2.4 Rotork Actuators

Introduction

A limited number of U.S. plants use Rotork actuators. Rotork Controls is headquartered in Bath, England, with its North and South America manufacturing facilities located in Rochester N.Y. Rotork Motorized Valve Operators (MOV'S) allow for local or remote positioning of a valve via an electrical motor which is part of the actuator.

Control components can be adjusted so that the valve can be made to stroke and stop once a predetermined position is reached or a certain amount of thrust has been attained. The valve itself is not manufactured by Rotork Controls, although the characteristics of the valve must be considered in the selection of the control components, control adjustments, and the actuator sizing.

The Rotork maintenance philosophy recommends modular replacement of components rather than replacement of individual pieces. Rotork actuators are guaranteed for one year from date of shipment and while under warranty should be repaired by Rotork field personnel. In some instances the warranty may be extended for up to two years if a Rotork field representative is present for actuator mounting and startup.

Rotork Type NA actuators are Syncroset watertight/explosion-proof actuators developed for installation in the containment of a nuclear power plant. Special seals and materials are used in many of the components, otherwise the actuators are identical to the Type A or non-nuclear actuators.

Before attempting any repair on a nuclear (NA) type actuator, Rotork should be consulted for problem diagnosis and particular attention should be paid to maintaining the nuclear qualification of the actuator. Please refer to Rotork in all cases for spare parts.

Rotork recommends no periodic preventive maintenance except for an annual lubrication level inspection.

NOTE: Due to the fact that Rotork Controls is a British company, some of the terms used for component description may be unfamiliar to most Americans.

Glossary

ACTIVE - Describes an actuator application that must operate during a reactor emergency.

ADD-ON-PAK (AOP) - A subassembly that can be fitted to either syncropak or syncroset actuators as an extension of the switch mechanism.

BELLEVILLE SPRING - A dish-shaped washer made from spring steel, stacked to allow for compression. A stack of Belleville springs is referred to as a BELLEVILLE SPRING PACK, or just a spring pack.

BUNG- Rubber or plastic plug.

DRIVE BUSH - The actuator connection to the valve stem; the drive bush is actually threaded or bored and keyed.

HELIX - The method used to convert linear motion to rotary motion on the torque drive of the switch mechanism.

IMPACT HAMMER BLOW - Designed "free-play" in an actuator to allow the motor to reach full speed before moving the valve stem.

NEMA - National Electrical Manufacturers Association.

PASSIVE - Describes an actuator application that must maintain structural integrity during and immediately following a reactor emergency.

SEL-LOC PIN - Self-locking pin (roll pin).

SWITCH MECHANISM - The assembly in a Rotork actuator that houses the torque and limit switch contacts, auxiliary contacts, and the torque helix.

SYNCROPAK - Rotork designation for an actuator having all the electrical components necessary for operation mounted on the actuator. Refer to provided training aid.

SYNCROSET - Rotork designation for an actuator having most of the electrical components necessary for operation located remotely from the actuator. Refer to Figure 2-54.

The nuclear sizes of Rotork actuators are listed in Table 2-10 along with their available output torque values.

Table 2-10 Rotork Actuator Size and Output Torque Values

Actuator	Torque, ft-lb							
7NA	25	25	23	20	20	16	--	--
11NA	50	50	45	40	40	32	--	--
14NA	120	120	100	80	80	60	45	--
16NA	225	225	190	150	150	110	80	--
30NA	400	400	375	300	300	240	190	--
40NA	750	750	625	500	500	400	300	--
70NA	1100	1100	950	750	750	550	475	400
90NA	1500	1500	1250	1000	1000	750	640	540

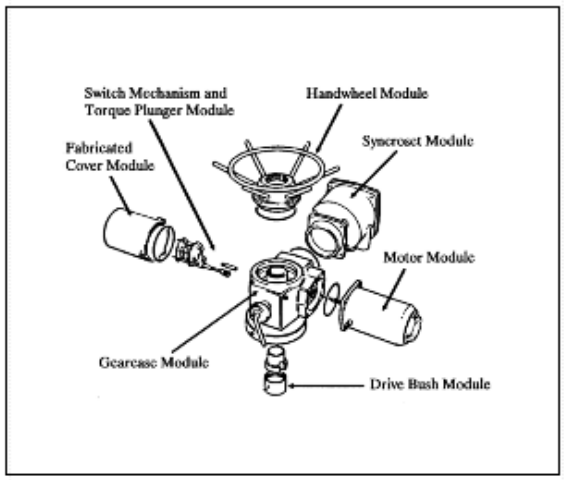

Figure 2-54 Rotork Syncroset

The two general categories that the actuators fall into are as follows:

Category 1 - sizes 7 and 11

Category 2 - sizes 14, 16, 30, 40, 70 and 90.

Actuators within a given category are similar except for physical size and available output torque, however, the two general categories principle of operation are closely related.

Principles of Operation

See Figures 2-55, 2-56, 2-57 and 2-58. Except where noted, the size of Rotork actuators addressed in this chapter are those identified previously as being in Category 2. Although the 70 and 90 size actuators differ slightly from the others, these differences will be pointed out during the discussion.

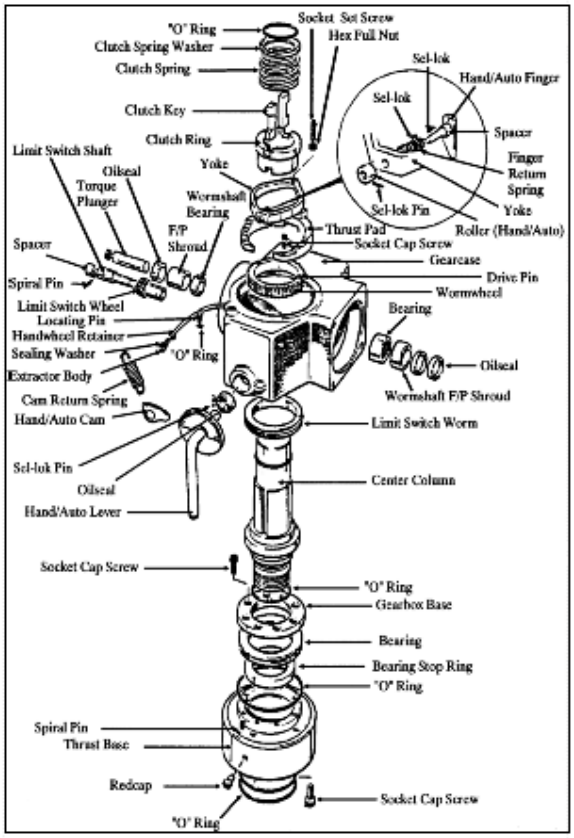

Figure 2-55 Rotork Assembly

Motor Operation

1. When the motor is energized, the motor shaft (wormshaft) rotates. The wormshaft is engaged with the wormwheel on the center column.
2. The wormwheel driven by the motor wormshaft rotates on the center column. The drive pins located on top of the wormwheel engage the lower portions of the clutch keys recessed in machined keyways on the center column. The clutch keys transmit the force from the wormwheel to the center column.

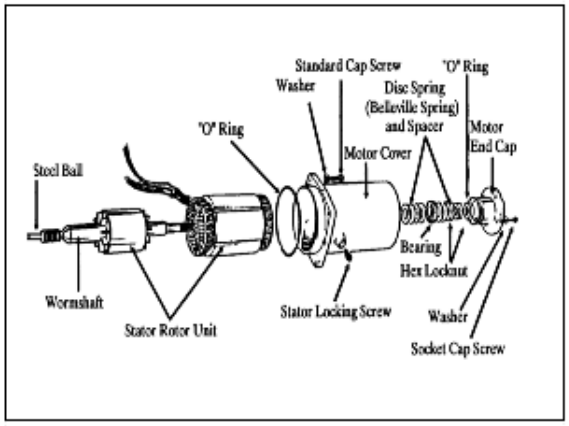

Figure 2-56 Rotork Stator Assembly

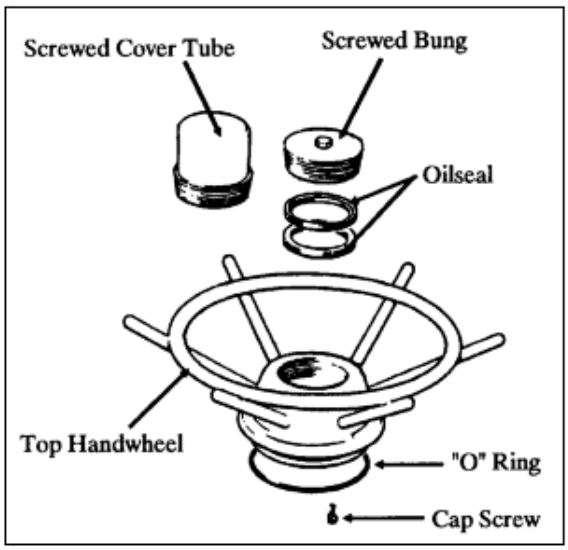

Figure 2-57 Rotork Handwheel Assembly

3. The center column drives the drive bush through lugs located on the bottom of the center column. The drive bush is threaded internally to match the threads on the valve stem. Rotating the drive bush opens or closes the valve.
4. When the valve reaches the full-stroke position (open or closed), the switch mechanism de-energizes the motor control circuit to interrupt power to the motor. The limit switch assembly is driven by a worm located on the center column.

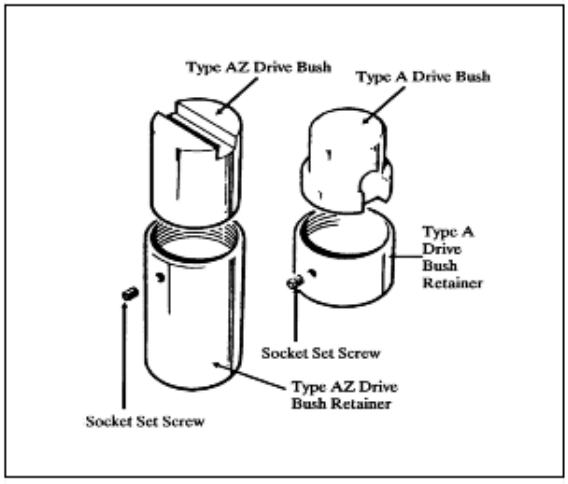

Figure 2-58 Rotork Socket Set Screw Types

5. In the event of an excessive torque condition or in "torque-shut" applications, the threading force of the wormshaft overcomes Belleville spring compression and "walks" the wormwheel. The movement of the wormshaft actuates the torque switch through the torque shaft. The actuation of the torque switch de-energizes the motor control circuit to interrupt power to the motor. Torque switch actuation on 70/90 actuators is by torque shaft movement through a ratio plate located at the rear of the switch mechanism.
6. When reversing direction, the actuator has an impact hammer blow effect. The motor is allowed to achieve full rated speed before it engages with the center column.

Actuators with no lost motion on the center column (instead of the impact hammer blow effect) are available if requested.

Manual Operation

1. To operate the actuator in manual, the hand/auto lever is depressed.
2. The hand/auto lever rotates the hand/auto cam to raise the yoke end and clutch ring. The clutch keys are raised away from the pins on the wormwheel by the clutch ring.
3. The top portions of the clutch keys are engaged by cap screw heads on the bottom of the handwheel. Rotation of the handwheel will then rotate the center column through the keys.

NOTE: On the 70/90 size actuators, the clutch keys do not extend above the clutch ring. Instead, hand drive screws are threaded into the top of the clutch ring.

4. When the yoke end is raised, the hand/auto finger is pivoted by spring tension to sit on the wormwheel and hold the actuator in manual.
5. When the motor is energized, the wormwheel begins rotation. The hand/auto finger (resting on the wormwheel) is carried out of position, allowing the clutch ring and clutch keys back onto the wormwheel.

NOTE: The actuator motor must be energized to return the actuator to motor operation.

6. Valve operating thrust does not exert force on the actuator drive gearing. A thrust base is used on Rotork actuators except on the lower casing size (7/11) and on non-thrust applications. The thrust base is bolted to the bottom of the actuator casing.

Manual Operation for Category 1 Actuators

Refer to Figure 2-59.

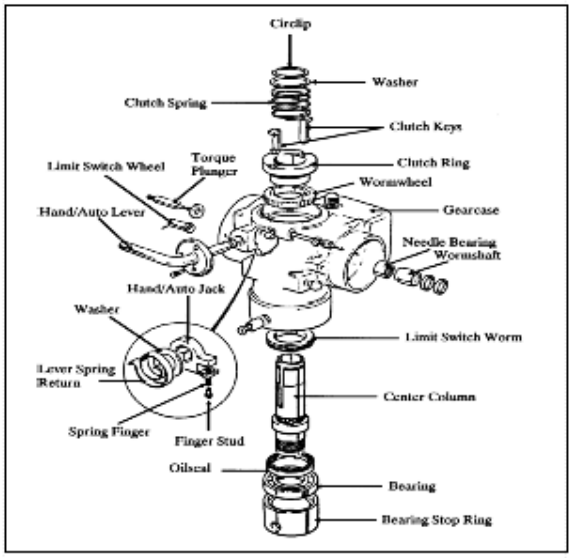

Figure 2-59 Rotork Category 1 Actuator

NOTE: The only significant difference between a Category 1 and a Category 2 actuator is the declutching mechanism, and

for that reason the following explanation is included.

1. To operate the actuator in manual, the hand/auto lever is depressed.
2. The hand/auto lever pivots the hand/auto jack to raise the clutch ring and clutch keys away from the lugs on the wormwheel.
3. The top portions of the clutch keys are engaged by cap screw heads on the bottom of the handwheel. Rotation of the handwheel will then rotate the center column through the clutch keys.
4. When the hand/auto jack is pivoted to raise the clutch ring, the spring finger and finger stud are pivoted to sit on the wormwheel and hold the hand/auto jack, clutch ring, and clutch keys away from the wormwheel against the clutch spring tension.
5. When the motor is energized, the wormwheel begins rotation. The spring finger and finger stud (resting on the wormwheel) are carried out of position, allowing the clutch ring and clutch keys back onto the wormwheel.

NOTE: The actuator motor must be energized to return the actuator to motor operation.

Nameplate Information and Rotork Options

Nameplate Information

Serial Number

The serial number on the actuator nameplate is specific to that unit. It is given to the actuator at the factory and should always be included in the data recorded for positive identification.

Wiring Diagram Number

The wiring diagram number identifies the electrical characteristics of the control system and motor. The diagram number should be supplied to factory personnel if questions or problems arise concerning the actuator control circuitry or electrical components.

Actuator Type - Nuclear

Rotork electric motor-driven actuators are classified into three types: NA-1, NA-4, and NA-5. The type NA-1 actuator is used for active applications inside the containment, while the NA-4 is used inside the containment for passive applications. The NA-5 actuator is used outside the containment in active applications. To further describe the NA actuator types, it is necessary to define the following terms:

ACTIVE: Applications required to operate during a reactor emergency.

PASSIVE: Applications that must maintain structural integrity during and immediately following a reactor emergency.

Actuator Type - Non-Nuclear

Non-nuclear electric motor-driven Rotork actuators are classified as A-type actuators. A-type non-nuclear actuators are similar in design and construction to the nuclear Rotork actuators.

Output Speed

The output speed of the actuator is specified in rpm's. The output speed is specified by the customer when the actuator is initially ordered.

NEMA Enclosure

The NEMA enclosure rating describes the environmental application for which the actuator housing (enclosure) is approved. Rotork actuators are supplied as standard with NEMA 6 watertight and explosion-proof enclosures and are capable of electric operation in up to 10 feet of water for 48 hours provided the conduit entries are sealed.

Rotork actuators can be supplied to meet other specifications when requested by the customer.

Lubricant

The type of lubricant supplied by the factory will be shown. The factory determines the lubricant based on requirements supplied by the customer. The lubricant type should not be changed without Rotork approval.

Horsepower

This number designates motor horsepower (hp). Rotork actuators are sized and rated according to torque and thrust output rather than motor horsepower.

Min - Duty Rating

The number in the "Min" block on the Rotork nameplate corresponds to the duty rating (in minutes) of the actuator. This duty rating corresponds to the amount of time the actuator can operate per hour, at an average running torque of 33% of maximum seating torque, without exceeding the allowable temperature increase over ambient conditions. Running the actuator longer than the stated duty cycle may cause the motor insulation to break down.

Motor Supply

The motor supply identification describes the electric power the actuator uses for operation.

Auxiliary Switch Rig

The auxiliary switch rig section of the actuator nameplate designates the operating voltage and current ratings (for both AC and DC) of the control circuit functions.

Options Available with Rotork Actuators

Drive Bushes

The output drive bush of a Rotork electric motor-driven actuator is available in four variations:

1. Type A - Made of aluminum bronze, used for normal size valve stems (all actuators).
2. Type AZ - Made of aluminum bronze, used for larger valve stem diameters than the Type A can accommodate.
3. Type AR - Made of mild steel, used for non-thrust drives in size 40 actuators and above. The AR bush is for non-rising stem applications only. (It is typically used for gearbox input drives.)
4. Type AB - Bush not supplied by Rotork, used for non-thrust applications only. The drive sleeve is bored and keyed at the output; two keyways are optional. The Type AB drive is available for the NA-1, NA-4, NA-5, 7A, and 11A actuators only.

Motor Brakes

Torque-limiting motor brakes are optional on Rotork actuators. Actuators having the torque-limiting brake are identified by the letter "T" in their model designation, e.g., 16 NAT 1.

Thrust-Absorbing Spring Packs

A thrust-absorbing spring pack consisting of Belleville springs is also available on Rotork actuators. When installed, this spring pack is located in the thrust base of the actuator. The spring pack absorbs thrust in fast-acting, high-thrust actuators or those subjected to large thermal transients.

Handwheel Drive

Rotork valve actuators have as standard a 1:1 handwheel drive ratio except for sizes 70 and larger, which have a 15:1 drive ratio. As an option, higher handwheel gear ratios are available for sizes 14 through 90.

Add-on-Pak 1

Refer to Figure 2-60. Add-on-Pak 1 (AOP 1) is a standard Rotork subassembly which can be fitted to either syncropak or syncroset actuators as an extension of the switch mechanism. The AOP 1 comprises the following components:

1. Set of gears for continuous local indication.
2. Position indicator.
3. Potentiometer for remote position indication.
4. Six changeover switches.
5. Extension housing and calibrated dial.

NOTE: Items 3 and 5 mentioned above are not shown on Figure 2-60.

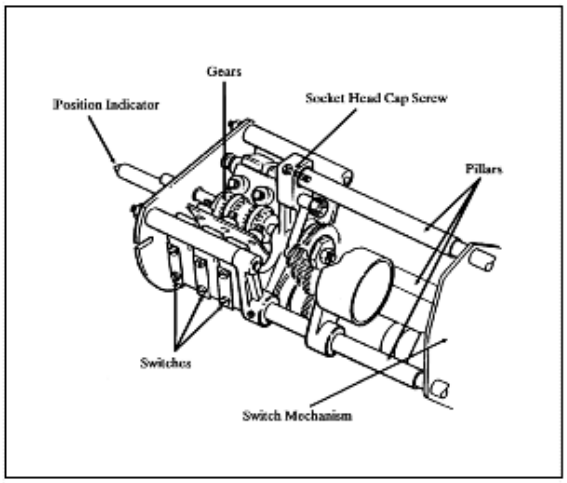

Figure 2-60 Rotork Add-on Pak

Millipot Stabilized Current Position Transmitter

The millipot stabilized current position transmitter (CPT) is used in Rotork A-range actuators to make the remote indication signal compatible for data scanning and logging bycomputer systems. The CPT is installed in conjunction with AOP 1 and gives a 4/20 mA output signal proportional to valve position.

Folomatic

Folomatic is a proportional control circuit for Rotork actuators. It enables a syncropak actuator to control the position of a valve in proportion to a continuous current or voltage signal. The control circuit has a feedback signal from the actuator position potentiometer for signal error.

Syncropak or Syncroset

The standard electrical circuitry associated with a Rotork actuator is available in two variations. The syncropak is an electrical "canister" used to house all the electrical components necessary for local operation of the actuator. A syncroset actuator has a terminal head only, and all the standard electrical components are housed in a control cabinet, usually located in a motor control cabinet. Syncropak actuators are not approved for nuclear use.

Traveling "Blinker"

A traveling light (blinker) is available for Rotork actuators. It can be supplied for installation on the switch mechanism or on AOP 1.

Valve Position Switch Unit

The valve position switch unit (VPSU) provides end position switch contacts for manually operated valves. The VPSU has three switches for each end of

valve travel. The switches are enclosed in a watertight and/or explosion-proof housing along with a handwheel drive. The VPSU replaces the original valve handwheel.

Supervisory Control Circuits

Supervisory control circuits with the following features are available for the syncropak actuators:

1. Incomplete travel alarm.
2. Unauthorized manual operation.
3. Exact end position indication.
4. Availability monitoring.
5. Fault analysis.

Summary

The actuator output torque, thrust, and speed depend on the motor speed, motor horsepower input into the actuator, and the gearing inside the actuator. Since there are so many variables associated with the actuator motor ratings, gearing, and electrical components, it is evident that Rotork actuators or components should not be interchanged among applications without consulting Rotork.

When or if it becomes necessary to consult with Rotork about an actuator, the following information (as a minimum) must be known:

1. Actuator type. e.g. Nuclear (NA) or Non-nuclear (A)
2. Actuator serial number
3. Actuator size. e.g. 7, 11 or 14

NOTE: The wiring diagram number should also be provided if information about the electrical components of the actuator is needed.

Actuator Comparisons

The Rotork Type NA actuator and the Limitorque Type SMB actuator are similar in that they are both motorized actuators that will operate valves by supplying the necessary force to a stem or input shaft to reposition the valve's internals. Both have the capabilities of allowing for local or remote operation of a valve while monitoring its position, providing local and remote indication, over thrust protection and other control features.

Despite their similarities, the Rotork Type NA and the Limitorque Type SMB have several distinct differences as follows:

1. Unlike Limitorque, Rotork recommends modular replacement of components rather than individual pieces.
2. The Belleville springs on the Rotork are located behind the motor's stator rotor unit, whereas on the Limitorque they are situated behind the worm.
3. The Rotork has only one gearing arrangement, that being between the worm and wormwheel. Limitorque

has two gearing arrangements, one between the motor pinion and wormshaft gear (wormshaft clutch gear on the SMB-0 through 4) with the other being between the worm and worm gear.

4. Rotork uses a thrust ring and a thrust pad on the top portion of the center column (Category 2 actuators) and a bearing on the lower portion of the center column to absorb radial and axial thrust loads, while Limitorque employs tapered roller bearings on both the top and bottom of its drive sleeve for the same purposes.
5. Rotork (Category 2 actuators) utilizes a yoke with a hand/auto finger attached to maintain the actuator in manual. Limitorque uses two trippers to accomplish the same.
6. Rotork Type NA actuators are categorized as watertight and explosion-proof while the Limitorque Type SMB actuators are not.
7. The torque and limit switches on the Limitorque Type SMB actuators are separate components as opposed to the Rotork Type NA actuators which combines the two into one device known as the switch mechanism.