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(54) **MODE INDICATOR FOR TRANSCEIVER MODULE**

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(51) **Int. Cl.**
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(52) **U.S. Cl.** **385/92**; 439/491

(58) **Field of Classification Search** 385/92; 439/488, 491

See application file for complete search history.

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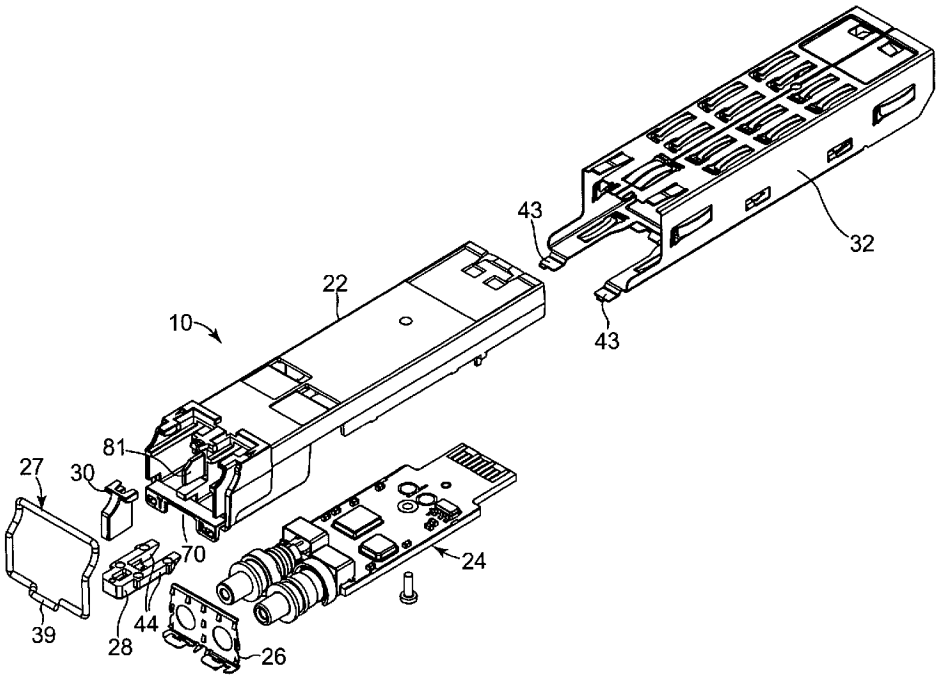
(57) **ABSTRACT**

A mode indicator for use with a transceiver module includes a colored plastic button having an engagement feature configured for attachment to a corresponding transceiver module engagement feature.

16 Claims, 8 Drawing Sheets



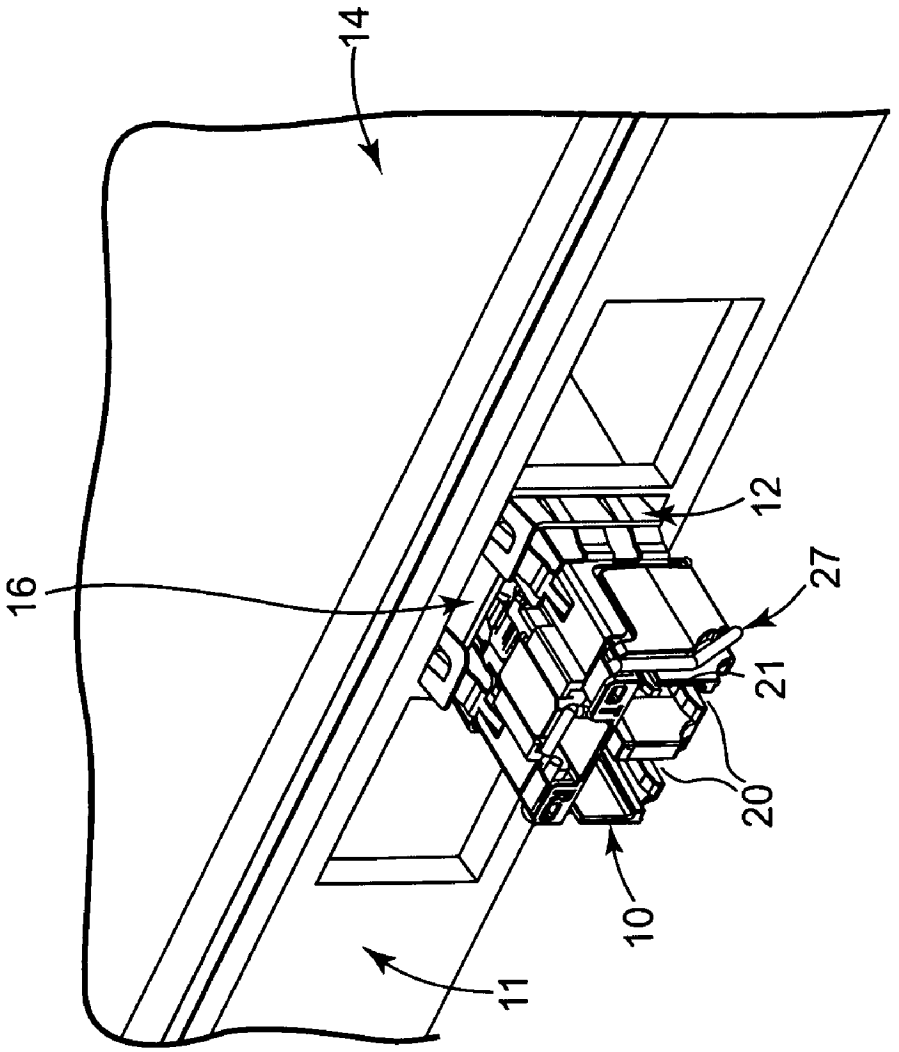


Fig. 1

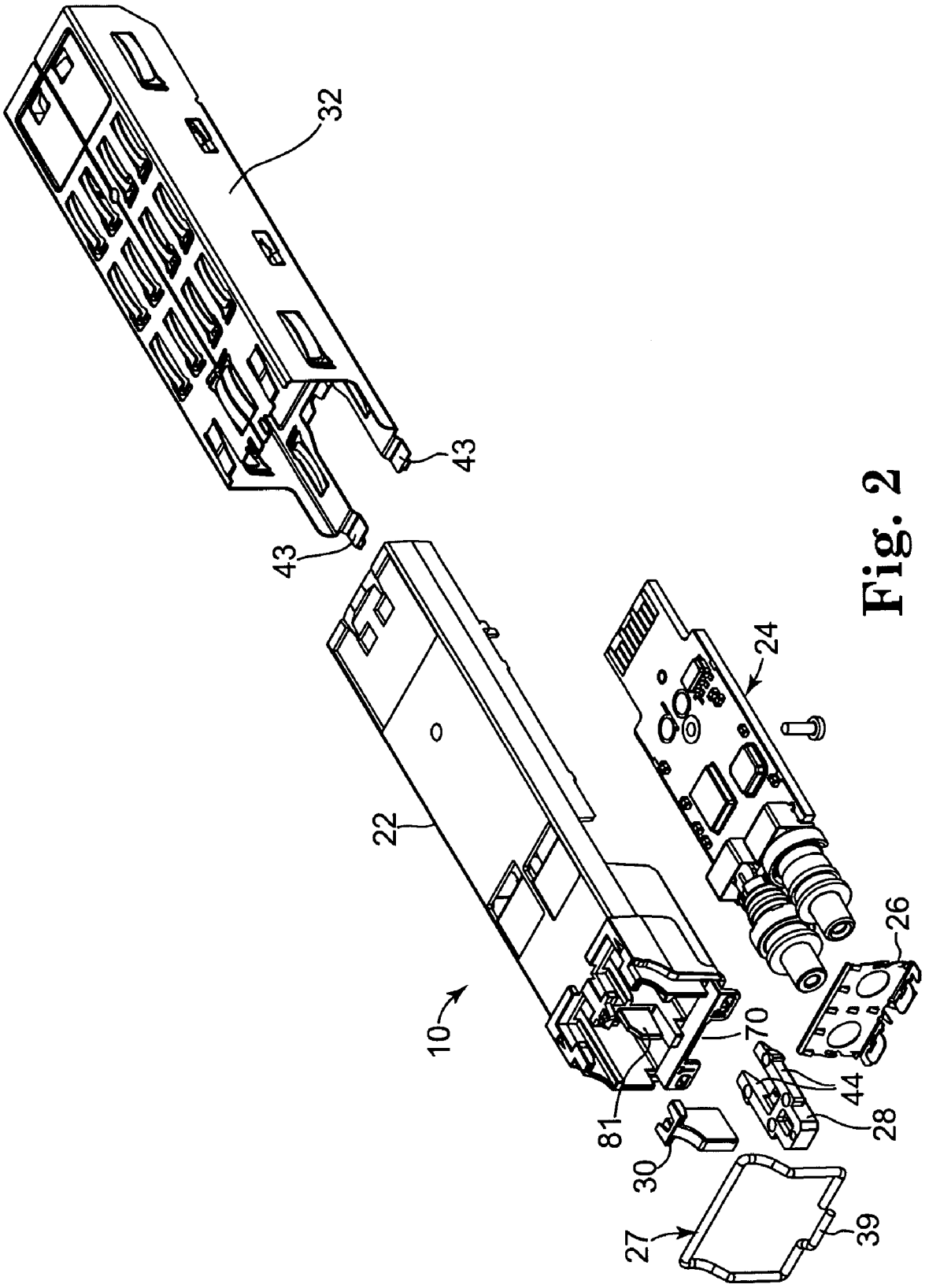


Fig. 2

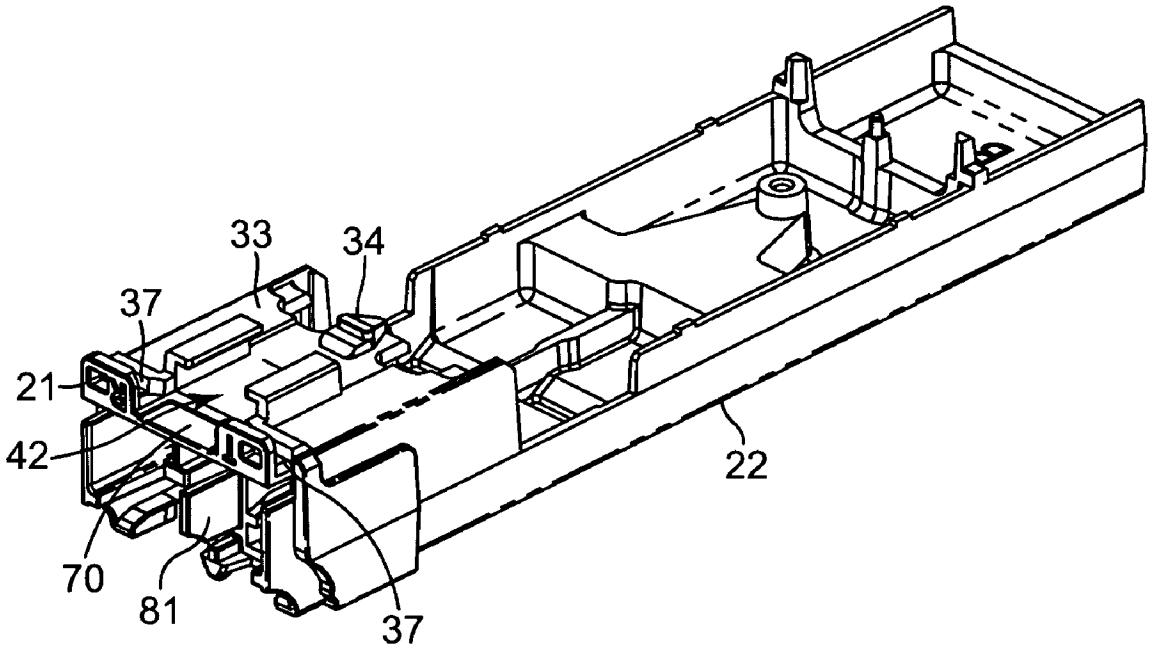


Fig. 3

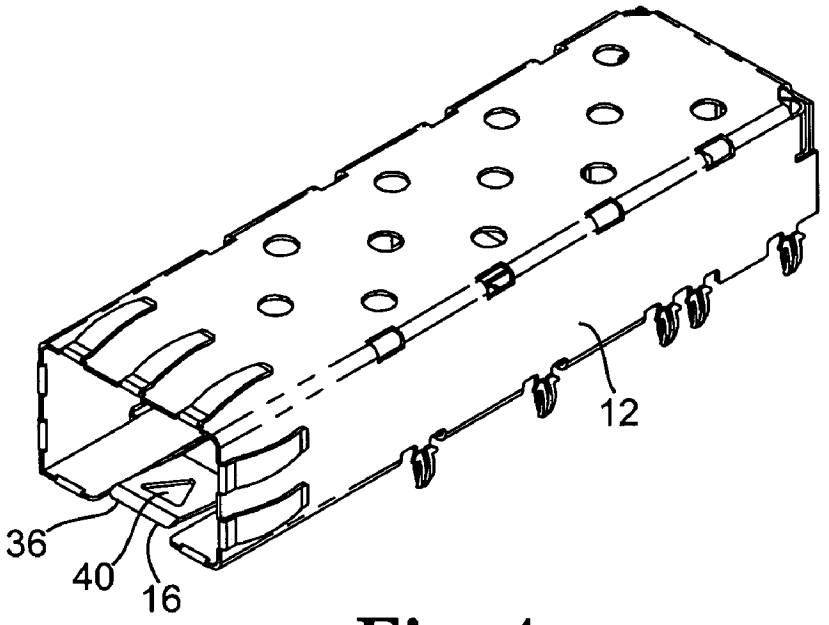


Fig. 4

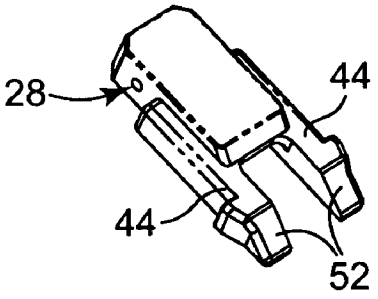


Fig. 5

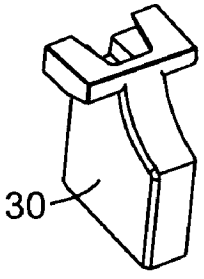


Fig. 9A

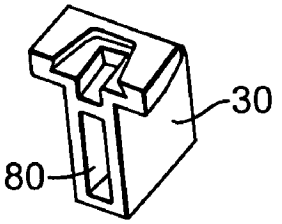


Fig. 9B

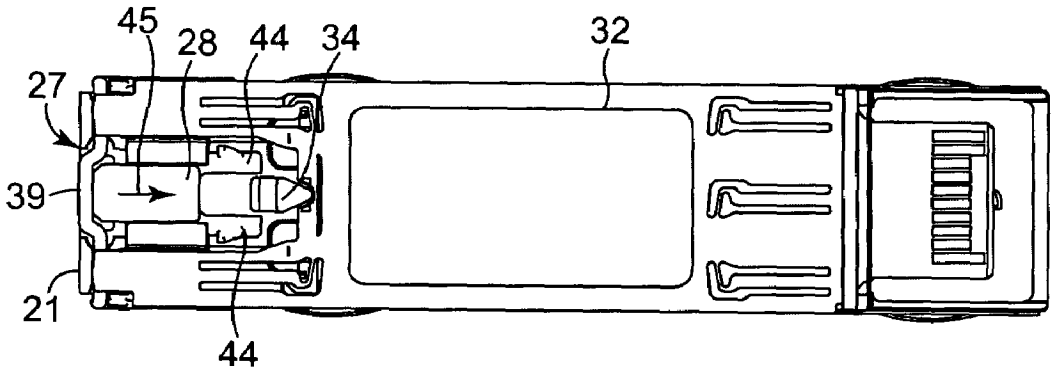


Fig. 6

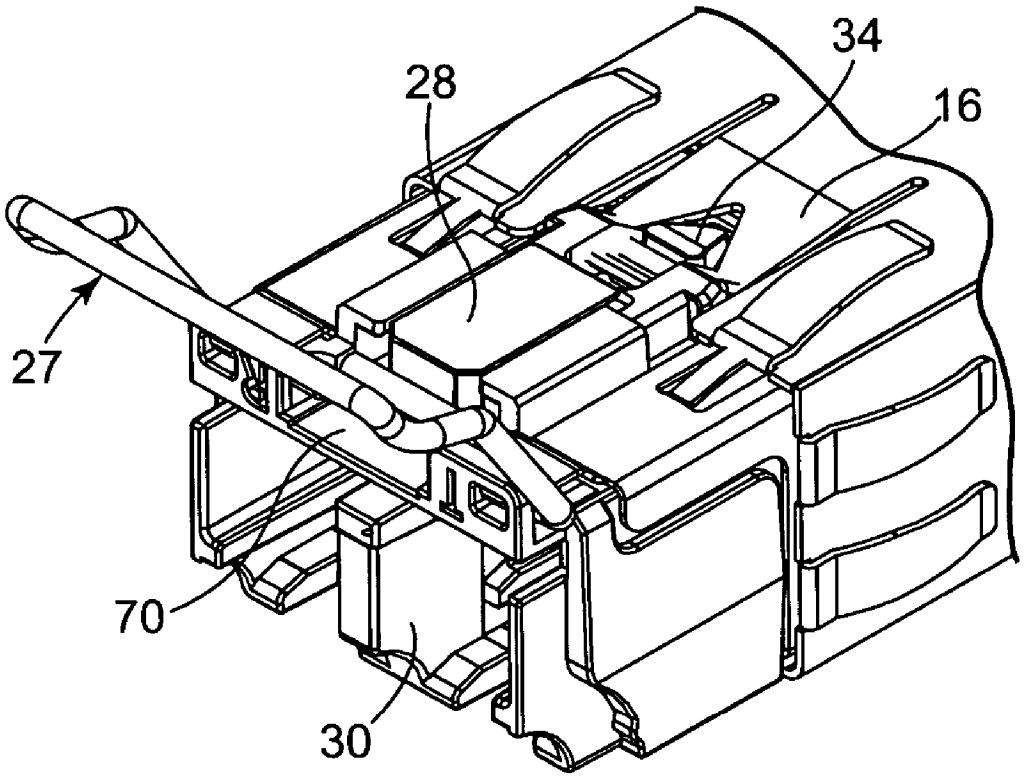


Fig. 7

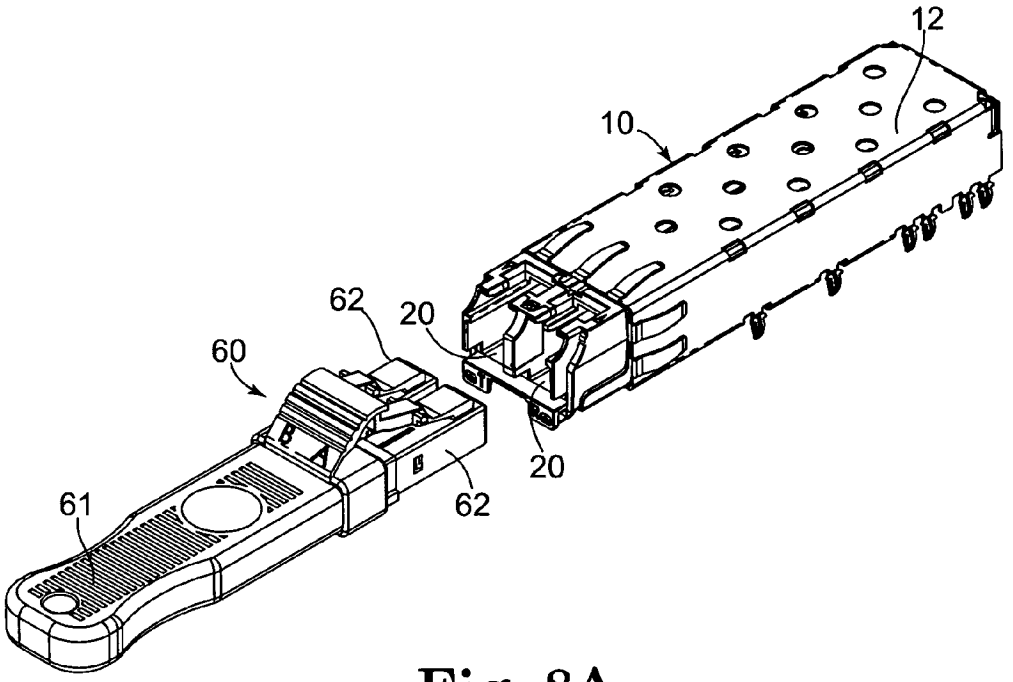


Fig. 8A

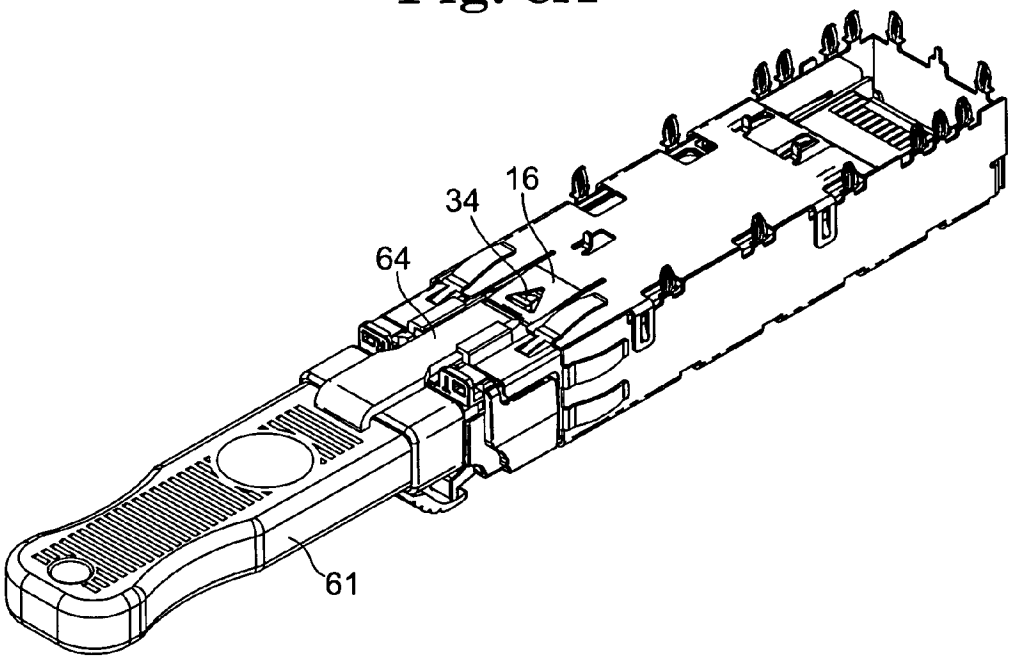


Fig. 8B

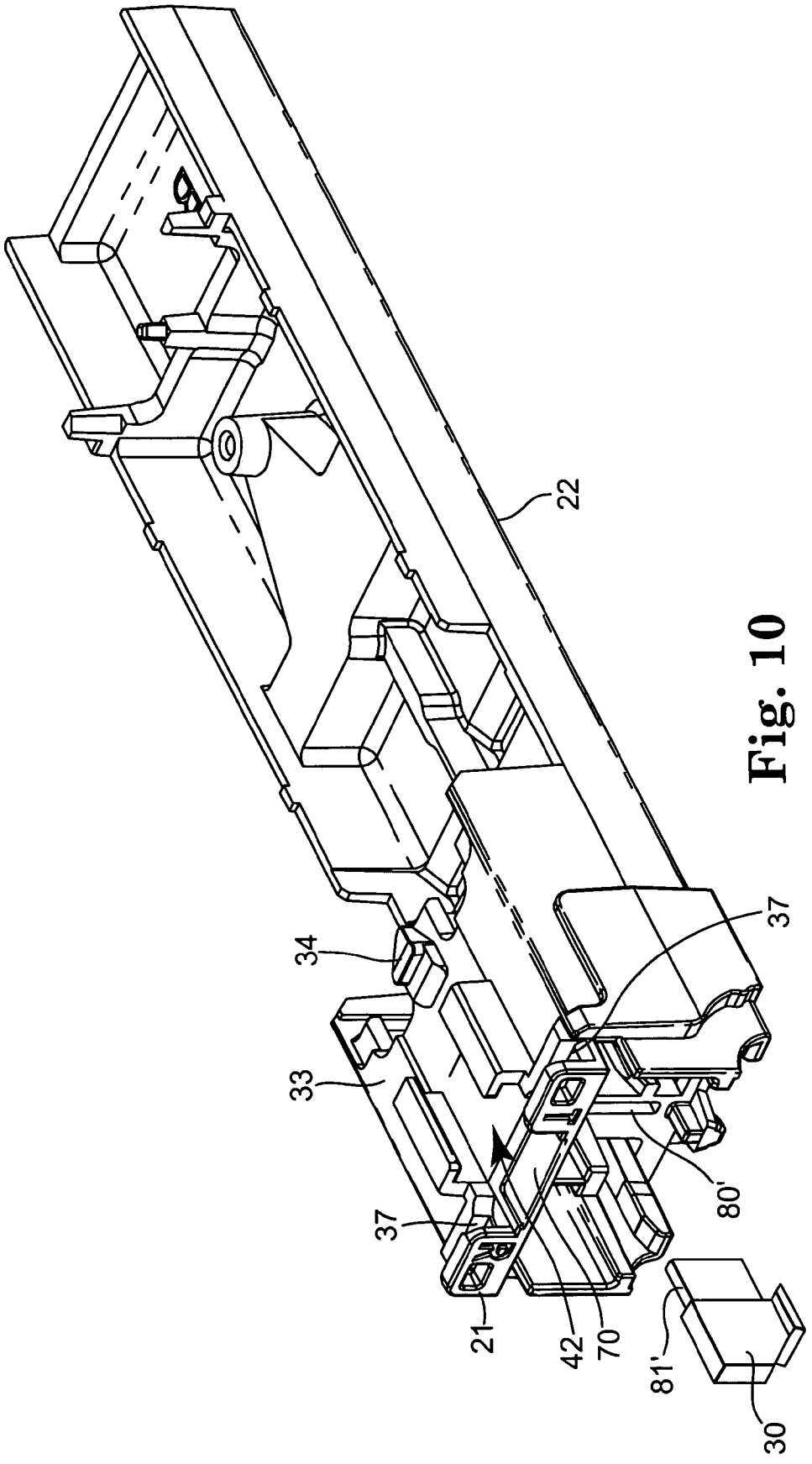


Fig. 10

MODE INDICATOR FOR TRANSCEIVER MODULE

BACKGROUND OF THE INVENTION

This invention relates to a pluggable transceiver module for use in a fiber optic switch.

Fiber optics are increasingly used for transmitting data signals. Typically, when data is transmitted by an optical network, it must be converted from an electrical signal to a light signal, and visa versa. In order to effectuate the conversion between electrical and optical signals, a transceiver module is used at both ends of a fiber optic cable. Each transceiver module typically contains a laser transmitter circuit capable of converting electrical signals to optical signals, and an optical receiver capable of converting received optical signals back into electrical signals.

Typically, a transceiver module is electrically interfaced with a host device, such as a host computer, switching hub, network router, switch box, computer I/O or the like. In many applications is it desirable for the transceiver modules to be "hot-pluggable," that is, the transceiver module may be inserted into and removed from the host system without removing electrical power. In this way, if a transceiver module fails, it can more readily be removed from the host device and replaced with a new module without soldering or the like.

Consequently, several pluggable transceiver module designs and standards have been introduced in which a pluggable transceiver module plugs into a receptacle which is electronically connected to a host circuit board. For example, such a standard is delineated in the Small Form-Factor Pluggable (SFP) Transceiver Multi-Source Agreement (MSA), dated Sep. 14, 2000. Such standards define a receptacle or cage that receives a transceiver module. The cage includes a cage latch. The transceiver module includes a latch boss which fits into the cage latch. The transceiver module also includes an actuator configured to engage the cage latch and deflect the cage latch away from the latch boss, thereby releasing the transceiver module from the cage. An exposed feature of the transceiver module is color coded to indicate if the transceiver module is multi-mode or single mode.

Typically, fiber optic components use color to designate mode (e.g., wavelength, contact type, product type, etc.), or in specific applications to designate user-specific information. Transceiver modules are generally small, with only a small portion of transceiver module visible when installed. The transceiver modules are also often installed in hard to access areas. It is difficult, therefore, to ensure that the mode designation color is visible to the user. Previously, color designation has been accomplished by, for example, manufacturing the entire assembly out of a single color material (typically a plastic), manufacturing the entire front of the module out of a single color material, or providing colored handles. However, manufacturing an entire assembly or significant portion thereof out of a single color material limits the usefulness of the assembly, as components of a particular color can only be used with a particular mode. In addition, to provide the necessary strength and visibility, plastic components are typically larger than would be preferred and add unwanted size to the device. Also, for some applications it is desirable to form components from materials which is not easily colored (such as metal for EMI shielding). Finally, although various standards have been given for the configuration of the transceiver module and the cage, variations between manufacturers exist as to some of the specific configurations. The variations between manufacturers are sometimes intended to satisfy different end-user requirements, such as how the transceiver is extracted from the cage. Consequently, some configurations of transceiver modules do not utilize components such as handles, making a color designating handle feature of no advantage. It is therefore desirable to have a color mode indicator that does not add to the size of the transceiver module, and that is easily adaptable and usable with different configurations of modules without requiring different tooling, molds, components, etc.

SUMMARY OF THE INVENTION

A mode indicator for use with a transceiver module comprises a colored plastic button having an engagement feature configured for attachment to a corresponding transceiver module engagement feature.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective illustration of a transceiver module in accordance with the present invention plugged into a cage mounted on a printed circuit board.

FIG. **2** is an exploded perspective illustration of the transceiver module.

FIG. **3** is a perspective illustration of the housing of the transceiver module.

FIG. **4** is a perspective illustration of the cage for receiving the transceiver module.

FIG. **5** is an enlarged perspective view of the actuator wedge used in one configuration of the transceiver module.

FIG. **6** is a bottom plan illustration of the assembled transceiver module.

FIG. **7** is a perspective illustration of a release handle being used to remove the transceiver module from the cage.

FIGS. **8**A and **8**B are perspective illustrations of a release tool used to remove the transceiver module from the cage.

FIGS. **9**A and **9**B are enlarged perspective views of the mode indicator button used with the transceiver module.

FIG. **10** is a partially exploded perspective illustration of another embodiment of the mode indicator button and transceiver module.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following Detailed Description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as "top," "bottom," "front," "back," "leading," "trailing," etc., is used with reference to the orientation of the Figure(s) being described. Because components of embodiments of the present invention can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

FIG. **1** illustrates transceiver module **10**, face plate **11**, cage **12**, and printed circuit board (PCB) **14** in accordance with the present invention. Cage **12** is shown mounted to PCB **14**. Cage **12** can be secured to PCB **14** in various ways

consistent with present invention. Face plate **11** is fixed the PCB **14** and typically includes a plurality of openings. Cage **12** is illustrated extending through one of the openings in face plate **11**. Cage **12** may be further secured to faceplate **11** with outwardly-extending prongs or springs or the like. Only a single cage **12** is illustrated extending through faceplate **11** for ease of illustration, but one skilled in the art will recognize that a multiplicity of cages can be mounted to PCB **14** and extend through faceplate **11** to receive a multiplicity of transceivers in accordance with the present invention.

Cage **12** includes cage latch **16**. In FIG. **1**, transceiver module **10** is shown inserted into cage **12** and secured by cage latch **16**. Cage latch **16** is resiliently biased to move toward transceiver module **10** thereby securing transceiver module **10** within cage **12**. Cage latch **16** can also be moved away from transceiver module **10** so that transceiver module **10** can be extracted from cage **12**, as will be described in more detail below.

Transceiver module **10** includes input/output receptacles **20** in its front face **21**. Input/output receptacles **20** may be used to provide both input and output for optical and electrical signals to and from transceiver module **10**. In other embodiments, one or more input/output receptacle **20** may be used. Front face **21** of transceiver module **10** is referred to as being at the front of transceiver module **10**. However, in this regard, such directional terminology is used with reference to the orientation of the Figures being described and is in no way meant to be limiting. One skilled in the art will recognize that components of embodiments of the present invention can be positioned in a number of different orientations.

In operation, optical and electrical signals can be transmitted to and from a destination or source that is plugged into input/output receptacles **20** to transceiver module **10**. When transceiver module **10** is plugged into cage **12**, it is in electrical communication with PCB **14** via the connections therebetween. Thus, signals can be sent to and from the PCB via transceiver module **10**. Transceiver module **10** is hot pluggable and may be removed from cage **12** and replaced.

FIG. **2** illustrates an exploded isometric view of the top-front side of a first configuration of transceiver module **10**. Transceiver module **10** includes housing **22** which receives transceiver opto-electronic components **24** and electromagnetic interference (EMI) shield **26**. In the first configuration of transceiver module **10**, release handle **27** and actuator wedge **28** are attached to housing **22** in manners described in greater detail below. A mode indicator button **30** is attached to housing **22** to indicate the particular mode of transceiver module **10**. Module cover **32** is configured to fit over housing **22** of transceiver module **10** and protects opto-electronic components **24**. Module cover **32** also helps secure module **10** in cage **12** when it is inserted therein, and also helps secure release handle **27** and actuator wedge **28** to housing **22**.

In one embodiment, housing **22** is formed of a die cast or molded conductor, such as metal or conductive plastic, while module cover **32** is formed from stamped and shaped sheet metal. Release handle **27** is formed of shaped wire, while wedge **28** and mode indicator button **30** are formed of a plastic material.

In a second configuration of transceiver module **10**, the same housing **22**, opto-electronic components **24**, EMI shield **26**, mode indicator button **30** and module cover **32** are utilized, but release handle **27** and actuator wedge **28** are omitted from transceiver module **10**. In this manner, different end-user configuration requirements for the transceiver module **10** can be satisfied with common components. In particular, housing **22** can be used for at least two different transceiver module configurations.

As best seen in FIG. **3**, the bottom side of housing **22** provides a surface **33**. A latch boss **34** extends away from surface **33** such that the top of latch boss **34** is raised relative to surface **33**. Latch boss **34** extends away from surface **33** and is configured to engage cage latch **16** of cage **12** (best seen in FIG. **4**). Specifically, when transceiver module **10** is inserted into cage **12**, latch boss **34** deflects latch **16** slightly away from transceiver module **10** such that latch boss **34** travels past the front edge **36** of latch **16** and toward latch slot **40** in latch **16**. When transceiver module **10** is fully inserted into cage **12**, latch boss **34** is aligned with latch slot **40** such that latch boss **34** extends through latch slot **40**. Latch **16** is configured with a bias such that when latch boss **34** is fully aligned with latch slot **40**, latch **16** transitions toward transceiver module **10**. In this way, transceiver module **10** will be locked into cage **12**.

In one embodiment, latch boss **34** and latch slot **40** are configured to be triangular in shape and complement each other such that latch boss **34** fits through latch slot **40**. Although latch slot **40** is specified as triangular in shape in the above-referenced Small Form-Factor Pluggable Transceiver Multi-Source Agreement, latch boss **34** and latch slot **40** may have shapes other than the triangular shape illustrated in the Figures. The shapes of latch boss **34** and latch slot **40** may be the same (i.e., both triangular, rectangular, circular, etc.), or may be different, so long as latch slot **40** is capable of securely engaging latch boss **34**.

In the first configuration of transceiver module **10**, release handle **27** is mounted in trough **37** or similar openings on housing **22**. Handle **27** is mounted in trough **37** such that it can be rotated relative to transceiver module **10**. Release handle **27** includes cam portion **39**. As described in greater detail below, when handle **27** is rotated, cam portion **39** engages actuator wedge **28** and causes wedge **28** to move away from front face **21** of transceiver module **10**. In one embodiment (best seen in FIG. **5**), tab portions **43** of module cover **32** trap handle **27** within trough **37** when module cover **32** is installed on housing **22**.

In the first configuration of transceiver module **10**, actuator wedge **28** (seen in FIGS. **2**, **5** and **6**) is slidably retained in a slot (shown as T-slot **42**) that is provided on surface **33**. Slot **42** is configured to retain actuator wedge **28** such that wedge **28** can move toward and away from the front side **21** of transceiver module **10**, but so that it cannot move laterally. The engaging shapes of actuator wedge **28** and slot **42** may differ from the T-shape illustrated, so long as slot **42** retains actuator wedge **28** adjacent surface **33** and permits wedge **28** to move toward and away from the front side **21** of transceiver module **10**, but constrains lateral movement of actuator wedge **28**.

Actuator wedge **28** includes tines **44** spaced to accommodate latch boss **34** therebetween, such that when latch boss **34** is placed between tines **44**, as illustrated in the Figures and described in greater detail below, linear movement of wedge **28** (in the direction of arrow **45** in FIG. **6**) will not be impeded by latch boss **34** as wedge **28** moves away from the front face **21** of transceiver module **10**. Tines **44** of wedge **28** are configured with ramp portions **52**. As wedge **28** moves away from the front face **21** of transceiver module **10**, ramp portions **52** of tines **44** engage latch **16** of cage **12** and deflect latch **16** away from surface **33** of module **10**. Ramp portions **52** are illustrated as having a generally linear slope, but can also be designed with non-linear slopes.

To extract transceiver module **10** from cage **12**, cage latch **16** must be moved away from surface **33** of transceiver module **10** a sufficient distance so that that latch slot **40** is removed from engagement with latch boss **34** and latch boss **34** clears the front edge **36** of latch slot **40**, as will be described more fully below.

In the configuration of transceiver module **10** having release handle **27** and actuator wedge **28**, the release handle **27** can be used to release transceiver module **10** from cage **12** so that it can be extracted therefrom. In FIGS. **1** and **6**, release handle **27** is shown in a closed or 0° position, such that it is generally parallel with the front face **21** of transceiver module **10**. In one embodiment, cam portion **39** of release handle **27** does not engage wedge **28** when release handle **27** is in the closed postion. As release handle **27** is rotated from the initial closed position toward a second open position (best seen in FIG. **7**), cam portion **39** moves away from the front of transceiver module **10** with the rotation, thereby engaging actuator wedge **28** and causing actuator wedge **28** to move in an approximately linear direction within slot **42** away from the front face **21** of transceiver module **10** with the rotation of release handle **27**.

As wedge **28** moves away from front surface **21**, ramp portions **52** of wedge **28** engage cage latch **16** and deflect latch **16** away from surface **33** of transceiver module **10** and consequently away from latch boss **34**. In this way, the movement of wedge **28** against latch **16** pushes latch **16** off latch boss **34** and provides clearance for latch boss **34** to pass out of latch slot **40**. Once adequate clearance is provided, transceiver module **10** can be removed from cage **12**, such as by pulling on handle **27**.

In the configuration of transceiver module **10** in which release handle **27** and wedge **28** are not present, release tool **60** (illustrated in FIGS. **8**A and **8**B) can be used to release transceiver module **10** from cage **12** so that it can be extracted therefrom. Release tool **60** includes a handle portion **61** having connector engagement elements **62** at one end thereof. Engagement elements **62** are configured to engage receptacles **20** of transceiver module **10**. Actuator arm **64** extends past connector engagement elements **62** and is shaped to approximately resemble wedge **28** at its distal end **66**. Accordingly, similar reference numbers are used herein to designate similar parts. As described above with respect to wedge **28**, when actuator arm **64** is actuated, such as by inserting the tool, ramp portion(s) **52** engages latch **16** of cage **12** and deflect latch **16** away from surface **33** of module **10**.

To remove transceiver module **10** using release tool **20**, actuator arm **64** is inserted through gap or opening **70** in front face **21** of housing **22**. Opening **70** is sized to receive actuator arm **64** and permit actuator arm **64** to pass unimpeded through slot **42**. From this first position, as removal tool **60** is advanced toward transceiver module **10**, connector engagement elements **62** engage receptacles **20**, and ramp portions **52** of actuator arm **64** engage cage latch **16**. Ramp portion(s) **52** deflect latch **16** away from surface **33** of transceiver module **10** and consequently away from latch boss **34** to provide clearance for latch boss **34** to pass out of latch slot **40**. Once actuator arm **64** of removal tool **60** is fully inserted and adequate clearance is provided, transceiver module **10** can be removed from cage **12**, such as by pulling on handle portion **61** of removal tool **60**.

Actuator arm **64** of removal tool **60** is illustrated as spatially fixed with respect to handle portion **61** and connector engagement elements **62**, such that connector engagement elements **62** engage receptacles **20** of transceiver module **10** concurrent with the engagement of actuator arm **64** and latch **16**. In other embodiments, actuator arm **64** may be movable with respect to handle portion **61** and connector engagement elements **62**, such that connector engagement elements **62** engage receptacles **20** of transceiver module **10** prior to the engagement of actuator arm **64** and latch **16**.

Typically, fiber optic components use color to designate mode (e.g., wavelength, contact type, product type, etc.). Transceiver module **10** is generally small and only a small portion of transceiver module **10** is visible when installed in cage **12**. Mode indicator button **30** (FIGS. **2**, **9**A and **9**B) provides a highly visible color signal adjacent the front face **21** of transceiver module **10**, and is visible from the front and top of transceiver module **10**. Mode indicator button **30** is a molded plastic button (in any desired color) that is integral to the fiber optic input/output receptacles **20** of transceiver module **10**, thereby clearly providing mode information to a user and adding no size to transceiver module **10**. In one embodiment, mode indicator button **30** includes a recessed portion **80** in its back surface that is shaped to receive protrusion **81** of housing **22**. Mode indicator button **30** may be secured to protrusion **81** by means including press fit and adhesive. In another embodiment (FIG. **10**), the positions of recessed portion **80** and protrusion **81** may be switched such that mode indicator button **30** has a protrusion **81'** receivable in a recessed portion **80'** of housing **22**.

Mode indicator button **30** can be used to designate transceiver module **10** optical mode information, or in specific applications can be used by the end-user to designate user specific information. Mode indicator button **30** provides several advantages over previous color marking features, such as color coded molded handles. For example, mode indicator button is easily assembled for different mode configurations, adds no size to the transceiver module, and allows the use of either a handle **27** or a removal tool **60** to release the transceiver module **10** from cage **12**. Previous color marking features, such as color coded molded handles, are obviously of no advantage in a transceiver module with no handle.

Although specific embodiments have been illustrated and described herein for purposes of description of the preferred embodiment, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent implementations calculated to achieve the same purposes may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. Those with skill in the mechanical, electromechanical, and electrical arts will readily appreciate that the present invention may be implemented in a very wide variety of embodiments. This application is intended to cover any adaptations or variations of the preferred embodiments discussed herein. Therefore, it is manifestly intended that this invention be limited only by the claims and the equivalents thereof.

What is claimed is:

1. A mode indicator for use with a transceiver module, the mode indicator comprising:

a colored plastic button having an engagement feature configured for stationary attachment to a corresponding transceiver module engagement feature, wherein the colored plastic button is shaped to form at least a portion of an input/output receptacle of the transceiver module.

2. The mode indicator of claim **1**, wherein the colored plastic button forms a common wall between two adjacent input/output receptacles.

3. The mode indicator of claim 1, wherein the button is attached to the transceiver module by one of press fit or an adhesive.

4. A mode indicator for use with a transceiver module, the mode indicator comprising:

a colored plastic button having an engagement feature configured for stationary attachment to a corresponding transceiver module engagement feature, wherein the button engagement feature comprises a recessed area within the button and the transceiver module engagement feature comprises a projection extending from the module, wherein the recessed area of the button is shaped to receive the projection of the module.

5. A mode indicator for use with a transceiver module, the mode indicator comprising:

a colored plastic button having an engagement feature configured for stationary attachment to a corresponding transceiver module engagement feature, wherein the button engagement feature comprises a projection extending from the button and the transceiver module engagement feature comprises a recessed area within the module, wherein the recessed area of the module is shaped to receive the projection of the button.

6. A transceiver module comprising:

a housing having an engagement feature adjacent a front face of the housing; and

a colored mode indicator attached to the engagement feature of the housing, wherein the mode indicator remains stationary with respect to the housing, and wherein the engagement feature adjacent the front face of the housing is a projection extending toward the front face, and wherein the projection is received in a recessed portion of the colored mode indicator.

7. A transceiver module comprising:

a housing having an engagement feature adjacent a front face of the housing; and

a colored mode indicator attached to the engagement feature of the housing, wherein the mode indicator remains stationary with respect to the housing, and wherein the engagement feature adjacent the front face of the housing is a recessed portion, and wherein the recessed portion receives a projection extending from the colored mode indicator.

8. A transceiver module comprising:

a housing having an input/output receptacle an engagement feature adjacent a front face of the housing; and

a colored mode indicator attached to the engagement feature of the housing, wherein the mode indicator remains stationary with respect to the housing, and wherein the colored mode indicator forms at least a portion of the input/output receptacle.

9. The transceiver module of claim 8, wherein the colored mode indicator is visible from a top and front of the transceiver module.

10. The transceiver module of claim 8, wherein the transceiver module is for insertion within a cage having a cage latch that retains the transceiver module in the cage, the transceiver module further comprising:

a release mechanism coupled to the housing to release the transceiver module from the cage;

wherein the colored mode indicator is separate from the release mechanism.

11. The transceiver of claim 8, further comprising two adjacent input/output receptacles in the housing, wherein the colored mode indicator forms a common wall between the adjacent input/output receptacles.

12. The transceiver of claim 8, wherein the housing formed of a metal and the colored mode indicator is formed of a plastic material.

13. The transceiver of claim 8, wherein the colored mode indicator is attached to the housing by press fit.

14. The transceiver of claim 8, wherein the colored mode indicator is attached to the housing by an adhesive.

15. A data transmission system comprising:

a printed circuit board;

a cage structure fixed to the printed circuit board, the cage structure having an opening and a latch adjacent the opening,;

a transceiver module having an input/output receptacle, the transceiver module pluggable into the opening of the cage structure, wherein the transceiver module is retained within the cage by the latch and wherein the transceiver module is removable from the cage by deflecting the latch with a release mechanism; and

a colored mode indicator attached to the transceiver module, wherein the colored mode indicator is separate from the release mechanism, and wherein the colored mode indicator forms at least a portion of the input/output receptacle.

16. The data transmission system of claim 15, wherein the transceiver module has a housing formed of a metal and the colored mode indicator is formed of a plastic material and attached to the housing.

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