United States Patent [19]

Nakanishi

[11] **3,776,505**

[45] **Dec. 4, 1973**

[54] **VALVE**

[75] Inventor: **Sadayuki Nakanishi**, Kobe, Japan

[73] Assignee: **Kobe Steel, Ltd.**, Kobe, Japan

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[21] Appl. No.: **297,992**

[30] **Foreign Application Priority Data**

Sept. 30, 1971 Japan 46/77224

[52] **U.S. Cl.** **251/163**, 251/215

[51] **Int. Cl.** **F16k 5/14**

[58] **Field of Search** 251/56, 157, 162, 251/163, 192, 203, 204, 213, 215

[56] **References Cited**

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Primary Examiner—Martin P. Schwadron

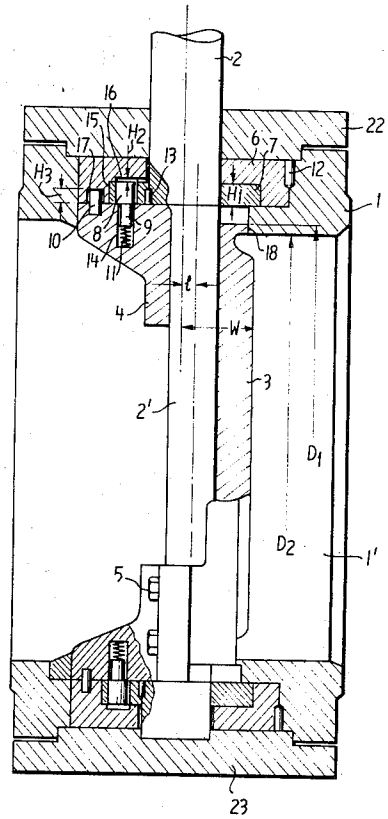
Assistant Examiner—David R. Matthews

Attorney—Norman F. Oblon et al.

[57] **ABSTRACT**

A valve comprising a valve plate for closing a through fluid passageway which is first retracted from the valve seat and then rotated in order to open, a valve rod having an eccentric portion rotatably supporting the valve plate, a retraction guide pin for the valve plate engaging with the body of the valve to guide the valve plate during its retraction upon rotating the valve rod through a first portion, and a rotation guide pin to lock the valve plate with the valve rod only during a second portion of rotation of the valve rod for movement therewith.

6 Claims, 13 Drawing Figures



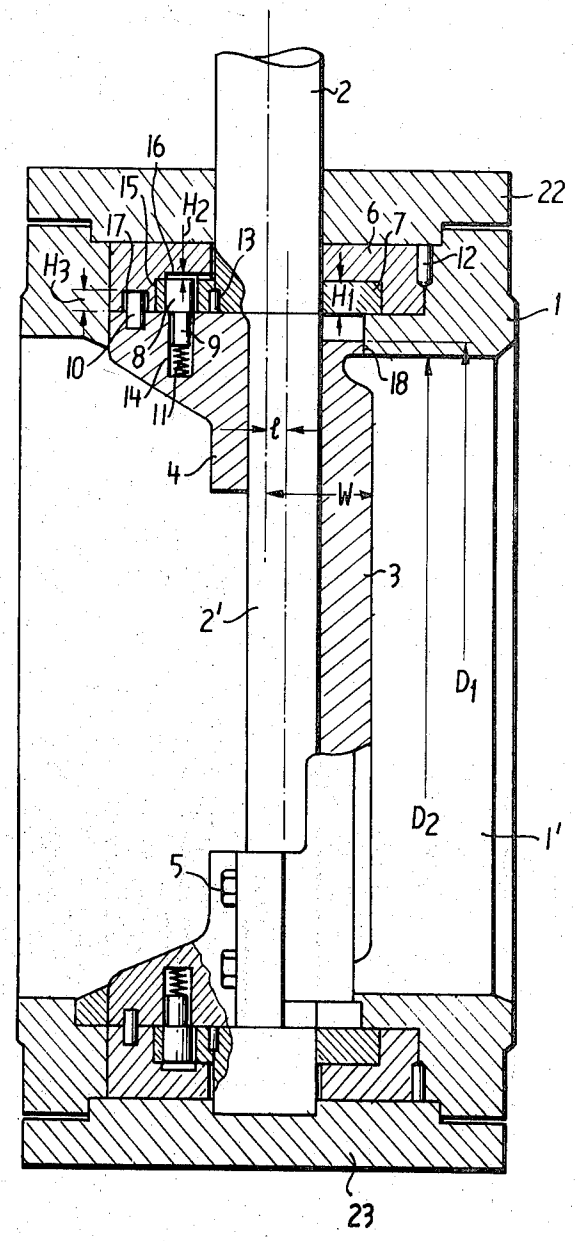


FIG. 1

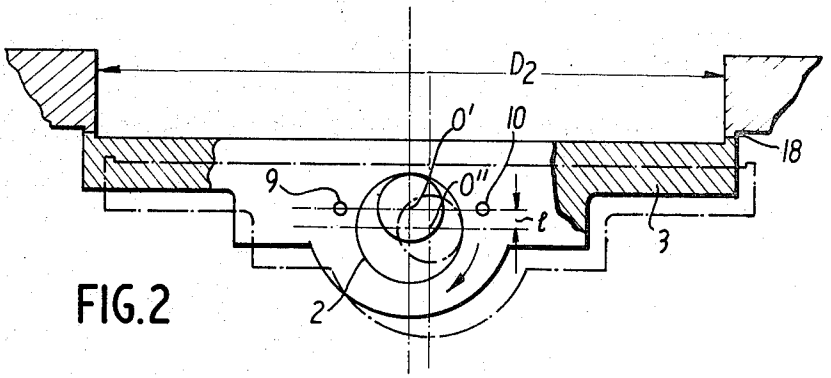


FIG.2

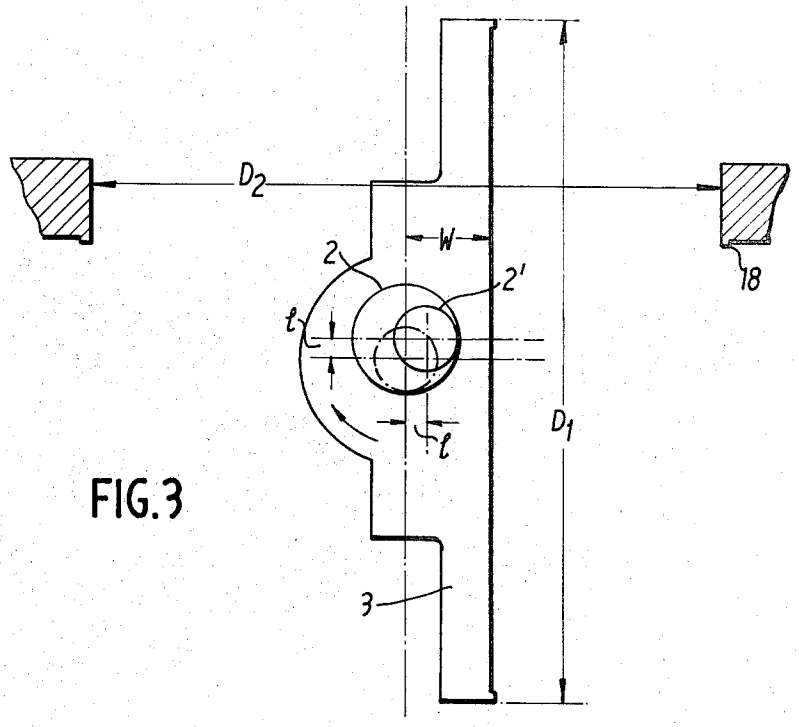


FIG.3

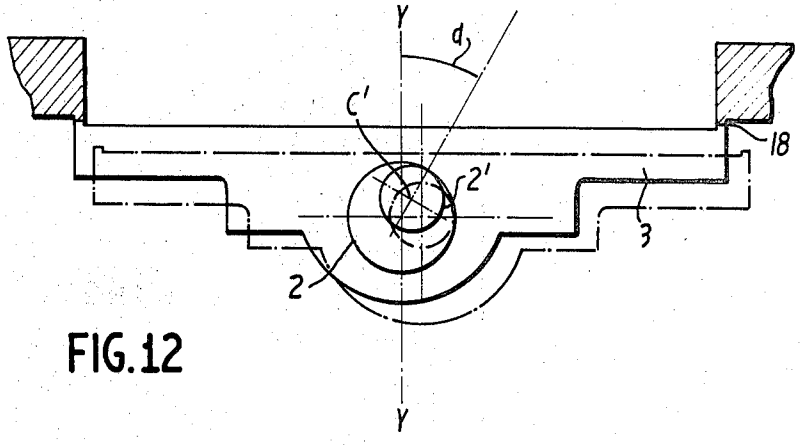


FIG.12

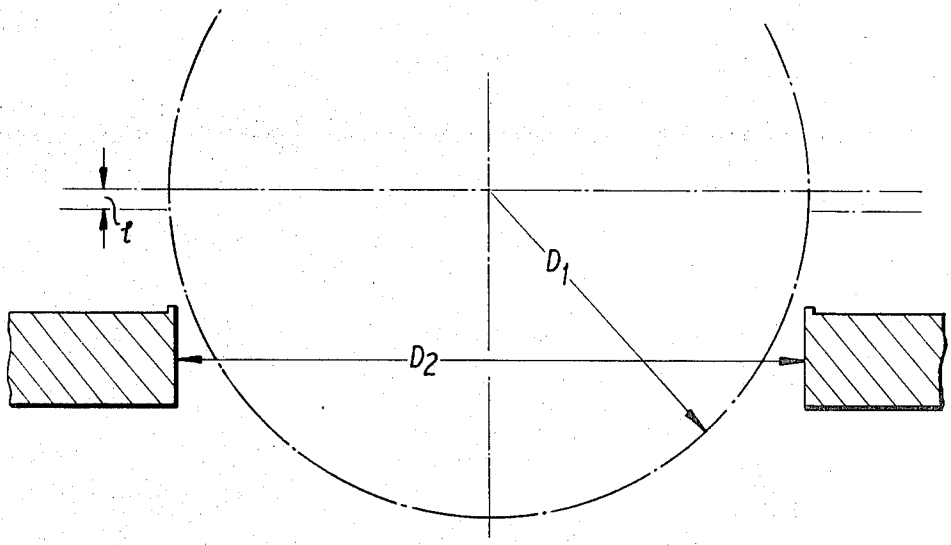


FIG. 4

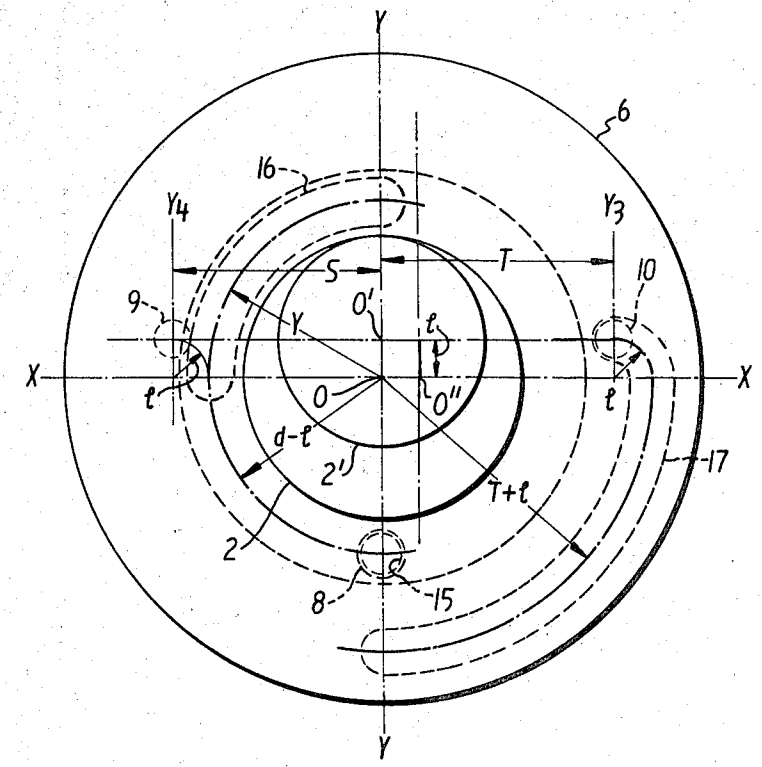


FIG. 5

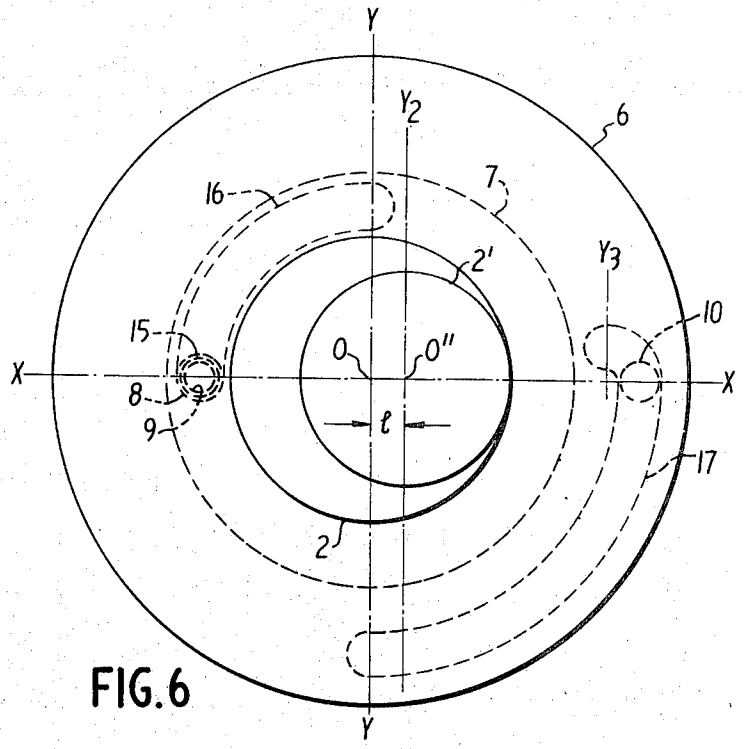


FIG.6

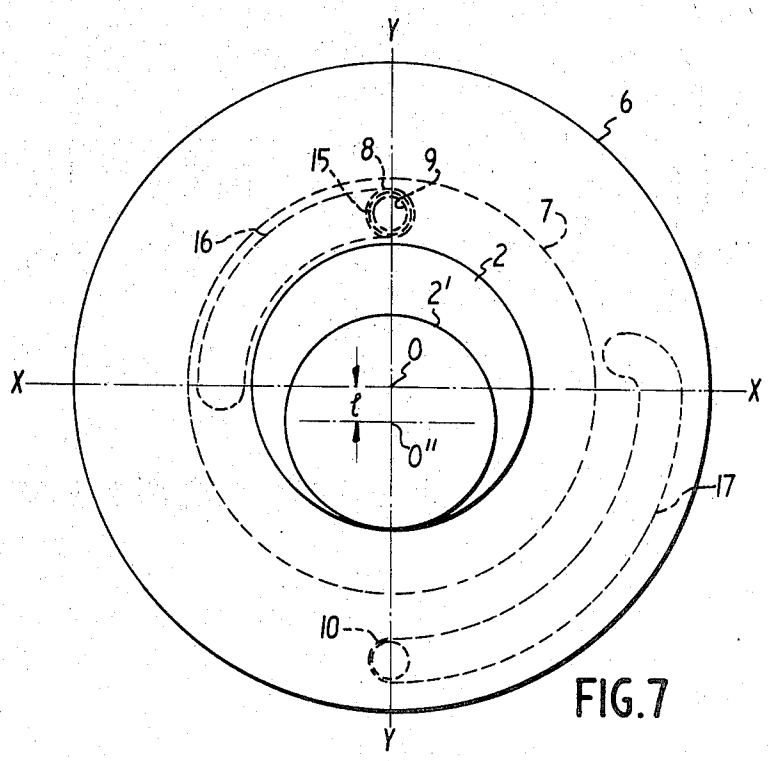


FIG.7

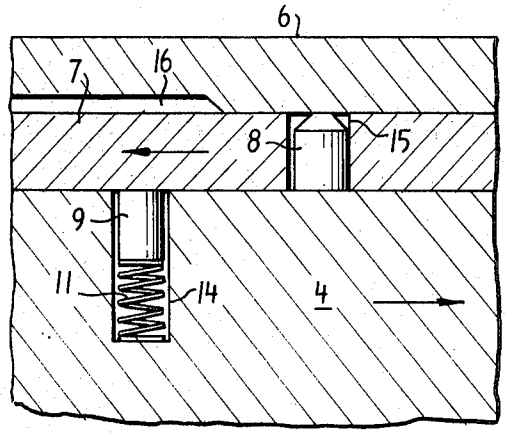


FIG. 8

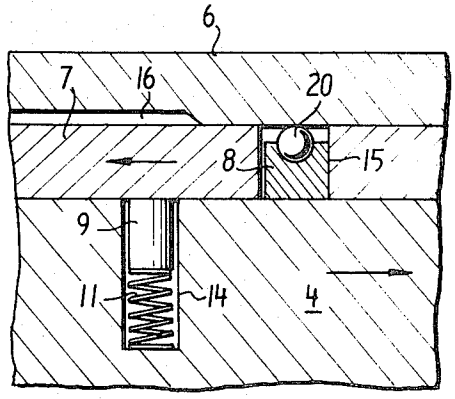


FIG. 11

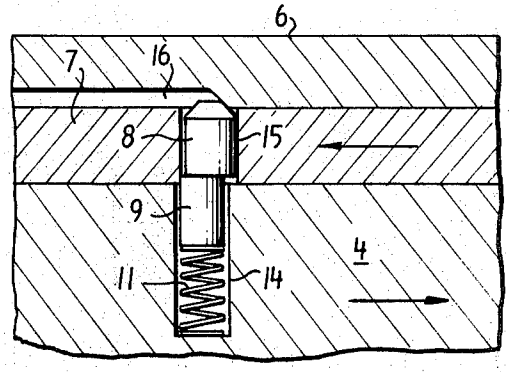


FIG. 9

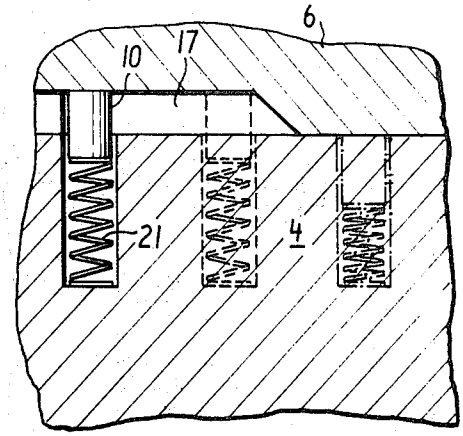


FIG. 13

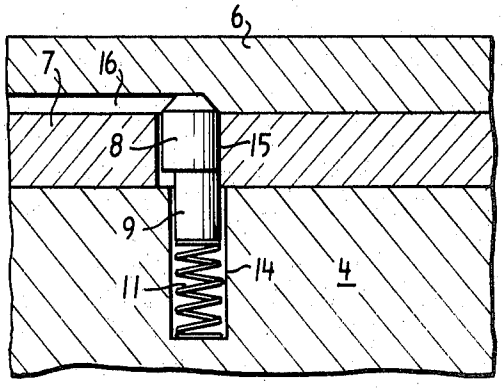


FIG. 10

VALVE

BACKGROUND OF THE INVENTION

1. Field Of The Invention:

The present invention relates generally to a valve, and more particularly to a valve including a valve body forming a fluid passageway therethrough, an annular valve seat coaxial with the axis of the fluid passageway, a valve rod rotatably disposed on the valve body being oriented perpendicular to the axis of the valve seat and adapted to operate from outside the valve body, and a valve plate adapted to engage the valve seat and thereby open and close the fluid passageway in response to operation of the valve rod.

2. Description Of The Prior Art:

Conventional valves having metallic engaging surfaces are widely utilized for opening and closing fluid passageways. However, such conventional type valves as angle valves and ball valves are generally heavy in weight, high in manufacturing cost, and large in operating power. Conventional throttle type valves are apt to leak while in their fully closed positions and thus necessitate non-metallic surface means to stop the leak. Further, throttle valves having metallic engaging surfaces are generally complex in construction and operation.

In one known proposed valve of the aforementioned kind, in the valve opening process, the valve plate is first retracted from the valve seat and then rotated through 90° without disturbing the valve seat. However, such known valves are complex in construction and lack reliability in operation, so that they cannot be widely used.

SUMMARY OF THE INVENTION

It is the primary object of the present invention to provide an improved valve having the last mentioned operating principle and yet being of simple and rugged construction and more reliable in operation.

The foregoing object and others are attained, according to the present invention, through the provision of a valve rod which is provided with an integral eccentric portion to rotatably support the valve plate. A first guide pin acting as a retraction guide pin and a second guide pin acting as a rotation guide pin are disposed on the valve plate. The first guide pin cooperates with a first groove formed in the valve body at a first portion of the rotation of the valve rod to retract the valve plate from the valve seat as the eccentric portion revolves about the axial center of the valve rod. The second guide pin cooperates with a recess means of the valve rod only at a second portion of the rotation of the valve rod to lock the valve plate with the valve rod so that it will rotate therewith. Consequently, in the valve opening operation, the valve plate first is retracted from the valve seat to clear a rotation path and then is rotated with the valve rod to a fully open position.

To engage the second guide pin with the recess means, a second guide groove may be provided to allow projection of the second guide pin only at the second portion of the rotation of the valve rod.

The construction is very simple and relative sliding parts are few, so that the valve, according to the invention, is easy to manufacture and has a long operational life.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in connection with the accompanying drawings, in which like reference characters designate like or corresponding parts, and wherein:

FIG. 1 diagrammatically shows a longitudinal sectional view of one embodiment of the valve according to the present invention;

FIG. 2 diagrammatically shows a plan view, a portion thereof being broken away, of the moving part of the valve shown in FIG. 1;

FIG. 3 is similar to FIG. 2, illustrating the open position of the valve;

FIG. 4 is a diagrammatic illustration of the open position of the valve;

FIG. 5 to FIG. 7 show relative positions of the valve elements on an enlarged scale, in which FIG. 5 shows the valve in its closed position, FIG. 6 shows the valve in its parallel retracted position, and FIG. 7 shows the valve in its open position;

FIG. 8 to FIG. 10 show three relative positions of the pins and the corresponding guide grooves on an enlarged scale, generally corresponding to FIGS. 5 to 7;

FIG. 11 is generally similar to FIG. 8, showing an alternative form of the engaging pin;

FIG. 12 is generally similar to FIG. 2, showing another embodiment to urge the valve plate; and,

FIG. 13 shows a diagrammatical sectional view of another embodiment of the guide pin shown in FIG. 1.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring now to the drawing, and more particularly to FIG. 1 thereof, a valve, according to the present invention is shown in its closed position. The valve provides a valve body 1 having a fluid passageway 1' axially formed therethrough and being adapted for insertion into a fluid pipe line, not shown, by suitable retaining means, such as bolts, also not shown. The valve body 1 forms a valve chamber to receive a valve plate 3, a valve plate actuating assembly, which will be described more fully hereinafter, and a valve seat 18 to be engaged by the valve plate 3 in its closed position. The valve seat 18 is shown as being a portion of the valve body 1, but it should be understood that the valve seat 18 can be separately formed as an annular ring which may be secured with the valve body 1 in known manner, such as by press fitting therein.

An elongate valve rod 2 is rotatably inserted in the valve chamber transversely extending across the fluid passageway 1'. The top end of the valve rod 2 is formed to receive a valve operating member, not shown, such as, for example, a lever, a handle or other suitable mechanism, to rotate the valve rod 2 between the closed and opened positions thereof.

The valve chamber is closed by covers 22 and 23 which also guide the valve rod 2 by suitable bearing means disposed therein not shown. A portion of the valve rod 2 is formed as an eccentric rod 2' which rotatably supports the valve plate 3 and two similar upper and lower mounting blocks 4 which are secured to the valve plate 3.

The upper and lower mounting blocks 4 each respectively provide a retraction guide pin 10 to retract or displace the valve plate 3 in parallel fashion and a rotational guide pin 9 to rotate the retracted valve plate 3

to a fully open position. The retraction guide pin **10** is secured within the mounting block **4** and projects radially outwards from the outer surface thereof. The rotation guide pin **9** is slidably engaged in hole **14** and is urged outwardly by a spring **11** which engages the bottom surface of pin **9.** In FIG. **1,** the guide pins **9** and **10** are shown as being arranged at one side of the rod **2** for convenience of illustration, however, the guide pins **9** and **10** are preferably arranged diametrically opposite of the center of the eccentric portion **2'** of the valve rod **2** and parallel to the valve plate **3,** as shown more clearly in FIGS. **2** and **5** to **7.** As the upper and lower mechanisms are similar to each other, only the upper mechanism is described fully herein.

The fixed ring **6** encircling the valve rod **2** is secured to the valve body **1** by one or more pins **12.** The fixed ring **6** has a guide groove **17** formed on its inner surface for engaging the projected portion of the retraction guide pin **10** and a guide groove **16** to receive the projection of the rotation guide pin **9.** As to the guide grooves **16** and **17,** detailed description will be given hereinafter, referring to FIGS. **5** to **7.**

An annular moving ring **7** is disposed in a cylindrical recess of the fixed ring **6** and is secured to the valve rod **2** by one or more pins **13.** The inner surfaces of the rings **6** and **7** engage the outer surface of the mouunting block **4.** The moving ring **7** has a through opening **15** disposed at a radius *r* from the center O of the valve rod **2** and diametrically opposite to the center O' of the eccentric portion **2'** or just as the position shown in FIG. **1.** The opening **15** slidably accommodates an engaging pin **8,** the top surface of which is engaged by the guide groove **16** and the bottom surface of which is engaged by the rotation guide pin **9.** The length of the engaging pin **8** corresponds to the thickness of the moving ring **7.** The relative positions of the engaging pin **8,** guide pin **9** and the guide groove **16** are arranged such that, in the closed position of the valve plate **3,** no relative engagement is present, as shown in FIG. **5,** and after the rod **2** is rotated through 90° and the valve plate **3** is retracted, the engaging pin **8,** guide pin **9** and the guide groove **16** are aligned as shown in FIG. **6,** and the guide pin **9** is thus projected into the hole **15** by the spring **11** to guide the valve plate **3** so that it rotates to the open position. In the engaging and disengaging position of the pin **8** and the groove **16,** the groove **16** is tapered to decrease the depth of the groove, to guide the head of the engaging pin **8,** as shown in FIG. **9.**

FIG. **5** shows the relative positions of the pins **8, 9** and **10** and the grooves **16** and **17** in the closed position of the valve. From the center O of the valve rod **2,** the Y—Y axis is parallel to the center axis of the valve opening **1'** and the X—X axis is perpendicular to the Y—Y axis and parallel to the surface of the valve seat **18.** In the closed position, center O of the eccentric portion **2'** of the rod **2** aligns with the Y—Y axis at a distance *l* from the center O.

The guide grooves **16** and **17** are fixed to the valve, and the guide groove **16** is formed in the second guadrant of the X–Y axis as a 90° arcuate groove having a center radius *r* about center O. The center of the hole **15** and the engaging pin **8** are spaced the same distance *r* from the center O. The guide pin **9** is arranged at a distance *s* from the center O' and parallel with the X-axis, and the distance $s = r + l$, so that when the center O' is on the X-axis, the guide pin **9** aligns with the groove **16.**

The guide pin **10** is arranged at a distance T from the center O' at opposite side of the pin **9.** The guide groove **17** consists of two different curves, the first of which starts from the closed position of the pin **10,** that is at the distance T along the X-axis and the distance *l* along the Y-axis and the radius of the curve is *l*, having its center at the X axis at the distance T from the center O. The end of the first curve aligns with the X-axis, and is connected with the second curve of a radius $T + l$ having a center O. The second curve extends about 90°. Thus the guide groove **17** guides the guide pin **10** along a full operating position of the valve.

The operation of the valve is as follows: FIG. **1** and the solid line of FIG. **2** show the closed position of the valve plate **3** which engages the valve seat **18** to shut off the fluid passageway **1'.** By rotating the valve rod **2** by suitable means, such as a lever, the valve plate **3** retracts from the valve seat for some distance, as shown by a dot-and-dash line in FIG. **2** and FIG. **6,** and upon further rotation of the valve rod **2,** the valve plate **3** rotates 90° to its fully open position, as shown in FIG. **3** and FIG. **7.** Relative positions of the pins **8, 9** and **10** and grooves **16** and **17** are shown in FIGS. **5** and **8** in the valve closed position, FIGS. **6** and **9** in its retracted position, and FIGS. **7** and **10** in its fully open position.

From the closed position shown in FIGS. **2** and **5,** the valve rod **2** is rotated clockwise to open the valve. The eccentric portion **2'** of the valve rod **2** rotates about the center O of the valve rod **2** by the radius of eccentricity *l.* When the valve rod **2** rotates 90°, the center O' of the eccentric portion aligns with the X-axis as shown in FIG. **6,** the new position of the eccentric portion being shown as O'' in FIG. **6.** As the valve plate **3** and the mounting block **4** are not secured with the eccentric portion **2',** and the guide pin **10** is guided by the first portion of the guide groove **17** of the fixed ring **6,** the valve plate **3** and the mounting block **4** retract from the valve seat **18** and displace rightward at eccentricity *l.* The curvature of the first portion of the guide groove **17** and the path of center O' of the eccentric portion are the same, that is, the periphery of a circle having radius *l,* as described before, thus the valve plate **3** retracts from the valve seat maintaining a relatively parallel position.

As the other guide pin **9** also moves along the periphery of a circle having a radius *l,* in the full retracted position shown in FIG. **6,** the rotation guide pin **8** aligns on the X-axis and also aligns with the guide groove **16.** Upon the rotation of the valve rod **2,** the engaging pin **8,** which is accommodated in the hole **15** of the moving ring **7** which is secured with the valve rod **2,** rotates with the valve rod **2** and aligns on the X-axis and also aligns with the guide pin **9** and the guide groove **16.** As shown in FIG. **9,** the engaging pin **8** begins to enter into the tapered portion of the guide groove **16** and the guide pin **9** first enters into the hole **15** of the moving ring **7.** When the guide pin **9** enters into the hole **15** of the moving ring **7,** the mounting block **4** is locked to the moving ring **7,** in turn being secured to the valve rod **2.** Thus, as long as the guide pin **9** is in the hole **15,** the mounting block **4** and the valve plate **3** rotate with the moving ring **7** and also with the valve rod **2.** That is, the valve plate **3** rotates as the valve rod **2** is rotated in the latter **90°** rotation thereof to the fully open position of the valve plate **3,** shown in FIGS. **3, 7** and **10.** More precisely, while the top end of the engaging pin **8** is in the guide groove **16,** the guide pin **9** is urged up-

wards by the spring **11** to press the engaging pin **8** upward to the inner wall of the guide groove **16.** Thus, the top portion of the guide pin **9** is projected into the hole **15** to lock the mounting block **4** to the moving ring **7.** Both end portions of the groove **16** are tapered to facilitate entry thereinto and departure therefrom of the engaging pin **8.**

At the end of the rotation of the valve rod **2,** the moving ring **7,** the mounting block **4** and the valve plate **3** reach the fully open position shown in FIGS. **3, 7** and **10.** The pins **8, 9** and **10** align on the Y-axis and the valve plate **3** rotates without contacting the valve seat **18.**

As the valve rod **2** rotates 180° from the closed position, in which the valve plate **3** closes the valve seat **18,** to the fully open position, in which the valve plate **3** is parallel to the axis of the valve, the center O′ of the eccentric portion **2′**, that is, the center of the valve plate **3** retracts twice the eccentricity, or $2l$. Consequently, although the outside diameter D_1 of the valve plate **3** is larger than the inside diameter D_2 of the valve seat **18,** the valve plate **3** can be rotated without contacting the valve seat **18.** The eccentricity l of the eccentric portion **2′** can be selected from the outside diameter D_1 of the valve plate **3,** inside diameter D_2 of the valve seat **18** and the distance W between the center of the valve rod **2** and the valve seat surface.

To close the valve, the operation is simply reversed. The valve rod **2** is rotated counterclockwise 180°. With the first 90° of rotation, the valve plate rotates 90° to the retracted position shown in FIG. **6,** and with the next 90° of rotation, the valve plate **3** contacts the valve seat **18** to provide the closed position.

The fixed ring **6,** moving ring **7,** pins **8, 9** and **10,** guide grooves **16** and **17** are preferably provided at both the upper and lower portions of the valve rod **2,** as shown in FIG. **1.** The valve operating mechanism is very simple and positive operation is readily attained.

FIG. **11** shows an alternative embodiment of the engaging pin **8.** A ball **20** is inserted in a recess at the top surface of the pin **8.** The ball **20** can pass through the tapered portion of the guide groove **16** easily and smoothly without causing excessive wear.

FIG. **12** shows another embodiment for urging the valve plate **3** to the valve seat **18** upon operation of the valve rod **2.** In the closed position of the valve plate **3,** shown in FIG. **12,** the center of the eccentric portion **2′** does not meet with the Y-axis and forms an angle α relative to the Y-axis. By displacing the center O of the valve rod leftward and inward from the position shown in FIG. **2,** the closed position shown in FIG. **12** can be attained. In this case, the rotation angle of the valve rod **2** to retract the valve plate **3** is decreased to $90° - \alpha$. As the angle α is small, a large urging force can be attained by relatively small rotational movement of the valve rod **2.** If desired, the same effect can be attained by providing a slightly higher valve seat **18** in the first described embodiment. In this case the center axis of the valve seat and that of the valve plate are slightly displaced.

FIG. **13** shows another embodiment of the guide pin **10** and the guide groove **17.** The guide pin **10** guides the valve plate **3** only during retraction of the valve plate **3,** so that only the first curved portion having a radius l is effective. By inserting a spring **21** under the guide pin **10,** the guide groove **17** can be limited only to the first portion as shown in FIG. **13.** The three positions of the guide pin **10** are shown in FIG. **13,** respectively being, from left to right, the closed position corresponding to FIG. **5,** the retracted position corresponding to FIG. **6,** and the valve open position between FIGS. **6** and **7.**

It will be appreciated that the valve according to the present invention provides a new fully open type shut-off valve having metal contact surfaces. The valve is light in weight compared with conventional angle valves or ball valves and simply and easily manufactured. The operating mechanism is very simple and the operation is also very simple. The valve can be closed positively without causing excesssive wear.

Obviously many modifications and variations of the present invention are possible in light of these teachings. It is to be understood therefore that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a valve including a valve body forming a fluid passageway therethrough, an annular valve seat coaxial with the axis of said fluid passageway, and a valve rod means rotatably disposed on the valve body perpendicular to the axis of said valve seat and adapted to be operated from outside said valve body, the improvement characterized by:

said valve rod having an integral eccentric portion;

a valve plate rotatably supported by said eccentric portion and engagable with said valve seat;

a first and a second guide pin disposed in said valve plate;

said valve body having a first guide groove to guide said first guide pin to retract said valve plate during a first portion of rotation of said valve rod;

said valve rod means forming recess means adapted to engage with said second guide pin;

means to engage said recess means with said second guide pin only during a second portion of rotation of said valve rod, whereby said valve plate first is retracted from said valve seat and then is rotated with said valve rod by rotation of the valve rod to open the valve.

2. A valve according to claim **1,** further comprising:

mounting block means mounting said valve plate to said valve rod, said first and second guide pins being disposed in said mounting block means.

3. A valve according to claim **1,** further comprising:

said valve rod means including a moving ring secured to said valve rod and having a through hole being said recess means;

and said means for engaging said recess means with said second guide pin being an engaging pin slidably disposed in said through hole and engageable with said second guide pin;

said valve body having a second guide groove engageable with said engaging pin, whereby during said second portion of rotation of the valve rod, said engaging pin engages said second guide groove and allows said second guide pin to slide into said through hole to lock said valve plate to said valve rod to rotate therewith.

4. A valve according to claim **1,** wherein the relative positions in the valve closed position of said valve rod, said eccentric portion, said valve plate and said valve seat are determined such that a line through the centers

of said valve rod and said eccentric portion forms an angle to the axis of said valve seat, whereby operation of said valve rod urges the valve plate toward the valve seat.

5. A valve according to claim **2,** wherein the relative positions in the valve closed position of said valve rod, said eccentric portion, said valve plate and said valve seat are determined such that a line through the centers of said valve rod and said eccentric portion froms an angle to the axis of said valve seat, whereby operation of said valve rod urges the valve plate toward the valve seat.

6. A valve according to claim **3,** wherein the relative positions in the valve closed position of said valve rod, said eccentric portion, said valve plate and said valve seat are determined such that a line through the centers of said valve rod and said eccentric portion forms an angle to the axis of said valve seat, whereby operation of said valve rod urges the valve plate toward the valve seat.

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