



White Paper

Manual Quarter-Turn Valve Actuators

Table of Contents

Introduction.	2
Traveling Nut Actuator	2
Worm Gears.	3
Actuator Operating Characteristics.	4
Conclusion.	5

Manual Quarter-Turn Valve Actuators

Introduction

Butterfly and ball valves are typically supplied with either a traveling nut or worm gear type actuator. Both types are listed in the applicable AWWA Valve Standards, C504 and C507. Each type has some important characteristics that affect the performance of the valve assembly and should be understood before selecting the best actuator for a particular application.

Traveling Nut Actuator

A common type of actuator provided with quarter-turn valves is the traveling nut actuator. It has been around for over 50 years and is provided in two designs the slotted lever and the link and lever. The traveling nut actuator was created to match the torque characteristics of butterfly and ball valves which have high seating torque. Therefore, a higher mechanical advantage at the end of travel is often desirable.

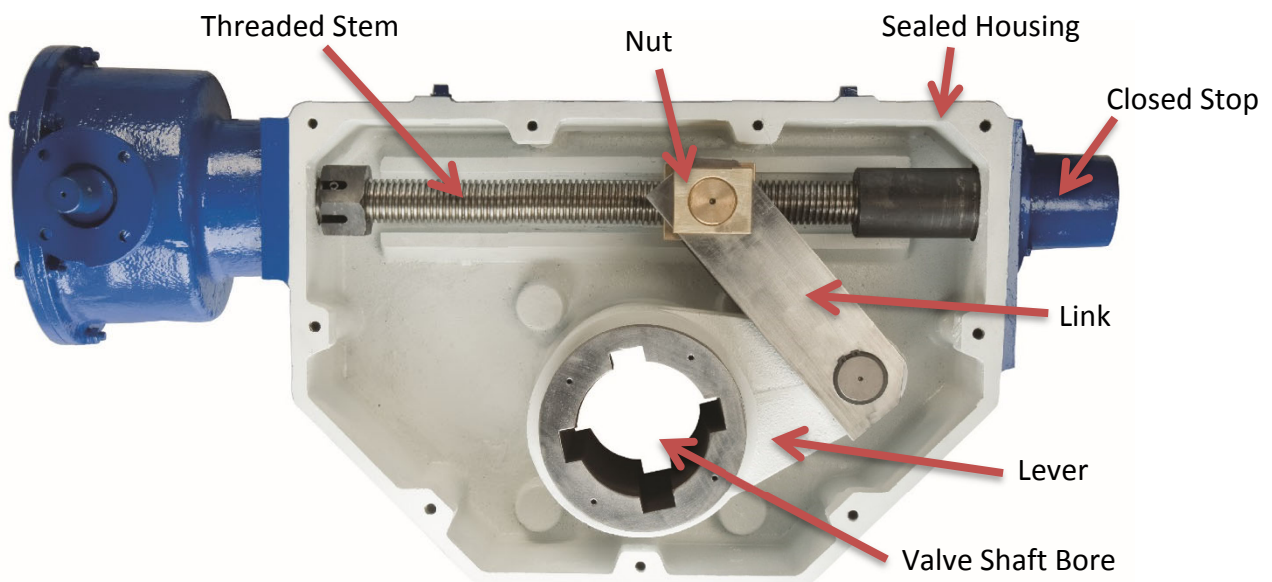


FIGURE 1. Link and Lever Traveling Nut Actuator

The traveling nut actuator consists of a sealed housing, threaded stem, threaded nut, and either a slotted lever or a link and lever. As the threaded rod is turned with the handwheel, the nut is driven to the left and right and supported by milled slots in the housing and cover of the actuator. (Figure 1) The nut in turn drives the lever, which in turn drives the valve shaft through 90 degrees of travel.

On a link and lever traveling nut actuator, the traveling nut is connected to the lever with a link. When the nut is at the right side of the housing in the photo, the link is near vertical orientation. At this location, travel of the nut provides a small change in lever rotation. Hence, at the right end (closed position) the mechanical advantage of the actuator can be twice that in the center or left position. The traveling nut actuator therefore matches the torque requirements of the valve.

Manual Quarter-Turn Valve Actuators

On a slotted lever traveling nut actuator, the traveling nut acts directly on the lever. In this design, the lever has a slot in which the traveling nut slides as it moves along the threaded stem. On a standard slotted lever actuator, at either the left or right end of the stem, travel of the nut provides a small change in the lever rotation and resulting in greater mechanical advantage.

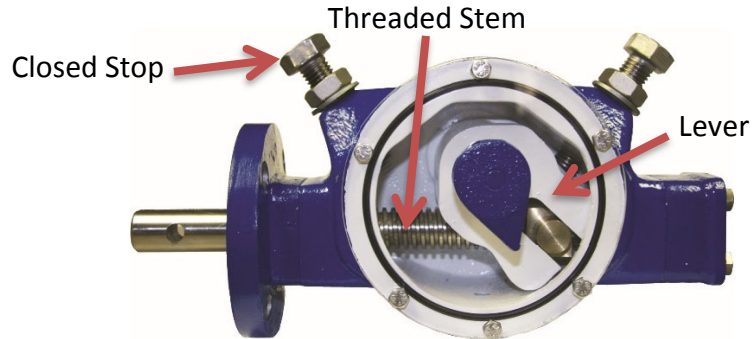


FIGURE 2. Slotted Lever Traveling Nut Actuator

A traveling nut operation can vary from 10 to 100 turns, and for large valves (i.e. greater than 36 in.), spur gears or bevel gears are provided. The closed and open stops of these actuators are typically threaded nuts that are pinned to the threaded stem for link and lever actuators. Because a high amount of torque can be resisted between two nuts jammed together and because the stop design does not apply a load to the housing, the stops are usually rated to 450 ft-lbs. This high torque rating prevents many valve failures in buried service. Val-Matic offers a special externally adjustable closed stop where the adjustment nut extends through the housing for easy access (Figure 1). The stops of a slotted lever actuator are external bolts with lock nuts (Figure 2).

Traveling nut actuators are usually constructed of an iron housing, steel links, and a ductile iron lever and are more economical than worm gear actuators. They are more economical than worm gears because the bronze worm gear is not needed, and they provide their greatest mechanical advantage at the closed position to match the requirements of the valve. Traveling nut actuators are the standard actuator for most AWWA butterfly and ball valve manufacturers. These actuators are designed and made by each valve manufacturer and designed specifically for these valves.

Worm Gear Actuators

Early butterfly and ball valves were provided with worm gear type actuators, which feature a sealed iron housing containing a hardened steel worm that drives a large gear, sometimes called a segment or sector gear. Adjustable bolts are provided to limit the travel of the actuator and precisely position the valve in the open and closed positions.

A basic worm gear actuator converts about 20 turns of the input shaft rotation into the 1/4 turn necessary to operate the butterfly valve. This operation translates into a mechanical ratio of about 80:1. However, with consideration to the friction in the gear faces, the efficiency of the actuator is only about 30% resulting in a mechanical advantage of about 25:1. Hence, if it takes 500 ft-lbs on the valve stem to operate the valve, then the input torque needed on the actuator is only 500/25 or 20 ft-lbs. When the input torque

Manual Quarter-Turn Valve Actuators

exceeds 150 ft-lbs or 80 lbs pull on the handwheel, spur gears are provided on the input side of the housing to provide additional mechanical advantage.

Worm gear actuators can be provided with handwheels for above ground service or 2" AWWA nuts for buried service. For buried service, the input shaft is made corrosion resistant stainless steel, the housing is packed with grease, and the indicator is replaced with a blind cover. One limitation of the worm gear actuator is that the closed stop design is usually limited to a torque of 300 ft-lbs because all of the torque is transmitted to the housing as force against the stop bolt. When a valve is buried, maintenance workers can sometimes exceed that torque and damage the actuator.

The worm gear actuator is a reliable actuator and is available from many alternate suppliers. However, its cost can be high given that its linear torque characteristic does not match the characteristic of the valve. It also provides external closed stop adjustment, which can be helpful in above ground applications.

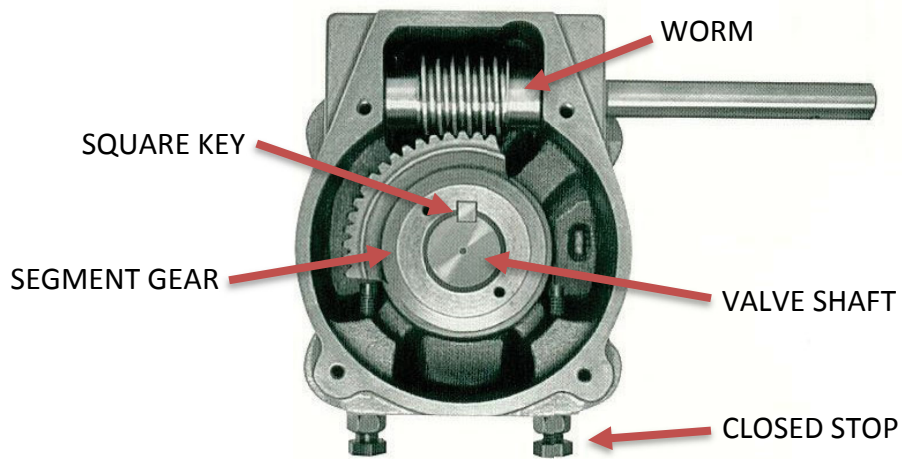


FIGURE 3. Worm Gear Actuator

Actuator Operating Characteristics

The last important consideration in selecting an actuator is the different operating characteristic of the two types. The worm gear has a linear characteristic which means that for every turn of the handwheel, the valve is rotated the same amount. Traveling nut actuators, on the other hand, exhibits "characterized closure." For a link and lever actuator, characterized closure means that during the first half of closure, the valve shaft is rotated rapidly, and during the last half of travel, the valve shaft is rotated slowly toward the closed position. For a standard slotted lever actuator, characterized closure means that during the last portion of travel the valve is rotated slowly into the closed position. During the midstroke of travel, the valve is rotated more rapidly. This difference in travel is a result of the geometry of the link and lever or slotted lever mechanism. The benefit of characterized closure is that the valve is closed during its last portion of travel slowly, which can reduce pipeline surges or water hammer.

Manual Quarter-Turn Valve Actuators



FIGURE 4. Actuator Operating Comparison

Conclusion

In the waterworks valve industry, about 75% of the manual actuators provided today are of the traveling nut type. In the wastewater industry it is predominately plug valves with worm gear actuators. Traveling nut actuators are more economical than worm gears, withstand higher input torques, and provide characterized closure. Given all of its advantages, the traveling nut actuator continues to be the most preferred actuator for butterfly and ball valves.

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