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Optical transceiver

Abstract

An optical transceiver includes an outer part provided outside the apparatus upon an engagement of the optical transceiver with the apparatus. The outer part includes a first spindle, a rotational member, a sliding member. The rotational member is configured to rotate on the first spindle. The sliding member is configured to move along the first direction. The rotational member has a hole. The sliding member has a second spindle. The first spindle and the second spindle are fit with the hole. The optical transceiver includes an inner part provided inside the apparatus upon the engagement with the apparatus. The hole has a first circular area, a second circular area, and a straight area. The first spindle is fit with the first circular area. The second spindle is fit with the second circular area. The straight area is connected between the first circular area and the second circular area.

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2016-186542	12/2015	JP	N/A

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION
(1) This application claims priority from Japanese Patent Application No. 2022-001102, filed on Jan. 6, 2022, the entire subject matter of which is incorporated herein by reference.
TECHNICAL FIELD
(2) The present disclosure relates to optical transceivers.
BACKGROUND
(3) U.S. Unexamined Patent Publication No. 2010/0091467 describes an electronic module including a base portion, a conduction panel portion, a circuit board, a cable, a gasket, and an extraction mechanism for an apparatus. A circuit board is accommodated between the base portion and the conduction panel portion. The extraction mechanism has a slide member, an actuator member, a fastening member, and a withdrawal member. When the withdrawal member is pulled, the actuator member rotates, and the slide member moves. The electronic module is extracted from the apparatus in association with the movement of the slide member.
(4) Japanese Unexamined Patent Publication No. 2016-186542 discloses a pluggable optical transceiver module that can be inserted into and extracted from a cage of a host apparatus. The pluggable optical transceiver module includes a main body part, a front base, an extraction bar, and

a slider. The extraction bar has a grip portion located at an end of the extraction bar and a cam plate located at an end of the extraction bar opposite to the grip portion. The slider has a release protrusion located at an end of the slider and a cam protrusion located at an end of the slider opposite to the release protrusion. When the extraction bar rotates, the cam plate pushes the cam protrusion to move the slider, and the pluggable optical transceiver module is disengaged from the cage by the movement of the slider.

(5) U.S. Pat. No. 6,929,403 describes an optical module with a latch mechanism that engages a latch in a host cage. The latch mechanism has a bail that can be rotatably operated and a latch key that moves in association with the rotating operation of the bail. A spindle having a cam surface that is in contact with the latch key is formed on the end of the bail. When the bail is rotated, the cam surface presses the latch key. As the latch key is allowed to slide in association with the pressing of the latch key, and by allowing the latch key to push the latch down, the optical module is disengaged from the latch.

SUMMARY

(6) An optical transceiver according to the present disclosure is an optical transceiver to be inserted into an apparatus along a first direction and be engaged with the apparatus. The optical transceiver includes an outer part provided outside the apparatus upon an engagement of the optical transceiver with the apparatus. The outer part includes a first spindle, a rotational member, a sliding member. The rotational member is configured to rotate on the first spindle. The sliding member is configured to move along the first direction. The rotational member has a hole. The sliding member has a second spindle. The first spindle and the second spindle are fit with the hole. The optical transceiver includes an inner part provided inside the apparatus upon the engagement with the apparatus. The hole has a first circular area, a second circular area, and a straight area. The first spindle is fit with the first circular area. The second spindle is fit with the second circular area. The straight area is connected between the first circular area and the second circular area.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a side view illustrating an optical transceiver according to an embodiment.

(2) FIG. **2** is a perspective view illustrating a rotational member of the optical transceiver according to the embodiment.

(3) FIG. **3** is a front view illustrating the optical transceiver of FIG. **1**.

(4) FIG. **4** is a side view illustrating the rotational member of FIG. **2**.

(5) FIG. **5** is a perspective view illustrating a sliding member and a rotational member of the optical transceiver according to the embodiment.

(6) FIG. **6** is a longitudinal sectional view illustrating a housing of the optical transceiver of FIG. **1**.

(7) FIG. **7** is a side view illustrating a state where the rotational member of FIG. **4** is rotated.

(8) FIG. **8** is a perspective view illustrating the sliding member in the state of FIG. **7**.

(9) FIG. **9** is a longitudinal sectional view illustrating the sliding member in the state of FIG. **7**.

(10) FIG. **10** is a side view illustrating a state where the rotational member of FIG. **7** is further rotated.

(11) FIG. **11** is a perspective view illustrating the sliding member in the state of FIG. **10**.

(12) FIG. **12** is a longitudinal sectional view illustrating the sliding member in the state of FIG. **10**.

DETAILED DESCRIPTION

(13) Specific examples of an optical transceiver according to an embodiment of the present disclosure will be described below with reference to the drawings. It is noted that the present invention is not limited to the following examples, but is intended to include all modifications indicated in the scope of the claims and within the scope equivalent to the scope of the claims. In

the description of the drawings, the same or corresponding elements are denoted by the same reference numerals, and redundant descriptions are omitted as appropriate. In addition, the drawings may be partially simplified or exaggerated for the better understanding, and the dimensional ratios and the like are not limited to those described in the drawings.

(14) FIG. **1** is a side view illustrating an optical transceiver **1** according to an embodiment. The optical transceiver **1** conforms to, for example, an SFP-DD (Small Factor Pluggable Double Density) standard. The standard stated herein is, for example, MSA (Multi Source Agreement), which is one of industry standards. The SFP-DD standard optical transceiver **1** has a long-plate outer shape. The optical transceiver **1** is, as an example, an SFP-DD standard Type 2 module. That is, a length in a first direction D**1**, which is the longitudinal direction of the optical transceiver **1**, is longer than a length in the longitudinal direction of the SFP standard optical transceiver. As described below, a long-plate outer shape denotes an outer shape that is longer in the longitudinal direction than the outer shape of the SFP standard.

(15) The optical transceiver **1** includes a metal housing **2**, a receptacle **4** located at one longitudinal end of the housing **2**, a bail **10** (rotational member) rotatably attached to the housing **2**, and a slider **20** (sliding member) movably attached to the housing **2**. The housing **2** includes, for example, an upper housing **6** and a lower housing **7**. It is noted that, in the following description, along the longitudinal direction, the side of the optical transceiver **1** having the receptacle **4** may be referred to as front, a front side, or forward, and the side opposite to the side having the receptacle **4** may be referred to as rear, a rear side, or rearward. The direction of viewing the upper housing **6** from the lower housing **7** may be referred to as up, an upper side, or upward, and the direction of viewing the lower housing **7** from the upper housing **6** may be referred to as down, a lower side, or downward. However, these directions are for the convenience of description and do not limit arrangement positions of objects.

(16) FIG. **2** is an enlarged perspective view of the front portion of the optical transceiver **1**. As illustrated in FIGS. **1** and **2**, the housing **2** extends in a first direction D**1**, a second direction D**2** that is a width direction of the optical transceiver **1**, and a third direction D**3** that is a height direction of the optical transceiver **1**. The first direction D**1**, the second direction D**2**, and the third direction D**3** are perpendicular to each other. The length of the optical transceiver **1** in the first direction D**1** is longer than the length of the optical transceiver **1** in the second direction D**2** and the length of the optical transceiver **1** in the third direction D**3**. The housing **2** has a rectangular parallelepiped shape, for example, when the housing **2** is cut along a plane perpendicular to the first direction D**1**, an outer shape of a cross section of the housing **2** is an rectangular shape. The optical transceiver **1** is inserted into and extracted from a cage provided in a host system (apparatus) along the first direction D**1**.

(17) The housing **2** has an outer part **2**A exposed to an outside the host system in a state where a rear side of the optical transceiver **1** is inserted into the cage and is engaged with the host system and an inner part **2**B accommodated inside the host system. For example, in the first direction D**1**, the outer part **2**A is located at one end on the front side of the optical transceiver **1**, and the inner part **2**B is located rearward from the outer part **2**A. The outer part **2**A and the inner part **2**B have a rectangular parallelepiped shape. The length of the outer part **2**A in the first direction D**1** is smaller than the length of the inner part **2**B in the first direction D**1**, and the length of the outer part **2**A in the third direction D**3** is larger than the length of the inner part **2**B in the third direction D**3**. For example, the length of the inner part **2**B in the third direction D**3** is smaller than the length of the cage in the third direction D**3**, and the length of the outer part **2**A in the third direction D**3** is larger than the length of the cage in the third direction D**3**. By the way, the lengthening described above denotes that the length of the outer part **2**A in the first direction D**1** is lengthened. For example, in the SFP standard, the length of the outer part **2**A in the first direction D**1** is defined to be 10 mm at maximum. In addition, in the SFP-DD standard, the length of the outer part **2**A in the first direction D**1** is defined to be 25 mm at maximum. Accordingly, in some cases, an outer shape in which the

length of the outer part **2**A in the first direction D**1** is larger than 10 mm may be referred to as a long-plate outer shape. In addition, an outer shape in which the length of the outer part **2**A in the first direction D**1** is 10 mm or less may be referred to as a short-plate outer shape or a normal-plate outer shape. FIG. **1** illustrates an example of the long-plate outer shape. FIG. **2** illustrates an example of the normal-plate outer shape. For the convenience of description, FIGS. **3** to **12** to be described below all illustrate examples of the normal-plate outer shape. Due to the lengthening, the bail **10** is arranged at a position farther from the inner part **2**B than the normal-plate outer shape in the first direction D**1**. Therefore, the lengthening increases a distance between the bail **10** and the inner part **2**B.

(18) FIG. **3** is a front view of the optical transceiver **1** viewed from the front along the first direction D**1**. As illustrated in FIGS. **2** and **3**, the outer part **2**A of the housing **2** includes a first step portion **2***b* that protrudes upward from the inner part **2**B, a second step portion **2***c* that protrudes downward from the inner part **2**B, a pair of holes **2***d* that define a recessed portion downward at the first step portion **2***b* and an inside of the receptacle **4**. The pair of holes **2***d* are aligned along the second direction D**2**. A thickness T of the housing **2** at a bottom **2***r* of the hole **2***d* is determined in consideration of rigidity and manufacturability of the housing **2** and is, for example, about 1 mm. When the thickness T is large, the rigidity of the housing **2** is increased, but a volume of an internal space of the housing **2** is reduced, and thus, there is a concern that parts that can be accommodated inside the housing **2** are limited. On the other hand, when the thickness T is small, the restrictions on the parts that can be accommodated inside the housing **2** are relaxed, but the housing **2** may be deformed by an external force.

(19) The outer part **2**A has a pair of side surfaces **2***f* respectively facing outward along the second direction D**2** and aligned along the second direction D**2**. The direction in which one of the side surfaces **2***f* faces is opposite to the direction in which the other of the side surfaces **2***f* faces. Recesses **2***g* recessed inward along the second direction D**2** are formed on the front side of each side surface **2***f*. The outer part **2**A has a pair of recesses **2***g* aligned along the second direction D**2**, and the bail **10** enters the pair of recesses **2***g*. The outer part **2**A has a first spindle **2***h* protruding outward along the second direction D**2** in each of the recesses **2***g*. The bail **10** is engaged with the first spindle **2***h*.

(20) The bail **10** is configured to be engaged with the first spindle **2***h* and rotate forward about the first spindle **2***h*. The outer part **2**A has a concave portion **2***j* recessed rearward at a step difference **2***t* defining the recesses **2***g*. The concave portion **2***j* is a portion into which a portion of the bail **10** enters by the rotating operation of the bail **10**. The bail **10** has a through-hole **11** into which the first spindle **2***h* is fitted. The through-hole **11** penetrates through the bail **10** along the second direction D**2**. A configuration of the through-hole **11** will be described in detail later. The bail **10** has a pair of first extension portions **12** and a second extension portions **13**. The pair of first extension portions **12** have respective through-hole **11** and are aligned along the second direction D**2**. The pair of first extension portions **12** extend along the direction D**3** in a state where the bail **10** is not rotating. The second extension portion **13** connects the pair of first extension portions **12** to each other. The second extension portion **13** extends in a direction intersecting with the direction in which the first extension portion **12** extends. For example, when the first extension portion **12** extends along the third direction D**3**, the second extension portion **13** extends along the second direction D**2**. The second extension portion **13** has, for example, a protrusion portion **13***b* protruding in a direction intersecting the second direction D**2** at a portion including the center in the second direction D**2**.

(21) FIG. **4** is a side view of the housing **2** and the bail **10** viewed along the second direction D**2**. FIG. **5** is a perspective view illustrating the housing **2**, the bail **10**, and the slider **20**. The bail **10** rotates forward and downward around the first spindle **2***h* as a center line. FIGS. **4** and **5** illustrate a state where the bail **10** is not rotating. The rotating operation is performed when the optical transceiver **1** is disengaged from the cage and the optical transceiver **1** is extracted from the cage. FIGS. **4** and **5** illustrate the state where the optical transceiver **1** is engaged with the cage or the

state where the optical transceiver **1** is not inserted into the cage. The first extension portion **12** extends from each of both ends of the second extension portion **13** in the direction D**2** toward the first spindle **2***h*. The first extension portion **12** has a protrusion portion **12***b* extending at the end opposite to the second extension portion **13** so as to increase the width of the first extension portion **12**. For example, the protrusion portion **12***b* has a circular arc shape at the end of the first extension portion **12**, and a portion of the through-hole **11** is formed in the protrusion portion **12***b*. That is, the protrusion portion **12***b* protruding forward so as to form the through-hole **11** as described later is provided to the first extension portion **12**.

(22) The slider **20** moves rearward along the first direction D**1** in association with the rotating operation of the bail **10** and disengages the optical transceiver **1** from the cage of the host system in association with the rearward movement of the slider **20**. The slider **20** includes a second spindle **21** that extends along the second direction D**2** and enters the through-hole **11** of each of the pair of first extension portions **12** and a release portion **22** that extends rearward from the second spindle **21** and moves rearward in association with the rotating operation to disengage the optical transceiver **1** from the cage. The through-hole **11** of each of the pair of first extension portions **12** is configured as a pair of through-holes **11**. For example, one of the through-holes **11** has the same shape as the other of the through-holes **11**. The pair of through-holes **11** are formed so that one end of the first spindle **2***h* enters one of the through-holes **11** and the other end of the first spindle **2***h* enters the other of the through-holes **11**.

(23) The second spindle **21** has an outer end **21**A that is engaged with the bail **10**, and for example, the second spindle **21** constitutes the outer end **21**A. The second spindle **21** has, for example, a cylindrical shape. One end of the second spindle **21** in the second direction D**2** is inserted into one of the through-holes **11**, and the other end of the second spindle **21** in the second direction D**2** is inserted into the other of the through-holes **11**. The release portion **22** has a plate shape in a region including the center of the second spindle **21** in the second direction D**2**. The release portion **22** has, for example, a plate-shaped portion **22***b* to which the second spindle **21** is connected and a tapered portion **22***c* located at the end of the plate-shaped portion **22***b* opposite to the second spindle **21**. That is, the second spindle **21** is connected to the front end of the plate-shaped portion **22***b*, and the tapered portion **22***c* is provided to the rear end of the plate-shaped portion **22***b*. The slider **20** has an inner end **21**B rearward from the outer end **21**A along the first direction D**1**, and for example, the tapered portion **22***c* constitutes the inner end **21**B. The slider **20** has the inner end **21**B at a position extending to the inner part **2**B.

(24) For example, the second step portion **2***c* has a hole portion **2***k* penetrating in the first direction D**1**, and the plate-shaped portion **22***b* of the slider **20** is passed through the hole portion **2***k*. The plate-shaped portion **22***b* is movable along the first direction D**1** in the hole portion **2***k*. As an example, the hole portion **2***k* has a rectangular shape. The release portion **22** has a pair of tapered portions **22***c* aligned along the second direction D**2**, and each tapered portion **22***c* is formed at the rear end of the plate-shaped portion **22***b*. Each of the tapered portions **22***c* has an inclined surface **22***d* that is inclined with respect to both the first direction D**1** and the third direction D**3**.

(25) Rearward from the second step portion **2***c*, a convex portion **2***p* protruding downward along the third direction D**3** is formed on the inner part **2**B, and the pair of tapered portions **22***c* at the two outer sides of the convex portion **2***p* in the second direction D**2** move along the first direction D**1** in association with the rotating operation. When the optical transceiver **1** is engaged with the cage, as illustrated in FIG. **6**, a cage tab C (refer to FIG. **6** and the like) of the cage is located so as to overlap the position of the convex portion **2***p*. At this time, the convex portion **2***p* is fitted into a hole provided in the cage tab C. Accordingly, the optical transceiver **1** is prevented from coming out of the cage along the direction D**1** (this state is referred to as engagement). When the tapered portion **22***c* moves rearward, the inclined surface **22***d* abuts against the cage tab C. This abutment allows the cage tab C to be pushed downward (pulled up in FIG. **5**) along the third direction D**3**, so that the optical transceiver **1** is disengaged from the cage. More specifically, when the cage tab C is

pushed downward, the convex portion **2**_p_ is removed from the hole provided in the cage tab C, so that the optical transceiver **1** can move along the direction D**1**.

(26) An example of designing the dimensions of each component of the bail **10**, the slider **20**, and the housing **2** will be described below. A distance K**1** from the reference line L extending along the first direction D**1** through the center of the outer part **2**A in the third direction D**3** to the second spindle **21** is longer than a distance K**2** from the reference line L to the first spindle **2**_h_. When the bail **10** is not rotating forward and downward (the state in FIG. **4**, hereinafter sometimes simply referred to as "at the time of not rotating") and when the bail **10** is most rotating forward and downward (the state of FIG. **10**, hereinafter sometimes simply referred to as "at the time of most rotating operation"), a distance K**3** in the third direction D**3** from the center of the first spindle **2**_h_ to the center of the second spindle **21** is, for example, 1.70 mm.

(27) A distance K**4** in the first direction D**1** from the rear end of the second step portion **2**_c_ of the housing **2** to the rear end of the slider **20** (the tapered portion **22**_c_ of the release portion **22**) when the bail **10** is not rotating is, for example, 0.85 mm at maximum. A distance K**5** in the first direction D**1** from the center of the first spindle **2**_h_ to the rear end of the second step portion **2**_c_ is arbitrarily set according to the total length of the slider **20** in the first direction D**1**. For example, the distance K**5** of the long-plate outer shape is larger than the distance K**5** of the normal-plate outer shape. A distance K**6** from the reference line L to the center of the second spindle **21** when the bail **10** is not rotating and when the bail **10** is most rotating is smaller than a distance K**7** from the reference line L to an end (lower end) of the inner part **2**B in the third direction D**3**. Herein, a distance (a difference between the distance K**7** and the distance K**6**) between the center of the second spindle **21** and the end (lower end) of the inner part **2**B in the third direction D**3** is determined in consideration of the rigidity and the manufacturability of the housing **2** and is, for example, about 1 mm. In addition, the upper limit of the length in the third direction D**3** of portions from the front side of the first step portion **2**_b_ and the second step portion **2**_c_ of the housing **2** and a trajectory of the rotating operation of the bail **10** is defined by the MSA.

(28) The first spindle **2**_h_ of the housing **2** and the second spindle **21** are engaged with the through-hole **11** of the bail **10**. The through-hole **11** includes a first circular area **11**_b_ engaged with the first spindle **2**_h_, a second circular area **11**_c_ engaged with the second spindle **21**, and a straight area **11**_d_ connecting the first circular area **11**_b_ and the second circular area **11**_c_ to each other. The first circular area **11**_b_ is formed at one end of the straight area **11**_d_, and the second circular area **11**_c_ is formed at the other end of the straight area **11**_d_. That is, the straight area **11**_d_ is located between the first circular area **11**_b_ and the second circular area **11**_c_. The first circular area **11**_b_ is expanded into a circular shape at one end of the straight area **11**_d_. For example, when the through-hole **11** is viewed along the direction D**2**, a diameter of the second circular area **11**_c_ is the same as a width of the straight area **11**_d_. In this case, the second circular area **11**_c_ is not expanded at the other end of the straight area **11**_d_. Therefore, the second spindle **21** is movable between the second circular area **11**_c_ and the straight area **11**_d_ in the state of being engaged with the through-hole **11**. During the rotating operation, the second circular area **11**_c_ moves toward the first spindle **2**_h_, so that the rotating operation is smoothly performed.

(29) For example, the diameter of the circular area of the first circular area **11**_b_ is larger than the diameter of the semi-circular area of the second circular area **11**_c_. The outer shape of the first circular area **11**_b_ viewed along the second direction D**2** is substantially the same as the outer shape of the first spindle **2**_h_ viewed along the second direction D**2**. It is noted that the first circular area **11**_b_ and the first spindle **2**_h_ are configured so that the first spindle **2**_h_ can be fitted into the first circular area **11**_b_. Therefore, the diameter of the first circular area **11**_b_ is larger than the diameter of the first spindle **2**_h_ to the extent that the first spindle **2**_h_ can fit. The outer shape of the second circular area **11**_c_ viewed along the second direction D**2** is substantially the same as the outer shape of the second spindle **21** viewed along the second direction D**2**. It is noted that the second circular area **11**_c_ and the second spindle **21** are configured so that the second spindle **21** can be fitted into

the second circular area **11***c*. Therefore, the diameter of the second circular area **11***c* is larger than the diameter of the second spindle **21** to the extent that the second spindle **21** can fit.

(30) FIG. **6** is a cross-sectional view of the optical transceiver **1** cut along a plane extending in both the first direction D**1** and the third direction D**3**. As described above, the forward and downward rotating operation of the bail **10** allows the slider **20** to move rearward, so that the release portion **22** abuts against the cage tab C. The outer part **2**A has a convex-shaped stopper **2***s* against which the second spindle **21** moved rearward by the rotating operation of the bail **10** abuts.

(31) As illustrated in FIG. **6**, the stopper **2***s* has a curved surface protruding downward. When the rotating operation approaches the most rotating state, a resistive force is exerted to stop the second spindle **21** from moving rearward along the first direction D**1** due to the curved surface. In association with the rotating operation of the bail **10**, the second spindle **21** moves further rearward over the curved surface downward by being pushed by a force larger than the resistive force. The second spindle **21** moves rearward from the stopper **2***s*, and the bail **10** is in the most rotating state. Even when the bail **10** returns from the most rotating state to the non-rotating state, the resistive force is exerted to stop the second spindle **21** from moving forward. Thus, the stopper **2***s* is provided to prevent the second spindle **21** from returning forward from the state where the bail **10** is most rotating. When the slider **20** moves rearward, the release portion **22** abuts against the cage tab C, and a spring force of the cage tab C can generate a push-back force of pushing the slider **20** forward. The stopper **2***s* stop the second spindle **21** from moving forward by exerting the resistive force so that the slider **20** does not move forward by this push-back force. Accordingly, the optical transceiver **1** can stably maintain the state where the bail **10** is most rotating.

(32) Next, the disengagement of the optical transceiver **1** from the cage will be described. First, in a state where the optical transceiver **1** is engaged with the cage, the second spindle **21** is located at the second circular area **11***c* of the through-hole **11** (refer to FIGS. **4**, **5**, and **6**). When the bail **10** rotates forward and downward in this state, as illustrated in FIGS. **7**, **8**, and **9**, the bail **10** performs the rotating operation around the center line of the first spindle **2***h*, and the through-hole **11** rotates around the center line of the first spindle **2***h*, so that the second spindle **21** moves rearward along the first direction D**1** in association with the rotation of the through-hole **11**. At this time, when the through-hole **11** rotates, the second spindle **21** moves from the second circular area **11***c* to the straight area **11***d* and also moves in the straight area **11***d* toward the first circular area **11***b*.

(33) When the bail **10** further rotates forward and downward, as illustrated in FIGS. **10**, **11**, and **12**, the second spindle **21** moves further rearward along the first direction D**1** and moves further rearward over the stopper **2***s*. At this time, the second spindle **21** moves away from the first spindle **2***h* and moves from the straight area **11***d* to the second circular area **11***c*. Then, the tapered portion **22***c* located at the rear end of the release portion **22** abuts against the cage tab C, and the inclined surface **22***d* pushes the cage tab C downward, so that the cage tab C is disengaged from the optical transceiver **1**. Accordingly, the user can extract the optical transceiver **1** from the cage (not illustrated) by pulling the bail **10** forward. FIGS. **10**, **11**, and **12** illustrate the state where the bail **10** has been rotated to the maximum. When the slider **20** moves forward from the position illustrated in FIGS. **10**, **11**, and **12** by the push-back force of the above-mentioned cage tab C, there is a concern that the disengagement of the cage tab C becomes incomplete, so that the optical transceiver **1** may not be smoothly withdrawn from the cage, or the engagement of the cage tab C becomes incomplete, so that the optical transceiver **1** may be unintentionally pulled out of the cage. For example, when the optical transceiver **1** is plugged into the cage, an optical connector attached to a distal end of an optical fiber is inserted into the receptacle **4** for communication. When the engagement is incomplete, the optical transceiver **1** may easily come out of the cage when the optical fiber is pulled, and thus, there is a concern that communication may be interrupted.

(34) When the tapered portion **22***c* abuts against the cage tab C, the tapered portion **22***c* receives a forward spring force from the cage tab C. However, even when the second spindle **21** receives the forward spring force, the second spindle **21** abuts against the stopper **2***s*, the second spindle **21** is

stopped from moving forward by the resistive force necessary to overcome the stopper **2***s*. Accordingly, the slider **20** can be prevented from moving forward and disengaging unintentionally. It is noted that, a distance K**8** from the rear end of the second step portion **2***c* to the rear end of the slider **20** (the tapered portion **22***c* of the release portion **22**) at the time of performing the most rotating operation is, for example, 2.95±0.25 mm. The stopper **2***s* allows the slider **20** to stably maintain the distance K**8**.

(35) Next, the functions and effects obtained from the optical transceiver **1** according to this embodiment will be described in more detail. In the optical transceiver **1**, a housing **2** has an outer part **2**A and an inner part **2**B, and a bail **10** and a slider **20** are attached to the outer part **2**A. The outer part **2**A has a first spindle **2***h* around which the bail **10** rotates. The slider **20** has a second spindle **21** that is engaged with the bail **10**. The bail **10** has a through-hole **11**. The through-hole **11** includes a first circular area **11***b* engaged with the first spindle **2***h* of the outer part **2**A, a second circular area **11***c* engaged with the second spindle **21** of the slider **20**, and a straight area **11***d* that connects the first circular area **11***b* and the second circular area **11***c* to each other.

(36) When the bail **10** rotates about the center line of the first spindle **2***h*, in association with the rotation of the through-hole **11**, the second spindle **21** moves between the second circular area **11***c* and the straight area **11***d*, and the release portion **22** connected to the second spindle **21** moves toward the inner part **2**B side (rear side) of the housing **2**. In association with the rotating operation of the bail **10**, the slider **20** moves toward the inner part **2**B side, and the tapered portion **22***c* of the slider **20** abuts against the cage tab C to push the cage tab C down. As a result, the cage tab C can be disengaged. Therefore, even when the outer part **2**A has an elongated outer shape that extends in the first direction D**1**, the disengagement can be appropriately performed by setting the length of the release portion **22** to an appropriate size by the rotating operation of the bail **10** and the movement of the slider **20** due to lengthening.

(37) The second spindle **21** may move along the first direction D**1** by the rotating operation of the bail **10**. In this case, the second spindle **21** moves along the first direction D**1** in association with the rotating operation of the bail **10**, so that the slider **20** can smoothly move toward the inner part **2**B side of the housing **2**. Therefore, due to the cooperation between the bail **10** and the slider **20**, since a rotating motion of the bail **10** during the rotating operation is converted into a linear motion of the slider **20** along the first direction D**1**, even though the position of the bail **10** is away from the inner part **2**B, the cage tab C can be disengaged due to lengthening.

(38) The slider **20** may have the inner end **21**B rearward from the outer end **21**A in the first direction D**1**. The inner end **21**B may move the cage tab C of the host system (apparatus) according to the rotating operation of the bail **10**. In this case, the disengagement can be appropriately performed with the inner end **21**B located rearward from the outer end **21**A of the slider **20**. For example, even when the distance between the bail **10** and the inner part **2**B is increased due to lengthening, by increasing the length of the slider **20** in the first direction D**1** (from the front end of the outer end **21**A to the rear end of the inner end **21**B), the disengagement can be performed by pushing the cage tab C downward due to the rotating operation of the bail **10**.

(39) The distance K**1** to the second spindle **21** from the reference line L passing through the center of the outer part **2**A and extending along the first direction D**1** may be longer than the distance K**2** from the reference line L to the first spindle **2***h*. In this case, since the distance K**1** from the reference line L to the second spindle **21** is longer than the distance K**2** from the reference line L to the first spindle **2***h*, the second spindle **21** of the slider **20** can be moved more smoothly along the first direction D**1** at the position away from the reference line L.

(40) The diameter of first spindle **2***h* may be larger than the diameter of second spindle **21**. The diameter of the circular area of the first circular area **11***b* may be larger than the diameter of the semi-circular area of the second circular area **11***c*. In this case, the rotating operation of the bail **10** about the center line of the first spindle **2***h* and the movement of the slider **20** in the first direction D**1** can be performed more smoothly.

(41) The outer part **2**A may have a convex-shaped stopper **2***s* against which the second spindle **21** moved by the rotating operation of the bail **10** abuts. The distance K**6** to the center of the second spindle **21** from the reference line L passing through the center of the outer part **2**A and extending along the first direction D**1** when the bail **10** is not rotating and when the bail **10** is most rotating may be smaller than the distance K**7** from the reference line L to the end of the inner part **2**B. By providing the stopper **2***s* against which the moved second spindle **21** abuts, by the spring force of the cage tab C, the second spindle **21** is prevented from returning forward from the position when the bail **10** is most rotating. Since the distance K**6** from the reference line L to the center of the second spindle **21** is smaller than the distance K**7** from the reference line L to the end of the inner part **2**B, the linear motion of the slider **20** along the direction D**1** in association with the rotating operation of the bail **10** can be stabilized.
(42) Heretofore, the embodiments of the optical transceiver according to the present disclosure have been described. However, the invention is not limited to the embodiments described above. That is, it is easily recognized by those skilled in the art that the present invention is capable of various modifications and changes within the scope of the spirit described in the claims. For example, the shape, size, number, material, and layout of each portion of the optical transceiver can be changed as appropriate without departing from the spirit described above.
(43) For example, in the above-described embodiment, an example where the diameter of the first spindle **2***h* of the housing **2** is larger than the diameter of the second spindle **21** of the slider **20** has been described. However, the diameter of the first spindle of the cage may be smaller than the diameter of the second spindle of the slider, and the size relationship between these diameters is not particularly limited. However, it is preferable that the first spindle **2***h* is always engaged with the first circular area **11***b* of the through-hole **11** and a mutual positional relationship is fixed. Therefore, when the diameter of the first spindle **2***h* is smaller than the diameter of the second spindle **21**, for example, it is preferable that the straight area **11***d* is configured so that the first spindle **2***h* does not move toward the second circular area **11***c*. In addition, in the above-described embodiment, an example where the optical transceiver **1** is a Type 2 module of the SFP-DD standard has been described. However, the optical transceiver according to the present disclosure may be an optical transceiver conforming standards other than the SFP-DD standard.

Claims

1. An optical transceiver to be inserted into an apparatus along a first direction and be engaged with the apparatus, the optical transceiver comprising: an outer part provided outside the apparatus upon an engagement of the optical transceiver with the apparatus, the outer part including a first spindle, a rotational member, a sliding member, the rotational member being configured to rotate on the first spindle, the sliding member configured to move along the first direction, the rotational member having a hole, the sliding member having a second spindle, the first spindle and the second spindle being fit with the hole; and an inner part provided inside the apparatus upon the engagement with the apparatus, wherein the hole has a first circular area, a second circular area, and a straight area, the first spindle being fit with the first circular area, the second spindle being fit with the second circular area, the straight area being connected between the first circular area and the second circular area.
2. The optical transceiver according to claim 1, wherein the second spindle moves along the first direction when the rotational member rotates on the first spindle.
3. The optical transceiver according to claim 1, wherein the sliding member has an outer end and an inner end in the first direction, wherein the outer end includes the second spindle, and wherein the inner end moves a cage tab of the apparatus when the rotational member rotates on the first spindle.
4. The optical transceiver according to claim 1, wherein the outer part has a first distance between

the second spindle and a center line, the first distance being larger than a second distance between the first spindle and the center line, the center line passing a center point of the outer part and extending along the first direction.

5. The optical transceiver according to claim 1, wherein the first spindle has a diameter larger than a diameter of the second spindle, and wherein the first circular area has a diameter larger than a diameter of the second circular area.

6. The optical transceiver according to claim 1, wherein the outer part has a protrusion, and wherein the second spindle climbs over the protrusion while the rotational member rotates.

7. The optical transceiver according to claim 1, wherein the outer part has a third distance between a center line and a center of the second spindle, the third distance being larger than a fourth distance between the center line and a bottom face of the inner part, the center line passing a center point of the outer part and extending along the first direction.