US010208870B1

(12) **United States Patent**
Huang et al.

(10) **Patent No.: US 10,208,870 B1**
(45) **Date of Patent: Feb. 19, 2019**

(54) **SOLENOID VALVE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

(21) Appl. No.: **15/672,504**

(22) Filed: **Aug. 9, 2017**

(51) **Int. Cl.**
F16K 31/06 (2006.01)

(52) **U.S. Cl.**
CPC ***F16K 31/0668*** (2013.01); ***F16K 31/0655*** (2013.01)

(58) **Field of Classification Search**
CPC F16K 31/0655; F16K 31/0668
USPC 251/129.15
See application file for complete search history.

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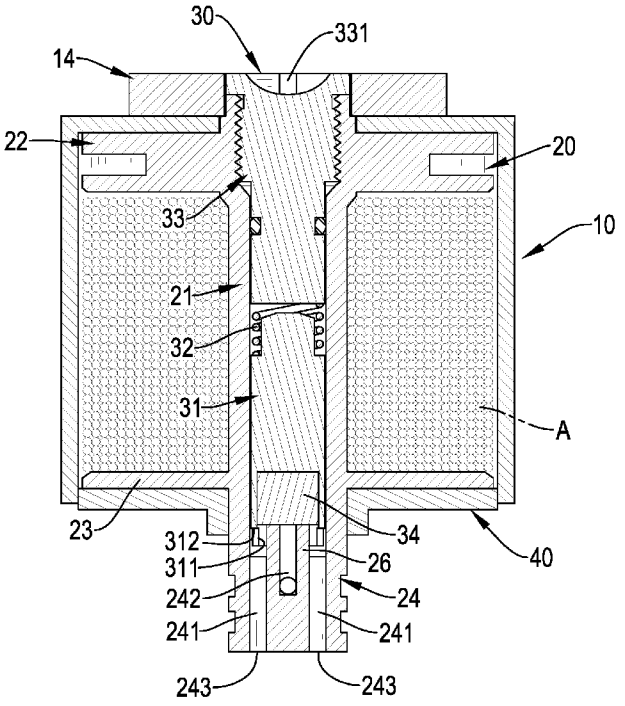
(57) **ABSTRACT**

A solenoid valve includes a coil housing, a coil barrel and an actuator. The coil barrel is mounted in the coil housing, is coiled with multiple coils, and has a valve gate formed on a bottom of the coil barrel. The actuator is moveably mounted in the coil barrel and has a piston, a magnetic shaft, a spring mounted between the piston and the magnetic shaft, and a sealing pad abutting the piston. The actuator is driven by the coils to move the piston. The piston has two notches being able to break a vacuum state, and can be pushed upward easily and efficiently to save electricity.

4 Claims, 7 Drawing Sheets



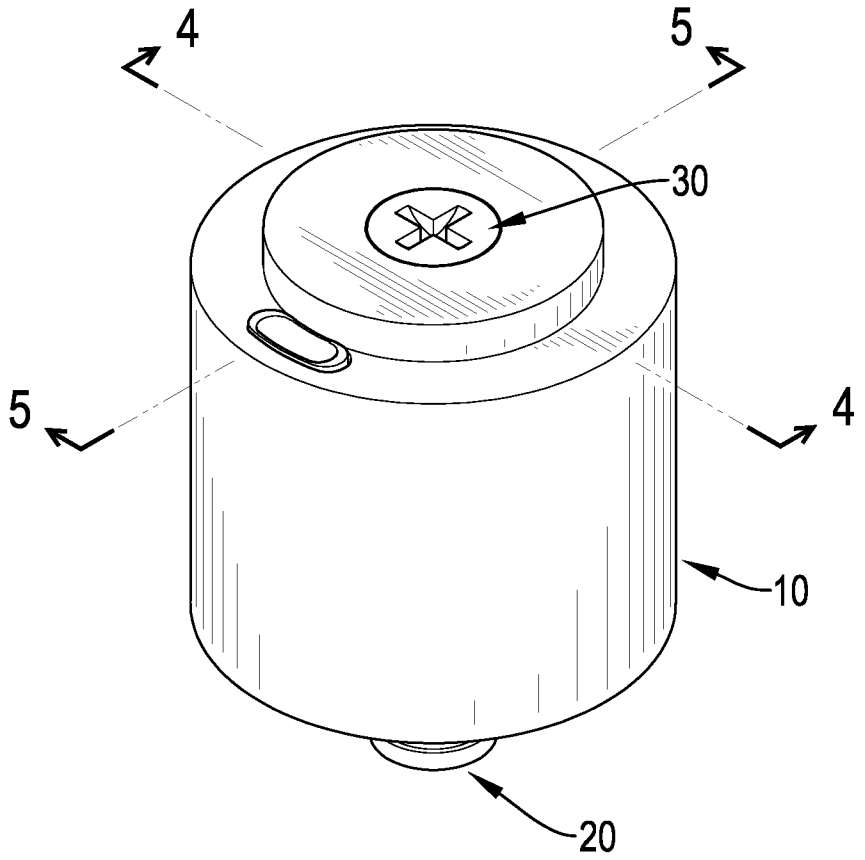


FIG.1

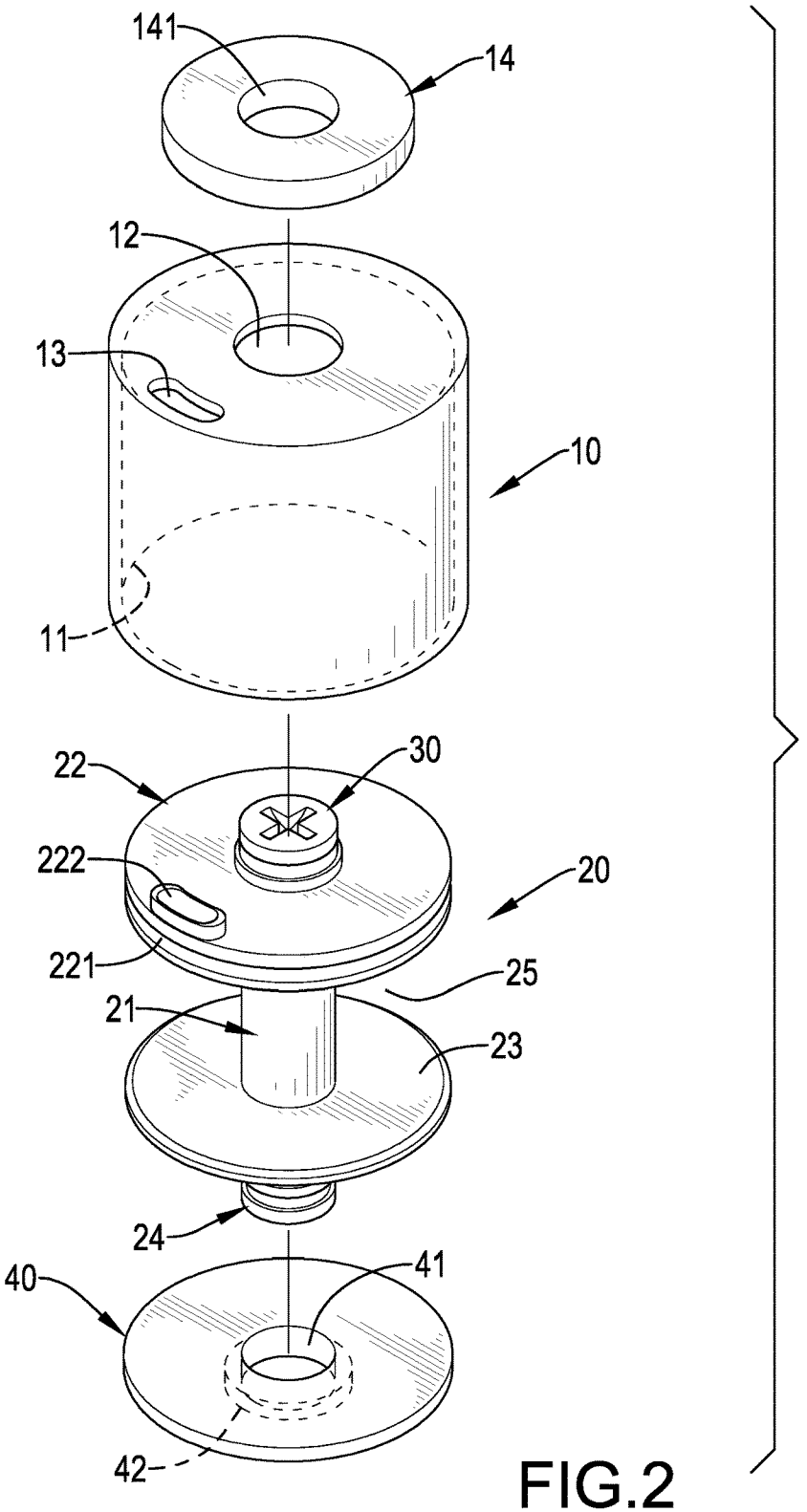
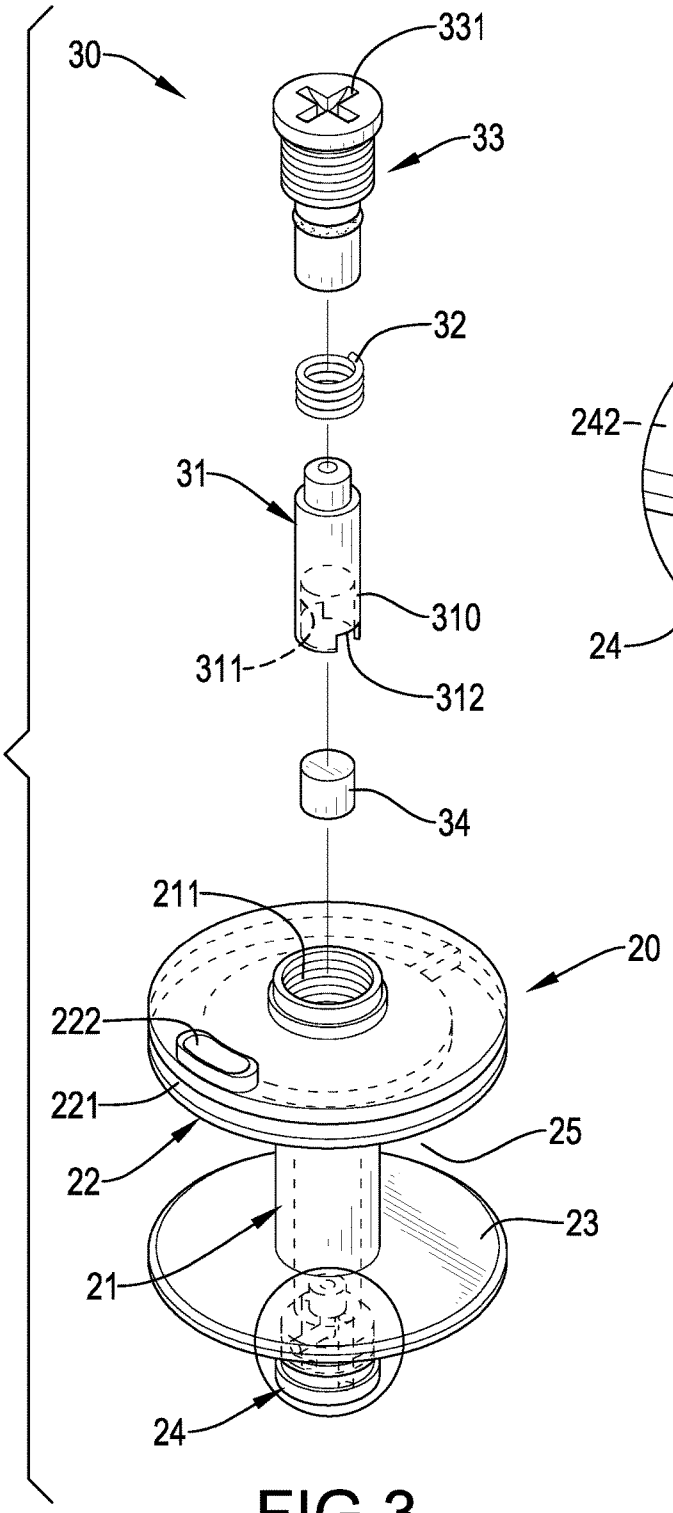


FIG.2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331
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310
311
312
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211
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FIG.3

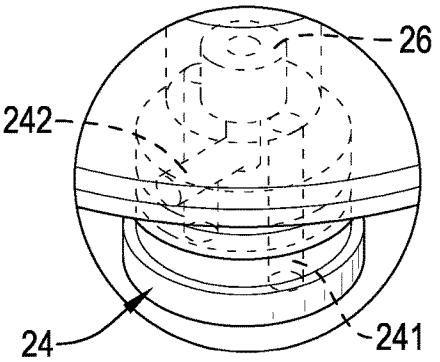
26
242
24
241

FIG.3A

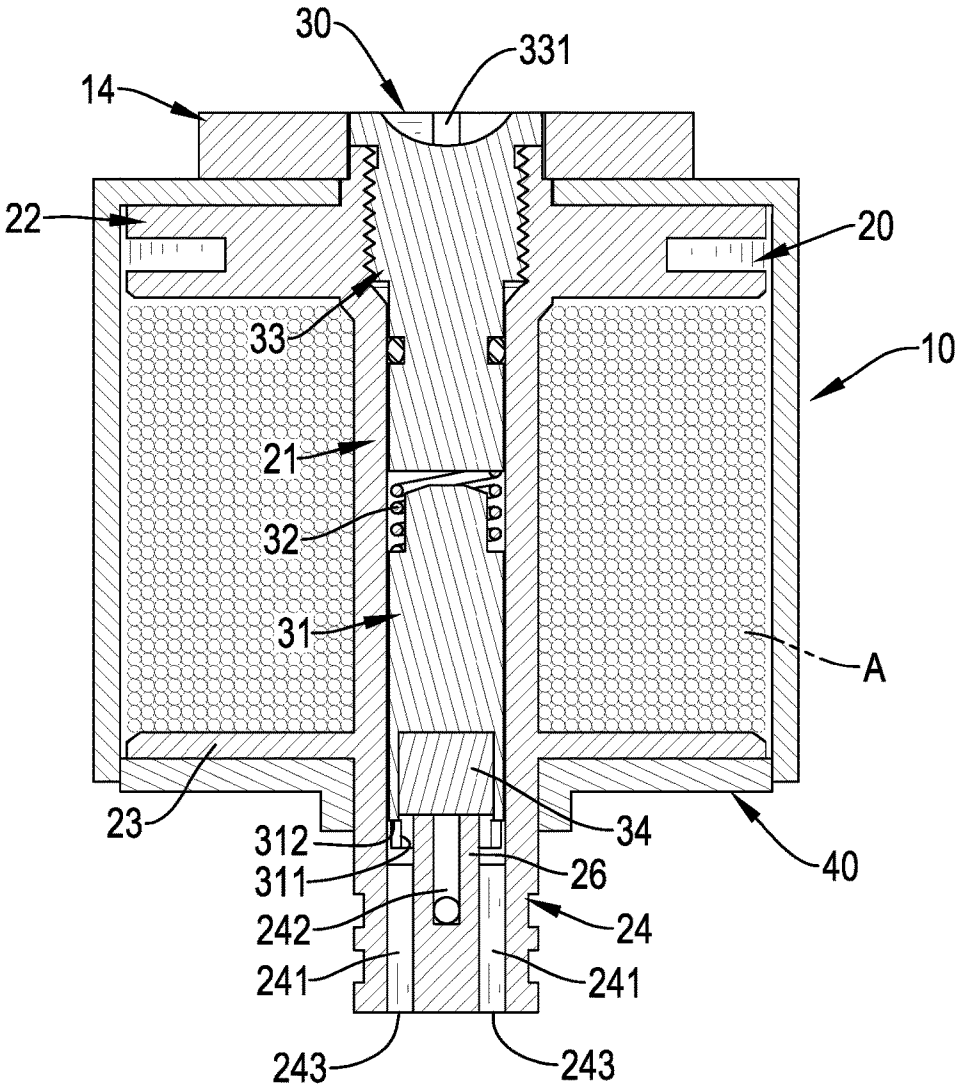
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FIG.4

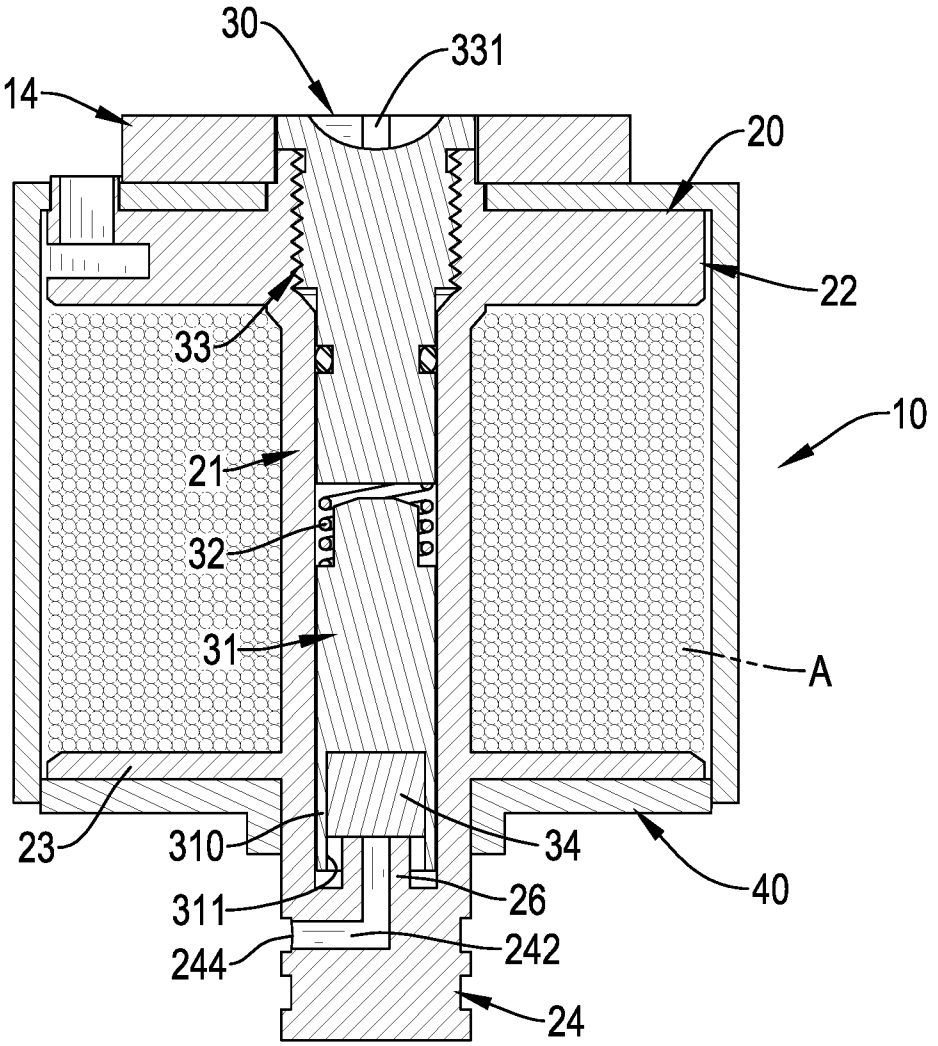

FIG.5

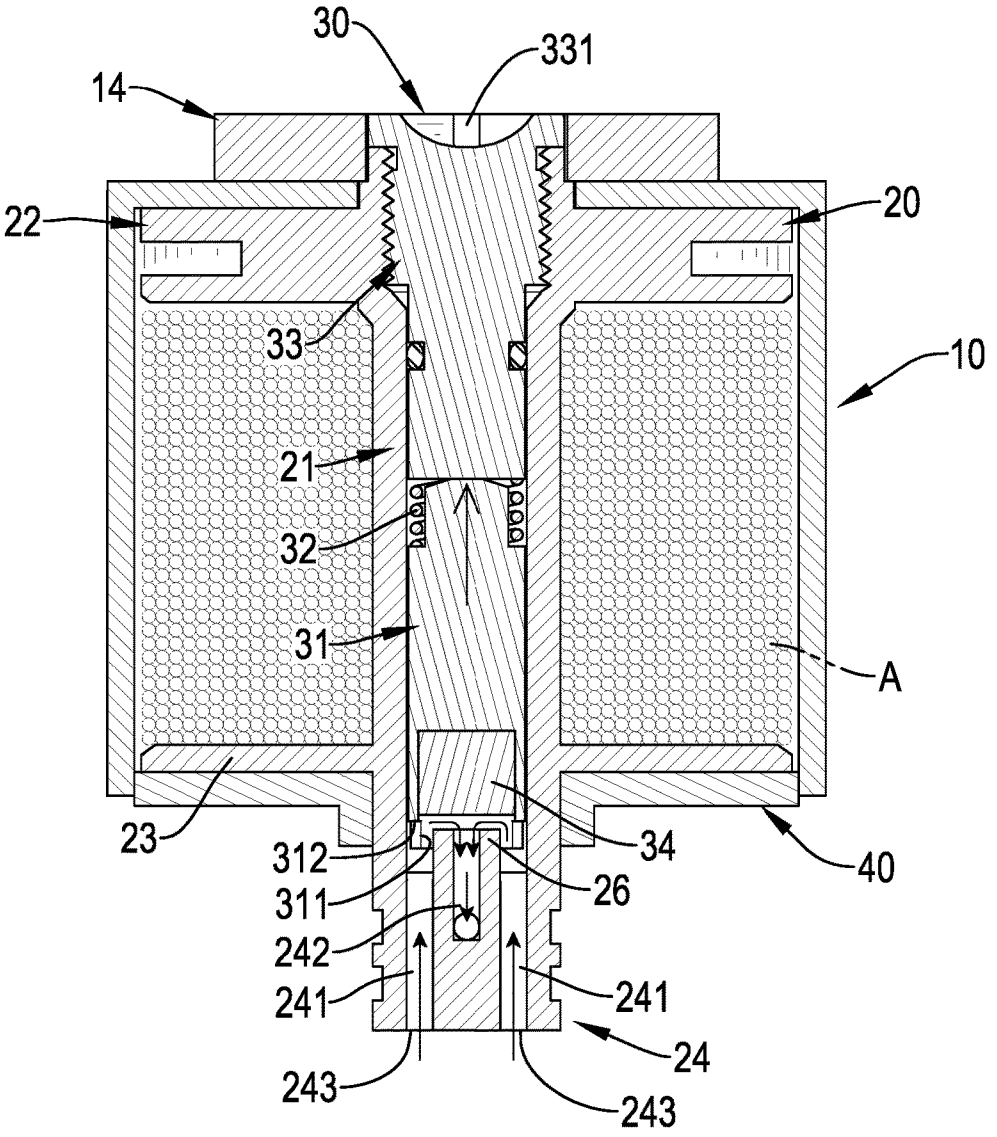
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FIG.6

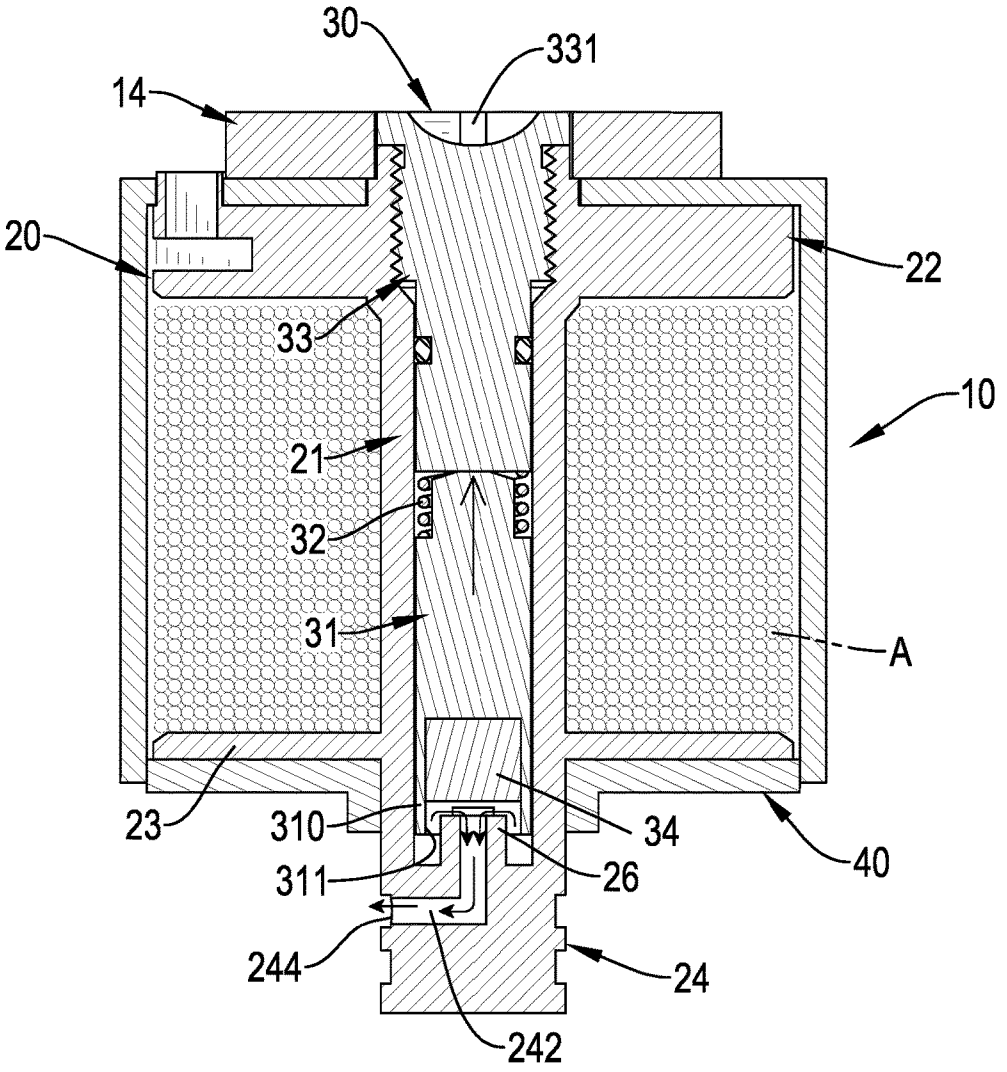

FIG.7

SOLENOID VALVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates a solenoid valve, more particularly to a solenoid valve that improves the stability of operation, prolongs the service time and has efficient movement to save electricity.

2. Description of Related Art

The conventional automatic water flushers are installed in most public toilets because people increasingly care about the hygiene issue. Therefore, the sink faucet or the urinal tap in the public toilet adopts automatic water flushers to avoid contact with and spread of bacteria or virus.

The conventional automatic water flusher includes a body sensor and a solenoid valve. The body sensor is used for detecting a human body or hand approaching by infrared rays. The solenoid valve includes a valve body and an electromagnet unit connected with the valve body.

The valve body has an inlet port, an outlet tube and a valve gate connected between the inlet port and the outlet tube. The inlet port is connected with a water pipe. The outlet tube is connected with a facility such as a water faucet, urinal tap or any other water flusher.

The electromagnet unit is mounted on the valve body and has a coil barrel, a coil mounted around the coil barrel, a magnetic shaft mounted in the coil barrel, and a piston mounted in the coil barrel and detachably connected with the magnetic shaft. A sealing pad is mounted in one end of the piston.

The solenoid valve is controlled by the body sensor to generate a magnetic field by the coil. The magnetic field passes the magnetic shaft and makes the piston move downward or upward to open or close the valve gate. So, the water from the water pipe can flow into the inlet port and flow out from the outlet tube to the facility.

The piston and a bottom housing extending upwardly will decrease a coiling space around the coil barrel, so the driving force from the coil to the piston will be reduced.

A side wall of the coil barrel is located above the valve gate of the valve body, which occupies a space around the valve gate and badly affects the magnetic route of the piston in movement.

Furthermore, the sealing pad is compressible and has a compression value, which means the compression value of the sealing pad will be bigger under a higher pressure. Consequently, a gap is formed and a magnetic resistance between the piston and the magnetic shaft is increased, and the service life of the sealing pad will be shortened.

In addition, the coil barrel and the valve body are manufactured separately and then assembled to each other. Due to manufacturing errors, an assembling gap is formed between the piston and the magnetic shaft and cannot be controlled at a constant value. It will make the solenoid valve unstable in driving and increases the manufacture time and steps of process.

To overcome the shortcomings of the conventional solenoid valve, the present invention provides a solenoid valve to mitigate or obviate the aforementioned problems.

SUMMARY OF THE INVENTION

The main objective of the present invention is to provide a solenoid valve.

The solenoid valve includes a coil housing, a coil barrel and an actuator. The coil barrel is mounted in the coil housing, is coiled with multiple coils, and has a valve gate formed on a bottom of the coil barrel. The actuator is moveably mounted in the coil barrel and has a piston, a spring, a magnetic shaft and a sealing pad. The spring is mounted between the piston and the magnetic shaft. One end of the piston is mounted around the valve gate.

The actuator can be driven by the coils. The valve gate is manufactured integratedly with the coil barrel. The piston abuts on the valve gate by a sealing pad to increase the strength and to reduce the volume of the valve gate.

Other objects, advantages, and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a solenoid valve in accordance with the present invention;

FIG. **2** is an exploded perspective view of the solenoid valve in FIG. **1**;

FIG. **3** is an enlarged exploded perspective view of an actuator and a coil barrel of the solenoid valve in FIG. **1**;

FIG. **3**A is an enlarged perspective view in partial section of the coil barrel of the solenoid valve in FIG. **3**;

FIG. **4** is a cross-sectional front view of the solenoid valve along the line **4-4** in FIG. **1**;

FIG. **5** is a cross-sectional side view of the solenoid valve along the line **5-5** in FIG. **1**;

FIG. **6** is an operational cross-sectional front view of the solenoid valve in FIG. **1**; and

FIG. **7** is an operational cross-sectional side view of the solenoid valve in FIG. **1**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

With reference to FIG. **1** to FIG. **5**, a solenoid valve of a preferred embodiment includes a coil housing **10**, a coil barrel **20**, an actuator **30** and a bottom cover **40**.

The coil housing **10** is hollow, is cylindrical, and has a top surface, a bottom opening **11**, an adjusting hole **12**, a wire hole **13** and a magnet **14**. The bottom opening **11** is formed in the bottom of the coil housing **10**. The adjusting hole **12** and the wire hole **13** are formed in the top surface of the coil housing **10**. The adjusting hole **12** is located at a center of the top surface of the coil housing **10**. The wire hole **12** is located adjacent to a periphery of the top surface of the coil housing **10**. The magnet **14** is a round disc, is mounted on the top surface of the coil housing **10**, and has a tube hole **141** aligned axially with the adjusting hole **12**.

The coil barrel **20** is mounted in the coil housing **10** and includes a shaft tube **21**, an upper wall **22**, a lower wall **23**, a valve body **24**, a coiling area **25** and a valve gate **26**. The shaft tube **21** has a top end, a bottom end, and an adjusting segment **211** formed on the top end of the shaft tube **21**. The adjusting segment **211** has an inner thread and is mounted in the adjusting hole **12** of the coil housing **10** and the tube hole **141** of the magnet **14**.

The upper wall **22** and the lower wall **23** are respectively and radially formed around the shaft tube **21**. The upper wall **22** is located adjacent to the adjusting segment **211** of the shaft tube **21** and has a wire channel **221** and a wire recess **222**. The wire channel **221** is annularly formed around a periphery of the upper wall **22**. The wire recess **222** is

formed through a top surface of the upper wall **22** and communicates with the wire channel **221**, and the shape of the wire recess **222** corresponds to the shape of the wire hole **13**. The lower wall **23** is located adjacent to the valve body **24** of the shaft tube **21**.

The valve body **24** is formed on the bottom end of the shaft tube **21** and has two inlet grooves **241**, an outlet groove **242**, two inlet openings **243** and an outlet opening **244**. The inlet grooves **241** are formed through the bottom end of the shaft tube **21**. The outlet groove **242** is L-shaped, is formed in the shaft tube **21** and is located between the inlet grooves **241**. The inlet openings **243** are formed in the bottom end of the shaft tube **21** and respectively communicate with the inlet grooves **241**. The outlet opening **244** is formed in a periphery of the shaft tube **21** and communicates with the outlet groove **242**.

The coiling area **25** is defined between the upper wall **22** and the lower wall **23**. Preferably, multiple coils A are coiled around the coiling area **25** of the coil barrel **20**. The valve gate **26** is formed in the valve body **24** and communicates with the inlet grooves **241** and the outlet groove **242**.

With reference to FIGS. **3** to **5**, the actuator **30** is mounted in the shaft tube **21** and includes a piston **31**, a spring **32**, a magnetic shaft **33** and a sealing pad **34**. The piston **31** is movably mounted in the shaft tube **21** and has a side wall **310** downwardly formed around a bottom end of the piston **31**, a pad recess **311** formed in the side wall **310**, and two notches **312** formed in a bottom edge of the side wall **310** diametrically opposite each other. The spring **32** is mounted around a top end of the piston **31**. The magnetic shaft **33** is columnar and is adjustably mounted in the adjusting segment **211** of the coil barrel **20** and abuts the spring **32**. The magnetic shaft **33** has a driving recess **331** formed in a top of the magnetic shaft **33** for a screw driver to rotate and to adjust the position of the magnetic shaft **33**. The magnetic shaft **33** further has an outer thread correspondingly screwed with the inner thread of the adjusting segment **211**. The sealing pad **34** is made of rubber and is mounted in the pad recess **311**. The piston **31** abuts the valve gate **26** by the sealing pad **34**. The side wall **310** of the piston **31** covers an outer side of the valve gate **26**.

With reference to FIGS. **2**, **4** and **5**, the bottom cover **40** is a round plate, is mounted on the bottom opening **11** of the coil housing **10**, and has a bottom surface, a through hole **41** and a flange **42**. The through hole **41** is formed through a center of the bottom surface of the bottom cover **40** and is mounted around the shaft tube **21**. The flange **42** is downwardly formed on the bottom surface of the bottom cover **40** and is located around the through hole **41**.

With reference to FIGS. **6** and **7**, the coils A are energized to generate an electromagnetic field to active the actuator **30**. The piston **31** will be pushed up by the electromagnetic force, and the sealing pad **34** is moved away from the valve gate **26** to make water flow from the inlet grooves **241** to the outlet groove **242**.

As described above, the advantages of the present invention are as follows:

1. The flange **42** of the bottom cover **40** is formed downward and will not occupy the coiling area **25** around the coil barrel **20**. Therefore, the coiling area **25** can be coiled with more coils to increase the driving force to push the piston **31**.

2. The side wall **310** of the piston **31** covering the outer side of the valve gate **26** can save space in the coil barrel **20** and keep the magnetic route of the piston **31** moving.

3. The piston **31** can abut on a surface around the valve gate **26** to limit the compression value of the sealing pad **34**, to reduce a gap and a magnetic resistance between the piston **31** and the magnetic shaft **33**, and to prolong the service life of the sealing pad **34**.

4. The valve body **24** and the valve gate **26** are manufactured integratedly with the coil barrel **20**, and the assembling gap between the piston **31** and the magnetic shaft **33** do not need adjusting. It can reduce the manufacturing error, save the production time, and simplify the processing steps.

5. When assembling without water pressure, the assembling gap between the piston **31** and the magnetic shaft **33** can be controlled at a constant value to increase stability of the solenoid valve.

6. The notches **312** of the piston **31** can break a vacuum state when the piston **31** is moved, so the piston **31** can be pushed upward easily and efficiently to save electricity.

Even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A solenoid valve comprising:

a coil housing being hollow and cylindrical and having a top surface and a bottom opening, wherein the coil housing has

an adjusting hole formed in the top surface of the coil housing and located at a center of the top surface of the coil housing; and

a wire hole formed in the top surface of the coil housing and located adjacent to a periphery of the top surface of the coil housing; and

a magnet having a tube hole;

a coil barrel mounted in the coil housing and including

a shaft tube having a top end and a bottom end, and an adjusting segment formed on the top end of the shaft tube and mounted in the adjusting hole of the coil housing;

the tube hole of the magnet disposed around the adjusting segment of the shaft tube;

an upper wall and a lower wall respectively and radially formed around the shaft tube;

a valve body formed on the bottom end of the shaft tube and having at least one inlet groove and at least one outlet groove;

a coiling area defined between the upper wall and the lower wall; and

a valve gate formed in the valve body and communicating with the at least one inlet groove and the at least one outlet groove;

an actuator mounted in the shaft tube and including

a piston movably mounted in the shaft tube and having

a side wall downwardly formed around a bottom end of the piston and covering the valve gate,

a pad recess formed in the side wall and the valve gate covered in the pad recess; and,

two notches formed in the side wall diametrically opposite each other;

a magnetic shaft adjustably mounted in the adjusting segment of the shaft tube, wherein the upper wall is located adjacent to the adjusting segment of the shaft tube and has a wire channel and a wire recess, and the wire channel is annularly formed around a periphery of the upper wall; and

the lower wall is located adjacent to the valve body;

a spring mounted between the piston and the magnetic shaft;

a sealing pad mounted in the pad recess of the piston; and

a bottom cover mounted on the bottom opening of the coil housing and having

a through hole formed through a center of the bottom cover and disposed around the shaft tube; and

a flange downwardly formed on a bottom surface of the bottom cover and located around the through hole,

wherein the bottom end of the shaft tube is mounted through the through hole of the bottom cover.

2. The solenoid valve as claimed in claim **1**, wherein

the at least one inlet groove of the valve body includes two inlet grooves, and the at least one outlet groove of the valve body includes one outlet groove;

the two inlet grooves are formed through the bottom end of the shaft tube and two inlet openings are formed in the bottom end of the shaft tube to communicate with the two inlet grooves; and

the outlet groove is L-shaped, is located between the two inlet grooves, and an outlet opening is formed in a periphery of the shaft tube to communicate with the outlet groove.

3. The solenoid valve as claimed in claim **1**, wherein the magnetic shaft is columnar and is connected with the adjusting segment of the coil barrel.

4. The solenoid valve as claimed in claim **3**, wherein

the at least one inlet groove of the valve body includes two inlet grooves, and the at least one outlet groove of the valve body includes one outlet groove;

the two inlet grooves are formed through the bottom end of the shaft tube and two inlet openings are formed in the bottom end of the shaft tube to communicate with the two inlet grooves; and

the outlet groove is L-shaped, is located between the two inlet grooves, and an outlet opening is formed in a periphery of the shaft tube to communicate with the outlet groove.

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