FLUID POWER Design Data Sheet-

Womack

Revised Sheet 7 – Womack Design Data File

CUSHIONING AND DECELERATING METHODS FOR CYLINDERS

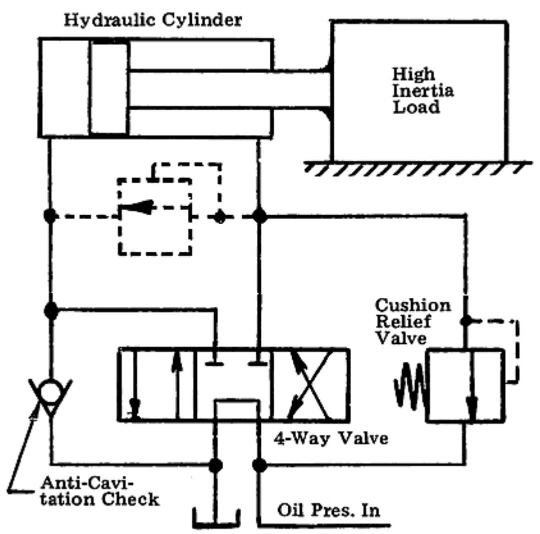

Figure 1. Preferred Method of Stopping a High Inertia Load in Mid Stroke of a Hydraulic Cylinder.

CUSHIONING AT MID STROKE

Figure 1. This circuit is designed to absorb high pressure surges caused when a hydraulic cylinder is stopped in mid stroke by centering the 4-way directional valve, especially where a very heavy (high inertia) load is being moved at high speed. On this type of application the momentum energy of the load may generate a high pressure surge which may damage circuit components. The load may also be damaged if stopped too abruptly.

A relief valve, shown in dotted lines, is sometimes used to dissipate the high pressure surge, and is connected to discharge to the opposite cylinder port. It should be adjusted to at least 500 PSI higher than maximum system pressure in order that it will not reduce cylinder tonnage on either the forward or return stroke. Thus, soft cushioning of the load is usually impractical.

A better way is to discharge the relief valve into the system pressure line, which during deceleration is connected to tank through the center of the 4-way valve. With the relief valve connected in this manner it may be adjusted either to a high pressure for abrupt cushioning, or to a low pressure for soft cushioning, and the cylinder tonnage will not be affected in either direction.

The relief is any adjustable hydraulic relief valve. The anti-cavitation check valve should have a low cracking pressure, 3 to 5 PSI. Its inlet port should be teed into the main tank return line near the 4-way valve. Normal back pressure in the tank return line will assist the flow of oil across the check valve at the time it is needed.

Cushioning is shown for the forward stroke only. If needed on the return stroke also, one more relief valve and check valve must be added.

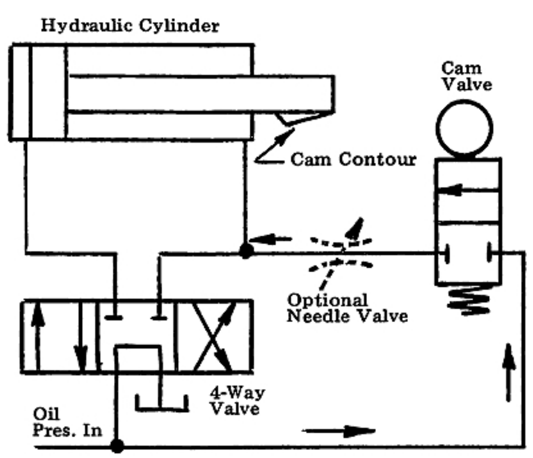

Figure 2. By-pass Method of Reducing Cylinder Speed Near the End of Its Forward Stroke.

DECELERATION AT THE END OF THE STROKE

Figure 2. This is a by-pass method of deceleration designed to reduce the forward speed of a cylinder piston when the cam valve position is reached. A part of the incoming oil supply is routed through an optional needle valve to the rod end port of the cylinder and to tank through the 4-way valve. The cam valve must be experimentally positioned to a suitable distance from the forward end of the stroke to produce the desired action.

This circuit works best on loads which have low inertia. It is a form of meter-in speed control, and like all meter-in speed control circuits is not very effective in holding back high inertia loads.

A more gradual reduction in speed will result if the moving cam is contoured to gradually close the cam valve.

The needle valve can be included for variable adjustment of the rate at which speed is reduced. If used, it must be a non-compensated type; a pressure compensated type will not give satisfactory performance.

The cam valve may be smaller in flow capacity than the 4-way valve, since it will not be required to pass all the flow to reduce cylinder speed. Its location in the circuit allows full system pressure to be applied to the rod end of the cylinder when the return stroke is started.

Figure 3. This circuit is designed for non-electrical applications to reduce piston speed of an air or hydraulic cylinder to reduce destructive impact as the piston rod reaches a positive stop.

Normal speed during the main part of the stroke before the cam valve position is reached, can be adjusted with Valve 4. As the cam valve is actuated, flow through Valve 4 is cut off. Exhaust flow from the cylinder is metered through Valve 3.

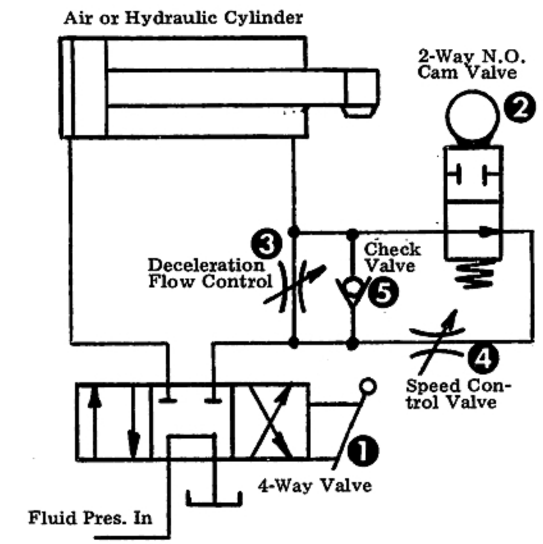

Figure 3. Series Method of Decelerating a Cylinder Using Non-Electrical Components.

Valve 4 can be a pressure compensated or non-compensated valve according to the application. Valve 3 should be a non-compensated type for best metering at low flows. Check Valve 5 is necessary for normal start-up and full speed in the return direction of cylinder piston travel.

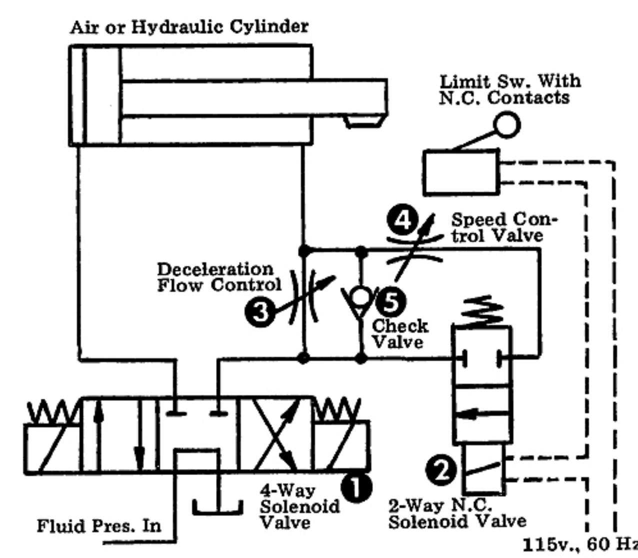

Figure 4. Series Method of Decelerating a Cylinder Using Electrical Components and Solenoid Valves.

Figure 4. This circuit is designed for solenoid valve operation, and uses the same flow control valve as in Figure 3.

This circuit is designed to be electrically fail-safe by using a normally closed (N.C.) Valve 2 for deceleration. If the coil on the valve should burn out, the cylinder would immediately be placed in the slow travel mode.

As in Figure 3, Valve 4 sets the maximum speed during the main part of the stroke. Solenoid Valve 2 is wired through the COM and N.C. contacts of the limit switch. When the switch is actuated, Valve 2 closes, and discharge oil from the cylinder is metered at a slower rate through flow control Valve 3.

In the electrical circuit for the machine, Valve 2 is tied in with the solenoids on the 4-way valve so if either solenoid on the 4-way valve is energized, Valve 2 also becomes energized, placing the cylinder in the fast-travel mode.

Figure 5. Internal Cushions. Cylinders can be ordered with cushions on one or both ends of the stroke. On cylinders larger than 2" these cushions are externally adjustable.

Cushions work well on hydraulic cylinders but are of limited effectiveness on air cylinders and are not generally recommended.

Cushions cannot be added in the field.

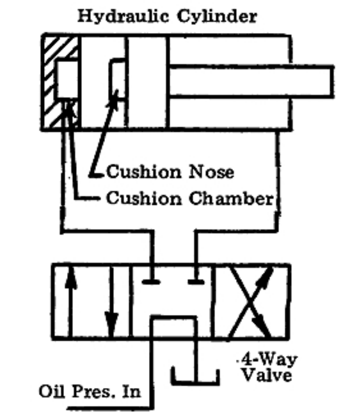

Figure 5. Cushioned Cylinder.

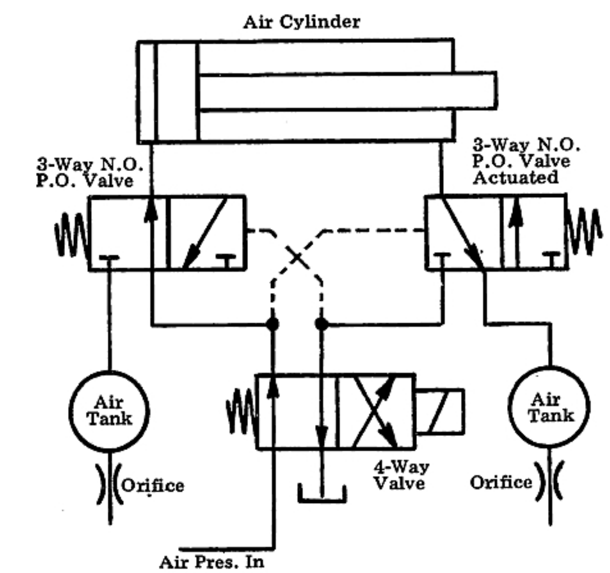

Figure 6. Novelty Circuit for Special Applications.

Figure 6. This is an experimental circuit suggested by Airmatic Valve Co. for air cylinders of large bore and long stroke which are moving loads having high inertia, where other methods of cushioning may have been ineffective.

As the cylinder moves in either direction, discharge air, instead of being vented to atmosphere, is discharged into pressure tanks. Thus, as the cylinder moves, back pressure builds up, preventing acceleration to unreasonable speeds. The orifice at the bottom of each tank bleeds off the back pressure, eliminating a tendency for the cylinder to creep.

The tanks are sized by starting with an oversize tank and partly filling it with oil or water. The cylinder is operated, and if it stops before making a full stroke, tank volume is increased by draining off some of the liquid. When operation is satisfactory, permanent tanks are built with this capacity.

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