



Actuators & Controls

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## SERVICE MANUAL No. I-0004

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### E-SERIES ROTARY AND LINEAR OPERATORS

CUSTOMER: \_\_\_\_\_

P.O.#: \_\_\_\_\_

W.O.#: \_\_\_\_\_

TAG: \_\_\_\_\_

DATE: \_\_\_\_\_

APPLIES TO OPERATOR MODEL: \_\_\_\_\_

SERVICE MANUAL  
FOR PNEUMATIC AND HYDRAULIC OPERATORS

<u>CONTENTS</u>	<u>DWG. NO.</u>	<u>PAGE</u>
INSTALLATION .....		3
MAINTENANCE .....		3
MODEL IDENTIFICATION .....		4
DISASSEMBLY		
CYLINDER .....		5
DRIVE CASE .....		6
INSPECTION AND CLEANING .....		6
ASSEMBLY		
DRIVE CASE .....		7
CYLINDER .....		8
LINEAR OPERATORS .....		
DISASSEMBLY .....		10
ASSEMBLY .....		10
TRAVEL STOP ADJUSTMENT .....		10
TESTING AND TROUBLESHOOTING .....		11
SPECIFICATIONS .....		12
FIGURE 1 - SERIES 35 THRU 70 CYLINDERS .....		13
FIGURE 1 - PARTS LIST, SERIES 35 THRU 70 .....		14
FIGURE 2 - SERIES 3, 5 AND 7 CYLINDERS .....		15
FIGURE 2 - PARTS LIST, SERIES 83 THRU 143, 85 THRU 185, 127 THRU 187 .....		16
GATE VALVE OPERATOR AND PARTS LIST .....	CB0273	17
NOTES .....		18

## **GENERAL**

Bettis "E-Series" linear operators are cylinders adapted to gate and globe valves and the like. Bettis "E-Series" quarter turn operators use a scotch yoke mechanism to convert piston motion to a 90° rotation.

## **INSTALLATION**

Place operator and valve in the same position (both open or both closed) and both safely maintained in that position (ie. line depressurized for gate and butterfly valves). Remove valve lever, handwheel or gear, per valve-manufacturer instructions. Check mounting surfaces, coupling, and orientation of the operator to the valve for any discrepancy. Set operator in position on the valve, and install all bolts and nuts. Align the operator to the valve stem while bolts are somewhat loose, then tighten bolts/nuts evenly and completely to mechanics standard torque or specifications (Page 12). Adjust operator end stops for fully open and fully closed positions, ensuring operator, not valve stops, absorb the load, except in special cases per valve-manufacturer explicit instructions..

NOTE: Operators shipped with valves have the end stops set at the factory, and should not require further adjustment.

## **MAINTENANCE**

The only servicing expected under normal operating conditions is O-ring and gasket replacement. Only cylinder disassembly is necessary for O-ring and gasket replacement, but full disassembly instructions will be provided by this manual. Tools and material required are:

- a set of standard sized wrenches
- snap ring pliers
- a pair of 10" or longer screwdrivers
- petroleum grease
- Dow Corning 55M grease or equivalent
- a tube of sealant (eg. silicone)
- commercial solvent (eg. varsol)
- leak detecting fluid (eg. soapy water)

All part numbers referred to are listed on the schematic diagrams Fig. No. 1 and No. 2. O-rings, gaskets and other soft parts, are available from the factory as repair kits. Lubricant also available from factory.

Please contact the factory or representative for repair kits or additional information, and include the complete serial number.

## **MODEL IDENTIFICATION**

Series 35 thru 70 (Series 35, 50, 60 and 70) have a one piece drive case, with stem extended from top and bottom. Refer to Fig. No. 1. The series numbers refer to piston diameter. (Eg. Model 50D refers to a double acting operator with a 5" diameter piston.) The letters immediately following the series number refer to type of operation:

- "S" "S" Series use only one double acting cylinder. Single acting. Pressure can be applied to one side of the piston to move it in one direction only. Force for the return stroke is provided by the opposing single acting piston or spring.
- "D" "D" Series use two double acting cylinders. Double acting. Pressure may be applied to either side of the piston to move it in either direction.
- "SSR" Spring return, with one single acting piston acting against the spring.
- "DSR" Spring return, with two single acting pistons acting against the spring.
- "MJ" Suffix following any of the above indicates jackscrew.
- "MH" Suffix following any of the above indicates hydraulic manual override.

Series 83 thru 163 (Series 83, 103, 123, 143, 163), Series 85 thru 185 (Series 85, 105, 125, 145, 165 and 185) and Series 127 thru 187 (Series 127, 147, 167 and 187) have a two piece drive case, with the yoke fitted directly over the valve stem or adaptor and keyed. Refer to Fig. No. 2. The series numbers refer to piston diameter and lever arm. The letters immediately following the series number refer to type of operation.

- "S" One double acting piston, the opposite end of the operator being simply a drive rod cover.
- "D" Two double acting pistons.
- "DSR" Spring return, with two single acting pistons acting against the spring.
- "M" Suffix following any of the above indicates hydraulic manual override.

(Eg. Model 85D refers to a double acting operator with a 8" diameter piston and 5" lever arm. Model 127D refers to a double acting operator with a 12" diameter piston and 7" lever arm.)

**WARNING NOTE:**      **DO NOT DISASSEMBLE SPRING CARTRIDGE IN SPRING RETURN MODELS. THIS UNIT IS UNDER LOAD AND MUST BE RETURNED TO THE FACTORY FOR SERVICE.**

## **DISASSEMBLY**

### **CYLINDER DISASSEMBLY**

1. Make sure no air pressure is being applied to the operator and then disconnect all piping to the operator.

#### **ALL MODELS:**

Follow Steps 2 thru 7 for each cylinder until only the drive case remains intact. The same procedure can be used for hydraulic cylinders but note that O-rings replace cylinder gaskets.

2. Remove jam nut (28), washer (27) and O-ring (26).

#### **SPRING RETURN (SR) MODELS ONLY:**

NOTE 1: Spring return operators use a spring in one of the cylinders to provide a positive fail-safe action in case of loss of air supply. At this time, identify the type of fail-safe action. Place the operator with the yoke bore or stem nearest you, and vertical, with cylinders extended to the sides. A spring cylinder (long cylinder) to the right side will open the valve on loss of air (eg. "fail-open"). A spring cylinder to the left side will provide "fail-close" action.

NOTE 2: The end cap of the spring cylinder does not require O-ring (26) or gasket (19) seals. If disassembly is required, carefully release the preload of the spring by slowly and evenly loosening the stay rod nuts (24) until the spring pressure is released. Remove the spring cartridge from the cylinder, taking care not to score the cylinder bore.

#### **WARNING: DO NOT DISASSEMBLE SPRING CARTRIDGE**

The spring cartridge (29) thru (34) is a self-contained unit, with the spring held in the cartridge under compression.

#### **ALL OTHER MODELS:**

3. Remove stay rod nuts (24), lockwasher (23), end cap (22) and gasket (19).
4. Remove cylinder (20).
5. Remove one or two stay rods (21) to allow removal of the piston. Leaving at least one stay rod in place will prevent confusion during reassembly of spring return models. (See WARNING NOTE above.)
6. Remove lock nut or capscrew (18). Remove piston (15), piston seal (17) and piston-center O-ring (16).
7. Remove cylinder plate (12), gasket (19), drive rod guide (13) and drive rod seal (14).

#### **MODELS 35S, 50S AND SERIES 35 THRU 70 SPRING RETURN (SR) MODELS ONLY**

Single acting cylinders do not require cylinder plate (12). Disregard Step 7.

SERIES 83 THRU 163, 85 THRU 185 AND 127 THRU 187 ONLY

Removal of cylinder plate (12) first requires removal of mounting screws (12a) and washers (12b).

MODELS 123S THRU 165S, 125S THRU 185S, AND 167S THRU 187S ONLY

One side of the operator is simply a drive rod cover and does not require disassembly. Disregard the following unless complete disassembly is required. Remove mounting screws (38) and drive rod cover (37).

**DRIVE CASE DISASSEMBLY**

SERIES 35 THRU 70 ONLY

- 8A. Remove drive rod (4) and roller assembly (5), (6) and (7). Remove snap rings (7). Remove drive rollers (6) and drive pin (5) from drive rod.
- 9A. Remove cover screws (10) and cover (2).
- 10A. Remove indicator (11) after noting its original position. Remove yoke pins (3c) and snap rings (3d). Remove stem (3b) and yoke (3).
- 11A. Remove stem bushings (8) and O-rings (9).

SERIES 85 THRU 185 AND 127 THRU 187 ONLY

- 8B. Remove breather plug (1a). Remove snap rings (7). Access to the lower snap ring is through breather hole with a pair of long screwdrivers. Remove drive rollers (6) and drive pin (5). Remove drive rod (4).
- 9B. Remove cover screws (10) and yoke cover screws (11b). Remove yoke cover (11a) and indicator (11) assembly after noting its original position. Remove drive case cover (2).
- 10B. Remove yoke (3) and thrust bearing (3a).
- 11B. Remove yoke bushing (8), drive rod guides (13) and O-rings (9).

**INSPECTION AND CLEANING**

Check O-rings, bushings and gaskets for damage. Replace if necessary. Check cylinder bore for scoring. Check metal parts for wear, corrosion and physical damage. All parts except gaskets should be cleaned with varsol. Lubricate yoke slots, drive pin, rollers, bushings and guides with a light coating of grease. Lubricate O-rings, gaskets and cylinder bore with a generous amount of Dow Corning 55M grease or equivalent.

**ASSEMBLY**  
**DRIVE CASE ASSEMBLY**

1. Install bushings (8) and drive rod guides (13).

**SERIES 35 THRU 70 ONLY**

- 2A. Install O-rings (9) on stem (3b). Assemble yoke (3) and stem in drive case (1). Install yoke pins (3c) and snap rings (3d).
- 3A. Make up drive rod assembly (4), (5), (6) and (7). Slide drive rod into position between yoke arms.
- 4A. Apply silicone sealant around edge of cover. Install cover (2) and cover screws (10).  
Replace indicator (11).

**SERIES 85 THRU 185 AND 127 THRU 187 ONLY**

- 2B. Install yoke thrust bearing (3a) on yoke (3). Install O-rings (9) in drive case cover (2) and drive case (1). Install yoke (3) in drive case (1).
- 3B. Install drive rod (4), drive rollers (6), drive pin (5) and snap rings (7). Access to lower snap ring is through breather plug (1a) hole.
- 4B. Apply silicone sealant around rim of drive case cover (2) and yoke cover (11a), and inside the bolt pattern to make it weather tight. Install drive case cover (2) and yoke cover (11a) and indicator (11) assembly. Install cover screws (10), yoke cover screws (11b) and breather plug (1a).

## CYLINDER ASSEMBLY

### SPRING RETURN (SR) MODELS ONLY

Identify fail-safe action desired before reassembly. See "DISASSEMBLY NOTE 1" page 5. Even tightening of stay rods on spring end is essential to keep cylinder aligned to housing and drive rod. If possible, reassemble with cylinder vertical. If not, support the spring cylinder while gradually and evenly tightening stay rod nuts in an alternating pattern.

### ALL MODELS

Proceed with Steps 5 thru 9 and repeat as necessary to reassemble all cylinders. Take care to align ports to match any existing tubing.

5. Install drive rod seal (14) and gasket (19) in cylinder plate (12). Install cylinder plate over drive rod (4).

### MODELS 35S, 50S, 35SSR AND 50SSR ONLY

Single acting cylinders do not require cylinder plate (12). Disregard Step 5.

### SERIES 35 THRU 70 SPRING RETURN (DSR) MODELS ONLY

The single acting cylinder opposite the spring cylinder does not require cylinder plate (12). Disregard Step 5 for this cylinder.

### SERIES 85 THRU 185 AND 127 THRU 187 ONLY

- 5A. Install washers (12b) and mounting bolts (12a) to fasten cylinder plate (12) to drive case (2).

### MODELS 125S THRU 185S ONLY

- 5B. Install drive rod cover (37) and mounting screws (38).

### MODEL 70D3 AND 70D3SR ONLY

These models include an additional cylinder on one side of the operator. Perform Step 6, using drive rod extension (35) to replace lock nut (18). Perform Step 7. Perform Step 8, using the longer of the two short cylinders on Model 70D3SR. Repeat Step 5, using center cylinder plate (36). Repeat Step 6 and 8.

6. Install piston seal (17) and piston center O-ring (16) on piston (15). Install piston on drive rod end. Install lock nut or capscrew (18).



### SPRING RETURN (SR) MODELS ONLY

Install spring cartridge as shown in Fig. No. 1 and Fig. No. 2. If possible, place operator with drive rod vertical, and install spring cartridge assembly before replacing spring cylinder. If not, position the drive rod so it extends as far as possible into the spring cylinder and install spring cartridge assembly. Be careful at all times not to score cylinder bore.

7. Install stay rods (21).
8. Slide cylinder (20) over piston (15) into cylinder plate groove.
9. Install cylinder gasket (19) on end cap (22), (except for spring cylinders) and install end cap. Ensure that the cylinder is seated in the end cap and cylinder plate groove. Install lockwashers (23) and nuts (24), tightening evenly across the end cap to prevent damage to the cylinder and to ensure a tight seal on the gaskets.
10. Install O-ring (26), washer (27) and jam nut (28) on end stop (25). Thread end stop into end cap to adjust travel and tighten jam nut.

## **LINEAR OPERATORS**

Bettis "E-Series" Gate Valve Operators (GVO) use pneumatic (GVO-LP) or hydraulic (GVO-HP) double acting cylinders to provide thrust on the valve stem. Refer to page 17.

### **DISASSEMBLY**

1. Make sure no pressure is being applied, then disconnect all piping to the operator. To replace O-rings and gaskets without demounting operator, proceed as follows:
2. Remove end stop (20), washer (18) and O-ring (17).
3. Remove stay rod nuts (16), lockwashers (15), end cap (14) and gasket or O-ring (11).
4. Remove sufficient stay rods (13) to allow removal of cylinder and piston.
5. Remove cylinder (12).
6. Remove lock nut (9), piston (8), piston seal (10) and piston center O-ring (7).
7. Remove cylinder plate (5), gasket or O-ring (11), drive rod guide (3) and drive rod seal (4).

### **ASSEMBLY**

1. Inspect and clean parts. See page 7.
2. Install drive rod seal (4), drive rod guide (3) and gasket or O-ring (11) in cylinder plate (5). Install cylinder plate and align port to match existing tubing.
3. Install piston center O-ring (7) and piston seal (10) in piston (8). Install piston (8) and lock nut (9) on drive rod (6).
4. Install cylinder (12) over piston (8) and ensure the cylinder end is seated properly on cylinder plate (5).
5. Install stay rods (13).
6. Install O-ring or gasket (11) on end cap (14). Install end cap and ensure cylinder end is properly seated.
7. Install O-ring (17), washer (18), jam nut (19) and end stop (20).

### **TRAVEL STOP ADJUSTMENT**

The stem connector (1) stops against the mounting plate (2) at bottom of stroke. It is adjustable on the valve stem and locked with a setscrew. The top of stroke end stop (20) is adjusted and then locked with jam nut (19).

## **TESTING AND TROUBLESHOOTING**

1. Check accessories to ensure adequate pressure and flow of air to cylinders.
2. If a mechanical override device (handwheel or hydraulic handpump) is present, ensure that it is disengaged to allow movement of the operator.
3. With pressure applied to the operator, check gaskets and end stops with soapy water or another leak detecting fluid. A leak indicates that nuts must be tightened or gaskets/O-rings replaced.
4. With pressure applied to the operator, check for leakage (blow-by) from the opposite side of the piston. A leak indicates that O-rings must be replaced.
5. If the operator has not been operated for a long period of time, some leakage past piston seals may be observed upon start-up. Operating the operator a few times should cause the O-rings to regain their resiliency and stop this leakage.

## SPECIFICATIONS

### ROTARY

MAXIMUM ALLOWABLE WORKING PRESSURE 160 PSI

MODEL (SERIES)	<b>SERIES 35</b>	<b>SERIES 50</b>	<b>SERIES 60</b>	<b>SERIES 70</b>
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### BOLT/NUT TORQUE (LB-FT)

COVER BOLTS	10	10	10	10
PISTON NUT	80	100	100	100
STAY ROD NUTS/BOLTS	20-30	50	80	80-100
MOUNTING BOLTS	20-30	50	80	100

### MAX ENGAGEMENT

MOUNTING BOLTS SIZE	3/8NC	1/2NC	5/8NC	3/4NC
INTO DRIVE CASE (INCH)	1-1/4	1-1/4	1-1/4	1-1/2

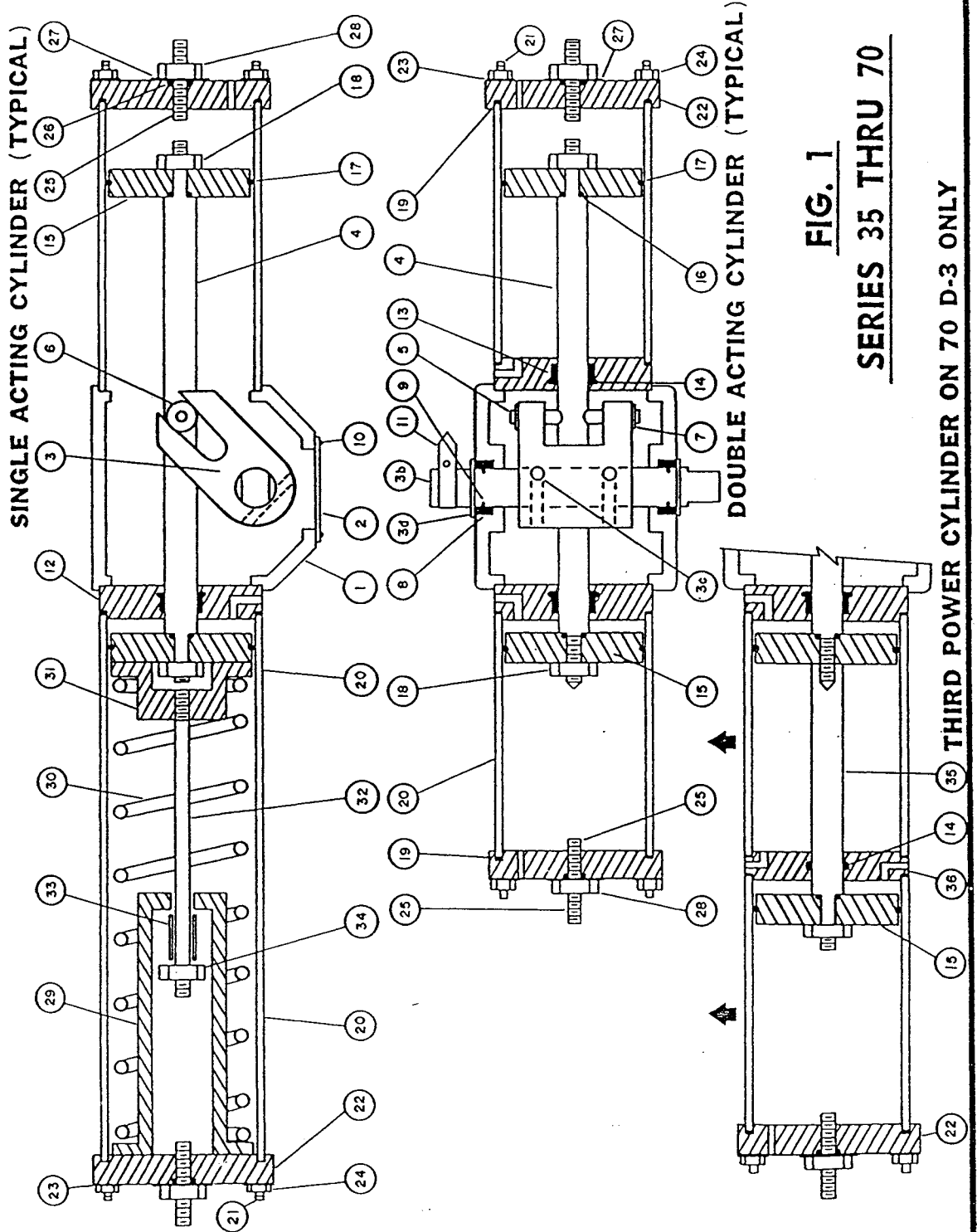
MODEL (SERIES)	<b>SERIES 3</b>	<b>SERIES 5</b>	<b>SERIES 7</b>
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### BOLT/NUT TORQUE (LB-FT)

COVER BOLTS	80	80	180
CYL. PLATE BOLTS	100	100	100
PISTON NUT/BOLTS	600	1500	2400
STAY ROD NUTS	80	80-100	100
MOUNTING PLATE BOLTS	120	120	350

### MAX ENGAGEMENT

MOUNTING BOLT SIZE	5/8NC	5/8NC	1NC
INTO DRIVE CASE (INCH)	1	1-1/8	1-3/4



**FIG. 1**  
**SERIES 35 THRU 70**

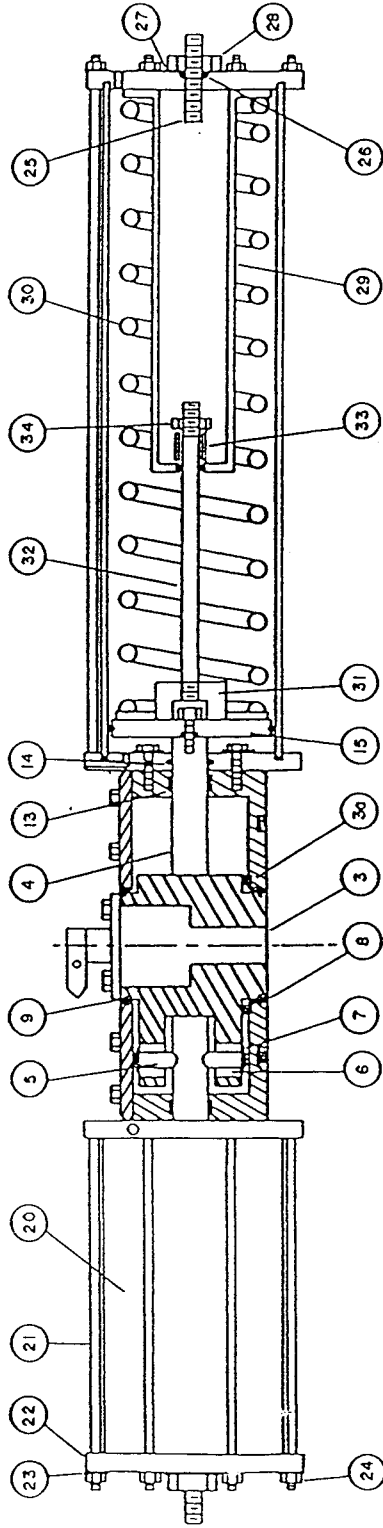
## SERIES 35 THRU 70 - PARTS LIST

ITEM	DESCRIPTION	MATERIALS OF CONSTRUCTION
1	Drive Case	Aluminum
2	Cover	Aluminum
3	Yoke	Ductile Iron
3b	Stem	Steel
3c	Yoke Pin	Steel
3d	Snap Ring	Spring Steel
4	Drive Rod	Steel - Chrome Plated
5	Drive Pin	Steel
6	Drive Roller	Steel - Heat Treated
7	Snap Ring	Spring Steel
8	Bushing	Nylon
*9	O-Ring	Buna
10	Cover Screw	Self-Tapping - Plated
11	Indicator	Steel - Plated
12	Cylinder Plate	Aluminum
13	Drive Rod Guide	Nylon
*14	Drive Rod Seal	Buna
15	Piston	Aluminum
*16	Piston Centre O-Ring	Buna
*17	Piston Seal	Buna
18	Piston Lock Nut	2H - Plated
*19	Cylinder Gasket	Plant Fibre
20	Cylinder	Spiral Wound Fibreglass (or) Steel - Plated
21	Stay Rod	Steel - Plated
22	End Cap	Aluminum
23	Lock Washer	Steel - Plated
24	Stay Rod Nut	2H - Plated
25	End Stop	Steel - Plated
*26	End Stop O-Ring	Buna
27	Washer	Machine Bushing - Plated
28	End Stop Jam Nut	2H - Plated
<b>SPRING RETURN (SR) MODELS</b>		
29	Barrel	Aluminum
30	Spring	Spring Steel
31	Retainer Rod	Aluminum
32	Spacer	Steel - Plated
33	Lock Nut	Steel - Plated
34	Lock Nut	2H - Plated
<b>MODEL 70D3 AND 70D3SR</b>		
35	Drive Rod Extension	Steel - Chrome Plated
36	Centre Cylinder Plate	Aluminum

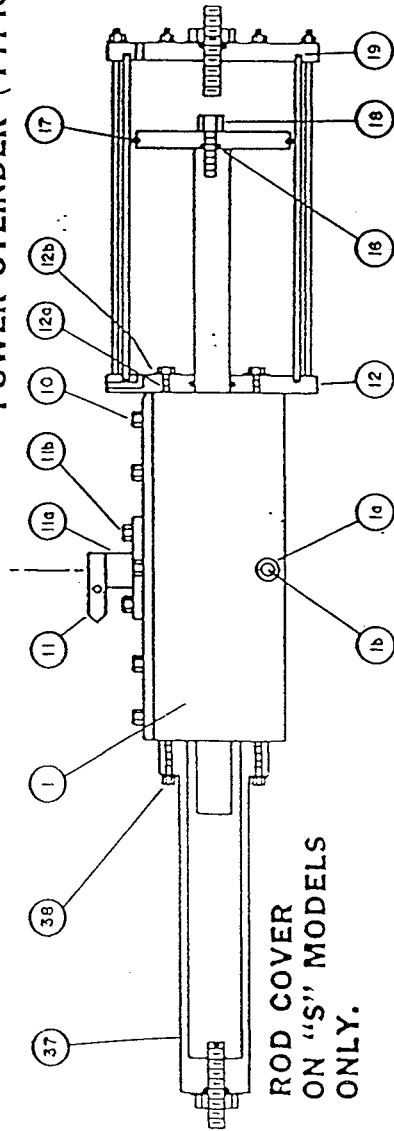
\*Recommended Spare Parts      \*\*When ordering spare parts, please advise serial no.

All repair kits are rated -40°C to 75°C unless specified otherwise.

SPRING RETURN CYLINDER (TYPICAL)



POWER CYLINDER (TYPICAL)



ROD COVER  
ON "S" MODELS  
ONLY.

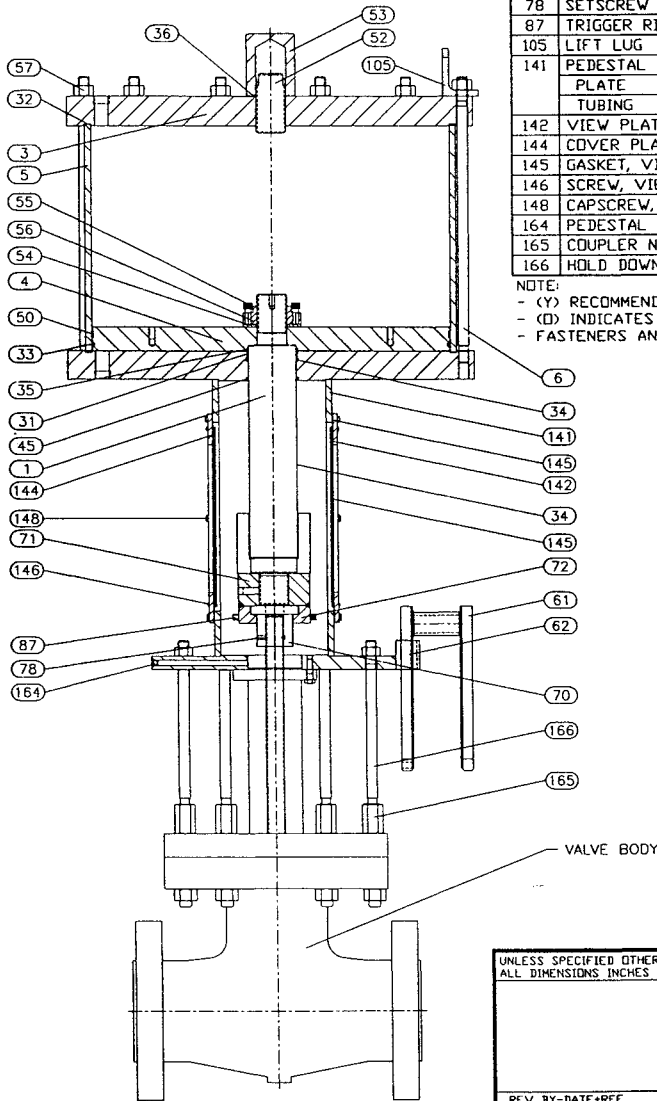
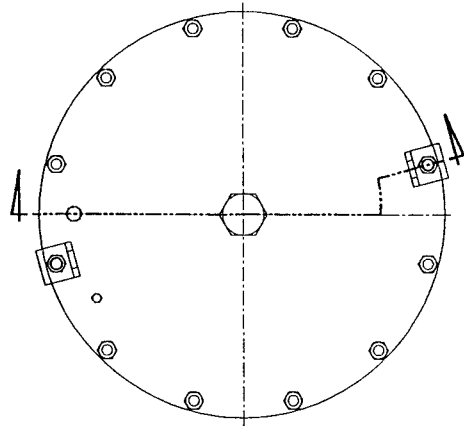
FIG. 2  
SERIES 85 THRU 185, 127 THRU 187

# SERIES 85 THRU 185, 127 THRU 187 - PARTS LIST

ITEM	DESCRIPTION	MATERIALS OF CONSTRUCTION
1	Drive Case	Aluminum
1a	Breather Plug	Iron - Plated
1b	Breather	Brass
2	Drive Case Cover	Aluminum
3	Yoke	Ductile Iron
3a	Thrust Bearing	Nylon
4	Drive Rod	Steel - Chrome Plated
5	Drive Pin	Steel
6	Drive Roller	Steel - Heat Treated
7	Snap Ring	Spring Steel
8	Bushing	Nylon
*9	O-Ring	Buna
10	Cover Screw	Gr. 5 - Plated
11	Indicator	Steel - Plated
11a	Yoke Cover	Aluminum
11b	Yoke Cover Screw	Gr. 5 - Plated
12	Cylinder Plate	Steel
12a	Mounting Screw	Gr. 5 - Plated
12b	Washer	Machine Bushing - Plated
13	Drive Rod Guide	Nylon
*14	Drive Rod Seal	Buna
15	Piston	Aluminum
*16	Piston Centre O-Ring	Buna
*17	Piston Seal	Buna
18	Piston Screw	Gr. 5 - Plated
*19	Cylinder Gasket	Plant Fibre
20	Cylinder	Spiral Wound Fibreglass (Of) Steel - Plated
21	Stay Rod	Steel - Plated
22	End Cap	Steel
23	Lock Washer	Steel - Plated
24	Stay Rod Nut	2H - Plated
25	End Stop	Steel - Plated
*26	End Stop O-Ring	Buna
27	Washer	Machine Bushing - Plated
28	End Stop Jam Nut	2H - Plated
<b>SPRING RETURN(SR) MODELS</b>		
29	Barrel	Welded Steel - Plated
30	Spring	Spring Steel
31	Retainer	Welded Steel - Plated
32	Rod	Steel - Plated
33	Spacer	Steel - Plated
34	Lock Nut	2H - Plated
<b>SINGLE PISTON(S) MODELS</b>		
37	Drive Rod Cover	Aluminum
38	Mounting Screw	Allen Head - Plated

\* Recommended Spare Parts All repair kits are rated -40°C to 75°C unless specified otherwise **FIG. 2**





ITEM	DESCRIPTION	MATERIAL	QTY	NOTE
1	DRIVE ROD	AISI C1045	1	
3	END CAP	ASTM A516-70	1	
4	PISTON	ASTM A516-70	1	
5	CYLINDER	AMALGON	1	
6	STAY ROD	AISI 4140	12	
31	ROD GUIDE	MOLYGARD	1	(Y)
32	CYLINDER GASKET	JM CLIPPER NA-60	2	(Y)
33	O-RING, PISTON	NITRILE	1	(Y)
34	O-RING, DRIVE ROD	NITRILE	1	(Y)
35	O-RING, PISTON CENTER	NITRILE	1	(Y)
36	O-RING, STOP COVER	NITRILE	1	(Y)
45	WIPER	URETHANE	1	(Y)
50	WEAR RING, PISTON	HALLITE 506	1	(Y)
52	END STOP	GR B7	1	
53	END STOP COVER	AISI C12L12	1	
54	JACKNUT WASHER	AISI 4140	1	
55	CAPSCREW, PISTON	GR 8	10	
56	JACKNUT, PISTON	AISI 4140	1	
57	NUT, STAY ROD	GR 2H	12	
61	LOCK DOWN BAR	AISI 1018../C1020	1	(D)
62	STOP HOLDER	CSA 350W	1	(D)
70	STEM NUT	AISI C12L14	1	
71	CONNECTOR BODY	AISI C1018../C1020	1	
72	CONNECTOR RETAINER	AISI C1018../C1020	1	
78	SETScrew	SS 304	2	
87	TRIGGER RING	AL 6061-T6	1	
105	LIFT LUG	ASTM A36	2	
141	PEDESTAL			
	PLATE	ASTM A516-70 / A36	2	
	TUBING	CSA G44.1 350W	1	
142	VIEW PLATE	POLYCARBONATE	2	
144	COVER PLATE	ASTM A36	2	
145	GASKET, VIEW PLATE	NEOPRENE	2	
146	SCREW, VIEWPLATE	SS 304	8	
148	CAPSCREW, COVER PLATE	SS 304	12	
164	PEDESTAL PLUG	SS 304	1	
165	COUPLER NUT	SA 564 TP630 H1150M	4	(D)
166	HOLD DOWN ROD	AISI 4140	4	(D)

NOTE:  
 - (Y) RECOMMENDED SPARE PARTS/REPAIR KIT  
 - (D) INDICATES OPTIONAL PART  
 - FASTENERS AND MAINTENANCE TOOLS ARE ANSI/INCH SIZE

UNLESS SPECIFIED OTHERWISE ALL DIMENSIONS INCHES (mm)		<b>BETTIS</b> BETTIS CANADA LTD. Actuators & Controls	
		ASSEMBLY SERIES GVO-LP-DA CLOSED PEDESTAL	
REV BY-DATE+REF		C-0273--DWG JUN-08-96	
TOLERANCES XXX ±0.5 (+10) XX ±0.2 (+5) X ±0.1 (+2)		SCALE 1:10 BY RB	CHK <i>[Signature]</i> DATE JUN-08-96
		W.D. 07482-1-B	DWG. NO. C.B0273 REV --

NOTES