MASCOT

High End Technology

Tight Shutoff

Reliability

Expertise you can trust

Spring Cylinder Linear Actuator

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Introduction

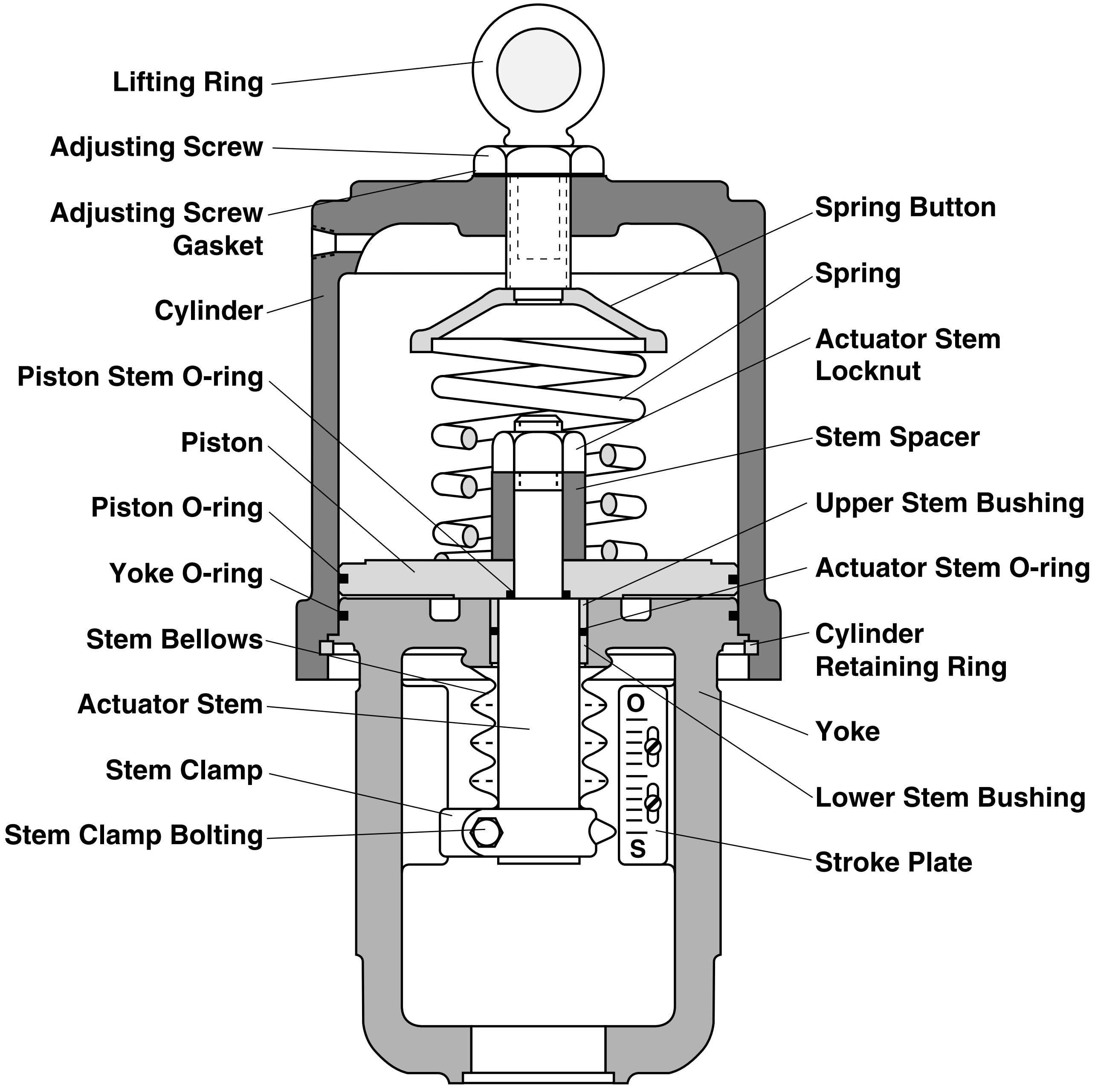

Figure 1: Spring Cylinder Linear Actuator

The Mascot spring cylinder linear actuator is a powerful, high-performance pneumatic actuator that provides positive throttling or on-off operation for automatic control valves. The positioner and most sized cylinders are designed for supply pressures up to 150 psi , making very high thrusts attainable in a compact unit.

This actuator is fully field reversible for air-to-open or air-to-close action without additional parts; a spring provides fail-safe operation. The positioner supplies air to both sides of the piston, providing exceptionally stiff, precise movement together with very high frequency response.

Spring Cylinder Linear Actuator

Features and Advantages

Important features and advantages of the Mascot spring cylinder linear actuator include:

Features	Advantages
High thrust capability	• 150 psi (10.3 Bar) operating pressure allows substantially higher thrust capabilities than comparable diaphragm actuators. • Higher thrust allows tighter valve shutoff.
High frequency	• Double-acting configuration responds quickly to signal changes. response
Compact and lightweight	• Spring cylinder linear actuators are substantially lighter and more compact than comparable linear diaphragm actuators, for easier installation and maintenance.
Wide range of sizes	• Standard actuator sizes 25, 50 and 100 will handle thrust requirements for over 95 percent of process applications. Larger sizes up through size 600 are available for special applications.
Fewer parts	• Spring cylinder linear actuators have 1/3 fewer parts than diaphragm linear actuators. Wear parts cost 1/10 of those for diaphragms, and less inventory is required to maintain actuators.
Dynamic positioning accuracy	• Supply pressure is sent to both sides of the piston for stiff, precise actuator operation. Small air volume between the piston and the bottom of the cylinder provides powerful pneumatic stiffness, allowing a high pressure drop – without plug slamming.
Field reversible	• Failure mode is easily reversed without additional parts. Reduced inventory costs.
No pressure regulators required	• Cylinder actuators easily handle air supplies up to 150 psi (10.3 Bar) with out a pressure regulator and can be operated with as little as 30 psi (2.1 Bar).*
Fail-safe spring	• Internal spring provides fail-safe operation in the event of air system failure. Universal spring bench set is not required.
Stiff operation	• Supply pressure is sent to both sides of piston for stiff actuator operation.
Durable components	• High quality materials require very little maintenance, no diaphragm to rupture.
Simple maintenance	• Periodic maintenance is easy to perform, since the spring cylinder actuator only requires the removal of two parts to access all internal parts.
Low air consumption	• Cylinder design uses less supply air than comparable diaphragm actuators.
Longer strokes	• Size 25 spring cylinder linear actuator has a 1 1/2 -inch (38 mm) stroke, in contrast to a 3/4 -inch (19 mm) stroke on a comparable linear diaphragm actuator. Larger actuators have similar comparisons. Stroke lengths are available up to 24-inches.
High-level positional stiffness	• Small air volume between the piston and the bottom of the cylinder provides powerful stiffness pneumatic – allowing high pressure, flow over the plug operation without plug slamming.

* Operating pressure on some sizes is limited because of valve sizes.

Spring Cylinder Linear Actuator

Actuator Stiffness

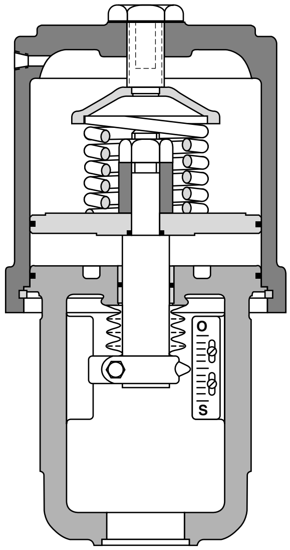

Figure 2: Cylinder Actuator at Mid-stroke

The typical control valve operates with a constantly fluctuating flow. As this dynamic force increases or decreases, the control valve must remain in the same relative position as dictated by the controller. To do this, the valve is dependent upon the actuator stiffness to minimize these position fluctuations. Actuator stiffness is defined as the ability of the actuator to withstand suddenly changing dynamic fluid forces acting on the valve trim. Since supply air pressure is delivered to both sides of the piston in the cylinder, the stiffness of the Mascot spring cylinder actuator is significantly greater than that of a diaphragm actuator.

The stiffness (spring rate) is equal to the expression:

$$K = \frac{kPA^2}{v}$$

Where:
- K = spring rate
- k = ratio of specific heat
- P = supply pressure
- A^2 = piston area (in $_2$)
- v = cylinder volume under piston

For a 25 square-inch cylinder actuator (typical for a 2-inch valve) with a supply air pressure of 100 psi (6.9 Bar) and a $^3/_4$-inch (19 mm) stroke, the spring rate would be 9333 lbs. per inch (1634 kN/m) at mid-stroke. See figure 2. The benefit of this principle is that as the volume under the piston becomes smaller, the stiffness factor becomes larger in a Mascot cylinder actuator. The equivalent diaphragm actuator (46 square-inch) on the same valve with a 3-15 psi (0-1 Bar) signal has a spring rate of only 920 lbs. per inch (161 kN/m) at mid-stroke. The spring rate for a diaphragm actuator remains the same, regardless of diaphragm position. When a valve with a diaphragm actuator is operated close to the seat with flow over the plug, sudden changes in the dynamic force can cause the valve to slam shut. Because of this low-stiffness factor, diaphragm operated valves are installed with the flow under the plug.

On the other hand, the stiffness of Mascot spring cylinder actuators actually increases as the valve plug approaches the seat. Chances of the plug slamming into the seat are significantly reduced. Example: in a properly designed and assembled, 25 square-inch cylinder actuator, with 100 psi (6.9 Bar) supply air pressure and the plug $^1/_8$-inch (3 mm) off the seat, the piston is $^3/_{16}$-inch (5 mm) from the bottom of the cylinder. At this point, the actuator generates a stiffness of 18,667 lbs. per inch (3269 kN/m). See figure 3.

Thus, a spring cylinder actuated control valve may be operated with the flow either over the plug or under the plug, and still maintain the precise, throttling control required by many of today's processes. This advantage allows the flow to assist the actuator spring in obtaining the required failure mode and increases the ability of the valve to shut off tightly.

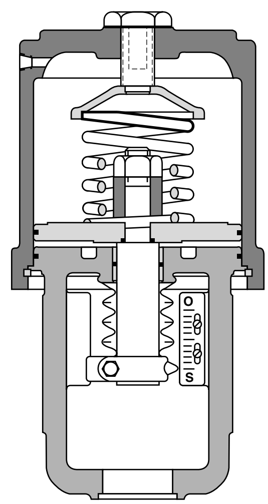

Figure 3: Cylinder Actuator with High Stiffness / Spring Rate

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Actuator Performance

Thrust Producing Capability

Mascot linear spring cylinder actuators produce substantially higher thrust than comparable diaphragm actuators because the cylinder operates with supply pressures up to 150 psi (10.3 Bar). Throttling diaphragm actuators are limited to 40-60 psi (2.8-4.1Bar), thus decreasing their thrust producing capability. Higher actuator air supply, coupled with high-pressure air on both sides of the actuator piston, provide exceptional stiffness for precise throttling control. Mascot cylinder actuator stiffness is sufficient to control high pressure drops and to permit the plug to throttle near the seat.

Speed and Sensitivity

High air-handling capacity of the positioner, combined with relatively low cylinder volumes, produces fast stroking speeds. High operating speed is achieved with virtually no overshoot when approaching the final plug position. At the same time, static sensitivity of the unit is excellent. For example, as little as 0.008 psi (0.0006 Bar) is required to move the stem 0.0005 inches (0.0127 mm) (the minimum detectable movement in the tests conducted) on a size 25 actuator. A signal change of only 0.01 psi (0.0007 Bar) is required to reverse the stem motion. Table I shows typical stroking times. Increased stroking speeds are available with Mascot flow booster valves.

Table I: Typical Actuator Stroking Times

Actuator Size	Time (Seconds) For Maximum Stroke* 1/4" Tubing	Time (Seconds) For Maximum Stroke* 3/8" Tubing	Stroke (inches)
25	1.2	1.0	1.5
50	3.5	3.1	3
100	9.6	8.6	4
200	20.8	18.4	4
300	31.3	27.7	4

Actuation pressure: 60 psi (4.1 Bar)

* Stroking time only (does not include time from receipt of signal and beginning of stem motion).

Frequency Response

The frequency response of Mascot cylinder actuators is extremely high – generally an order of magnitude better than comparable diaphragm actuator units. Such response is achieved through a double-acting configuration that uses pressure on both sides of the piston.

Size 25 Actuator, 9 psi ± 2 psi

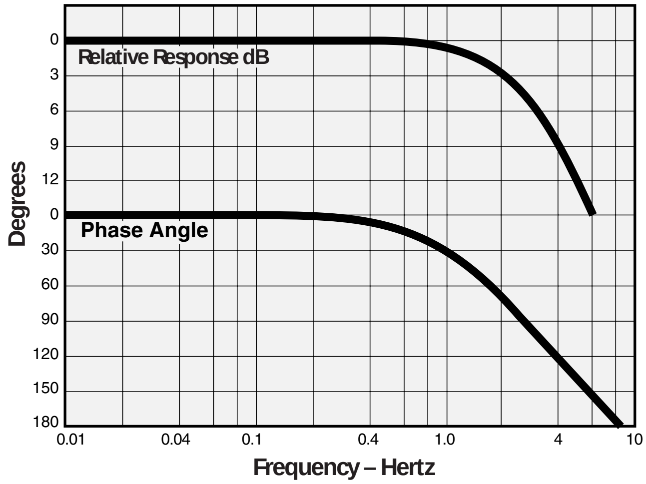

Figure 4: Frequency Response

Hysteresis and Linearity

An important characteristic of any actuator is its ability to respond linearly to signal changes from the controller and to give uniform response unaffected by decreasing or increasing pressures. Tests have shown the linearity of the cylinder actuator to be within ±1.0%. The same tests showed that the difference in valve position for a given instrument signal, regardless of the required direction of change in the pistonÕs position, was extremely small (refer to Table VII: HiFlo Positioner Performance, page 11).

Size 25 Actuator, Signal 4.2 to 13.8 psig

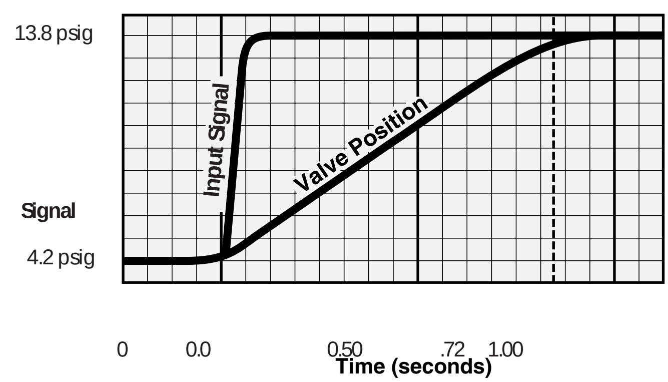

Figure 5: Step Test

Spring Cylinder Linear Actuator

Spring Cylinder Construction

Reversible Air Action

Standard cylinder actuators are supplied to provide either air-to-open (air-to-retract) or air-to-close (air-to-extend) action, with easy reversal in the field.

With air-to-open action, the spring is installed on the upper side of the piston. For air-to-close action, the spacer and spring are installed on the underside of the piston with the spring button stored on top of the piston.

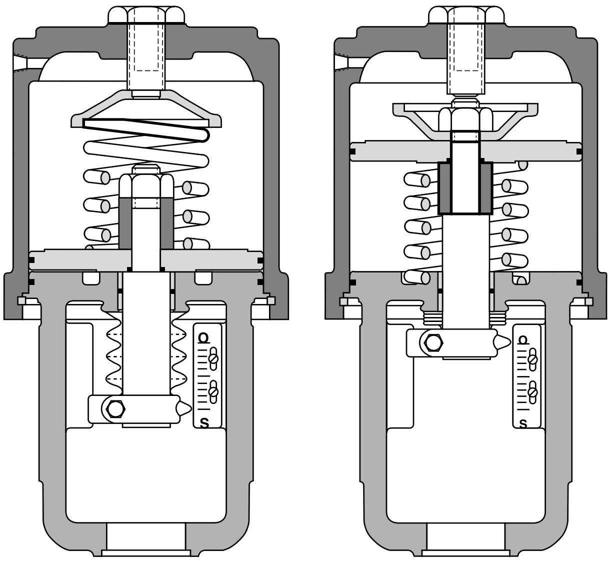

Figure 6: Spring Cylinder Air Action

Sizes

Spring cylinder linear actuators are available in three standard sizes: 25, 50, and 100 square-inches (nominal piston area) and five oversized actuator sizes: 200, 300, 400, 500 and 600 square-inch. The 400 and 600 sizes have a tandem, double piston configuration.

Standard Materials of Construction

The cylinder and piston are made of corrosion resistant anodized aluminum. A tough ductile iron yoke is used to withstand impact. The exposed actuator stem is stainless steel and is guided by oilite bronze bushings. For service in extremely corrosive atmospheric conditions, the yoke, cylinder, clamps and other exposed parts can be supplied in stainless steel, or the actuator can be completely coated in neoprene. (Stainless steel clamps, bolts, nuts and yokes are available from regular stock.)

Table II: Materials of Construction

Part	Material
Yoke	Phosphated, painted ductile iron
Yoke clamp	Stainless steel
Yoke clamp bolts	Zinc plated steel
Stem clamp*	Phosphated, painted ductile iron
Stem clamp nut and bolt	Zinc plated steel
Cylinder retaining ring	Zinc plated steel
Actuator stem	416 stainless steel
Stem spacer	Aluminum
Actuator stem	lock nut Zinc plated steel
O-rings	Buna-N
Spring	Alloy steel
Spring button	Painted steel
Adjusting screw	Zinc plated steel
Piston	Anodized aluminum
Cylinder	Painted anodized aluminum

*Denotes stainless steel material on 25 and 50 sq.in.

Table III: Actuator Specifications

Type	Cylinder with positive spring action
Sizes	25, 50, 100, 200, 300, 400, 500 and 600 sq. in.
Spring Designs	Single (std.) and dual
Action	Field reversible: Air-to-open, Air-to-close
Operating pressure	Up to 150 psi (10.3 Bar)
Temperature range	-40 °to 350 °F* (-40 °to 177 °C*)

* Ambient temperatures greater than 180 °F (82 °C) require Viton O-rings. Ambient temperatures below -40 °F (-40 °C) require fluorosilicone O-rings.

Table IV:Mascot Cylinder Data

Cylinder Size	Cylinder Bore Dia. (in.)	Upper Cylinder Area (sq.in.)	Lower Cylinder Area (sq.in.)	Stem Diameter (in.)	Stem Area (sq.in.)	Maximum Volume Over Piston (cu.in.)
25	5.50	23.76	22.97	1.00	0.79	100
50*	7.75	47.17	46.39	1.00	0.79	331
50	7.75	47.17	45.67	1.38	1.50	331
100*	11.00	95.03	93.26	1.50	1.77	1031
100	11.00	95.03	91.06	2.25	3.98	1031
200	15.50	188.7	184.7	2.25	3.98	2087
300	19.50	298.6	292.7	2.75	5.94	3733
400**	15.50	371.5	365.5	2.75	5.94	3033
500	25.25	500.7	494.8	2.75	5.94	5519
600**	19.50	590.2	583.1	3.00	7.07	5661

*Used as oversized actuators in place of the next smaller actuator
**Tandem, double piston configuration

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Actuator Springs

Table V: Cylinder Actuator Spring Data

					Air-to-open (Air-to-retract)				Air-to-close (Air-to-extend)			
Cylinder	Stroke (inches)	Spring Design	Rate lb/in	Rate (N/m)	Spring Ext. lbs	Spring Ext. N	Spring Ret. lbs	Spring Ret. N	Spring Ret. lbs	Spring Ret. N	Spring Ext. lbs	Spring Ext. N
	3/4	STD	180	31523	281	1250	416	1850	450	2002	315	1401
	1	STD	180	31523	236	1050	416	1850	450	2002	270	1201
25	1 1/2	STD	180	31523	146	649	416	1850	450	2002	180	801
	3/4	DUAL	447	78282	629	2798	964	4288				
	1	DUAL	447	78282	629	2798	1075	4782				
	1 1/2	DUAL	447	78282	405	1802	1075	4782				
	1 1/2	STD	164	28721	369	1641	615	2736	656	2918	410	1824
	2	STD	164	28721	287	1277	615	2736	656	2918	328	1459
	2 1/2	STD	164	28721	205	912	615	2736	656	2918	246	1094
50	3	STD	164	28721	123	547	615	2736	656	2918	164	730
	1 1/2	DUAL	447	78282	1194	5311	1864	8291				
	2	DUAL	447	78282	970	4315	1864	8291				
	2 1/2	DUAL	447	78282	747	3323	1864	8291				
	3	DUAL	447	78282	523	2326	1864	8291				
	2	STD	300	52538	1125	5004	1725	7673	1725	7673	1125	5004
	2 1/2	STD	300	52538	975	4337	1725	7673	1725	7673	975	4337
100	3	STD	300	52538	825	3670	1725	7673	1725	7673	825	3670
	4	STD	300	52538	525	2335	1725	7673	1725	7673	525	2335
	2	HEAVY*	535	93693	2098	9332	3168	14092				
thru	2 1/2	HEAVY*	535	93693	1831	8145	3168	14092				
	3	HEAVY*	535	93693	1563	6953	3168	14092				
	4	HEAVY*	535	93693	1028	4573	3168	14092				
	2	DUAL	885	154987	3471	15440	5241	23313				
600	2 1/2	DUAL	885	154987	3029	13474	5241	23313				
	3	DUAL	885	154987	2586	11503	5241	23313				
	4	DUAL	885	154987	1701	7566	5241	23313				

* Heavy spring includes outer spring of dual spring set.

Because of the unique, four-way, double-acting design, Mascot cylinder actuators do not require springs for positioning. The spring serves only as a fail-safe device. It should be noted that although valve flow direction usually assists the actuator on loss of air, normally the spring is designed to achieve the fail position independently. Proper sizing of the cylinder spring requires an understanding of the specific spring force listed in the table above.

Dual Spring Actuator Construction

Dual springs are available for heavy duty service in the air-to-retract (air-to-open) configuration only. Retrofitting a standard cylinder actuator to dual springs requires only five additional parts: a new actuator stem, a spring button, the inner spring, the outer spring, and a spring guide. Valves equipped with dual spring actuators are not field reversible and require a minimum of 60 psi (4.1 Bar) supply air to compress the springs.

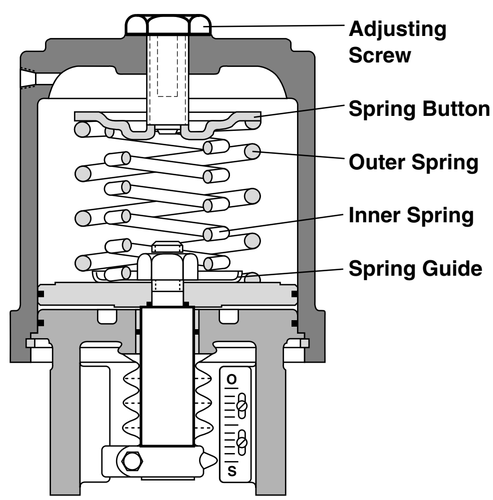

Figure 11: Dual Spring Actuator

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HiFlo Positioner Specifications

Table VI: HiFlo Positioner Specifications

Specification	Pneumatic Module
Input signal range:	3-15 psi (0-1 Bar), 2 or 3-way split range; 6-30 (0.4-2.1 Bar) psi, 2 or 3 and 4-way
Supply pressure	30 psi to 150 psi (2.1 to 10.3 Bar)
Ambient	Standard model: -20° to +185° F
temperature limits	(-30° to 85° C) Ext. temp. model: -50° to +250° F (-46° to 121° C)
Connections	Supply, instrument and output: 1/4-inch NPT; Gauges: 1/8-inch NPT
Standard materials	Stainless steel, anodized aluminum, nickel-plated steel, epoxy powder-painted steel and Buna-N
Net weight	3 lbs. (1.4 kg)

Table VII: HiFlo Positioner Performance*

HiFlo Positioner Performance		Pneumatic Module
Independent Linearity – Maximum deviation from a best fit straight line		±1.0% F.S.
Hysteresis – Maximum position error for the same value of input when approached from opposite ends of the scale.		0.5% F.S.
Repeatability – Maximum variation in position for the same value of input when approached from the same direction.		0.2% F.S.
Response Level – Maximum change in input required to cause a change in valve stem position in one direction.		0.2% F.S.
Dead Band – Maximum change in input required to cause a reversal in valve stem movement.		0.3% F.S.
Resolution – Smallest possible change in valve stem position.		.1% F.S.
Steady State Air Consumption @ 60 psi (4.1 Bar)		.25 SCFM
Supply Pressure Effect – Position change for a 10 psi (0.7 Bar) supply pressure change.		.05 % F.S.
"Open-loop" Gain – Ratio of cylinder pressure unbalance to instrument pressure change with locked stem.		300:1 @60 psi
Maximum Flow Capacity @ 60 psi (4.1 Bar)		11 SCFM
Frequency Response – (With sinusoidal input of ±5% F.S. centered about 50% F.S.)	-6 dB Frequency Phase Angle at -6dB	.8 Hz -71°
Stroking Speed –	Closed to open - Open to closed -	2.3 in/sec. 1.3 in/sec.

*Data is based on tests of the HiFlo positioner mounted on a double-acting cylinder actuator having a piston area of 25 square inches with a valve stroke of 1.5 inches (38mm) and 60 psi (4.1 Bar) supply pressure. Instrument signal was 3-15 psi (0-1 Bar) with pneumatic module

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Side-mounted Continuously Connected Handwheels

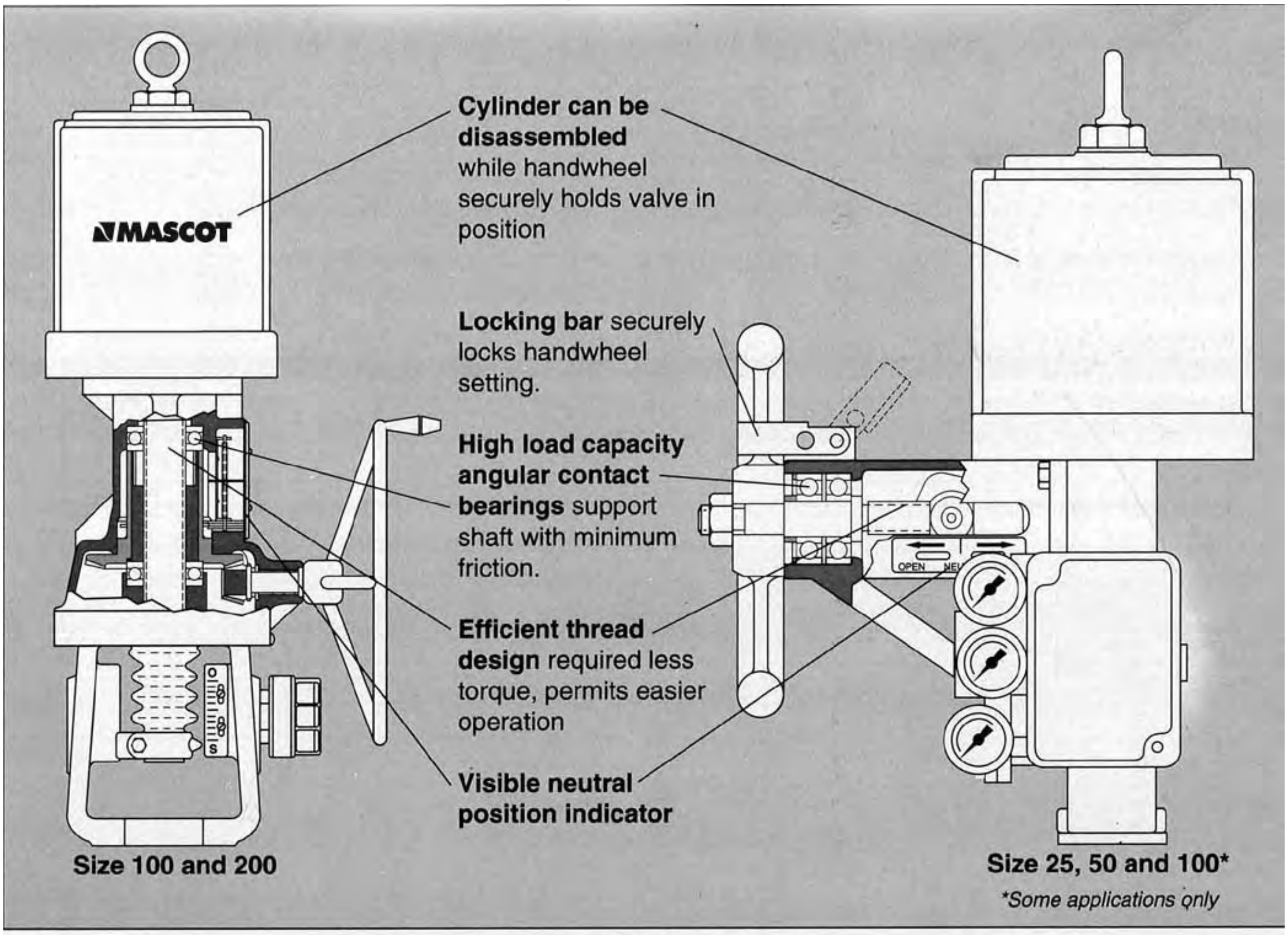


Figure 14: Side-mounted Auxiliary Handwheels

Mascot side-mounted handwheel is a continuously connected, declutchable design that permits manual operation of linear actuators. The standard for valves up and including 4-inch strokes, it is especially convenient during start-up, in emergencies, or due to air failure.

Its efficient design utilizes heavy-duty, anti-friction bearings that allow high thrust with low torque on the handwheel. The side-mounted handwheel provides the mechanical advantage needed for manual operation. Therefore, the handwheel provides an effective means to overcome the fluid forces or friction within the valve during manual operation.

Other advantages characterize side-mounted design:

1. The pneumatic spring cylinder can be disassembled while the handwheel holds the valve in position on fail-open valves. On fail-closed valves, the valve must be closed.
2. Convenient access allows operator to turn the handwheel easily in a more natural position.
3. Easy adaptation to a chain-driven mechanism is possible.

Due to the continuously-connected design, the handwheel can act as a high or low-limit stop. By effectively isolating the actuator stem from the actuator, the continuously-connected handwheel permits positioner and actuator maintenance without interruption of service.

The side-mounted handwheel features a highly visible, neutral-position indicator and comes standard with a locking bar.

A three-way bypass valve is installed in the positioner supply line to shut off the air supply or neutralize the pressure across the piston when operating the valve manually.

Spring Cylinder Linear Actuator

Side-mounted Continuously Connected Handwheels

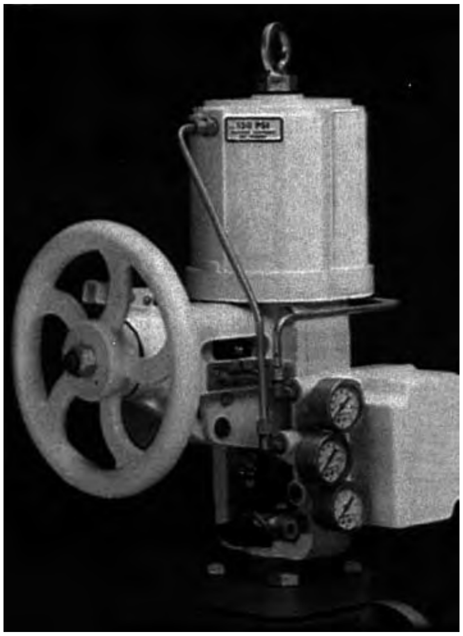


Table VIII: Standard Materials of Construction

Size 25, 50, 100 and 200

Part	Material
Yoke	Ductile iron
Actuator stem pin	Stainless steel (hardened)
Crank lever	4130 alloy steel (heat treated)
Crank pivot pin	416 stainless steel
Drive nut	Aluminum bronze*
Handwheel shaft (ACME screw)	416 stainless steel*
Handwheel	Aluminum/Tubular Steel
Housing	Ductile iron

*Coated with electro film lubricant

Table IX: Side-mounted Continuously Connected Handwheel Specifications

Act.Size	Spud	HW Operator Size	HW Diameter		Turns per		Force Amplification Factor	Maximum Stroke		Weight	
			in	mm	in	mm		in	mm	lb	kg
25	2.00	25	9	230	5.3	.21	44:1	1.5	38	39	18
50	2.00	25	12	305	5.3	.21	58:1	3.0	76	85	39
50	2.62	50	12	305	6.7	.26	63:1	3.0	76	96	44
100(1)	2.62	50	18	455	6.7	.26	95:1	4.0	102	198	90
100	2.88-4.75	100/200	24	610	8.0	.31	126:1	4.0	102	290	132
200	2.88-4.75	100/200	24	610	8.0	.31	126:1	4.0	102	395	179

Table X: Top-mounted Continuously Connected Handwheel Specifications

100	2.62-4.75	100/200	18	455	12	305	128:1	6.0/8.0	152/203	285	129
200	2.62-4.75	100/200	18	455	12	305	128:1	6.0/8.0	152/203	400	181

(1) 100 psi (6.89 Bar) maximum supply pressure when 50-inch HW Operator is used on a 100-inch actuator.

Example: if you apply 50 lb (222 N) rim pull on the 12-inch (305-mm) handwheel of a 50-inch HW operator, then the operator output will be: 50 lb (222 N) rim pull x 63 = 3150 lb (14011 N) output thrust.

Spring Cylinder Linear Actuator

Top-mounted Handwheels

Top-mounted handwheels can be mounted on size 100 and large actuators. Two types are available: continuously- connected and push-only.

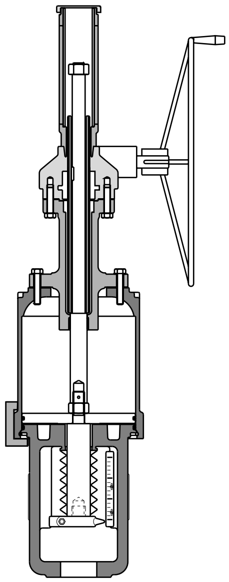


Figure 15:

Continously-Connected Handwheel

Continuously-connected handwheels are highly versatile. They can be used to retract or extend the stem, and act as either a high or low-limit stop. A simplified design makes it easy to place the handwheel in a neutral position for automatic operation of the actuator.

This ruggedly built handwheel utilizes a precision-made bevel gear sealed in a weatherproof housing to maximize performance. High-thrust output can be achieved with low-torque input on the handwheel. Consult the factory on capacities for specific applications.

In operation, the handwheel is turned counterclockwise to move the handwheel screw against the stem locknut, retracting the stem. Moving the handwheel clockwise turns the handwheel screw down against the shoulder on the stem, forcing the stem to extend. Returning the handwheel screw to the neutral position (top of the screw even with a neutral line as seen through the transparent cap liner) permits operation of the actuator without interference from the handwheel. Adjusting the handwheel screw to a position other than neutral provides a limit stop to limit travel in either direction.

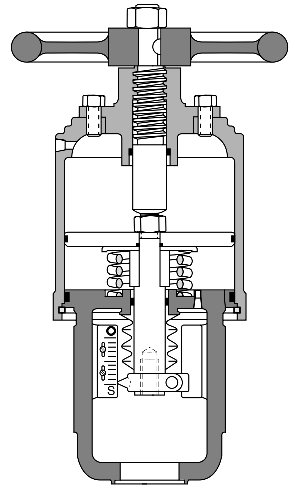


Figure 16: Push-only Handwheel

Turning the handwheel clockwise drives the handwheel stem down to extend the actuator stem. This handwheel can be used to limit upward travel.

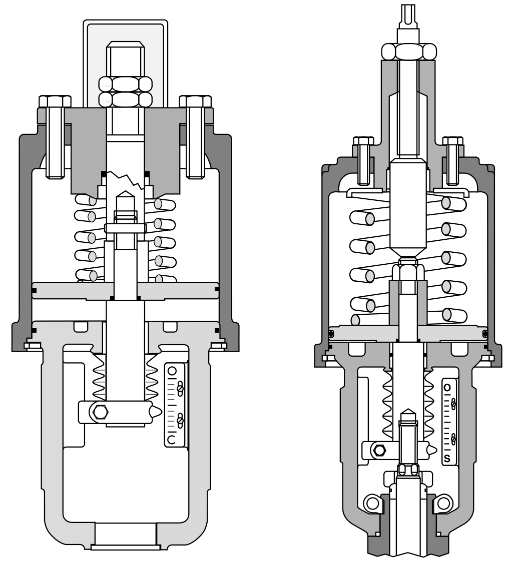


Figure 17: Actuator Limit Stops

Simple actuator stops are available to limit either opening or closing of the valve. Handwheels are not provided, and locknuts are included to maintain precise setting of the selected limit stop position.

Spring Cylinder Linear Actuator

Lever and Handwheel Actuators

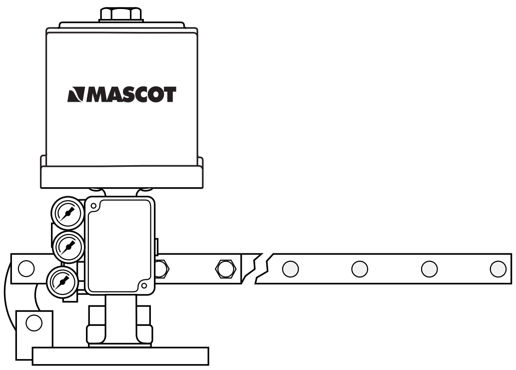
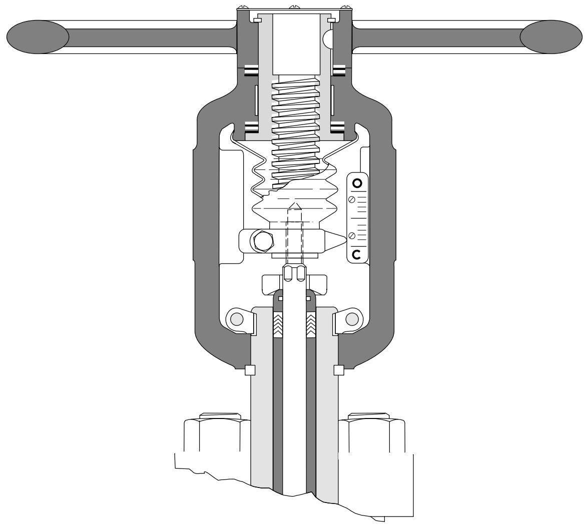


Figure 18: Lever Actuators

Mascot cylinder-operated lever actuators can be used to automatically position dampers, louvers, variable pitch fans, and to make other mechanical adjustments to process machinery. Lever actuator designs are available for size 25, 50 and 100 cylinders.

Table XI: Lever Actuator Force

Cyl.Size	Lever Travel		Available Force (lb / N) at Supply Pressure (Psig / Barg)					
	in	mm	80	5.5	100	6.9	150	10.3
25	4	102	621	2762	776	3452	1164	5178
	5	127	496	2206	621	2762	932	4146
	6	152	414	1842	518	2304	776	3452
	7	178	355	1579	444	1975	665	2958
	8	203	311	1383	388	1726	582	2589
	9	229	276	1228	345	1535	518	2304
	10	254	248	1103	311	1383	466	2073
	11	279	226	1005	282	1254	423	1882
	12	305	207	921	259	1152	388	1726
50	6	152	1311	5832	1639	7291	2458	10934
	7	178	1124	5000	1405	6250	2107	9372
	8	203	983	4373	1229	5467	1844	8203
	9	229	874	3888	1093	4862	1639	7291
	10	254	787	3501	983	4373	1475	6561
	11	279	715	3180	894	3977	1341	5965
	12	305	656	2918	819	3643	1229	5467
100	12	305	1428	6352	1852	8238	2913	12958
	16	406	1071	4764	1389	6179	2184	9715
	20	508	857	3812	1111	4942	1747	7771
	24	610	714	3176	926	4119	1457	6481



Manual handwheels are available wherever an ultra-high- performance, manual operation is required. Handwheels are of the rising stem design and are sized for easy operation. The handwheel yoke is designed to be interchangeable with cylinder or diaphragm actuators.

Table XII: Manual Handwheel Specifications

Hand wheel Size*	Body Size (Class 150-600) inches	Handwheel Diameter inches (mm)		Thrust @50 lb (222N) Rim Pull	
25	1/2 - 2	9 (STD)	230	2024	9003
		12 (OPT)	305	2699	12008
50	3 - 4	12(STD)	305	2187	9728
	6 (Class 150)	18 (OPT)	455	3280	14590
100	6 (300 & 600)	18 (STD)	455	2180	9697
	thru 8	24 (OPT)	610	2907	12931

* Handwheel size is comparable to standard cylinder actuator size.

Spring Cylinder Linear Actuator

Cylinder Systems

Occasionally, some applications require greater actuator spring forces than standard or dual springs can provide. In such cases, building special, extra-strong failure springs may be mechanically difficult and economically unfeasible. The air spring is designed to solve many such problems.

Air springs, which provide a locked-up volume of air to drive the actuator in the failure direction, are used primarily to close valves upon air failure. A fail-closed Mascot valve is customarily operated with the flow directed over the plug. Thus, with the plug on the seat, the upstream pressure acts to hold the valve closed. Air springs on Mascot valves work only during the instant of air failure to drive the valve to the closed position. Process line pressure will insure the valve stays closed.

Air Spring Using Cylinder Volume

Utilizing the stored volume within the cylinder itself for failure protection, an air spring is a common fail-safe system. In this case, the valve positioner is operated as a 3-way valve positioner to supply air only to the underside of the piston. A 3-way switching valve senses air supply pressure. When pressure drops to a predetermined value, the switching valve locks the air on the upper side of the piston to drive the valve closed. With full air supply pressure to the 3-way switching valve, an airset regulates the proper amount of air pressure to the upper side of the cylinder.

Air Spring with External Volume Tank

If the volume on the top of the cylinder is insufficient to cause the valve to fully stroke upon air failure, an external volume tank is used to supply the additional volume required. This system requires a small lock-up valve in the air supply to each side of the cylinder. The lock-up valve serving the bottom of the piston operates to exhaust that side upon failure. The lock-up valve on the top side of the cylinder admits volume tank air to the cylinder upon air failure. The volume tank can be sized as required.

Fail-in-place Lock-up System

The purpose of this system is to hold the actuator in the last operating position upon air failure. A 3-way switching valve is used to sense air supply. Upon failure of the air supply, this valve operates to exhaust the signal connections to two lock-up valves. These lock-up valves, in turn, hold the existing pressure on both sides of the piston, thus locking it in place.

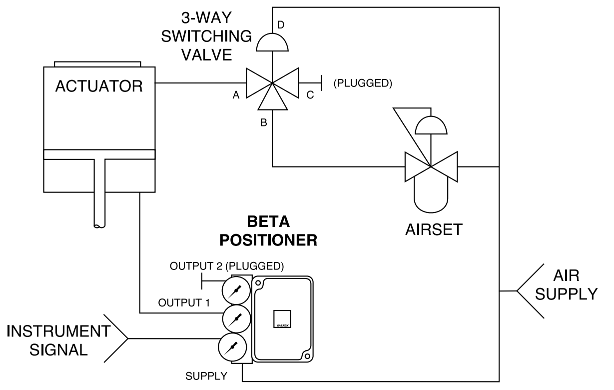


Figure 23: Air Spring Using Cylinder Volume

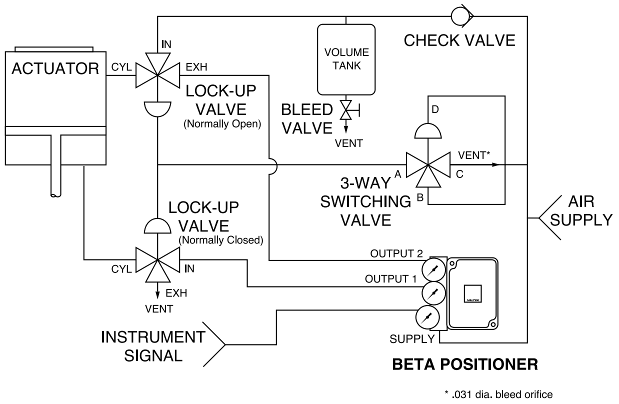


Figure 24: Air Spring With External Volume Tank

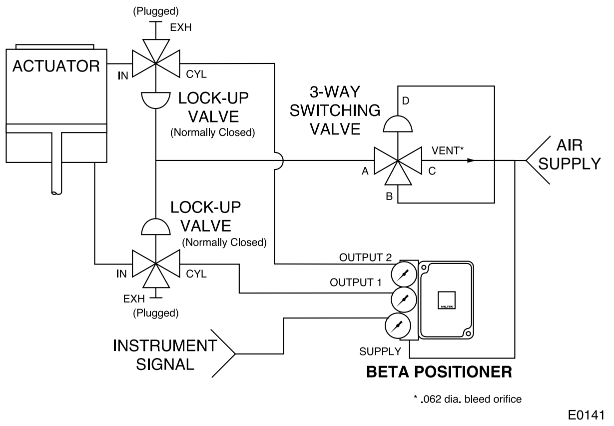
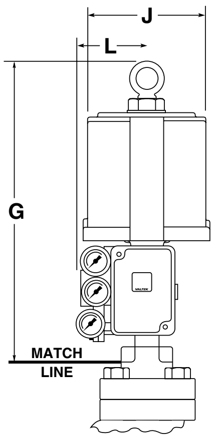


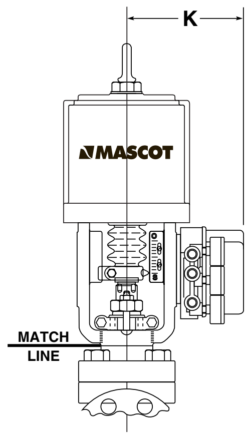
Figure 25: Fail-in-place Lock-up System

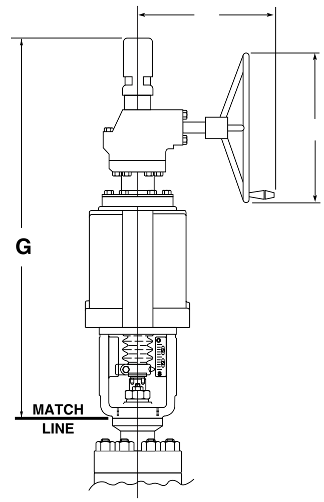
Spring Cylinder Linear Actuator

Dimensions

(Lifting ring available on sizes 25 and 50 only)







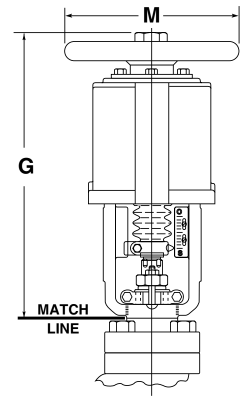


Table XIII: Standard Actuator and Handwheel (inches/mm)

Cylinder Size (sq. in.)	Body Size (inches) Class 125 - 600	Class 900 - 2500	Spud Diameter		G* Std.		G* Top-mounted Handwheel Cont. Conn.		Push Only		J		K		L		M***		N	
25	½ to 2	½ to 1	2.0	51	14.5	369	–	–	17.9	454	6.5	165	7.3	186	4.9	124	9.0	229	–	–
50	½ to 2	½ to 1	2.0	51	18.5	469	–	–	26.6	676	9.1	232	8.6	218	4.6	118	12.0	305	–	–
	3 to 4, 6 (Class 150)	1½ to 2	2.6	67	20.7	526	–	–	28.9	733	9.1	232	7.3	184	4.6	118	12.0	305	–	–
100	3 to 4, 6 (Class 150)	1½ to 2	2.6 - 2.9	67 - 73	25.9	658	44.6	1132	38.1	967	12.5	318	9.9	252	4.5	114	18.0	457	16.0	406
	6 to 8, 10 to 12 (Class 150)	3 to 4	3.4	86	26.9	683	45.6	1157	39.1	992	12.5	318	10.3	260	4.5	114	18.0	457	16.0	406
	10 to 14	6 and larger	4.0 - 4.8	102 - 121	26.9	683	45.6	1157	39.1	992	12.5	318	10.7	272	4.5	114	18.0	457	16.0	406
200	3 to 4, 6 (Class 150)	½ to 2	2.6 - 2.9	67 - 73	26.6	675	45.2	1149	38.1	967	17.5	445	9.9	252	4.5	114	18.0	457	16.0	406
	6 to 8, 10 to 12 (Class 150)	3 to 4	3.4	86	27.5	699	46.2	1173	39.1	992	17.5	445	10.3	260	4.5	114	18.0	457	16.0	406
	10 to 14	6 and larger	4.0 - 4.8	102 - 121	27.5	699	46.2	1173	39.1	992	17.5	445	10.7	272	4.5	114	18.0	457	16.0	406
300	6 and larger	6 and larger	3.4 - 4.8	86 - 121	30.5	774	54.1	1373	****	****	21.8	552	11.1	283	4.1	105	18.0	457	16.0	406
400	6 and larger	6 and larger	3.4 - 4.8	86 - 121	36.6	930	56.7	1439	****	****	18.0	457	10.7	272	4.5	114	18.0	457	16.0	406
500	6 and larger	6 and larger	3.4 - 4.8	86 - 121	31.0	787	***	***	****	****	28.0	711	11.1	283	4.1	105	18.0	457	16.0	406
600	6 and larger	6 and larger	3.4 - 4.8	86 - 121	45.8	1163	***	***	****	****	21.8	552	11.1	283	4.1	105	18.0	457	16.0	406

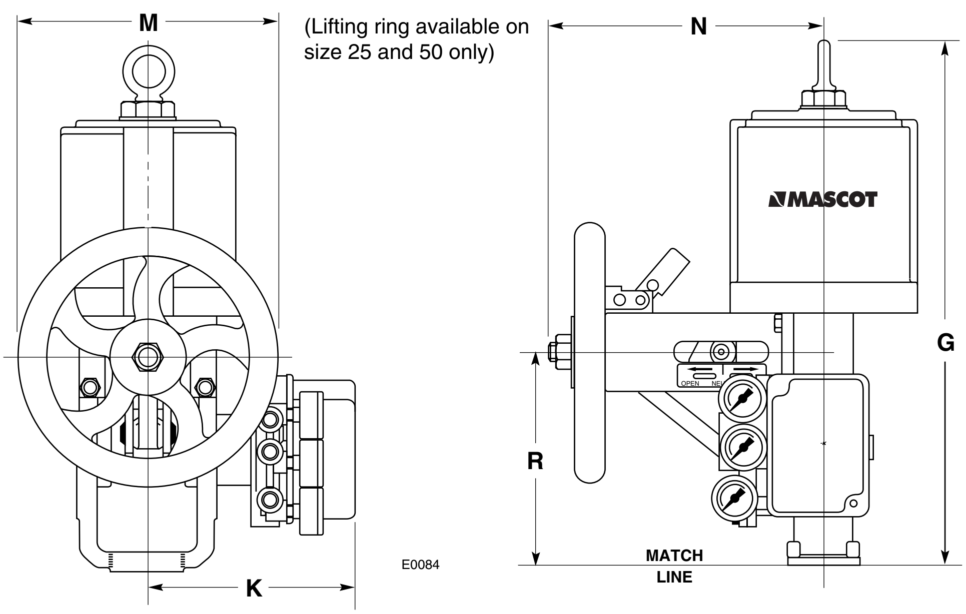
* 100 sq. in. and larger, 4-inch maximum stroke. Consult factory.

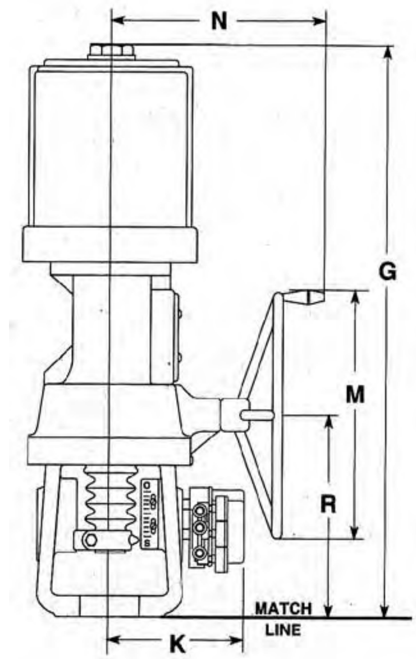
*** Standard size shown. Handwheel diameter subject to change per torque requirements.

**** Consult factory.

Spring Cylinder Linear Actuators

Dimensions





With Size 100 and 200

Table XIV: Side-mounted Handwheel Dimensions (inches/mm)

Cylinder Size	Body Size (inches) Class 150-600	Body Size (inches) Class 900-2500	Spud Diameter		Handwheel Design	G*		K		M		N		R	
25	½ to 2	½ to 1	2.0	51	Acme Screw	17.9	454	7.3	186	9.0	229	9.4	238	7.3	185
50	½ to 2	½ to 1	2.0	51	Acme Screw	21.9	555	7.8	199	9.0	229	9.4	238	7.3	185
	3 to 4, 6 (Class 150)	1½ to 2	2.6	67	Acme Screw	25.6	650	7.3	184	12.0	305	12.7	322	10.3	262
100	3 to 4, 6 (Class 150)	1½ to 2	2.6	67	Acme Screw	28.9	735	8.6	218	12.0	305	12.7	322	10.3	262
	4, 6 (Class 150)		2.9	73	Bevel Gear	40.9	1038	9.9	252	18.0	457	15.3	388	13.8	352
	6 to 8, 10 to 12 (Class 150)	3 and 4	3.4	86	Bevel Gear	41.8	1062	10.3	260	18.0	457	15.3	388	14.8	376
	10 to 14	6 and larger	4.0-4.8	102-121	Bevel Gear	41.8	1062	10.7	272	18.0	457	15.3	388	14.8	376
200	4, 6 (Class 150)		2.9	73	Bevel Gear	41.6	1057	9.9	252	18.0	457	15.3	388	13.8	352
	6 to 8, 10 to 12 (Class 150)	3 and 4	3.4	86	Bevel Gear	42.6	1082	10.3	260	18.0	457	15.3	388	14.8	376
	10 to 14	6 and larger	4.0-4.8	102-121	Bevel Gear	42.6	1082	10.7	272	18.0	457	15.3	388	14.8	376

* 100 sq. in. and larger 4-inch maximum stroke, consult factory for larger strokes

Spring Cylinder Linear Actuator

Dimensions

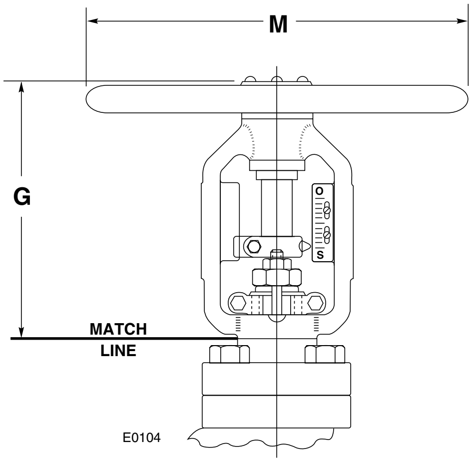


Table XV: Manual Handwheel Dimensions (inches/mm)

Handwheel Type	Body Size (inches) Class 150 thru 600	Spud Size (inches)	G		M	
HA	1/2 thru 2	2.00	8.8	223	9.0	229
HB	3, 4, 6 (Class 150)	2.62/2.88	13.1 13.3	334 339	12.0 18.0	305 457
HC	4, 6 (Class 150)	2.88	17.4 18.0	442 457	18.0 24.0	457 610
HD	6 (Class 300, 600), 8, 10, 12 (Class 150)	3.38	17.5 18.1	445 461	18.0 24.0	457 610