

CLAMP APPARATUS

BACKGROUND

1. Field of the Invention

5 The present invention relates to a clamp apparatus, and more specifically, to a clamp apparatus which firmly and fixedly couples a housing and a head of a filter assembly to prevent chemical leakage and also allows the fixing and releasing to be more easily performed.

10 2. Discussion of Related Art

 Generally, all companies, such as companies for manufacturing semiconductors, semiconductor apparatuses, liquid crystal displays (LCDs), and organic light-emitting diodes (OLEDs), pharmaceutical companies, and paint companies, which use hazardous chemicals, use various kinds of chemicals, and
15 methods of safely supplying the chemicals are also diversified.

 Such a chemical is supplied through a chemical filter in order to be used in a high purity state, in which foreign matter is minimized, according to characteristics of a manufacturing process.

 Shapes and replacing methods of chemical filters are different from each
20 other according to types thereof, and replacement periods of the chemical filters are different from each other according to the types and necessary high purity maintenance criteria of the chemicals.

 When a chemical filter is replaced, a housing of a filter assembly and a head are separated, a cartridge is replaced, the housing is coupled to the head again, a
25 coupling portion of the housing and the head is clamped using a clamp apparatus to

firmly couple the housing and the head, and thereby preventing leak of a chemical and fume in the filter assembly.

A clamp apparatus according to the related art is provided to operate in a manner in which a ring-shaped housing clamp is coupled to a lower end of a housing,
5 a ring-shaped head clamp is coupled to an upper end of a head, and the housing clamp and the head clamp are coupled.

In this case, the housing clamp and the head clamp are generally screw-coupled at a plurality of positions along ring-shaped coupling surfaces of the housing clamp and the head clamp.

10 According to the related art, in order to uniformly couple the housing clamp and the head clamp, uniform adjustment of screw-coupling degrees was needed at the plurality of positions, and to this end, a considerable amount of time and a complex process were required.

In addition, in order to release the coupling of the housing clamp and the
15 head clamp, it is troublesome to release the screw-coupling at the plurality of positions one by one.

For an apparatus for fixing a chemical filter, Korean Patent Laid-Open Publication No. 10-2003-0043124 (disclosed at Jun 2, 2003) was disclosed.

SUMMARY OF THE INVENTION

20 The present invention is directed to providing a clamp apparatus which firmly fixes a housing and a head of a filter assembly to prevent chemical leakage and also allows the fixing and releasing to be easily performed when a chemical filter is replaced.

According to an aspect of the present invention, there is provided a clamp
25 apparatus including a first clamp coupled to an outer side of any one of a filter head

and a filter housing of a filter assembly, a second clamp coupled to the outer side of the remaining one of the filter head and the filter housing, and a third clamp which applies a force to a rear surface of the first clamp or the second clamp to press the first clamp and the second clamp in a coupling direction in which the first clamp and the second clamp move toward each other.

The third clamp is coupled to the first clamp, is in contact with the rear surface of the second clamp, and applies the force to the rear surface in the coupling direction in which the first clamp and the second clamp move toward each other.

The third clamp includes: a first pressing member of which one side is provided with a first pressing part which is in contact with the rear surface of the second clamp and applies a pressure to the rear surface in the coupling direction; and a fixing arm to which the first pressing member is rotatably coupled.

The third clamp further includes a second pressing member provided with a second pressing part which is in contact with a rear surface of the first pressing part and applies the pressure to the rear surface in the coupling direction.

The third clamp further includes a cylinder which provides driving power so that the first pressing member rotates.

The cylinder includes a cylinder body and a push rod and is extended or contracted as the push rod is reciprocated by driving of the cylinder driving part so that the first pressing member is rotated; the second pressing member is rotatably connected to an end of the push rod and a rear surface of the first pressing member; and the second pressing part protrudes toward one side of the second pressing member.

The second pressing part perpendicularly protrudes toward one side from a straight line connecting a connection portion of the second pressing member and the

push rod and a connection portion of the second pressing member and the first pressing member.

In the cylinder, the push rod is positioned in a direction in which the push rod faces the filter assembly and reciprocates in directions to move in a direction
5 toward or away from the filter assembly.

In a case in which the push rod extends, the second pressing member rotates in an inward direction, and presses the rear surface of the first pressing member first in the coupling direction through a connection portion, which is connected to the first pressing member, of the second pressing member, and the second pressing part
10 secondarily presses a rear surface of the first pressing part in the coupling direction, and accordingly, the first pressing member rotates in the inward direction, the first pressing part presses the rear surface of the second clamp in the coupling direction, and the first clamp and the second clamp are clamped; and in a case in which the push rod contracts, the second pressing member rotates in an outward direction,
15 accordingly, the pressure applied to the rear surface of the first pressing member by the second pressing part is released, the first pressing member rotates in the outward direction, the pressure applied to the rear surface of the second clamp by the first pressing part is released at the same time, and the clamping of the first clamp and the second clamp is released.

20 An operation state of the third clamp includes: an unclamping step which is a state in which the push rod is contracted and the first pressing member and the second pressing member are completely separated from the rear surface of the second clamp; a first clamping step which is a state in which the first pressing part is in contact with the rear surface of the second clamp, the second pressing member is
25 positioned at a first angular position, and the second pressing part is separated from

the rear surface of the first pressing member; and a second clamping step which is a state in which the first pressing part is in contact with the rear surface of the second clamp, the second pressing member is positioned at a second angular position, and the second pressing part is in contact with the rear surface of the first pressing member, wherein the first angular position is an angular position at which the second pressing member rotates in an outward direction from a vertical angular position perpendicular to a horizontal plane, and the second angular position is an angular position at which the second pressing member rotates in an inward direction from the vertical angular position.

10 As the push rod extends, the operation state of the third clamp sequentially proceeds to the unclamping step, the first clamping step, and the second clamping step; and as the push rod contracts, the operation state of the third clamp sequentially proceeds to the second clamping step, the first clamping step, and the unclamping step.

15 In a case in which the operation state of the third clamp proceeds from the first clamping step to the second clamping step, a position of the first pressing member is maintained in a state in which the first pressing part is in contact with the rear surface of the second clamp, and accordingly, the second pressing member rotates from the first angular position to the second angular position in a state in which a position of a connection portion of the second pressing member and the first pressing member is fixed so that an arc-shaped trajectory, in which a rotary shaft of a connection portion of the second pressing member and the push rod and the end of the push rod connected to the rotary shaft rotate in the inward direction, move vertically upward, and move downward, is formed; and in a case in which the operation state of the third clamp proceeds from the second clamping step to the first

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clamping step, the position of the first pressing member is fixed in the state in which the first pressing part is in contact with the rear surface of the second clamp, and accordingly, the second pressing member rotates from the second angular position to the first angular position in the state in which the position of the connection portion of the second pressing member and the first pressing member is fixed so that an arc-shaped trajectory in which the rotary shaft of the connection portion of the second pressing member and the push rod and the end of the push rod connected to the rotary shaft rotate in the outward direction, move vertically upward, and move downward, is formed.

10 The fixing arm includes: a fixing part fixedly coupled to the first clamp; and a cylinder support part which is coupled to the fixing part and to which the cylinder body is rotatably connected.

 The first pressing member is rotatably connected to the fixing part.

 The clamp apparatus comprise a link member of which both ends are
15 rotatably connected to the fixing arm and the end of the push rod.

 A rotation plane formed by rotation of the link member is formed to be parallel to a vertical plane including a reciprocation track of the push rod.

 A second rotary shaft which is a rotary shaft of a connection portion at which the fixing part and the first pressing member are connected, a third rotary shaft which
20 is a rotary shaft of a connection portion at which the first pressing member and the second pressing member are connected, a fourth rotary shaft which is a rotary shaft of a connection portion at which the end of the push rod and the second pressing member are connected, a fifth rotary shaft which is a rotary shaft of a connection portion at which the fixing part and the link member are coupled, and a sixth rotary
25 shaft which is a rotary shaft of a connection portion at which the end of the push rod

and the link member are connected are provided; and a sum of a length between the fifth rotary shaft and the third rotary shaft and a length between the third rotary shaft and the fourth rotary shaft is greater than a length between the fifth rotary shaft and the sixth rotary shaft.

5 The fourth rotary shaft and the sixth rotary shaft share the same rotary shaft.

A knob extending from the link member is provided; and a user grips and pushes or pulls the knob using a hand to rotate the link member about a rotary shaft of a connection portion of the link member and the fixing part.

The user pushes the knob in a direction toward the filter assembly to clamp
10 the third clamp to the first clamp and the second clamp and pulls the knob in a direction away from the filter assembly to release the clamping of the third clamp.

The link member includes a pair of link members connected to both sides of each of the fixing part and the push rod; and both ends of the knob extend from the pair of link members and are disposed between and connected to the pair of link
15 members.

A rotation plane formed by rotation of the first pressing member and the second pressing member is formed to be parallel to a vertical plane including a reciprocation track of the push rod.

The first clamp and the second clamp are formed in ring shapes and each
20 coupled to a circumference of one of the filter head and the filter housing; and the third clamp is provided as a plurality of third clamps which are clamped at predetermined intervals along circumferences of the first clamp and the second clamp.

An observation window is provided in at least one of the first clamp and the second clamp at a position at which a coupling portion of the filter housing and the filter head is visually checkable.

5 The observation window is formed in a coupling surface of the second clamp and the first clamp.

The observation window is formed as a plurality of observation windows along a circumference of a coupling portion of the filter housing and the filter head.

BRIEF DESCRIPTION OF THE DRAWINGS

10 The above and other objects, features and advantages of the present invention will become more apparent to those of ordinary skill in the art by describing exemplary embodiments thereof in detail with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating a state in which clamping of a clamp
15 apparatus according to the present invention is released and a filter housing and a filter head of a filter assembly are separated;

FIG. 2 is a perspective view illustrating a state in which the filter assembly is coupled and clamped to the clamp apparatus according to the present invention;

FIG. 3 is a view illustrating a state in which the filter assembly is coupled to
20 the clamp apparatus according to the present invention and clamping is released;

FIG. 4 is a view illustrating a state in which the filter assembly is coupled and clamped to the clamp apparatus according to the present invention;

FIG. 5 is a vertical cross-sectional view illustrating a detailed state in which the filter head, to which a first clamp is coupled, and the filter housing, to which a
25 second clamp is coupled, are coupled to each other according to the present invention;

FIG. 6 is a perspective view illustrating the first clamp and the second clamp according to the present invention;

FIG. 7 is a perspective view illustrating a state in which the first clamp and the second clamp according to the present invention are in vertical contact with each other;

FIG. 8 is a side view illustrating a third clamp at an unclamping step according to the present invention;

FIG. 9 is a side view illustrating the third clamp at a first clamping step according to the present invention;

FIG. 10 is a side view illustrating the third clamp at a second clamping step according to the present invention; and

FIG. 11 is a perspective view illustrating the third clamp according to the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Hereinafter, a clamp apparatus of the present invention will be described in detail with reference to the accompanying drawings.

Referring to FIGS. 1 to 11, a clamp apparatus 1 according to one embodiment of the present invention includes a first clamp 100 coupled to an outer side of any one of a filter head 30 and a filter housing 20 of a filter assembly 2, a second clamp 200 coupled to the outer side of another of the filter head 30 and the filter housing 20, and a third clamp 300 which applies a force to at least one of a rear surface (not shown) of the first clamp 100 and a rear surface 201 of the second clamp 200 to press the first clamp 100 and the second clamp 200 in coupling directions in which the first clamp 100 and the second clamp 200 move toward each other.

The first clamp 100 and the second clamp 200 move toward each other in a case in which the filter head 30 and the filter housing 20 are coupled and move away from each other in a case in which the filter head 30 and the filter housing 20 are separated.

5 The clamp apparatus 1 is for maintaining the coupling of the filter head 30 and the filter housing 20 and preventing separation thereof, and the coupling directions may be directions in which pressures for coupling the filter head 30 and the filter housing 20 and maintaining the coupling are applied.

 The coupling directions may be directions of forces perpendicularly applied
10 to a coupling surface m, at which the filter head 30 and the filter housing 20 are coupled in contact with each other, from both sides of the filter head 30 and the filter housing 20.

 As an example, as illustrated in the drawings, in a case in which the filter head 30 is positioned at a lower side, the filter housing 20 is positioned at an upper
15 side, and the filter head 30 and the filter housing 20 are coupled to each other, a direction in which the filter head 30 is pushed upward and a direction in which the filter housing 20 is pressed downward may be the coupling directions.

 In the first clamp 100 and the second clamp 200, the rear surfaces are surfaces opposite to facing surfaces which face each other, the rear surface of the first
20 clamp 100 is an opposite of the facing surface, which faces the facing surface of the second clamp 200, of the first clamp 100, and the rear surface 201 of the second clamp 200 is an opposite surface of the facing surface, which faces the facing surface of the first clamp 100, of the second clamp 200.

 As an example, as illustrated in the drawings, in the case in which the first
25 clamp 100 is positioned at the lower side, the second clamp 200 is positioned at the

upper side, and the first clamp 100 and the second clamp 200 move toward each other, an upper surface of the second clamp 200 is the rear surface 201.

The third clamp 300 may be provided as a first clamp pressing clamp provided to apply a force to the rear surface of the first clamp 100 or may also be
5 provided as a second clamp pressing clamp provided to apply a force to the rear surface 201 of the second clamp 200.

In addition, the clamp apparatus 1 may also include both of the third clamp for pressing the first clamp and the third clamp for pressing the second clamp.

In addition, the third clamp 300 may be provided to be coupled to the first
10 clamp 100 or the second clamp 200 or may also be supported by a support member (not shown) provided at the outside in addition to the first clamp 100 and the second clamp 200.

In the case in which the third clamp 300 is coupled to the first clamp 100, the third clamp 300 may be provided to be in contact with and press the rear surface 201
15 of the second clamp 200 in the coupling directions in which the first clamp 100 and the second clamp 200 move toward each other.

In addition, in the case in which the third clamp 300 is coupled to the second clamp 200, the third clamp 300 may be provided to be in contact with and press the rear surface (not shown) of the first clamp 100 in the coupling directions in which the
20 first clamp 100 and the second clamp 200 move toward each other.

The filter assembly 2 is provided to filter a chemical to provide the filtered chemical to an apparatus in which a chemical is used.

The filter assembly 2 accommodates a cartridge 10 for filtering foreign matter contained in the chemical, and the filter head 30 is coupled to open one side of
25 the filter housing 20.

The filter housing 20 and the filter head 30 may be coupled in a vertical direction. In the accompanying drawings, a case, in which the filter housing 20 is positioned in an upper portion of the filter assembly 2 and the filter head 30 is positioned in a lower portion there, is illustrated.

5 In addition, conversely, although not illustrated in the drawings, the filter assembly 2 may also be installed so that the filter housing 20 is positioned in the lower portion, and the filter head 30 is installed to be positioned in the upper portion.

In FIG. 1, a perspective view of a state, in which clamping of the clamp apparatus 1 is released and the filter housing 20 and the filter head 30 are separated,
10 is illustrated, and in FIG. 2, a perspective view of a state in which the filter housing 20 and the filter head 30 are coupled and are clamped by the clamp apparatus 1 is illustrated.

In the filter assembly 2, when replacement of the cartridge 10 is performed, the clamping by the clamp apparatus 1 is released, the filter housing 20 and the filter
15 head 30 are separated, the cartridge 10 is replaced, and the filter housing 20 and the filter head 30 are coupled again and then are clamped by the clamp apparatus 1.

To this end, a housing driving part 3 which transfers the filter housing 20 to separate the filter housing 20 from the filter head 30 and couples the filter housing 20 to the filter head 30 again may be provided.

20 As illustrated in the drawings, in the case in which the filter housing 20 is positioned in the upper portion and the filter head 30 is positioned in the lower portion, the housing driving part 3 supports the filter housing 20 to move the filter housing 20 in an upward direction so as to separate the filter housing 20 from the filter head 30 and move the filter housing 20 downward so as to couple the filter
25 housing 20 to the filter head 30.

In addition, although not illustrated in the drawings, in the case in which the filter housing 20 is positioned in the lower portion and the filter head 30 is positioned in the upper portion, the housing driving part 3 supports the filter housing 20 to move the filter housing 20 in a downward direction so as to separate the filter housing 20 from the filter head 30 and move the filter housing 20 in the upward direction so as to couple the filter housing 20 to the filter head 30.

In FIGS. 3 and 4, vertical cross-sectional views of the filter assembly 2 in which the filter housing 20 and the filter head 30 are coupled are illustrated.

In FIG. 3, a state in which clamping of the filter assembly 2 is released by the clamp apparatus 1 is illustrated, and in FIG. 4, a state in which the filter assembly 2 is clamped by the clamp apparatus 1 is illustrated. In FIG. 5, a state in which the filter housing and the filter head, to which the first clamp 100 and the second clamp 200 are coupled, of the filter assembly are coupled is illustrated.

A plurality of coupling parts, through which a chemical supplied from a chemical supply part (not shown) is introduced, the chemical passing through the cartridge 10 is discharged to be supplied to a process apparatus, a chemical remaining in a space 12 between the cartridge 10 and the filter housing 20 is discharged, and a chemical remaining in an inner space 11 of the cartridge 10 is discharged, are formed in the filter head 30.

In addition, a head body 38, in which a cartridge insertion part is formed in an upper end of the head body 38, is formed on the filter head 30, wherein one side end of the cartridge 10 is inserted into the cartridge insertion part.

The filter housing 20 includes a housing body 21 in which a space is formed, wherein the cartridge 10 is accommodated in the space in a longitudinal direction, a housing flange 22 protruding outward from one side of the housing body 21 to be

pressed against an upper end surface of the cartridge insertion part of the head body 38, and a coupling part 23 which is formed in an end portion of the other side of the housing body 21 and through which nitrogen gas is introduced or discharged.

5 An O-ring 40 for maintaining air tightness is provided between facing surfaces of the cartridge insertion part of the head body 38 and one side end of the housing body 21.

When the replacement of the cartridge 10 is performed, a process, in which clamping of the filter assembly 2 performed by the clamp apparatus 1 is released, the filter housing 20 is separated from the filter head 30 by driving of the housing driving part 3, the cartridge 10 is replaced, the filter housing 20 is coupled to the filter head 30 by driving of the housing driving part 3, and the filter housing 20 and the filter head 30 are clamped by the clamp apparatus 1, is performed.

Hereinafter, the clamp apparatus 1 of the present invention will be described with reference to FIGS. 5 to 11.

15 In the description below, an example, in which the first clamp 100 is coupled to the filter head 30, the second clamp 200 is coupled to the filter housing 20, the filter housing 20 is coupled to the filter head 30 from above so that the vertical coupling direction is generated, and the third clamp 300 is coupled to the first clamp 100 and is in contact with and presses the rear surface 201 of the second clamp 200 in the downward direction, will be described.

The first clamp 100 and the second clamp 200 will be described with reference to FIGS. 5 to 7.

In FIG. 6, each of the first clamp 100 and the second clamp 200 is illustrated, and in FIG. 7, a state in which the first clamp 100 and the second clamp 200 are in contact with each other is illustrated.

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The first clamp 100 and the second clamp 200 may be coupled to end portions, at which the filter head 30 and the filter housing 20 are coupled, of the filter head 30 and the filter housing 20.

Since inner side surfaces of the first clamp 100 and the second clamp 200 are
5 formed in shapes to be coupled to outer side surfaces of the filter head 30 and the filter housing 20 in an engaging manner, the first clamp 100 and the second clamp 200 may be coupled to and pressed against the filter head 30 and the filter housing 20, respectively.

The first clamp 100 and the second clamp 200 may be formed in ring shapes
10 which surround circumferences of the filter housing 20 and the filter head 30.

Fitting end portions 110 may be formed on the ring shaped first clamp 100 in order to provide a space for inserting the filter head 30 into the first clamp 100.

The fitting end portions 110 of the first clamp 100 may be formed in a pair of flanges which protrude outward in a radius direction and face each other, and
15 since a screw is coupled to the pair of flanges, the first clamp 100 may be tightened to be pressed against the filter head 30.

In addition, fitting end portions 210 may be formed on the ring shaped second clamp 200 in order to provide a space for inserting the filter housing 20 into the second clamp 200.

20 The fitting end portions 210 of the second clamp 200 may be formed to have a structure which is the same as that of the fitting end portions 110 of the first clamp 100.

As illustrated in FIG. 5, facing surfaces (not shown), which are formed in directions in which the facing surfaces face each other, of the first clamp 100 and the

second clamp 200 may be formed to gradually move toward and be coupled to each other when clamping is performed.

In addition, although not illustrated in the drawings, a state in which the first clamp 100 is spaced a certain distance or different distances from the second clamp 200 may be maintained even when a pressure is applied thereto by the third clamp 300 when clamping is performed.

When the first clamp 100 and the second clamp 200 are clamped, a degree of tight contact therebetween may be changed according to positions at which the first clamp 100 and the second clamp 200 are coupled to the filter head 30 and the filter housing 20, respectively.

In a case in which the first clamp 100 and the second clamp 200 are in contact with each other, since the facing surfaces provided on the first clamp 100 and the second clamp 200 are formed in shapes to be coupled to each other in an engaging manner, the first clamp 100 and the second clamp 200 may be pressed against each other through the facing surfaces.

At least one third clamp coupling part 101 to which a fixing part 321 of the third clamp 300 is coupled may be provided on the first clamp 100.

A coupling unit 101 to be coupled to the fixing part 321 may be formed in the third clamp coupling part 101.

The coupling unit 101 may include a coupling groove 101-1 into which a coupling protrusion 321a-1 of the fixing part 321 is inserted and may further include a screw hole 101-2 for screw coupling.

The third clamp coupling part 101 may be provided as a plurality of third clamp coupling parts 101 at predetermined intervals along a circumference of the

ring shaped first clamp 100, and accordingly, the plurality of third clamps 300 may be coupled at the predetermined intervals to the circumference of the first clamp 100.

As an example, third clamp coupling parts 101 of the first clamp 100 are provided in opposite directions, and a pair of third clamps 300 may be coupled thereto.

The plurality of third clamps 300 are in contact with the rear surface 201 of the second clamp 200 at the predetermined intervals along a circumference of the second clamp 200 to apply a pressure in the coupling directions of the first clamp 100 and the second clamp 200.

Accordingly, since the circumference of the filter assembly 2 can be uniformly clamped, coupling stability of the filter head 30 and the filter housing 20 can be improved, and chemical leakage can be prevented.

A flange part 220 in contact with the third clamp 300 may be provided on the second clamp 200.

The flange part 220 may be formed in a shape protruding outward from a body of the ring shaped second clamp 200.

Accordingly, the third clamp 300 is in contact with the rear surface 201 of the flange part 220 and applies a force in the coupling directions of the first clamp 100 and the second clamp 200.

The flange part 220 may be provided at a position corresponding to the third clamp coupling part 101 of the first clamp 100 and provided as a plurality of flange parts at predetermined intervals along the circumference of the ring shaped second clamp 200.

Observation windows W may be provided in the first clamp 100 and the second clamp 200.

The observation windows W are for visually checking coupling of the filter housing 20 and the filter head 30 and are formed at positions at which the coupling portion m at which the filter housing 20 and the filter head 30 are coupled in contact with each other is visually checkable.

5 Since a user may visually check the coupling surface m of the filter housing 20 and the filter head 30 through the observation windows W and determine whether the coupling is proper, chemical leakage due to a coupling failure can be prevented.

As shown in the drawings, the observation windows W may be formed in coupling surfaces of the first clamp 100 and the second clamp 200, and windows
10 formed in the first clamp 100 and the second clamp 200 are connected to each other so that one observation window W may be formed.

In addition, although not illustrated in the drawings, the observation window W may also be individually provided in the first clamp 100 or the second clamp 200.

In addition, the observation window W may be provided as a plurality of
15 observation windows along a circumference of the coupling portion m of the filter housing 20 and the filter head 30 to check whether the filter housing 20 and the filter head 30 are uniformly pressed against each other.

The third clamp 300 will be described with reference to FIGS. 8 to 11.

In FIGS. 8 to 10, side views of the third clamp 300 are illustrated, and in FIG.
20 11, a perspective view of the third clamp 300 is illustrated.

The third clamp 300 includes a cylinder 310 configured to extend or contract, a fixing arm 320 which is fixed to the first clamp 100 and supports the cylinder 310, a first pressing member 330 which applies a pressure to the rear surface 201 of the second clamp 200, a second pressing member 340 which applies a pressure to a rear

surface 331 of the first pressing member 330, and a link member 350 which connects the fixing arm 320 and the cylinder 310.

The cylinder 310 includes a push rod 312 which is reciprocated by driving of a cylinder driving part (not shown) and a cylinder body 311 which supports the push
5 rod 312.

In the cylinder 310, the push rod 312 is positioned in a direction in which the push rod 312 faces the filter assembly 2, and the cylinder body 311 is positioned in an opposite direction so that the push rod 312 can be provided to reciprocate in directions in which the push rod 312 moves toward or away from the filter assembly
10 2.

The fixing arm 320 may include a fixing part 321 fixedly coupled to the first clamp 100 and a cylinder support part 322 coupled to the fixing part 321.

The cylinder body 311 is rotatably connected to the cylinder support part 322. A connection portion at which the cylinder support part 322 and the cylinder body
15 311 are connected is referred to as a first connection portion, and the cylinder body 311 rotates within a predetermined angle about a first rotary shaft S1 which is a rotary shaft provided in the first connection portion.

A coupling unit 321a to be coupled to the third clamp coupling part 101 is provided at one side of the fixing part 321, and the first pressing member 330 and the
20 link member 350 are rotatably connected to an upper portion of the fixing part 321.

The coupling unit 321a may include a coupling protrusion 321a-1 inserted into the coupling groove 101-1 and may further include a screw hole 321a-2 provided at a position corresponding to the screw hole 101-2.

According to the pair of coupling units 101 and 321a, the coupling
25 protrusion 321a-1 may be inserted into the coupling groove 101-1, and screws may

be coupled to the pair of screw holes 101-2 and 321a-2 so that the third clamp 300 can be coupled to the first clamp 100 and a position thereof can be fixed.

The first pressing member 330 is rotatably coupled to each of the fixing part 321 and the second pressing member 340.

5 A connection portion at which the fixing part 321 and the first pressing member 330 are connected is referred to as a second connection portion, and a connection portion at which the first pressing member 330 and the second pressing member 340 are connected is referred to as a third connection portion.

10 The first pressing member 330 rotates within a predetermined angle about a second rotary shaft S2, which is a rotary shaft provided in the second connection portion, and a third rotary shaft S3 which is a rotary shaft provided in the third connection portion.

15 A first pressing part 332 which is in contact with the rear surface 201 of the second clamp 200 and applies a pressure in the coupling directions of the first clamp 100 and the second clamp 200 is provided at one side of the first pressing member 330.

 The first pressing part 332 may be formed in a “7” shape of which one end is bent.

20 According to the above-described shape, since an end of the first pressing part 332 is perpendicularly in contact with the rear surface 201 of the second clamp 200 so that a perpendicular pressure can be more efficiently applied, a clamping effect by the third clamp 300 can be improved.

25 Here, since the fixing part 321 is coupled to the first clamp 100 so that a position thereof is fixed, the second connection portion is usually formed at a fixed position normally.

Accordingly, the first pressing member 330 operates so that the third rotary shaft S3 and the first pressing part 332 rotate about the second rotary shaft S2.

In the first pressing member 330, the third connection portion S3 may be formed on the rear surface 331 of the first pressing part 332.

5 In the first pressing part 332, the rear surface 331 of the first pressing part 332 refers to an opposite surface of a surface in contact with the rear surface 201 of the second clamp 200 and is an action point for pressing the first pressing part 332 to apply a perpendicular pressure to the rear surface 201 of the second clamp 200.

Both ends of the second pressing member 340 are rotatably connected to an
10 end of the push rod 312 and the first pressing member 330.

A connection portion, at which the end of the push rod 312 and the second pressing member 340 are connected, is referred to as a fourth connection portion. The second pressing member 340 rotates within a predetermined angle about the third rotary shaft S3 and a fourth rotary shaft S4 which is a rotary shaft provided in
15 the fourth connection portion.

The second pressing member 340 includes a second pressing part 342 which protrudes to one side from a straight line connecting the third rotary shaft S3 and the fourth rotary shaft S4, is in contact with the rear surface 331 of the first pressing part 332, and applies a perpendicular pressure to the rear surface 331 of the first pressing
20 part 332.

That is, according to the third clamp 300, since the rear surface 201 of the second clamp 200 is pressed by the first pressing member 330, and the rear surface 331 of the first pressing part 332 is pressed by the second pressing member 340 so that coupling of the first clamp 100 and the second clamp 200 is double clamped, a
25 clamping effect can be further improved.

In this case, since a portion, which is in contact with an end of the second pressing part 342, of the first pressing part 332 is formed closer to an end of the first pressing part 332, that is, the second clamp 200, than a portion at which the third connection portion is formed, a double clamping effect can be further improved.

5 In addition, the second pressing part 342 may be formed in a “7” shape of which one end is bent like the first pressing part 332.

According to the above-described shape, since the end of the second pressing part 342 is in perpendicular contact with the rear surface 331 of the first pressing part 332 so that the perpendicular pressure can be more efficiently applied, a clamping
10 effect by the third clamp 300 can be further improved.

In addition, more preferably, the second pressing part 342 perpendicularly protrudes to one side from a central portion of the straight line connecting the third rotary shaft S3 and the fourth rotary shaft S4, and a rotating force of the second pressing member 340 may be more stably transmitted to the rear surface 331 of the
15 first pressing part 332 through the second pressing part 342.

Both ends of the link member 350 are rotatably connected to an end of the push rod 312 and the fixing part 321.

A connection portion at which the fixing part 321 and the link member 350 are connected is referred to as a fifth connection portion, and a connection portion at
20 which the end of the push rod 312 and the link member 350 are connected is referred to as a sixth connection portion. The link member 350 rotates within a predetermined angle about a fifth rotary shaft S5, which is a rotary shaft provided in the fifth connection portion, and a sixth rotary shaft S6 which is a rotary shaft provided in the sixth connection portion.

The fourth rotary shaft S4 and the sixth rotary shaft S6 may be provided to share the same rotary shaft.

Here, since the fixing part 321 is coupled to the first clamp 100 so that the position of the fixing part 321 is fixed, the fifth connection portion is usually formed
5 at a fixed position.

Accordingly, the link member 350 operates so that the sixth rotary shaft S6 rotates about the fifth rotary shaft S5.

The second pressing member 340 and the link member 350 rotate according to extension or contraction of the push rod 312, and the first pressing member 330
10 rotates according to a change in position of the second pressing member 340.

Accordingly, a rotation plane formed by rotation of the first pressing member 330, the second pressing member 340, and the link member 350 is formed parallel to a vertical plane including a reciprocation track of the push rod 312.

The rotation plane and the vertical plane are formed on planes parallel to a
15 ground surface based on FIGS. 8 to 10.

Hereinafter, an operation of the third clamp 300 will be described.

In the description below, based on the side views illustrated in FIGS. 8 to 10, rotation in a counterclockwise direction is referred to as an inward rotation and rotation in a clockwise direction is referred to as an outward direction.

20 An operation state of the third clamp 300 includes an unclamping step which is a state in which clamping is completely released, a first clamping step which is a specific state when clamping is being performed, and a second clamping step which is a clamping completion state.

In FIG. 8, a side view of the third clamp 300 in the unclamping step is
25 illustrated, in FIG. 9, a side view of the third clamp 300 in the first clamping step is

illustrated, and in FIG. 10, a side view of the third clamp 300 in the second clamping step is illustrated. In addition, in FIG. 11, a perspective view of the third clamp 300 in the unclamping step is illustrated.

First, a clamping operation of the third clamp 300 will be described.

5 In a case in which the push rod 312 is extended by driving of the cylinder driving part, the sixth rotary shaft S6 is pushed to a left side so that the link member 350 rotates about the fifth rotary shaft S5 in an inward direction.

Accordingly, an arc-shaped trajectory, in which the sixth rotary shaft S6 and the end of the push rod 312 connected to the sixth rotary shaft S6 rotate about the
10 fifth rotary shaft S5 in the inward direction, is formed.

At the same time, the fourth rotary shaft S4 is pushed to the left side so that the second pressing member 340 also rotates in the inward direction.

In this case, at first, a vertical level of the third connection portion of the second pressing member 340 is lowered to apply a downward pressure to the rear
15 surface 331 of the first pressing part 332, and secondly, the second pressing part 342 is in contact with the rear surface 331 of the first pressing part 332 and applies a downward pressure to the rear surface 331.

Accordingly, the first pressing member 330 rotates about the second rotary shaft S2 in the inward direction, and the first pressing part 332 rotates about the
20 second rotary shaft S2 in the inward direction to be in contact with the rear surface 201 of the second clamp 200 and apply a downward pressure to the rear surface 201.

That is, as the push rod 312 extends, the first pressing part 332 and the second pressing part 342 rotate in the inward direction to apply the pressure to the rear surface 201 of the second clamp 200 in the coupling direction so that the filter
25 assembly 2 is clamped.

The clamping operation of the third clamp 300 sequentially satisfies states of the unclamping step, the first clamping step, and the second clamping step as the push rod 312 extends.

5 The unclamping step is a state in which the push rod 312 is contracted and the first pressing member 330 and the second pressing member 340 are completely separated from the rear surface 201 of the second clamp 200 (see FIG. 8).

The first clamping step is a state in which the first pressing part 332 is in contact with the rear surface 201 of the second clamp 200 and the second pressing member 340 is positioned at a first angular position l1 so that the second pressing
10 part 342 is separated from the rear surface 331 of the first pressing member 330 (see FIG. 9).

The second clamping step is a state in which the first pressing part 332 is in contact with the rear surface 201 of the second clamp 200 and the second pressing member 340 is positioned at a second angular position l2 so that the second pressing
15 part 342 is in contact with the rear surface 331 of the first pressing member 330 (see FIG. 10)

The first angular position l1 and the second angular position l2 refer to angular positions of the straight line connecting the third rotary shaft S3 and the fourth rotary shaft S4 on the second pressing member 340.

20 The first angular position l1 may be an angular position formed in a direction away from the filter assembly 2 when the second pressing member 340 rotates a predetermined angle in the outward direction from a vertical angular position l_r perpendicular to a horizontal plane.

The second angular position l2 may be an angular position formed in a direction toward the filter assembly 2 when the second pressing member 340 rotates a predetermined angle in the inward direction from the vertical angular position lr.

Referring to FIGS. 9 and 10, the first angular position l1 is formed at a right side of the vertical angular position lr, and the second angular position l2 is formed at the left side of the vertical angular position lr.

The first angular position l1 and the second angular position l2 may be formed at positions at which the second pressing member 340 rotates to a right side and the left side from the vertical angular position lr. In this case, an angle α between the vertical angular position lr and the first angular position l1, and an angle β between the vertical angular position lr and the second angular position l2 may be the same or different from each other.

Here, the first pressing member 330 is connected to the fixing part 321 of which the position is fixed, and once the first pressing part 332 is in contact with the rear surface 201 of the second clamp 200, the first pressing member 330 can no longer rotate in the inward direction.

Accordingly, while the clamping operation of the third clamp 300 proceeds from the first clamping step to the second clamping step, in a state in which the first pressing part 332 is in contact with the rear surface 201 of the second clamp 200, a position of the first pressing member 330 is maintained, and a position of the third connection portion is also fixed.

Accordingly, in the case in which the clamping operation of the third clamp 300 proceeds from the first clamping step to the second clamping step, the second pressing member 340 rotates about the third rotary shaft S3 from the first angular position l1 to the second angular position l2 in the inward direction, and an upward

convex arc-shaped trajectory, in which the fourth rotary shaft S4 and the end of the push rod 312 connected to the fourth rotary shaft S4 rotate inwardly about the third rotary shaft S3, move vertically upward, and move downward, is formed.

In addition, while the clamping operation of the third clamp 300 proceeds
5 from the first clamping step to the second clamping step, the sixth rotary shaft S6 positioned at the end of the push rod 312 moves with the fourth rotary shaft S4 so that an arc-shaped trajectory which is similar to that of the fourth rotary shaft S4 is formed, and thus, the link member 350 rotates about the fifth rotary shaft S5 in the inward direction.

10 Here, in the case in which the sixth rotary shaft S6 and the fourth rotary shaft S4 share the same rotary shaft, a trajectory of the sixth rotary shaft S6 and a trajectory of the fourth rotary shaft S4 are formed in the same shape.

However, according to one embodiment of the present invention, in the first clamping step and the second clamping step, the sum ($d1+d2$) of a first pressing
15 length $d1$, which is a length between the fifth rotary shaft S5 and the third rotary shaft S3, and a second pressing length $d2$, which is a length between the third rotary shaft S3 and the fourth rotary shaft S4, is greater than a link length D which is a length between the fifth rotary shaft S5 and the sixth rotary shaft S6.

In this case, since the link length D is smaller than the sum ($d1+d2$) of the
20 first pressing length $d1$ and the second pressing length $d2$, while the clamping operation of the third clamp 300 proceeds from the first clamping step to the second clamping step, a tensile force is applied to the link member 350 and a compressive force is applied to the second pressing member 340.

That is, the above-described upward convex arc-shaped trajectory serves as a
25 catching trap, and while the fourth rotary shaft S4, the sixth rotary shaft S6, and the

end of the push rod 312 connected to the sixth rotary shaft S6 move along the catching trap, the tensile force and the compressive force are respectively applied to the link member 350 and the second pressing member 340.

5 The tensile force and the compressive force increase gradually as the second pressing member 340 rotates from the first angular position l1 to the vertical angular position lr, are applied most strongly at the vertical angular position lr, and decrease gradually as the second pressing member 340 rotates from the vertical angular position lr to the second angular position l2.

10 Accordingly, in order for the clamping operation of the third clamp 300 to proceed from the first clamping step to the second clamping step by overcoming the tensile force and the compressive force, sufficient output driving power, by which the push rod 312 is extended, of the cylinder driving part is required.

15 The output driving power of the cylinder driving part required for the clamping operation of the third clamp 300 to proceed from the first clamping step to the second clamping step is required to become higher as a difference between the sum ($d1+d2$) of the first pressing length $d1$ and the second pressing length $d2$ and the link length D increases.

20 The difference between the sum ($d1+d2$) of the first pressing length $d1$ and the second pressing length $d2$ and the link length D may be applied to be different according to a capacity of the output driving power of the cylinder driving part, and a value of the difference may become greater as the capacity of the output driving power of the cylinder driving part becomes higher.

25 In addition, in a case in which the clamping operation is performed and clamping is completed, the cylinder driving part may maintain a length of the push rod 312 as the length thereof in the second clamping step and stably support the push

rod 312 in order for the clamping state to not be released due to contraction of the push rod 312 by an external force.

Next, an unclamping operation of the third clamp 300 will be described.

In a case in which the push rod 312 is contracted by driving of the cylinder
5 driving part, the sixth rotary shaft S6 is pulled to the right side based on FIGS. 8 to 10, the link member 350 rotates outward, and the sixth rotary shaft S6 and the end of the push rod 312 connected to the sixth rotary shaft S6 rotate outward about the fifth rotary shaft S5.

At the same time, the fourth rotary shaft S4 is pulled to the right side, and the
10 second pressing member 340 is also rotated outward. In this case, first, the second pressing part 342 is lifted upward, and a pressure applied to the first pressing member 330 by the second pressing part 342 is released. Secondly, the second pressing member 340 rotates outward, and a vertical level of the third connection portion is raised, the rear surface 331 of the first pressing member 330 is lifted
15 upward, the first pressing member 230 rotates outward, and a pressure applied to the rear surface 201 of the second clamp 200 by the first pressing part 332 is released.

Accordingly, the pressures applied by the first pressing part 332 and the second pressing part 342 in the coupling directions of the first clamp 100 and the second clamp 200 are released, and the clamping is released.

20 The unclamping operation of the third clamp 300 sequentially satisfies the states of the second clamping step, the first clamping step, and the unclamping step according to the contraction of the push rod 312. That is, the unclamping operation is performed in a reverse order of the order of the clamping operation.

In the case in which the unclamping operation of the third clamp 300
25 proceeds from the second clamping step to the first clamping step, in a state in which

a position of the third rotary shaft S3 is fixed, the second pressing member 340 rotates from the second angular position l2 to the first angular position l1.

Accordingly, an upward convex arc-shaped trajectory in which the fourth rotary shaft S4, the sixth rotary shaft S6, and the end of the push rod 312 rotate
5 outward about the third rotary shaft S3, move vertically upward, and move downward, that is, a catching trap, is formed.

Accordingly, like in the clamping operation, in order for the unclamping operation of the third clamp 300 to proceed from the second clamping step to the first clamping step by overcoming the tensile force and the compressive force
10 respectively applied to the link member 350 and the second pressing member 340 and moving along the catching trap, sufficient output driving power, by which the push rod 312 is pulled and contracted, of the cylinder driving part is required.

However, as the second pressing member 340 is connected to the left side of the fourth rotary shaft S4 and the sixth rotary shaft S6, and the push rod 312 is
15 connected to the right side of the fourth rotary shaft S4 and the sixth rotary shaft S6, a length of the second pressing member 340 is smaller than the length of the push rod 312.

In addition, according to the clamping operation, the push rod 312 pushes the fourth rotary shaft S4 and the sixth rotary shaft S6 to the left side from the right side
20 to vertically move the fourth rotary shaft S4 and the sixth rotary shaft S6 in the upward direction so that the fourth rotary shaft S4 and the sixth rotary shaft S6 move along the catching trap, but according to the unclamping operation, the second pressing part 342 is moved upward, and the fourth rotary shaft S4 and the sixth rotary shaft S6 are pushed to the right side from the left side and are vertically moved

in the upward direction so that the fourth rotary shaft S4 and the sixth rotary shaft S6 move along the catching trap.

However, in the law of the lever having a support beam in which a longer shaft and a shorter shaft are provided at one side and the other side about an action
5 point, a force for moving the longer shaft and a force for moving the shorter shaft are inversely proportional.

Accordingly, in order to perform the clamping operation, a force for lifting the second pressing part 342 in the upward direction to rotate the second pressing member 340 in the outward direction, push the fourth rotary shaft S4 and the sixth
10 rotary shaft S6 to the right side, move the fourth rotary shaft S4 and the sixth rotary shaft S6 in the upward direction, and move the fourth rotary shaft S4 and the sixth rotary shaft S6 along the catching trap at the same time is required to be greater than a force for pushing the push rod 312 to the left side to push the fourth rotary shaft S4 and the sixth rotary shaft S6 to the left side, move the fourth rotary shaft S4 and the
15 sixth rotary shaft S6 in the upward direction, and move the fourth rotary shaft S4 and the sixth rotary shaft S6 along the catching trap at the same time in order to perform the clamping operation.

Therefore, according to the third clamp 300 according to the present invention, since the force required for the above-described unclamping operation is
20 required to be greater than the force required for the above-described clamping operation, the clamping of the third clamp 300 in the state in the second clamping step is not easily released, which is advantageous for stably fixing the coupling of the first clamp 100 and the second clamp 200.

Particularly, even in a case in which an abnormality occurs in a clamp
25 driving part due to a failure and the like of the cylinder 310, and the push rod 312 is

in an unstable state, since the clamping of the third clamp 300 is not easily released, the coupling of the first clamp 100 and the second clamp 200 can be stably fixed.

In addition, the third clamp 300 may further include a knob 360 extending from the link member 350.

5 The knob 360 is provided so that a user grips the knob 360 and pushes or pulls the knob 360 to rotate the link member 350 about the fifth rotary shaft S5 and is used to manually extend or contract the cylinder 310 in a case in which the cylinder driving part does not operate.

 The knob 360 may be formed in a shape in which both ends thereof extend
10 from a pair of link members 350 to connect the pair of link members 350.

As described above, since the knob 360 is provided on extension lines of the link members 350 without an additional component, the apparatus can be simplified and utilization of a space can be improved.

 In addition, the user can push or pull the knob 360 to more easily rotate the
15 pair of link members 350 according to the principle of the lever.

In FIG. 11, the fixing part 321, the push rod 312, and the pair of link members 350, between which the first pressing member 330 and the second pressing member 340 are disposed and which are connected to both of the fixing part 321 and the push rod 312, are illustrated.

20 As illustrated in FIG. 11, the knob 360 is provided to be connected to upper sides of the pair of link members 350 so that the user can conveniently push or pull the knob 360.

 As described above, according to the clamp apparatus 1 according to the present invention, since the third clamp 300, which clamps the coupling of the first
25 clamp 100 and the second clamp 200, is provided, the coupling of the filter housing

20 and the filter head 30 of the filter assembly 2 is firmly fixed, and thus chemical leakage can be prevented, and fixing and releasing can be more easily performed.

In addition, since the observation window W, through which the coupling surface of the filter housing 20 and the filter head 30 may be visually checked, is
5 provided in the clamp apparatus 1, occurrence of chemical leakage due to a coupling failure between the filter housing 20 and the filter head 30 can be prevented.

According to a clamp apparatus according to the present invention, when a chemical filter is replaced, a housing and a head of a filter can be firmly fixed to prevent chemical leakage, and fixing and releasing can be more easily performed at
10 the same time.

In addition, since an observation window, through which a coupling surface of the housing and the head of the filter assembly can be visually checked, is provided in the clamp apparatus, chemical leakage due to a coupling failure of the housing and the head can be prevented.

15 Although the present invention has been described with reference to the exemplary embodiments as described above, the present invention is not limited to the above-described embodiments and may be variously modified and made within the scope of the claims, the detailed description of the present invention, and the accompanying drawings, and the modifications will also fall within the present
20 invention.

WHAT IS CLAIMED IS:

1. A clamp apparatus comprising:

5 a first clamp coupled to an outer side of any one of a filter head and a filter housing of a filter assembly;

a second clamp coupled to the outer side of the remaining one of the filter head and the filter housing; and

10 a third clamp which applies a force to a rear surface of the first clamp or the second clamp to press the first clamp and the second clamp in a coupling direction in which the first clamp and the second clamp move toward each other.

2. The clamp apparatus of claim 1, wherein the third clamp is coupled to the first clamp, is in contact with the rear surface of the second clamp, and applies the force to the rear surface in the coupling direction in which the first clamp and the
15 second clamp move toward each other.

3. The clamp apparatus of claim 1, wherein the third clamp includes:

20 a first pressing member of which one side is provided with a first pressing part which is in contact with the rear surface of the second clamp and applies a pressure to the rear surface in the coupling direction; and

a fixing arm to which the first pressing member is rotatably coupled.

4. The clamp apparatus of claim 3, wherein the third clamp further includes a second pressing member provided with a second pressing part which is in contact

with a rear surface of the first pressing part and applies the pressure to the rear surface in the coupling direction.

5. The clamp apparatus of claim 4, wherein the third clamp further includes a
5 cylinder which provides driving power so that the first pressing member rotates.

6. The clamp apparatus of claim 5, wherein:

the cylinder includes a cylinder body and a push rod and is extended or
contracted as the push rod is reciprocated by driving of the cylinder driving part so
10 that the first pressing member is rotated;

the second pressing member is rotatably connected to an end of the push rod
and a rear surface of the first pressing member; and

the second pressing part protrudes toward one side of the second pressing
member.

15

7. The clamp apparatus of claim 6, wherein the second pressing part
perpendicularly protrudes toward one side from a straight line connecting a
connection portion of the second pressing member and the push rod and a connection
portion of the second pressing member and the first pressing member.

20

8. The clamp apparatus of claim 6, wherein, in the cylinder, the push rod is
positioned in a direction in which the push rod faces the filter assembly and
reciprocates in directions to move in a direction toward or away from the filter
assembly.

25

9. The clamp apparatus of claim 6, wherein:

in a case in which the push rod extends, the second pressing member rotates in an inward direction, and presses the rear surface of the first pressing member first in the coupling direction through a connection portion, which is connected to the first pressing member, of the second pressing member, and the second pressing part secondarily presses a rear surface of the first pressing part in the coupling direction, and accordingly, the first pressing member rotates in the inward direction, the first pressing part presses the rear surface of the second clamp in the coupling direction, and the first clamp and the second clamp are clamped; and

in a case in which the push rod contracts, the second pressing member rotates in an outward direction, accordingly, the pressure applied to the rear surface of the first pressing member by the second pressing part is released, the first pressing member rotates in the outward direction, the pressure applied to the rear surface of the second clamp by the first pressing part is released at the same time, and the clamping of the first clamp and the second clamp is released.

10. The clamp apparatus of claim 6, wherein an operation state of the third clamp includes:

an unclamping step which is a state in which the push rod is contracted and the first pressing member and the second pressing member are completely separated from the rear surface of the second clamp;

a first clamping step which is a state in which the first pressing part is in contact with the rear surface of the second clamp, the second pressing member is positioned at a first angular position, and the second pressing part is separated from the rear surface of the first pressing member; and

a second clamping step which is a state in which the first pressing part is in contact with the rear surface of the second clamp, the second pressing member is positioned at a second angular position, and the second pressing part is in contact with the rear surface of the first pressing member,

5 wherein the first angular position is an angular position at which the second pressing member rotates in an outward direction from a vertical angular position perpendicular to a horizontal plane, and the second angular position is an angular position at which the second pressing member rotates in an inward direction from the vertical angular position.

10

11. The clamp apparatus of claim 10, wherein:

as the push rod extends, the operation state of the third clamp sequentially proceeds to the unclamping step, the first clamping step, and the second clamping step; and

15 as the push rod contracts, the operation state of the third clamp sequentially proceeds to the second clamping step, the first clamping step, and the unclamping step.

12. The clamp apparatus of claim 11, wherein:

20 in a case in which the operation state of the third clamp proceeds from the first clamping step to the second clamping step, a position of the first pressing member is maintained in a state in which the first pressing part is in contact with the rear surface of the second clamp, and accordingly, the second pressing member rotates from the first angular position to the second angular position in a state in
25 which a position of a connection portion of the second pressing member and the first

pressing member is fixed so that an arc-shaped trajectory, in which a rotary shaft of a connection portion of the second pressing member and the push rod and the end of the push rod connected to the rotary shaft rotate in the inward direction, move vertically upward, and move downward, is formed; and

5 in a case in which the operation state of the third clamp proceeds from the second clamping step to the first clamping step, the position of the first pressing member is fixed in the state in which the first pressing part is in contact with the rear surface of the second clamp, and accordingly, the second pressing member rotates from the second angular position to the first angular position in the state in which the
10 position of the connection portion of the second pressing member and the first pressing member is fixed so that an arc-shaped trajectory in which the rotary shaft of the connection portion of the second pressing member and the push rod and the end of the push rod connected to the rotary shaft rotate in the outward direction, move vertically upward, and move downward, is formed.

15

13. The clamp apparatus of claim 6, wherein the fixing arm includes:
a fixing part fixedly coupled to the first clamp; and
a cylinder support part which is coupled to the fixing part and to which the cylinder body is rotatably connected.

20

14. The clamp apparatus of claim 13, wherein the first pressing member is rotatably connected to the fixing part.

15. The clamp apparatus of claim 6, further comprising a link member of
25 which both ends are rotatably connected to the fixing arm and the end of the push rod.

16. The clamp apparatus of claim 15, wherein a rotation plane formed by rotation of the link member is formed to be parallel to a vertical plane including a reciprocation track of the push rod.

5

17. The clamp apparatus of claim 16, wherein:

a second rotary shaft which is a rotary shaft of a connection portion at which the fixing part and the first pressing member are connected, a third rotary shaft which is a rotary shaft of a connection portion at which the first pressing member and the second pressing member are connected, a fourth rotary shaft which is a rotary shaft of a connection portion at which the end of the push rod and the second pressing member are connected, a fifth rotary shaft which is a rotary shaft of a connection portion at which the fixing part and the link member are coupled, and a sixth rotary shaft which is a rotary shaft of a connection portion at which the end of the push rod and the link member are connected are provided; and

10

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a sum of a length between the fifth rotary shaft and the third rotary shaft and a length between the third rotary shaft and the fourth rotary shaft is greater than a length between the fifth rotary shaft and the sixth rotary shaft.

20 18. The clamp apparatus of claim 17, wherein the fourth rotary shaft and the sixth rotary shaft share the same rotary shaft.

19. The clamp apparatus of claim 15, wherein:

a knob extending from the link member is provided; and

a user grips and pushes or pulls the knob using a hand to rotate the link member about a rotary shaft of a connection portion of the link member and the fixing part.

5 20. The clamp apparatus of claim 19, wherein the user pushes the knob in a direction toward the filter assembly to clamp the third clamp to the first clamp and the second clamp and pulls the knob in a direction away from the filter assembly to release the clamping of the third clamp.

10 21. The clamp apparatus of claim 19, wherein:
the link member includes a pair of link members connected to both sides of each of the fixing part and the push rod; and
both ends of the knob extend from the pair of link members and are disposed between and connected to the pair of link members.

15 22. The clamp apparatus of claim 6, wherein a rotation plane formed by rotation of the first pressing member and the second pressing member is formed to be parallel to a vertical plane including a reciprocation track of the push rod.

20 23. The clamp apparatus of claim 1, wherein the first clamp and the second clamp are formed in ring shapes and each coupled to a circumference of one of the filter head and the filter housing; and
the third clamp is provided as a plurality of third clamps which are clamped at predetermined intervals along circumferences of the first clamp and the second
25 clamp.

24. The clamp apparatus of claim 1, wherein an observation window is provided in at least one of the first clamp and the second clamp at a position at which a coupling portion of the filter housing and the filter head is visually checkable.

5

25. The clamp apparatus of claim 24, wherein the observation window is formed in a coupling surface of the second clamp and the first clamp.

26. The clamp apparatus of claim 24, wherein the observation window is
10 formed as a plurality of observation windows along a circumference of a coupling
portion of the filter housing and the filter head.