LatchTool Group, LLC

FastFlow® Technology

Annular Flow Control Microhydraulics

Introductory Disclosure Package

This information is intended for persons registered with the LatchTool Group, LLC as a teaching aid. If you have not registered, please submit your contact information via email. You will be eligible for subsequent updates as available.

LatchTool Group, LLC
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LatchTool Group, LLC

FastFlow®

Annular Flow Control

Microhydraulics

LatchTool is in the business of accelerating adoption
of technology through cross-licenses and
collaborative developments.

Products and machines that deliver more power
in less space, with less weight and
for less cost than imaginable.

The Company practices an OPEN Business Model through
syndicated engineering design firms and licensed OEM's.

Motion Control &
***high force* Fluid Power**
connect™

14760 Cherry Hills Place
Colorado Springs, CO 80921
(719) 488-8800

www.LatchTool.com

FastFlow® Technologies – Elementary Precepts

The Basics (How our systems work)

O-ring seals are made to double as floating seal valves

Concentric seals, backup rings, seats and springs create large annular flow paths

Minimize real estate and eliminate pressure restrictions

Enables *fluidic* flow control

> **_FastFlow®_ Valves**
>
> A class of ***tiny*** automatic valves where O-ring seals double as valves…
>
> - compact and inexpensive
> - eliminate valve body - reduce system real estate
> - annular flow paths – permit large volumetric flows
> - rapid closure - negligible backflow – non fouling
> - enable *fluidic* flow control
> - patented & trade secret protected…
> - configure as check valves, spring loaded valves & bi-directional valves

Design principles

- Design as a closed-standalone system
- Single action cylinder
- Rod side of ram cylinder is the reservoir
- Accumulator volume ≥ the volume of the displaced rod
- Bulkhead separates pump from actuator, directs fluid distribution
- Seals seat in direction of rod travel
- Maximum pressure, overpressure and reset valve is one unit – Dart Valve
- Rod retracted mechanically
- Design system in a hogged-out or investment cast manifold, contains all porting
- Pump driven either manually or by motor
- There are exceptions to all *rules of thumb*

- HWCF (high water-content fluid)
  - Four times less compressible that typical oils - eliminate sponginess.
  - Low viscosity reduces frictional losses
  - High surface tension keeps water based fluids from leaking
  - Keep low pressure zones between high pressure zones & atmosphere
  - Additives provide lubricity, rust prevention, anti-freeze, etc.

- Challenge of near sonic fluid velocities
  - *Lost* or blown-out seals
  - Bernoulli

These phenomena stopped the development of floating seal valves. Affirmed accepted tenet that O-rings should be used statically☺

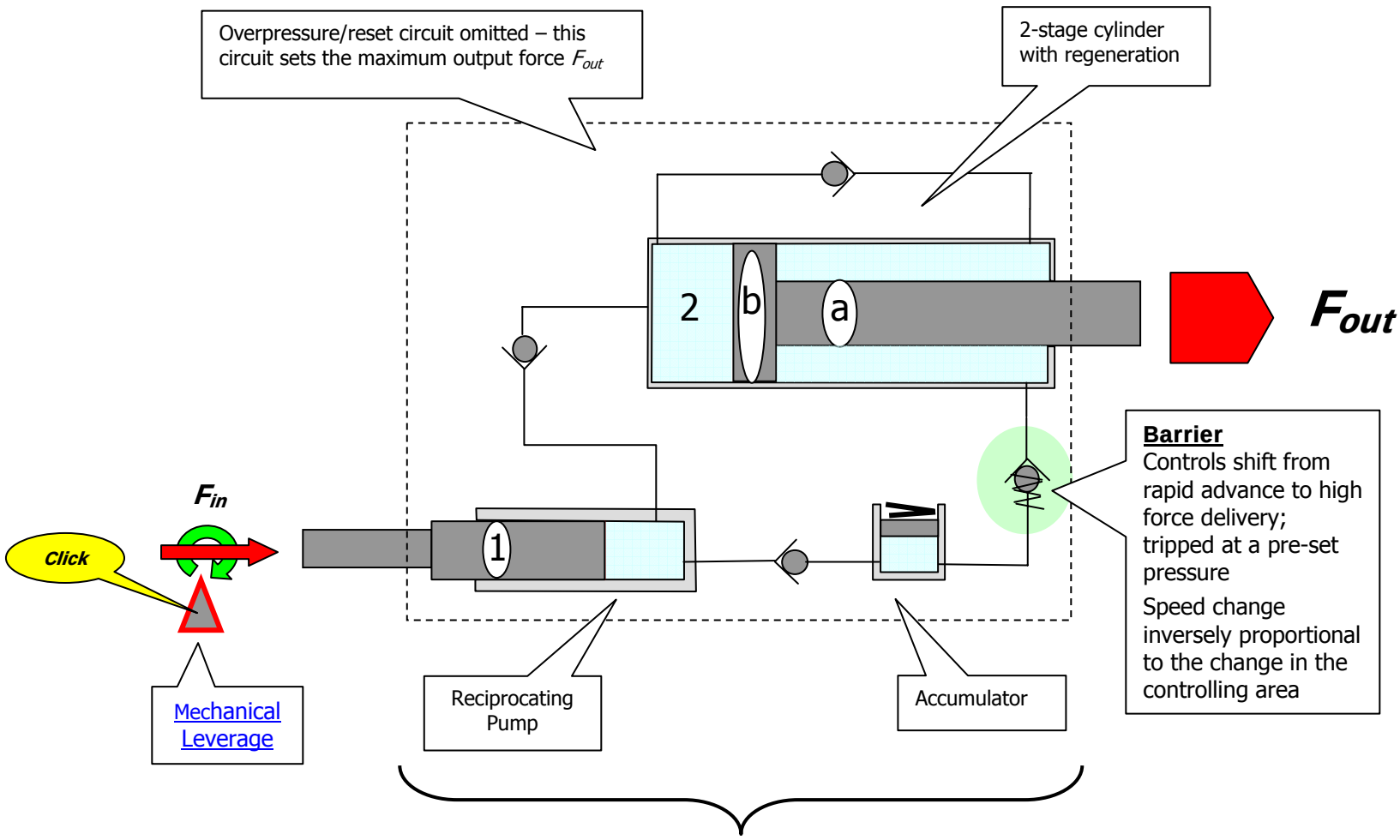
- Hydraulic Advantage – Pascal compliant circuits

- Two Speed Ram – Regenerative Circuit With Barrier/Piston Head Combination
  - Rapid advance/low force – driven by the X-sectional area of the ram rod, (a)
  - High force/slow advance – driven by the area of the piston head, (b)
  - Barrier controls shift – tripped by reservoir pressure (alt: rod displacement)

- Hi-Bar Pumps – Low Flow/High Pressure Piston Pumps
  - Single and double action

Review BOMs – PowerCylinder, PEX Crimper and PowerPliers

Elementary *FastFlow®* Hydraulic Circuit – *FastFlow®* Valves represented as check or spring loaded check valves.



Calculus

$A = \pi D^2/4$

D_{pump} = ¼, A_1 = 0.049

D_a = ¼. A_{2a} = 0.049

D_b = ⅞, A_{2b} = 0.601

Mechanical Leverage = 6:1

F_{in} = 300 lbs

$P = F_{in}/A_1 \geq 6{,}000$ psi

$S_{rapid} = S_{out}\, A_{2b}/A_{2a} = S_{out} \times 12.3$

Hydraulic Leverage = 10:1

$F_{out} = P \times A_{2b} \geq 3{,}000$ lbs

$A_{2a}/A_{2b} = 0.082$

$F_{rapid} = 250$

$F_{rapid} = F_{out} \times (A_{2a}/A_{2b})$

A = Area, D = Diameter, F = Force, P = Pressure. S - Speed

The LatchTool Barrier and Ram-Cap Assembly

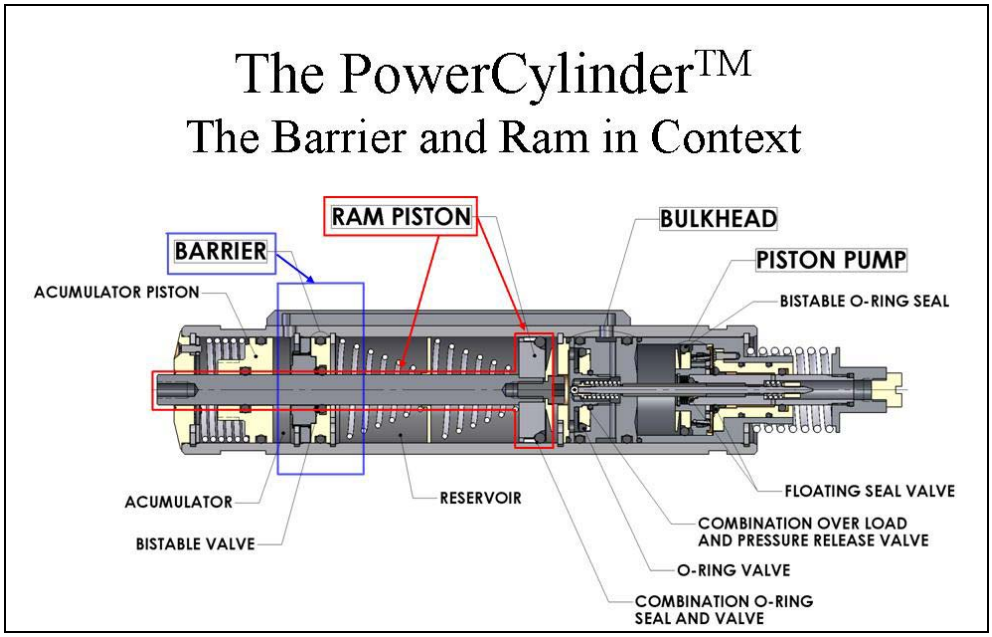


Figure 1

LatchTool *microhydraulic* systems™ are based on the Company's FastFlow™ technology. Two patented mechanical subassemblies, the Barrier and Ram-Cap, work in tandem to create a hydraulic circuit that rapidly advances a cylinder's ram. Able to use very small parts, the circuit produced is the classical *regenerative circuit* used extensively in the fluid power industry, particularly in mobile hydraulics. This is the circuit that allows the arm on an excavator to extend rapidly. Until LatchTool's development, this circuit relied on an external pump, plumbing, valve manifold, and reservoir to drive a hydraulic cylinder.

A positive displacement pump drives the ram. The Barrier/Ram assembly controls the shift of the system in and out of the regenerative mode. It is a totally automatic process regulated by the resistance encountered by the ram. Working in combination with the Ram-Cap, the Barrier stops the flow of fluid from the reservoir (the rod-side of the ram) to the accumulator such that the fluid displaced by the advancing ram is forced back through the Ram-Cap into the Ram Chamber to create a regenerative circuit. See Figures 1 & 2.

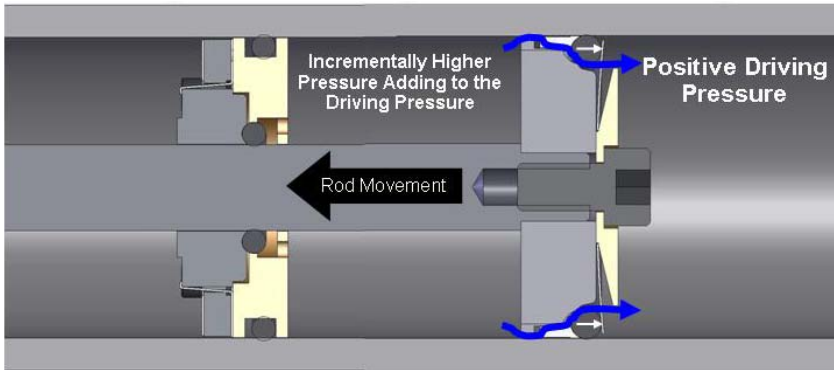


Figure 2

The ram is being driven by the cross sectional area of the ram-rod. As the ram engages its work resistance and pressure build. At a pre-determined pressure, the floating seal valve in the Barrier squeezes off the land of the seal plate opening the Barrier Gate. Fluid on the rod-side of the ram is now expressed into the accumulator and the ram is driven by the cross sectional area of the Ram-Cap. The transition from the regenerative to expectant circuit happens instantaneously. See Figure 3.

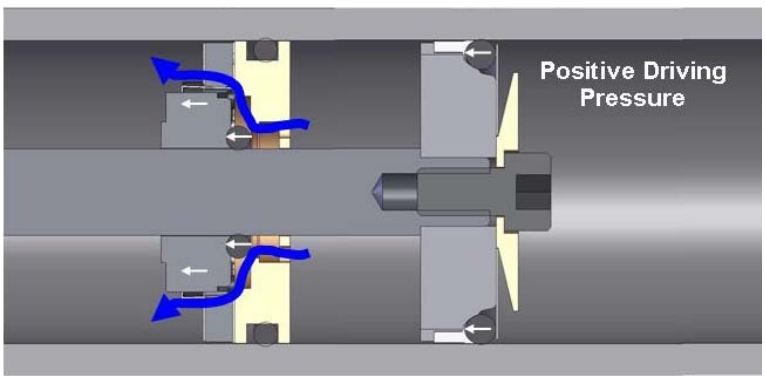
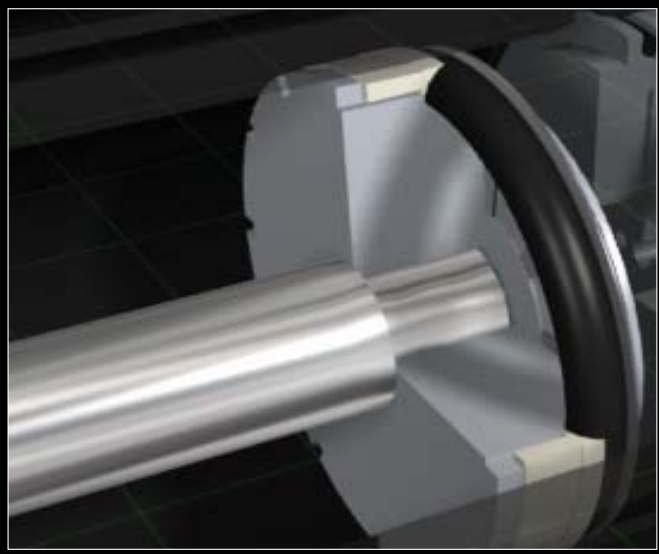


Figure 3

FastFlow

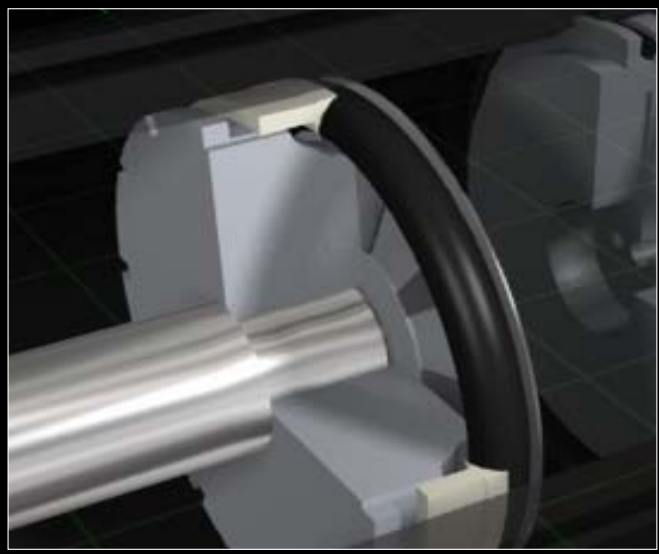
Floating Seal Valve



Valve Closed

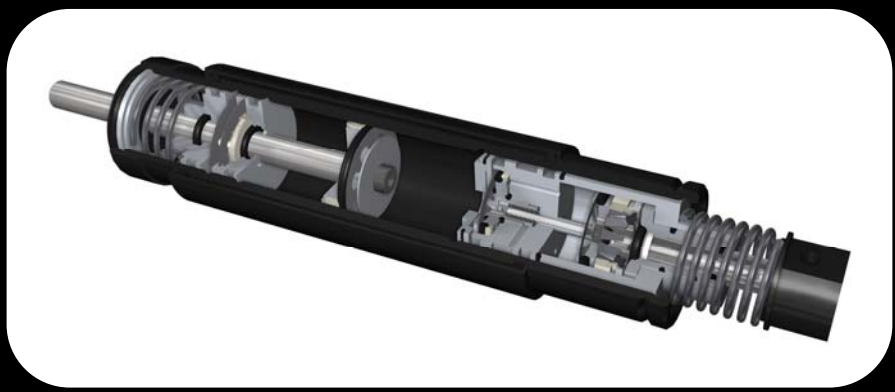
FastFlow

Floating Seal Valve

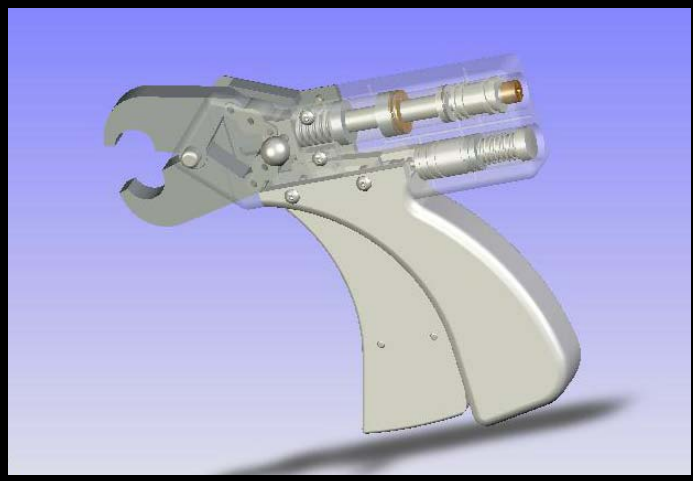


Valve Opened

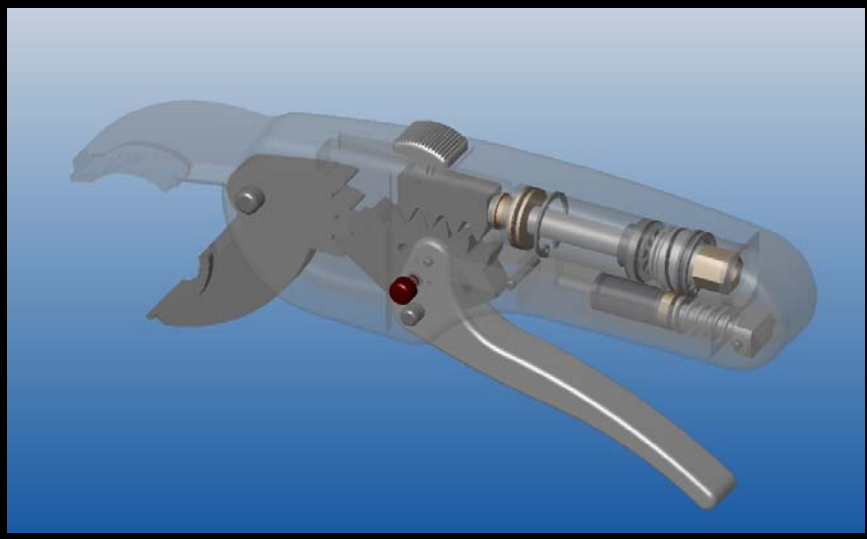
PowerCylinder^{tm}

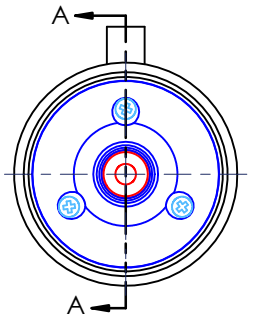


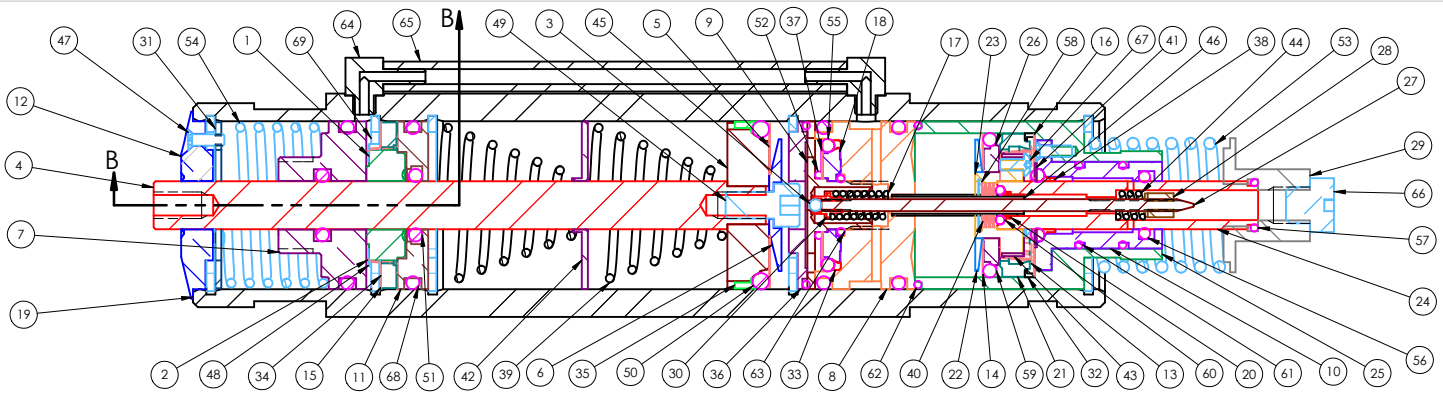
½ “ PEX Crimper



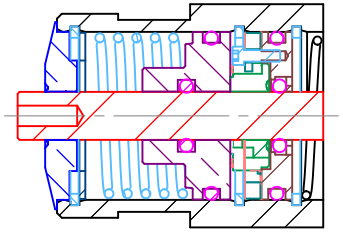
PowerPliers







SECTION A-A



SECTION B-B

QTY.	PART NUMBER	DESCRIPTION	ITEM NO.
1	0244	MODULATION SPRING	44
1	0243	PRELOAD RING	43
1	0242	GUIDE RING	42
1	0241	WASHER	41
7	0240	PUMP DISC SPRING	40
2	0239	TAPERED SPRING	39
1	0238	BACKUP RING	38
1	0237	BULKHEAD VALVE SPRING	37
1	0236	RING, MACHINED	36
1	0235	BACKUP RING	35
1	0234	BARRIER RING	34
1	0233	BACKUP RING	33
1	0232	RING, MACHINED	32
1	0231	END PLATE	31
1	0230	CAGE	30
1	0229	PUMP END PLATE	29
1	0228	DART ADJUSTMENT NUT	28
1	0227	DART	27
1	0226	PUMP PISTON SEAL PLATE	26
1	0225	PUMP HEAD	25
1	0224	PUMP ROD	24
1	0223	CLAMP RING	23
1	0222	PUMP PISTON CAP	22
1	0221	PUMP LATCH RING	21
1	0220	BACKUP RING	20
1	0219	CYLINDER FOR M3 FITTINGS	19
1	0218	BULKHEAD SEAL PLATE	18
1	0217	OVER PRESSURE SPRING	17
1	0216	PUMP SPRING	16
1	0215	BARIER RETURN SPRING	15
1	0214	PUMP SPRING	14
1	0213	PUMP LATCH SPRING	13
1	0212	LEFT END CAP	12
1	0211	BARRIER	11
1	0210	PUMP INSERT	10
1	0209	BULKHEAD CAP PLATE	9
1	0208	BULKHEAD	8
1	0207	RESERVOIR PISTON	7
1	0206	RAM SPRING BACKUP PLATE	6
1	0205	RAM SPRING	5
1	0204	RAM ROD	4
1	0203	RAM PISTON	3
1	0202	BARRIER LATCH SPRING	2
1	0201	BARRIER LATCH RING	1

BOM Table

QTY.	PART NUMBER	DESCRIPTION	ITEM NO.
5	MMC 91580A191	INTERNAL RETAINING RING	69
4	2-018or	2-018 O-RING	68
3		#0-80 BHCS, 1/4 L	67
1		10-32 PLUG	66
1	BESWICK 1016	5/64 ID TUBE	65
2	BESWICK M3LS-1016	ELBOW FITTING, BARB & M3	64
1		6ID X 1W mm O-RING	63
2		20ID X 1W mm O-RING	62
2		9.5ID X 1W mm O-RING	61
1		2.6ID X 1.2W mm O-RING	60
1		2-016 O-RING	59
1	MMC 91580A114	INTERNAL RETAINING RING	58
1		5ID X 1W mm O-RING	57
1		6ID X 1.5W mm O-RING	56
1		2-015 O-RING	55
1	CSC B12-46	COMPRESSION SPRING	54
1	CSC 11675	COMPRESSION SPRING	53
1		7ID X 1W mm O-RING	52
3		2-010 O-RING	51
1		18ID X 2.2W mm O-RING	50
1		#6-32 SHCS, 1/4 L	49
3		#0-80 SHCS, 3/16 L	48
6		#0-80 FHCS, 3/16 L	47
1		.109 OD X .089 ID X .688 L TUBE	46
1		1/16 DIA BALL	45

BOM Table

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ±1/32 ANGULAR ±1/2˚ TWO PLACE DECIMAL ±.01 THREE PLACE DECIMAL ±.005	DRAWN	OS	
	CHECKED		
	ENG APPR.		
	MFG APPR.		
INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994	Q.A.		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

Latch-Tool Development Co., LLC
14760 Cherry Hills Place
Colorado Springs, CO 80921
Phone: 719-488-8800

TITLE:

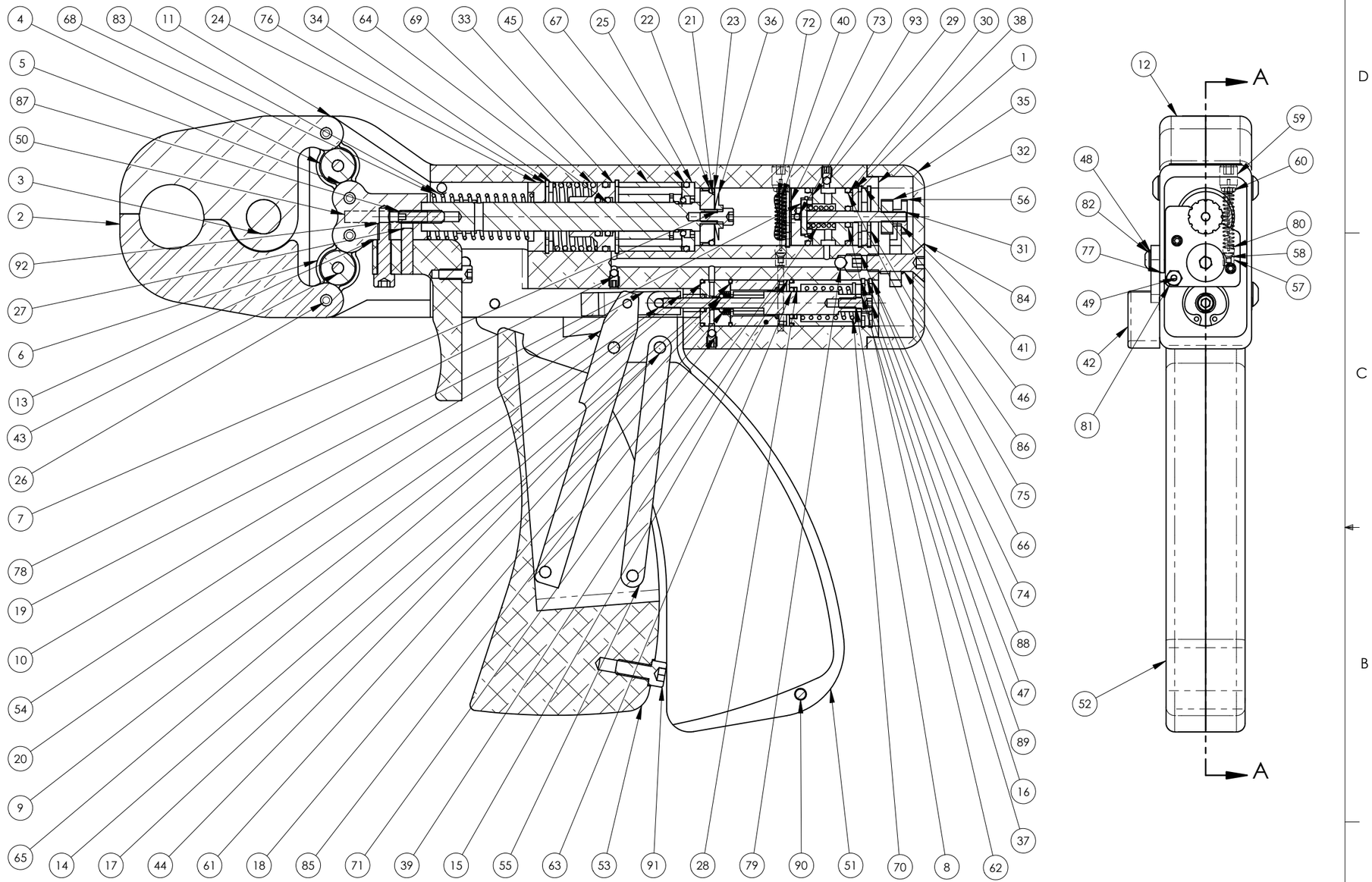
POWER CYLINDER .875 DIA

SIZE	DWG. NO.	REV
A	0200	1

SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

REVISIONS		
REV.	DESCRIPTION	DATE
1	CREATE DRAWING	6/5/2006



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
93		1/16 DIA SST BALL	1
92		HX-SHCS 0.138-32x0.5625-N	1
91		HX-SHCS 0.164-32x0.375-N	1
90		HX-SHCS 0.112-40x0.5-N	1
89		HX-SHCS 0.112-40x0.25-N	3
88		SSCUPSKT 0.19-32x0.1875-HX-N	1
87		SSFLATSKT 0.138-32x0.5-HX-N	1
86		SSCONESKT 0.112-40x0.3125-HX-N	2
85		SSCUPSKT 0.112-40x0.125-HX-N	4
84		SCHCSCREW 0.19-32x0.625-HX-N	1
83		SBHCSCREW 0.138-32x0.25-HX-N	8
82		SBHCSCREW 0.112-40x0.375-HX-N	1
81		HX-SHCS 0.164-32x0.5625-N	2
80		1/8 DIA RUBBER BALL	1
79		1/8 DIA SST BALL	1
78		5/64 DIA SST BALL	4
77		3/32 SQUARE RUBBER CORD	1
76	Truarc N5000-75 - S0.75	INTERNAL RETAINING RING	2
75	Truarc N5000-62 - S0.625	INTERNAL RETAINING RING	3
74	Truarc N5000-50 - S0.5	INTERNAL RETAINING RING	2
73	CSC CDM-155204	DISC SPRING	1
72	CSC A-80	COMPRESSION SPRING	1
71	CSC YY-48	COMPRESSION SPRING	1
70	CSC 71124	COMPRESSION SPRING	1
69	CSC KK-93	COMPRESSION SPRING	1
68	CSC FF-55	COMPRESSION SPRING	1
67		16.1ID X 1.6W mm O-RING	2
66		13ID X 1.5W mm O-RING	3
65		11ID X 1W mm O-RING	3
64		7.5ID X 1.5W mm O-RING	3
63		6ID X 1.2W mm O-RING	1
62		3ID X 1.5W mm O-RING	1
61		2.6ID X 1.2W mm O-RING	2
60		2ID X 1W mm O-RING	1
59	0459	SEAL SCREW	1
58	0458	BALL BACKUP RING	1
57	0457	VALVE SEAT	1
56	0456	DART NUT	1
55	0455	HANDLE, SHORT LINK	1
54	0454	HANDLE, LONG LINK	1
53	0453	HANDLE TRIGGER	1
52	0452	HANDLE RIGHT COVER	1
51	0451	HANDLE LEFT COVER	1
50	0450	KEY	1
49	0449	DART LIFT ROD	1
48	0448	DART LEVER BUSHING	1
47	0447	PUMP STOP RING	1
46	0446	BULKHEAD WASHER	1
45	0445	BARRIER BACKUP RING	1
44	DPM 0.125x0.75	DOWEL PIN	2
43	DPM 0.125x0.625	DOWEL PIN	2
42	0442	DART LIFT LEVER	1
41	0441	DART LEVER	1
40		SPRING WIRE .02 DIA X 11/16 L	1
39	0439	PUMP SEAL WASHER	1
38	0438	BULKHEAD SEAL WASHER	1
37	0437	PUMP SHAFT WASHER	1
36	0436	RAM SPRING BACKUP PLATE	1
35	0435	END CAP	1
34	0434	RESERVOIR WASHER	1
33	0433	RESERVOIR PISTON	1
32	0432	DART NUT	1
31	0431	DART	1
30	0430	BULKHEAD SEAL BUSHING	1
29	0429	BULKHEAD	1
28	0428	PUMP O-RING BACKUP RING	1
27	DPM 0.125x0.5	DOWEL PIN	3
26	DPM 0.125x0.25	DOWEL PIN	8
25	0425	BARRIER	1
24	0424	CAP PLATE	1
23	0423	RAM SPRING	1
22	0422	RAM BACKUP RING	1
21	0421	RAM PISTON	1
20	DPM 0.0938x0.25	DOWEL PIN	2
19	DPM 0.0625x0.375	DOWEL PIN	1
18	0418	PUMP DISC SPRING	7
17	0417	PUMP BACKUP RING	1
16	0416	PUMP SEAL BUSHING	1
15	0415	PUMP HOUSING, OUT	1
14	0414	PUMP HOUSING, IN	1
13	0413	TRIGGER	1
12	0412	RIGHT COVER	1
11	0411	LEFT COVER	1
10	0410	YOKE	1
9	0409	PUMP SHAFT YOKE	1
8	0408	PUMP ROD	1
7	0407	RAM ROD	1
6	0406	ROLLER COVER	4
5	0405	CAM	1
4	0404	ROLLER	2
3	0403	PIVOT BOLT	1
2	0402	JAW	2
1	0401	BODY	1

BOM Table

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±1/32
ANGULAR ±1/2°
TWO PLACE DECIMAL ±.01
THREE PLACE DECIMAL ±.005

INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	OS	
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

Latch-Tool Development Co., LLC
14760 Cherry Hills Place
Colorado Springs, CO 80921
Phone: 719-488-8800

TITLE:
POWER PEX CRIMPER

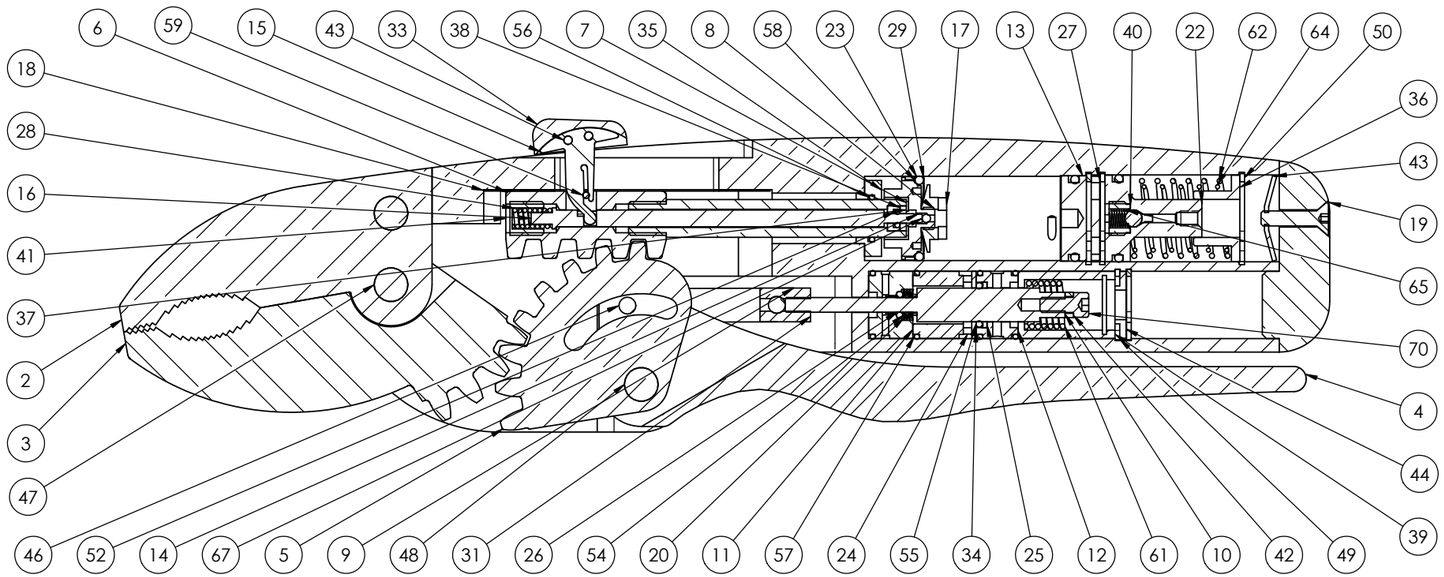
SIZE	DWG. NO.	REV
B	400-1	1

SCALE:	WEIGHT:	SHEET 1 OF 1

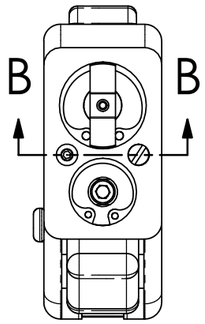
REVISIONS		
REV.	DESCRIPTION	DATE
1	CREATE DRAWING	4/16/2005
2	REVISED	10/5/2006
3	REVISED RESERVOIR, RAM O-RING FILL VALVE AND FUID PATHS	3/23/2007

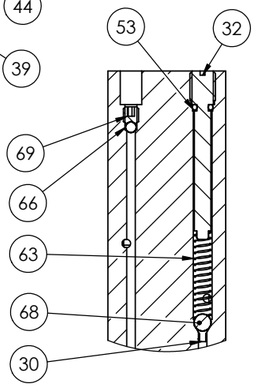
QTY.	PART NUMBER	DESCRIPTION	ITEM NO.
1		SCHCSCR 0.112-40x0.5x0.5-HX-N	71
1		HX-SHCS 0.112-40x0.25x0.25-N	70
6		SSCUPSKT 0.112-40x0.125-HX-N	69
2		1/8 DIA RUBBER BALL	68
1		1/16 DIA BALL	67
6		5/64 DIA SST BALL	66
1	CSC 10775	COMPRESSION SPRING	65
1	CSC 3755	COMPRESSION SPRING	64
1	CSC A-80	COMPRESSION SPRING	63
1	CSC 2719	COMPRESSION SPRING	62
1	CSC 71124	COMPRESSION SPRING	61
1	CSC KK-7	COMPRESSION SPRING	60
1		3/64 DIA X .31 L DRILL BLANK	59
3		12.8ID X 1.6W mm O-RING	58
4		11ID X 1W mm O-RING	57
1		7ID X 1W mm O-RING	56
1		6ID X 1.2W mm O-RING	55
2		2.6ID X 1.2W mm O-RING	54
1		2ID X 1W mm O-RING	53
1		1.5ID X 1W mm O-RING	52
1	Truarc 5103-12	EXTERNAL RETAINING RING	51
3	Truarc N5000-62 - S0.625	INTERNAL RETAINING RING	50
2	Truarc N5000-50 - S0.5	INTERNAL RETAINING RING	49
1	DPM 0.25x0.875	DOWEL PIN	48
2	DPM 0.25x0.6875	DOWEL PIN	47
2	DPM 0.125x0.625	DOWEL PIN	46
2	DPM 0.0625x0.5	DOWEL PIN	43
1	0347	PUMP STOP RING	44
1	0346	LOCKING PLATE	43
1	0345	PUMP SHAFT WASHER	42
1	0344	DART VALVE SPRING HOUSING	41
1	0343	FILL VALVE SPRING HOUSING	40
1	0342	PUMP SLEEVE	39
1	0341	DART CUP	38
1	0340	DART WASHER	37
1	0339	BUSHING	36
1	0338	BUSHING	35
1	0337	PUMP SEAL WASHER	34
1	0335	RELEASE BUTTON	33
1	0334	SEAL SCREW	32
1	0333	PUMP SHAFT YOKE	31
2	0332	BALL BACKUP RING	30
1	0330	RAM SPRING	29
1	0329	OVER PRESSURE SPRING	28
1	0328	WASHER	27
1	0327	PUMP BACKUP RING	26
1	0326	PUMP O-RING BACKUP RING	25
1	0325	PUMP HOUSING	24
1	0324	RAM BACKUP RING	23
1	0323	RESERVOIR PISTON	22
1	0322	BUTTON	21
7	0321	PUMP DISC SPRING	20
1	0320	END CAP	19
1	0319	SHIM	18
1	0318	RAM NUT	17
1	0317	DART PLUNGER	16
1	0316	RELEASE LEVER	15
1	0315	DART	14
1	0314	SEAL PLATE	13
1	0312	PUMP SEAL PLATE	12
1	0311	PUMP HOUSING	11
1	0310	PUMP ROD	10
2	0309	PUMP LINK	9
1	0308	RAM PISTON	8
1	0307	RAM ROD	7
1	0306	SPUR RACK	6
1	0305	SPUR GEAR SECTOR	5
1	0304	TRIGGER	4
1	0303	LOWER JAW	3
1	0302	UPPER JAW	2
1	0301	BODY	1

BOM Table

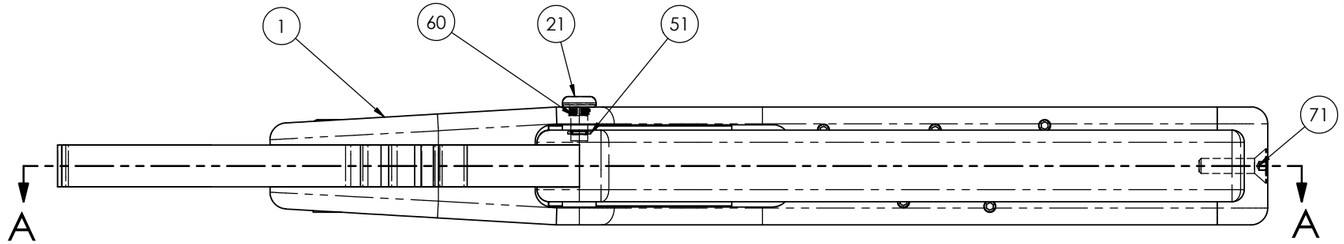


SECTION A-A





SECTION B-B



UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ±1/32 ANGULAR ±1/2° TWO PLACE DECIMAL ±.01 THREE PLACE DECIMAL ±.005	DRAWN	OS	
	CHECKED		
	ENG APPR.		
	MFG APPR.		
INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994	Q.A.		
MATERIAL			
FINISH			
DO NOT SCALE DRAWING			

Latch-Tool Development Co., LLC
14760 Cherry Hills Place
Colorado Springs, CO 80921
Phone: 719-488-8800

TITLE:

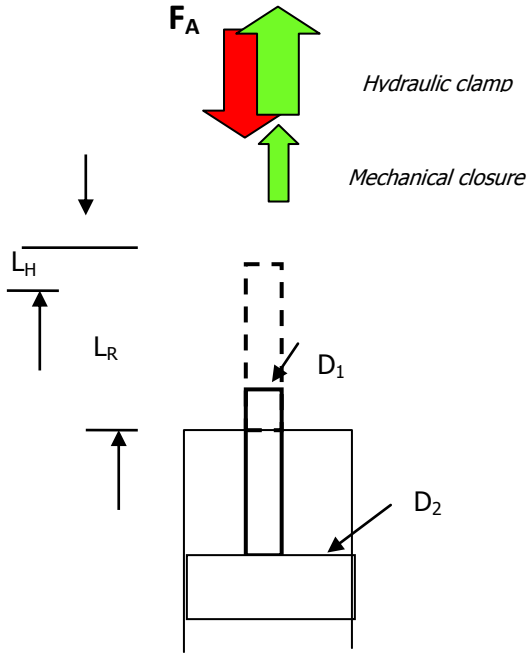
POWER PLIERS

SIZE	DWG. NO.	REV
B	0300	3

SCALE:	WEIGHT:	SHEET 1 OF 1

Example 1: Clamp & Hold Application - LatchTool's *PowerPliers* platform with double acting Hi-Bar pump in a ⅝-inch Ø actuator with ½-inch stroke and a motor/gearbox that advances the ram and ramps up the pressure for 1,000-pounds a *soft-touch* clamping force. The motor/gearbox also lifts the dart valve to release the pressure and retracts the ram upon the completion of the task.

Platform
PowerPliers - mechanical advance, hydraulic clamp



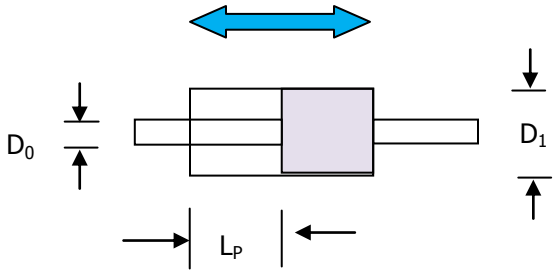
F_A=1,000 lbs or ½ ton
L_R (Ram Stroke) = 0.5 inches
L_H (Compression) < 0.05 inches
Determined by force/deflection data

Ram
D_1=0.2500
D_2=⅝ in=0.6250
A_1=3.1416xD_1^2/4=0.0491
A_2=3.1416xD_2^2/4=0.3068

P= F_A/A_2=3,259 psi

Compression volume = L_HxA_2 = 0.05x0.3068 = 0.0153 in^3
No. Strokes = 0.0153/0.0149 = 1.0295 or ≈ 1.03 strokes

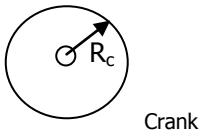
Pump
D_0=0.109
D_1=0.250
A_0=0.0093
A_1=0.0491
A_{1-0}=0.0398
L_P= Pump Stroke = 3/16 in x 2 (Double Action)
V_P= Stroke Volume = 0.1875x2x0.0398=0.0149 in^3



Pump Force Required
3,259psi x 0.0398 in^2**=129.7 lbs**

Approximations for illustrative purposes: motor and gearbox or gearmotor are application specific.

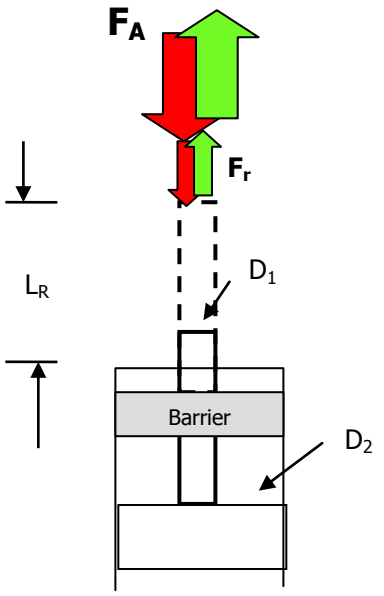
Motor/Gearbox
R_c(crank radius)=3/16=0.1875 inches
Torque=129.7x0.1875 or
≈ 24.32 inch-pounds



Specify
60:1 gear reduction @1,800 rpm
Torque → 24.32/60=0.1053 inch-lbs
With 1.03 strokes to clamp
Then =1.03x60/1800=0.0343 minutes/cycle ≈ 2 seconds to clamp

Example 2: A PowerCylinder™ for Applying a Shear Load - LatchTool's ram circuitry and *double action* Hi-Bar pump combine to produce a self-contained 2¼-inch diameter actuator that reaches the work at 1.4 inches/second and then drives 15 tons at a rate of ≈ 0.11 inches/minute.

The shift out of regeneration is controlled by the Barrier. A design parameter sets this is to occur when the internal pressure approach ~95% of the design maximum as controlled by the dart valve (speed of advance is traded off for force). This is triggered by an external resistance (small red arrow) in the example reaches 2,200 lbs.



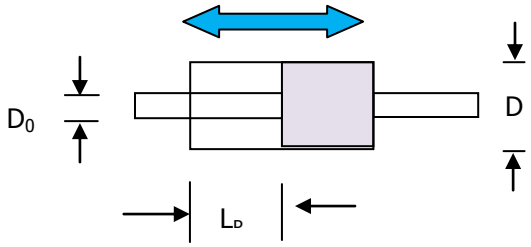
F_A=14,000 lbs or 7 tons
L_R (Ram Stroke) = 1.5 inches

Platform – PEX Power Crimper

Ram
D_1=0.6250
D_2=2.2500
A_1=3.1416xD_1^2/4=0.3068
A_2=3.1416xD_2^2/4=3.9761

P= F_A/A_2=14,000lbs/3.9762in^2=3,521 psi
Barrier Shift →$F_r \leq P x A_1 \approx$1,080lbs

Pump
D_0=0.109
D_1=0.250
A_0=0.0093
A_1=0.0491
$A_{1\text{-}0}$=0.0398
L_P= Pump Stroke = 3/16 in x 2 (Double Action)
V_P= Stroke Volume = 0.1875 x2x0.0398=0.0149 in^3



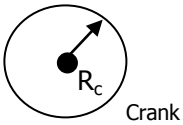
Pump force required to advance 7-Tons
3,521psi x 0.0398 in^2 =**140.14 lbs**

Barrier Open → no regeneration, convention circuit
Ram volume for complete stroke = $L_R x A_2$ = 1.5x3.9767 = 5.9651 in^3
No. Pump Strokes → 5.9651in^3/0.0149in^3/stroke = **400.3 strokes**

Barrier Closed → enables regeneration
Ram volume for complete stroke = $L_R x A_1$ = 1.5x0.3068 = 0.4602 in^3
No. Pump Strokes = 0.4602in^3/0.0149in^3/stroke = **30.8 strokes**

Approximations for illustrative purposes: motor and gearbox or gearmotor are application specific.

Motor/Gearbox
R_c(crank radius)=3/16=0.1875 inches
Torque=140.1x0.1875 or 26.27 inch-pounds



Specify
60:1 gear ratio @**1,800 rpm**
Output Torque → 26.3/60=0.4378 inch-lbs
Output Speed → 1,800x60=108,000 rpm

Rate of Ram Advance – 1.5-inch excursion
Conventional Circuit: 1.5 inches/400.3x60/1800rev/min ≈ 0.1124 inches/minute
Regeneration Circuit: 1.5 inches/30.8X60/1800 ≈ 1.461 inches/minute

October 2007

Issued Patents		
1	6,957,603 "Modulated Overpressure Valve Structure For Fluid Operated Device"	Dart valve… means of reaching inside of a closed, pressurized system to control and modulate the encapsulated hydraulics
2	6,341,621 "Valve Structure For A Fluid Operated Device"	Floating seal valve construction → Fast Flow Valves
3	6,035,634 "Compact, Resistance Regulated, Multiple Output Hydraulic Tool And Seal Valve Arrangement"	Integrates a Regenerative Circuit and Intensifier Circuit in a piston pump/single action ram combination using floating seal valves.
4	5,836,400 "Three Speed Circuit For Hydraulic Tool"	Integrates a regenerative circuit and intensifier circuit in a piston pump/single action ram combination. → PowerCylinder
5	7,251,980 "Hydraulically Powered Gripping Tool"	Circuitry for the PowerPliers – Uses a floating seal valve to flood the pump--
Pending Patent Applications		
6	11/ 580,881 "Force Multiplying Structure For Ram Actuated Devices"	Cam-roller mechanism that links the ram to the jaws in a non-linear relationship… accelerates the closing of a jaw or cutter
7	Appln. No. Not yet Assigned, based on 60/848,398 "Fluid Operated Device With Improved Seal Valve"	Determination of a critical parameter in the design of a floating seal valve.
Provisionals		
8	60/799,021 "Hydraulic Tool With Displacement Determined Shift From Regeneration Mode to High Force Mode" -- US regular application not yet filed (Provisional Abandoned)	Alternative mechanism to shift out of the regenerative mode. Predicated on ram displacement rather than resistance encountered by the ram.
9	60/929,076 "Fastflow Microhydraulic/Mechatronic Device" -- US regular and PCT due by June 12, 2008	Double action pump delivers instant high force and displacement with computer controlled precision.

October 2007

PCT		
10	Appln. No. Not yet Assigned, based on 60/848,398 "Fluid Operated Device With Improved Seal Valve" -- National filings due by April 2, 2009	Same as #7
11	PCT/US06/41289 "Force Multiplying Structure for Ram Actuated Devices" -- National filing deadline is 04-24-2008	Same as #6
Europe		
12	European Application No. 99966118.4 "A Compact, Resistance Regulated Multiple Output Hydraulic Package And Seal Valve Arrangement" --Under examination	Essentially the same patent as #3 (a few embellishments), that took this long to wend its way through the WPO. Update (October 2007) Patent will issue soon…
13	European Application No. (not yet assigned) 6118.4 "A Compact, Resistance Regulated Multiple Output Hydraulic Package And Seal Valve Arrangement"	This is a division of #12
14	European Application 06758314.6 "Hydraulically Powered Gripping Tool"	Same as #5
China		
15	Chinese Application No. 200580042365.X "Modulated Overpressure Valve Structure For Fluid Operated Device"	Same as #1
India		
16	Indian Application No. 3487/DELNP/2007 "Modulated Overpressure Valve Structure For Fluid Operated Device"	Same as #1