USING

FORCE-MULTIPLYING PNEUMATIC CYLINDERS

IN RIVET, HOLE PUNCH AND BROACHING APPLICATIONS

How to control pneumatic cylinder forces

FABCO-AIR
A member of Festo Group

Riveting, hole punching and broaching may seem like small jobs, but completing them requires tools that pack a punch. Typically, these processes are done on an arbor press. These small, hand-operated presses leverage tons of force through the use of a lever or wheel, achieving small precision jobs by hand.

For smaller projects this can be acceptable, but when using an arbor press for larger scale projects you can run into problems. Using the press manually slows production time. This issue is normally fixed by hydraulic automation, but that solution requires costly extra equipment and can be messy.

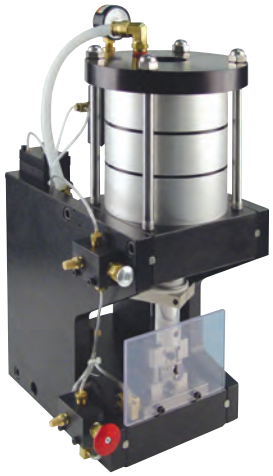
Luckily, there's an alternative. Where hydraulics use liquids, pneumatics use gas, applying a great deal of force with pressurized air. When wired to the right pneumatic cylinder, you'll easily boost your project's productivity. This method does have a few limitations. Unlike hydraulic fluid, air is limited as it is highly compressible, to the point that it would be cost prohibitive to compress the air to the levels required to achieve the forces you need. Luckily, there are alternatives that leverage the cost benefit of using compressed air without having to grow in bore size or compression power.

BEGIN WITH FORCE-MULTIPLYING PNEUMATIC CYLINDER

Riveting, hole punching and broaching require high force levels, this is why it's best to begin with a force-multiplying cylinder to best achieve the level you need. Fabco-Air Multi-Power® Air Cylinders are the ideal choice for this type of application. These powerful cylinders operate on the principle of attaching multiple pistons to a common shaft with an internal air passage to all pistons. Depending on the number of pistons used, the cylinder can achieve up to two, three or four times the amount of force when compared to a single piston cylinder.

With 10 bore sizes to choose from, the Multi-Power® Air Cylinder can achieve up to 44,000 pounds of force, a number that can rival most hydraulic systems.

For example: An application requires 4,800 pounds of force for upsetting a rivet holding a stack of laminations together. By dividing 4,800 by our standard shop air supply of 90 PSI, that means that we require 53.3 square inches of piston area to achieve the proper of level of force. After consulting the *Cylinder Selection Guide*, you can see that the two standard Multi-Power Air Cylinders meet those requirements: a five-inch bore three-piston cylinder has 56.4 square inches while a six-inch bore two-piston unit has 55.3 square inches Both of these units have more than enough force to get the job done.



Model F55 press with 3-stage power cylinder.

CONTROLLING SPEED AND SHOCK WHEN PUNCHING HOLES

The Multi-Power® Air Cylinder is also a good choice for punching holes in laminations. While you can easily get as much as 39,843 pounds of force from a 12-inch bore four-piston cylinder, it is important to accommodate the inertial and impact forces that are released as the tooling breaks through the work piece.

To prevent damage to the the cylinder and tooling, an air-over-oil tank is incorporated in the circuit to capture these potentially destructive forces.

HOW DOES THIS WORK?

The fluid in the air-over-oil tank is only used for the cylinder's return media. The fluid flow and cylinder speed are controlled by a flow control valve or needle. In Figure 1, we have chosen a flow control valve to control the speed of the "work" stroke while allowing a full speed retract stroke. The non-compressible fluid resists the rapid movement as the material shears and the cylinder tries to complete the stroke. This fluid "catches" the built-up forces and dissipates them before the cylinder can bottom out. As a result, the piston won't "pound" on the piston stop.

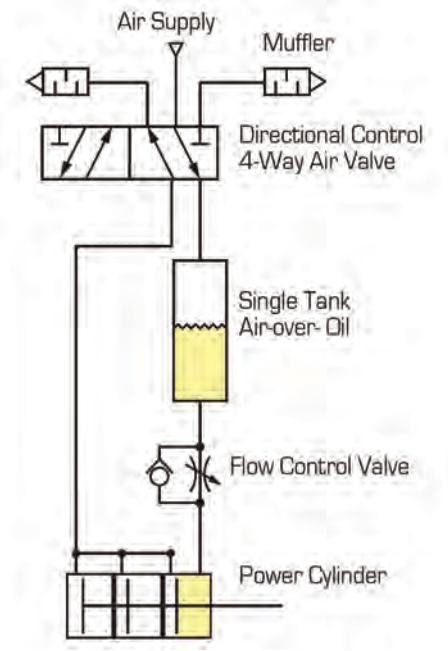


Figure 1. Air-over-oil shock control circuit.

THE HYDRAULIC SHOCK OPTION

Using the hydraulic shock option, the seals on the piston, piston rod and cylinder tube are increased in the single-stage retract section. This is shown in yellow in Figure 2. In this case, dynamic Poly-Pak® seals combine an O-spring energizer with an automatic lip-type seal that provides excellent sealing for up to 500 PSI. The piston thickness is increased.

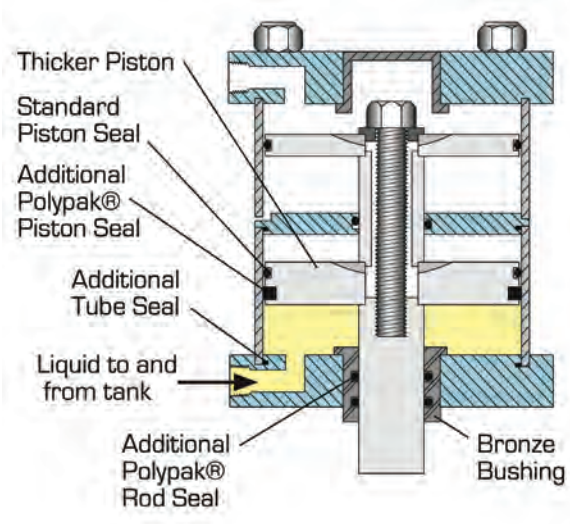


Figure 2. Beefed-up construction.

DETERMINING FORCE REQUIREMENTS

HOW MUCH FORCE DOES IT TAKE TO CRIMP A PIECE OF TUBING OR PRESS A BEARING INTO ITS HOUSING?

Here's a simple, economical circuit to use for the job:

1. Adjust regulator to zero pressure.
2. Situate work under the work stroke.
3. Shift valve to extend position.
4. Slowly adjust regulator to raise pressure.
5. Rod will move to the application.
6. Continue increasing pressure while watching the application.
7. At the moment application is completed, read pressure gauge.
8. Multiply gauge pressure by effective piston area of your cylinder (find piston areas in the *Cylinder Selection Guide*)
9. Result is the force (lb.) required by your application.

PRODUCING EXACT, REPEATABLE FORCES WITH A PRESSURE SENSING CONTROL

With its unique "poppet-type" seal, the Fabco-Air "RV" valve senses the pressure being applied in the application and opens at a pre-adjusted set point to provide a pilot signal for circuit control. Force is a direct function of pressure multiplied by area, and because of this the "RV" provides direct and precise adjustable force sensing.

If the system pressure drops below the "RV" valve's set point, it cannot open. As a result, the cycle will hold until the required amount of pressure to create a perfect crimp or rivet is achieved.

Once the correct pressure is restored, the cycle can continue and the part that had been under the unfinished work stroke will be completed properly. The sensed pressure is confirmed by the pressure gauge.

CYLINDER SELECTION GUIDE

Bore (Inches)	Stages (No. of Pistons)	Total Effective Piston Area (Square Inches)	Equivalent Bore of a Single Piston Cylinder	Force at 90 psi	Single Stage Retract Piston Area (Square inches)
1/2	2 3 4	.35 .50 .65	.6 .7 .9	30 45 52	.15
. .	. .	. .	. .	. .	. .
4	2 3 4	24.4 36.1 47.9	5.6 6.8 7.9	2,196 3,249 4,311	11.8
5	2 3 4	38.0 56.4 74.8	7.0 8.5 9.7	3,420 5,076 6,732	18.4
6	2 3 4	55.3 82.3 109.4	8.4 10.2 11.8	4,977 7,407 9,846	27.0
8	2 3 4	98.6 147.0 195.4	11.2 13.7 15.8	8,874 13,230 17,586	48.5
10	2 3 4	153.9 229.3 304.7	14.0 17.1 19.7	13,851 20,637 27,423	75.4
12	2 3 4	222.9 332.8 442.7	16.8 20.6 23.7	20,061 29,952 39,843	109.9

TWO-SPEED WORK STROKE WITH SHOCK CONTROL

A single air/oil tank with sequence, needle and shut-off valves, provides us with a two-speed work stroke operation. This is shown in Figure 3.

The sequence is as follows:

1. Rapid "extend" stroke to approach the work.
2. Automatic switch to controlled rate when resistance is met and pressure builds up to the point where a Fabco-Air RV "Sequence Valve" actuates the two-way shut-off valve, forcing fluid flow through the speed-controlling needle valve.
3. Fluid catches cylinder, again as described in our previous hole punching application, thus controlling the shock that could otherwise occur.
4. Automatic return to rapid rate on "Cylinder Retract" stroke.

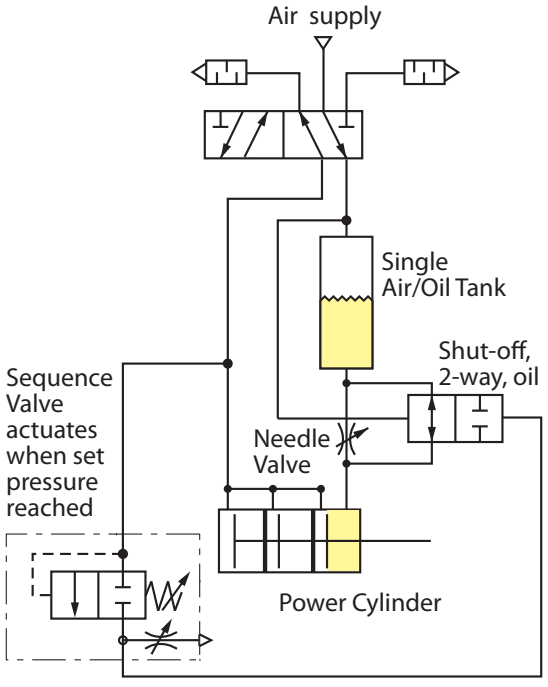


Figure 3. Two-speed work stroke circuit.

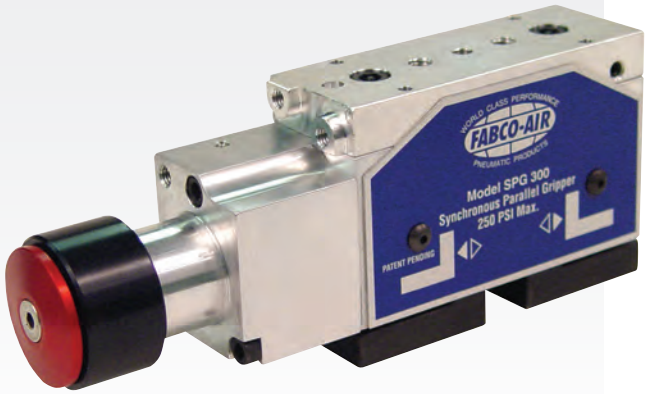
A USEFUL OPTION FOR MULTI-POWER® DEVICES — DIAL-A-STROKE®

ADJUSTABLE EXTEND STROKE

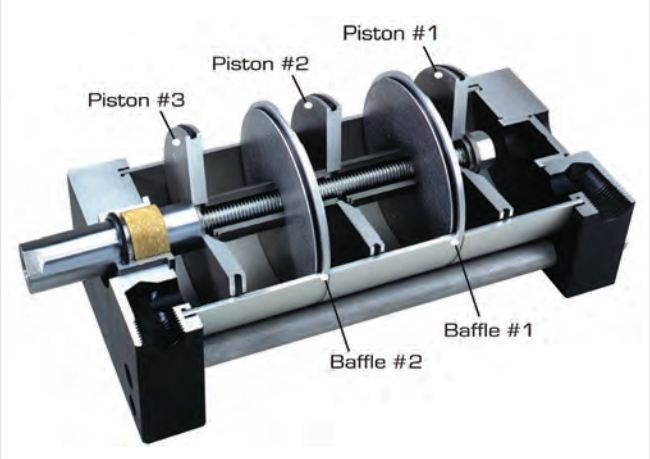
The Dial-A-Stroke® features a rugged precision adjustment of any Multi-Power® cylinder with strokes up to six inches. Depending on the size of the cylinder, one revolution of the adjustment nut adjusts the stroke by .050 to .071 inches. These settings are amplified by scale markings on the nut skirt and stop tube. Full enclosure to contact surfaces and minimum clearances can combine to eliminate pinch points.

As shown in the figures below, the Dial-A-Stroke® is not limited to Multi-Power® cylinders. This component can be added to a number of actuators including linear slides, air presses, pneumatic grippers and conventional piston grippers.

With the Multi-Power® principle and addition of the Dial-A-Stroke®, using pneumatics for broaching, hole punching and riveting can be far easier than using conventional methods to achieve the same results.



Dial-A-Stroke® unit on a pneumatic gripper facilitates quick change-overs on production line.



Cutaway view of 3-stage Multi-Power Cylinder.

Bench-mounted assembly tool.

MULTI-POWER® PRINCIPLE APPLIED TO OTHER DEVICES

MULTI-POWER® AIR PRESSES

There are many ways to use the Multi-Power® principle. Fabco-Air can apply this principle to a precision framework and base, providing the ultimate in a powerful, compact, air-powered bench press for production or laboratory use.

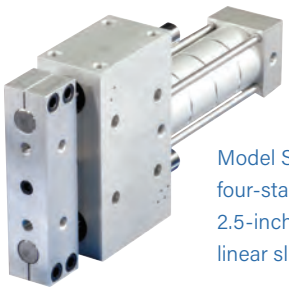
The resulting power cylinder has all of the features of a Multi-Power® Air Cylinder with the addition of beefed-up construction that can meet the rigors of press-type applications. Plated steel keys mate the cylinder head and a base plate to high-strength aluminum frame plates, providing you with the precision and long press life that can't be found in any other "C" frame or post-type construction.

MULTI-POWER® ASSEMBLY TOOLS

The manufacturing functions of handheld or bench-mounted assembly tools are numerous. These tools can be used to make plumbing assemblies; splice wire rope and cable; crimp electrical components; swage mechanical fasteners; stake, punch, pierce and flare; seal, emboss and notch; clamp and hold assemblies and more.

MULTI-POWER® LINEAR SLIDES

When you apply the Multi-Power® principle to linear slides, it increases slide thrust without increasing the bore or the mounting footprint. Shown below is a Fabco-Air slide model SE1000, utilizing a four-stage Multi-Power® cylinder capable of producing 1,830 pounds extend force at 100 PSI supply pressure. A conventional cylinder would yield only 491 pounds force at the same supply pressure.



Model SE1000 four-stage, 2.5-inch bore linear slide