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(71) Applicant: **Panasonic Corporation**
Kadoma-shi
Osaka 571-8501 (JP)

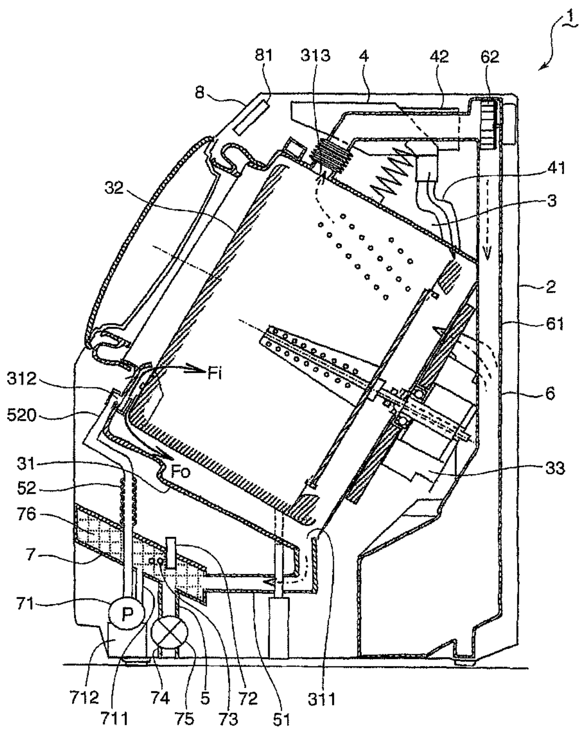
(72) Inventors:
- **Murao, Tsuyoshi**
  Osaka 540-6207 (JP)
- **Horibe, Yasuyuki**
  Osaka 540-6207 (JP)

(74) Representative: **Schwabe - Sandmair - Marx**
Patentanwälte
Stuntzstraße 16
81677 München (DE)

(54) **Laundry machine**

(57) A laundry machine includes a laundry sink (3) provided with a discharge port (311) through which washing water is discharged; a pipeline (701, 702) connected to the discharge port; a suction pipeline (711) connected to the pipeline (701, 702) so as to extend in a direction different from an extending direction of the pipeline (701, 702); a feeder (71) configured to feed the washing water from the discharge port (311) to the suction pipeline (711); and a sensor (73) configured to detect a physical property of the washing water, wherein the sensor (73) protrudes from an inner surface of the pipeline (701, 702) opposite a connecting portion (771) between the suction pipeline (711) and the pipeline (701, 702).

FIG. 1



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Description

[0001] The invention relates to a laundry machine configured to easily remove lint (such as yarn waste and dust) contained in washing water for laundry from a sensor protruding in a flow path of the washing water.

[0002] Recently various types of laundry machines have been launched into the market. JP 2008-54826A discloses a laundry machine provided with a circulation pump configured to circulate washing water. The laundry machine disclosed in JP 2008-54826A circulates the washing water with the circulation pump to thereby reduce water dosage for the laundry.

[0003] It is likely that lint from laundry is adhered and deposited to a protrusion formed in a circulation path of washing water. Consequently the deposition on the protrusion in the circulation path may result in clogging of the circulation path.

[0004] JP Hei 5-220291A discloses a technique for avoiding protrusion deployment in a circulation path. The laundry machine disclosed in JP Hei 5-220291 A is provided with an optical sensor including a light emitter and a light receiver configured to receive light from the light emitter. The laundry machine disclosed in JP Hei 5-220291A detects turbidity of washing water with the optical sensor configured not to protrude in the circulation path.

[0005] In the case of a laundry machine under control with a physical property of washing water, which is measured by a contact sensor, the contact sensor typically protrudes in a flow path of the washing water. As described above, the contact sensor protruding in the flow path may cause deposition of lint on the sensor.

[0006] It is an object of the invention to provide a laundry machine configured to easily remove lint contained in washing water for laundry from a sensor protruding in a flow path of the washing water.

[0007] A laundry machine according to an aspect of the invention includes a laundry sink provided with a discharge port through which washing water is discharged; a pipeline connected to the discharge port; a suction pipeline connected to the pipeline so as to extend in a direction different from an extending direction of the pipeline; a feeder configured to feed the washing water from the discharge port to the suction pipeline; and a sensor configured to detect a physical property of the washing water, wherein the sensor protrudes from an inner surface of the pipeline opposite a connecting portion between the suction pipeline and the pipeline.

[0008] These and other objects, features and advantages of the present invention will become more apparent upon reading of the following detailed description along with the accompanying drawings, in which:

FIG. 1 is a diagram showing a schematic configuration of a drum laundry machine according to one embodiment of the invention.

FIGS. 2A and 2B are diagrams showing a housing to be used in a discharge control unit of the drum laundry machine shown in FIG. 1.

FIG. 3 is a plan view of the discharge control unit of the drum laundry machine shown in FIG. 1.

FIG. 4 is a front view of the discharge control unit of the drum laundry machine shown in FIG. 1.

FIG. 5 is a side view of the discharge control unit of the drum laundry machine shown in FIG. 1.

FIG. 6 is an opposite side view of the discharge control unit shown in FIG. 5.

FIG. 7 is a diagram showing an attachment structure of an optical sensor for the discharge control unit shown in FIGS. 3 through 6.

FIGS. 8A through 8E are diagrams showing the optical sensor shown in FIG. 7.

FIGS. 9A through 9F are diagrams for describing a configuration of a bracket for the optical sensor shown in FIGS. 8A through 8E.

FIGS. 10A and 10B are diagrams showing an electrode sensor for the discharge control unit shown in FIGS. 3 through 6.

FIGS. 11A and 11B are diagrams showing an attachment structure for the electrode sensor shown in FIGS. 10A and 10B.

FIG. 12 is a diagram for describing a flow of washing water around the electrode sensor shown in FIGS. 11A and 11B.

FIG. 13 is a diagram for describing a flow of washing water in a flow path from the optical sensor shown in FIG. 7 to the electrode sensor shown in FIGS. 11A and 11B.

FIG. 14 is a diagram for describing a flow of washing water directed from the electrode sensor of the discharge control unit shown in FIGS. 3 through 6 to a circulation pump.

FIGS. 15A and 15B are diagrams for describing a flow of washing water around the electrode sensor during operation of the circulation pump and a discharge valve of the discharge control unit shown in FIGS. 3 through 6.

FIGS. 16A through 16C are schematic diagrams of the circulation pump of the discharge control unit shown in FIGS. 3 through 6.

FIGS. 17A through 17C are diagrams for describing a periphery configuration of an inlet port of a tub of the drum laundry machine shown in FIG. 1.

FIG. 18 is a diagram for describing a functional configuration of a control circuit section of the drum laundry machine shown in FIG. 1.

[0009] In the following, an embodiment of the invention is described referring to the accompanying drawings. The terms such as "up", "down, "left", and "right" indicating the directions, which will be used in the following description, are provided simply to clarify the description, and do not limit the invention. Further, the terms "upstream" and/or "downstream" to be used in the following description indicate "upstream" and/

or "downstream" of a flow of washing water directed from a discharge port of a tub of a laundry machine toward a discharge control unit, which will be described later, without any special explanation.

[0010] FIG. 1 is a schematic configuration diagram of a drum laundry machine according to one embodiment of the invention. The principle to be described in the following is not limited to application to the drum laundry machine shown in FIG. 1, but may be applied to other laundry machine (e.g. a pulsator laundry machine or a rotary laundry machine).

[0011] A drum laundry machine 1 is provided with a housing 2 in which a laundry sink 3 is disposed. The laundry sink 3 includes a cylindrical tub 31 swingably supported inside the housing 2, a cylindrical rotary drum 32 rotatably supported inside the tub 31, and a motor 33 configured to rotate the rotary drum 32. Each of the tub 31 and the rotary drum 32 includes a bottom portion. The motor 33 is attached to an outer surface of the bottom portion of the tub 31. The tub 31 is formed with a discharge port 311 configured to discharge washing water, and an inlet port 312 into which the washing water is allowed to flow. The washing water is circulated from the discharge port 311 to the inlet port 312.

[0012] The housing 2 further accommodates therein a water supply system 4 configured to supply water into the tub 31, a water discharge system 5 configured to discharge or circulate the washing water inside the tub 31, and a dryer system 6 configured to blow heated air for drying laundry into the laundry sink 3, although the dryer system 6 is not an essential element.

[0013] The dryer system 6 includes a circulation pipeline 61 including one end connected to an air outlet port 313 of the tub 31, and an air inlet port configured to draw in the heated air for drying the laundry from the bottom portion of the tub 31. The dryer system 6 further includes a blower 62 inside the circulation pipeline 61. The blower 62 blows the air within the circulation pipeline 61. The dryer system 6 may include a filter configured to collect and remove e.g. lint and dust, a dehumidifying section configured to dehumidify the introduced air after the dust removal, and a heating section configured to heat the air after the dust removal to generate dry and high-temperature air.

[0014] The drum laundry machine 1 is provided with an operation panel 8 disposed on an upper portion of a front surface of the housing 2. The operation panel 8 allows the user to select one of modes corresponding to operation courses and various functions of the drum laundry machine 1. The operation panel 8 includes a control circuit section 81. The control circuit section 81 causes a display section provided in the operation panel 8 to display information inputted by the user. Further, the control circuit section 81 may receive detection signals from e.g. an optical sensor 72 to be used as a liquid level sensor configured to detect liquid level within the tub 31, or a turbidity sensor configured to detect turbidity of the washing water; and an electrode sensor 73 to be used as a conductivity sensor configured to detect conductivity of the washing water. In response to setting for starting an operation mode of the drum laundry machine 1 through the operation panel 8, the control circuit section 81 controls an electromagnetic valve included in the water supply system 4 and a discharge valve 75 included in the water discharge system 5, based on the detection signals. The motor 33, the water supply system 4, the water discharge system 5 and the dryer system 6, which are automatically controlled by the control circuit section 81, execute at least a washing process, a rinsing process, a dewatering process, and a drying process in cooperation with each other in accordance with the set mode or a control program.

[0015] The water supply system 4 includes a water supply pipeline 41 connected to the tub 31 and a detergent storing section 42 configured to store detergent. The water supply system 4 is operable to supply water into the tub 31 through the water supply pipeline 41 at an appropriate timing with an opening/closing operation of the electromagnetic valve (see the solid-line arrows in FIG. 1). Further, the drum laundry machine 1 shown in FIG. 1 is operable to dispense into the tub 31 the detergent stored in the detergent storing section 42 partially across the water supply pipeline 4, at an appropriate timing with the water supply from the water supply system 4.

[0016] The water discharge system 5 includes a first pipeline 51 having one end connected to the discharge port 311 of the tub 31 and a discharge control unit 7 connected to the other end of the first pipeline 51. The discharge control unit 7 receives the washing water from the tub 31. The water discharge system 7 further includes a second pipeline 52 extending between the tub 31 and a circulation pump 71 provided in the discharge control unit 7. The circulation pump 71 of the drum laundry machine 1 is fixedly attached to a base plate 712. One end of the second pipeline 52 is connected to an eject port of the circulation pump 71. Further, the other end of the second pipeline 52 is connected to the inlet port 312 of the tub 31. The tub 31, the first pipeline 51, the discharge control unit 7, and the second pipeline 52 constitute a circulation path of the washing water. The circulation pump 71 flows and/or circulates the washing water from the discharge port 311 toward the inlet port 312 within the circulation path.

[0017] The discharge control unit 7 is provided with the optical sensor 72 to be used as a turbidity sensor configured to detect turbidity of the washing water, the electrode sensor 73 to be used as a conductivity sensor configured to detect conductivity of the washing water, a discharge pipeline 74 configured to discharge the washing water to the exterior of the laundry machine I, and the discharge valve 75 disposed at an appropriate position in the discharge pipeline 74, in addition to the circulation pump 71, The discharge valve 75 opens/closes the discharge pipeline 74. The discharge control unit 7 further includes a filter portion 76 configured to collect lint (such as yam waste) contained in the washing water flowing from the first pipeline 51.

[0018] The discharge valve 75 is opened e.g. once the washing process or the rinsing process is complete. As a result of the above operation, the washing water is allowed to flow from the first pipeline 51 into the discharge control unit 7. Thereafter, the washing water through the filter portion 76 is subjected to a lint removal process, and then, discharged to the exterior of the laundry machine 1.

[0019] In response to closing of the discharge valve 75 and actuation of the circulation pump 71, the washing water in the tub 31 is allowed to flow into the discharge control unit 7 through the first pipeline 51. Thereafter, the washing water passes through the filter portion 76 disposed in the discharge control unit 7 to remove a dirt component. The washing water after passing through the filter portion 76 is allowed to flow into the circulation pump 71 through a suction pipeline 711 connected to a suction port of the circulation pump 71. Thereafter, the washing water is returned to the tub 31 through the second pipeline 52 connected to the eject port of the circulation pump 71. The aforementioned circulation process for the washing water may be repeatedly performed, as necessary, whenever the washing process or the rinsing process is executed. The repetitive circulation process of the washing water contributes to a refined washing process or rinsing process.

[0020] The rotating speed of the circulation pump 71 may be variable. If the rotating speed of the circulation pump 71 is set to a large value (e.g. 3,500 rpm), the washing water flowing through the inlet port 312 of the tub 31 is allowed to flow along a trajectory toward the interior of the rotary drum 32 (see the arrow Fi in FIG. 1). On the other hand, if the rotation speed of the circulation pump 71 is set to a small value (e.g. I,OC30 rpm), the washing water flowing through the inlet port 312 of the tub 31 is allowed to flow toward the space defined between the rotary drum 32 and the tub 31 (see the arrow Fo in FIG. 1).

[0021] The circulation pump 71 is rotated at a lower speed e.g. once at least one of the washing process and the rinsing process starts. This operation is likely to prevent detergent residue still undissolved at end of the washing process or considerably concentrated softener immediately after softener dispense from dripping onto the laundry in the rotary drum 32.

[0022] The washing water flowing into the space between the rotary drum 32 and the tub 31 is discharged to the water discharge system 5 through the discharge port 311, and is returned to the inlet port 312 of the tub 31 (in-tub circulation process). The repetitive in-tub circulation process facilitates dissolution of the detergent and/or uniform concentration of the softener. Thus, the above configuration advantageously avoids a drawback such as stains on the laundry resulting from the undissolved detergent or the considerably concentrated softener.

[0023] The in-tub circulation process may be preferably performed about 10 seconds after start of a water supply process in the washing process and/or the rinsing process. Alternatively, the in-tub circulation process may be started when it is detected that liquid level reach about 40 mm from a lower end of the tub 31. The above operation is likely to avoid operation of the circulation pump 71 in which insufficient washing water is filled. Thus, it is possible to avoid abnormal sound resulting from cavitation of the circulation pump 71, an anomaly temperature of the circulation pump 71 resulting from the insufficient amount of the washing water as well as operation of the circulation pump 71 under the anomaly temperature.

[0024] The drum laundry machine 1 may be further provided with a pump configured to supply water from a bathtub. In this case, after the pump supplies water from the bathtub, the in-tub circulation process may be executed, so that synchronizing operation of the circulation pump 71 with the pump for supplying the water from the bathtub, which may cause larger noise annoying the user, is less likely to happen.

[0025] A timer reservation may be set for the drum laundry machine 1 through the user's manipulation of the operation panel 8. In the case where the drum laundry machine 1 is operated according to the timer reservation, the in-tub circulation process may be performed for e.g. a period twice as long as that for an ordinary operation. The above operation is advantageous in sufficiently dissolving detergent which is likely to solidify during a stand-by time resulting from a timer reservation (a period from when the timer reservation is set to when the operation of the drum laundry machine 1 is actually started). This results in less amount of undissolved detergent, which in turn achieves sufficiently higher washing performance.

[0026] Optionally, the drum laundry machine 1 may be provided with a temperature sensor. The time required for the in-tub circulation process may be changed depending on temperature of the washing water measured by the temperature sensor. For instance, in the case where the temperature sensor detects that the temperature of the washing water is 5 °C, for instance, the in-tub circulation process is executed for a period twice as long as a period required in the case where the temperature of the washing water is detected to be 20 °C. As a result of the above operation, the detergent is sufficiently dissolved in a lower water temperature.

[0027] FIGS. 2A and 2B are cross-sectional views of a housing of the discharge control unit 7 shown in FIG. 1. FIG. 2A shows a cross section of one side portion of the housing. FIG. 2B shows the opposite cross section of the housing.

[0028] The discharge control unit 7 includes a housing 70 on which the circulation pump 71, the optical sensor 72, the electrode sensor 73, the discharge pipeline 74, the discharge valve 75 and the filter portion 76 shown in FIG. 1 are mounted. The housing 70 includes a straight conduit 701 extending in a horizontal direction. The straight conduit 701 includes one end to be connected to the first pipeline 51. The housing 70 further includes an accommodation conduit 702 connected to the other end of the straight conduit 701. The accommodation conduit 702 extends obliquely upward from a connecting portion with the straight conduit 701. The housing 70 further includes a filter portion 76 accommodated in the accommodation conduit 702. The filter portion 76 removes lint from the washing water. The straight conduit 701 and the accommodation conduit 702 are integrally molded into a pipeline.

[0029] The generally cylindrical straight conduit 701 includes a flat inner surface 772 extending from an appropriate position of the straight conduit 701 toward the downstream accommodation conduit 702. The flat inner surface 772 extending along a horizontal surface passing a center axis of the straight conduit 701 forms a flat strip region extending toward the accommodation conduit 702. The flat inner surface 772 through which infrared light from the optical sensor 72 is emitted and received prevents the infrared light of the optical sensor 72 from undesirable refraction.

[0030] The straight conduit 701 is formed with a pair of through-holes 773 configured to receive the electrode sensor 73. An electrode portion of the electrode sensor 73 protrudes in the interior of the straight conduit 701 to contact with the washing water filled in the straight conduit 701.

[0031] A first opening 774 to be connected to the discharge pipeline 74 and a second opening 771 to be connected to the suction port of the circulation pump 71 are defined in a lower portion of an inner space of the accommodation conduit 702. The first opening 774 and the second opening 771 are defined in a surface opposing to the through-holes 773 of the straight conduit 701. The first opening 774 serves as a connecting portion to the discharge pipeline 74 while the second opening 771 serves as a connecting portion to the circulation pump 71.

[0032] The filter portion 76 includes a meshed filter 776 and a lid 704 configured to be connected to the filter 776. The lid 704 is sealably connected to an opening in a leading end of the accommodation conduit 702. The filter 776 is configured to remove the lint. The lid 704 includes a knob 705 outwardly extending from an outer surface of the lid 704 along an axis of the accommodation conduit 702. The filter portion 76 is detachably mounted to the accommodation conduit 702. In this configuration, the user is allowed to access the knob 705 to easily detach the filter portion 76 from the accommodation conduit 702.

[0033] FIG. 3 is a plan view of the discharge control unit 7. FIG. 4 is a front view of the discharge control unit 7. FIG. 5 is a side view of the discharge control unit 7 observed from a side of the circulation pump 71. FIG. 6 is a side view of the discharge control unit 7 observed from a side of the electrode sensor 73.

[0034] FIGS. 3, 5, and 6 partially show the first pipeline 51, through which the washing water is allowed to flow from the tub 31 to the discharge control unit 7. The optical sensor 72 detects turbidity of the washing water flowed into the discharge control unit 7.

[0035] FIG. 7 shows the optical sensor 72 attached to the straight conduit 701 of the housing 70 of the discharge control unit 7. FIGS. 8A through 8E are diagrams of the optical sensor 72, wherein FIG. 8A is a vertical cross-sectional view, FIG. 8B is a front view, FIG. 8C is a right side view, FIG. 8D is a left side view, and FIG. 8E is a plan view. FIGS. 9A through 9F are diagrams of a support member provided in the optical sensor 72, wherein FIG. 9A is a vertical cross-sectional view, FIG. 9B is a front view, FIG. 9C is a right side view, FIG. 9D is a left side view, FIG. 9E is a plan view, and FIG. 9F is a bottom plan view.

[0036] The optical sensor 72 includes a light emitter 721 configured to emit the infrared light and a light receiver 722 configured to receive the infrared light emitted from the light emitter 721. The light emitter 721 and the light receiver 722 disposed on the exterior of the straight conduit 701 oppose to each other so that an optical path of the infrared light is defined between the light emitter 721 and the light receiver 722. The straight conduit 701 is made of a transparent material with respect to the infrared light. The infrared light from the light emitter 721 is transmitted through the washing water filled in a space enclosed by a pipe wall portion of the straight conduit 701. If the turbidity of the washing water is large, an amount of the infrared light received by the light receiver 722 goes down while if the turbidity of the washing water is small, the amount of the infrared light received by the light receiver 722 goes up. Thus, the optical sensor 72 functions as a turbidity sensor configured to detect the turbidity of the washing water.

[0037] The optical sensor 72 is further provided with a support member 723 configured to hold the light emitter 721 and the light receiver 722. The support member 723 with a generally U-shaped cross section includes a first support 724 configured to support the light emitter 721, a second support 725 configured to support the light receiver 722, and a bridge 726 configured to bridge a gap between the first support 724 and the second support 725. The bridge 726 holds the light emitter 721 and the light receiver 722 so that the light emitter 721 and the light receiver 722 oppose to each other. The bridge 726 above the straight conduit 701 orthogonally extends with respect to the axis of the straight conduit 701.

[0038] A circuit board 727 configured to cause the light emitter 721 to emit the infrared light is disposed in the first support 724, in addition to the light emitter 721. A circuit board 728 configured to generate a voltage signal in accordance with the amount of the infrared light received by the light receiver 722 is disposed in the second support 725, in addition to the light receiver 722. Further, the optical sensor 72 includes an electric wire 829 for electric power supply to the circuit boards 727 and 728. The longitudinal axes of the thin placoid circuit boards 727 and 728 (see FIGS. 7 and 8) vertically extend.

[0039] The first support 724 includes an inner side surface 241 facing the second support 725. The inner side surface 241 includes a lens 211 of the light emitter 721.

The infrared light emitted from the light emitter 721 is directed to the second support 725 through the lens 211, which is slightly bulged with respect to the other portion of the inner side surface 241. A first rib 242 formed along a vertical edge of the inner side surface 241 inwardly protrudes from the inner side surface 241 (in a direction toward the center axis of the straight conduit 701).

[0040] The second support 725 includes an inner side surface 251 facing the first support 724. The inner side surface 251 includes a lens 221 of the light receiver 722. The infrared light emitted from the light emitter 721 is received by the light receiver 722 through the lens 221, which is slightly bulged with respect to the other portion of the inner side surface 251. A second rib 252 formed along a vertical edge of the inner side surface 251 inwardly protrudes from the inner side surface 251 (in a direction toward the center axis of the straight conduit 701).

[0041] The pipe wall portion of the straight conduit 701 includes not only the flat inner surface 772 but also a flat outer surface. Therefore the infrared light emitted from the light emitter 721 is less likely to be refracted on both wall surfaces of the straight conduit 701. The support member 723 is mounted on the straight conduit 701 from above. The light emitter 721 emits the infrared light from the exterior of the straight conduit 701. The light receiver 722 receives the infrared light at the exterior of the straight conduit 701. When the support member 723 is mounted on the straight conduit 701, the first rib 242 of the first support 724 and the second rib 252 of the second support 725 are abutted against the flat outer surface of the straight conduit 701. The first rib 242 and the second rib 252 keep the inner side surface 241 of the first support 724 and the inner side surface 251 of the second support 725 away from the flat outer surface of the straight conduit 741. This configuration reduces damage of the lens 211, the lens 221 and the straight conduit 701 resulting from mounting of the support member 723 on the straight conduit 701. Accordingly, larger pressing forces (fitting forces) between the first rib 242/the second rib 252 and the outer surface of the straight conduit 701 may be acceptable. Thus, the support member 723 is rigidly attached to the straight conduit 701.

[0042] A vertically extending annular accommodation wall 261 is formed at a central portion of the bridge 726 of the support member 723. The annular accommodation wall 261 defines a columnar accommodation space 263 in cooperation with a receiving plate 262 which also forms an upper surface of the bridge 726. A through-hole 264 is formed in the receiving plate 262. The through-hole 264 is communicated with the accommodation space 263. The straight conduit 701 includes an upwardly extending columnar protrusion 265. When the support member 723 is mounted on the straight conduit 701, the protrusion 265 is received in the accommodation space 263, so that an upper surface of the protrusion 265 is abutted against a lower surface of the receiving plate 262. The protrusion 265 is formed with a downwardly extending threaded hole. A screw received in the through-hole 264 of the receiving plate 262 is engaged with the threaded hole of the protrusion 265. Thus, the support member 723 is tightly fixed to the straight conduit 701. The receiving plate 262 extending above the light emitter 721 and the light receiver 722 receives falling objects such as dust and water droplets, which may fall onto the straight conduit 701 attached with the support member 723.

[0043] Now, FIGS. 2 through 6 are referred to again. The discharge valve 75 disposed at a slightly downstream position with respect to the optical sensor 72 is connected to the housing 70 of the discharge control unit 7 via the discharge pipeline 74. When the discharge valve 75 is opened, the washing water filled in the straight conduit 701 and the accommodation conduit 702 is discharged to the exterior of the laundry machine 1 through the discharge pipeline 74. The connecting position between the discharge pipeline 74 and the housing 70 may be set to a position near a base end of the accommodation conduit 702. In this configuration, in response to opening the discharge valve 75, a flow of the washing water in a direction opposite to the direction while the circulation pump 71 operates is generated in the accommodation conduit 702 and the vicinity of a connecting portion between the accommodation conduit 702 and the straight conduit 701.

[0044] The electrode sensor 73 is disposed at a slightly downstream position with respect to a connecting position between the discharge pipeline 74 and the accommodation conduit 702. The electrode sensor 73 is disposed at a downstream side with respect to the optical sensor 72. The optical sensor 72 functions as a turbidity sensor configured to detect the turbidity of the washing water. The electrode sensor 73 functions as a conductivity sensor configured to detect conductivity of the washing water.

[0045] The electrode sensor 73 includes a pair of terminal plates 731 and 732. The terminal plate 732 is disposed at a downstream position of the terminal plate 731. An electric wire 733 is connected to both of the terminal plates 731 and 732. A high frequency alternating voltage is applied to the terminal plates 731 and 732. The frequency and the amplitude of the voltage to be applied to the terminal plates 731 and 732 are not specifically limited, as far as the conductivity of the washing water can be measured.

[0046] FIGS. 10A and 10B are schematic diagrams of the terminal plate 731. FIG. 10A is a side view of the terminal plate 731. FIG. 10B is a front view of the terminal plate 731. FIGS. 3 and 6 are referred to along with FIG. 10. The downstream terminal plate 732 described referring to FIGS. 2 through 6 may have the same shape and size as the terminal plate 731.

[0047] The terminal plate 731 constituted of one metal plate has a bent structure. Specifically, edges 735 and 736 of the terminal plate 731 are bent in the same direction along a vertical bending line 734. Accordingly, the terminal plate 731 becomes highly rigid with respect to a bending moment about an axis across the bending line 734. A connecting portion 737 to the electric wire 733 is formed on an upper portion of the terminal plate 731.

[0048] A thicker disk portion 738 and a columnar electrode portion 739 are formed on a surface of the terminal plate 731 opposite to the bending direction of the edges 735 and 736 of the terminal plate 731. The terminal plate 731 is connected to a base end of the electrode portion 739 via the thicker portion 738. An O-ring 371 is fitted on the base end of the electrode portion 739. The electrode portion 739 is received in each of the through-holes 773 (see FIG. 2A) defined in the straight conduit 701 of the housing 70 of the discharge control unit 7.

[0049] A pair of through-holes 310 is formed in the terminal plate 731. One of the through-holes 310 is formed at an upper position than the electrode portion 739. The other of the through-holes 310 is formed at a lower position than the electrode portion 739. The paired through-holes 310 and the electrode portion 739 are vertically aligned. The bending line 734 extends in parallel to a line connecting the center points of the paired through-holes 310. A fixing member such as a bolt is received in each of the through-holes 310. Thus, the through-holes 310 function as a fixing portion configured to attach the terminal plate 731 to the outer surface of the straight conduit 701.

[0050] Pressing contact of the terminal plate 731 by using the fixing member against the outer surface of the straight conduit 701 compresses the O-ring 371 mounted on the base end of the electrode portion 739. Resilience of the O-ring 371 and the fixing member received in each of the through-holes 310 generate a bending moment on the terminal plate 731. Bending the left and right edges of the terminal plate 731 along the bending line extending in the alignment direction of the paired through-holes 310 provides the terminal plate 731 with high rigidity against the bending moment. Accordingly, the terminal plate 731 is tightly attached to the outer surface of the straight conduit 701. In this configuration, the O-ring 371 at the base end of the electrode portion 739 is compressed by a stronger force to thereby perform sufficient sealing. Thus, the above configuration is advantageous in less leakage of the washing water through the through-holes 773 defined in the straight conduit 701. In this embodiment, the bending line 734 intersects perpendicularly to the axis of the bending moment. However, the intersecting angle between the bending line 734 and the axis of the bending moment is not specifically limited to the above. Further, in this embodiment, the through-holes 310 are exemplified as a fixing portion. Alternatively, for instance, a fixing approach of pressingly contacting the terminal plate 731 against the outer wall of the straight conduit 701 by a clamp or other fixing method capable of pressingly contacting the terminal plate 731 against the outer wall of the straight conduit 701 with a force sufficient for causing the O-ring to exhibit a sealing performance may be used. In the case where a clamp is used, portions of the terminal plate 731 to be gripped by the clamp function as a fixing portion.

[0051] FIGS. 11A and 11B are cross-sectional views of the straight conduit 701 attached with the terminal plates 731 and 732. FIG. 11A is a cross-sectional view in a vicinity of the upstream terminal plate 731 and the corresponding electrode portion 739. FIG. 11B is a cross-sectional view of a vicinity of the downstream terminal plate 731 and the corresponding electrode portion 739.

[0052] The electrode portion 739 protruding in the interior of the straight conduit 701 across the flat inner surface 772 of the straight conduit 701 is contacted with the washing water filled in the straight conduit 701. The high frequency alternating voltage to measure conductivity (impedance) of the washing water flowing between the paired electrode portions 739 is applied to the terminal plates 731 and 732 through the electric wire 733.

[0053] FIG. 12 is a diagram schematically showing a flow of the washing water in the vicinity of the electrode portions 739. In FIG. 12, the upstream electrode portion is indicated with the reference numeral "739a" and the downstream electrode portion is indicated with the reference numeral "739b".

[0054] As shown in FIG. 12, the paired electrode portions 739a and 739b are arranged side by side in a longitudinal direction of the straight conduit 701. A flat plane P defined between the axes of the paired electrode portions 739a and 739b is substantially in parallel to the axis of the straight conduit 701. The upstream electrode portion 739a separates the washing water flowing along the axis of the straight conduit 701 into an upper flow and a lower flow. As a result of the above operation, the flow rate of the washing water across the flat plane P is reduced. As a result of the above operation, a space between the electrode portions 739a and 739b is suitably defined for measuring the conductivity of the washing water (e.g. the space may be set to not smaller than 15 mm but not larger than 30 mm) so that fluidity of the washing water is reduced in the space. Thus, suitable fluidity of the washing water for measuring conductivity is obtained.

[0055] Further, as shown in FIG. 12, the flat plane P including the axes of the paired electrode portions 739a and 739b defines a horizontal plane. Preferably, both of the paired electrode portions 739a and 739b do not intersect with an upper portion of the inner space of the straight conduit 701, where the air is likely to stagnate according to a design of the discharge control unit 7 (e.g. a region corresponding to an upper one-fifth of the inner space of the straight conduit 701), and a lower portion of the inner space of the straight conduit 701, where a dirt component is likely to deposit according to the design of the discharge control unit 7 (e.g. a region corresponding to a lower one-fifth of the inner space of the straight conduit 701). In this configuration, an entire protruded surface of the electrode portions 739a and 739b is contacted with the washing water in the straight conduit 701. Accordingly, the air is less likely to affect the conductivity measurement. Further, in the case where the electrode portions 739a and 739b protrude in a region corresponding to upper four-fifths of the inner space of the straight conduit 701, a dirt component deposited in the straight conduit 701 is less likely to affect the conductivity measurement.

[0056] FIG. 13 is a diagram schematically showing a flow of the washing water in the vicinity of the optical sensor 72 and the electrode sensor 73. FIG. 13 shows the optical path 250 of the infrared light between the light emitter 721 and the light receiver 722 of the optical sensor 72 described referring to FIGS. 7 through 9F. Similarly to FIG. 12, the upstream electrode portion is indicated with the reference numeral "739a" and the downstream electrode portion is indicated with the reference numeral "739b".

[0057] The flat inner surface 772 formed in the inner wall surface of the straight conduit 701 to prevent undesirable refraction of the infrared light along the optical path 250 includes an upstream end 277 bulging from the other inner wall surface. Accordingly, the upstream end 277 may disturb the flow of the washing water. In view of the above, it is preferable to form the upstream end 277 at a sufficiently upstream position away from the optical path 250 in order to regulate the flow of the washing water before the flow reaches the optical path 250. In this configuration, the flow of the washing water across the optical path 250 may be suitable for measuring turbidity of the washing water based on the amount of the infrared light received by the light receiver 722 of the optical sensor 72 as described in the context of FIGS. 7 through 9F. The infrared light of the optical sensor 72 is less likely to affect the fluidity of the washing water. Accordingly, the regulated washing water reaches the electrode portions 739a and 739b.

[0058] As described referring to FIG. 12, a part of the flow in parallel to the axis direction of the straight conduit 701 is separated into the upper flow and the lower flow by the upstream electrode portion 739a. As a result of the above operation, the flow of the washing water may be disturbed. The turbulent flow of the washing water due to the electrode portion 739 is less likely to affect the turbidity measurement by the optical sensor 72 because the turbulent flow is generated after the optical sensor 72.

[0059] As described referring to FIG. 12, the flat plane P defined by the axes of the electrode portions 739a and 739b is substantially in parallel to the axis of the straight conduit 701. Accordingly, in the case where the washing water flows in the opposite direction (in a direction from the straight conduit 701 toward the discharge port 311 (see FIG. 1) of the tub 31) within the straight conduit 701, the electrode portion 739b, which separates the flow of the washing water into an upper flow and a lower flow, overlapping with the electrode portion 739a in the flow direction of the washing direction is less likely to be excessively disturb the flow of the washing water. Accordingly, even if the washing water reversely flows, the turbidity of the washing water passing the optical axis 250 is very accurately detected.

[0060] The cross section of the straight conduit 701 has a concave contour around an upper edge 391 defining an upper border of the flat inner surface 772 and a lower edge 392 defining a lower border of the flat inner surface 772 (see FIG. 7). The flow of the washing water is likely to stagnate in the concave portion of the straight conduit 701 in cross section, as compared with the other portion. As shown in FIG. 13, the cross sections of the electrode portions 739a and 739b are partially embedded in the flat inner surface 772. This configuration is advantageous in obtaining a less fluid flow, which is suitable for measuring the conductivity of the washing water because the washing water is specifically likely to stagnate in the vicinity of the upper edge 391 sandwiched between the electrode portions 739a and 739b. Further, the conductivity is also accurately measured because the flat plane P defined between the electrode portions 739a and 739b is substantially in parallel to the upper edge 391.

[0061] FIGS. 1 through 5 are referred to again. The circulation pump 71 is disposed at a downstream position of the electrode sensor 73. The suction pipeline 711 including one end connected to the suction port of the circulation pump 71 and the other end connected to the second opening 771 defined in the housing 70 of the discharge control unit 7 is disposed between the circulation pump 71 and the housing 70 of the discharge control unit 7. The second pipeline 52 extending from the eject port of the circulation pump 71 is connected to the inlet port 312 formed in the tub 31.

[0062] FIG. 14 is a plan view schematically showing a flow of the washing water from the electrode sensor 73 to the circulation pump 71. FIGS. 1 and 2 are referred to along with FIG. 14. In FIG. 14, the suction pipeline 711 is shown. As shown in FIG. 14, the electrode sensor 73 is disposed at an upstream position of the connecting portion 771 (indicated as the second opening 771 in FIG. 2B) between the suction pipeline 711 and the discharge control unit 7. Similarly to FIG. 12, the upstream electrode portion is indicated with the reference numeral "739a" and the downstream electrode portion is indicated with the reference numeral "739b".

[0063] The straight conduit 701 and the accommodation conduit 702 constituting the housing 70 of the discharge control unit 7 form a straight flow path in plan view (in FIG. 14, a border between the straight conduit 701 and the accommodation conduit 702 is shown by the dotted line). The suction pipeline 711 is connected to the straight flow path defined by the straight conduit 701 and the accommodation conduit 702. The suction pipeline 711 extends in a direction different from the extending direction of the straight flow path defined by the straight conduit 701 and the accommodation conduit 702 (an orthogonal direction in the structure of the discharge control unit 7 shown in FIG. 14). The flow direction of the washing water flowing along the straight flow path is changed by a suction force from the circulation pump 71 toward the suction pipeline 711. The electrode sensor 73 protrudes from the inner surface of the straight conduit 701 on the side opposing to the connecting portion 771. The "inner surface on the side opposing to the connecting portion 771" corresponds to an inner surface at a position away from the connecting portion 771, in the case where the straight conduit 701 and the accommodation conduit 702 are vertically divided along a longitudinal axis of the straight conduit 701 and the accommodation conduit 702. The "inner surface on the side opposing to the connecting portion 771" further corresponds to an inner surface area of the accommodation conduit 702 and/or the straight conduit 701 located upstream and/or downstream with respect to the axis of the suction pipeline 711 by a length equal to e.g. three times to four times of the inner diameter of the suction pipeline 711. More preferably, the "inner surface" means an inner surface area of the accommodation conduit 702 and/or the straight conduit 701 located upstream and/or downstream with respect to the axis of the suction pipeline 711 by a length equal to 3.5 times of the inner diameter of the suction pipeline 711. Furthermore preferably, the "inner surface" means an inner surface area of the accommodation conduit 702 and/or the straight conduit 701 located upstream and/or downstream with respect to the axis of the suction pipeline 711 by a length equal to three times of the inner diameter of the suction pipeline 711. The electrode portions 739a and 739b of the electrode sensor 73 protrude from such inner surface area.

[0064] FIG. 14 shows a given point P1 on a cross section C across a pipeline near the electrode sensor 73. The point P1 is a point at a position away from the connecting portion 771 (in other words, the vicinity of a plane opposing to the connecting portion 771). A flow force V1 of the washing water directed from the base ends of the electrode portions 739a and 739b toward the lead ends thereof is acted on the point P1. Accordingly, disposing the electrode sensor 73 at a position opposing to the connecting portion 771 facilitates removal of the lint adhered to the electrode sensor 73.

[0065] As described above, the electrode portions 739a and 739b form protrusions inside the straight conduit 701. Accordingly, the lint contained in the washing water flowing into the discharge control unit 7 is likely to adhere to the electrode portions 739a and 739b. However, the lint adhered to the electrode portions 739a and 739b is relatively easily removed from the electrode portions 739a and 739b by the flow force V1. As shown in FIGS. 2A and 2B, a part of the filter portion 76 (see FIG. 1) accommodated in the accommodation conduit 702 is disposed between the electrode sensor 73 and the connecting portion 771. In FIG. 14, the filter portion 76 is schematically illustrated as a mesh area. After passing the electrode sensor 73 disposed at an upstream position of the filter portion 76, the washing water passes the filter portion 76 disposed in the accommodation conduit 702 before reaching the suction pipeline 711 disposed at a downstream position of the filter portion 76. Accordingly, the lint is trapped by the filter portion 76 after the removal from the electrode portions 739a and 739b. Further, the flow of the washing water around the electrode portions is rapidly reduced immediately after the circulation pump 71 is stopped because the filter portion 76 functions as a resisting element against the flow of the washing water.

[0066] FIGS. 15A and 15B are diagrams for describing the lint removal by the circulation pump 71 and the discharge valve 75. FIG. 15A is a plan view schematically showing a flow of the washing water from the electrode sensor 73 to the circulation pump 71. FIG. 15B is a plan view schematically showing a flow of the washing water from the electrode sensor 73 to the discharge valve 75. FIG. 1 is referred to along with FIGS. 15A and 15B. The suction pipeline 711 defining a flow path to the circulation pump 71 and the discharge pipeline 74 defining a flow path to the discharge valve 75 are shown in FIGS. 15A and 15B. Similarly to FIG. 12, the upstream electrode portion is indicated with the reference numeral "739a" and the downstream electrode portion is indicated with the reference numeral "739b". FIG. 15A showing substantially the same diagram shown in FIG. 14 is provided for comparison with FIG. 15B showing a flow state of the washing water.

[0067] As shown in FIG. 15A, preferably, the electrode 73 may be disposed at a downstream position of the connecting portion 774 (the first opening 774) of the discharge pipeline 74, and disposed at an upstream position of the connecting portion 771 (the second opening 771) of the suction pipeline 711. In response to opening of the discharge valve 75, as shown in FIG. 15B, the washing water flows in the direction opposite to the flow direction during operation of the circulation pump 71 in a pipeline portion where the electrode portions 739a and 739b under the above-described arrangement protrude. Thus, the lint adhered to the electrode portions 739a and 739b is easily removed from the electrode portions 739a and 739b.

[0068] FIGS. 16A through 16C are diagrams showing the circulation pump 71. FIG. 16A is a cross-sectional view of the circulation pump 71. FIG. 16B is a plan view of the circulation pump 71. FIG. 16C is a diagram of the circulation pump 71 from the suction port.

[0069] The circulation pump 71 includes a pump casing 713 forming an outer wall of the circulation pump 71. A bearing partition 714 inside the pump casing 713 divides an inner space of the pump casing 713 into two sub spaces. An impeller 717 is disposed in the sub space communicating with a suction port 715. A motor 718 is disposed in the sub space adjacent to the sub space where the impeller 717 is disposed. A preferred example of the motor 718 is a DC brushless motor. A shaft 719 of the motor 718 across the bearing partition 714 extends into the sub space where the impeller 717 is disposed. The impeller 717 integrally formed with the bearing partition 714 is supported by the shaft 719. The impeller 717 driven by the motor 718 rotates with the bearing partition 714.

[0070] The suction port 715 to be connected to the suction pipeline 711 and the eject port 716 to be connected to the second pipeline 52 are formed in the pump casing 713. The suction port 715 and the eject port 716 communicate with the sub space where the impeller 717 is disposed.

[0071] An attachment seat 131 radially protrudes from an outer surface of the pump casing 713. The attachment seat 131 of the circulation pump 71 shown in FIGS. 16B and 16C includes three C-shaped attachment pieces 132 protruding largely outward. The attachment pieces 132 are fixedly attached to bosses of the base plate 712 (see FIG. 1) by using bolts.

[0072] FIGS. 17A through 17C are diagrams showing a structure of a connecting portion between the tub 31 and the second pipeline 52. FIG. 17A is a plan view of a duct constituting the connecting portion. FIG. 17B is a transverse cross-sectional view of the duct shown in FIG. 17A. FIG. 17C is a vertical cross-sectional view of the duct shown in FIG. 17A.

[0073] The inlet port 312 of the tub 31 is formed by an annular rib 121 protruding upwardly from an outer wall of the tub 31. An O-ring 122 is disposed along an inner surface of the annular rib 121. The O-ring 122 is pressed by a duct 520.

[0074] The duct 520 has a main body 521 bent into an L-shape. The main body 521 includes a duct pipe 522 connected to the second pipeline 52, and a lower half pipeline 523 extending from the duct pipe 522 toward the inlet port 312. A lead end of the lower half pipeline 523 includes an annular protrusion 525 forming a complementary outer perimeter with the opening of the inlet port 312. A narrowing wall 123 is disposed inside the annular protrusion 525. A cross section of the narrowing wall 123 downwardly curves into an arc shape from a substantially center position of the inner space of the annular protrusion 525 and then directs to a rotational axis of the rotary drum 32. Both ends of the narrowing wall 123 are connected to an inner wall surface of the annular protrusion 525. The O-ring 122 compressed between the annular projection 525 and the annular rib 121 functions as a seal member.

[0075] The lower half pipeline 523 of the duct 520 in proximity to the annular rib 121 is fixedly attached to a thicker portion 124 formed on a wall of the tub 31 by using a fixing member 125 (in FIG. 17B, a screw is shown as the fixing member 125).

[0076] The duct 520 further includes a cover 524 configured to form, by cooperation with the lower half pipeline 523, a flow path which is bent from a flow path defined by the duct pipe 522 toward the inlet port 312. Actuation of the circulation pump 71 allows the washing water to flow from the second pipeline 52 into the inlet port 312 through the duct 520. The circulation pump 71 is rotated at a rotation speed of e.g. 3,500 rpm.

[0077] The rotary drum 32 is disposed inside the tub 31. A blocking wall 126 between an upper surface of the rotary drum 32 and the inlet port 312 is supported by a connection wall 127 connected to the outer wall of the tub 31. The blocking wall 126 forms a narrow flow path together with the narrowing wall 123. The narrow flow path functions as an injection port 129 through which the washing water is injected into the laundry sink 3.

[0078] After passing through the injection port 129 defined by the blocking wall 126 and the narrowing wall 123, the washing water passes through a flow path 281 defined by a front end wall 128 constituting a part of the outer surface of the tub 31 and a front end wall 321 of the rotary drum 32, to be supplied into the rotary drum 32. The front end wall 128 presses the O-ring 122 by cooperation with the narrowing wall 123.

[0079] The injection port 129 is defined independently of the rotary drum 32. The laundry in the rotary drum 32 is not contacted with the injection port 129. Accordingly, the injection port 129 does not significantly affect a washing process, a rinsing process or a drying process. The injection port 129 is less likely to impair the appearance of the finished laundry, so that the clothes for laundry may be less likely to be damaged or torn. Further, the flow path defined after the injection port 129 by the front end wall 128 of the tub 31 and the front end wall 321 of the rotary drum 32 requires no additional structure for preventing water leakage. In the structure shown in FIGS. 17A through 17C, only the O-ring 122 is used as a seal member.

[0080] The front end wall 128 of the tub 31 and the front end wall 321 of the rotary drum 32 form an annular exit port 282. The washing water passing through the flow path 281 flows through the annular exit port 282 to be injected toward the rotational center axis of the rotary drum 32. The washing water through the exit port 282 is efficiently injected over an inner rotary region of the rotary drum 32. Thus, the washing water is efficiently supplied to the laundry independently from a volume of the laundry in the rotary drum 32.

[0081] A back surface of the front end wall 128 of the tub 31 (a surface defining the flow path 281) includes an inclined surface 283 and a curved surface 284. The inclined surface 283 configured to gradually reduce a cross sectional area of the flow path 281 in a downstream direction gradually increases a flow velocity of the washing water passing through the flow path 281. Accordingly, the washing water passing through the flow path 281 is accelerated and directed toward the curved surface 284. The curved surface 284 changes the flow direction of the washing water toward the bottom portion of the rotary drum 32. Accordingly, the washing water injected through the exit port 282 is directed toward the bottom portion of the rotary drum 32. As a result of the above operation, the washing water is efficiently supplied to the laundry.

[0082] The injection port 129 is circumferentially opened in a given range of the laundry sink 3. The connection wall 127 and the blocking wall 126 cause the injection port 129 to open toward the rotational center axis of the rotary drum 32. The connection wall 127 and the blocking wall 126 guide the washing water flowing through the inlet port 312 to the flow path 281 with no or less disturbance. The washing water circumferentially spreads until the washing water reaches the injection port 129 to be allowed to stably flow through the flow path 281. Thereafter, the washing water is allowed to flow to the annular exit port 282 with circumferentially spreading. Accordingly, the washing water is injected from the entire exit port 282 to be stably supplied to the laundry independently from the volume of the laundry placed in the rotary drum 32.

[0083] The cover 524 of the duct 520 defines a flow path directed to the inlet port 312 with a simplified attachment structure. A proper flow of the washing water into the rotary drum 32 is obtained by the properly shaped and sized cover 524 configured to cover the inlet port 312, the properly shaped and sized connection wall 127, and the properly shaped and sized blocking wall 126. The proper design parameters for the cover 524, the connection wall 126 and the blocking wall 126 may determine a proper width, thickness and velocity of the flow of the washing water to be injected through the injection port 129 so that the washing water is efficiently supplied to the laundry, independently from the volume of the laundry placed in the rotary drum 32.

[0084] The attachment structure for the cover 524 of the duct 520 as well as the simplified structures for the connection wall 127 and the blocking wall 126 shown in FIGS. 17A through 17C contribute to reduction in water leakage and production cost.

[0085] As described above, the duct 520 defines a flow path directed to the inlet port 312 by the lower half pipeline 523 and the cover 524. As shown in FIG. 1, the flow path defined by the duct 520 extends along the outer surface of the tub 31. Accordingly, a flat pipeline with a rectangular cross section defined by the lower half pipeline 523 and the cover 524 is formed in a small clearance between the tub 31 and the housing 2. The flat pipeline defines a flow of the washing water with a suitable flow width and thickness for the shape and the size of the injection port 129. The flow of the washing water passing through the flat pipeline is regulated and directed to the injection port 129.

[0086] A plurality of ribs 322 are formed on the front end wall 321 of the rotary drum 32. The ribs 322 circumferentially extend on the front end wall 321 of the rotary drum 32 by a given length. The circumferential and/or radial positions of the ribs 322 may be different from each other. The ribs 322 locally reduce the cross-section area of the flow path 281 defined after the injection port 129. Flow trajectories of the washing water to be injected through the exit port 282 are different from each other between a case that the cross-sectional area of the flow path is narrowed by the ribs 322 at a position near the exit port 282 and a case that the cross-sectional area of the flow path is narrowed by the ribs 322 at a position away from the exit port 282. In this configuration, the washing water to be discharged through the exit port 282 is sprinkled in a wider range within the rotary drum 32 to thereby be highly efficiently supplied to the laundry.

[0087] The shape of the ribs 322 is not limited to the one shown in FIGS. 17A through 17C. For instance, the ribs 322 may be shaped into a wave or wing form. Any shape of the ribs 322 configured to vary the flow trajectory of the washing water to be discharged through the exit port 282 may be adopted. Further alternatively, any shape of the ribs 322 configured to vary the flow trajectory of the washing water to be discharged through the exit port 282 may be disposed at any position.

[0088] A clearance 266 is defined between the blocking wall 126 and the rotary drum 32. When the circulation pump 71 is operated at a lower speed (e.g. 1,000 rpm), the washing water is allowed to flow into the clearance 266 through the injection port 129. The washing water flowing into the clearance 266 is directed to the discharge port 311 of the tub 31 through the space between the rotary drum 32 and the tub 31.

[0089] FIG. 18 exemplifies a functional configuration of the control circuit section 81.

[0090] The control circuit section 81 includes a computing section 813, a determining section 814, and a signal transmitting section 815. The computing section 813 identifies e.g. a type or concentration of detergent and an amount of a dirt component based on signals from the optical sensor 72 and the electrode sensor 73.

[0091] The determining section 814 determines whether or not a given control is to be executed, based on a calculation result by the computing section 813. For instance, if the amount of the dirt component calculated by the computing section 813 exceeds a given threshold value, the determining section 814 transmits a signal for operating the water supply system 4 and/or the water discharge system 5 to the signal transmitting section 815.

[0092] The signal transmitting section 815, upon receiving a command from the determining section 814, transmits a signal for operating the water supply system 4 and/or the water discharge system 5. For instance, the signal transmitting section 815 transmits a signal to open the electromagnetic valve in the water supply system 4 or a signal to open the discharge valve 75 in the water discharge system 5.

[0093] FIG. 1 is referred to along with FIG. 18. A period for measuring a condition of the washing water during the washing process and/or the rinsing process is set. During the period, a signal (a stop signal) for stopping an operation of the circulation pump 71 is transmitted from the control circuit section 81 to the circulation pump 71. In response to stopping the circulation pump 71, the flow of the washing water in the discharge control unit 7 is stopped. As a result of the above operation, a condition suitable for measurement by the optical sensor 72 and/or the electrode sensor 73 is obtained. However, there is a case that a flow of the washing water within the discharge control unit 7 is continued for a certain period due to an inertia moment of the circulation pump 71 or an inertia flow of the washing water itself, even after the stop signal is transmitted. In this embodiment, an undesirable flow of the washing water after the transmission of the stop signal is earlier suppressed because the filter portion 76 is disposed near the optical sensor 72 and the electrode sensor 73. Accordingly, turbidity and conductivity of the washing water are highly accurately measured within a shorter period. In this embodiment, the filter portion 76 is disposed at a downstream side of the optical sensor 72 and the electrode sensor 73 and at an upstream side of the second opening 771 (the connecting portion 771) to be used in connection with the suction pipeline 711 shown in FIG. 2B. Accordingly, an adverse effect by e.g. an inertia moment or a vibration of the circulation pump 71 is advantageously suppressed by the filter portion 76. Thus, it is possible to advantageously measure very accurate turbidity and conductivity of the washing water.

[0094] In the foregoing description, the electrode sensor 73 configured to measure the conductivity is exemplified as a sensor protruding in a flow path. The above principle is not limited to the above, but may be applied to a laundry machine incorporated with any sensor requiring a direct contact with the washing water to detect a physical property of the washing water.

[0095] In the foregoing description, the optical sensor 72 is used to measure turbidity of the washing water. Alternatively, the optical sensor 72 may be used for the other measurement. The above principle may be applied to the optical sensor 72 to be used in detecting deposition of a dirt component, or may be advantageously applied to detection of other physical properties or an environmental change to be measured by the optical sensor 72.

[0096] In the foregoing description, a pump is exemplified as a feeder configured to feed the washing water. Alternatively, the washing water may be allowed to flow by using a screw or a like member disposed in a circulation path or a flow path.

[0097] The above embodiment mainly includes a laundry machine with the following configurations.

[0098] A laundry machine according to an aspect of the invention includes a laundry sink provided with a discharge port through which washing water is discharged; a pipeline connected to the discharge port; a suction pipeline connected to the pipeline so as to extend in a direction different from an extending direction of the pipeline; a feeder configured to feed the washing water from the discharge port to the suction pipeline; and a sensor configured to detect a physical property of the washing water, wherein the sensor protrudes from an inner surface of the pipeline opposite a connecting portion between the suction pipeline and the pipeline.

[0099] According to the above configuration, the washing water is allowed to flow from the discharge port of the laundry sink toward the suction pipeline by actuation of the feeder. Since the suction pipeline extends in a direction different from the extending direction of the pipeline connected to the discharge port, a flow force of the washing water directed from the pipeline toward the suction pipeline is generated near the connecting portion between the pipeline and the suction pipeline. The sensor is disposed at a position opposing to the connecting portion between the pipeline and the suction pipeline. Accordingly, the flow force for sucking the washing water in the direction toward the connecting portion is acted on the washing water near the sensor. The flow force of the washing water has a function of removing lint adhered to the surface of the sensor. Accordingly, it is possible to easily remove the lint from the sensor disposed at the position opposing to the connecting portion between the pipeline and the suction pipeline.

[0100] In the above configuration, preferably, the sensor includes a conductivity sensor configured to measure conductivity of the washing water.

[0101] According to the above configuration, a type or concentration of detergent contained in the washing water are detected by the sensor configured to measure the conductivity of the washing water. Further, as described above, since the removal of the lint from the sensor is facilitated, the lint is less likely to affect the conductivity measurement. Furthermore, as the lint removal is facilitated, it is possible to highly accurately measure the conductivity by utilizing an electrode portion configured to largely protrude into the flow of the washing water.

[0102] In the above configuration, preferably, the sensor is disposed at such a position that the sensor is subjected to a flow of the washing water in a first flow direction directed from the discharge port toward the suction pipeline and a flow of the washing water in a second flow direction opposite to the first flow direction.

[0103] According to the above configuration, the lint adhered to the sensor, which is hardly removed by the washing water in the first flow direction, is easily removed by the washing water in the second flow direction.

[0104] In the above configuration, preferably, the laundry machine may further include a discharge pipeline connected to the pipeline to discharge the washing water to an exterior, wherein the discharge pipeline is formed at an upstream side of the connecting portion of the suction pipeline in the first flow direction, and the sensor is disposed at an upstream side of the connecting portion in the first flow direction and at a downstream side of a connecting portion between the pipeline and the water discharge pipeline in the first flow direction.

[0105] According to the above configuration, the washing water around the sensor, which is discharged from the discharge pipeline toward the exterior, flows in the second flow direction opposite to the first flow direction in which the washing water is allowed to flow during activation of the feeder. Accordingly, it is possible to easily remove the lint adhered to the sensor when the washing water is discharged through the discharge pipeline.

[0106] In the above configuration, preferably, the laundry machine may further include a filter portion configured to remove a dirt component contained in the washing water, wherein the filter portion is disposed near the sensor.

[0107] In the above configuration, the lint detached from the protrusion is collected by the filter portion. Since the filter portion acts as a resisting element against the flow of the washing water through the pipeline, the flow rate of the washing water is reduced within a shorter time after the feeder is stopped. Accordingly, even in a condition that the physical property measurement for the washing water by the sensor is likely to be affected by the flow of the washing water, it is possible to highly accurately measure the physical property of the washing water within a shorter time.

[0108] In the above configuration, preferably, at least a part of the filter portion is placed between the sensor and the connecting portion of the suction pipeline.

[0109] According to the above configuration, the filter portion acts as a resisting element against the flow of the washing water at the connecting portion between the sensor and the suction pipeline. Accordingly, an influence from the feeder, which is transmitted through the washing water, becomes moderate. Thus, even in a condition that the physical property measurement for the washing water by the sensor is likely to be affected by the flow of the washing water, it is possible to highly accurately measure the physical property of the washing water.

[0110] In the above configuration, preferably, the pipeline includes a straight conduit where the sensor protrudes, and an accommodation conduit connected to the straight conduit and the suction pipeline and configured to accommodate the filter portion, and the accommodation conduit is upwardly inclined with respect to the straight conduit.

[0111] According to the above configuration, air bubbles flowing into the straight conduit are forced to flow back into the accommodation conduit, and are less likely to return from the accommodation conduit. Accordingly, the air bubbles are less likely to stagnate in the straight conduit, and even in a condition that the physical property measurement for the washing water by the sensor is likely to be affected by the air bubbles in the pipeline, it is possible to highly accurately measure the conductivity of the washing water within a shorter time. Further, the head of the washing water in the accommodation conduit suppresses an undesirable flow of the washing water resulting from the inertia moment of the feeder after a signal for stopping the feeder is transmitted. Accordingly, even in a condition that the physical property measurement for the washing water by the sensor is likely to be affected by the flow of the washing water, it is possible to highly accurately measure the physical property of the washing water.

[0112] This application is based on Japanese Patent Application No. 2009-194613 filed on August 25,2009, the contents of which are hereby incorporated by reference.

[0113] The embodiments or the examples described in the detailed description of the invention are provided to clarify the technical contents of the invention. The invention should not be construed to be limited to the embodiments or the examples. The invention may be modified in various ways as far as such modifications do not depart from the spirit and the scope of the invention hereinafter defined.

Claims

1. A laundry machine (1) comprising:

a laundry sink (3) provided with a discharge port (311) through which washing water is discharged;
a pipeline (701, 702) connected to the discharge port;
a suction pipeline (711) connected to the pipeline (701, 702) so as to extend in a direction different from an extending direction of the pipeline (701, 702);
a feeder (71) configured to feed the washing water from the discharge port (311) to the suction pipeline (711); and
a sensor (73) configured to detect a physical property of the washing water, wherein
the sensor (73) protrudes from an inner surface of the pipeline (701, 702) opposite a connecting portion (771) between the suction pipeline (711) and the pipeline (701, 702).

2. The laundry machine (1) according to claim 1, wherein
the sensor (73) includes a conductivity sensor (73) configured to measure conductivity of the washing water.

3. The laundry machine (1) according to claim 1 or 2, wherein
the sensor (73) is disposed at such a position that the sensor (73) is subjected to a flow of the washing water in a first flow direction directed from the discharge port (311) toward the suction pipeline (711) and a flow of the washing water in a second flow direction opposite to the first flow direction.

4. The laundry machine (1) according to claim 3, further comprising a discharge pipeline (74) connected to the pipeline (701, 702) to discharge the washing water to an exterior, wherein
the discharge pipeline (74) is formed at an upstream side of the connecting portion (771) of the suction pipeline (711) in the first flow direction, and
the sensor (73) is disposed at an upstream side of the connecting portion (771) in the first flow direction and at a downstream side of a connecting portion (774) between the pipeline (701, 702) and the water discharge pipeline (74) in the first flow direction.

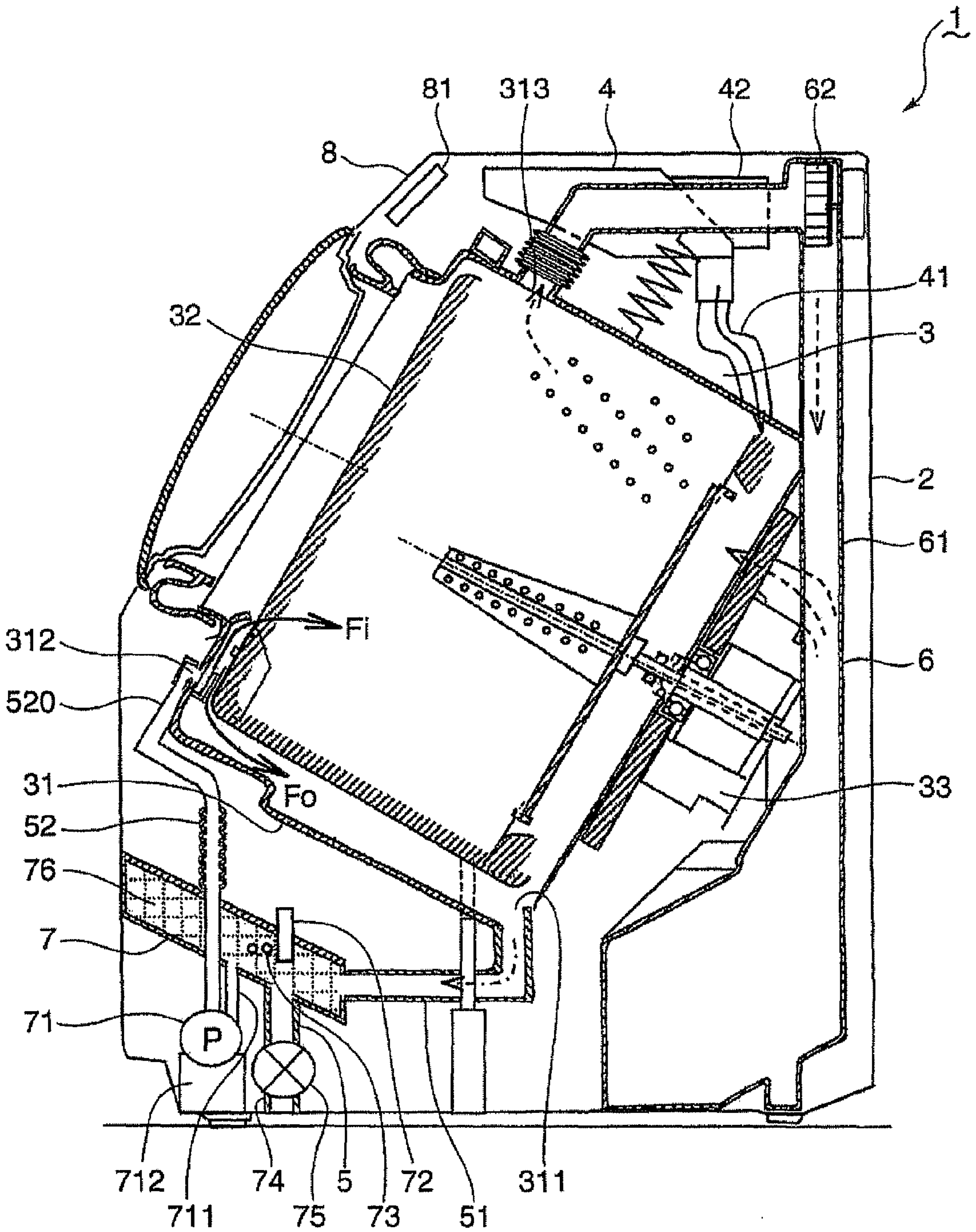
5. The laundry machine (1) according to any one of claims 1 through 4, further comprising a filter portion (76) configured to remove a dirt component con-

tained in the washing water, wherein
the filter portion (76) is disposed near the sensor (73).

6. The laundry machine (1) according to claim 5, wherein
at least a part of the filter portion (76) is placed between the sensor (73) and the connecting portion (771) of the suction pipeline (711).

7. The laundry machine (1) according to claim 6, wherein
the pipeline (701, 702) includes a straight conduit (701) where the sensor (73) protrudes, and an accommodation conduit (702) connected to the straight conduit (701) and the suction pipeline (711) and configured to accommodate the filter portion (76), and
the accommodation conduit (702) is upwardly inclined with respect to the straight conduit (701).

FIG. 1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81
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Fi
312
6
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33
Fo
31
52
76
7
71
P
712
711
74
75
5
73
72
51
311

FIG. 2A

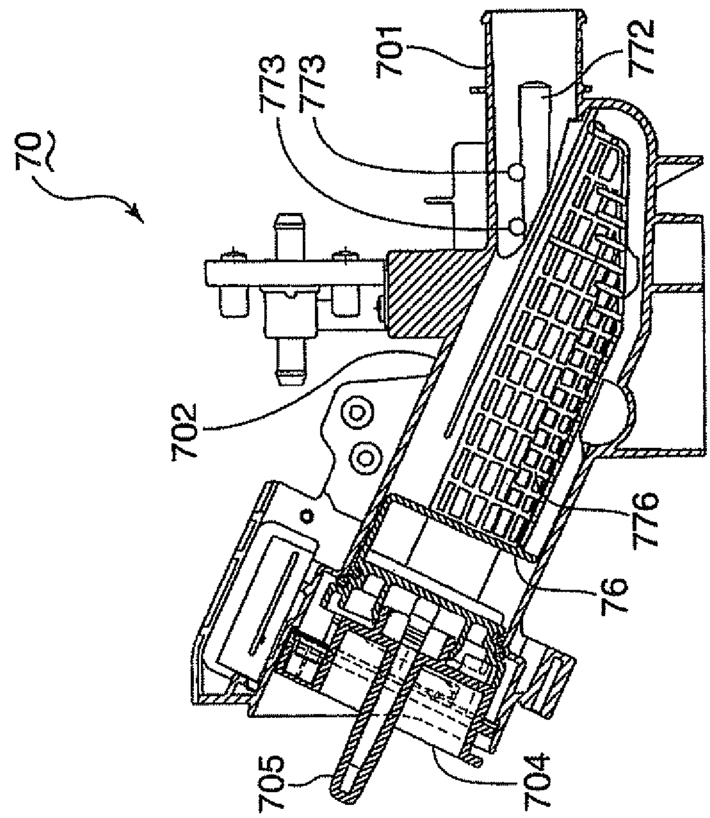
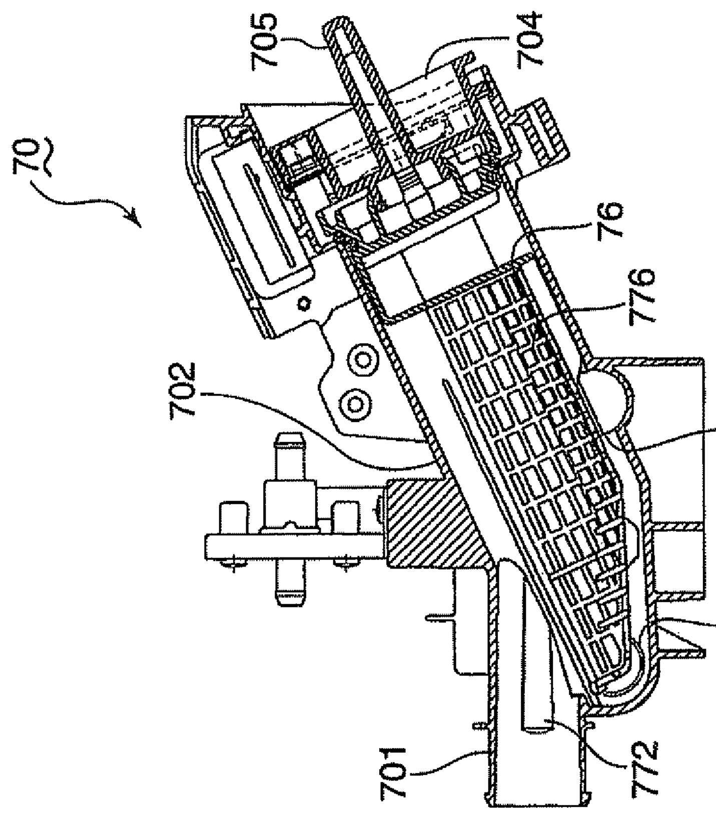

70
701
702
704
705
76
772
773
773
776

FIG. 2B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701
702
704
705
76
771
772
774
776

FIG. 3

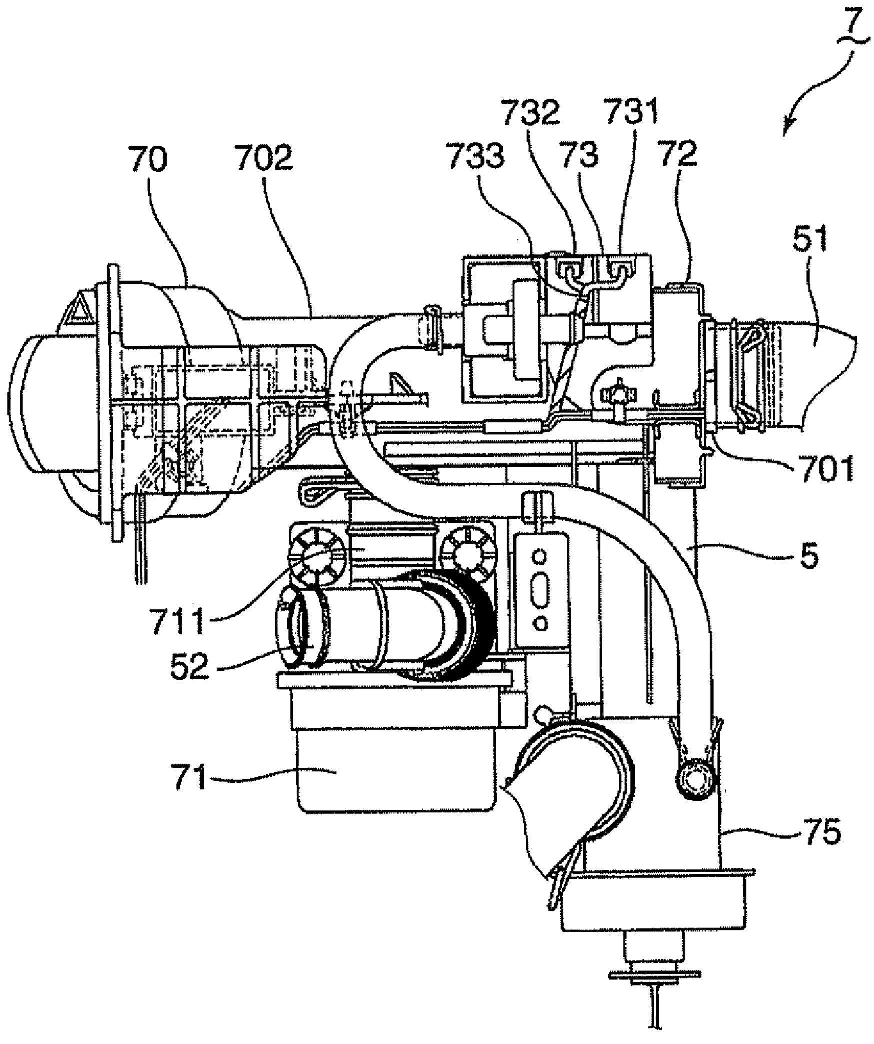


FIG. 4

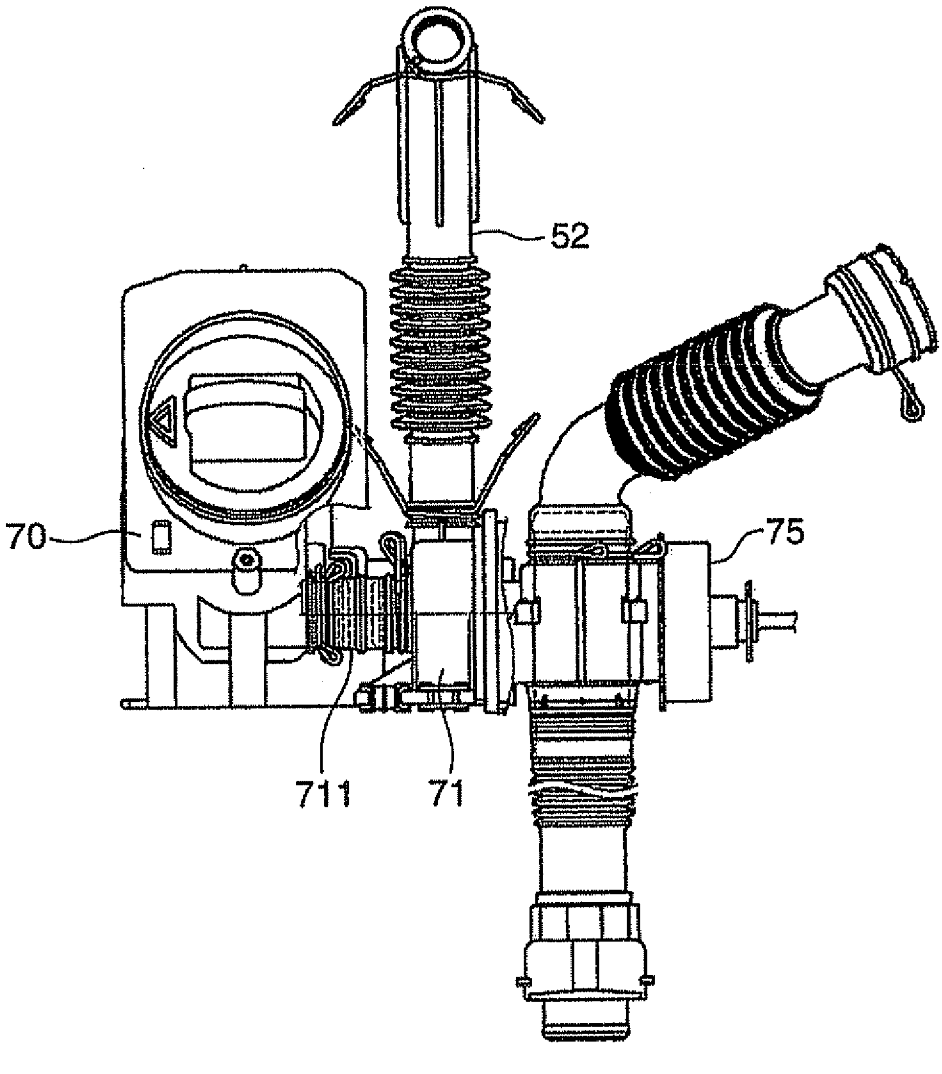


FIG. 5

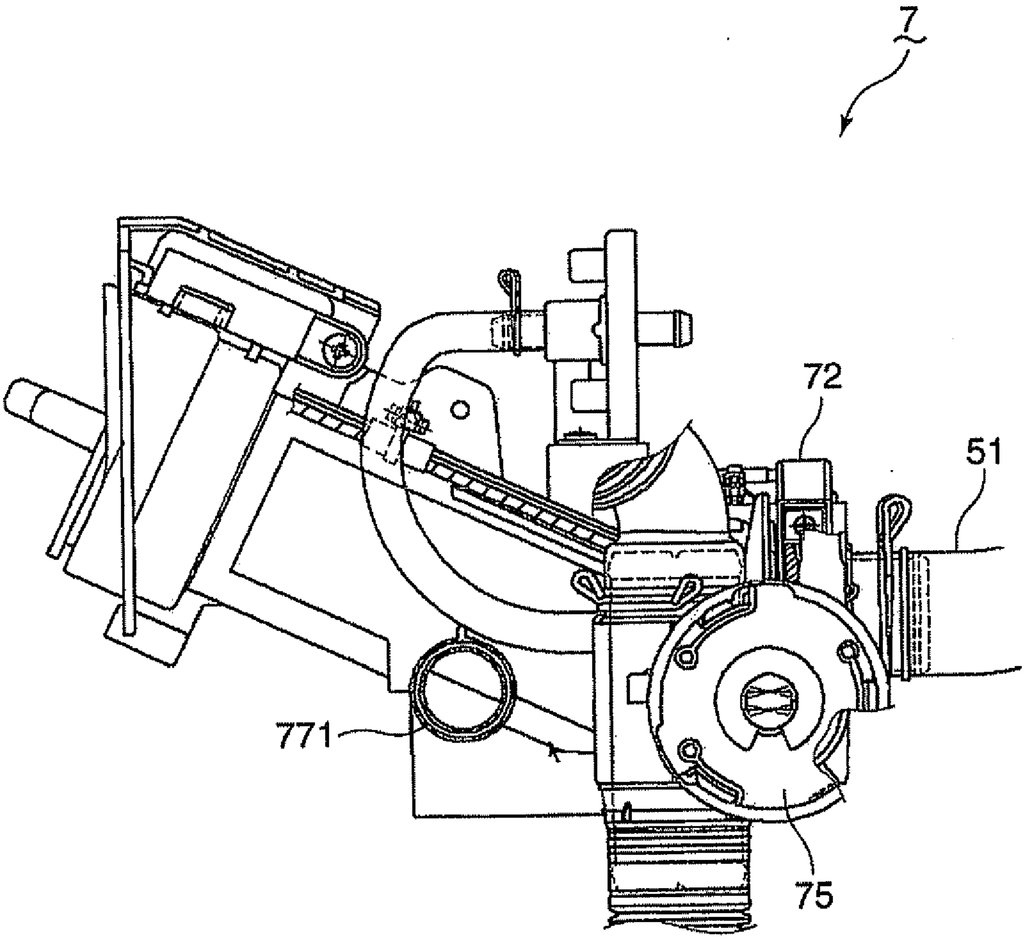


FIG. 6

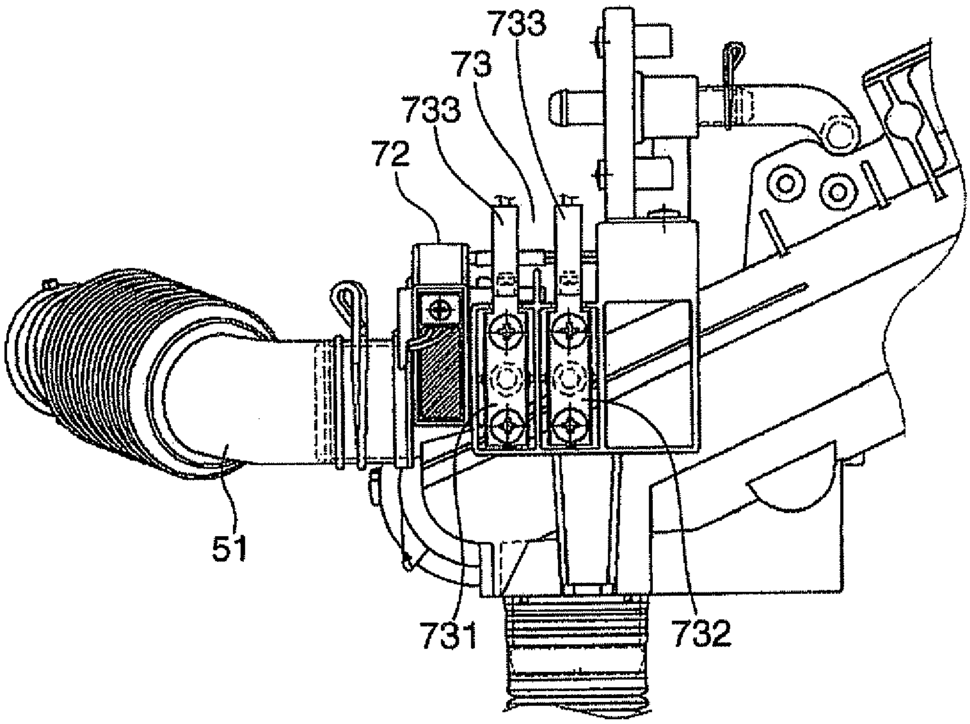
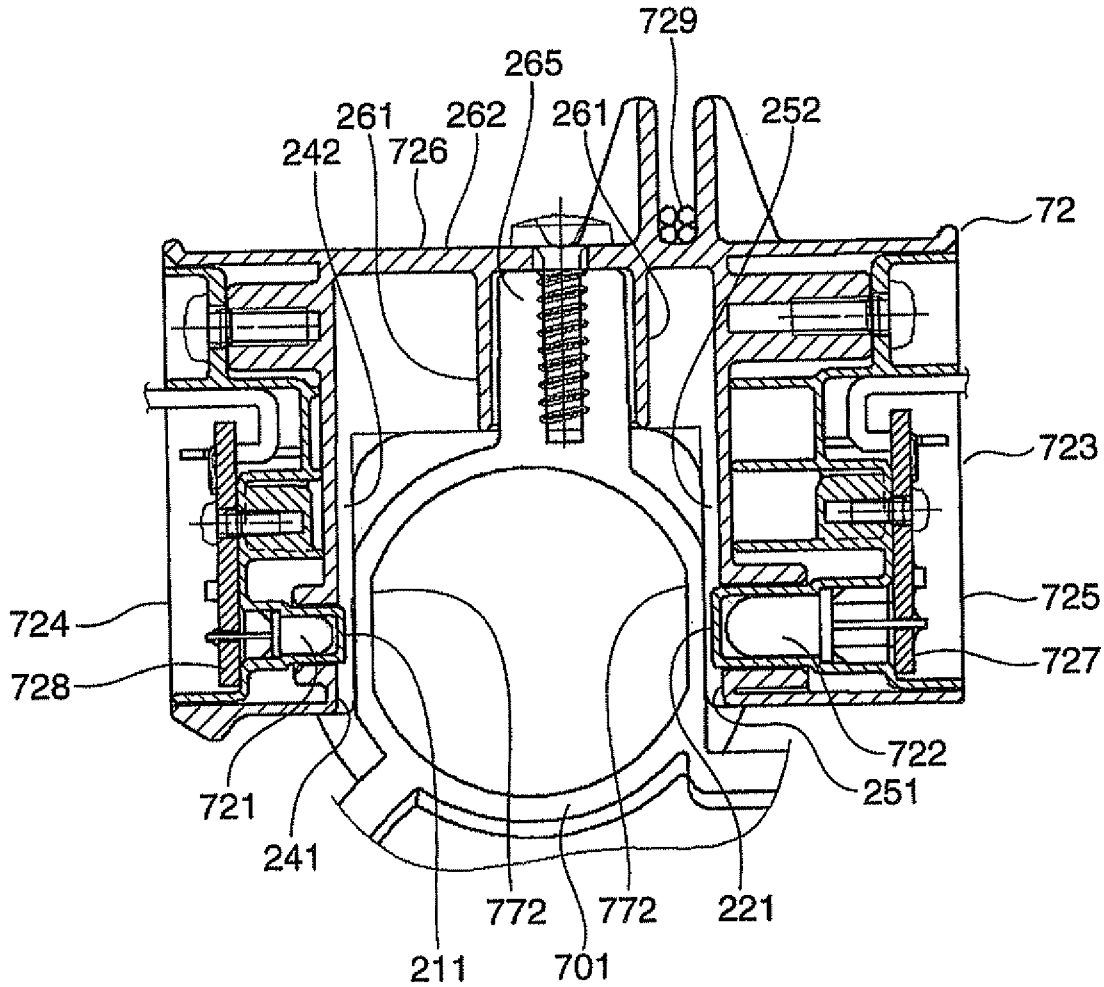


FIG. 7


729
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261
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261
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723
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721
251
241
772
772
221
211
701

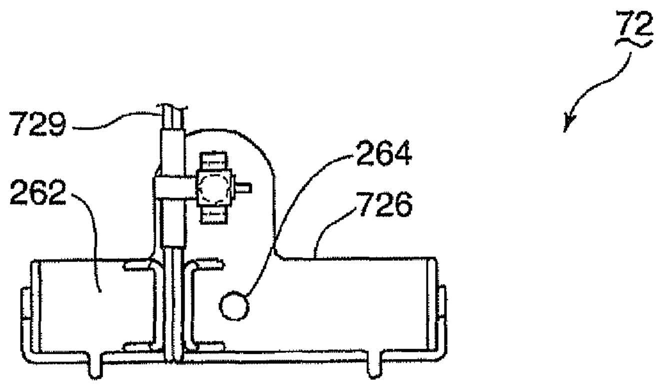


FIG. 8E

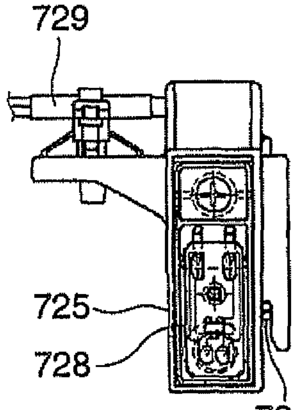


FIG. 8D

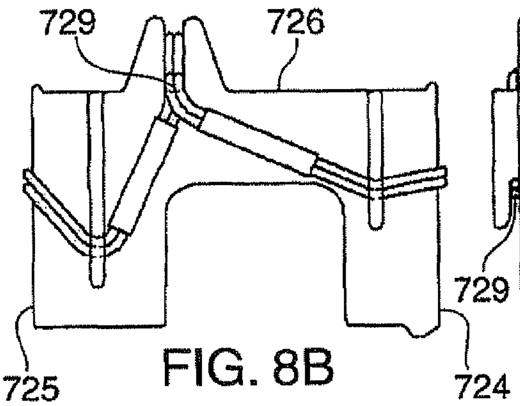


FIG. 8B

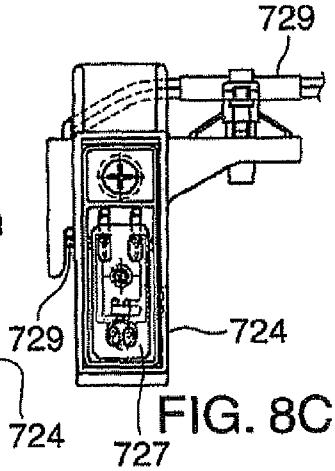


FIG. 8C

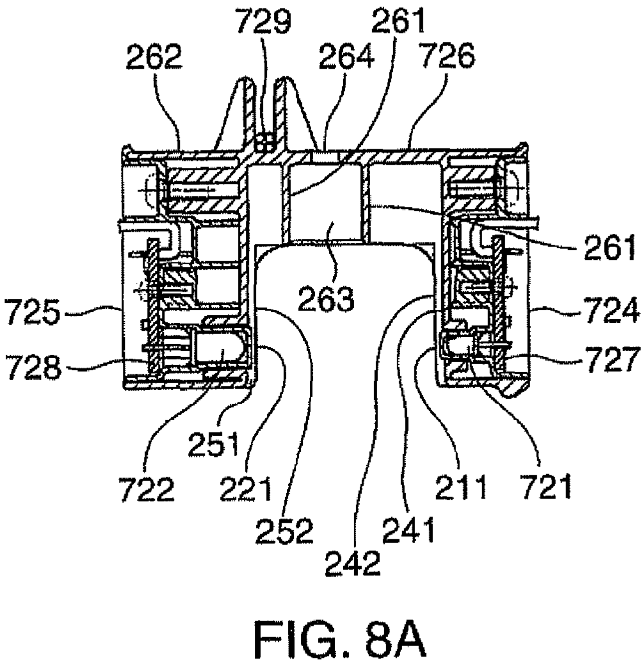


FIG. 8A

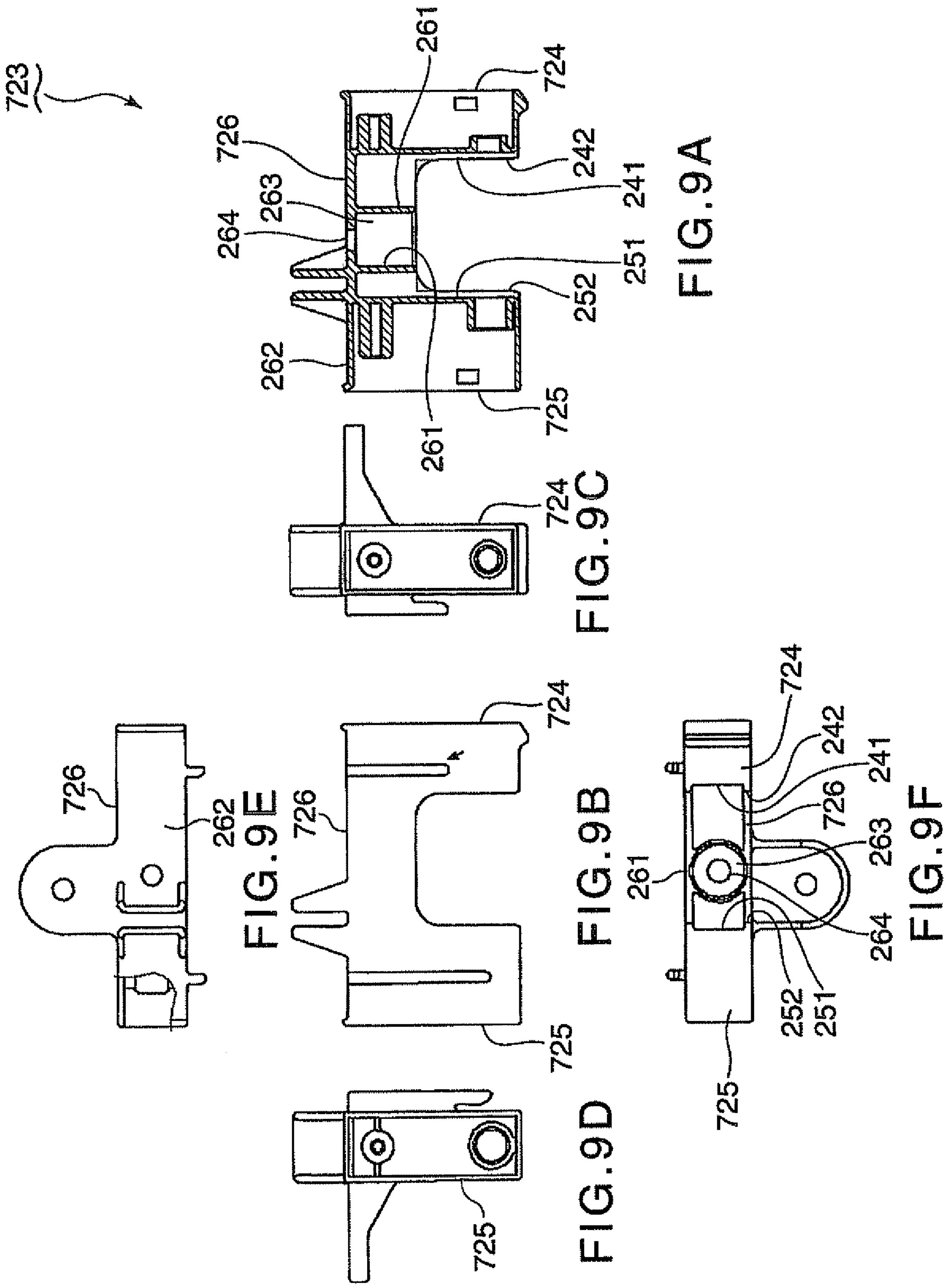


FIG.9A

FIG.9B

FIG.9C

FIG.9D

FIG.9E

FIG.9F

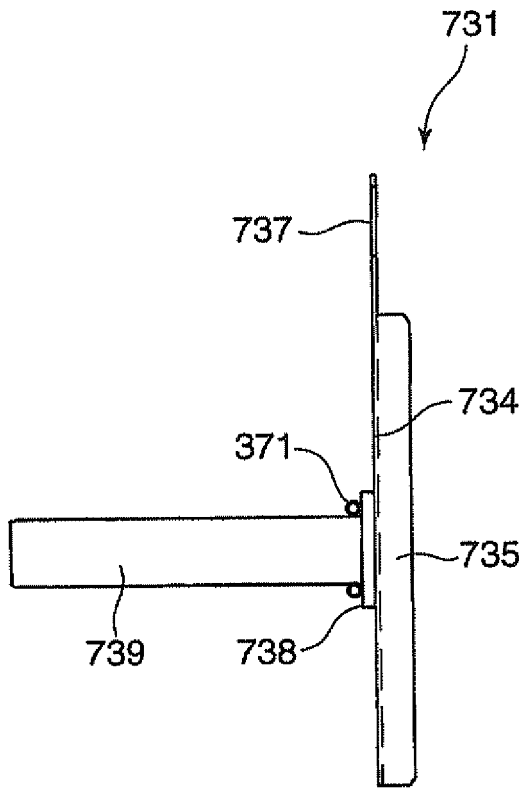


FIG. 10A

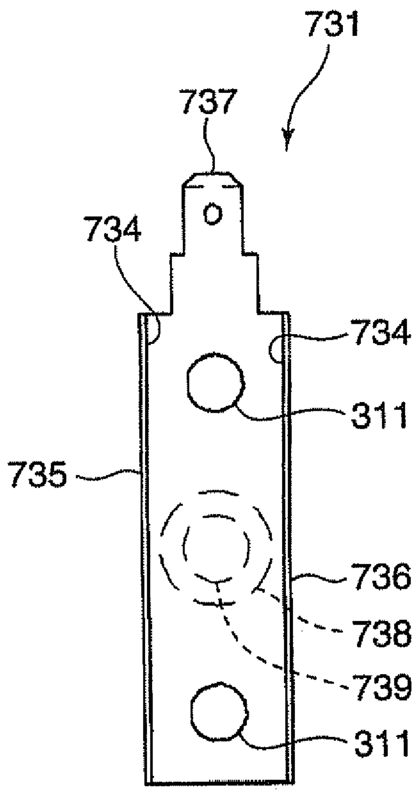


FIG. 10B

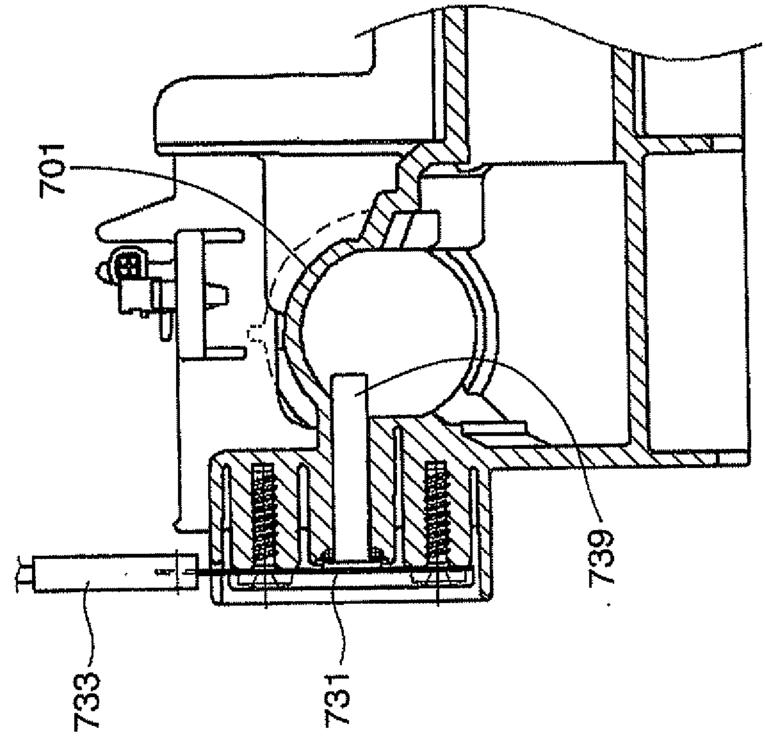


FIG. 11A

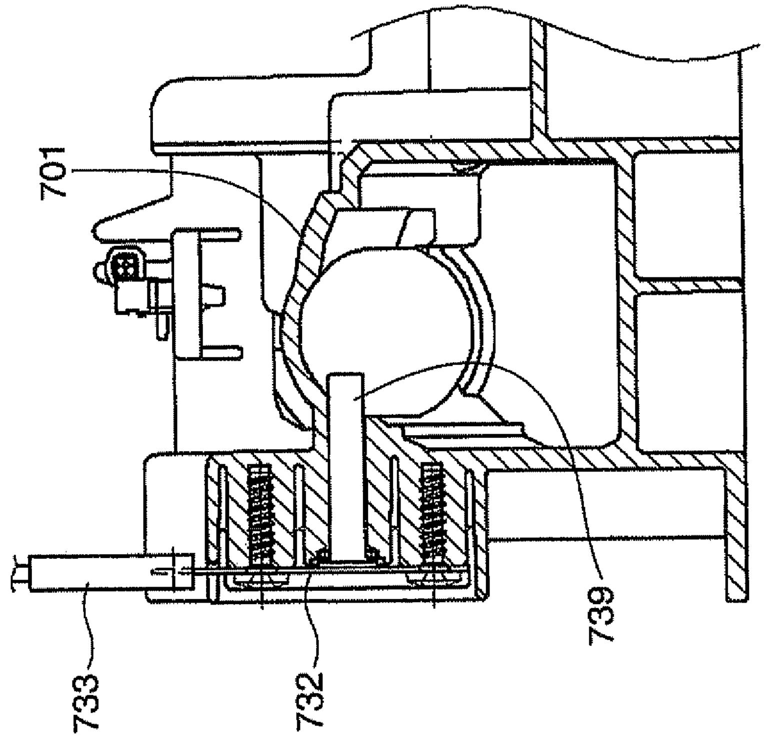


FIG. 11B

FIG.12

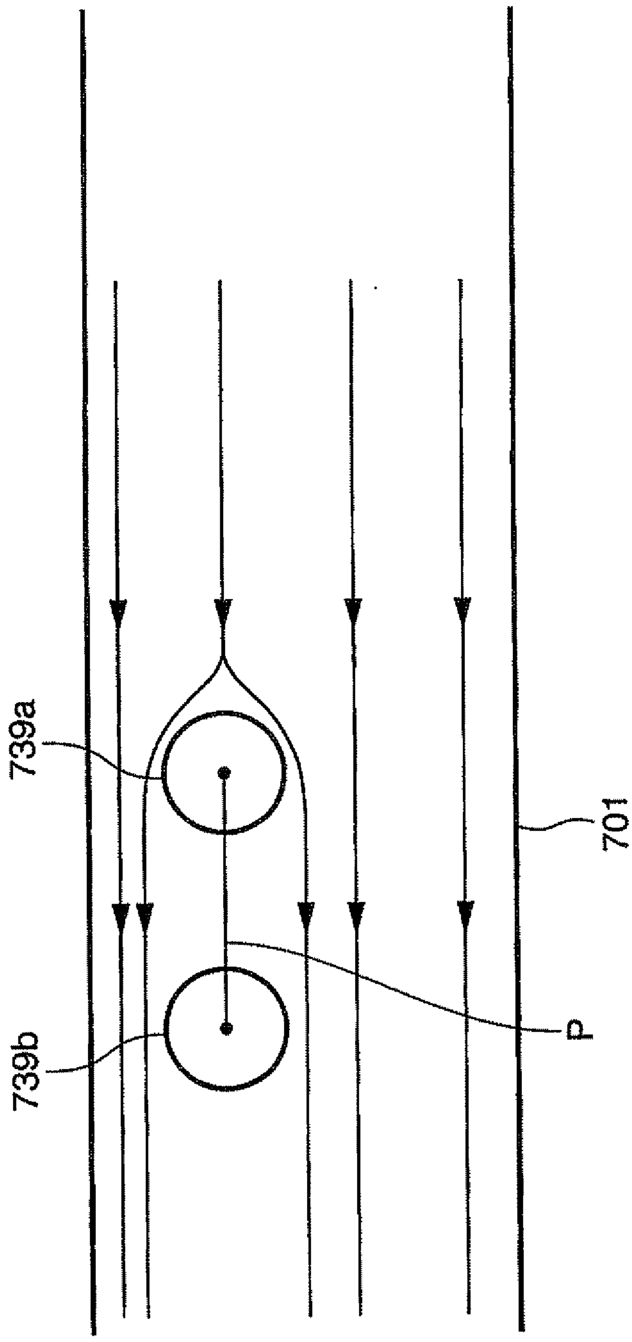


FIG. 13

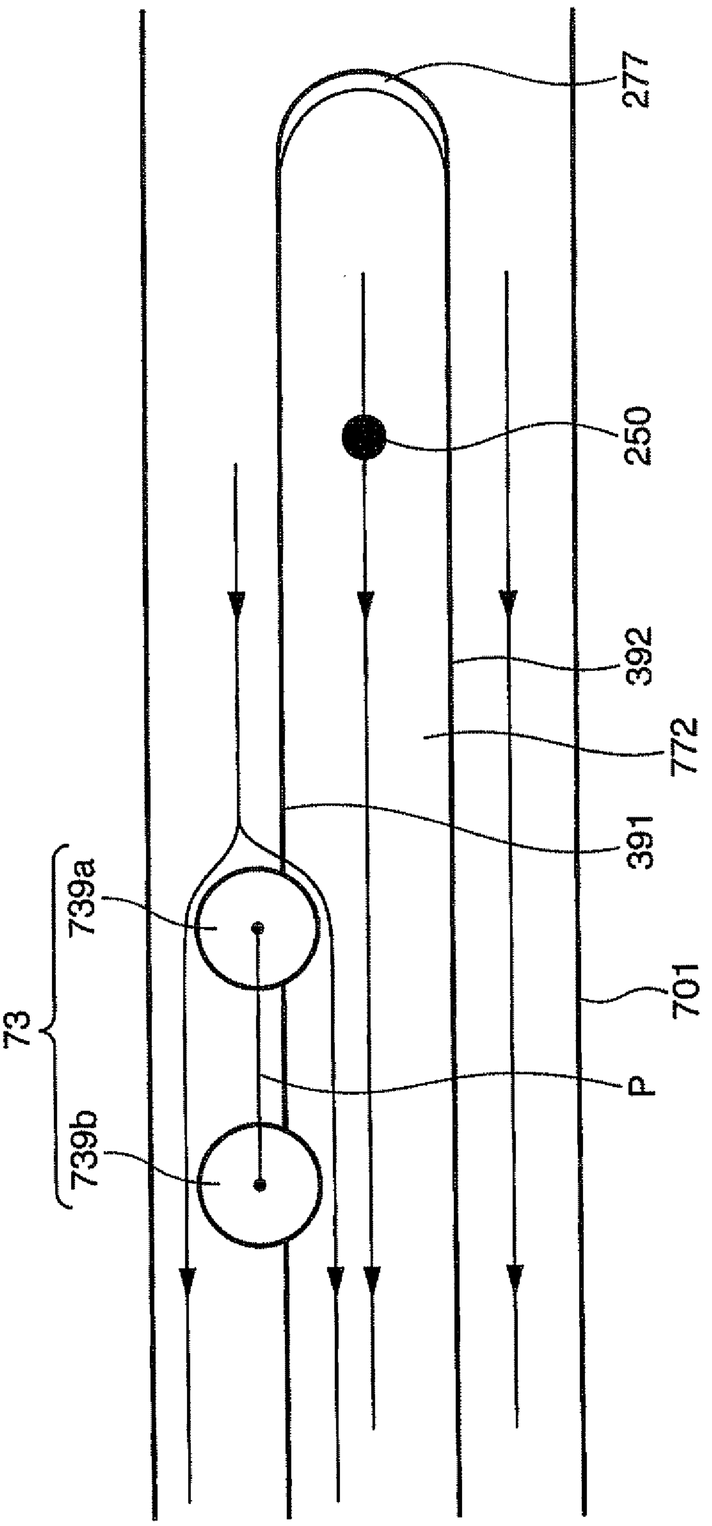


FIG. 14

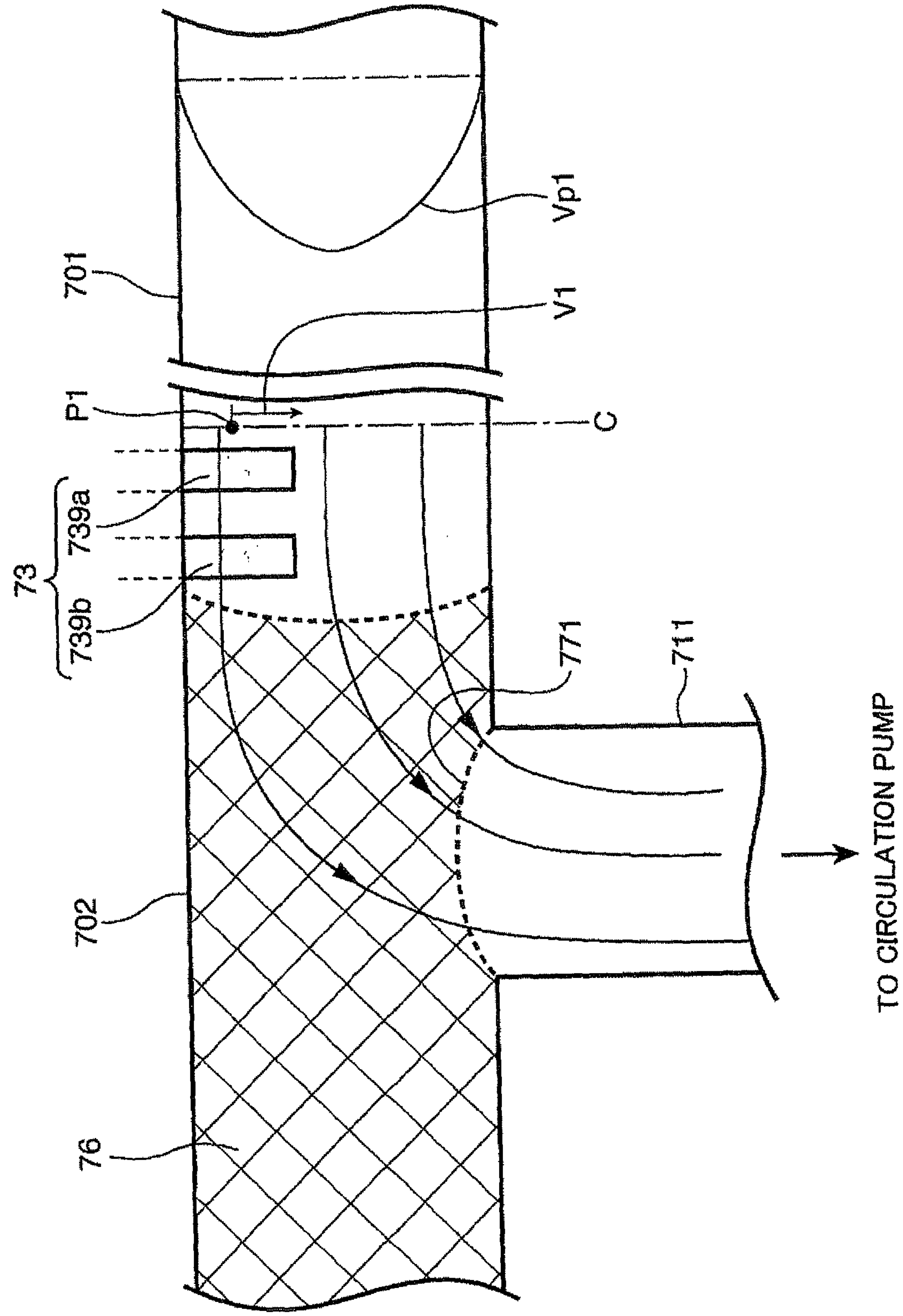


FIG. 15A

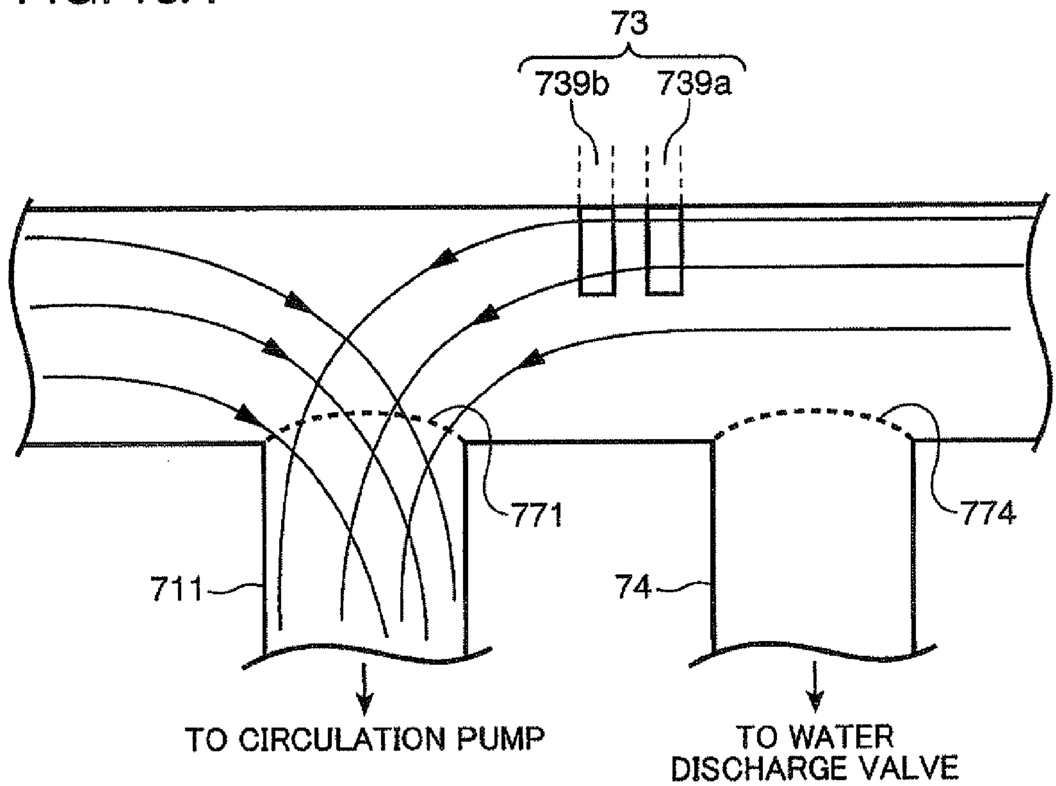


FIG. 15B

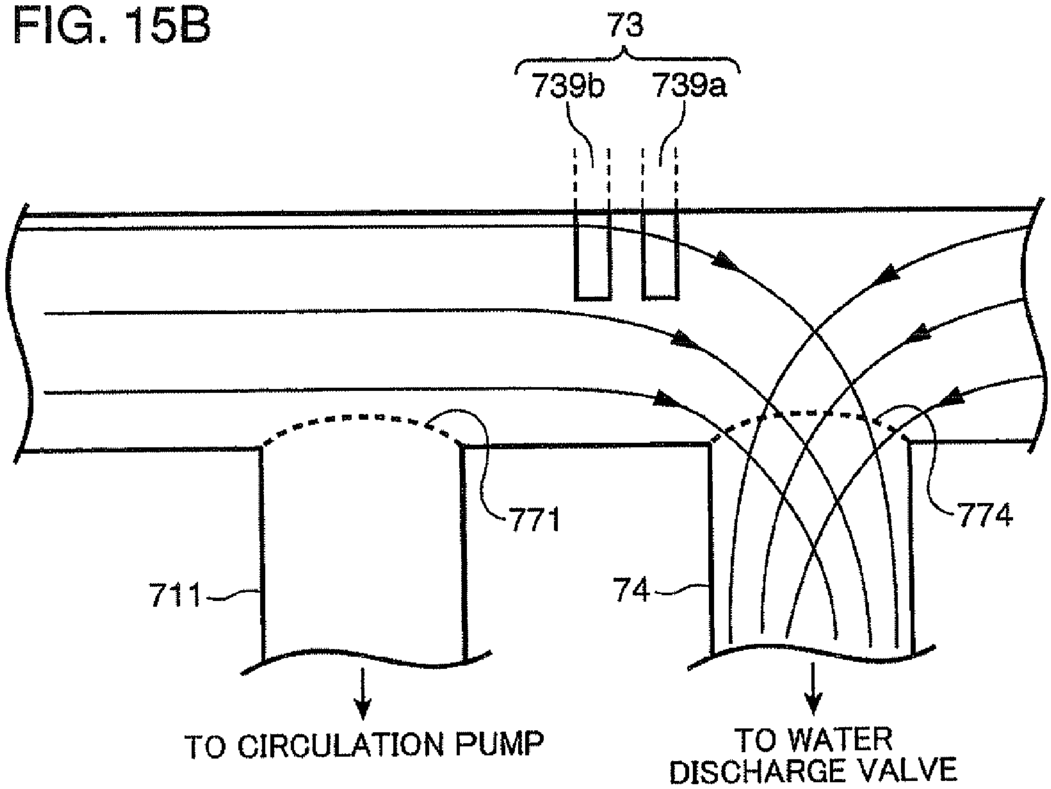


FIG. 16A

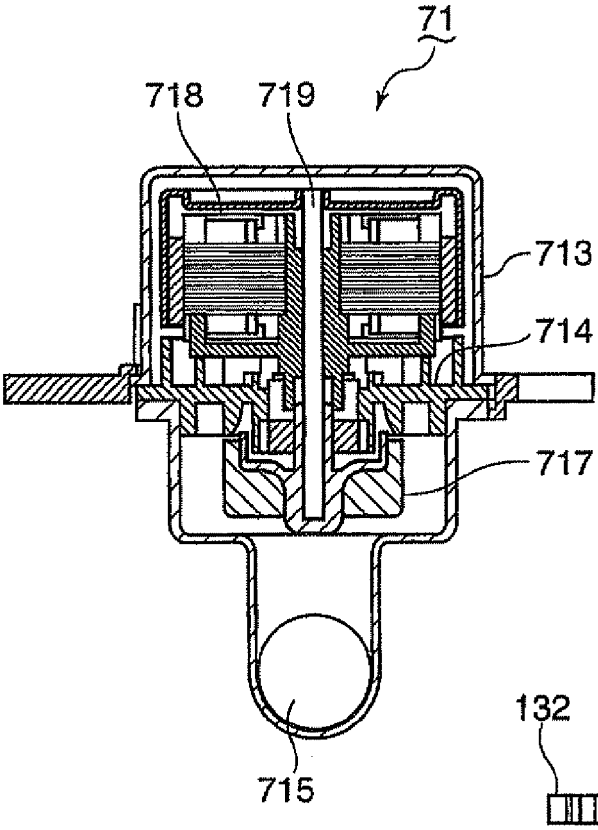


FIG. 16B

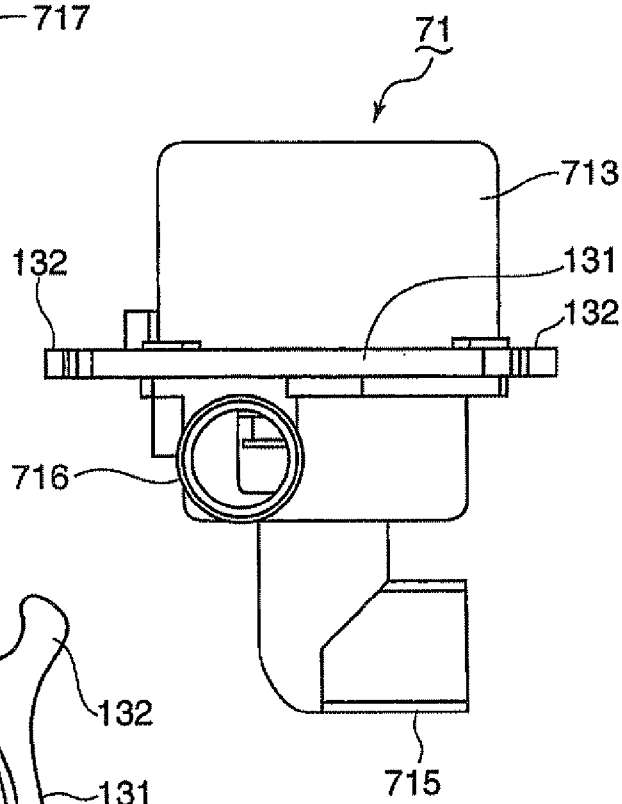
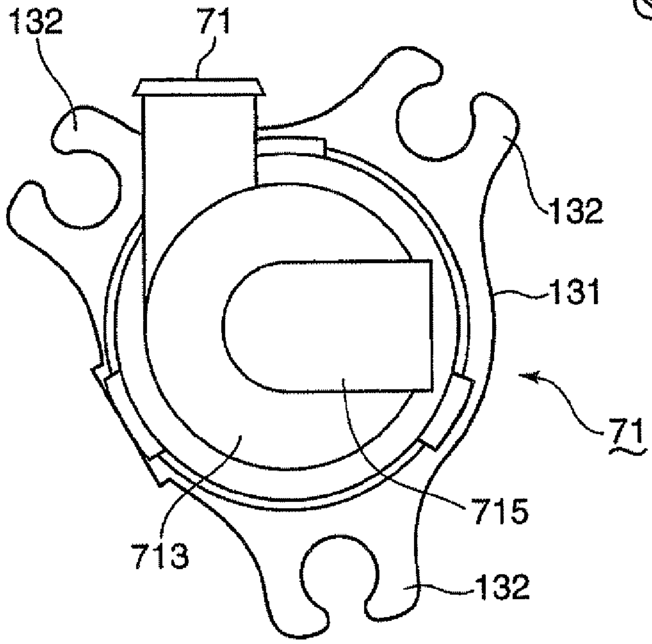


FIG. 16C



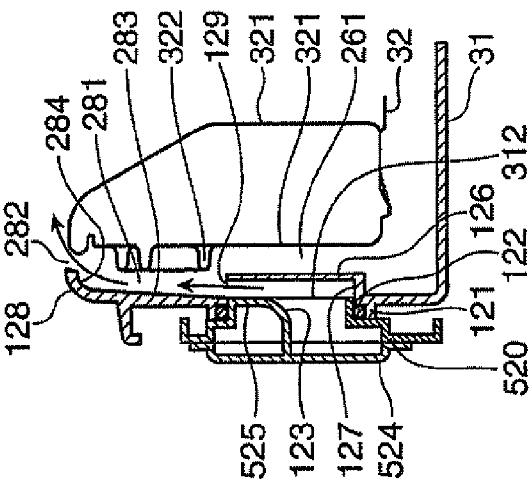


FIG. 17C

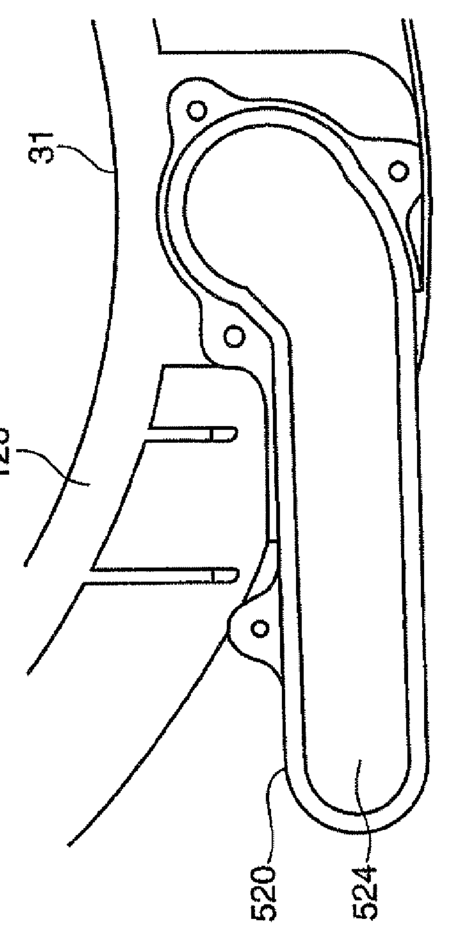


FIG. 17A

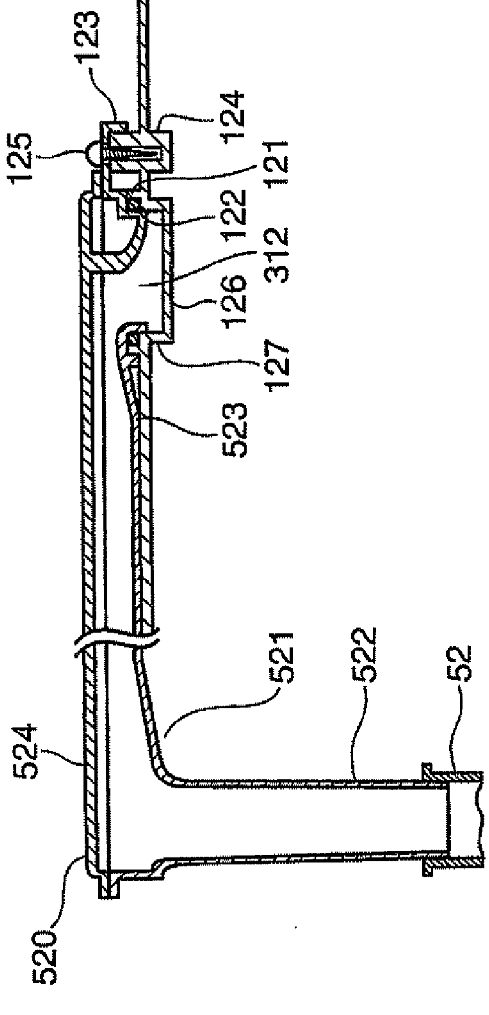
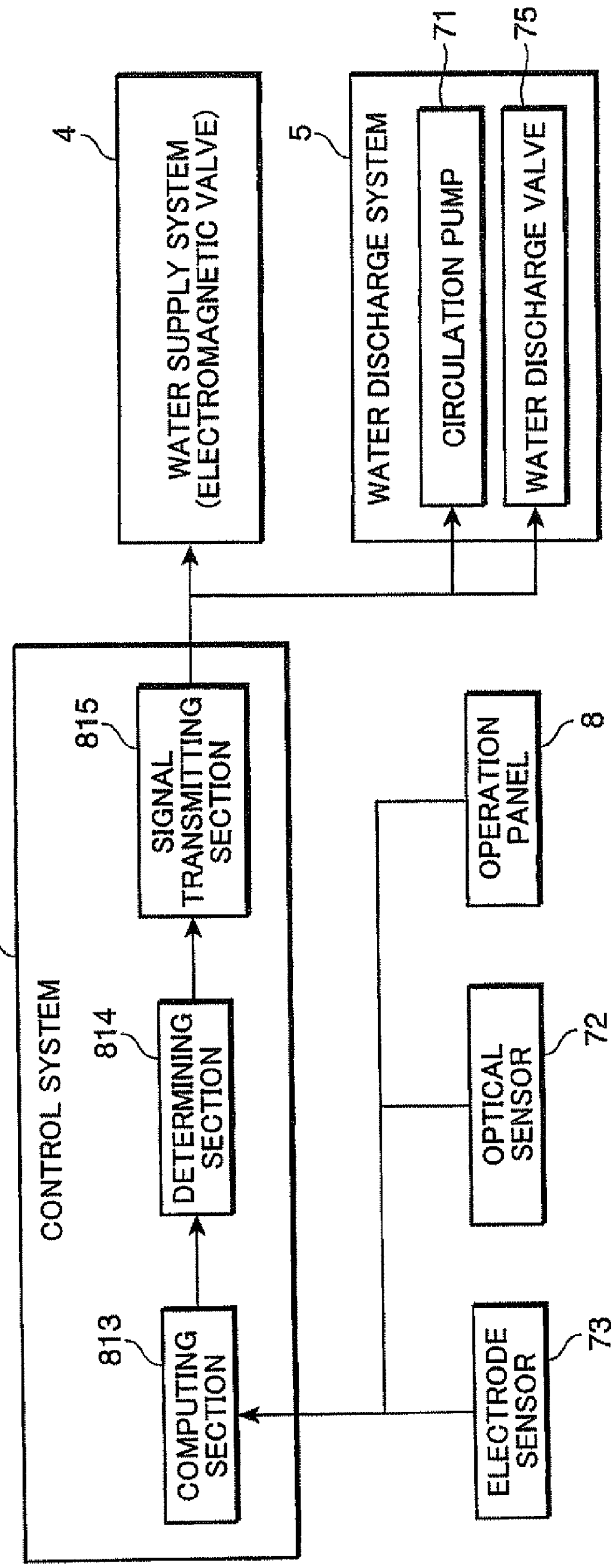


FIG. 17B

FIG. 18



WATER SUPPLY SYSTEM (ELECTROMAGNETIC VALVE)
4
WATER DISCHARGE SYSTEM
5
CIRCULATION PUMP
71
WATER DISCHARGE VALVE
75
CONTROL SYSTEM
81
COMPUTING SECTION
813
DETERMINING SECTION
814
SIGNAL TRANSMITTING SECTION
815
ELECTRODE SENSOR
73
OPTICAL SENSOR
72
OPERATION PANEL
8

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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 3831

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	GB 2 266 898 A (HOTPOINT LTD [GB]) 17 November 1993 (1993-11-17) * paragraph bridging pages 3 & 4figure 1 * * page 5, paragraph 2 *	1,2 3-7	INV. D06F39/00
X	DE 102 44 242 A1 (AWECO APPLIANCE SYS GMBH & CO [DE]) 25 March 2004 (2004-03-25) * paragraph [0028] - paragraph [0036]; figure 1 *	1,2	
A	WO 2004/048676 A1 (LG ELECTRONICS INC [KR]; PARK YONG-SUCK [KR]; SONG YOUNG-HAN [KR]) 10 June 2004 (2004-06-10) * page 13, line 7 - page 14, line 33; figures 1,10 *	1-7	

TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	10 November 2010	Hannam, Martin

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10-11-2010

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- JP HEI5220291 A **[0004]**
- JP 2009194613 A **[0112]**