(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 August 2011 (11.08.2011)

PCT

(10) International Publication Number
WO 2011/097083 A1

(51) International Patent Classification:
E03C 1/04 (2006.01)

(21) International Application Number:
PCT/US2011/022207

(22) International Filing Date:
24 January 2011 (24.01.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/300,781 2 February 2010 (02.02.2010) US
12/714,443 27 February 2010 (27.02.2010) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

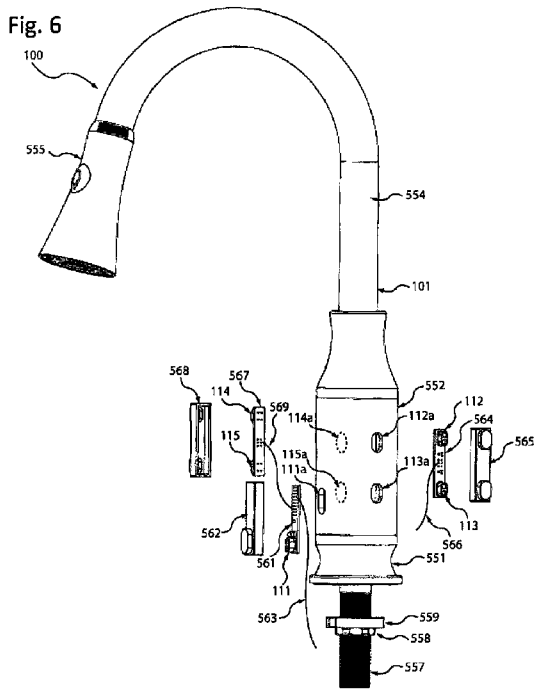
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: MIXING SYSTEM AND FAUCET SENSOR SYSTEM FOR A TOUCH FREE AUTOMATIC FAUCET

Fig. 6



(57) Abstract: A water flow and temperature mixing system for touch free automatic faucets comprises motorized actuator mechanisms coupled to a water flow mechanism. The water flow mechanism comprises a housing, hot and cold water inlets, a solenoid valve, and a water outlet. The water is mixed in the water flow mechanism, and exits through the solenoid valve and the water outlet. A faucet sensor system for a touch free automatic faucet comprises a sensor housing, a plurality of sensor assemblies coupled to a sensor holding element and a securing nut to secure the plurality of sensor assemblies within the sensor housing, and a faucet stationary base. The plurality of sensor assemblies comprise a primary sensor assembly, a secondary sensor assembly, and a tertiary sensor assembly. The secondary sensor assembly and the tertiary sensor assembly can be interchangeably placed on either side of the sensor housing to control water flow and temperature.

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MIXING SYSTEM AND FAUCET SENSOR SYSTEM FOR A TOUCH FREE AUTOMATIC FAUCET

CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to copending application Ser. No. 12/714,443, filed February 27, 2010, which is herein incorporated by reference, and claims the benefit of Provisional Application No. 61/300,781 filed on February 2, 2010.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention generally relates to the field of automatic faucets. More particularly, the present invention relates to a mixing system and a faucet housing for a touch free automatic faucet.

Description of the Related Art

Automatic faucets have become popular for water saving. Because of personal hygiene concerns, touch free automatic faucets are ideal for public locations, and commercial and residential applications.

The conventional automatic faucet is controlled with a single electronic sensor to toggle water on and off with a preset water temperature. However, most applications such as kitchens, lavatories and commercial facilities require adjustments on water flow, temperature and continuous water flow services.

BRIEF SUMMARY OF THE INVENTION

In accordance with the present invention, structures and associated methods are disclosed which address these needs and overcome the deficiencies of the prior art.

In one aspect, a water flow and temperature control mixing system is provided for a touch free automatic faucet. The mixing system includes a cold water motorized actuator mechanism, a hot water motorized actuator mechanism, and a water flow mechanism. The water flow mechanism comprises a hot water inlet connector and a cold water inlet connector to supply hot water and cold water, a solenoid valve, and a water outlet connector. The water is mixed in the water flow mechanism to obtain the desired temperature, and then directed through the solenoid valve and out of the water outlet connector. An electronic logic processor is connected to the mixing system.

In a further aspect, a faucet sensor system for a touch free automatic faucet is provided. The faucet sensor system includes a sensor housing, a plurality of sensor assemblies coupled to a sensor holding element and a securing nut within the sensor housing, and a faucet stationary base. In this embodiment, the plurality of sensor assemblies comprise a primary sensor assembly, a secondary sensor assembly, and a tertiary sensor assembly. The secondary sensor assembly and the tertiary sensor assembly can be interchangeably placed on either side of the sensor housing. The interaction of the plurality of sensor assemblies allows the user of the touch free automatic faucet to control water temperature and flow rate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 illustrates a water flow and temperature control mixing system for a touch free automatic faucet according to a preferred embodiment;

FIG.2 illustrates a side interior view of a water flow housing according to a preferred embodiment;

FIG.3 illustrates a top interior view of the water flow housing shown in Fig. 2 according to a preferred embodiment;

FIG.4 illustrates another side interior view of the water flow housing shown in Fig. 2 according to a preferred embodiment;

FIG.5 illustrates an exploded view of the water flow and temperature control mixing system shown in Fig. 1 according to a preferred embodiment;

FIG.6 illustrates an exploded view of a faucet sensor system according to a preferred embodiment; and

FIG.7 illustrates a transparent view of a sensor housing for the faucet sensor system shown in FIG. 6 according to a preferred embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description is made for the purpose of illustrating the general principles of the invention and is not meant to limit the inventive concepts claimed herein. Further, particular features described herein can be used in combination with other described features in each of the various possible combinations and permutations. Unless otherwise specifically defined herein, all terms are to be given their broadest possible interpretation including meanings implied from the specification, as well as meanings understood by those skilled in the art and/or as defined in dictionaries, treatises, etc. The description may disclose several preferred embodiments for a water flow and temperature mixing system for touch free automatic faucets, as well as operation and/or component parts thereof. While the following description will be described in terms of automatic touch free faucets for clarity and placing the invention in context, it should be kept in mind that the teachings herein may have broad application to all types of systems, devices and applications.

In FIG. 1, a first preferred embodiment of a water flow and temperature mixing system, or simply mixing system, is designated by the reference numeral 10. As illustrated, the mixing system 10 comprises a hot water motorized actuator mechanism 503, a cold water motorized actuator mechanism 502, and a water flow mechanism 501. The water flow mechanism 501 comprises a water flow housing 500, hot water inlet connector 508, a cold water inlet connector 507, a water outlet connector 509, and a solenoid valve housing 504. The water flow housing includes a first tubular portion 517 and a second tubular portion 518.

The mixing system 10 defines an axis "A," a distal end 20, a proximal end 22, a hot water side 24 and a cold water side 26. In the preferred embodiment, the hot water and cold water inlet connectors 508 and 507, and the outlet connector 509 are generally parallel to the axis A.

The hot water motorized actuator mechanism 503 is preferably located side-by-side to the cold water motorized actuator mechanism 502 adjacent to the distal end 20, and both motorized actuator mechanisms 502 and 503 are coupled to the water flow mechanism 501. The cold water inlet connector 507 is coaxial to the first tubular portion 517 and the

cold water motorized actuator mechanism 502. The hot water inlet connector 508 is coaxial to the second tubular portion 518 and the hot water motorized actuator mechanism 503. The solenoid valve housing 504 is placed coaxial to axis A, in front of and in between the hot water and cold water motorized actuator mechanisms 503 and 502. Alternatively stated, the solenoid valve housing 504 in the preferred embodiment is centrally located in that it is positioned medially between the hot water side 24 and the cold water side 26, as well as in between the distal end 20 and the proximal end 22. The solenoid valve housing 504 includes a water outlet connector 509, coaxially placed along the axis A and in parallel to the hot water inlet connector 508 and the cold water inlet 507.

FIG. 2 illustrates a cross-sectional view of the preferred embodiment of the water flow mechanism 501 taken along a cross-sectional line 2-2 of FIG. 3. Cold water 104 enters the water flow mechanism 501 through the cold water inlet connector 507 at the proximal end 22, which is coaxial to a cold water flow valve 535 in parallel to the axis A. The cold water inlet connector 507 and the coaxial cold water flow valve 535 collectively form a cold water passage way 541. Hot water 105 enters the water flow mechanism 501 through the hot water inlet connector 508 at the proximal end 22, which is coaxial to a hot water flow valve 536 in parallel to the axis A. The hot water inlet connector 508 and the coaxial hot water flow valve 536 collectively form a hot water passage way 542. A water mixing chamber 510 is disposed within the water flow mechanism 501, between the cold water passage way 541 and the hot water passage way 542. The incoming cold water 104 enters the water mixing chamber 510 through the cold water passage way 541 and an opening 543 disposed in the cold water flow valve 535. Similarly, the incoming hot water 105 enters the mixing chamber 510 through the hot water passage way 542 and an opening 544 disposed in the hot water flow valve 536. A valve (505) (see Fig. 5) in the valve chamber 537 of the cold water motorized actuator mechanism 502 at the distal end 20 is housed within the first tubular portion 517 and coaxially coupled to the cold water flow valve chamber 535 in parallel to the axis A. Also adjacently, a valve (506) (see Fig. 5) in the valve chamber 538 of the hot water motorized actuator mechanism 503 at the distal end 20 is housed within the second tubular portion 518 and coaxially coupled to the hot water flow valve chamber 536 in parallel to the axis A. Although the cold water flow valve 505 and the hot water flow valve 506 are preferably cartridge valves, they may comprise ball

valves, cylinder valves, or any other types of valves.

FIG. 3 illustrates a top interior view of the preferred embodiment of the water flow mechanism 501 with cross-sectional lines 2-2 and 4-4. A bracket portion 539 and a bracket portion 540 are provided on the outside of the water flow housing 500 to help facilitate the securing of the water flow mechanism 501 to the hot water and cold water motorized actuator mechanisms 503 and 502 . (See also FIG. 5). The bracket portion 539 is disposed at the distal end 20 of the first tubular portion 517 and coaxial to the stem portion 537 of the cold water motorized actuator mechanism 502 in parallel to the axis A. The bracket portion 540 is disposed at the distal end 20 of the second tubular portion 518 and coaxial to the stem portion 538 of the hot water motorized actuator mechanism 503 in parallel to the axis A. A water temperature sensor housing 592 is disposed within the water flow housing 500 in between the first tubular portion 517 and the second tubular portion 518.

FIG. 4 illustrates a cross-sectional view of the preferred embodiment of the water flow mechanism 501 taken along a cross-sectional line 4-4 of FIG.3. As shown, the cold water inlet connector 507 is coaxial to the cold water flow valve 535 in parallel to the axis A, and the hot water inlet connector 508 is coaxial to the hot water flow valve 536 in parallel to the axis A.

The temperature of the water output is controlled by determining the respective amount of cold water and hot water going into the water mixing chamber 510. A rotating cold water cartridge 505 (see FIG. 5) disposed in the cold water flow valve chamber 535 adjusts the incoming cold water flow by turning the opening 543 to align with an opening of a cold water conduit 532 and allow cold water to flow into the mixing chamber 510, or by turning the opening 543 away from the opening of the cold water conduit 532 to reduce cold water from flowing into the mixing chamber 510. Similarly, a rotating hot water cartridge 506 (see FIG. 5) disposed in the hot water flow valve chamber 536 adjusts the incoming hot water flow by turning the opening 544 to align with an opening of a hot water conduit 534 and allow hot water to flow into the mixing chamber 510, or by turning the opening 544 away from the opening of the hot water conduit 534 to reduce hot water from flowing into the mixing chamber 510. The water temperature sensor housing 592 is

coupled to the water mixing chamber 510 along the axis A within the water flow housing 500. The cold water and hot water valve stem portions 517 and 518 hold the water motorized actuator mechanisms 502 and 503 to rotate the cold water valve 505 and the hot water valve 506.

FIG. 5 illustrates an exploded view of the preferred embodiment of the mixing system 10. An inlet cold water filter 513 is connected internally with a check valve 512 within the cold water inlet connector 507. An inlet hot water filter 515 is connected internally with a check valve 514 within the hot water inlet connector 508. The check valves 512 and 514 prevent or reduce water backflow from the cold water and the hot water inlet connectors 507 and 508. The water flow housing 500 includes the tubular portions 517 and 518, and the bracket portions 539 and 540 to secure the water flow mechanism 501 to the motorized cold water and hot water actuator mechanisms 502 and 503. The cold water motorized actuator mechanism 502 comprises the rotating cold water cartridge 505, a gasket 587C, a cartridge locking nut 586C , a motor actuator adapter 585C, a motor actuator 511C, an actuator connector 589C and electric wire 588C. The hot water motorized actuator mechanism 503 comprises the rotating hot water cartridge 506, a gasket 587H, a cartridge locking nut 586H, a motor actuator adapter 585H, and a motor actuator 511H, an actuator connector 589H and electric wire 588H. The rotating cold water cartridge 505 and the rotating hot water cartridge 506 are preferably two-way ceramic valve cartridges. However, they may comprise cylinder valves, ball valves, disk valves, or any other types of valves.

As signals are received from a logical processor such as a printed circuit board (PCB), the cold water motorized actuator mechanism 502 turns the actuator connector 589C that is connected to the motor actuator adapter 585C and rotating cold water cartridge 505 such that the opening 543 aligns with the opening of the cold water conduit 532 within the water flow housing 500 to allow cold water to flow into the mixing chamber 510. (See Fig. 4). The cartridge locking nut 586C and the gasket 587C hold the cold water cartridge 505 in position. Similarly, upon receiving signals from the PCB, the hot water motorized actuator mechanism 503 turns the actuator connector 589H that is connected to the motor actuator adapter 585H and rotating hot water cartridge 506 such that the opening 544 aligns with the opening of the hot water conduit 534 within the water

flow housing 500 to allow hot water to flow into the mixing chamber 510. The cartridge locking nut 586H and the gasket 587H hold the hot water cartridge 506 in position. The hot and cold water flow are mixed in the water mixing chamber 510. The mixed water, which now has the desired temperature, is directed through the solenoid valve housing 504 and out of the water outlet connector 509. A water temperature sensor 591 is coupled to a gasket 594 and an O-ring 593, and the assembly is housed in the water temperature sensor housing 592 connected to the water mixing chamber 510 within the water flow housing 500, to detect the mixed water temperature in the water mixing chamber 510.

In FIG. 6, an exploded view of a first preferred embodiment of a faucet sensor system is designated by the reference numeral 100 and is configured for use in connection with a touch free automatic faucet system. In this preferred embodiment, the faucet sensor system 100 comprises a faucet spout 101, a water outlet spray head 555, a faucet stem 554, a sensor housing 552, a water pipe/shaft 557, a faucet stationary base 551, an installation bracket 559, and a tightening nut 558. The sensor housing 552 is coupled to the faucet spout 101, and comprises a primary sensor 111, a plurality of secondary sensors 112 and 113, and a plurality of tertiary sensors 114 and 115. The plurality of sensors are assembled on printed circuit boards (PCBs), placed inside sensor covers, and aligned with their respective matching windows or openings disposed in the sensor housing 552. As an example, the secondary sensor 112 on PCB 564 is placed inside a sensor cover 565 and matched with a window/opening 112a disposed in the sensor housing 552; the secondary sensor 113 on PCB 564 is placed inside the sensor cover 565 and matched with a window/opening 113a disposed in the sensor housing 552; the primary sensor 111 on PCB 561 is placed inside a sensor cover 562 and matched with a window/opening 111a disposed in the sensor housing 552; the tertiary sensor 114 on PCB 567 is placed inside a sensor cover 568 and matched with a window/opening 114a disposed in the sensor housing 552; and the tertiary sensor 115 on PCB 567 is placed inside the sensor cover 568 and matched with a window/opening 115a disposed in the sensor housing 552. In the preferred embodiment of the faucet sensor system 100, the sensors 112, 113, 114, and 115 are interchangeable on either side of the faucet sensor housing 552 through the windows/openings 112a, 113a, 114a, and 115a.

FIG. 7 illustrates a transparent view of the preferred embodiment of the sensor housing 552. In this preferred embodiment, the plurality of sensors 111, 112, 113, 114, and 115 are installed on the plurality of PCBs 561, 564, and 567, assembled inside the plurality of sensor covers 562, 565, and 568, and secured to the sensor housing 552 using a sensor holding element 572 and a securing nut 573. Further, the primary sensor 111 is configured in the same direction as the water outlet spray head 555.

The various embodiments of the invention provide a touch-free automatic faucet with three or more sensors to control water flow and temperature for commercial and residential applications for easy and convenient operation, water conservation, and personal hygiene protection.

Reference in the specification to "an embodiment," "one embodiment," "some embodiments," or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily all embodiments. The various appearances of "an embodiment," "one embodiment," or "some embodiments" are not necessarily all referring to the same embodiments. If the specification states a component, feature, structure, or characteristic "may," "might," or "could" be included, that particular component, feature, structure, or characteristic is not required to be included. If the specification or claim refers to "a" or "an" element, that does not mean there is only one of the element. If the specification or claims refer to "an additional" element, that does not preclude there being more than one of the additional element.

While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention not be limited to the specific constructions and arrangements shown and described, since various other modifications may occur to those ordinarily skilled in the art.

CLAIMS

What is claimed is:

1. A water flow and temperature control mixing system for a touch free automatic faucet, comprising:

a water flow mechanism, comprising:

a water flow housing;

a hot water inlet connector;

a cold water inlet connector;

a water mixing chamber;

a solenoid valve housing; and

a water outlet connector

a first motorized actuator mechanism coupled to the water flow mechanism, the first motorized actuator mechanism configured to receive hot water and comprising:

a stem portion; and

a hot water flow valve; and

a second motorized actuator mechanism coupled to the water flow mechanism, the second motorized actuator mechanism configured to receive cold water and comprising:

a stem portion; and

a cold water flow valve.

2. The system of claim 1, wherein the water flow housing comprises a first tubular portion to house the stem portion of the first motorized actuator mechanism and a second tubular portion to house the stem portion of the second motorized actuator mechanism, and the two tubular portions are parallel and adjacent to each other.

3. The system of claim 1, wherein the water flow housing comprises a bracket portion disposed at the distal end of the first tubular portion and a bracket portion disposed at the distal end of the second tubular portion.

4. The system of claim 1, further comprising a water temperature sensor disposed within the water flow housing.

5. The system of claim 1, wherein the hot water inlet connector and the cold water inlet connector each comprises an inlet water filter and a check valve.

6. The system of claim 1, wherein the hot water valve and the cold water valve comprise a rotating hot water cartridge with a first opening and a cold water cartridge with a second opening respectively.

7. The system of claim 1, wherein:

the first motorized actuator mechanism comprises a rotating hot water cartridge, a gasket, a cartridge locking nut, a motor actuator adapter, and a motorized actuator; and

the second motorized actuator mechanism comprises a rotating cold water cartridge, a gasket, a cartridge locking nut, a motor actuator adapter, and a motorized actuator.

8. The system of claim 1, wherein the hot and cold water flow are mixed in the water mixing chamber, and the mixed water is directed through the solenoid valve housing and out of the water outlet connector.

9. A water flow and temperature control mixing system for a touch free automatic faucet, comprising:

a water flow mechanism, comprising:

a water flow housing;

a hot water inlet connector;

a cold water inlet connector;

a water mixing chamber;

a solenoid valve housing; and

a water outlet connector

a first motorized actuator mechanism coupled to the water flow mechanism, the first motorized actuator mechanism configured to receive hot water and comprising:

a stem portion; and

a hot water flow valve;

a second motorized actuator mechanism coupled to the water flow mechanism, the second motorized actuator mechanism configured to receive cold water and comprising:

a stem portion; and

a cold water flow valve;

wherein the first motorized actuator mechanism and the second motorized actuator mechanism are parallel to each other on the distal end of the water flow mechanism, the hot water inlet connector is coaxial to the first motorized actuator mechanism, and the cold water inlet connector which is coaxial to the second motorized actuator mechanism.

10. The system of claim 9, wherein the solenoid valve housing is positioned medially between the first motorized actuator mechanism and the second motorized gear mechanism, and medially between the distal end and the proximal end of the water flow mechanism.

11. The system of claim 9, wherein the water flow housing of claim comprises a first tubular portion to house the stem portion of the first motorized actuator mechanism and a second tubular portion to house the stem portion of the second motorized actuator mechanism, and the two tubular portions are parallel and adjacent to each other.

12. The system of claim 11,wherein the water flow housing comprises a bracket portion disposed at the distal end of the first tubular portion and a bracket portion disposed at the distal end of the second tubular portion.

13. The system of claim 9, further comprising a water temperature sensor disposed in a a water temperature sensor housing coupled to the water mixing chamber.

14. The system of claim 9, wherein the hot and cold water flow are mixed in the water mixing chamber, and the mixed water is directed through the solenoid valve housing and out of the water outlet connector.

15. A water flow and temperature control mixing system for a touch free automatic faucet, comprising:

a water flow mechanism, comprising:

a water flow housing;

a hot water inlet connector;

a cold water inlet connector;

a water mixing chamber;

a solenoid valve housing; and

a water outlet connector

a first motorized actuator mechanism coupled to the water flow mechanism, the first motorized actuator mechanism configured to receive hot water and comprising:

a rotating hot water cartridge;

an actuator;

a second motorized actuator mechanism coupled to the water flow mechanism, the second motorized actuator mechanism configured to receive cold water and comprising:

a rotating cold water cartridge;

an actuator;

wherein the first motorized actuator mechanism and the second motorized actuator mechanism are parallel to each other on the distal end of the water flow mechanism, the hot water inlet connector is coaxial to the first motorized actuator mechanism, and the cold water inlet connector which is coaxial to the second motorized actuator mechanism.

16. The system of claim 15, wherein the solenoid valve housing is positioned medially between the first motorized actuator mechanism and the second motorized actuator mechanism, and medially between the distal end and the proximal end of the water flow mechanism.

17. The system of claim 16, wherein the solenoid valve housing is coaxial to the water outlet connector, and the water outlet connector is parallel to the cold water inlet connector and the hot water inlet connector.

18. The system of claim 15, wherein the water flow housing comprises a first tubular portion to house the stem portion of the first motorized actuator mechanism and a second

tubular portion to house the stem portion of the second motorized actuator mechanism, wherein the first and second tubular portions are parallel and adjacent to each other.

19. The system of claim 15, further comprising a water temperature sensor disposed within a water temperature sensor housing coupled to the water mixing chamber.

20. The system of claim 15, wherein the hot and cold water flow are mixed in the water mixing chamber, and the mixed water is directed through the solenoid valve housing and out of the water outlet connector.

21. The system of claim 15, wherein the cold water inlet connector is coaxial to the cold water flow valve to collectively form a cold water passage way, and the hot water inlet connector is coaxial to the hot water flow valve to collectively form a hot water passage way.

22. A faucet sensor system, comprising:

a faucet spout;

a sensor housing coupled to the faucet spout;

a plurality of sensor assemblies disposed within the sensor housing;

a sensor holding element coupled to the plurality of sensor assemblies disposed within the sensor housing;

a securing nut coupled to the sensor holding element disposed within the sensor housing; and

a faucet stationary base.

23. The system of claim 22, wherein the plurality of sensor assemblies comprises a primary sensor assembled on a first printed circuit board and placed inside a sensor cover to form a primary sensor assembly, a plurality of secondary sensors assembled on a second printed circuit board and placed inside a sensor cover to form a secondary sensor assembly, and a plurality of tertiary sensors assembled on a third printed circuit board and placed inside a sensor cover to form a tertiary sensor assembly.

24. The system of claim 23, wherein the sensor housing comprises a window configured to align with the primary sensor assembly, a window configured to align with the secondary sensor assembly, and a window configured to align with the tertiary sensor assembly.

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25. The system of claim 22, further comprising a water outlet spray head, and wherein the primary sensor assembly is configured in the same direction as the water outlet spray head.

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Fig. 1

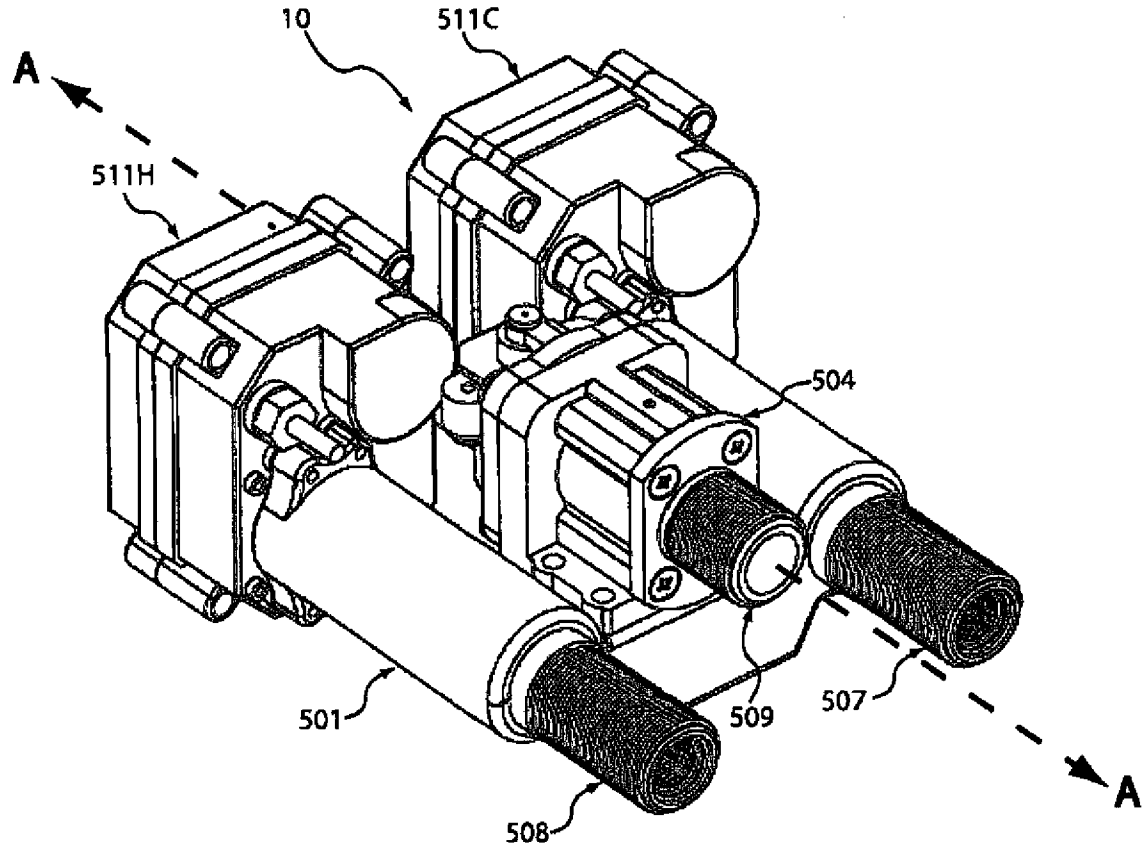
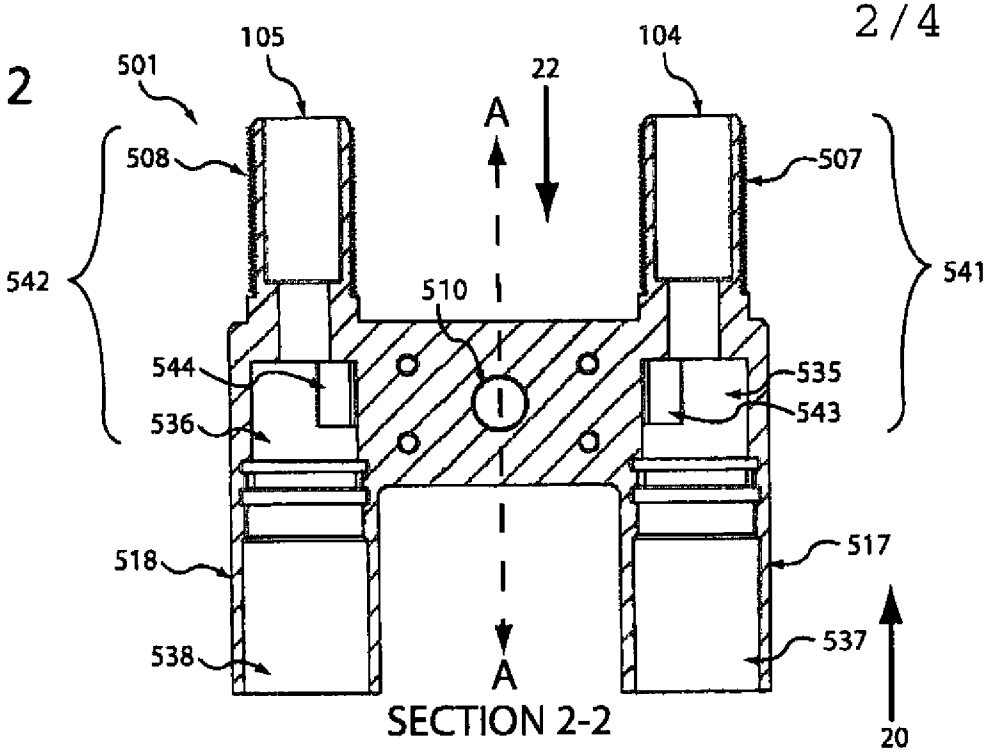


Fig. 2



SECTION 2-2

Fig. 3

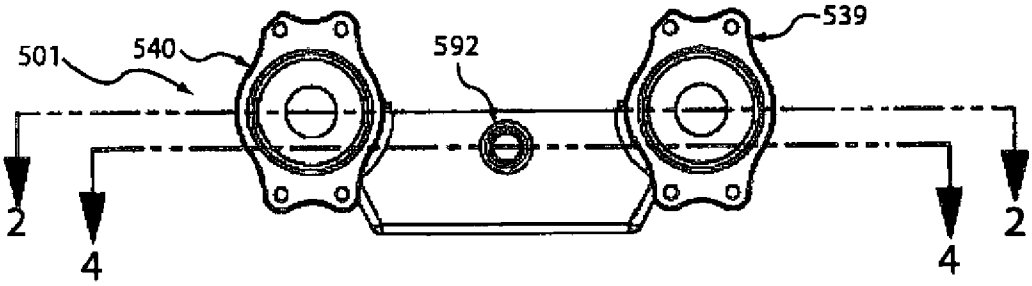
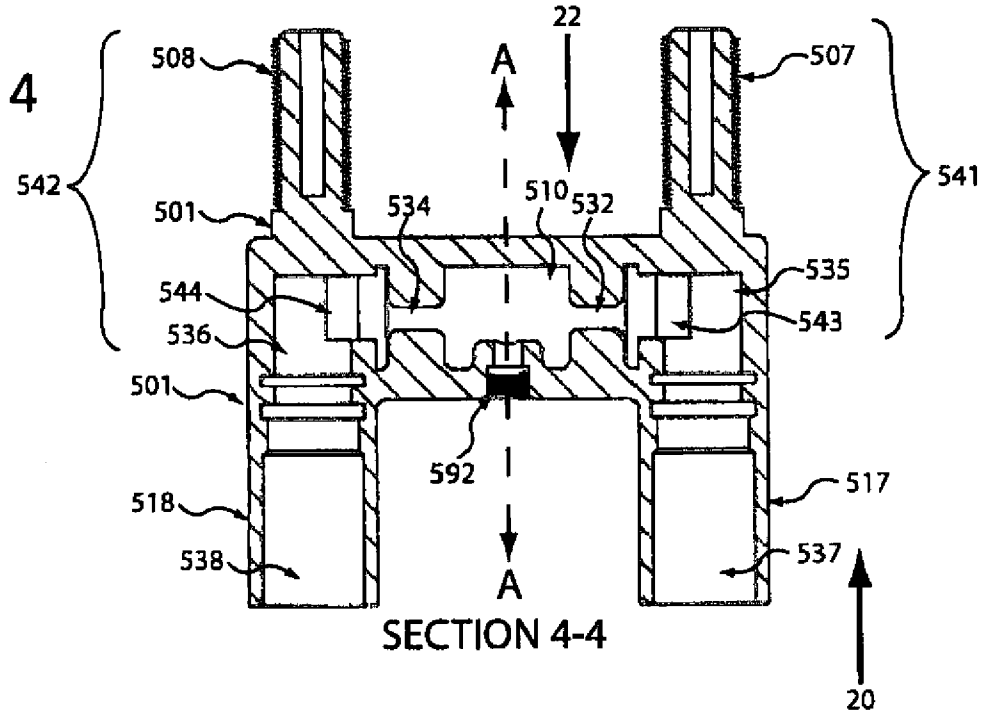


Fig. 4



SECTION 4-4

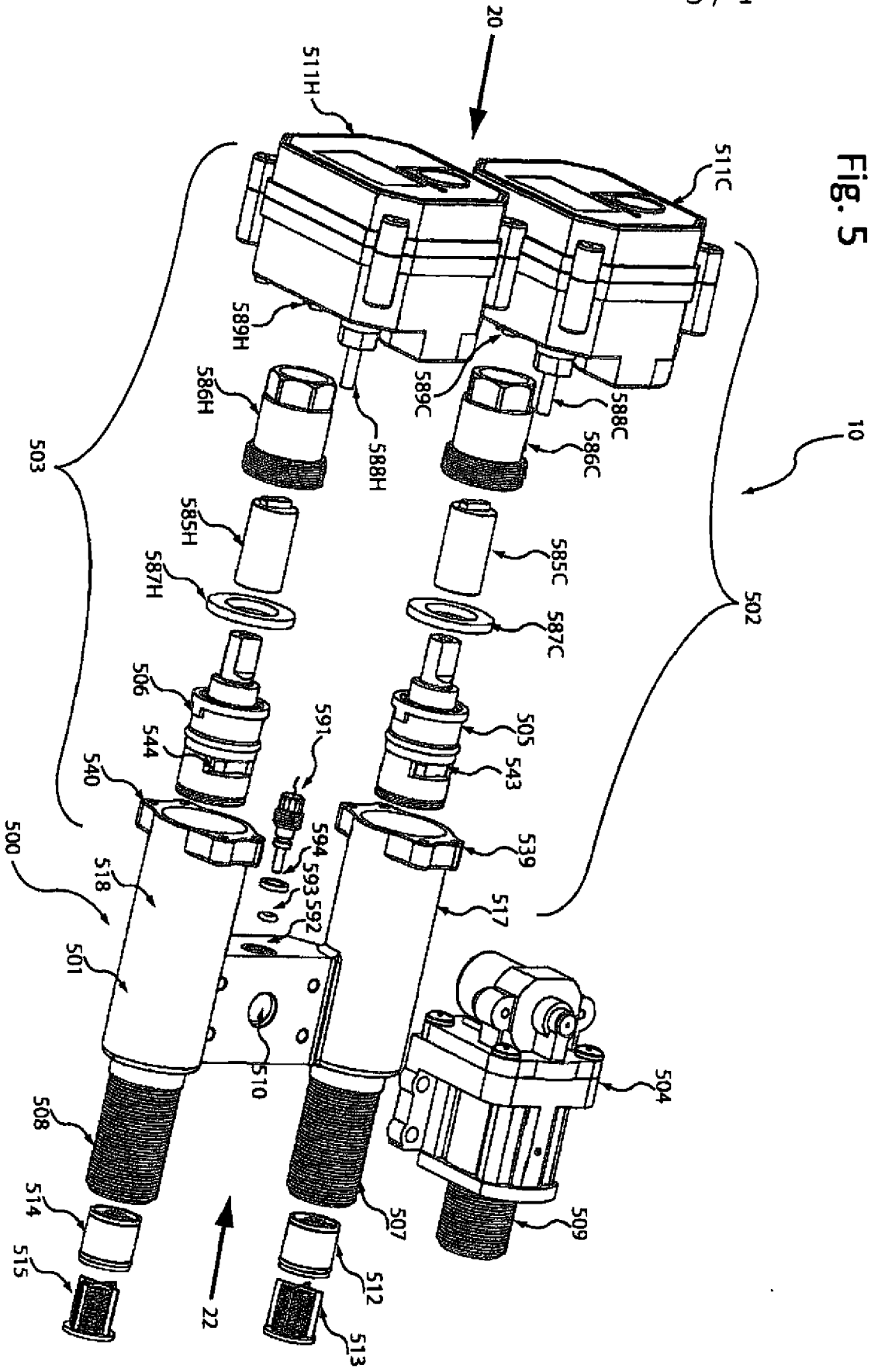

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511C
589H
589C
586H
588C
588H
586C
503
10
585H
585C
587H
587C
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506
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505
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Fig. 5

Fig. 6

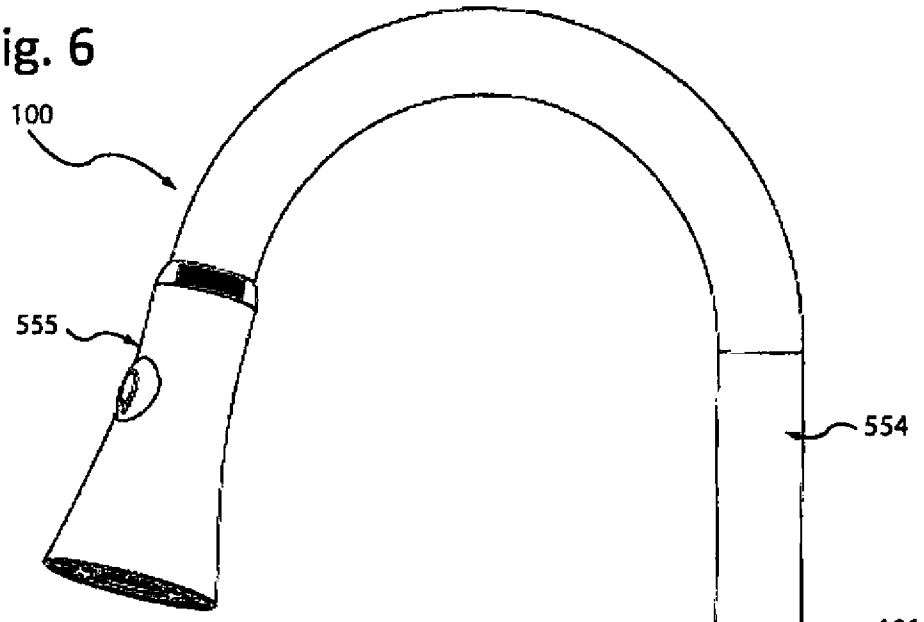
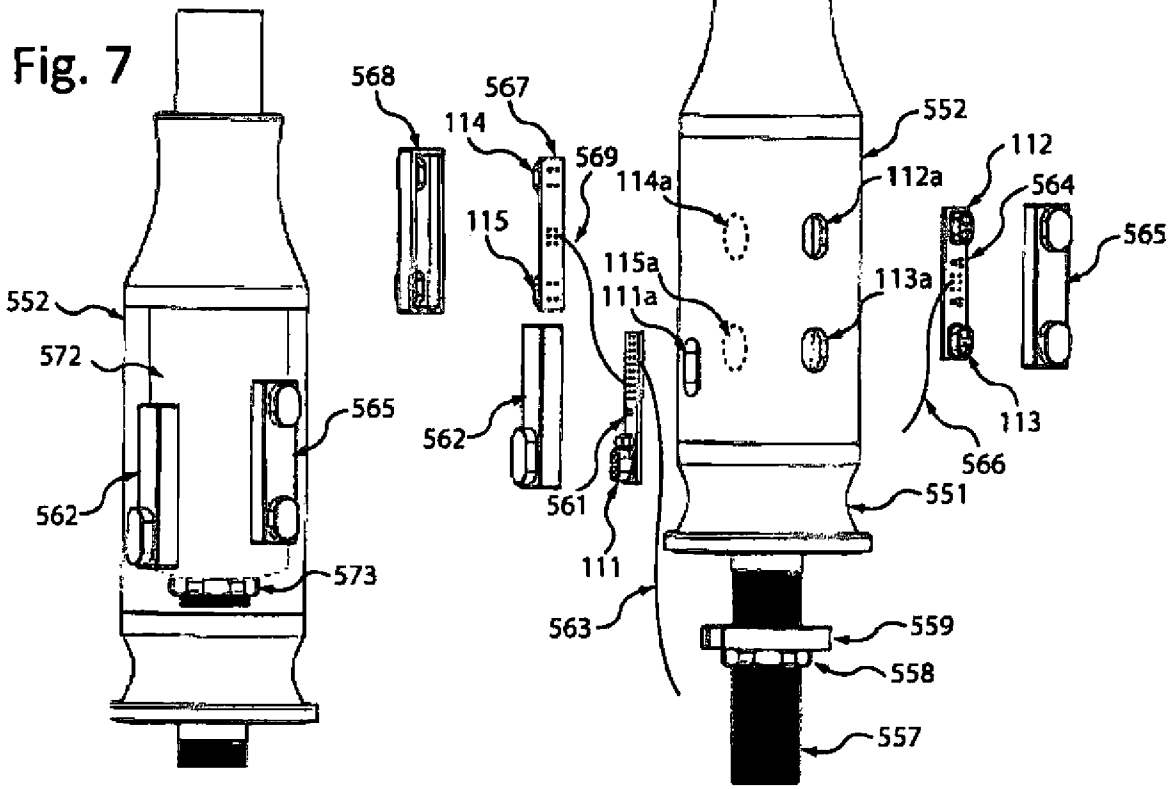

100
555
554
101

Fig. 7


568
567
114
569
114a
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115a
111a
552
572
565
562
573
562
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112
112a
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113
566
551
559
558
557

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/22207

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - E03C 1/04 (2011.01)
USPC - 4/676
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - E03C 1/04 (2011.01)
USPC - 4/676

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8) - E03C 1/04 (2011.01)
USPC - 4/675, 676, 678; 251/89, 129.01, 129.15, 142, 205, 213, 356; 137/2, 78.1, 79, 80, 343, 386, 455, 561R

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWest (PGPB, USPT, EPAB, JPAB); Google (Patents, Scholar, Web)
Search Terms: faucet, spigot, automatic, hand, touch, free, housing, tube, tubular, cylinder, hot, warm, heat, water, cold, cool, mix, blend, combine, valve, solenoid, inlet, filter, check, outlet, actuate, motor, automatic, actuator, second, two, rotate, pivot, cartridge, gasket, nu

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/0271238 A1 (REEDER et al.) 06 November 2008 (06.11.2008) Fig. 7, 21, 25, 42-44; Para [0137], [0173]-[0177], [0207]-[0215]	1-4, 8-14
Y		5-7, 15-21
Y	US 7,134,451 B1 (MALAPANES) 14 November 2006 (14.11.2006) Fig. 4; col 48-59	5
Y	US 6,298,875 B1 (WARSHAWSKY et al.) 09 October 2001 (09.10.2001) Fig. 4-5; col 3, ln 39-47	6-7, 15-21

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 May 2011 (13.05.2011)	25 MAY 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/22207

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Group I: claims 1-21: directed to a water flow and temperature control mixing system.

Group II: claims 22-25: directed to a faucet sensor system.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Claims 1-21

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.