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Automatic analyzer

Abstract

An automatic analyzer capable of improving maintainability by facilitating access to an interlock unit. The interlock unit includes an operation member configured to be movably supported between a lock position and a lock release position, and obstruct rotation to an open position of a cover; an electromagnetic driving unit configured to drive the operation member, and a driving connecting unit configured to connect the operation member and the electromagnetic driving unit and drive the operation member by conveying an operation of the electromagnetic driving unit to the operation member. The interlock unit is provided to be attachable and detachable to and from the housing.

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Background/Summary

TECHNICAL FIELD

(1) The present invention relates to an automatic analyzer.

BACKGROUND ART

(2) An automatic analyzer is a device that automatically analyzes blood and other biological samples and outputs the results, and is an indispensable device in hospitals and medical testing facilities. The automatic analyzer is required to perform a wider variety of inspections in a shorter time. On the other hand, in the automatic analyzer, an openable and closable safety cover equipped with an interlock mechanism (interlock unit) is provided on the upper part of the working surface where the analysis work is performed, and the safety cover is locked so that the safety cover does not open while the device is being driven, causing the device to stop and delay the inspection. In addition, when the operator replaces consumables, the device is stopped and the lock by the interlock mechanism is released so that the safety cover can be opened and closed, and the operator can access the working surface with the safety cover open to perform various tasks.

(3) As a technique related to such an interlock mechanism, for example, JP-A-2013-076678 (PTL 1) discloses a specimen processing device for processing a specimen, the device including a processing device main body provided with an operation mechanism and operating the operation mechanism to execute a specimen processing operation, a cover that covers at least one operation mechanism, a lock mechanism that locks the cover to prohibit the opening of the cover, and a control unit that controls the lock mechanism, in which the control unit is configured to be able to set a first mode in which the cover is not unlocked until an instruction to release the lock is received from the user after the specimen processing operation by the operation mechanism is completed, and a second mode for automatically unlocking the cover after the specimen processing operation by the operation mechanism is completed.

CITATION LIST

Patent Literature

(4) PTL 1: JP-A-2013-076678

SUMMARY OF INVENTION

Technical Problem

(5) However, in the above-mentioned related art, no consideration is given to the maintainability of the lock mechanism. For example, when it is necessary to repair the lock mechanism while the cover is locked and the opening of the cover is prohibited, it is expected that access to the lock mechanism is not easy and the lock mechanism will be difficult to repair.

(6) The present invention has been made in view of the above, and an object of the present invention is to provide an automatic analyzer capable of improving maintainability by facilitating

access to an interlock unit.

Solution to Problem

(7) The present application includes a plurality of units for solving the above problems. As an example, an automatic analyzer includes a housing that accommodates an analyzer for analyzing a specimen; a cover provided to cover an upper side of a working surface which is an upper surface of the housing, and pivotally supported around a support shaft provided on one side of a rear side on the upper surface of the housing between a closed position and an open position in an upper-lower direction; and an interlock unit provided on a front side on the upper surface of the housing, and capable of preventing the cover from rotating from the closed position to the open position, in which the interlock unit includes a hollow case provided on a lower side of an end of the front side at the closed position of the cover, and having a rectangular parallelepiped shape disposed at a position adjacent to a front surface of the inside of the housing; an operation member supported to be movable between a lock position and a lock release position on the upper surface of the case, and inhibiting rotation to the open position of the cover by engaging with a protruding portion provided on the end of the front side of the cover at the lock position; an electromagnetic driving unit for driving the operation member; and a driving connecting unit for connecting the operation member to the electromagnetic driving unit and driving the operation member by conveying an operation of the electromagnetic driving unit to the operation member, the housing has a front surface opening provided at a position on the front surface of the housing corresponding to the interlock unit and covered with a front plate detachable from the housing, and the interlock unit is provided to be attachable and detachable to and from the housing via the front surface opening in a state where the front plate is detached.

Advantageous Effects of Invention

(8) Maintainability can be improved by facilitating access to the interlock unit.

Description

BRIEF DESCRIPTION OF DRAWINGS

(1) FIG. **1** is a plan view showing an overall configuration of an automatic analyzer including a reagent disk.

(2) FIG. **2** is a perspective view showing a state where a safety cover of the automatic analyzer is opened.

(3) FIG. **3** is a left side view showing the state where the safety cover of the automatic analyzer is opened.

(4) FIG. **4** is a perspective view showing a state where an interlock unit is attached to a frame.

(5) FIG. **5**A is a top view showing a lock release state of an interlock unit according to a first embodiment.

(6) FIG. **5**B is a cross-sectional view of FIG. **5**A taken along the line A-A.

(7) FIG. **6** is a perspective view showing the lock release state of the interlock unit.

(8) FIG. **7** is a transparent view showing the lock release state of the interlock unit.

(9) FIG. **8** is a cross-sectional view taken along the line A-A and showing a locked state of the interlock unit in FIG. **5**A.

(10) FIG. **9** is a transparent view showing the lock state of the interlock unit.

(11) FIG. **10** is a cross-sectional view of FIG. **8** taken along the line B-B.

(12) FIG. **11** is a cross-sectional view of FIG. **8** taken along the line C-C.

(13) FIG. **12** is an exploded perspective view showing a configuration of the interlock unit.

(14) FIG. **13** is a side view showing the locked state of the interlock unit.

(15) FIG. **14** is a rear view showing the locked state of the interlock unit.

(16) FIG. **15** is a cross-sectional view taken along the line A-A in FIG. **5**A and showing the lock

state of the interlock unit, and is a partially enlarged view of the vicinity of a lock claw.
(17) FIG. **16** is a cross-sectional view taken along the line A-A in FIG. **5**A and showing the lock state of the interlock unit, and is a partially enlarged view of the vicinity of the lock claw.
(18) FIG. **17**A is a rear view of the interlock unit, and is an explanatory view showing a reactive force when the interlock unit is locked in an L-shape.
(19) FIG. **17**B is a rear view of the interlock unit, and is an explanatory view showing a reactive force when the interlock unit is locked in a T-shape.
(20) FIG. **18**A is a rear view of the interlock unit, and is an explanatory view showing a dimension relationship between a lock lever and a lock receiving unit.
(21) FIG. **18**B is a rear view of the interlock unit, and is an explanatory view showing the dimension relationship between the lock lever and the lock receiving unit.
(22) FIG. **19** is a cross-sectional view taken along the line A-A in FIG. **5**A and showing the interlock unit, and is a view showing a drain passage for a liquid invading into the case.
(23) FIG. **20** is a cross-sectional view taken along the line A-A in FIG. **5**A and showing the locked state of the interlock unit, and is a partially enlarged view of the vicinity of the lock lever.
(24) FIG. **21** is a cross-sectional view showing an operation when an abnormal locked state of the interlock unit is released.
(25) FIG. **22** is a perspective view showing a configuration of a liquid guiding unit according to a second embodiment.
(26) FIG. **23** is a cross-sectional view taken along the line A-A in FIG. **5**A and showing a lock release state of an interlock unit according to a third embodiment.
(27) FIG. **24** is a transparent perspective view showing the lock release state of the interlock unit.
(28) FIG. **25** is a cross-sectional view taken along the line A-A and showing a locked state of the interlock unit.
(29) FIG. **26** is a transparent perspective view showing the lock state of the interlock unit.
(30) FIG. **27**A is a top view of an interlock unit according to a fourth embodiment.
(31) FIG. **27**B is a cross-sectional view taken along the line A-A in FIG. **5**A and showing the interlock unit according to the fourth embodiment.
(32) FIG. **28** is a perspective view of an interlock unit according to a fifth embodiment.
(33) FIG. **29** is a cross-sectional view of an interlock unit according to a sixth embodiment.
(34) FIG. **30** is a block diagram showing an outline configuration of the automatic analyzer.
(35) FIG. **31** is a flow chart showing operations of the interlock unit.

DESCRIPTION OF EMBODIMENTS

(36) Hereinafter, embodiments of the present invention will be described with reference to the drawings.

First Embodiment

(37) The first embodiment of the present invention will be described in detail with reference to FIGS. **1** to **21**.
(38) (1) Automatic Analyzer **1**
(39) FIG. **1** is a plan view showing an overall configuration of an automatic analyzer including a reagent disk. Further, FIG. **2** is a perspective view showing a state where a safety cover of the automatic analyzer is opened, and FIG. **3** is a left side view. In the following description, when the automatic analyzer **1** is installed, the upper direction is defined as the upper side (upper), the lower direction is defined as the lower side (lower side), the side accessed by the operator of the automatic analyzer **1** is defined as the front side (front), the opposite side thereof is defined as the rear side (rear), the right direction when the automatic analyzer **1** is viewed from the front is defined as the right side (right), and the left direction is defined as the left side (left).
(40) As shown in FIGS. **1** and **2**, the automatic analyzer **1** includes a reagent disk (reagent vessel holder) **2**, a safety cover **4**, a sample transport unit **5**, a sample dispensing unit **6**, a tip rack **7**, a transport unit **8**, an incubator **9**, a sample dispensing tip buffer **11**, a disposal hole **12**, an agitation

unit **13**, a reagent dispensing probe **15**, an agitation unit **16**, a cleaning unit **17**, a reaction solution dispensing probe **18**, a detecting unit **19**, a housing **21**, a working surface **22**, and a reagent cool box (reagent storage) **24**.

(41) The housing **21** has a substantially rectangular parallelepiped shape to cover a front plate **56**, a left and right side plate **57**, a rear plate **58**, and the upper surface, that is, a working surface **22** around a highly rigid housing frame **55** in which steel plates are joined by means such as welding or riveting, and houses the sample transport unit **5**, the cleaning unit **17**, the reagent cool box **24**, a substrate (not shown), a flow path (not shown), and the like inside. The front plate **56**, the left and right side plate **57**, and the rear plate **58** are configured to be detachable during maintenance work.

(42) The safety cover **4** is supported on one side of the upper surface of the housing **21** by, for example, a hinge, and is configured to be openable and closable around the hinge. The alternate long and short dash line in FIGS. **1** and **2** shows the state where the safety cover **4** is closed. The safety cover **4** is provided with an interlock that uses, for example, a solenoid as a drive source. During the operation of the automatic analyzer **1**, the solenoid is energized to be latched and the safety cover **4** is maintained in a closed state. While the automatic analyzer **1** is stopped, the energization of the solenoid is released and the safety cover **4** can be opened.

(43) The interlock is provided separately from the lock mechanism specified in ISO and the like, which restricts the opening and closing of the safety cover for the purpose of ensuring safety and is provided to prevent the analysis operation from a delay in the entire work resulted from being temporarily stopped when the operator accidentally opens the safety cover.

(44) The interlock includes a lock receiving unit **25**, which is a protruding portion that is provided substantially in the center of the left and right sides of a safety cover front side **24**, which is the lower side of the front surface of the safety cover **4** (safety cover front surface **23**), and faces backward from the front surface of the safety cover **4** (safety cover front surface **23**), that is, protrudes toward the inside of the automatic analyzer; and a lock unit **26** (hereinafter, may be referred to as an interlock unit) that is provided at a position facing the lock receiving unit **25** on the working surface **22** when the safety cover **4** is closed, and acts on the lock receiving unit **25**.

(45) The interlock unit **26** is attached to the housing frame via a mounting bracket **59**. The details of the configuration of the interlock unit **26** will be described later.

(46) A door opening/closing detection **202** is connected to a power supply (not shown), and the power supply is connected to enable the automatic analyzer **1** to operate when the safety cover **4** is closed, and the power supply is cut off to stop the automatic analyzer **1** when the safety cover **4** is opened.

(47) The sample transport unit **5** is configured of, for example, a belt conveyor, a rack handler, or the like, and moves a sample **5***a* in the automatic analyzer **1** to transport the sample **5***a* to the range of motion of the sample dispensing unit **6**.

(48) The tip rack **7** is configured to be attachable and detachable to and from the automatic analyzer **1** and is disposed on the upper surface of the automatic analyzer **1** by an operator in a state where a plurality of sample dispensing tips **10** and a plurality of reaction vessels **14** are placed therein.

(49) The transport unit **8** is configured to be movable in the plane direction and the Z-axis direction and is configured to be movable above the tip rack **7**, a part of the incubator **9**, the sample dispensing tip buffer **11**, the disposal hole **12**, and the agitation unit **13**. As the transport unit **8**, for example, a triaxial robot or the like can be used. The transport unit **8** grips the reaction vessels **14** one by one from the tip rack **7** and moves the reaction vessels to the incubator **9**. Further, the transport unit **8** grips the sample dispensing tips **10** one by one from the tip rack **7** and moves the sample dispensing tips to the sample dispensing tip buffer **11**.

(50) The sample dispensing tip buffer **11** is a buffer on which the sample dispensing tip **10** gripped by the transport unit **8** is temporarily placed. The sample dispensing tip buffer **11** is configured so that a plurality of sample dispensing tips **10** can be placed.

(51) The incubator **9** has a substantial disk shape and is configured to be rotatable. The incubator **9** holds a plurality of reaction vessels **14** along the circumferential direction, and each reaction vessel **14** can be moved to a predetermined position by the rotation of the incubator **9**.
(52) The sample dispensing unit **6** moves to the upper part of the sample dispensing tip buffer **11**, grips any one of the sample dispensing tips **10**, moves to the upper part of the sample **5***a* and aspirates the sample **5***a* into the inside of the sample dispensing tip **10**. After that, the sample dispensing unit moves to the upper part of the reaction vessel **14** on the incubator **9** and discharges the sample **5***a* from the inside of the sample dispensing tip **10** into the reaction vessel **14**. After that, the sample dispensing unit **6** moves to the upper part of the disposal hole **12** and drops the sample dispensing tip **10** into the inside of the disposal hole **12**.
(53) The reagent cool box **24** has a substantially cylindrical shape and accommodates the reagent disk **2**. A reagent vessel loading port **20** for attaching and detaching a reagent vessel **3** to and from the reagent disk **2** is provided on the upper surface of the reagent cool box **24**. Further, the reagent vessel loading port **20** is provided with an openable and closable reagent vessel loading port cover (not shown). The reagent cool box **24** has a heat insulating function in order to control the reagent vessel **3** to a constant temperature.
(54) The reagent disk **2** forms a slot for holding a plurality of reagent vessels **3** radially along the circumferential direction. The reagent disk **2** is configured to be rotatable around a central axis extending in the vertical axis direction, and by rotating the reagent disk **2**, each reagent vessel **3** is moved to a predetermined position. For example, the rotation of the reagent disk **2** can move the reagent vessel **3** containing the target reagent to a reagent dispensing position **15***a*. The reagent vessel **3** may contain magnetic particles for agitating the reagent.
(55) The reagent dispensing probe **15** is configured to be movable in the front-rear and left-right directions (horizontal direction) by, for example, an actuator. The reagent dispensing probe **15** aspirates a predetermined amount of the reagent from the reagent vessel **3** located at the reagent dispensing position **15***a* with a reagent dispensing probe (not shown) and dispenses the reagent into the reaction vessel **14** held in the incubator **9**.
(56) The agitation unit **16** is provided above the reagent dispensing position **15***a* and includes a magnetic particle agitating arm that is rotatable around a central axis extending in the vertical axis direction. At the lower end of the magnetic particle agitating arm, for example, a paddle-shaped or spiral-shaped magnetic particle agitating unit is provided. The magnetic particle agitating arm agitates the reagent by lowering and rotating the magnetic particle agitating unit in the reagent containing the magnetic particles. In order to prevent precipitation of magnetic particles in the reagent, the magnetic particle agitating arm agitates the reagent immediately before the reagent is dispensed by the reagent dispensing probe **15**. After agitating, the magnetic particle agitating arm moves to the cleaning unit **17** containing the cleaning liquid and rotates the magnetic particle agitating unit for cleaning.
(57) The reaction vessel **14** into which the predetermined reagent and the sample **5***a* are dispensed is managed to a predetermined temperature by the incubator **9**, and the reaction is promoted for a predetermined time. The reaction solution of the reagent and the sample **5***a* is supplied from the reaction vessel **14** to the detecting unit **19** by the reaction solution dispensing probe **18** and the physical characteristics thereof are detected by the detecting unit **19**. Examples of the physical characteristics include, but are not limited to, the amount of light emitted, the amount of scattered light, the amount of transmitted light, the current value, and the voltage value. The detecting unit **19** may perform the analysis while holding the reaction solution in the reaction vessel **14**.
(58) The reaction vessel **14** containing the reaction solution for which the analysis by the detecting unit **19** has been completed is moved to the upper part of the disposal hole **12** by the transport unit **8** and is discarded in the disposal hole **12**. Depending on the type of measurement, one reaction vessel **14** may be used for a plurality of measurements. In that case, the reaction vessel **14** is washed after discarding the reaction solution in the reaction vessel **14** for which the analysis has

been completed.
(59) A host computer **200** is connected to the automatic analyzer **1**, and a series of operations of the above configuration of the automatic analyzer **1** is controlled by the host computer **200**. The automatic analyzer **1** can efficiently analyze a plurality of samples with respect to a plurality of analysis items by combining or repeating the above operations.
(60) (2) Interlock Mechanism
(61) In FIG. **3**, the state where the safety cover **4** is closed is shown by a solid line, and the state where the safety cover **4** is opened is shown by an alternate long and short dash line. The front side of the safety cover **4** is provided with a handle portion **27**, which is a concave portion into which a finger is inserted when the safety cover **4** is opened from the closed position. In the present embodiment, the lock receiving unit is provided so as to come into contact with the rear surface of the handle portion **27** and extend rearward.
(62) The safety cover **4** is pivotally supported between the fully open position and the closed position around a cover support shaft **28** provided along the vicinity of the rear side of the main body, and if the safety cover **4** is opened to come into contact with a stopper (not shown) and supported by a support unit (not shown) not to be closed due to its own weight, the front side of the safety cover **4** rises to a height of H**1**. The operator can insert an arm or upper body through the gap between the working surface **22** and the front side of the safety cover **4** to clean or replace a group of various operation mechanisms **29** provided on the working surface **22**, to clean the working surface **22**, or to replace the reagent vessel **3**. Therefore, it is desirable that the front side height H**1** of the safety cover **4** has a sufficient height, and it is desirable that there are no partial protrusions or the like downward from the front side of the safety cover **4**, or it is desirable to have a smooth outer shape even if there are protrusions.
(63) It is effective that the handle portion **27** and the lock receiving unit **25** are provided close to the substantially central portion of the safety cover **4** in the left-right direction. In particular, it is particularly preferable to provide the lock receiving unit **25** on the back surface of the handle portion **27**. That is, when the operator tries to open the safety cover **4** in the locked state, if the lock receiving unit **25** is provided in the vicinity of the handle portion **27** or on the back surface of the handle portion **27**, the safety cover **4** is locked with slightly opened. On the contrary, there is a problem that when the lock receiving unit **25** is displaced to the left or right with respect to the handle portion **27**, a moment is generated by the force of the hand trying to open the safety cover **4**, and the reaction force from the lock receiving unit **25** trying to lock, and thus, the safety cover **4** tends to rise on the side of the handle portion **27** while being twisted, and the lifting amount on the side surface of the safety cover **4** on the side close to the handle portion **27** increases.
(64) (3) Outline of Attaching Interlock Unit **26** to Frame **55**
(65) FIG. **4** is a perspective view showing a state where the interlock unit is attached to the frame.
(66) The interlock unit **26** includes a case **47** having a substantially rectangular parallelepiped shape made of resin, a lock lever **35** which is an acting member provided on the upper surface of the case, and a solenoid **41** which is a driving unit provided on the lower surface of the case **47**, and the case includes a driving connecting unit (driving connecting member) that connects the plunger of the solenoid **41** and the lock lever **35** to operate. The details will be described later.
(67) As described above, the front plate **56** forming the front surface of the housing **21** is detachably provided during maintenance work such as periodic inspection, and FIG. **4** shows a state where the front plate **56** is detached and the front surface of the housing **21** is opened as a front surface opening. The interlock unit **26** is provided immediately behind the front plate **56** and configured to be screwed and fixed from the front via the mounting bracket **59** with respect to the housing frame **55** constituting the housing **21** via screw holes **105** by mounting screws **61**. The interlock unit **26** is attached from the lower side of the working surface **22** through a working surface opening **22***a* provided on the working surface **22**, and the upper surface is exposed from the working surface **22** and positioned and fixed so as to have substantially the same surface as the

working surface **22**. As an example, the mounting bracket **59** has a substantially U-shape that is symmetrical in the left and right in the top view and is provided with a mounting groove **60** that is a vertically long slit in which the upper end is opened in the center of the left and right in the front view and the lower end is connected to the left and right. Both the left and right sides of the mounting groove **60** facing the front surface is a unit mounting surface **93**. The left-right width of the mounting groove **60** is larger than the case width of the interlock unit **26** and the interlock unit **26** can be arranged in the mounting groove **60** and screwed from the front by the mounting screw **61**. Since the height of the mounting screw **61** is lower than the working surface **22** and the mounting screw **61** is arranged at a position to be able to be directly viewed from the front through the front surface opening if the front plate **56** of the housing **21** is detached, the mounting screw **61** can be easily attached and detached by the driver and maintainability is good. Therefore, attachment and detachment are easy, and assembly and maintainability are excellent.

(68) Further, as shown in FIG. **3**, since the interlock unit **26** is formed to be long in the upper-lower direction and short in the front-rear direction, even when the safety cover **4** is closed, if the mounting screw **61** is detached from the front by the driver **62** in the state where the front plate **56** is detached, the interlock unit **26** can be easily detached downward via the front surface opening. Therefore, even if the safety cover **4** cannot be opened in the locked state due to a failure or the like, the interlock unit **26** can be easily removed, and thus, maintainability is excellent. The suitable arrangement of the interlock unit **26**, the mounting bracket **59**, and the frame will be described later.

(69) (4) Handle Portion **27** and Lock Receiving Unit **25**

(70) The handle portion **27**, which is a concave portion for inserting fingers along the lower end, is provided on the front side of the safety cover **4** and is in contact with the rear surface of the handle portion **27**, and a pair of left and right lock receiving units **25** protrudes rearward via a plate-shaped lock receiving base **30**. The downwardly facing surfaces of the pair of lock receiving units **25** have inclined surfaces that are tapered so that the lock receiving units **25** become thinner toward the tip in a side view, and the left and right ends of the pair of lock receiving units **25** have inclined surfaces that are tapered so that the lock receiving units **25** become thinner toward the tip in a plan view, and the ridgeline on the side surface of the lock receiving unit **25** has an obtuse angle, thereby forming a smooth shape. The upper surface of the lock receiving unit **25** is an inclined surface whose height increases as the distance from the front surface of the safety cover **4** increases, and θ**1**, which is the angle formed by the vertical surface and the upper surface of the lock receiving unit **25**, is an acute angle smaller than 90°. For example, if the lock receiving unit **25** is molded from POM (polyacetal) resin, a smooth shape can be easily created, which is suitable.

(71) (5) Case **47**

(72) The case **47** of the interlock unit **26** has a substantially rectangular parallelepiped shape and includes a left side case **47***a*, a right side case **47***b*, and an upper surface case **47***c*. The left side case **47***a* and the right side case **47***b* are a pair of the left and right, and the outer shape is substantially symmetrical in the left and right. In the present embodiment, the left side case **47***a* and the right side case **47***b* have a form in which the width in the left-right direction is smaller than the length in the front-rear direction, and the height of the upper-lower direction is maximized. The solenoid **41**, which is a drive source (actuator), fixes a plunger **42** upward on the lower surface of the case **47**. The plunger **42**, a connecting plate **40**, a first gear **32**, a second gear **38**, and a pull spring **45**, which are a driving connecting unit **53**, are arranged in the case **47**. The left side case **47***a*, the right side case **47***b*, and the upper surface case **47***c* can be integrally molded of, for example, ABS resin, and even a complicated shape can be realized at low cost, which is preferable.

(73) (6) Positional Relationship between Lock Lever **35**, Driving Connecting Unit **53**, and Solenoid **41**

(74) Here, the lock lever **35**, which is an acting member, is provided on the upper surface of the case **47**, the solenoid **41**, which is an actuator, is provided below the lower surface of the case **47**,

the driving connecting unit **53** for transmitting a driving force between the acting member and the actuator is provided, and the acting member, the driving connecting unit **53**, and the actuator are arranged in a vertical row. Therefore, the projected area when viewed from above can be small, the configuration can be suitable for miniaturization of the housing **21**, and the dimensions in the front-rear direction can be reduced, and thus, the interlock unit **26** can be placed along the front plate **56** in the rear portion of the housing **21** in the vicinity of the front plate **56**.

(75) (7) First Gear **32** and Lock Lever **35**

(76) A first support shaft **31** is integrally molded of, for example, ABS (acrylonitrile butadiene styrene) resin together with the left side case **47***a*, and is extended toward the right side case **47***b* in parallel with the safety cover front surface **23**, and the tip of the first support shaft **31** is fitted to the first support bearing portion **63**, which is a concave portion provided in the right side case **47***b*. The right side case **47***b* may also be molded of ABS resin in the same manner as the left side case **47***a*. The first gear **32** is pivotally supported around the first support shaft **31** via a first gear shaft hole **90**. The teeth of the first gear **32** are provided around the first gear shaft hole **90** in a range of approximately 90°. A support rod portion **33** that is integrally molded with the first gear **32** and extended rearward, and the tip of the support rod portion **33** form a pair of lock portions **34** which are convex in the left-right direction in parallel with the first support shaft **31** with the support rod portion **33** interposed therebetween. The pair of lock portions **34** and the support rod portion **33** form the lock lever **35** having a substantial T-shape. The lock lever **35** is molded of, for example, POM resin, and the lock portion **34** has a flat upper surface and a tapered shape that becomes thinner toward the lower side in a side view viewed from the left and right when the lock is released, and the lower side has a substantially semi-cylindrical cross section that is smooth in a semi-cylindrical shape. Further, the pair of lock portions **34** have a rectangular shape extending in the left-right direction with R provided at the corners when viewed from the upper surface, and the lower half has a hemispherical smooth shape. The joint portion between the support rod portion **33** and the pair of lock portions **34** is smoothly connected in an R shape to prevent damage due to stress concentration. That is, the lock lever **35** is an example of an acting member that acts to lock the safety cover **4** with respect to the lock receiving unit **25**.

(77) (8) Other Examples of Shape of Lock Lever **35**

(78) Regarding the lock lever **35**, the amount of protrusion of the pair of lock portions **34** in the left-right direction with respect to the support rod portion **33** does not have to be the same and the lock lever **35** may have an asymmetrical shape in which one is long and the other is short. Alternatively, the lock portion **34** may have a substantially L shape in a plan view, which is extended to only one side with respect to the support rod portion **33**.

(79) (9) Cylindrical Portion **48**

(80) From the gear tooth tip on the lower surface side of the first gear **32** to the support rod portion **33** is a cylindrical portion **48** having no teeth, which is equal to the tooth tip circle of the first gear **32**.

(81) (10) Positional Relationship Between Working Surface **22** and Lock Lever **35**

(82) The lock lever **35** is arranged so as to face the front-rear direction in parallel with the working surface **22** when the lock is released. The upper surface of the upper surface case **47***c* is provided on substantially the same surface as the working surface **22** and is provided with a concave portion for accommodating the lock lever **35** when the lock is released. That is, the left-right width of the upper surface case **47***c* is larger than the width of the concave portion for accommodating the lock lever **35**. The upper surface of the lock lever **35** is configured to be flat and is flush with the upper surface of the upper surface case **47***c*. Further, the upper surface of the upper surface case **47***c* may be provided with a pair of left and right covering portions **36** having a partial columnar shape, which are gentle protrusions that cover the first support shaft **31** with the lock lever **35** interposed therebetween.

(83) (11) Positional Relationship Between Covering Portion **36** and Lock Lever **35**

(84) In the lock release state, the portion of the upper surface of the lock lever **35** sandwiched between the pair of left and right covering portions **36** has a partial columnar shape similar to that of the covering portion **36**, and the covering portion **36** and the lock lever **35** may be continuously and smoothly formed. Since no steps or protrusions are generated, when the user cleans the working surface **22**, for example, a cleaning tool such as a cloth or a brush is not caught.
(85) (12) Lock Portion **34**
(86) The inner distance between the pair of lock receiving units **25** in the left-right direction is larger than the width in the left-right direction of the support rod portion **33**, and the support rod portion **33** is configured to be able to enter between the pair of lock portions **34**. The total width of the pair of lock portions **34** in the left-right direction is larger than the width of the tips of the pair of lock receiving units **25** in the left-right direction. The lock portion **34** on the left side is configured to be able to be engaged with the lock receiving unit **25** on the left side, and the lock portion **34** on the right side is configured to be able to be engaged with the lock receiving unit **25** on the right side.
(87) (13) Second Gear **38**
(88) The second support shaft **37** is provided integrally with the left side case **47***a* and extends parallel to the first support shaft **31** toward the right side case **47***b*, and the tip of the second support shaft **37** is fitted in a second support bearing portion **64**, which is a concave portion provided in the right side case **47***b*. The second gear **38** is molded of, for example, POM resin, is pivotally supported around the second support shaft **37**, and meshes with the first gear **32** to rotate. The number of teeth of the second gear **38** is provided within a range in which the first gear **32** can be rotated by 90° to 90° or more to stand up.
(89) (14) Solenoid **41**
(90) The second gear **38** is provided with a connecting shaft **39** in parallel with the second support shaft **37**, and one end of the connecting plate **40** is pivotally supported by the connecting shaft **39**. The other end of the connecting plate **40** is pivotally supported by a driving pin **43** provided at one end of the cylindrical plunger **42** of the solenoid **41**, which is an electromagnetic actuator. The plunger **42** is supported so as to be movable in the longitudinal direction with respect to the solenoid **41** and has a configuration in which when the solenoid **41** is energized from a power supply device (not shown), the plunger **42** is attracted so as to be close to the solenoid **41**, and when the energization is released, the attractive force is released. In the present embodiment, the plunger **42** can be moved in the upper-lower direction, and a hole through which the driving pin **43**, which will be described later, penetrates is provided in the left-right direction in the vicinity of the upper end of the plunger **42**.
(91) A first spring hooking portion **44** is provided at one end of the second gear **38**, and one end of the pull spring **45** is hooked. The other end of the pull spring **45** is hung on a second spring hooking portion **46** provided integrally with the left side case **47***a*, and the spring force of the pull spring **45** is biased in a direction in which the plunger **42** is pulled out from the solenoid **41** via the second gear **38** to act as a return spring when the energization of the solenoid **41** is released.
(92) (15) Driving Connecting Unit **53**
(93) The plunger **42**, the connecting plate **40**, the first gear **32**, the second gear **38**, and the pull spring **45** constitute the driving connecting unit **53** for transmitting the driving force between the solenoid **41** and the lock lever **35** when driving the lock lever **35**.
(94) (16) Case **47** (Left Side Case **47***a* and Right Side Case **47***b*)
(95) A solenoid mounting portion **66** is provided integrally with the left side case **47***a* and arranged so that the mounting surface of the solenoid **41** faces rearward, and screws the housing of the solenoid **41** with a screw **107** from the front. The plunger **42** is arranged upward. A thin plate-shaped mounting seat **67***a* extending in the upper-lower direction is provided on the right side of the left side case **47***a*, and a thin plate-shaped mounting seat **67***b* extending in the upper-lower direction is provided on the left side of the right side case **47***b*. The interlock unit **26** can be

screwed from the front surface to the mounting bracket **59** provided on the housing frame **55** of the housing **21** via the mounting seat **67***a* and the mounting seat **67***b*. The mounting seat **67***a* and the mounting seat **67***b* are provided at approximately the same as the first support shaft **31** in the front-rear direction when viewed from the left and right, or slightly in front of the first support shaft **31**, that is, in the immediate vicinity of the lock receiving unit **25** provided on the safety cover **4**. The strength of the mounting seats **67***a* and **67***b* is ensured by the reinforcement ribs **68**.

(96) (17) Width and Axial Stress of Case **47**

(97) When a load is applied to the first support shaft **31** and the second support shaft **37** supporting the first gear **32**, the second gear **38**, and the pull spring **45**, and the first spring hooking portion **44**, the maximum bending stress is generated at the root portion. In order to reduce this bending stress, it is effective to increase the shaft diameter and shorten the shaft length. Here, since the first support shaft **31**, the second support shaft **37**, and the first spring hooking portion **44** are molded of resin integrally with the left side case **47***a*, it is preferable to narrow the distance between the side wall portion **65***a* of the left side case **47***a* and the side wall portion **65***b* of the right side case **47***b*, that is, the width of the case **47** in order to shorten the length of the shaft. That is, by making the widths of the left side case **47***a* and the right side case **47***b* narrower than the width of the upper surface case **47***c*, or by making the widths of the left side case **47***a* and the right side case **47***b* narrower than the width of the lock lever **35** and the width of the solenoid **41**, the stress can be reduced to obtain a highly reliable interlock unit **26**.

(98) That is, the left side case **47***a* and the right side case **47***b* have an expanded width in the vicinity of the upper surface facing the upper surface case **47***c* to form the upper surface case mounting portion **69**, and a step **70***a* is provided between the side wall portions **65***a* and **65***b*. Further, a step **70***b* is provided between the solenoid mounting portion **66** and the side wall portions **65***a* and **65***b*.

(99) (18) Snap Fit Claws **73**

(100) The right side case **47***b* is provided with so-called snap fit claws **71** for fitting to the left side case **47***a*, for example, at two locations, a front surface, and a rear surface. The left side case **47***a* is provided with a receiving portion **72** corresponding to the snap fit claw **71**. The upper surface case **47***c* is provided with two snap fit claws **73** on the left and right for fitting to the right side case **47***b* and the left side case **47***a*, and the right side case **47***b* and the left side case **47***a* are provided with receiving portions **74** corresponding to the respective snap fit claws **73** and are fixed to each other by snap fit.

(101) (19) Another Example of Connecting Left Side Case **47***a* and Right Side Case **47***b*

(102) The left side case **47***a* may be provided with a female screw (not shown), a screw hole is provided at a corresponding position of the right side case **47***b*, and one or a plurality of screws may be used to fasten the right side case **47***b* and the left side case **47***a* to each other.

(103) (20) Upper Surface Case **47***c* and Upper Surface Cover **76**

(104) The upper surface case **47***c* is provided with through holes **75** for passing the lock portions **34** protruding to the left and right of the lock lever **35** at the time of assembly between the first support shaft **31** and the front surface of the upper surface case **47***c*. The upper surface cover **76** can close the through hole **75** from above and is fixed to the upper surface case **47***c* from the inside by a snap fit claw **77**. The front end of the upper surface case **47***c* is located in front of the front edge of the through hole **75**, and the rear end of the upper surface case **47***c* is located behind the rear edge of the concave portion **49** in which the lock lever **35** is housed, thereby making a rectangular shape in a plan view. The outer circumference of the upper surface cover **76** is extended downward, and in the cross section in the left-right direction, it is configured to cover the upper surface case mounting portion **69** provided near the upper ends of the left side case **47***a* and the right side case **47***b* from the outside. The upper surface case mounting portion **69** of the left side case **47***a* and the right side case **47***b* functions as a case open prevention portion **91** that prevents deformation that spreads in the left-right direction.

(105) (21) Case Surrounding Rib **47***d*

(106) The upper surface of the upper surface case **47***c* is attached so as to pass through from below the working surface opening **22***a* opened in the working surface **22**, making substantially the same surface as the working surface opening **22***a*. In this state, a case surrounding rib **47***d*, which is a rib protruding around the upper surface case **47***c* in a plan view, is provided slightly below the upper surface of the upper surface case **47***c*. With the interlock unit **26** attached, the case surrounding rib **47***d* is located slightly below the working surface **22**, and the outer circumference of the case surrounding rib **47***d* is larger than the working surface opening **22***a*, and if the interlock unit **26** is attached, the gap formed between the upper surface case **47***c* and the working surface opening **22***a* is closed in a plan view to prevent the intrusion of a liquid or foreign matter.

(107) (22) Connecting Plate **40**

(108) The connecting plate **40** has a substantial H-shape symmetrical when viewed from the front, and is molded of, for example, POM resin, and a driving pin hole **78** is bored at one end in the lower portion in the left-right direction and a connecting shaft hole **79** is bored at the other end in the upper portion in parallel with the driving pin hole **78**.

(109) The driving pin hole **78** at one end has a gap having a width slightly larger than the diameter of the plunger **42**, and by sandwiching the plunger **42** inside the gap and penetrating the driving pin **43**, the connecting plate **40** is pivotally supported with respect to the plunger **42**. The connecting shaft hole **79** at the other end is pivotally fitted to the connecting shaft **39**, which is a protrusion provided on the second gear **38** by a so-called snap fit. In order to facilitate the insertion of the snap-fit into the connecting shaft **39** portions, an inclined surface **80** open outward from the connecting shaft hole **79** may be formed. Alternatively, an inclined surface facing the inclined surface **80** may be formed at the tip of the connecting shaft **39**.

(110) (23) Second Gear **38** and Waterproof Rib **82**

(111) The second gear **38** is pivotally supported by fitting the second gear shaft hole **81** into the second support shaft **37**. On the inner circumference of the gear teeth provided on a part of the outer circumference of the second gear **38**, a thin plate portion cylindrical waterproof rib **82** larger than the tooth width in the left-right direction is provided integrally in a shape concentric with the second gear **38** and is extended so as to be close to the inner wall surface of each of the left side case **47***a* and the right side case **47***b*. The rear end side of the waterproof rib **82** has a shape that is extended downward and is configured so that the liquid dropped on the upper surface of the waterproof rib **82** flows through. The rear end of the waterproof rib **82** is located behind the plunger **42** and the connecting plate **40** of the solenoid **41** to be a first waterproof rib end **83**. The front end of the waterproof rib **82** on the opposite side of the first waterproof rib end **83** is a second waterproof rib end **84**.

(112) (24) Labyrinth Structure (Case **47**)

(113) A first case rib **85** and a second case rib **86**, which are concentric with the waterproof rib **82** and are partially arcuate and convex inward, are provided on the inner wall surfaces of the left side case **47***a* and the right side case **47***b*. The inner circumference of the first case rib **85** is larger than the outer circumference of the waterproof rib **82** of the second gear **38** and is arranged with a gap of, for example, about 1 mm. The outer circumference of the second case rib **86** is smaller than the inner circumference of the waterproof rib **82** of the second gear **38** and is arranged with a gap of, for example, about 1 mm. The first case rib **85** and the second case rib **86** are provided so as not to come into contact with the second gear **38**, and the tips of the first case rib **85** and the second case rib **86** are arranged with a gap of, for example, about 1 mm from the left and right side surfaces of the second gear **38**. That is, the first case rib **85**, the second case rib **86**, the waterproof rib **82**, and the left and right side surfaces of the second gear **38** have a so-called labyrinth structure having an intricate cross-sectional shape. Since the first case rib **85**, the second case rib **86**, and the waterproof rib **82** are concentric circles, the labyrinth structure is maintained even if the second gear **38** rotates. The labyrinth structure prevents the liquid from passing between the first case rib

85 or the second case rib **86**, and the waterproof rib **82**.
(114) (25) Gutter **87** and First Drain Port **88**
(115) The rear surface of the second case rib **86** extends vertically downward along the plunger **42** behind the plunger and the connecting plate **40** of the solenoid **41**. The vicinity of the lower end of the second case rib **86** is seamlessly extended from the inner wall of the left side case **47***a* to the inner wall of the right side case **47***b*, and the lower surface thereof forms a gutter **87** that forms an inclined surface inclined so as to gradually decrease from the inner wall of the right side case **47***b* to the inner wall of the left side case **47***a*. The portion of the inner wall of the left side case **47***a* in contact with the gutter **87** is opened to form a first drain port **88**.
(116) (26) Third Case Rib **89** and Second Drain Port **92**
(117) A third case rib **89** is provided on the opposite side of the plunger **42** of the solenoid **41** from the gutter **87** and below the second support shaft **37**. The third case rib **89** is integrally planted with the left side case **47***a*, and its lower end is in contact with the lower surfaces of the left side case **47***a* and the right side case **47***b*. After extending vertically upward from the lower end, it is bent in a direction close to the connecting plate **40**, inclined to the vicinity of the lower part of the second support shaft **37**, and extended to the third case rib end **106**. Of the lower surfaces of the left side case **47***a* and the right side case **47***b*, a second drain port **92** is opened between the third case rib **89** and the front surfaces of the left side case **47***a* and the right side case **47***b*.
(118) (27) Molding of Case **47**
(119) By using the left side case **47***a*, the right side case **47***b*, and the upper surface case **47***c* as resin molded parts, the liquid guide units such as the first case rib **85**, the second case rib **86**, the third case rib **89**, and the gutter **87** and the drain ports **88** and **92** can be appropriately arranged together with the case, therefore, there is an effect that the number of parts can be reduced to realize a simple configuration.
(120) (28) Assembling Procedure of Interlock Unit **26**
(121) Next, an example of the assembling procedure of the interlock unit **26** will be described.
(122) The plunger **42** of the solenoid **41** and the connecting plate **40** are connected by passing the driving pin **43** through the driving pin hole **78**. The connecting shaft hole **79** of the connecting plate **40** is fitted by a snap fit into the connecting shaft **39** provided in the second gear **38**. The solenoid **41** is screwed to the solenoid mounting portion **66** provided integrally with the left side case **47***a*, and the second gear shaft hole **81** is passed through the second support shaft **37**. One end of the pull spring **45** is hooked on the first spring hooking portion **44**, and the other end is hooked on the second spring hooking portion **46**. The first gear shaft hole **90** of the lock lever **35** is passed through the first support shaft **31**, and when the plunger **42** is pulled out from the solenoid **41** by a predetermined amount, that is, an operating stroke amount by the pulling force of the pull spring **45**, the lock lever **35** is arranged so as to be in the release position, the first gear **32** and the second gear **38** are engaged, and the right side case **47***b* and the left side case **47***a* are snap fitted or screwed together.
(123) FIG. **8** is a sectional view taken along the line A-A showing the locked state of the interlock unit in FIG. **5**A. As shown in FIG. **8**, since the tips of the first support shaft **31**, the second support shaft **37**, and the first spring hooking portion **44** are fitted into the corresponding concave portions provided in the right side case **47***b*, the first support shaft **31**, the second support shaft **37**, and the first spring hooking portion **44** are not cantilevered but double-sided beams. Therefore, it is possible to reduce the stress generated when an external force is applied and realize a highly reliable interlock unit.
(124) Next, after passing the lock portion **34** through the through hole **75** provided in the upper surface case **47***c*, the upper surface case **47***c* is sandwiched from above between the upper surface case mounting portion **69** which is the enlarged width portion of the upper surfaces of the left side case **47***a* and the right side case **47***b*. The through hole **75** is closed with an upper surface cover **76**. The upper surface cover **76** is joined by a pair of snap fit claws **77** provided on the left and right

sides and projecting outward by a so-called snap fit from the inside of the through hole **75**.
(125) Since the first support shaft **31**, the second support shaft **37**, the first spring hooking portion **44**, and the solenoid mounting portion **66** are all provided integrally with the left side case **47***a*, the solenoid **41** and the driving connecting unit **53** are attached and held in the left side case **47***a*, and then, the right side case **47***b* and the upper surface case **47***c* can be attached to the left side case **47***a*, which makes the assembly easy.
(126) (29) Upper Surface Cover **76***c*
(127) The T-shaped concave portion **49** provided in the upper surface cover **76***c* has a bottomed shape with a bottom surface **50** to prevent foreign matters and liquids from falling from the concave portion **49** into the case **47**.
(128) (30) Operation of Solenoid **41**
(129) If the power supply is cut off due to a sudden power failure or the like while the safety cover **4** is locked and the automatic analyzer is operating, the interlock is desirably released and the safety cover **4** can be opened and closed. This is because if the safety cover **4** is left closed, post-treatment such as taking out the remaining reagent cannot be performed. As a configuration in which the interlock is released when the power is cut off, it is desirable to use a solenoid instead of a motor as the drive source because as a characteristic of this, the aspiration force of the solenoid disappears with a power failure, and therefore, the force of the return spring shifts from the locked state to the released state. When the drive source is a motor, the safety cover **4** cannot be opened because the safety cover does not operate in the locked position where the power supply is turned off.
(130) (31) Positional Relationship Between Lock Lever **35** and Upper Surface Cover **76**
(131) By the way, when the safety cover **4** is opened and the operator handles a liquid such as a reagent solution, the liquid may be accidentally spilled on the working surface **22**. If a watertight structure is to be used to prevent the spilled liquid from entering the inside of the interlock unit **26**, a gap cannot be provided between the lock lever **35** and the upper surface cover **76**, and thus, it is necessary to fill the gap with, for example, a rubber watertight member. However, with such a configuration, frictional resistance is generated when the lock lever **35** is rotated, and the operation of the lock lever **35** is hindered. When a motor is used as the drive source, it is possible to have a configuration in which deceleration is made by a gear or the like to increase the torque and drive against frictional resistance, but when a solenoid is used, due to the small operating stroke of the solenoid, it is generally used without deceleration, and thus, it is desirable to reduce the drive load as much as possible. Therefore, a watertight member cannot be used, and a gap is required between the rotating member and the fixing member so as not to interfere with the operation.
(132) That is, since the lock lever **35** and the first gear **32** are integrally pivotally configured around the first support shaft **31**, a gap enough to cause a backlash of, for example, about 0.2 to 0.5 mm is provided between the upper surface case **47***c* and the upper surface cover **76** so as not to hinder the rotation. Therefore, if a liquid such as a reagent solution is accidentally spilled in the vicinity of the lock lever **35**, the liquid may enter the case through the gap. The liquid that has entered the case passes through, for example, the tooth surface or side surface of the first gear **32**, then through the tooth surface or side surface of the second gear **38**, and reaches the upper surface of the waterproof rib **82**. Since the upper surface of the waterproof rib **82** has a cylindrical shape and the left and right side surfaces have a labyrinth structure that makes it difficult for liquid to pass through, the liquid on the upper surface of the waterproof rib **82** flows along the waterproof rib **82** toward the rear first waterproof rib end **83** or the front second waterproof rib end **84**.
(133) (32) Drain Passage
(134) FIG. **19** is a cross-sectional view taken along the line A-A of the interlock unit in FIG. **5**A, showing a drain passage of the liquid that has entered the case. As shown by an arrow in FIG. **19**, provided is a first liquid guide portion that drops the liquid that has flowed rearward from the upper surface of the waterproof rib **82** toward the first waterproof rib end **83** into the gutter **87** from the

first waterproof rib end **83** to drain the liquid from the first drain port **88** to the outside of the case. Provided is a second liquid guide portion that drops the liquid that has flowed forward from the upper surface of the waterproof rib **82** toward the second waterproof rib end **84** from the second waterproof rib end **84** to the portion between the front surface of the case and the third case rib **89** to drain the liquid from the second drain port **92** to the outside of the case.

(135) (33) Liquid Guide Unit

(136) The waterproof rib **82**, the labyrinth structure provided with the waterproof rib **82**, the first case rib **85** and the second case rib **86**, the gutter **87**, and the third case rib **89** described above form a liquid guide unit, and there is the effect of draining the liquid that has entered the inside of the case from the first drain port **88** or the second drain port **92** to the outside of the case **47** to prevent the liquid from flowing into the solenoid **41**.

(137) (34) Lock Release

(138) FIG. **5**A is a top view showing a lock release of the interlock unit according to the first embodiment, and FIG. **5**B is a sectional view taken along the line A-A in FIG. **5**A. Further, FIG. **6** is a perspective view showing a lock release of the interlock unit, and FIG. **7** is a perspective view.

(139) In the states shown in FIGS. **5**A to **7**, energization of the solenoid **41** is released, the second gear **38** is rotated clockwise in FIG. **5**B by the spring force of the pull spring **45**, and the plunger **42** is pulled out to the maximum from the solenoid **41** via the connecting plate **40**. The first gear **32** rotates counterclockwise in FIG. **5**B and is stored in the concave portion **49** provided in the working surface **22** so that the upper surfaces of the support rod portion **33** and the pair of lock portions **34** are flush with the working surface **22**. The concave portion **49** has a T-shape when viewed from the upper surface so that the T-shaped lock lever **35** can be stored, and is formed one size larger with a gap of, for example, about 1 mm from the periphery of the outer circumference of the lock lever **35** so as not to interfere with the outer circumference of the lock lever **35**.

(140) That is, in this state, since the lock portion **34** does not act on the lock receiving unit **25** provided on the safety cover **4**, it is in the lock release, and the user can freely open and close the safety cover **4**.

(141) (35) Locked State

(142) FIG. **8** is a sectional view taken along the line A-A showing the locked state of the interlock unit in FIG. **5**A and FIG. **9** is a perspective view showing the locked state of the interlock unit. FIG. **10** is a cross-sectional view taken along the line B-B in FIG. **8**, and FIG. **11** is a cross-sectional view taken along the line C-C in FIG. **8**.

(143) In the states shown in FIGS. **8** to **11**, the locked state of the safety cover **4** is shown. When the safety cover **4** is closed, the plunger **42** is aspirated by a force exceeding the spring force of the pull spring **45** by energizing the solenoid **41**, and the connecting plate **40** and the connecting shaft **39** are brought close to the solenoid **41** via the driving pin **43** to rotate the second gear **38** counterclockwise in FIG. **8**. Since the first gear **32** meshes with the second gear **38**, the first gear **32** rotates clockwise, and the support rod portion **33** and the lock portion **34** stand up from the working surface **22** and are brought into contact with the lock receiving base **30** to stop above the pair of lock receiving units **25** provided behind the handle portion **27** of the safety cover **4**. In this state, when the user puts his finger on the handle portion **27** to lift the front surface of the safety cover **4** and try to open the safety cover **4**, the lock receiving unit **25** rises together with the front surface of the safety cover **4**, and the upper surfaces of the pair of left and right lock receiving units **25** come in to contact with the respectively corresponding lower surfaces of the pair of left and right lock portions **34** to prevent the safety cover **4** from opening. That is, it is in a locked state where the safety cover **4** cannot be opened.

(144) (36) Arrangement of Lock Lever **35**, First Gear **32**, Second Gear **38**, Connecting Plate **40**, Plunger **42**, and Solenoid **41**

(145) Since the lock lever **35**, the first gear **32**, the second gear **38**, the connecting plate **40**, the plunger **42**, and the solenoid **41** are arranged on the same plane symmetrically, no force is

generated to move in the left-right direction even when an upward external force is applied to the lock lever **35**, and only pulling force is generated to the connecting plate **40**, and thus it is possible to provide an interlock unit with stable operation and high reliability. Furthermore, if the left-right width of the interlock unit **26** is reduced, the first support shaft **31** and the second support shaft **37** can be shortened, and therefore, stress can be reduced, which is suitable for miniaturization and enables highly reliable interlock unit **26** to be realized.

(146) (37) EMC Countermeasures

(147) Since the safety cover **4** has a configuration that can rotate around the cover support shaft **28**, when the safety cover **4** is made of resin, it is difficult to electrically ground the lock receiving unit **25** and the lock receiving base provided on the safety cover **4** because it requires connecting a ground wire. Further, since the lock lever **35** and the connecting drive member are movable parts, it is also difficult to electrically ground the above.

(148) Therefore, not only the lock lever **35**, the lock receiving unit **25**, and the lock receiving base **30**, but also the structural parts constituting the interlock unit **26** including the case **47** are made of resin molded parts instead of metal parts, thereby, not giving electromagnetic interference (EMI) to the surroundings. In addition, by increasing electromagnetic susceptibility (EMS), it is also possible to provide a highly reliable automatic analyzer with excellent electromagnetic compatibility (EMC) that can reduce noise mixing even when, for example, a cable through which a weak signal passes is arranged near the interlock unit **26**.

(149) (38) Mounting Surface and External Force Acting Surface

(150) Next, a preferable arrangement of the mounting seats **67***a* and **67***b* of the interlock unit **26**, the mounting bracket **59**, and the housing frame **55** will be described with reference to FIGS. **13** and **4**.

(151) FIG. **13** is a side view showing the locked state of the interlock unit. As shown in FIG. **13**, since the mounting seats **67***a* and **67***b* of the case **47** are provided substantially directly below the lock receiving unit **25** provided on the safety cover **4**, the mounting bracket **59** is also located directly below the lock receiving unit **25**. Therefore, when the user applies an upward external force to open the locked safety cover **4**, the external force is transmitted to the left side case **47***a* and the right side case **47***b* from the lock portion **34** meshing with the lock receiving unit **25** via the first support shaft **31**, and further transmitted to the mounting bracket **59** via the mounting seats **67***a* and **67***b*. Here, since the lock receiving unit **25**, the mounting seats **67***a* and **67***b*, and the mounting bracket **59** are arranged vertically on substantially the same surface, an external force is applied to the mounting bracket **59** as a tensile load, and no bending moment is generated. Therefore, the interlock unit **26** is stable even if the interlock unit **26** receives an external force because the force of the out-of-plane deformation that the interlock unit **26** tries to move in the front-rear direction does not act when the interlock unit **26** receives an upward external force. Further, since the mounting bracket **59** is attached to the housing frame **55** as shown in FIG. **4**, the external force is not transmitted to the working surface **22** and does not cause deformation of the working surface **22**. Since the upward external force is transmitted to the strong housing frame **55** via the mounting bracket **59**, it is possible to provide an automatic analyzer having high support rigidity and high reliability.

(152) (39) Cap Effect of Upper Surface Case **47***c*

(153) Next, the load applied to the left side case **47***a* and the right side case **47***b* will be described with reference to FIG. **14**. FIG. **14** is a rear view of the locked state of the interlock unit. When the operator tries to open the safety cover **4** in the locked state, an upward load is generated on the lock lever **35** via the lock receiving unit **25**, and the load is applied to the first support shaft **31**. The first support shaft **31** is resin-molded integrally with the left side case **47***a*, and its tip is fitted into the first support bearing portion **63**, which is a concave portion provided in the right side case **47***b*, to form a so-called double-sided beam. Here, when an upward load is applied to the first support shaft **31**, if the fastening force between the left side case **47***a* and the right side case **47***b* is insufficient,

since the left side case **47***a* and the right side case **47***b* are made of resin, the left side case **47***a* and the right side case **47***b* are bent in the direction of opening each other as shown in FIG. **14**. Then, the tip of the first support shaft **31** is disengaged from the fitting of the concave portion, and the first support shaft **31** becomes a cantilever form. When compared with the form of the double-sided beam, the bending stress occurring at the base of the first support shaft **31** becomes large and there is a risk of breakage.

(154) Therefore, as shown in FIG. **11**, the upper surface case **47***c* is configured to cover the upper surfaces of the left side case **47***a* and the right side case **47***b*, and by providing a gap wider than the left and right widths of the left side case **47***a* and the right side case **47***b*, the cross-sectional shape of the upper surface case **47***c* forms a U-shaped case open prevention portion **91** having a large size and an open lower surface. That is, since the case open prevention portion **91** is configured to be fitted from the outside so as to prevent the upper surfaces of the left side case **47***a* and the right side case **47***b* from being deformed in the left-right outer direction. Since the left side case **47***a* and the right side case **47***b* do not open outward and the tip of the first support shaft **31** does not come off from the first support bearing portion **63** which is a concave portion provided in the right side case **47***b* even if an upward load is applied to the lock lever **35**, it is possible to provide an automatic analyzer having high strength and high reliability without the first support shaft **31** becoming cantilevered and broken.

(155) In this way, the strength between the left side case **47***a* and the right side case **47***b* can be obtained by attaching the upper surface case **47***c*, and thus, the left side case **47***a* and the right side case **47***b* may be assembled only by fitting with a snap fit without being screwed to each other.

(156) (40) Acute Angle Effect of Lock Receiving Unit **25**

(157) Next, the detailed shapes of the lock portion **34** and the lock receiving unit **25** will be described with reference to FIGS. **15** and **16**. FIGS. **15** and **16** are cross-sectional views taken along the line A-A in the locked state of the lock unit **26** of the safety cover **4** and are partially enlarged views in the vicinity of the lock lever portion.

(158) In FIG. **15**, the upper surface of the lock receiving unit **25** is an inclined surface whose height increases as the distance from the front surface of the safety cover **4** increases, and θ**1** which is an angle formed by the vertical surface and the upper surface of the lock receiving unit **25** is an acute angle smaller than 90°. Further, the surface of the lock portion **34** that forms a part of the lock lever **35** and is close to the support rod portion **33** also has an acute angle smaller than 90°, which is approximately equal to 01 and is formed as a vertical surface when the lock lever is upright.

(159) That is, since the lower surface of the lock portion **34** and the upper surface of the lock receiving unit **25**, which are in contact with each other, have acute angles, the reaction force generated when the user tries to open the safety cover **4** in the locked state is the lock portion **34**. Since the lock receiving unit **25** works in a direction of attracting each other and approaching each other, the engagement between the lock portion **34** and the lock receiving unit **25** is further strengthened, and the locked state can be reliably maintained.

(160) (41) Protrusion Effect of Lock Receiving Unit **25**

(161) As shown in FIG. **16**, a protruding portion **51** that smoothly protrudes upward is provided at the rear end portion of the lock receiving unit **25** farthest from the front surface of the safety cover **4**. FIG. **16** shows a case where, for example, the voltage applied to the solenoid **41** is reduced and the lock lever **35** does not rotate to the upright state shown in FIG. **15** but rotates to an angle θ**2** smaller than a right angle. In such a case, the protruding portion **51** abuts on the semi-cylindrical portion on the rear surface side of the lock portion **34**, and the reaction force when the safety cover **4** is opened acts in a direction separated from the first support shaft **31** and becomes the direction of the perpendicular line with respect to the contact surface, which is the first support. It acts in a direction separated from the shaft **31** by a radius R to generate a moment in a direction in which the lock lever **35** is close to the lock receiving base **30**. Therefore, the lock lever **35** does not come off and can maintain the locked state.

(162) (42) T-Shaped Effect

(163) In the present embodiment, the lock lever **35** has a substantially L-shape in which the lock portion **34** is extended from the support rod portion **33** to one side, or constitutes the lock lever **35** having a substantially T-shape in which a pair of lock portions **34** are extended from the support rod portion **33** to both sides. The actions and effects of the substantially L-shape and the substantially T-shape will be described with reference to FIGS. **17**A and **17**B.

(164) FIG. **17**A shows a state where a reaction force F when the safety cover **4** is opened is applied to a substantially L-shaped lock lever **35** in which the lock portion **34** protrudes only to the left from the support rod portion **33**. Since the reaction force F is applied only to the left lock portion **34**, a bending moment M that bends the lock lever **35** to the right is generated, and the lock lever **35** bends to the right and tries to move to the right, so that the lock portion **34** and the lock receiving unit **25** are easily disengaged. Further, since the support rod portion **33** generates bending stress due to the bending moment M in addition to the tensile stress due to the reaction force F, the stress generated in the lock lever **35** becomes large.

(165) FIG. **17**B shows a state where a reaction force F when the safety cover **4** is to be opened is applied to the lock lever **35** having a substantially T-shape in the present embodiment.

(166) The reaction force F is evenly applied (F/2) to the pair of left and right lock portions **34**. Since the reaction force (F/2) is applied symmetrically to the support rod portion **33**, no force is generated to move in either the left or right direction, and the lock lever **35** operates stably. Even if the reaction force (F/2) acts on a position deviated from the symmetrical position, the moment generated in the support rod portion **33** is only the product of the amount of deviation from the symmetrical position and the reaction force, and therefore, the bending moment is small, and almost only the tensile force acts.

(167) In the lock lever **35** having a substantially T-shape, the pulling force due to the reaction force F is dominant in the support rod portion **33**, and the bending moment is small. Therefore, even if the reaction force F is the same, the stress generated in the lock lever **35** is smaller than that of the substantially L-shaped lock lever **35** shown in FIG. **17**A, and there is an effect that a more reliable automatic analyzer can be provided.

(168) (43) Dimensions of Lock Lever **35**

(169) With reference to FIGS. **18**A and **18**B, a preferable dimensional relationship between the lock portion **34** of the lock lever **35** and the lock receiving unit **25** will be described. FIGS. **18**A and **18**B are schematic views showing a state where the safety cover **4** is fully shifted to the left with the interlock actuated, and an upward external force is applied to open the safety cover **4**. In FIGS. **18**A and **18**B, L**1** is the inner width of the lock receiving unit **25**. L**2** is the width of the straight portion of the side of the lower surface of the lock portion **34** that comes into contact with the lock receiving unit **25** and indicates the width of the straight portion of the tip of the lock portion **34** up to the front of the R portion. The difference between FIGS. **18**A and **18**B is that in FIG. **18**A, L**2** is small because the tip R of the lock portion **34** is large, while the width L**1** of the lock receiving unit **25** is large, showing the relationship L**1**>L**2**. In FIG. **18**B, L**2** is large because the tip R′ of the lock portion **34** is small, while the width L**1** of the lock receiving unit **25** is small, showing the relationship of L**1**<L**2**.

(170) In FIG. **18**A, when an external force F is applied to the lock lever **35** and a load of F/2 is applied equally to the left and right lock receiving units **25**, since the lock receiving unit **25** on the left side of the drawing is in contact with the tip R portion of the lock portion **34**, the lock receiving unit **25** may shift upward along the tip R and move while deforming to be unlocked. On the other hand, if the relationship of L**1**<L**2** is set as shown in FIG. **18**B, since the lock receiving unit **25** on the left side does not shift to the position of the tip R′ and comes into contact with the straight portion on the lower surface of the lock portion **34**, the lock receiving unit **25** does not come off even when a load F is applied, and a highly reliable analyzer can be provided.

(171) The above describes the state where the safety cover **4** is shifted to the left, but conversely,

even in the state where the safety cover **4** is shifted to the right, the same operation is performed except that the left and right sides are symmetrical.

(172) (44) Overrun Effect

(173) FIG. **20** is a cross-sectional view taken along the line A-A of the locked state of the safety cover lock unit, which is a partially enlarged view of the vicinity of the lock lever portion, and shows a state where the operator applies a force forward to the handle portion **27** of the safety cover **4** and the safety cover **4** is bent and moved forward. Since the lock receiving unit **25** also moves forward together with the safety cover **4**, it is desirable that the lock portion **34** further rotates by an angle θ**3** so that the lock portion **34** moves forward rather than in the upright state of the lock lever **35**, and even in the state where the safety cover **4** bends, the engagement between the lock portion **34** and the lock receiving unit **25** is reliable. Such a configuration can be achieved by appropriately selecting the operating amount of the plunger **42**, and the number of teeth of the first gear **32** and the second gear **38** so that the lock lever **35** further rotates by an angle θ**3** from the upright state when the plunger **42** of the solenoid **41** is aspirated to the maximum.

(174) (45) Arrangement of the Interlock Unit **26**

(175) In the present embodiment, since the interlock unit **26** is arranged at the central portion of the front surface of the safety cover, the central portion is locked when the interlock unit **26** acts to lock the safety cover. Therefore, even if a force in the opening direction is applied to the left and right sides of the safety cover, the main body cover is not easily deformed and bent, and a gap is hard to open between the main body and the lower end of the main body cover.

(176) The lock receiving unit **25** is configured to protrude rearward from the inside of the safety cover **4**, and the lock lever **35** is configured to be rotated from the working surface **22** toward the front surface of the safety cover **4** from the inside to the front to act on and lock the lock receiving unit **25**. Therefore, the amount of protrusion of the lock receiving unit **25** can be reduced to reduce the size, and the lock receiving unit **25** can have a smooth shape that is not a hook shape or a collar shape.

(177) Further, since the lock receiving unit **25** is arranged in contact with the rear of the handle portion **27**, when the operator applies a force in the opening direction to the handle portion **27** during locking, the opening operation of the safety cover **4** is surely hindered, which is suitable.

(178) When the lock unit **26** is not working, the lock lever **35** is configured flushing to be the same surface as the working surface **22**. Therefore, when the safety cover **4** is opened, the claw portion of the lock lever having a hook shape or a collar shape does not protrude from the working surface **22** and does not interfere with cleaning the working surface **22** with a cleaning tool such as a cloth or a brush.

(179) Further, the concave portion for accommodating the lock lever **35** of the upper surface cover **76** is provided with a bottom to prevent liquid or foreign matters from falling from the concave portion.

(180) (46) Drain Structure

(181) Since the driving connecting unit (drive connecting member) connecting the actuator and the lock lever is provided with the liquid guide unit and the case is provided with the drain port, liquids such as water and reagents that have entered the inside of the case from the gap around the lock lever provided on the upper surface cover **76** are drained from the drain port to the outside of the case via the liquid guide unit and do not reach the actuator provided at the lower end of the case. Therefore, it is possible to provide a highly reliable interlock unit having a simple structure and being able to be miniaturized, and an automatic analyzer equipped with the interlock unit.

(182) (47) Lock Abnormality Release

(183) When the interlock unit **26** remains in the locked state because the energization is not released due to, for example, a circuit failure, an example of the operation of mechanically releasing the lock and opening the safety cover **4** will be described. FIG. **21** is a cross-sectional view showing an operation when releasing the abnormally locked state of the interlock unit.

(184) In the present embodiment, there is no step or protrusion that becomes an obstacle between the lower surface **94** of the handle portion on the front surface of the safety cover **4** and the working surface **22**, and a release piece **95** can be inserted from the front until the release piece touches the lock lever **35** from the gap between the lower surface **94** of the handle portion and the working surface **22**. When the release piece **95** is pushed further rearward, the lock lever **35** is rotated rearward around the first support shaft **31** via the release piece **95**, and the lock portion **34** is moved from the lock receiving unit **25** to be separated. Therefore, the safety cover **4** can be opened in that state.
(185) As described above, the lock lever **35** can be unlocked even if the interlock unit **26** breaks down and does not operate in the locked state without having a special mechanical unlock mechanism. Therefore, the safety cover **4** can be opened to replace the reagent or take out the specimen before repairing or replacing the failed interlock unit **26**.
(186) However, the above operation is a case where the lock lever **35** is not stuck and can be rotated rearward, although the lock lever **35** cannot be released in the locked state.
(187) (48) Replacement of Interlock Unit **26**
(188) Next, the configuration will be described in which even if the interlock unit **26** fails and does not operate in the locked state, and the lock lever **35** is stuck and does not move, the failed interlock unit **26** can be easily replaced.
(189) In the present embodiment, as shown in FIGS. **4** and **13**, the interlock unit **26** is fixed to the mounting bracket **59** fixed to the housing frame **55** from the front with mounting screws **61** and is detachably fixed via the front surface opening that is generated on the front surface when the front plate **56** is removed. As shown in FIGS. **2** and **3**, since the interlock unit **26** is arranged close to the rear portion of the front plate **56** of the housing **21**, it can be easily visually recognized by removing the front plate **56**. Since the mounting screw **61** is mounted within the range of the front surface opening below the working surface so that it can be directly viewed from the front surface, the mounting screw **61** can be removed by the driver **62** even when the safety cover **4** is kept closed. Further, if the interlock unit **26** is moved forward and downward and the connector **54** that supplies power to the solenoid **41** is disconnected, the failed interlock unit **26** can be removed from the housing **21** in a short time. Further, since the interlock unit **26** that operates normally can be attached in the reverse procedure, it is possible to provide an automatic analyzer with good maintainability. Needless to say, if the failed interlock unit **26** is removed, the safety cover **4** can be opened at that time.
(190) (49) Vertically Stacked Arrangement
(191) As described above, the shape of the interlock unit **26** for facilitating the attachment/detachment of the interlock unit **26** from the front surface is desirably a vertically long shape having a large dimension in the upper-lower direction but a small in the front-rear direction. On the contrary, if the interlock unit **26** has a horizontally long shape having a large dimension in the front-rear direction, there is a problem that when removing the interlock unit **26**, the interlock unit **26** cannot be removed unless it is moved significantly forward due to the large depth dimension, and the upper surface of the upper surface cover **76** is easily caught when the interlock unit **26** is attached or detached because the upper surface of the interlock unit **26** is fitted into the opening of the working surface **22** when the installation of the interlock unit **26** is completed.
(192) On the other hand, in the case of the vertically long shape, if the interlock unit **26** is moved downward while rotating forward after removing the mounting screw **61**, the upper surface and the opening of the working surface **22** are disengaged, and the interlock unit **26** can be easily removed with a small amount of movement.
(193) That is, the lock lever **35**, which is an acting member acting on the lock receiving unit **25**, is provided on the upper surface of the interlock unit **26**, and the solenoid **41**, which is an electromagnetic driving unit, is arranged at the lower end so that the solenoid **41** is vertically elongated and the operation direction of the plunger **42** is the upper-lower direction. Further, the

first gear **32**, the second gear **38**, the connecting plate **40**, the pull spring **45**, and the like are provided between the lock lever **35** and the solenoid **41**. Since the driving connecting unit for connecting and moving the lock lever **35** so as to move between the non-operating position and the operating position according to the energization to the solenoid **41** is provided, the interlock unit **26** as a whole has a vertically long shape with a small depth and a large upper-lower direction.

(194) (50) Mounting Position of Solenoid **41**

(195) Since the solenoid **41** is arranged below the case **47** so as to be exposed to the outside air, heat dissipation is better than when the solenoid **41** is arranged inside the case **47**, and the temperature does not rise even if the locked state is continued for a long time, the interlock unit **26** with high reliability without overheating can be realized. Further, when the solenoid **41** is arranged on the bottom surface of the case **47**, the liquid that has entered the case **47** may collect on the bottom surface of the case and infiltrate the solenoid **41**. On the other hand, in the present embodiment, a drain port in contact with the bottom surface of the case **47** is provided at a position higher than the solenoid **41** to prevent liquid from accumulating inside the case **47**, and the liquid drained from the drain ports **88** and **92** is discharged outside the case, the liquid does not infiltrate the solenoid **41**, and a highly reliable interlock unit **26** can be realized.

Second Embodiment

(196) A second embodiment of the present invention will be described with reference to FIG. **22**. In the drawing, the same members as those in the first embodiment are designated by the same reference numerals, and the description thereof will be omitted.

(197) FIG. **22** is a perspective view of the second gear **38** used in the interlock unit **26**, and the difference from the first embodiment is that the lower side of the waterproof rib **82** forming a part of the second gear **38** is not horizontal in the left-right direction but an inclined side, and the first waterproof rib end **83** has a sharpened shape. With such a shape, the liquid dripping on the waterproof rib **82** reaches the first waterproof rib end **83** along the inclined side and drips from the first waterproof rib end **83**. If the first waterproof rib end **83** has a sharp shape, the amount of liquid remaining on the first waterproof rib end **83** is smaller than that in the case of the horizontal shape, so that it is possible to provide a highly reliable interlock unit **26** with an improved drainage property. Alternatively, the first waterproof rib end **83**′ may be inclined toward either the left or right side, in this case, the liquid flows so as to be close to the inner wall of the side surface of the case on the side inclined downward along the first waterproof rib end **83**′, and flows along the inner wall of the side surface of the case due to the surface tension of the liquid. Here, it is desirable to incline the first waterproof rib end **83**′ downward in a direction close to the first drain port **88** because the drainage property is further improved.

Third Embodiment

(198) The third embodiment of the present invention will be described with reference to FIGS. **23** to **26**.

(199) The difference from the first embodiment of the present embodiment is that a lock lever cover portion **52** is provided so as to protrude upward from the working surface **22** and open at the front, and the lock lever **35** is provided with the lock portion **34** having a hook shape at the upper end instead of T-shape, the upper surface of the lock lever **35** is not on the same surface as the working surface **22** in the lock release, and the lock lever **35** is in a standby position in the lock lever cover portion **52** in the lock release.

(200) FIG. **23** is a cross-sectional view taken along the line A-A in FIG. **5**A of the lock release of the interlock unit according to the present embodiment, and FIG. **24** is a perspective view. Further, FIG. **25** is a cross-sectional view taken along the line A-A in FIG. **5**A in the locked state of the interlock unit, and FIG. **26** is a perspective view. In the drawing, the same members as those in the first embodiment are designated by the same reference numerals, and the description thereof will be omitted.

(201) In the present embodiment, the lock receiving unit **25** is not provided as a pair on the left and

right but is provided at one position facing the lock lever **35**.
(202) The connecting shaft **39** is provided integrally with the lock lever **35**, and when the plunger **42** is attracted to the solenoid **41**, the hook-shaped lock portion **34** at the tip of the lock lever **35** is configured to rotate forward around the first support shaft **31** to engage with the lock receiving unit **25** via the connecting plate **40** and the connecting shaft **39**. The lock receiving unit **25** is not a pair but is provided at one position corresponding to the lock lever **35**.
(203) A waterproof rib **96** is provided on the connecting plate **40** that connects the driving pin **43** of the plunger **42** and the connecting shaft **39** and is inclined so that the front is high and the rear is low. One end of the rear is bent further downward, and the lower end is a waterproof rib end **97**. The lower end of a fourth case rib **98** is integrated with the bottom surface of the case **47**, and the upper end is arranged behind the connecting plate **40** and in front of the waterproof rib end **97**. A drain port **99** is provided between the fourth case rib **98** and the rear lower end portion of the case **47**.
(204) The liquid that has entered the case through the gap around the lock lever **35** flows rearward along the slope on the upper surface of the waterproof rib **82**, drops from the waterproof rib end **97** onto the fourth case rib **98**, and is drained from the drain port **99** to the outside of the case **47**.
(205) In FIGS. **23** and **24**, the plunger **42** of the solenoid **41** is moved away from the solenoid **41** by the pull spring **45**, and the lock lever **35** rotates around the first support shaft **31** counterclockwise in the drawing. Then, the hook-shaped lock portion **34** provided at the upper end of the lock lever **35** is separated from the lock receiving unit **25**, and the lock portion **34** and the lock receiving unit **25** are not engaged with each other, so that the safety cover **4** is in a lock release where the operator can open and close the safety cover **4**.
(206) In FIGS. **25** and **26**, the solenoid **41** is energized and the plunger **42** overcomes the tensile force of the pull spring **45** and is aspirated by the solenoid **41**. Since the connecting shaft **39** moves in the direction close to the solenoid **41** via the connecting plate **40**, the lock lever **35** rotates clockwise around the first support shaft **31** in the drawing, and the lock portion **34** moves above the lock receiving unit **25**. This state is the same locked state as in FIG. **9** in the first embodiment.
(207) In the present embodiment, in the lock release, the lock lever **35** is housed inside the lock lever cover portion **52** instead of being flush with the working surface, and since the rotation angle of the lock lever **35** from the lock release to the locked state is smaller than that of the first embodiment, the first gear **32** and the second gear **38** provided in the first embodiment are unnecessary, which has the effects that the number of parts is small, and the configuration is simple.
(208) Also in the present embodiment configured as described above, the engaging portion between the lock portion **34** and the lock receiving unit **25** has an acute angle as shown in FIG. **15** of the first embodiment, the lock receiving unit **25** is provided with a protruding portion **51** as in the case of FIG. **16**, and is further rotated by the angle θ**3** as in the case of FIG. **20**, so that the engagement between the lock portion **34** and the lock receiving unit **25** can be further ensured as in the first embodiment.
(209) In addition, also in the present embodiment, as in the first embodiment, mechanical unlocking as shown in FIG. **21** is possible, and if the front plate **56** is removed from the housing **21**, it is needless to say that the interlock unit **26** is configured to be attachable/detachable as shown in FIG. **3**.
Fourth Embodiment
(210) The fourth embodiment of the present invention will be described with reference to FIGS. **27**A and **27**B.
(211) FIG. **27**A is a top view of the lock release of the interlock unit **26** according to the fourth embodiment of the present invention, and FIG. **27**B is a cross-sectional view taken along the line A-A in FIG. **5**A.
(212) The difference of the present embodiment from the first embodiment is that a hole IC **100** for

detecting magnetism is provided in contact with the lower surface of the upper surface cover **76**, and a magnet **101** is provided at a position, which is the lower surface of the handle portion of the safety cover **4** facing the hole IC **100** when the safety cover **4** is closed.

(213) When the safety cover **4** is closed, the hole IC **100** detects magnetism and transmits a signal, and when the safety cover **4** is opened, the magnet **101** is separated and the hole IC **100** does not detect magnetism, and thus, the signal is interrupted. With such a configuration, since the opening/closing detection of the safety cover **4** can be built in the interlock unit **26**, it is not necessary to separately provide an opening/closing detection element, and the wiring from the hole IC **100** and the wiring from the solenoid **41** can be combined into one connector **54**, and thus, the configuration becomes simple and the reliability can be further improved.

Fifth Embodiment

(214) A fifth embodiment of the present invention will be described with reference to FIG. **28**.

(215) FIG. **28** is a perspective view of the interlock unit according to the present embodiment. The present embodiment is a modification of the lock lever **35** form, and the difference from the first embodiment is that the shape of the lock lever **35** is not substantially T-shaped, and the two left and right support portions **33***a* and **33***b* are provided symmetrically, and the tips of the respective support portions **33***a* and **33***b* are connected to form the lock portion **34** extending in the left-right direction. The lock receiving unit **25** is provided only at one place in the center, unlike the lock receiving units **25** provided at two places symmetrically in the first embodiment, and is configured to act on the lock portion **34** when the lock lever **35** stands up.

(216) Also in the present embodiment, as in the first embodiment, it is possible to provide a highly reliable automatic analyzer capable of reliably locking the safety cover **4** and easily attaching and detaching the interlock unit **26**.

Sixth Embodiment

(217) The sixth embodiment of the present invention will be described with reference to FIG. **30**.

(218) The difference of the present embodiment from the third embodiment is that the lock receiving unit **25** is provided so as to face the rear side of the front surface lower portion **102** of the safety cover in which the handle portion **27** is extended downward, instead of the back surface of the handle portion **27** of the safety cover **4**.

(219) In FIG. **30**, the lock lever **35** is arranged below the working surface **22**, and the lock portion **34** protrudes towards the rear surface the front surface lower portion **102** of the safety cover from the front surface opening of the step portion **103** provided between the working surface **22** and the front plate **56** of the housing **21** facing the lock receiving unit **25**, acts on the lock receiving unit **25** and locks the safety cover **4**. The liquid that has entered from the periphery of the lock lever **35** flows forward along the slope on the upper surface of the waterproof rib **96** provided on the connecting plate **40**, and drops between the inner front surface of the case **47** and a fifth case rib **104** planted from the bottom surface of the case to be discharged from the drain port **99**.

(220) FIG. **31** is a block diagram showing a configuration of a part related to the driving operation of the interlock unit in the present embodiment.

(221) A drive signal is transmitted from a host computer **200** that controls the overall operation of the automatic analyzer **1** to the driver **201** that drives the solenoid **41**, power is supplied to the driver **201**, and the solenoid **41** can be driven based on the drive signal from the host computer **200**. A door opening/closing detection **202** is connected to a power supply **203**, supplies power when the safety cover **4** is closed, and shuts off the power supply when the safety cover **4** is open. A display unit **204** can display the operating state of the automatic analyzer **1** or display an alarm when an abnormality is detected to notify the operator.

(222) FIG. **32** is a flowchart showing the operation of the interlock unit according to the present embodiment.

(223) As shown in FIG. **32**, the following processing is performed when the automatic analyzer **1** is operated. That is, it is determined whether or not the start switch of the automatic analyzer **1** has

been operated (step S**101**), and if the determination result is NO, the determination in step S**101** is repeated until the start switch is operated.
(224) Further, when the determination result in step S**101** is YES, that is, when the start of processing is instructed, the door opening/closing detection **202** determines whether or not the safety cover **4** is closed (step S**102**), and if the determination result is NO, the determination in step S**102** is repeated until the determination result becomes YES.
(225) If the determination result in step S**102** is YES, that is, when the safety cover **4** is closed, the closure of the safety cover **4** is confirmed (step S**103**), the solenoid **41** is energized, and the safety cover **4** is locked (cover lock) (step S**104**).
(226) Subsequently, the automatic analyzer **1** is operated to analyze the specimen (step S**105**), and when the analysis is completed, the stop switch is operated to start the stop process (step S**106**).
(227) It is determined whether or not the operation st p of each part of the automatic analyzer **1** has stopped (step S**107**). If the determination result is NO, the process of step S**107** is repeated until the determination result becomes YES.
(228) If the determination result in step S**107** is YES, the energization of the solenoid **41** is cut off (step S**108**), and the process ends. When the solenoid **41** lock is released, the safety cover **4** can be opened and closed, and thus, samples and reagents can be taken out, replaced, and supplied.
(229) <Effect>
(230) The effects of the present invention configured as described above are summarized below.
(231) That is, in the present invention, the lock lever **35** is arranged so as to face the front-rear direction in parallel with the working surface **22** when the lock is released, and a concave portion for accommodating the lock lever **35** when the lock lever **35** is released is provided on the upper surface case **47***c* provided on substantially the same surface as the working surface **22**. The upper surface of the lock lever **35** is flat and has a smooth shape so as to be flush with the working surface **22**. Therefore, when the safety cover **4** is opened in the lock release, there is no protrusion from the working surface **22**, and when the operator opens the safety cover **4** to perform the cleaning or replacement of a group of various operation mechanisms **29**, the cleaning of the working surface **22**, and the replacement of the reagent vessel **3**, there is no hindrance, and when cleaning the working surface **22**, the cleaning tool such as a cloth or a brush does not get caught, and thus, there is an effect that an easy-to-use automatic analyzer can be provided.
(232) Further, in the present invention, the lock receiving unit **25** provided so as to protrude from the rear surface of the safety cover **4** or the front side of the handle portion **27** has a smooth shape rather than a hook shape, the cleaning tool such as a cloth or a brush does not get caught, and thus, there is an effect that an easy-to-use automatic analyzer can be provided.
(233) Further, if the lock lever **35** has a substantially T-shape in which the lock portions **34** protrude from the support rod portion **33** on both the left and right sides, the reaction force F generated in the lock lever **35** when the safety cover **4** is substantially symmetrically in the left and right to the lock support rod portion **33**, no force is generated to move the lock lever **35** in either the left or right direction, and the lock lever **35** operates stably. Further, since the support rod portion **33** is configured such that the tensile stress is dominant and the bending moment is small, there is an effect that a highly reliable automatic analyzer **1** with a small stress can be provided.
(234) Further, by making the width L**2** of the straight portion of the side that comes into contact with the lock receiving unit **25** on the lower surface of the lock portion **34** larger than the inner width L**1** of the lock receiving unit **25**, even when an upward external force is applied to the direction opening the safety cover **4** in a state of being shifted to the left and right, the lock is not released, and there is an effect that a highly reliable automatic analyzer **1** can be provided.
(235) Further, since the lock portion **34** is configured to rotate further by the angle θ**3** so as to move forward from the upright state of the lock lever **35**, the engagement between the lock portion **34** and the lock receiving unit **25** is ensured even when the safety cover **4** is bent. There is an effect that it is possible to provide a highly reliable automatic analyzer **1** that can securely close the safety

cover **4** in a locked state.
(236) Further, since the concave portion **49** provided in the upper surface case **47***c* for accommodating the lock portion **34** is bottomed to prevent liquids and foreign matters from falling from the concave portion **49**, there is an effect that a highly reliable automatic analyzer with a simple structure can be provided.
(237) Further, since the lock lever **35** and the driving connecting unit **53** form the interlock unit **26** covered with a case **47** made of a resin molded product, there is an effect that it is easy to assemble and replace the unit, and a highly reliable automatic analyzer with a simple structure can be provided.
(238) Further, the lock lever **35**, which is an acting member, is pivotally provided on the upper surface of the case **47** of the interlock unit **26**, and the solenoid **41**, which is an actuator, is provided on the lower surface of the case **47**, the driving connecting unit **53** that transmits a driving force between the acting member and the actuator is provided, and the acting member, the driving connecting unit **53**, and actuator are arranged in a vertical row, and thus, the projected area when viewed from above can be reduced, the configuration is suitable for miniaturizing the housing **21**, and the dimensions in the front-rear direction can be reduced. Therefore, there is an effect that the interlock unit **26** can be arranged in the rear portion near the front plate **56** of the housing **21** along the front plate **56**.
(239) Further, in the case **47**, the range of the side wall where the support shaft for supporting the gear and the spring is planted has a narrower width than those of the upper surface case mounting portions **69***a* and **69***b*, and the length of the support shaft for supporting the gear and the spring is shortened. Therefore, the stress generated when a load is applied can be reduced, and a highly reliable interlock unit can be realized.
(240) Further, since the solenoid **41**, which is an electromagnetic driving unit, is provided below the case **47** to be exposed to the outside air, the heat dissipation is better than when the solenoid **41** is arranged in the case, and even if the solenoid **41** is continuously energized, overheating does not occur, whereby, a highly reliable interlock unit can be realized.
(241) Further, even if a liquid such as a reagent spills into the inside of the case **47** through the gap on the upper surface of the case **47**, a drain port for discharging the liquid to the outside of the case **47** and a liquid guide unit for guiding the liquid to the drain port are provided. Therefore, there is an effect that a highly reliable automatic analyzer without flowing into the solenoid **41** can be provided.
(242) Further, the case **47** includes the left side case **47***a*, the right side case **47***b*, and the upper surface case **47***c*, each of which is molded of resin, and the rotary support shafts **31** and **37** of the gear and the spring hooking portion **44** are integrally molded with the case. Further, since the first gear **32** and the lock lever **35** are integrated and the second gear **38** and the waterproof rib **82** are integrally molded, there is an effect that the number of parts can be reduced and the configuration can be made inexpensive. Further, by covering the outer surface of the upper surface of the left side case **47***a* and the right side case **47***b* with the case open prevention portion **91** in which the outer circumference of the upper surface case **47***c* is extended downward, it is possible to prevent the left side case **47***a* and the right side case **47***b* from being deformed in the opening direction even when the lock lever **35** receives an upward load. Therefore, since it is possible to prevent the first support shaft **31** from being cantilevered and damaged, there is an effect that a highly reliable automatic analyzer can be provided. Furthermore, since the rigidity of the left side case **47***a* and the right side case **47***b* can be obtained by the case open prevention portion **91** of the upper surface case **47***c*, the assembly may be possible only by locking by so-called snap fit without screwing, and an inexpensive configuration is possible.
(243) Further, when the lock lever **35** is in an abnormal lock state where the lock lever **35** does not return in the locked state, the release piece **95** is inserted into the gap between the lower side of the safety cover **4** and the working surface **22** and the lock lever **35** is pushed from the front. As a

result, the lock lever **35** can be rotated rearward to release the lock, and the safety cover **4** can be opened. Therefore, even if the interlock unit breaks down, the abnormal lock can be easily released, and thus, an easy-to-use automatic analyzer can be provided.
(244) Further, since the interlock unit **26** is configured to be screwed to the mounting bracket **59** attached to the housing frame **55** from the front, it is easy to mount and remove, and the assemblability and maintainability are excellent. Furthermore, even if the lock lever **35** is stuck and does not return, the configuration is made to be attachable and detachable via the front surface opening generated on the front surface when the front plate **56** of the housing is removed. Since the interlock unit **26** can be removed from the front and the lower part by removing the above, the unit can be replaced in a short time, and the maintainability is excellent.
(245) Further, although the drive source connected to the driving connecting unit **53** is the solenoid **41**, the drive source is not limited to the solenoid and may be a motor such as a stepping motor, a DC motor, or an AC motor, and further, a deceleration unit such as a spur gear or a worm gear may be further provided between the motor and the lock lever. Alternatively, an actuator operated by compressed air or hydraulic pressure may be used as a power supply.
(246) Further, although the lock lever **35** that rotates around the axis in the left-right direction has been described as an example of the acting member, the present invention is not limited to such a lock lever, and may be a linear motion member that repeats the projection and retraction in the up-down direction, the left-right direction, or the front-rear direction, or may be a rotary member that rotates around a rotation axis in the upper-lower direction.
(247) Further, the unit mounting surface **93** of the mounting bracket **59** and the mounting seat **67** of the interlock unit **26** are extended in the upper-lower direction, and the mounting screw **61** is described as being detached from the front in the horizontal direction. The unit mounting surface **93** and the mounting seat **67** are not limited thereto, and for example, the upper end may be inclined so as to be rearward from the lower end, and the screw may be attached/detached by inserting a driver from diagonally above.
(248) <Others>
(249) The present invention is not limited to the above-described embodiments and includes various modifications. For example, the above-described embodiments have been described in detail in order to explain the present invention in an easy-to-understand manner, and do not necessarily include all the described configurations. In addition, a part of one embodiment can be replaced with the configuration of another embodiment. It is also possible to add the configuration of another embodiment to the configuration of one embodiment. It is also possible to delete a part of the configuration of each embodiment.
(250) For example, each of the above-described embodiment describes as an example the case where, in the interlock unit **26**, the solenoid **41**, which is a driving unit, is arranged below the lock lever **35**, which is an acting member, and the lock lever **35** arranged up and down by the driving connecting unit (driving connecting member) **53**, and the solenoid **41** are connected to each other and the lock lever **35** is driven by the solenoid **41**, but the present invention is not limited thereto, and the present invention can also be applied when an interlock unit, in which the solenoid **41** is arranged behind the lock lever **35** and connected by the driving connecting unit **53**, is used.
REFERENCE SIGNS LIST
(251) **1**: Automatic analyzer **2**: Reagent disk **3**: Reagent vessel **4**: Safety cover **5**: Sample transport unit **6**: Sample dispensing unit **7**: Tip rack (sample dispensing tip/reaction vessel supply unit) **8**: Sample dispensing tip/reaction vessel transport unit **9**: Incubator **10**: Sample dispensing tip **11**: Sample dispensing tip buffer **12**: Sample dispensing tip/reaction vessel disposal hole **13**: Reaction solution agitation unit **14**: Reaction vessel **15**: Reagent dispensing probe **15***a*: Reagent dispensing position **16**: Agitation unit **17**: Cleaning unit **18**: Reaction solution aspiration nozzle **19**: Detecting unit **20**: Reagent vessel loading port **21**: Housing **22**: Working surface **22***a*: Working surface opening **23**: Safety cover front surface **23***a*: Safety cover front side **25**: Lock receiving unit **26**:

Lock unit (interlock unit) **27**: Handle portion **28**: Cover support shaft **29**: Group of various operation mechanisms **30**: Lock receiving base **31**: First support shaft **32**: First gear **33**: Support rod portion **34**: Lock portion **35**: Lock lever **36**: Covering portion **37**: Second support shaft **38**: Second gear **39**: Connecting shaft **40**: Connecting plate **41**: Solenoid **42**: Plunger **43**: Driving pin **44**: First spring hooking portion **45**: Pull spring **46**: Second spring hooking portion **47**: Case **47***a*: Left side case **47***b*: Right side case **47***c*: Upper surface case **47***d*: Case surrounding rib **48**: Cylindrical portion **49**: Concave portion **50**: Bottom surface **51**: Protruding portion **52**: Lock lever cover portion **53**: Driving connecting unit **54**: Connector **55**: Housing frame **56**: Front plate **57**: Side plate **58**: Rear plate **59**: Mounting bracket **60**: Mounting groove **61**: Mounting screw **62**: Driver **63**: First support bearing portion **64**: Second support bearing portion **65**, **65***a*, **65***b*: Side wall portion **66**: Solenoid mounting portion **67**, **67***a*, **67***b*: Mounting seat **68**: Reinforcement rib **69**: Upper surface case mounting portion **70***a*, **70***b*: Step **71**: Snap fit claw **72**: Receiving portion **73**: Snap fit claw **74**: Receiving portion **75**: Through hole **76**: Upper surface cover **77**: Snap fit claw **78**: Driving pin hole **79**: Connecting shaft hole **80**: Inclined surface **81**: Second gear shaft hole **82**: Waterproof rib **83**: First waterproof rib end **84**: Second waterproof rib end **85**: First case rib **86**: Second case rib **87**: Gutter **88**: First drain port **89**: Third case rib **90**: First gear shaft hole **91**: Case open prevention portion **92**: Second drain port **93**: Unit mounting surface **94**: Handle portion lower surface **95**: Release piece **96**: Waterproof rib **97**: Waterproof rib end **98**: Fourth case rib **99**: Drain port **100**: Hole IC **101**: Magnet **102**: Safety cover front surface lower portion **103**: Step portion **104**: Fifth case rib **105**: Screw hole **106**: Third case rib end **107**: Mounting screw **200**: Host computer **201**: Driver **202**: Door opening/closing detection **203**: Power supply **204**: Display unit

Claims

1. An automatic analyzer comprising: a housing configured to accommodate an analyzer configured to analyze a specimen; a cover provided to cover an upper side of a working surface which is an upper surface of the housing, and configured to be pivotally supported around a support shaft provided on one side of a rear side on the upper surface of the housing between a closed position and an open position in an upper-lower direction, and the cover includes a protruding portion provided on the end of a front side of the cover; and an interlock unit provided on a front side on the upper surface of the housing, and capable of preventing the cover rotating from the closed position to the open position, wherein the interlock unit includes: a hollow case provided on a lower side of an end of a front side at the closed position of the cover, and having a rectangular parallelepiped shape disposed at a position adjacent to a front surface of an inside of the housing; a lock lever having a L- or T-shape comprising a support rod portion and a pair of lock portions extending from the support rod portion, and the lock lever configured to be movably supported between a lock position and a lock release position on an upper surface of the hollow case, and inhibiting rotation to the open position of the cover by engaging with the protruding portion provided on the end of the front side of the cover at the lock position; a solenoid configured to drive the lock lever; and a mechanical linkage configured to connect the lock lever to the solenoid and drive the lock lever by conveying an operation of the solenoid to the lock lever, the housing has a front surface opening provided at a position on the front surface of the housing corresponding to the interlock unit and covered with a front plate detachable from the housing, and the interlock unit is provided to be attachable and detachable to and from the housing via the front surface opening in a state where the front plate is detached; Note: all of the functional/process language in the instant allowed claims (e.g. “configured to be pivotally supported”, “configured to be movably supported”, “configured to drive the lock lever”, etc.,) have been given full patentable weight by the examiner; The determination of whether the functional/process language limits a claim is made on a case-by-case basis in light of the facts in each case; In certain instances, functional/process recitations recited in apparatus type claim are not limiting; However, in this case the functional language in the

claims have received given patentable weight because it clearly defines a specific structural feature or mechanism that performs a function, rather than simply describing the intended use or result of the invention; The instant claimed functional/process language is supported by the specification and provides a clear understanding of the claimed invention to someone skilled in the art; essentially, the function/process language is tied to a defined structure or process, not just a general concept.

2. The automatic analyzer according to claim 1, wherein the interlock unit is disposed at a position corresponding to a substantial center of a front side of the cover on the housing.

3. The automatic analyzer according to claim 1, wherein the housing includes: a frame configured to form a frame body of the housing; and an interlock unit mounting bracket provided in the frame, the hollow case at least covers the driving connecting unit, and holds the lock lever and the solenoid integrally, and the interlock unit is fixed to the housing by fixing the hollow case to the interlock unit mounting bracket with mounting screws accessible through the front surface opening.

4. The automatic analyzer according to claim 1, wherein a plate-shaped release piece is provided to reach the lock lever of the interlock unit between a lower end of a front side of the cover at the closed position of the cover and the upper surface of the housing and connects an inside and an outside of the cover, and the lock lever obstructs the rotation to the open position of the cover at the lock position moved from a rear side close to a front side with respect to the cover by engaging with the protruding portion, and allows rotation to the open position of the cover at the lock release position estranged from the front side to the rear side with respect to the cover, and the rotation to the lock release position can be realized by inserting the plate-shaped release piece from a front side to a rear side of the cover.

5. The automatic analyzer according to claim 1, wherein the interlock unit includes: the lock lever configured to obstruct the rotation to the open position of the cover by engaging with the protruding portion provided on the end of the front side of the cover on the upper surface of the housing at the lock position; the solenoid provided on a lower side of the operation member and configured to drive the lock lever; and the driving connecting unit extending in the upper-lower direction so as to connect the lock lever and the solenoid and configured to drive the lock lever by conveying the operation of the solenoid to the lock lever.