2.3.2 SMB/SB-0 through -4

Introduction

The SMB-0 and larger actuators operate on the same basic principles as the smaller size SMB's, but the overall arrangement is greatly modified. In the SMB-0 and larger, the power train passes through the worm in both the electric and manual modes, and the declutch mechanism is completely removed from the drive sleeve. Specific differences will be covered in the text.

SB Modification

The SB actuator version is a variation of the standard SMB actuator in that the standard locked "two-piece" stem nut arrangement is replaced by a Belleville spring assembly which allows the stem nut to move upward when the Belleville spring assembly thrust setting is overcome.

This application is useful with high speed rising stem valves and in systems where a valve stem "grows" due to high temperatures after being closed. In the SB version, thrust is absorbed only in the upward direction, which applies to valve closing only.

A SBD modification which can absorb thrust in both directions, is available from Limitorque but is not discussed in this course. Both the SB and SBD modifications can be performed on any size SMB actuator.

The most apparent external or visible difference of an SB or SBD actuator is a raised "Top Hat" housing section above the actuator body where the Belleville springs are located. There is a pointer on this section of the housing which indicates spring compression in inches. The SB can be distinguished from the SBD version by the pointer. The SB pointer has the 0 at the bottom while the SBD has the 0 at the center.

For high speed service (which is approximately 24 in. /min. for gate valves, 8 in. / min. for globe valves, or for actuator output greater than 120 RPM), the SB absorbs the high shock loads when the valve seats. The SB also absorbs thrust loads which occur due to inertia and coast after the electrical contactor is deenergized. Damage to the valve stem, bearings, valve disc and seat can occur without the modification.

For high temperature service, which is approximately 900°F for small valves and somewhat less for larger valves, the SB modification counteracts expansion of the valve stem. Damage to the valve stem, bearings, valve disc and seat can occur without the modification. The SB modification cannot compensate for thermal expansion and contraction of the valve seat and disc, which may bind the valve internally.

One of the greatest benefits from the SB conversion is having the ability to easily open a valve after having the stem heated and expanded during heat-up, with the Belleville spring assembly absorbing the stem expansion, rather than having the disc driven into the valve seats.

SMB Principles of Operation

Some benefits of using an actuator instead of direct manual operation are: remote operation, remote indication, valve protection, permissive operation, reduction of the need for Operations Personnel, seating of a valve with required thrust, and controlled time for valve stroking.

The actuator can provide remote operation, safety, manual operating capabilities and valve closure with the proper seating force at the correct speed, while shutting off the power at the appropriate point without damage to the equipment.

The actuator will open the valve against the system's differential pressure and place the valve on or near the backseat. An individual has to make sure that the indication matches the valve position and any permissives or interlocks operate at the proper time.

Electrical operation of the actuator is initiated by pressing an open or close button or using an automatic circuit to initiate motion. This signal starts the motor rotating in the correct direction and, if necessary, causes the actuator to disengage from the manual mode and places it in the electric or motor mode.

The valve stem begins to move, which repositions the valve, while the indication and control circuitry reacts to the motion, going from the closed or open state to a mid-position condition. When the valve reaches the desired open or closed condition, the electric circuitry again changes to stop the motion, either by sensing valve position or by sensing the load on the actuator. The indication reacts to the change in valve position and shows the correct position of the valve.

In manual, the person operating the actuator will place it in the manual mode and position the actuator to the desired position by means of a handwheel. The indication and control circuits will detect the position change and be correct for the valve position. This allows the actuator to be started electrically after manual motion without having to readjust the controls.

If excessive force or valve bars are used when in manual, it is possible to damage the valve and/or actuator because there is nothing to prevent excessive force from being applied to the mechanisms.

The torque switch and limit switch do not protect from over-zealous operators.

The declutch mechanism is particularly sensitive to excessive force, as the declutch shaft is made of soft steel and excessive force on the declutch handle causes the splines to twist in the declutch link area.

If the actuator is started electrically while someone is operating the actuator in manual, a built-in safety feature ensures that the person will not be injured. This is accomplished by the three-piece clutch mechanism, which disengages the handwheel during electrical operation.

SMB/SB-1 Thru -4 Power Train

The power train is a sequence of components which transmit power from a motor or a person turning the handwheel, with the end result of repositioning the valve. The valve moves as a result of raising or lowering the valve stem as in a rising stem valve or as a rotation of the input shaft on a gearbox for a quarter turn valve.

Electric Power Train

In the electric mode, (refer to Figure 2-31) operation begins with rotation of the motor shaft. The motor shaft has a gear attached (MOTOR PINION) which rotates a matching gear (WORM SHAFT CLUTCH GEAR) free wheeling (i.e. not coupled or splined to the worm shaft) on the WORM SHAFT. The two gears are helical gears and are always engaged.

The worm shaft clutch gear has lugs on it which drive a splined sliding WORM SHAFT CLUTCH. The WORM SHAFT rotates due to the matching splines of the clutch and passes all the way through the actuator housing. The worm shaft drives a WORM, which is half of a WORM/WORM GEAR set, through another set of splines. The worm drives the WORM GEAR which is located around the DRIVE SLEEVE. The worm gear has lugs on the upper half that engage and drive matching lugs on the drive sleeve. The drive sleeve has internal splines which rotate the STEM NUT as the drive sleeve rotates. The stem nut is internally threaded for rising stem valves or keyed or splined for quarter turn valves.

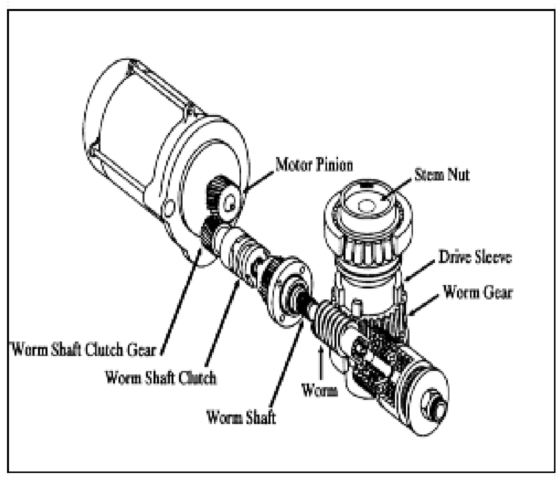
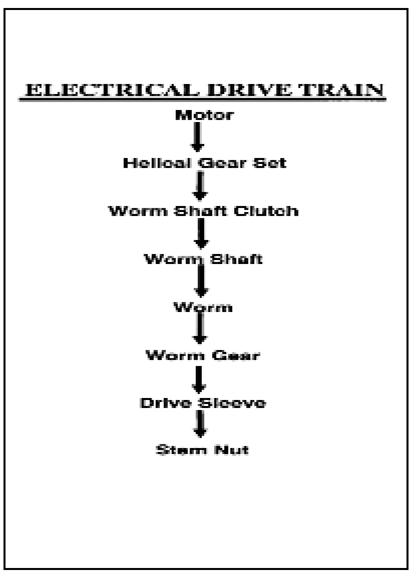


Figure 2-31 SB Electric Power Train

The stem nut threads match those of the valve stem, and if the stem nut is properly held in place by the stem nut locknut, the valve stem is raised or lowered as the stem nut rotates. The stem, as it raises or lowers will reposition the valve. The keyed stem nut used on quarter turn valves does not raise or lower a stem, but turns an input shaft clockwise or counterclockwise to rotate a valve disc.

The valve will continue to be repositioned until the limit switch, torque switch, a manual stop or the motor overload protection activates to stop motor rotation. If one of these stopping mechanisms do not work or are improperly adjusted, the valve will only stop when the motor burns out or the valve or actuator breaks. The SB Electric Drive Train is functionally identical to that of the SMB. Table 2-6 summarizes the electrical drive train.

Table 2-6 SB Electrical Drive Train



Manual Power Train

In manual mode, the HANDWHEEL rotates the HANDWHEEL SHAFT, which passes through the actuator into the motor compartment. The other end of the shaft has the HANDWHEEL GEAR bolted and keyed to it.

Refer to Figure 2-32. When in manual, the handwheel gear is engaged with and rotates the HANDWHEEL CLUTCH PINION, which has lugs which engage the WORM SHAFT CLUTCH. The two gears are spur gears and are always engaged.When the actuator is engaged in manual, the worm shaft clutch and its manual lugs are moved to engage the handwheel clutch pinion lugs. The clutch drives the WORM SHAFT through internal splines, and the manual power train is identical to that of the electric power train from this point.

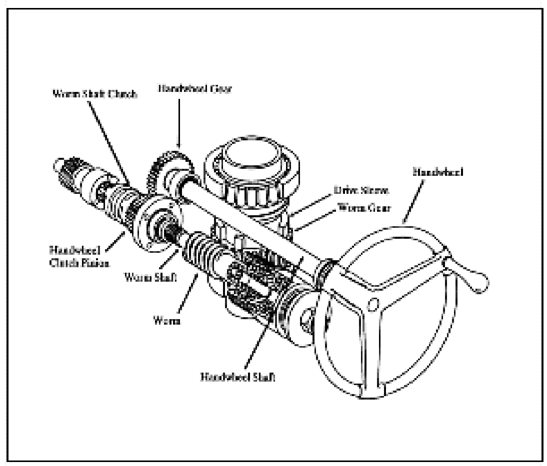
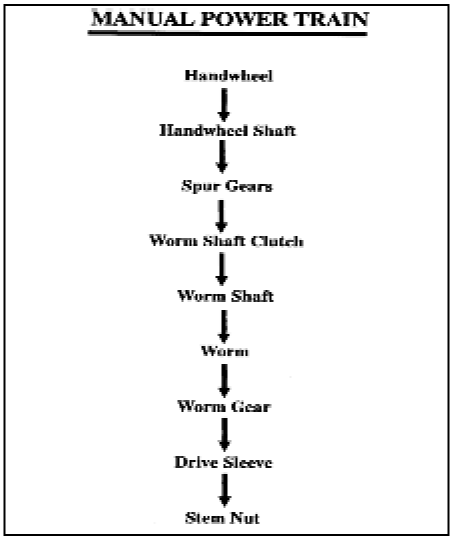


Figure 2-32 SB Manual Power Train

The manual power train does not have any protection schemes built in to protect the actuator or valve. Operating personnel must be extremely careful to prevent damage which can be caused by exerting excessive force on the handwheel. The worm/worm gear and handwheel gear set ratios allow the operator to provide more torque than the motor. In manual, the valve is only protected by a well-trained operator.

Table 2-7 SB Manual Power Train



The SB Manual Drive Train is functionally identical to the SMB. Table 2-7 summarizes the manual power train.

Holding in Manual

Refer to Figure 2-33. To change the actuator from electric mode to manual mode, the DECLUTCH LEVER (which is not shown) must be pressed. This rotates the DECLUTCH SHAFT, which rotates the DECLUTCH LINK. The declutch link is splined to the declutch shaft, and rotates against the pivoting DECLUTCH FORK.

The declutch fork is engaged with the WORM SHAFT CLUTCH so that as the fork pivots, the clutch slides along the worm shaft splines against the resistance of the FORK RETURN SPRING until its lugs engage with the HANDWHEEL CLUTCH PINION lugs. The handwheel clutch pinion is also spring loaded so that and if the lugs of the sliding clutch are positioned on top of the handwheel-driven gear lugs, the handwheel clutch pinion can "give" to allow latching in manual. Note that this is different from the SMB-000/00 actuators in that there is no need to move the handwheel to get the gears to mesh. The sliding action of the clutch prevents the actuator from being engaged in motor and manual at the same time.

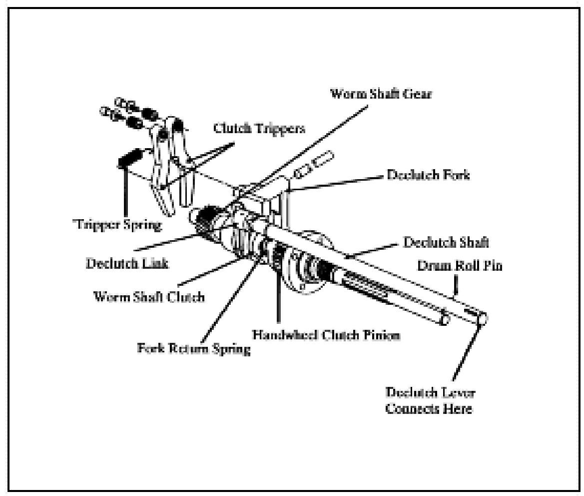


Figure 2-33 SB Declutch Mechanism

A part of the machined declutch fork lowers as the fork is pivoted by the action of the declutch handle and allows the notched and spring loaded CLUTCH TRIPPERS to be pulled towards the worm shaft by the TRIPPER SPRING and engage the declutch fork. This action prevents the declutch fork from pivoting back to the motor position.

Only motor operation can cause the CLUTCH TRIPPERS to release the declutch fork and return it to motor operation. The declutch handle is spring loaded and returns to its original position when released.

Only one of the trippers is required to hold the actuator in manual, but two trippers are necessary to ensure positive engagement into manual. The notches in the trippers are placed at slightly different distances from the center of their mounting holes or are adjusted for the same effect to ensure positive disengagement from manual mode. Fixed or adjustable trippers is a Limitorque factory variation which depends on time of manufacture.

The trippers are disengaged from the declutch fork by the rotation of the worm shaft clutch gear, which has a radial mounted pin that strikes the trippers as it rotates. The trippers are forced away from the declutch fork in a sequence which releases the fork allowing the compressed fork return spring to force the fork and clutch back to the motor position.

The SB is functionally identical to the SMB.

SB Principles of Operation

Refer to Figure 2-34. The SB modification is a Belleville spring compensator housing cover assembly whose purpose is to absorb thrust due to high speed and high temperatures. The thrust is absorbed by letting the stem nut indirectly float against the Belleville springs. The spring compensator for each of the SB-0 through 4 sizes is very similar, but there are minor differences. The following sections will describe the specifics of the SB-0 actuator.

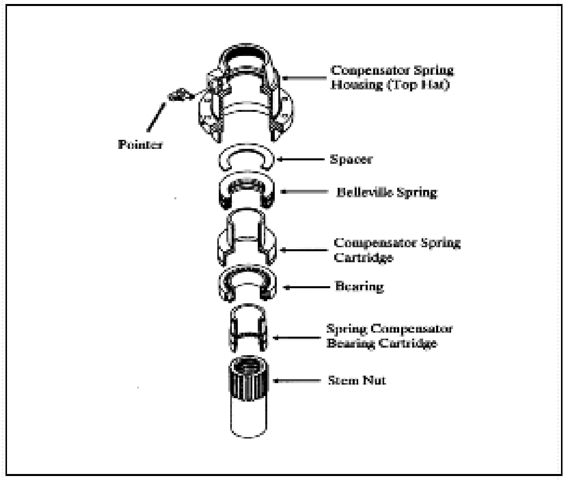


Figure 2-34 SB Belleville Spring Compensator Housing Cover Assembly

Most actuator applications with rising stem valves use the torque switch to deenergize the motor at the valve closed position, which is intended to allow the actuator to deliver a uniform seating force and protect the valve and actuator from damaging overloads. When the torque switch trips and the close contacts open, both motor contactor lag in opening and inertia of the moving parts prevent the valve stem from stopping instantaneously.

Contactor lag is the time lag that occurs from the time that the torque switch contacts open to the time that the contactor actually removes power from the motor. The time lag, which is in the order of 15 to 35 milliseconds, causes a large increase of thrust on the seat in high speed valves. As the stem speed increases, the higher the thrust will be without compensation.

Inertial thrust depends on system rigidity, motor size, motor speed and the actuator output speed. The motor has inertia because the rotor inside the motor does not stop spinning the instant that power is removed. How long it continues to turn depends on how large it is and how fast it is turning.

The Belleville spring compensator minimizes the effect of contactor lag and inertia by installing a set of Belleville springs locked to the stem nut and allowing the springs to compress when the disc seats or the stem expands or contracts.

SMB/SB-0 and Larger Electric Controls

The limit switch on the larger actuators is driven by a helical gear machined on the worm shaft, instead of being driven directly off the drive sleeve, as on the SMB-000/00. The operation of the limit switch is identical to that of the smaller actuators, the only difference in construction being the cartridge.

When operating the actuator with a lost motion drive sleeve, there is lost motion when the actuator reverses direction when the worm shaft and limit switches turn but the drive sleeve doesn't. This occurs as the drive lugs on the worm gear move from one side of the drive lugs on the drive sleeve to the other ("hammer blow"). The limit switches can count a large number of rotations while the drive sleeve is stationary.

The TORQUE SWITCH operation, except for the drive, is identical to that of the later SMB-00 clamshell (knee action) type. The SMB-0 units have a straight cut gear on the end of the torque switch shaft, which is driven by a gear that is cut into the spring pack bearing cartridge cap creating a rack and pinion arrangement. The torque switch is functional during mechanical operation as well as electrical.

When using an actuator with SB modification, the operation should be set to allow the torque switch to operate and all inertia taken up without fully compressing the compensator Belleville springs. Once the Belleville springs are fully compressed, the total output thrust of the actuator can only be determined by diagnostic testing.

SMB/SB-0 and Larger Motor

The motors for the larger actuators are the same as those for the smaller actuators except for size.

SMB/SB-0 and Larger Helical Gear Set

Refer to Figure 2-35. Motor rotation is transmitted by the motor pinion to the worm shaft clutch gear. The gears are a matched set and are supplied as a pair by Limitorque, and should be replaced as a set. The motor pinion is keyed, set screwed and lockwired to prevent the gear from loosening, also, the keyway is "pinned" with a punch to prevent the key from falling out.

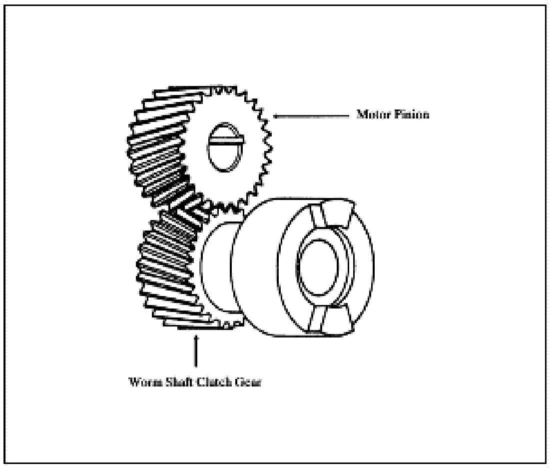


Figure 2-35 SMB/SB-0 Worm Shaft Clutch Gear

The worm shaft clutch gear has two holes drilled in the worm shaft gear 180 degrees apart and has a pin, which is used to force the trippers off the declutch fork, inserted in one hole. This action allows the actuator to return to motor mode of operation.

Refer to Figure 2-36. In the SMB-1 through 4 actuators the motor pinion is installed in a reverse direction from all the other actuators. If the pinion gear is installed in the reverse direction, the two pinions will still mesh, but mesh is approximately 40 percent of the tooth area, instead of 100 percent.

In some actuators with high speed applications, the worm shaft clutch pinion is constructed of several parts in a "soft clutch" arrangement. The piece with lugs that drive theclutch is called the "worm shaft clutch gear sleeve", and the piece with the gear teeth is called the "worm shaft clutch gear".

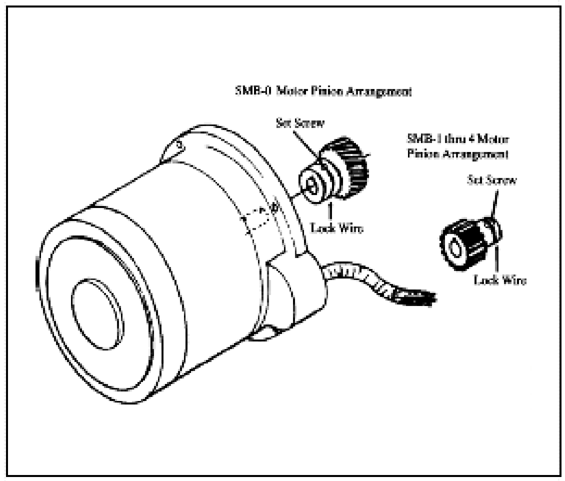


Figure 2-36 SB-0 Motor Pinion Arrangement

Between the inner shell with the gear and the outer shell with the hardened worm shaft clutch engagement lugs are a series of elastomer rollers. These cushion high speed motor start impacts. A hard clutch should only be used on a soft clutch actuator in an emergency, and then only after consulting with Limitorque.

Refer to Figure 2-37. The center piece of the three-piece clutch, called the worm shaft clutch, drives the worm shaft in both electrical and manual mode. When in electric mode, the motor driven worm shaft clutch gear drives the worm shaft clutch, and in manual, the handwheel driven handwheel clutch pinion gear drives the worm shaft clutch.

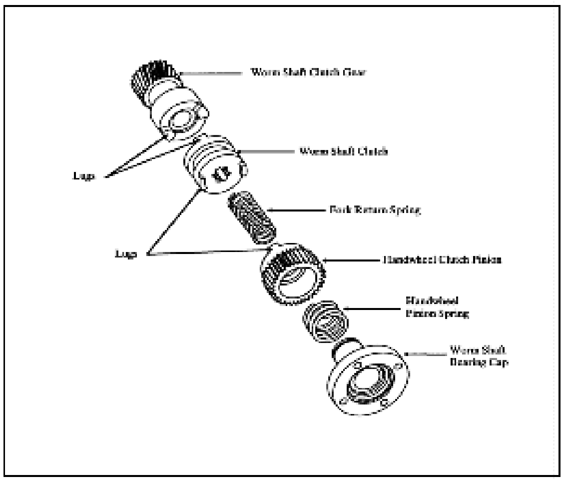


Figure 2-37 SMB/SB-0 Worm Shaft Clutch

The worm shaft clutch is constructed of steel and has internal splines that engage matching external splines on the worm shaft. Early versions of the clutch were hardened on the motor end only. Later versions have the entire clutch hardened. There is lost motion between the lugs of the worm shaft clutch gear and lugs of the worm shaft clutch, which allows the motor to start rotating before driving the worm shaft.

Because of the physical size of the components involved, it is not possible for the worm shaft clutch to engage both the worm shaft clutch gear and the handwheel clutch pinion at the same time. This protects personnel from being hurt by the handwheel if someone were to start the motor while the actuator is in the manual mode.

The worm shaft clutch is spring loaded into the worm shaft clutch gear by the fork return spring. The manual mode lugs engage when declutching action moves the worm shaft clutch towards the handwheel clutch pinion. The hand wheel clutch pinion is spring loaded by the hand wheel pinion spring, which allows the actuator to be placed in manual even though the lugs butt against each other. Refer to Figure 2-38 and 2-39.

When the declutch lever is moved downward, it causes the declutch fork to pivot, and moves the worm shaft clutch by use of the rollers on the end or the declutch fork. The rollers engage in an external groove machined in the worm shaft clutch.

There is a difference in the size of the lugs on each end of the worm shaft clutch and the lugs they mate with. The thicker lugs mate with the thicker lugs on the worm shaft clutch gear and are used for motor operation. The thinner lugs mate with the thinner lugs on the handwheel clutch pinion and are used for manual operation. It is extremely important that the clutch be oriented properly during assembly.

SMB/SB-0 and Larger Worm Shaft

The function of the worm shaft is to rotate the worm. An exploded view of the worm shaft can be seen in Figure 2-38. It is a steel shaft directly supported by one bearing (two in SMB/SB-3 and 4) in the middle of the shaft and a bushing at the motor end. The spring pack provides an additional bearing support at the other end. It is splined at both ends to allow the worm and clutch to slide axially.

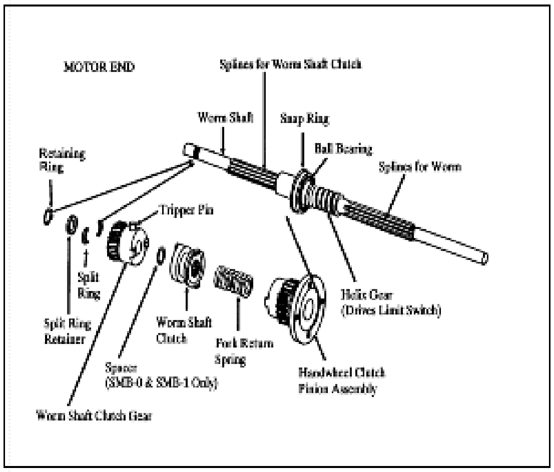


Figure 2-38 SMB/SB-0 Worm Shaft Exploded View

The worm shaft is rotated by the worm shaft clutch through the splines. The worm, with its internal splines, is located on the spring pack and rotates with the worm shaft through its matching splines. The worms position on the splines allow it movement in either direction. This allows the worm/spring pack to sense torque in both the open and close directions.

Starting at the motor end of the worm shaft, the following pieces are either mounted on the worm shaft or around it: retaining ring, split ring keeper, split ring, worm shaft gear and bushings, clutch spacer and worm shaft clutch, fork return spring, handwheel clutch pinion and spiral retaining ring, hand wheel pinion spring, bearing cap, bearing retaining ring and bearing. A helix gear is cut into the worm shaft itself to drive the limit switch drive assembly as the worm shaft rotates. Figure 2-39 shows an assembled worm shaft and its relationship to the declutch mechanism.

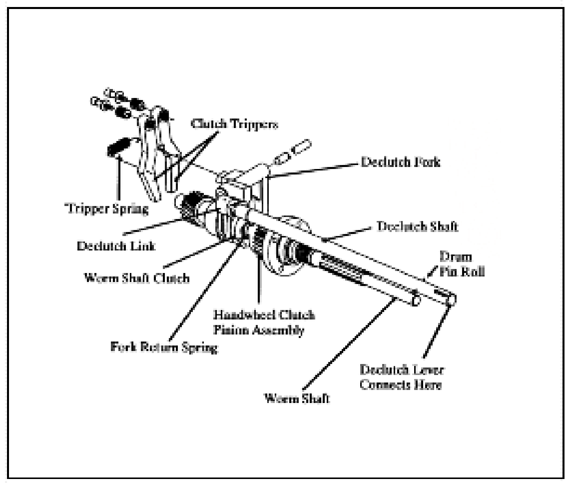


Figure 2-39 SMB/SB-0 Worm Shaft and Declutch Mechanism

SMB/SB-0 and Larger Worm and Worm Gear Set

The function of the worm and worm gear, Figure 2-40, is to change the direction of the rotating force by 90 degrees and rotate the drive sleeve. The worm attempts to thread itself out of the worm gear when the axial forces overcome the spring preload of the spring pack.

There are many worm and worm gear set ratios available from Limitorque, with the size selected depending on application, size of the actuator, valve manufacturer limitations, system pressure, speed of opening or closing, type of packing used and many other possible variables.

Low pitch gear sets, which require just a few turns of the worm to give one turn of the worm gear, can have the worm gear as the driver gear and the worm as the driven gear during periods of high stem load.

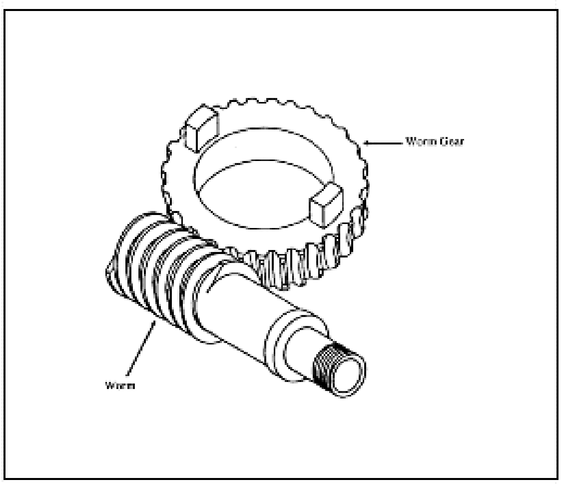


Figure 2-40 SMB/SB-0 Worm and Worm Gear

This action allows the valve to partially open. These gear sets are known as non-locking gear sets. High pitch sets offer too much resistance for this to occur. Low pitch worm and worm gear sets are usually used in high closing speed applications.

SMB/SB-0 and Larger Worm

The worm is one part of the worm and spring pack assembly, and is the driving gear of the worm/worm gear set. The worm is cut from steel and has one or more external leads (threads) on the outside which will engage and drive the worm gear, and splines on the inner bore. The internal splines slide over the worm shaft and transmit the rotation from the worm shaft to the worm.

The worm is part of the spring pack assembly, Figure 2-41, which has three functions: 1) the worm drives the worm gear, 2) a rack on the bearing cartridge cap drives the pinion gear on the torque switch shaft and 3) the Belleville springs and their spring tension set the amount of torque it takes to allow the worm to slide axially. The spring tension of the spring pack is called the "Preload," and is set by the stop nut on the bearing cartridge stem. Tightening the nut increases the spring tension which increases the preload.

Loosening the nut reduces spring tension and reduces the preload. The proper position of the nut is determined by Limitorque and should be maintained in order to keep the torque switch calibration plate accurate. If the proper nut position is not known, the information should be acquired from Limitorque.

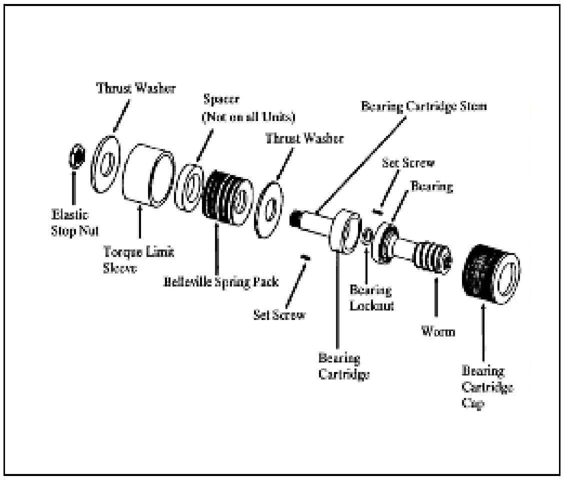


Figure 2-41 SMB/SB-0 Spring Pack Assembly

They will supply the information as either a number of rotations or as the "X" dimension. If supplied as rotations, the starting point is the point where the spring washers become snug. If it is supplied as a dimension, it is the dimension between the torque limit sleeve (the cylinder around the springs) and the washer on either end of the spring pack, and it is set with a dial caliper. Before disassembly, inspect the nut carefully to make sure any set screws are removed.

If any of the Belleville spring parameters, such as spring thickness, spring quantity or spring preload is changed, the force required to move the worm axially along the worm shaft will change and the torque supplied to the valve stem for a given setting of the torque switch will change.

The worm and spring pack assembly are joined together by threading the bearing cartridge into the bearing cartridge cap. This locks the bearing in place. To change the worm or the bearing, it is necessary to separate the bearing housing and remove the elastic locknut on the end of the worm.

SMB/SB-0 and Larger Worm Gear

Refer to Figure 2-40. The worm gear function is to rotate the drive sleeve, with the rotational forces being transmitted through a set of lugs on the top of the worm gear to lugs machined in the outside diameter of the drive sleeve. There are no splines or keys for the worm gear to directly drive the drive sleeve.

The worm gear is driven by the worm and is mounted around the drive sleeve. The worm gear is made of brass which is anti-galling and will usually fail before the worm. The worm gear teeth have a radius cut in the tops of the teeth, which matches the root diameter of the worm. The number of teeth on the worm gear and the leads and pitch of the worm determine the ratio of the gear set.

The worm gear has lugs which engage the drive sleeve, but not through its full rotation. The worm gear can rotate part way around the drive sleeve before hitting the lugs on the drive sleeve. This is called lost motion. When the lugs finally engage, they generate a "hammer blow" to the drive sleeve, which may not help in unseating a valve, but it does assist in breaking the "friction" between the stem and stem nut in rising stem valves.

In addition, the lost motion allows the motor to reach operating speed before acquiring load, The worm gear is free floating on the drive sleeve, but is held axially by the lower drive sleeve bearing. There is a spacer between the lower bearing and the worm gear.

When overhauling an actuator, the worm gear teeth should be examined for indications of misalignment between the worm and worm gear. The worm gear wear should be centered on the teeth, and not high or low. If the wear is not centered, the drive sleeve shims need to be corrected, or the bearings on the drive sleeve are not properly loaded by the housing cap.

SMB-0 and Larger Drive Sleeve

Refer to Figure 2-42. The function of the drive sleeve in the SMB-0 and larger actuators is to rotate the stem nut, causing the valve to operate. There are bearings on both the upper and lower ends to absorb the radial and thrust loads. The bearings are tapered roller (Timken) type in the SMB, where the SB has a different bearing setup. Which bearing is loaded depends on the direction of valve stem travel.

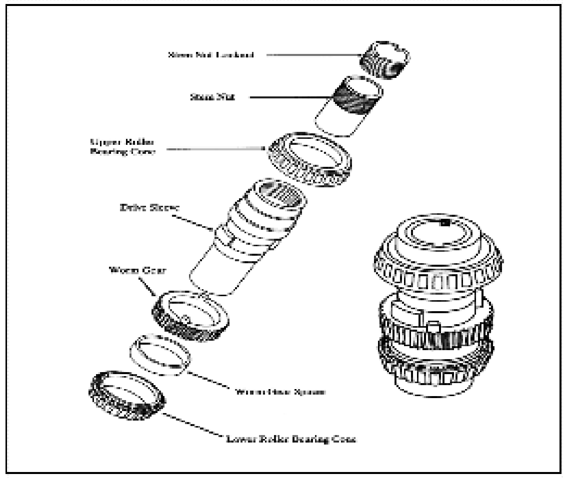


Figure 2-42 SB-0 Drive Sleeve

If a rising stem valve is being opened, the drive sleeve will pull on the stem and load the lower bearing. If the valve is being closed, the drive sleeve will push the valve stem into the valve and will load the top bearing. The outer races are mounted in the actuator housing and housing cover, with the rollers and races being separated when the drive sleeve is removed.

There are splines on the inside of the drive sleeve to mate with the stem nut. The internal bore of the SMB drive sleeve also has threads which are used by the stem nut locknut(s) to hold the stem nut in place. There are drive sleeves and worm gears which mate up solidly so there is no lost motion and no hammerblow.

The drive sleeve bearings must be preloaded correctly to prevent damage to the worm gear, bearings, actuator, and valve, and to insure that accurate worm walk will occur. This bearing preload is set by the gasket thickness of the housing cover. Changing the bearings can change the position of the drive sleeve, and the alignment of the worm/worm gear should be blue checked after assembly.

SMB/SB-0 and Larger Stem Nut

The function of the stem nut is to operate the valve stem, either by raising and lowering the stem in rising stem designs, or by turning the stem in non-rising stem designs. It is constructed of brass, which has self lubricating properties and can minimize galling. This does not imply that lubrication isn't required.

The internal bore of the stem nut is either threaded, keyed or splined depending on how the valve stem mating is accomplished. For rising stem valves, the drive sleeve is threaded, usually with an ACME thread. The valve stem may have one, two, three or four leads; this requires that the stem nut have matching leads.

For non-rising stem valves, quarter-turn valves and gearboxes, the internal bore is keyed or slotted. There are external splines for mating with the drive sleeve. The stem nut is held in the drive sleeve by the stem nut locknut. The stem nut locknut threads into the drive sleeve and holds the stem nut solidly against the stem thrust.

The stem nut locknut is held in place by staking the threads just behind the locknut. If the valve stem is being pushed into the valve, the stem nut tries to rise out of the drive sleeve. If the stem nut and stem nut locknut are not solidly against each other, the stem nut will thread up or down on the valve stem, depending on the travel direction.

The limit switches will lose their relationship with the valve stem. If the drive sleeve and stem nut splines come out of engagement the valve stem will probably not move any further, but the motor may keep running and burn out after the motor duty cycle time has been exceeded.

The number of leads of the stem or stem nut can be easily determined. This can be accomplished by placing a piece of string around the stem, staying in the same thread for one revolution and counting the number of threads between the string from the starting point to the finish point. The number of threads indicate the number of leads.

The mating of the stem nut on the stem should be checked over the full threaded length of the stem. If the stem nut threads easily for some of the stem threads but then jams, either the stem threads or the stem nut threads are damaged. The stem nut should be turned over and tried again to determine which one. Slight stretching of the stem is all that is required for the stem nut to jam. If the stem nut or stem is damaged, both should be replaced.

SMB/SB-0 and Larger Handwheel Components

Refer to Figure 2-43. The handwheel operates the handwheel shaft, and the handwheel shaft operates the handwheel gear set. The handwheel is sized to supply the correct amount of force to the valve using only hands. Valve bars should not be required to properly seat the valve.

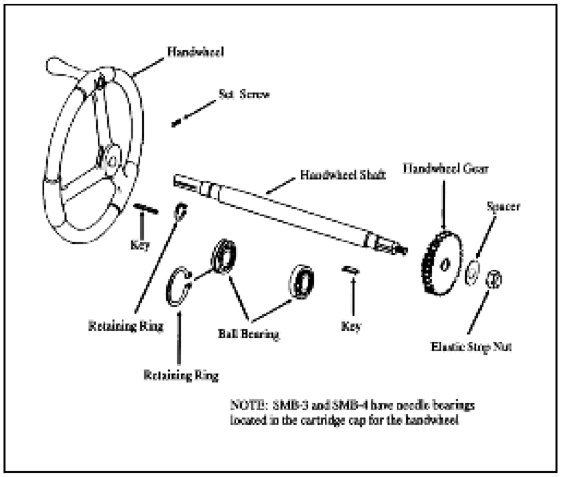


Figure 2-43 SMB/SB-0 Handwheel Assembly

Usually the handwheel has a cast-in arrow that indicates which way to turn the valve for opening or closing. There are arrows pointing both directions when the actuator leaves Limitorque, it is the responsibility of the valve company to grind one of them off.

The handwheel is keyed and set screwed to the handwheel shaft and positioned with a spacer between the housing and the wheel. The handwheel shaft is supported by two bearings.

The handwheel end bearing is held on the shaft by a retaining ring and located in the housing by an external retaining ring. The motor end bearing is a press fit held in place by the handwheel gear.

The SMB/SB-0 and larger handwheel gear and the handwheel clutch pinion are always in mesh, regardless if the actuator is in manual or electric mode.

Declutch Mechanism

General

Refer to Figure 2-44. The function of the mechanism is to shift the clutch and its lugs from engagement with the worm shaft clutch gear lugs (motor mode) to engagement with the handwheel clutch pinion lugs (manual mode). The trippers hold everything in manual.

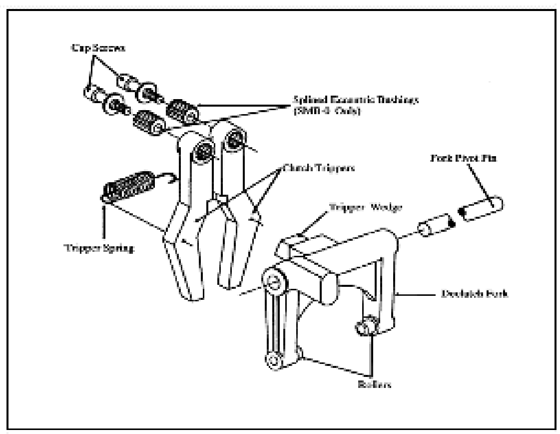


Figure 2-44 SMB/SB-0 Declutch Mechanism

Declutch Shaft

Refer to Figure 2-45. The declutch shaft is externally splined opposite from the lever end and is engaged with the matched internal splines of the declutch link. The declutch shaft is supported at the handle end by the hole in the spring cartridge cap. At the declutch link end, the shaft is supported by the support rod (not shown in referenced figure).

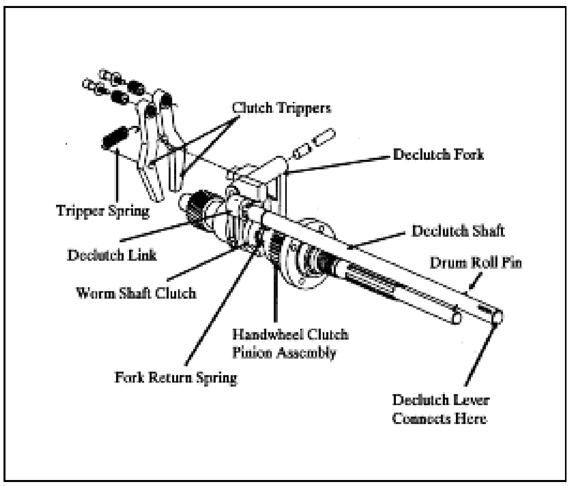


Figure 2-45 SMB/SB-0 Declutch Shaft

There are no bushing supports for the shaft. On some SMB/SB-0 and larger models, the declutch shaft has a retaining ring in a groove that retains it in place. The splined area of the declutch shaft is smaller in diameter to match the support rod, and will fail if extreme force is used on the declutch handle.

At the lever end of the shaft, a pin extends through the shaft for loading the torsion spring (not shown in referenced figure). When assembling the actuator, the relationship of the spring, shaft keyway, and declutch link must be correctly set in order to function properly. A pin in the spring cartridge cap section of the housing holds the declutch lever preload which returns the lever to its original position after operation.

Declutch Link

The declutch link function is to pivot the declutch fork when the lever is pressed down and the shaft is rotated. The link is subject to extreme pressure wear at the point where it engages with the declutch fork.

Declutch Fork

The declutch fork is mounted on a shaft in the clutch housing, and is forced to pivot by the declutch link when the declutch lever rotates the declutch shaft. The declutch fork engages the clutch through a set of rollers which are pressed into the fork. The front section of the declutch fork is extended for engagement with the tripper fingers and to hold the actuator in manual. The declutch fork pivot pin is held in the housing with a set screw.

Support Rod

The support rod is a hollow steel rod with one end open. The opening engages with the end of the declutch shaft to support the shaft. The rod fits in a hole located in the clutch housing, which bolts to the actuator housing.

Torsion Spring

The torsion spring is cylindrical and slides over the bushing on the handwheel end of the declutch shaft. Its function is to force the declutch lever back to its normal position by spring action after the actuator is engaged and held in manual mode.

This action allows for a smaller fork return spring, and eliminates a safety hazard of older style actuators and small SMB styles. The lever on the SMB/SB-0 and larger actuators will not "kick" up when the actuator returns to electric operation after being engaged in manual mode.

The spring ends terminate in such a manner that one end fits into a matching hole in the housing and the other end is positioned so the pin on the declutch shaft engages it. The spring is bi-directional and may be installed with either end facing inward. During reassembly of the actuator, the spring is preloaded to provide the necessary force for lever return.

To set the proper spring tension, the keyway on the declutch lever should point upward, with the spring catch on the left side of the pin inserted through the declutch lever. The declutch link points downward with the flat side against the housing.

Install the gasket and spring cartridge cap over the declutch shaft, then place the lever and key on the shaft. The spring must have its internal end seated in the hole in the housing.

Hold the spring cartridge cap away from the housing approximately 1/4 to ½ inch. Rotate the lever counterclockwise until the pin through the declutch shaft passes the pin in the spring cartridge cap, and push the spring cartridge cap against the housing.

The spring should push the declutch lever clockwise against the pin in the spring cartridge cap, and the declutch link should be positioned under the extension of the declutch fork. The declutch lever should not be able to be rotated clockwise past the point where spring tension is released.

SMB/SB-0 and Larger Trippers

The trippers are the components that keep the actuator in manual. The declutch mechanism can place the actuator in manual while the lever is held down, but the trippers have to be properly adjusted to hold the declutch fork in manual and to release the fork when the motor starts.

The trippers are spring loaded toward the declutch fork with a single spring. When the extended area of the fork passes the corners on the trippers during transfer from motor to manual mode, the tripper spring pulls the tripper corners onto the declutch fork extension holding the actuator in manual.

When the motor starts to turn, the radial pin in the worm shaft clutch gear pushes the trippers off the declutch fork extension and the fork return spring forces the actuator back into electric mode by sliding the worm shaft clutch towards the worm shaft clutch gear.

The trippers are mounted on two separate shoulder bolts extending out from the clutch housing. The trippers are located on either side of the worm shaft clutch gear. A later modification of the tripper mounting is a set of splined eccentric bushings which mate with the tripper. This allows the hole in the tripper to be moved off-center which locates the tripper for proper adjustment.

The trippers should be match marked before disassembly so they can be reassembled in the same manner. They should be tested before motor reinstallation to verify that they will be pushed off the rest when the worm shaft clutch gear turns. Failure to do this may prevent the motor from returning the actuator to the electric mode, and will require removal of the motor at a later date to properly set the trippers.

The reason for two trippers is to ensure that the actuator can always be latched into manual, no matter what the position of the pin on the worm shaft clutch gear is. If one tripper can't move onto the declutch fork because the pin is holding it out, the other can. The tripper corners are offset slightly to make sure that the trippers can get off the declutch fork as the rotating pin strikes each finger.

If the notches (corners) were exactly even with respect to the declutch fork, a tripper would fall back on the fork as the pin moves past the tripper. This would continue indefinitely and the actuator might never release from manual mode. The corner offset had to be filed on early SMB/SB-0 and larger but can be adjusted on later SMB/SB-0 and larger actuators which have the splined eccentric bushing adjustment.

Only one tripper holds the actuator in manual - the tripper with the lower corner being the more probable. The tripper with the higher corner holds the actuator in manual when the pin prevents the other tripper from latching the fork in the manual position.

The normal sequence of finger release is as follows: the lower notch holds the fork, the pin on the rotating gear and worm shaft pushes the tripper off the fork, the fork pivots slightly until the other tripper holds it, the original tripper cannot get back on top of the fork, the pin rotates 180 degrees and pushes the other tripper off the fork which allows the fork to pivot back to the electric mode position.

Adjustment

Torsion Spring

The torsion spring must be installed in such a manner that it returns the declutch lever to its normal position.

NOTE: The locknut in the spring cartridge cap must be adjusted before doing these steps.

1. Install the declutch shaft with the torsion spring mounted and the declutch lever key facing up.
2. Catch the projection on the inner end of the torsion spring in the hole drilled in the bottom of its recess in the housing.
3. Locate the declutch handle pin on the right side of the outside spring projection.
4. Mount the cartridge cap over the declutch shaft, but not far enough to catch the declutch shaft pin.
5. Mount the declutch link with the free end pointing downward and flat side toward the housing.
6. Temporarily install the declutch key and lever.
7. Rotate the declutch lever counterclockwise until the declutch shaft pin passes the roll pin projecting from the cartridge cap. You should feel spring resistance.
8. Once past the pin in the cartridge cap, push the cartridge cap up against the housing, then bolt in place.

Clutch Trippers

Refer to Figure 2-44

1. Mount both clutch trippers in the clutch housing; do not install the tripper spring.
2. Press the declutch handle while manually forcing the clutch tripper to engage the declutch fork. If one does not go onto the fork, rotate the worm shaft clutch gear to move the tripper pin. Install the tripper spring.
3. When both clutch trippers are on the declutch fork, one tripper should be easy to pull off the declutch fork with your finger; and when released, will return to the declutch fork.
4. If either clutch tripper cannot get onto the declutch fork, the splined eccentric bushing hole must be moved upward by rotating the splined eccentric bushing in the clutch tripper. If the actuator does not have the splined eccentric bushings, the clutch trippers may have to be exchanged or the notches filed.
5. After the clutch tripper heights are correct, test the tripping action by rotating the worm shaft clutch gear.
6. If a clutch tripper cannot be pushed off the declutch fork by the tripper pin in the worm shaft clutch gear, the

splined eccentric bushing hole must be moved by turning it around. If there are no eccentrics, exchange the clutch trippers.

Housing

Refer to Figure 2-46. The housing holds all the operating pieces in their proper location and alignment. It is made up of five main pieces: the housing, housing cover, limit switch compartment cover, spring cartridge cap and spring cartridge cap cover plate, and clutch housing (clutch compartment).

All of the components are normally made of cast steel, although the limit switch housing cover may be aluminum. The baseplate is a flange for mounting to the valve yoke. There are several openings, normally fitted with piper plugs, used for checking lubricants with several more for conduit entrances. The housing cover, housing bottom, and shaft penetrations are sealed with lip seals, quad rings, or "O" rings.

The housing cover is sealed with a gasket(s) whose thickness is critical to the operation of the actuator. The lower bearing race shims and the gasket for the housing cover set the operating position of the drive sleeve.

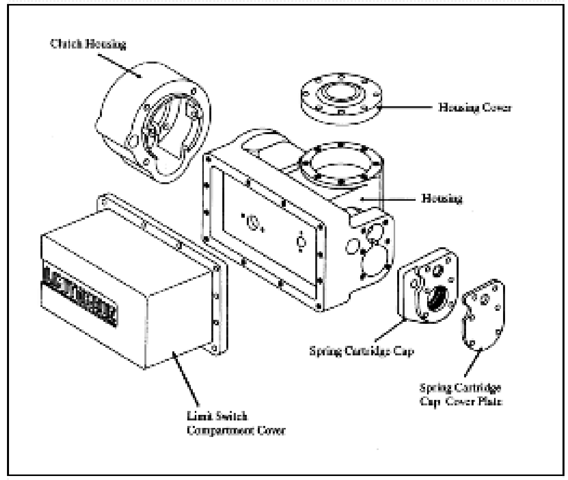


Figure 2-46 SMB/SB-0 Housing

The spring cartridge cap provides a stop for the spring pack assembly motion in the close direction with the locknut, a stop for the torsion spring and penetrations for the declutch shaft and handwheel shaft. A shoulder in the housing provides a stop for the spring pack assembly in the opening direction.

The locknut is locked in place using an internal set screw. The position of the locknut is critical to the operation of the actuator, and it must be set correctly. On SMB and SB-0, 1 and 2 actuators, the locknut threads into the cartridge cap; SMB and SB-3 and 4 actuators have a one piece spring cartridge cap with no locknut. Its correct position is one where it holds the spring pack assembly snug, but does not add to the preload on the spring pack assembly.

Prior to setting, the worm should be drawn completely into the actuator by turning the worm shaft with the worm shaft clutch gear or the handwheel. To achieve the proper setting, the cartridge cap should be bolted in place (with a gasket) on a SMB or SB-0, 1, or 2, and the locknut should be threaded up against the large thrust washer on the spring pack assembly. It should not be overtighten.

The locknut should be locked in place using the set screw. The spring cartridge cap will need to be removed to preload the declutch lever, if not already done.

The housing should be inspected for cracks, and all threaded holes should be checked for damaged threads. The threads should be cleaned using a bottoming tap. The bearing cup bores and the worm shaft bearing bores should be inspected for the correct diameter and roundness.

SB Modification Components

SB Drive Sleeve

Refer to Figures 2-47 and 2-48. The SB actuator uses a different drive sleeve to allow the installation and use of the spring compensator. The drive sleeve must be different since the stem nut is allowed to move upward when the actuator thrust is in the down direction, where in the SMB, the stem nut is rigidly held in place by a stem nut locknut.

The SB drive sleeve has a radial bearing mounted on top instead of the thrust bearing as in the SMB actuator. The bearing's function is only to hold the drive sleeve in place to prevent any side to side movement. This bearing does not absorb any thrust since the stem nut is not locked to it. The upper bearing is mounted to the bearing cartridge, and moves with the stem nut.

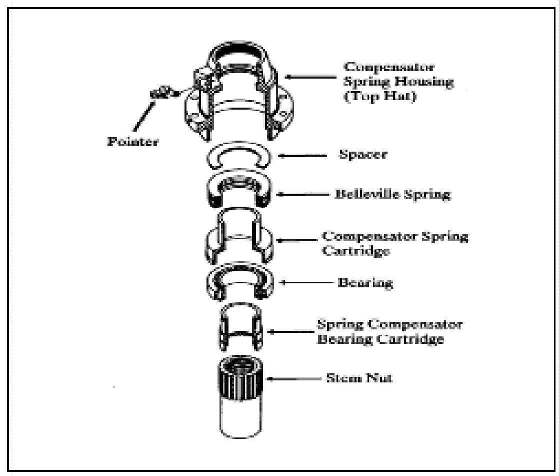


Figure 2-47 SMB Spring Compensator

The upper portion of the SB drive sleeve has been changed to allow for stem movement and to transfer the thrust of the stem nut to the spring compensator components. The upper portion of the drive sleeve extends beyond the SMB drive sleeve dimensions and the threads for the stem nut locknut(s) have been eliminated.

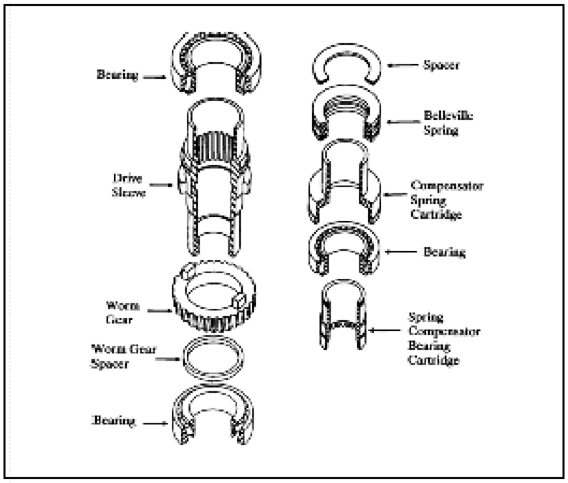


Figure 2-48 SB Spring Compensator

The stem nut locknut is replaced by a spring compensator bearing cartridge which has an internal spline section that fits over the stem nut. The spring compensator bearing cartridge becomes an extension of the stem nut but is not locked to the drive sleeve in any manner.

This causes the stem nut and spring compensator bearing cartridge to rise as the valve disc seats on the mainseat, and thrust increases to the point where the compensator begins to compress. If the stem nut and spring compensator bearing cartridge were not restrained, they would thread up the valve stem and completely rise out of the drive sleeve. This does not occur because the spring compensator bearing cartridge is held in place by the compensator spring housing, compensator spring, and compensator spring cartridge. On some actuators, there is also a compensator spring housing spacer.

The SB drive sleeve is not interchangeable with SMB drive sleeves but the worm gear and lower thrust bearing can be interchanged. The drive sleeve still positions the worm gear with the worm and must still be adjusted with gasket and shims as in the SMB. The gasket will now seal the actuator housing with the compensator housing, or housing cover.

SB Spring Compensator Assembly

General

The spring compensator consists of four major components: the housing (and housing spacer and housing cover in some sizes), Belleville spring assembly, bearing cartridge (Figure 2-49) and spring cartridge (Figure 2-50). The compensator's function is to absorb excessive thrust when the valve is going closed during high speed operation or to keep the valve firmly seated, but not bound up, under conditions of large temperature changes.

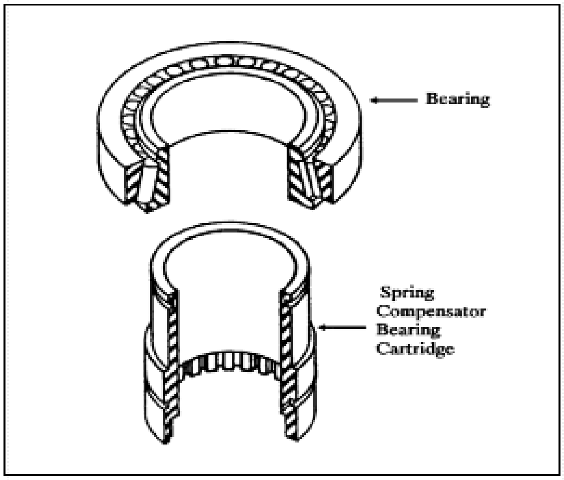


Figure 2-49 SB Belleville Spring Assembly with Bearing Cartridge

The spring compensator assembly is commonly called a "Top Hat". All the compensators are sized for full-thrust output of the actuator; so a valve can still be damaged if the limit and torque switches are not adjusted properly.

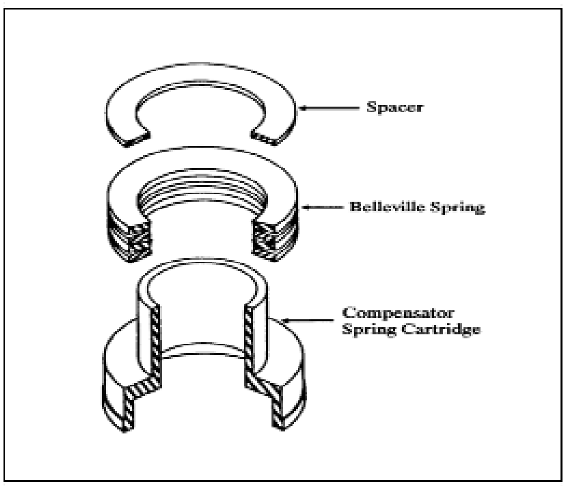


Figure 2-50 SB Belleville Spring Assembly with Spring Cartridge

Bearing Cartridge

The bearing cartridge is notched at the bottom with internal splines which match the external splines of the stem nut. The cartridge has the inner race, cage, and rollers of a Timken bearing mounted on it to transfer thrust of the stem nut to the Belleville springs through the bearing inner race and the spring cartridge. The bearing cartridge rotates with the stem nut.

Spring Cartridge

The spring cartridge has the outer race of the Timken thrust bearing mounted on the lower portion and mounts on top of the bearing cartridge. The spring cartridge is also the platform where the Bellevilles are stacked. As the stem nut rises in response to thrust forces, the thrust is transferred through the bearing to the spring cartridge and its spring platform.

All these pieces are rising: stem nut, bearing cartridge with bearing, spring cartridge, and springs. The springs must be restrained from moving at the other end to properly absorb the thrust. The spring cartridge does not rotate if the compensator is installed properly. The spring cartridge has two "O" ring sealing surfaces for grease sealing. One "O" ring sealing surface, at the bottom of the cartridge on the inside, seals between the bearing cartridge and the spring cartridge. The other "O" ring sealing surface is at the top of the cartridge on the outside with the "O" ring mounted in a groove in the compensator housing. An additional sealing surface is on the extreme lower portion of the cartridge.

This surface is only a close fit between the spring cartridge and the compensator housing. It is designed to prevent grease pumped into the compensator from draining immediately into the main actuator compartment. In addition, three small holes are drilled in the lower portion of the spring cartridge to allow lubrication to enter the thrust bearing.

Spring Assembly

The spring assembly consists of the Belleville springs and a spacer. Each size SB actuator has a fixed number of springs associated with it. The stack of springs ends at the top with a spacer to provide a good surface for the springs to compress against the housing. Some of the larger SB's may have a spacer at each end of the stack. Table 2-8 lists the number of springs which are required for the different size actuators.

Table 2-8 Spring Compensators

SB Spring Compensators	
SB-0	4 Springs
SB-1	14 Springs
SB-2	5 Springs
SB-3	10 Springs
SB-4	4 Springs

SB Housing

The SB spring compensator housing locks the components together and maintains the Belleville spring compression. The upper SB housing contains an indicator device and its associated scale, from 0 to ½ in., which shows the amount of spring compression.

The indicator is an arm and a pointer with a coiled spring. The pointer extends through the housing. The arm rests against the top of the spring cartridge and as the cartridge moves up, the arm moves and rotates the pointer. All the SB units have identical scales since the Belleville springs are sized in thickness and quantity by Limitorque to accomplish this.

At the upper portion of the housing is the "O" ring and its groove for grease sealing. There is no raised surface on the housing to match the raised sealing surface of the spring cartridge. There is a zerk fitting in the side of the housing to lubricate the thrust bearing.

The flange at the bottom of the housing matches the bolt pattern of the actuator housing where it replaces the SMB housing cover. The gasket between the housings is used to position the drive sleeve.

On some size actuators there may be a combination of housing spacer and /or a housing cover or compensator cover. The housing cover, compensator housing or spacer may need a measured gasket in order to properly load the drive sleeve bearings. The construction of components should be examined in order to determine the location of the critical gasket since it varies depending on actuator size.

In general, the part of the housing which holds the upper bearing in place is called the housing cover (unless there is no spacer); the component with the pointer is the compensator housing; and any part between these two is called the spacer.