. It should be at the center of turn table 9, in order to make possible a stable and accurate disc clamping operation. For this reason, the movement of the tray T from the disc standby position Y to the recording/reproducing position Z benefits from the over stroke design. This will ensure the tray T can hit the stopper 5d and stop at a well-defined position in the recording/reproducing position Z. With the separation of the tray drive rack 64 and the tray catch lever 61, the tray drive rack 64 can move further after the tray T hits the stopper 5d. At this time, the tray catch lever 61 can rotate by some angle in order to avoid stressing the shaft profile 64b of the tray drive rack 64.

[0105] In the embodiment, a simple trigger construction is used to achieve gear engagement between the tray drive rack 64 and the transverse slide plate 65. A second

play lever 63 is rotated to push the first play lever 62 when the tray drive rack 64 reaches the disc recording/reproducing position Z. A boss profile 62b of the first play lever 62 is then pushed to the transverse slide plate 65 to engage the second play gear 111. The second play lever 63 is fixed to the mechanical chassis 3 while the first play lever 62 is fixed on UD base 5.

[0106] In the embodiment, the first play lever 62 is fixed on UD base 5 in order that it can move with the recording/reproducing section 70 and have a stable connection to the transverse slide plate 65. The second play lever 63 which has a long shaft 63b is fixed to the mechanical chassis 3 in order to ensure a stable connection between the tray drive rack 64 and the first play lever 62. An opening 62a of the first play lever 62 slides on the shaft 63b of the second play lever 63 when the recording/reproducing section 70 operates for selecting a tray. With these configurations, a transfer motion between the tray drive rack 64 and the transverse slide plate 65 can be done with minimum force loss as part of a loading or unloading operation.

[0107] As explained above, the tray driving rack unit 60 is provided with the cylindrical tray catch lever 61 and the tray drive rack 64 having the vertical long shaft 64b which is inserted into the tray catch lever 61. The tray catch lever 61 is supported by UD (up/down) base 5 and capable of moving in the up/down (vertical) direction. According to a movement of the tray drive rack 64, the tray catch lever 61 is capable of holding and moving a selected tray T between the disc standby position Y and the disc recording/reproducing position Z. In other words, the mechanism for permitting movement of the tray catch lever 61 consists of two separate parts (the cylindrical part of the tray catch lever 61 and the shaft profile 64b) which are capable of sliding in vertical direction relative to each other, so it can easily deal with a plurality of trays T aligned in vertical direction. The tray drive rack 64 does not need to move in the vertical direction but needs to move only in horizontal direction. This simplifies the construction of the disc changer 1, and also reduces the height thereof.

[0108] When the tray catch lever 61 is moved to a selected tray T by a movement of tray drive rack 64, the tray catch lever 61 is rotated at a position corresponding to the disc standby position Y and thereby engages the selected tray T, and moves while engaged with the selected tray T. Further, the tray catch lever 61 is rotated by a movement of tray

drive rack 64 when it returns to the position corresponding to the disc standby position Y. Thereby, the engagement between the catch lever 61 and the selected tray T is released, and at this stage the tray catch lever 61 serves as a stopper for the tray T.

[0109] The tray catch lever 61 has a cylindrical body for fitting with the long shaft 64d of the tray drive rack 64, and a round ring protrusion 61c with a smooth surface is formed on the inner surface of the cylindrical body. That is, the inner surface of the cylindrical body of the catch lever 61 contacts the round ring protrusion 61c. This configuration can minimize the contact area between them, and thereby it is capable of achieving a smooth relative motion of the two parts, even if the cylindrical body of the catch lever 61 declines by a certain degrees against the long shaft 64d of the tray drive rack.

[0110] Figs. 52 and 53 are side views respectively showing clamper unit 10 in unclamping and clamping conditions. The transverse unit 6 in the disc recording/reproducing unit section 70 is supported by UD base 5 and transverse slide plate 65. Two of the side bosses 6a at the rear side of the transverse unit 6 are mounted to hook profiles. And bosses 6b at the front side of the transverse unit 6 (refer to Fig. 39) are mounted into the cam profile 65c of transverse slide plate 65 (refer to Fig. 39). With the pivot at rear side, the transverse unit 6 will rotate to a clamping position when the transverse side plate 65 moves from the left side to the right side, and to a unclamping position when transverse side plate 65 moves from the right side to the left side.

[0111] At the time of clamping, a clamper support plate 11 is pushed downward to a turn table 9 in order to place the clamper unit 10 to the turn table 9. With the lifting of clamper unit 10 by clamper support plate 11 at the time of unclamping, tray T can have more gap when it moves to recording/reproducing position Z. The movement of clamper support plate 11 is controlled by the movement of bosses 6b of the transverse unit 6.

In the unclamping condition, a rib 6c of the transverse unit 6 touches a rib 11a of the clamper support plate 11. The clamper support plate 11 is lifted away from the turn table 9 and clamper unit 10 is at its upper position. In the clamping condition, the other side of the rib 6c of the transverse unit 6 touches the other side of the rib 11a of clamper support plate 11. This brings down the clamper support plate 11 and also clamper unit 10. The clamper unit 10 now is sitting on turn table 9 and able to rotate freely with the turn table 9.

[0112] Fig. 54 shows a locking system for trays T at the disc standby position Y. The locking system uses a triggering system 50 that consists of a trigger gear 51, a trigger slide plate 52 and tray lock levers 53.

[0113] Fig. 55(a) and 55(b) are respectively a top view and an isometric view of the tray lock levers 53. Each tray lock lever 53 includes a first protrusion 53a, a stopper rib 53b, a second protrusion 53c and a plastic spring 53d. The first protrusion 53a provides an “inter-locking” effect to tray T. The stopper rib 53b is to ensure a stable locking state to tray T. The second protrusion 53c is a profile which is used to unlock the tray T from the tray lock lever 53. The plastic spring 53d is to provide a spring effect to the tray lock lever 53, and to ensure that the position of the first protrusion 53a is correct, in order to create a stable locking effect when the stopper rib 53b is not touching a locking profile of the trigger slide plate 52.

[0114] The lock/unlock operation is carried out simultaneously in a tray triggering and opening operation. It can be referred to as part of the operation to drive a tray T to the disc exchange position X.

[0115] Fig. 56 (discussed in more detail below) is a diagram showing a relationship between cam gear 114 positions and locking types of the tray T. Fig. 57(a) to 57(c) are enlarged plan views showing tray lock levers 53 in locking trays T at standby position Y. Fig. 48 is a perspective view of the disc changer from the front side in a state in which the trays T are locked at the standby position Y. The trays T at the standby position Y are locked by tray lock lever 53 from going to front position (disc exchange position X) at any time of operation except when trays T are driven to the disc exchange position X (open tray operation). This is a shipment locking position where the trays T are locked in a permanent manner at the disc standby position Y, and the disc changer 1 at all times carries out operations to lock tray T at the shipment locking position after any operation (such as driving tray T between disc standby position Y and disc recording/reproducing position Z or driving the recording/reproducing unit 70 moving up/down to select tray T).

[0116] In other states, the trays T are held in the locking condition by the “inter-locking” profile of tray T and the tray lock lever 53. Fig. 46 shows a timing chart when the cam gear 114 rotates from “HOME” position to disc exchange position X and types of locking condition of the tray lock lever 53 and trigger slide plate 52. For type A shown in

Fig. 57(a), the first protrusion 53a of tray lock lever 53 is being pushed toward the surfaces Tk and Tm of the tray T by the first protrusion 52e of the trigger slide plate 52. This creates a strong stable locking condition in which the trays T cannot move to any position. For type B shown in Fig. 57(b), the trigger slide plate 52 moves toward the front side and the first protrusion 52e of the trigger slide plate 52 is away from the first protrusion 53a of tray lock lever 53, so the locking is only by “inter-locking” between tray T and tray lock lever 53.

[0117] The plastic spring 53d is touching a wall of mechanical chassis 3 and tray lock lever 53 is not able to rotate to unlock direction. At this time, the trays T are not able to move to the front side (disc exchange position X) but the tray T which is aligned to the tray catch lever 61 (the selected tray T to be driven to recording/reproducing section 70) can move to the rear side (disc recording/reproducing position Z) if it is pulled by tray driving rack unit 60. Regarding to the other trays T, they are blocked by either tray rear stopper 95 or a wall of UD base wall as shown in Fig. 58. An unlock period only happens before the trays T triggering, when the tray lock lever unlock profile 53c is being pushed by the second protrusion 52d of the trigger side plate 52 and the tray is unlocked for a short period so that it can be pushed by trigger slide plate 52 to engage with the tray driving gear unit 20.

[0118] Fig. 59 is a perspective view of the disc changer 1 from the rear side in a state in which the trays T are locked at the stand by position Y. The recording/reproducing section 70 and tray catch lever 61 are aligned to the tray T3, and in this state the trays T1, T2 are locked in standby position Y by tray lock lever 53 and tray rear stopper 95. Trays T4 and T5 are locked in the standby position Y by tray lock lever 53 and UD base wall and rib 5d. The rear side of selected tray T3 is stopped by a concave portion 61b of the tray catch lever 61. When tray catch lever 61 is rotated and the concave portion 61b goes into tray hook portion Tg, the tray T3 can be driven to the disc recording/reproducing position Z.

[0119] Fig. 60 is a plan view showing the locking system at the recording/reproducing section 70. One portion of the locking system is for the transverse unit 6 and the tray driving rack unit 60, and another portion of the locking system is for the recording/reproducing section 70. The locking system is to ensure that the disc changer 1

can sustain external vibration and impact which can cause the disc changer 1 malfunction while transportation or mishandling. The locking system ensures that there is no position shift and dislocation of parts, by holding each part securely with a locking device. The locking device used to achieve this function is a first lock lever 93 for locating the transverse unit 6 and tray driving rack unit 60, and a second lock lever 94 for locking the whole recording/reproducing section 70.

Both of lock levers 93, 94 are controlled by cam grooves 114c, 114d of the cam gear 114 and pivot on pitch plate boss. One end of both lock levers 93, 94 have bosses that insert into the cam grooves 114c, 114d and the other end have special locking protrusions that create maximum locking effect when they engage the profile on a second play gear 111 and a second UD gear 109.

[0120] Figs. 61(a) and 61(b) are perspective views showing a first lock lever 93 and a second play gear 111 in a locking condition. A hook portion 93a of the first lock lever 93 engages with a gear tooth 111a of the second play gear 111 to lock the tray play/stock gear train. A taper profile 93c on the hook portion 93a of the first lock lever 93 and a taper profile 111c on the gear tooth 111a of the second play gear 111 create an inter-locking effect. These configurations provide a strong locking condition to the tray play/stock system gear train.

[0121] Fig. 62(a) and 62(b) are a plan view and a perspective view showing the first lock lever 93 as a locking device of the disc changer 1 in two conditions. These drawings show the first lock lever 93 in a state where a hook portion 93a of the first lock lever 93 engages with a gear tooth 111a of a second play gear 111, thereby locking the second play gear 111. At this time, gear teeth 111a are engaged with a rack gear 64a of a tray drive rack 64. This condition will happen when the tray drive rack 64 is at standby position Y and no trays T are at disc recording/reproducing position Z.

Fig. 63(a) and 63(b) are a plan view and a perspective view showing the first lock lever 93. These drawings also show the first lock lever 93 in a state where a hook portion 93a of the first lock lever 93 engages with a gear tooth 111a of the second play gear 111, thereby locking the second play gear 111. At this time, gear teeth 111a engage a rack gear 65a of a transverse slide plate 65. This condition will happen when the tray drive

rack 64 drives a tray T to the disc recording/reproducing position Z and the transverse slide plate 65 moves to clamp the disc to conduct disc recording/reproducing.

[0122] Fig 64(a) is a plan view showing a locking state of the first lock lever 93. In this condition, a boss 93b of the first lock lever 93 fits into a cam gear groove 114c located in a first range 114c-1 of the cam gear groove 114c where the first lock lever 93 is directed to rotate in a lock direction. Fig. 64(b) is a plan view showing an unlocking condition of the first lock lever 93. In this condition, the boss 93b is located at a second position 114c-2 of the cam gear groove 114c where the first lock lever 93 is directed to rotate in an unlock direction. There is only one portion 114c-2 on cam gear groove 114c, where the same position is used to change the state of function lever 125.

[0123] Fig. 65 is a perspective view showing a state of the locking system in which the cam gear 114 rotates to a position for unlocking the first lock lever 93. In this state, the position of a function lever 125 is changed in order to drive a gear train of a tray play/stock system (a tray driving rack unit).

[0124] Fig. 66 is a plan view showing a second lock lever 94 as a locking device in the disc changer 1. In the state shown in Fig. 56, a protruded portion 94a of the second lock lever 94 engages a locking profile 109b of a second UD gear and locks the second UD gear 109. At this time, gear teeth 109a engage a rack gear 32b of UD rack 32. This condition will happen after the recording/reproducing section 70 complete the up/down movement to select a tray T for driving to the recording/reproducing position Z.

[0125] Fig. 67 is a perspective view showing the second lock lever 94 and the second UD gear 109 in an unlocked condition. A protruded portion 94a of the second lock lever 94 enters into a locking profile 109b of the second UD gear 109 to lock the elevation gear train. The second UD gear 109 has a taper portion 109c for reliable engagement with the protruded portion 94a of the second lock lever 94 and alignment of the second UD gear 109.

[0126] Fig. 68(a) is a plan view showing a locking state of the second lock lever 94. In this state, a boss 94b of the second lock lever 94 fits into a cam gear groove 114d located at a first range 114d-1 of the cam gear groove 114d where the second lock lever 94 is directed to rotate in a lock direction. Fig. 58(b) is a plan view showing an unlocking state of the second lock lever 94. In this state, the boss 94b is located at a second position

114d-2 of the cam gear groove 114d where the second lock lever 94 is directed to rotate in an unlock direction. There is only one portion 114d-2 on cam gear groove 114d, where the same position is used to change the state of function lever 125.

[0127] Fig. 69 is a plan view of a cam gear 114 explaining an operation thereof when it rotates in a clockwise and a counter-clockwise direction. Rotational motion of the cam gear 114 starts from a HOME position, and the cam gear 114 will rotate in a clock-wise direction to RESET the tray driving gear unit 20 in position A. The trays T do not move during this operation. From the HOME position, the cam gear 114 rotates in the clockwise direction to a PLAY DRIVING position to change the level of function lever 126 from a level for engaging to a first UD gear 108 to a level for engaging a first PLAY gear 110. From the PLAY DRIVING position to the HOME position, the operation is reversed. In a range of positions B, the trigger slide plate 52 triggers the trays T to engage to the tray driving gear unit 20. And in a range of positions C, trays T are driven to the disc exchange position X. When the cam gear 114 rotates in a counter-clockwise direction, the tray T1 is first driven to the disc standby position Y in the range of positions C, and it will be followed by trays T2 to T5 in order.

[0128] Fig. 70 is a perspective view showing a state in which the cam gear 114 is rotated to a position for unlocking the second lock lever 94. In this state, a position of the function lever 126 is changed in order to drive the gear train of elevation system (elevation unit).

[0129] Fig. 71 is a perspective view showing another locking system that prevents a movement of the recording/reproducing section 70 when one of the trays T is at the recording/reproducing position Z. The locking system can protect the disc changer 1 from external shock and vibration if there is an illegal power off during a recording/reproducing operation. At the right side of transverse slide plate 65, there is provided a pin 65d which is capable of going into any of holes 32e-1 to 32e-5 of the UD rack 32. The holes 32e-1 to 32e-5 correspond respectively to the recording/reproducing positions that align tray T1 to tray T5. With this configuration, recording/reproducing is locked at a current recording/reproducing tray T position.

[0130] Fig. 72 is a locking system summary table for the recording/reproducing section 70. At all times, there is a lock system that is activated to lock the recording/reproducing section 70.

[0131] Needless to say, the present invention is not limited to the foregoing embodiment, and can be variously modified or corrected without departing from the spirit and the scope of the present invention.

Claims

1. A disc changer for storing a plurality of discs, transporting a disc selected from the plurality of discs, and performing recording/reproducing information signal on the disc, the disc changer comprising:

a plurality of trays which respectively can be loaded with discs, can be moved substantially in a horizontal direction parallel to main surfaces of the discs, and are stacked substantially in a vertical direction perpendicular to the main surfaces of the discs;

a tray driving gear unit capable of shuttling the trays between a standby position in which the trays are stored in a mechanical chassis as a housing of the disc changer and a disc exchange position in which the trays are protruded outward from the mechanical chassis thereby the discs can be put on the trays and removed from the trays;

a gear driving mechanism driven by an electrical motor to generate driving force for driving the tray driving gear unit;

a tray triggering unit capable of locking/unlocking the trays in the standby position, the unit capable of pushing all trays to engage with the tray driving gear unit after unlocking the trays and capable of driving the trays outward from the mechanical chassis toward the disc exchange position;

a recording/reproducing unit for recording and/or reproducing information signal on a disc placed on a turntable; and

an elevation unit capable of moving the recording/reproducing unit with the turntable in a vertical direction to align the recording/reproducing unit to a tray and place a disc on the tray onto the turntable;

wherein there is provided a tray driving rack unit for driving the tray between the disc standby position and a disc recording/reproducing position, and the tray driving rack unit consists of a plurality of separate parts; and

wherein the tray drive rack unit comprises a tray drive rack and a tray catch lever, the tray drive rack having a rack profile which engages with a drive gear and

moves at a fixed vertical position, and wherein the tray drive rack also has one boss profile which is used to drive the tray catch lever.

2. A disc changer according to claim 1, wherein the tray catch lever is operative to pull the tray from the disc standby position to the recording/reproducing position, and wherein the tray catch lever has a hole at a center which receives a shaft profile of the tray drive rack.

3. A disc changer according to claim 2, wherein the tray catch lever is supported on a UD base (recording/reproducing section), the tray catch lever moves and aligns to the selected tray following to the recording/reproducing section, and wherein the tray catch lever has a catch profile which fit into a tray's hook profile to drive the tray, and the tray catch lever also has a cam profile which provides rotating motion following to a cam profile of UD base, thereby the tray catch lever can rotate away from tray's hook profile when the tray reaches at disc standby position.

4. A disc changer according to claim 3, wherein the internal hole of the tray catch lever has a round ring surface which contacts a shaft profile of the tray drive rack at any tray position and the outer surface of the tray catch lever has a round surface which contacts a side wall of UD base.

5. A disc changer according to claim 4, wherein the tray is stopped by hitting a mechanical stopper at the recording/reproducing position, and the tray drive rack is able to move further to ensure that the tray can stop at correct position even there are some variations of related parts.

6. A disc changer according to claim 1, wherein the tray drive rack and the transverse slide plate is connected by a trigger lever structure which can transfer and trigger the transverse slide plate to engage a drive gear when the tray drive rack drives the tray to the disc recording/reproducing position, and wherein the trigger lever structure transfers and triggers the tray drive rack to engage with the drive gear when

the transverse slide plate is moved to release completely a clamping condition by a clamper.