د. نزار عبد الرحمن

## متابعة تمارين الهواء المضغوط التحكم بعدة مفعّلات :

عند التحكم بعدة مفعلات يجب الأخذ بعين الاعتبار الملاحظات التالية:

1- تعريف المسألة بشكل واضح

2- تمثيل العناصر وحركتها باستخدام مخطط الازاحة ،وكذلك تعريف الشروط الابتدائية

3- في حالة وجود شروط إضافية يجب تحديدها بدقة

4- يتم رسم الدارة وفق القواعد المذكورة سابقا لرسم مخطط الدارات

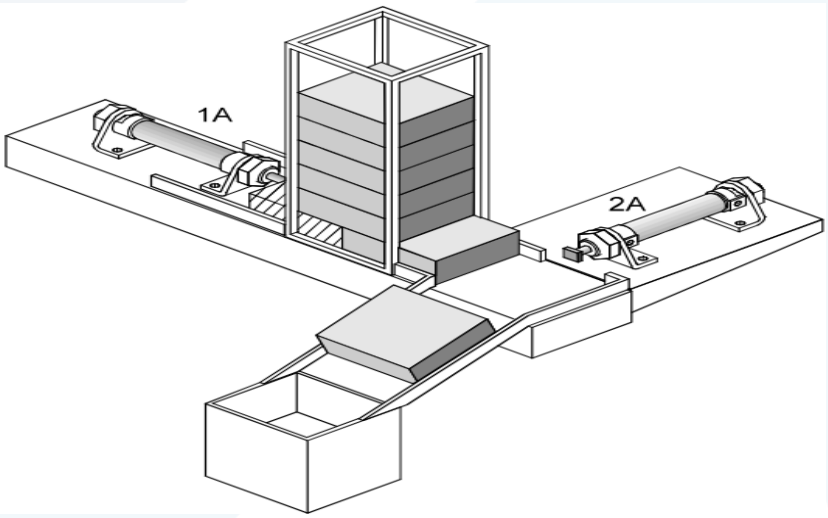
5- يجب تجنب الاشارات المزدوجة ،وهي الاشارات التي يتم تطبيقهما معا على بوابتي التحكم للصمام ثنائي القيادة.

## تمرين 7:الحركة المتناسقة -- التغذية بالثقل

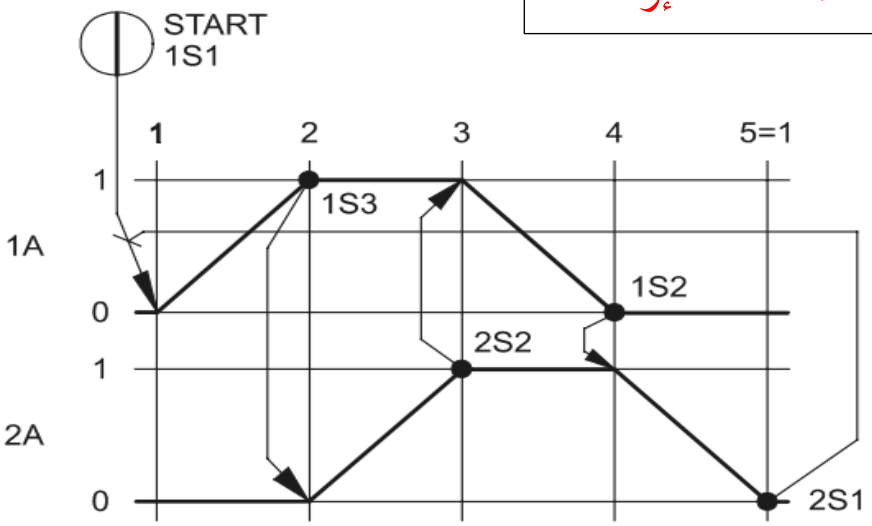
تستخدم اسطوانتين من أجل نقل قطع من مخزن إلى صندوق عن طريق مجرى ،عند الضغط على مفتاح التشغيل يتقدم مكبس الاسطوانة الأولى لتدفع القطعة من المخزن ،وتضعها أمام المكبس الثاني ،الذي بدوره يدفعها

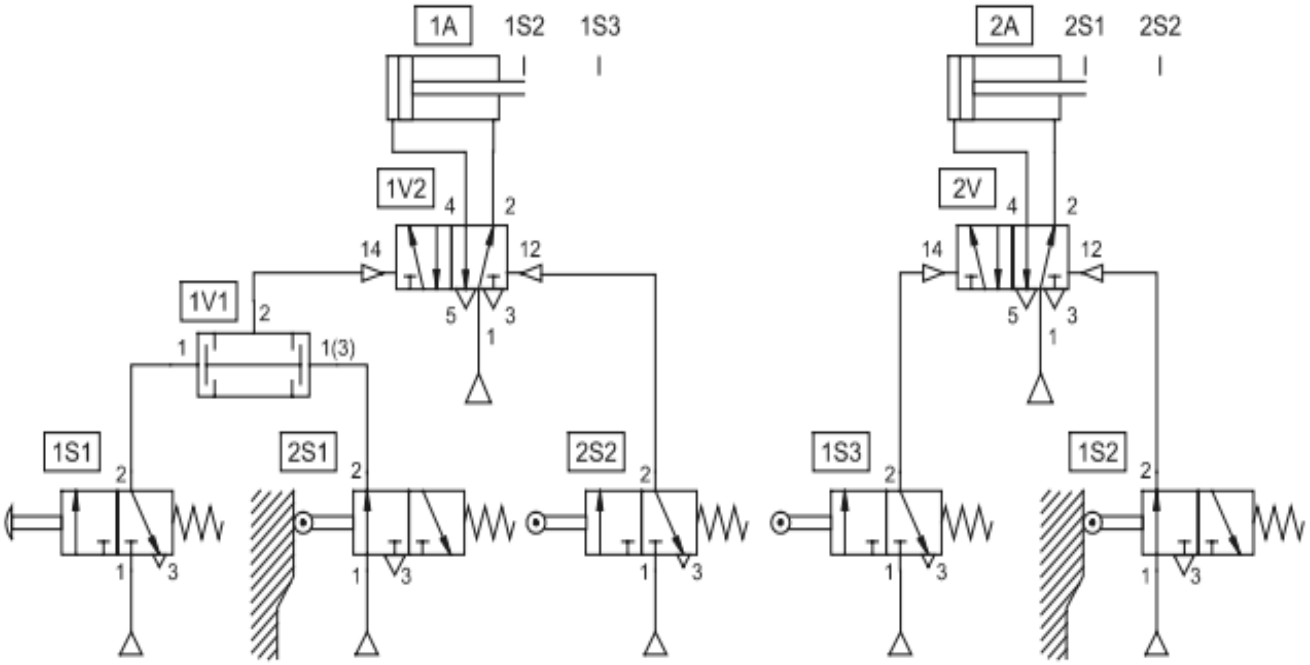
باتجاه المجرى. بعد نقل القطعة يعودمكبس الاسطوانة الأولى إلى الوضع الأولي ،ثم يتبعه مكبس الاسطوانة الثانية.

الهدف : التعرف على آلية عمل اسطوانتين معا ،باستخدام حساسات في بداية ونهاية الشوط ،مع توضيح آلية عمل الصمام بعجلة، مع صمام التحكم بإشارتين هوائيتين .




مخطط الإزاحة –






**الحل:**

في الوضع الابتدائي يكون كلا المكبسين في حالة التراجع ،,يكون كلا المفتاحين 2S1و1S2 مشغلين .

يمكن توضيح دورة العمل وفق الخطوات التالي :

- الخطوة الأولى :1S1 و2S1مفعّلين ⇐ تقدم الاسطوانة 1A

- الخطوة الثانية : 1S3 مفعّل ⇐ تقدم الاسطوانة 2A

-الخطوة الثالثة : 2S2 مفعّل ⇐ تراجع الاسطوانة 1A

- الخطوة الرابعة : 1S2 مفعّل ⇐ تراجع الاسطوانة 2A

- الخطوة الخامسة : 2S1 مفعّل ⇐ الوضع الابتدائي

الشرح :

1- إذا تم تفعيل المفتاح 1S1، عندها يتم التأثير على الصمام 2/5 ، 1V2 ويتقدم مكبس الاسطوانة 1Aوبداية اخراج القطع من المخزن .

2- عندما تصل الاسطوانة 1A إلى نهاية موقع التقدم، يتم تفعيل المفتاح 1S3 ، وتشغيل الصمام 2V وتقدم مكبس الاسطوانة 2A ،ودفع القطع باتجاه المجرى .

3- عندما يصل مكبس الاسطوانة 2Aإلى نهاية الموقع ،يتم تشغيل المفتاح 2S2 ،وتفعيل عنصر التحكم 1V2 ،وتراجع مكبس الاسطوانة 1A.

4 – عندما يتراجع مكبس الاسطوانة 1A إلى نهايته ، يتم تفعيل المفتاح 1S2 ،وتفعيل عنصر التحكم 2V . يتراجع مكبس الاسطوانة 2A ،ويفعّل المفتاح 2S1

5-الوضع الابتدائي للنظام محقّق مرة ثانية .

يمكن البدء بدورة عمل جديدة عن طريق تفعيل المفتاح 1S1 .

## Example 8 :Foil welding drum

### Training aims:

- Indirect actuation of a double-acting cylinder with a bi-stable valve

- Operating a pressure regulator to limit the piston force

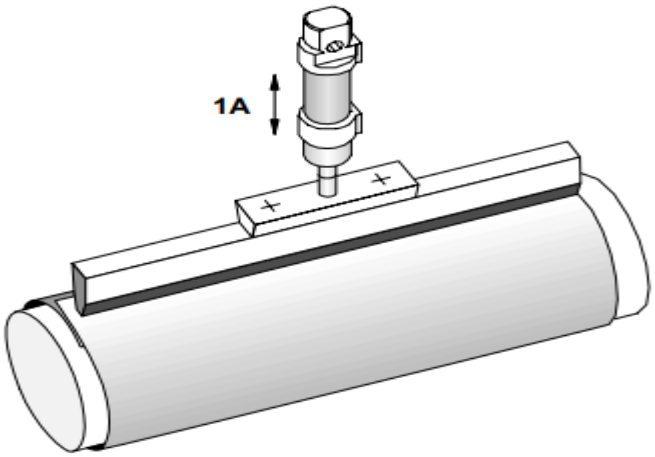
- Use of a pressure sequence valve

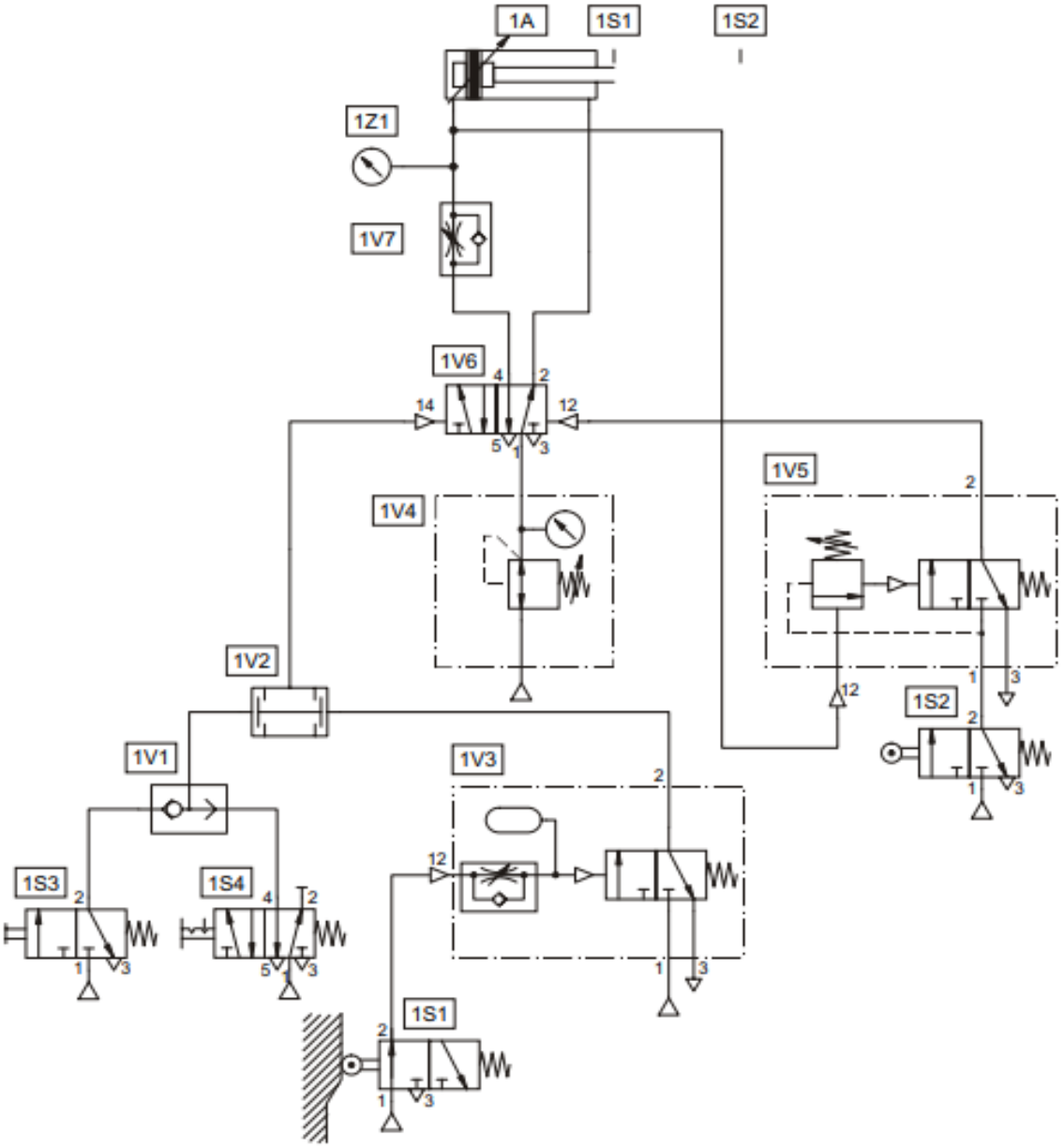
- Realization of a control system with single cycle and continuous cycle by means of a valve with selector switch

### Problem description

An electrically heated welding rail is pressed on to a rotatable cold drum by a double-acting cylinder (1A) and welds a continuous plastic sheet into pieces of tubing. The forward stroke is triggered by means of a push button. The maximum cylinder force is set at 4 bar (= 400 kPa) via a pressure regulator with pressure gauge. (This prevents the welding rail damaging the metal drum.) The return stroke is not initiated until the forward end position has been

acknowledged and the pressure in the piston area has reached 3bar (= 300 kPa). The supply air is restricted for the movement of the cylinder. The flow control should be adjusted so that the pressure increase to p = 3 bar (= 300 kPa) only takes place after t1 = 3 seconds, after the cylinder has reached the forward end position (the foil edges which are overlapped are welded by the heated welding rail as increased pressure is applied). Restarting is only possible when the retracted end position has been reached and a time of t2 = 2 seconds has elapsed. Reversing a 5/2-way valve with selector switch causes the control to be switched to continuous cycle.




1A
1S1
1S2
1Z1
1V7
1V6
1V4
1V5
1V2
1V1
1V3
1S3
1S4
1S1
1S2

## Solution description

Initial position In the initial position, the cylinder assumes the retracted end position. The final control valve (1V6) supplies pressure to the chamber on the piston rod side of the cylinder. The roller lever valve (1S1) is depressed and the time delay valve (1V3) is actuated. A one-signal is present at the right-hand input of the dual-pressure valve (1V2).

Step 1-2 If the push button (1S3) is actuated, the shuttle valve (1V1) passes on a signal to the dual-pressure valve (1V2). This causes the reversal of the final control element (1V6). The cylinder extends slowly with supply air throttled (1V7). The pressure regulator (1V4) limits the pressure to a maximum of p = 4 bar (= 400 kPa). (The drum cannot be damaged by the rail). In the forward end position, the trip cam of the cylinder actuates the roller lever valve (1S2). This causes pressure to be applied to the pressure sequence valve (1V5) at input 1. The pressure sequence valve is actuated when a pressure of p = 3 bar (= 300 kPa) has been reached in the piston chamber. Adjust the flow control (1V7) so

that the slow increase in pressure causes the cylinder to pause (t1 = 3 seconds) in the forward end position.

Step 2-3 Once the pressure sequence valve 1V5) has been switched, the final control element (1V6) is reversed. The cylinder travels to its initial start position. Re-actuation of the roller lever valve (1S1) causes power to be supplied to the pilot port of the time delay valve. Once the specified time of t2 = 2 seconds has elapsed, the dual-pressure valve (1V2) is supplied with air to the right of the time delay valve (1V3) so that a renewed start is possible.

Continuous cycle If the selector switch of the valve (1S4) is reversed, the control is switched to continuous cycle. Returning the detent to its initial position causes the control to stop at the end of the cycle.

# Example 9:Vibrator for paint buckets

**Training aims:**

- Indirect actuation of a double-acting cylinder

- Application of a roller lever valve in the central position of the piston rod

- Realisation of a fast to and fro movement in the partial stroke range

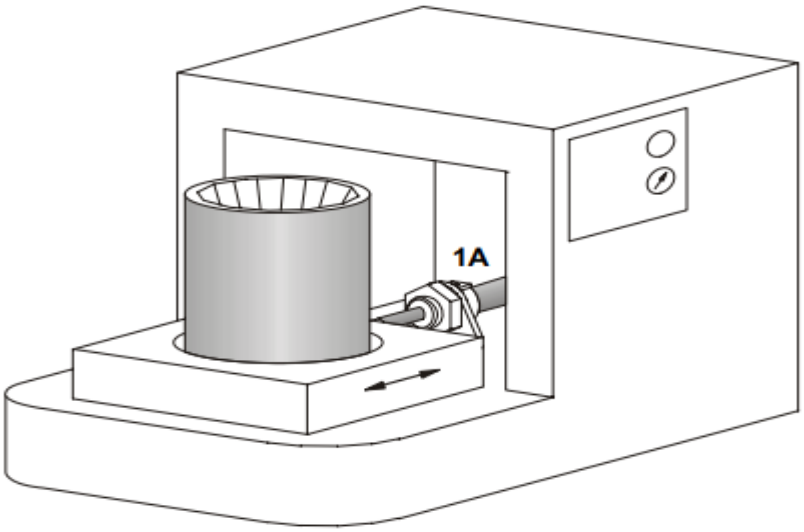
- Recognise that the oscillating frequency can be according to the flow rate

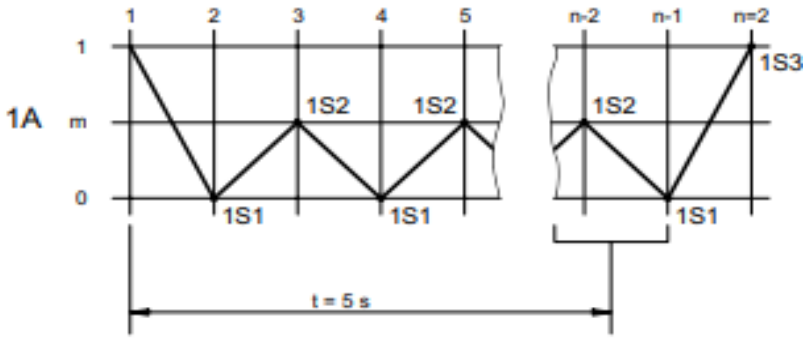
-Construction of a pulse actuated signal input with a pneumatic memory (5/2-way pneumatic bi-stable valve.

**Problem description:**

After the liquid paint colours have been poured together into a bucket, they are mixed in by the vibrating machine. When a push button has been pressed, the extended cylinder (1A) retracts completely and executes a to and fro movement in the rear stroke range. The oscillating is limited to the retracted end position by a

roller lever valve as well as a second roller lever valve in the central position. The frequency of oscillating is adjustable within limits by setting a pressure regulator controlling the amount of air supply. Set an operating pressure of p = 4 bar (= 400 kPa). After a specified interval, the oscillator is switched off. The double-acting cylinder extends completely and actuates the third roller lever valve. Set a vibration time of t = 5 seconds.




Displacement -step

## Solution description

Initial position In the initial position, the cylinder assumes the forward end position and actuates the roller lever valve (1S3). The final control element (1V5) assumes the right-hand switching status. The memory valve (1V2) is also in the right-hand switching position.

Step 1-2 Actuating the push button (1S4) reverses the memory valve (1V2). Air is present at the pilot port of the time delay valve (1V1). The final control element (1V5) is reversed via the actuated roller lever valve (1S3) and the shuttle valve (1V4); the cylinder retracts. Travelling over the roller lever valve (1S2) does not yet have any effect. The trip cam actuates the roller lever valve (1S1) in the retracted end position.

Step 2-3 With the roller lever valve (1S1) actuated, the final control element (1V5) reverses. The cylinder partially extends and actuates the central roller lever valve (1S2).

Step 3-4 The cylinder is reversed again by actuation of the central roller lever valve (1S2). The reversing procedure for the valves

(1S2), (1V4) and (1V5) lasts only a few milliseconds so that the trip cam does not travel over the roller lever valve (1S2).

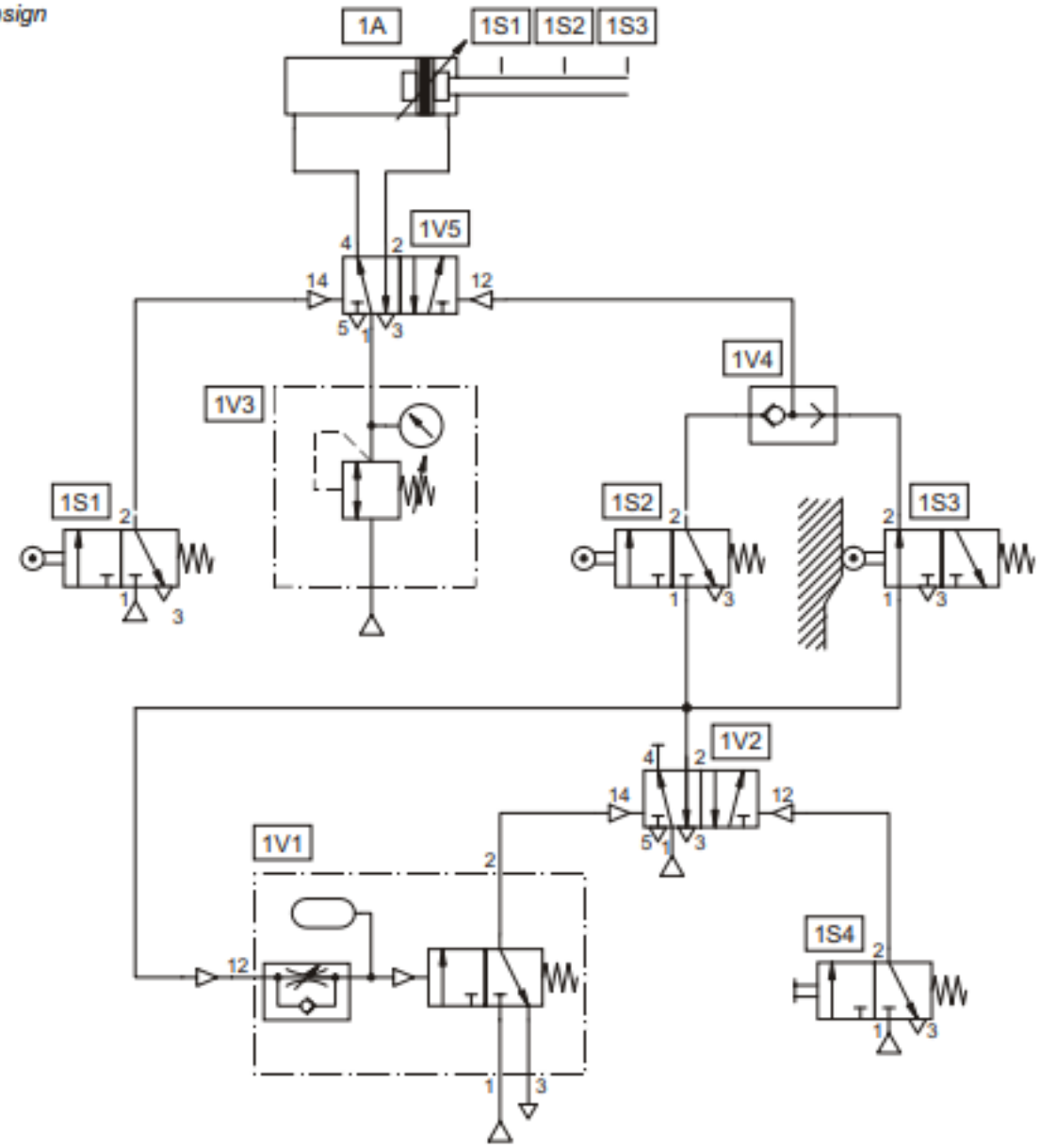
Step 4-5 See step 2-3.

Oscillating movement The cylinder oscillates backwards and forwards between the roller lever valves (1S1) and (1S2) until the specified time of t = 5 seconds has expired.

Steps n-2 to n After the time delay valve (1V1) has been switched, the memory valve (1V2) is reversed. Roller lever valves (1S2) and (1S3) are no longer supplied with compressed air. The cylinder travels to the initial position (forward end position).

| *Components list* | *Components* | *Description* |
|---|---|---|
| | 0Z1 | Service unit with on-off valve |
| | 0Z2 | Manifold |
| | 1A | Double-acting cylinder |
| | 1S1 | 3/2-way roller lever valve, normally closed |
| | 1S2 | 3/2-way roller lever valve, normally closed |
| | 1S3 | 3/2-way valve with push button, normally closed |
| | 1S4 | 5/2-way valve with selector switch |
| | 1V1 | Shuttle valve |
| | 1V2 | Dual-pressure valve |
| | 1V3 | Time delay valve, normally closed |
| | 1V4 | Pressure regulator with pressure gauge |
| | 1V5 | Pressure sequence valve |
| | 1V6 | 5/2-way double pilot valve |
| | 1V7 | One-way flow control valve |
| | 1Z1 | Pressure gauge |

*Circuit design*



# Example 10: Welding machine for thermoplastics

## Training aims

- Indirect actuation of two double-acting cylinders with two final control valves

- Use of a 5/2-way double pilot valve as control valve

- Parallel movement of two cylinders through adjustable exhaust air restriction

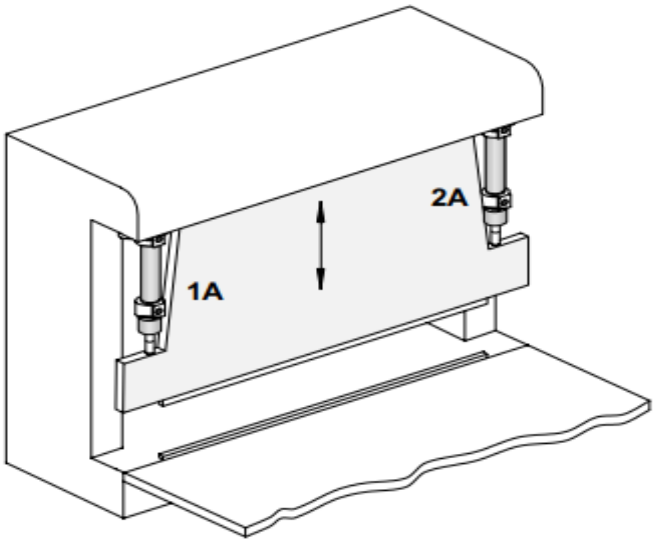
- Establishing an AND-function through a dual-pressure valve and through connecting roller lever valves in series.

## Problem description:

Two double-acting cylinders (1A) and (2A) press together two electrically heated bars and, in doing so, join two thermoplastic sheets by welding. The thickness of the sheets varies between 1.5 mm and 4 mm. The seams may be of any length. The piston force of both cylinders is limited via a pressure regulator. Value set p = 4 bar (=400 kPa). By actuating a push button, two double-acting cylinders are made to advance in parallel with their exhaust air restricted. To assist regulation, pressure gauges have been fitted

between the cylinders and the oneway flow control valves. The end positions of the cylinders are interrogated. After a time of

t = 1.5 seconds, the bar moves back to the initial position. The return stroke may be instantly initiated by means of a second push button




## Solution description

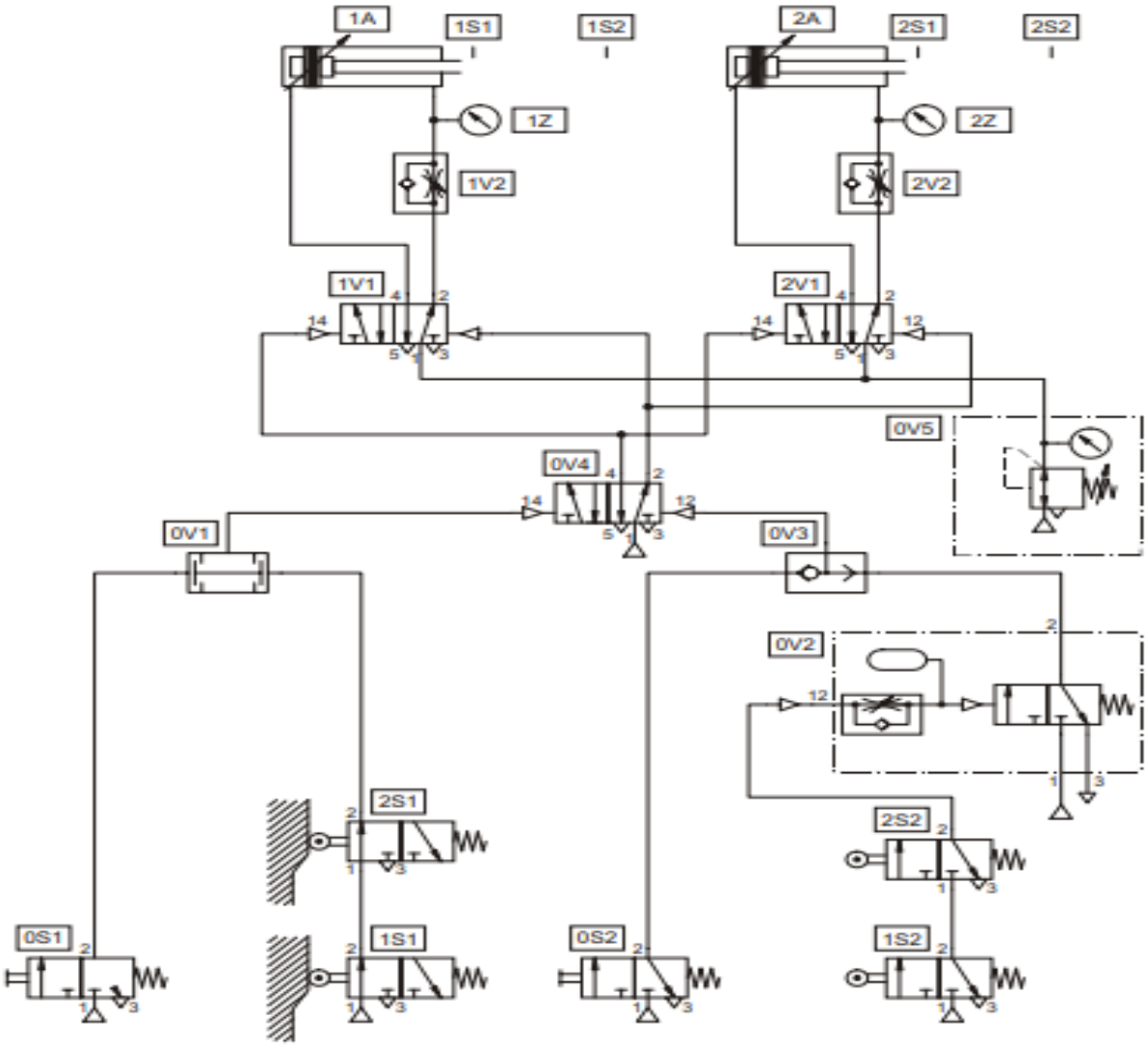
Initial position In the initial position, both cylinders (1A) and (2A) assume the retracted end position. The roller lever valves (1S1) and (2S1) are actuated. Final control elements (1V1) and (2V1) and

directional control valve (0V4) are in the left-hand switching position.

Step 1-2 When push button (0S1) is operated, first directional control valve (0V4) and then final control elements (1V1) and (2V1) are reversed. Both cylinders advance with their exhaust air restricted. In the forward end position, roller lever valves (1S2) and (2S2) are actuated. The cylinders remain in the forward end position. The pilot port of time delay valve (0V2) is pressurised via the two roller lever valves (1S2) and (2S2). The valve is required to switch when a time lag of t =1.5 seconds has elapsed.

Step 2-3 After the time delay valve (0V2) has switched through, the three identical 5/2-way double pilot (bi-stable) valves reverse. The cylinders move into the retracted position and there again actuate the roller lever valves (1S1) and (2S1).

Push button (0S2) If 3/2-way valve (0S2) is operated, the three identical 5/2-way double pilot (bi-stable) valves(1V1), (2V1) and (0V4) are reversed; the cylinders return to the retracted end position.


1A
1S1
1S2
2A
2S1
2S2
1Z
2Z
1V2
2V2
1V1
2V1
0V5
0V4
0V1
0V3
0V2
2S1
2S2
0S1
1S1
0S2
1S2

| Components list | Components | Description |
|---|---|---|
| | 0Z1 | Service unit with on-off valve |
| | 0Z2 | Manifold |
| | 1A | Double-acting cylinder |
| | 1S1 | 3/2-way roller lever valve, normally closed |
| | 1S2 | 3/2-way roller lever valve, normally closed |
| | 1S3 | 3/2-way valve with push button, normally closed |
| | 1S4 | 5/2-way valve with selector switch |
| | 1V1 | Shuttle valve |
| | 1V2 | Dual-pressure valve |
| | 1V3 | Time delay valve, normally closed |
| | 1V4 | Pressure regulator with pressure gauge |
| | 1V5 | Pressure sequence valve |
| | 1V6 | 5/2-way double pilot valve |
| | 1V7 | One-way flow control valve |
| | 1Z1 | Pressure gauge |

# Example 11:Compactor for domestic rubbish

## Training aims

- Learning how to interpret a displacement-step diagram with signal lines

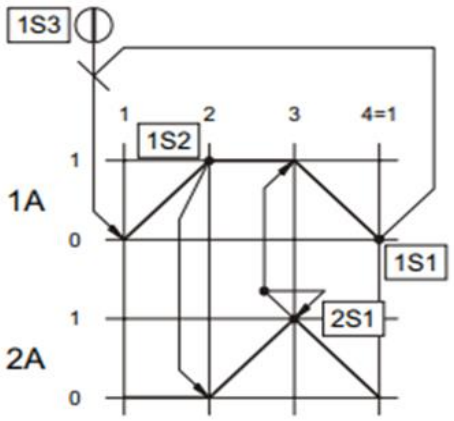
- Indirect activation of two cylinders with two final control valves

- Controlling the motion sequence with three roller lever valves

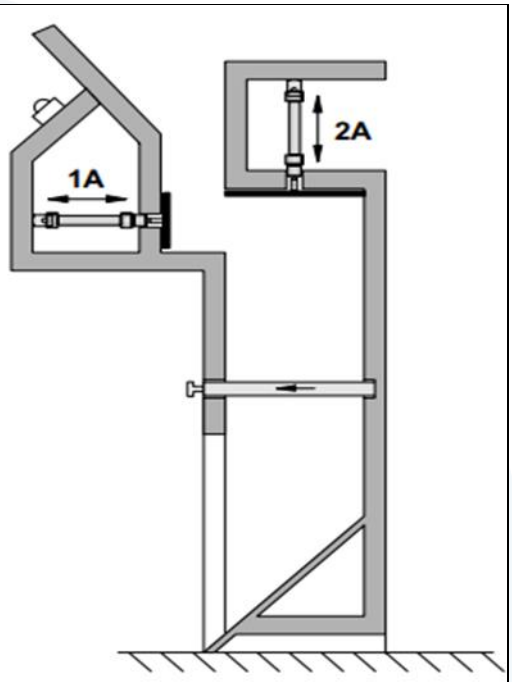
- Operating a pressure sequence valve.

## Problem description

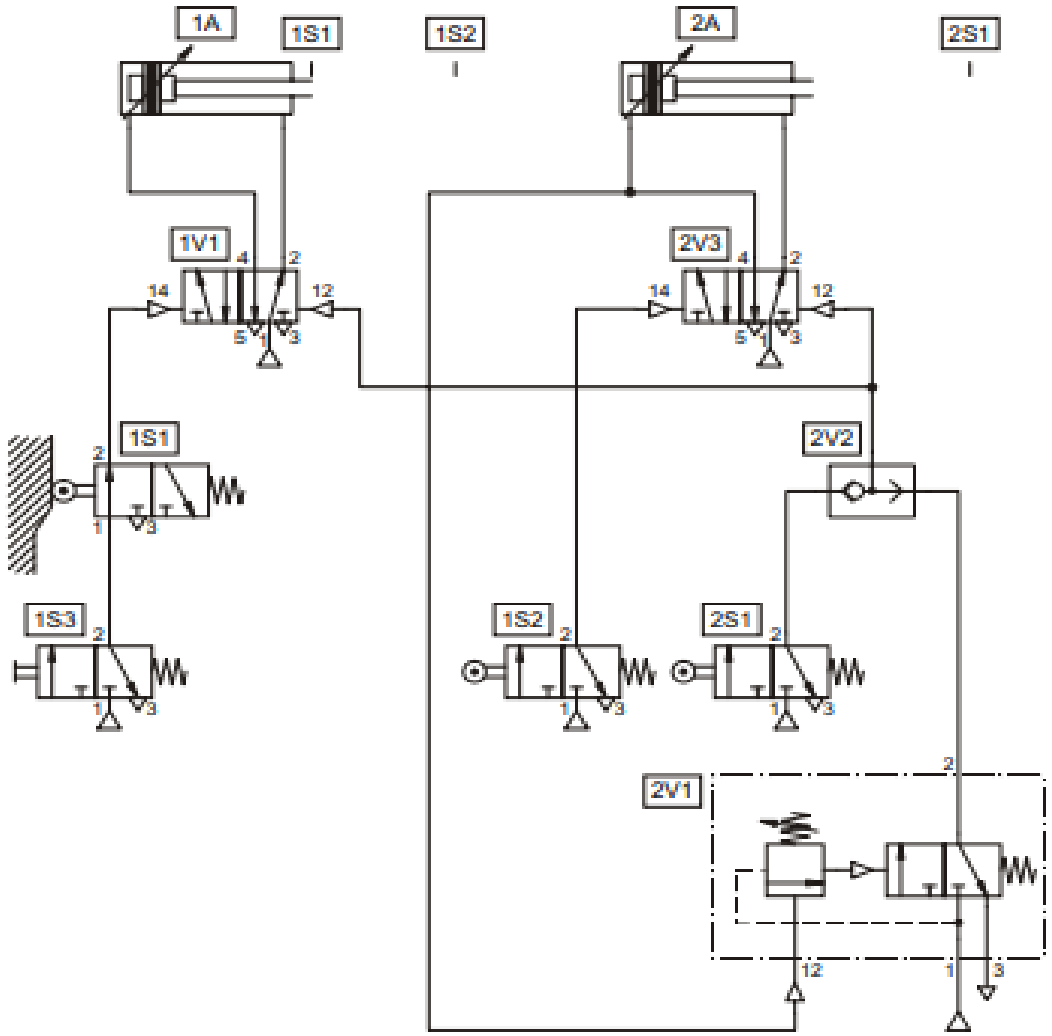
The prototype of a pneumatic domestic rubbish compactor (under table model) is operated with a maximum working pressure of p = 3bar = 300 kPa. It is equipped with a pre-compactor (1A) including glass crusher as well as a main compactor (2A), which exerts a maximum force of F = 2200 N. When a start button is pressed, first the precompactor advances, then the main compactor. The subsequent return stroke of both double-acting cylinders takes place simultaneously. In the event that the main compactor does not reach the forward end position – rubbish bins full –, the return stroke of both cylinders is initiated by a pressure sequence valve. It is set to switch at p = 2.8 bar = 280 kPa.




Displacement -step




| *Components* | *Description* |
|---|---|
| 0Z1 | Service unit with on-off valve |
| 0Z2 | Manifold |
| 1A | Double-acting cylinder |
| 1S1 | 3/2-way valve with push button, normally closed |
| 1S2 | 3/2-way roller lever valve, normally closed |
| 1S3 | 3/2-way roller lever valve with idle return, normally closed |
| 1V1 | 5/2-way double pilot valve |
| 1V2 | One-way flow control valve |
| 2A | Double-acting cylinder |
| 2S1 | 3/2-way roller lever valve with idle return, normally closed |
| 2S2 | 3/2-way roller lever valve, normally closed |
| 2S3 | 3/2-way valve with push button, normally closed |
| 2V1 | Dual-pressure valve |
| 2V2 | Pressure regulator with pressure gauge |
| 2V3 | 5/2-way double pilot valve |
| 2V4 | One-way flow control valve |
| 2Z1 | Optical display |




## Solution description

Initial position In the initial position, both cylinders are in the retracted end position. Roller lever valve (1S2) is actuated.

Step 1-2 After operation of push button (1S3), final control valve (1V1) – also referred to as power valve – is reversed. Cylinder (1A)

advances. In the forward end position, the trip cam activates roller lever valve (1S2).

Step 2-3 Through the actuation of roller lever valve (1S2), final control valve (2V3) is reversed. Cylinder (2A) advances. In the forward end position, the cylinder actuates roller lever valve (2S1).

Step 3-4 The actuation of roller lever valve (2S1) causes both final control valves (1V1) and (2V3) to be pressurised from the right; both cylinders are reversed. In the retracted end position, cylinder (1A) again actuates the roller lever valve (1S1).

Pressure sequence valve (2V1) If cylinder (2A) fails to reach the forward end position because the rubbish bin is full, the pressure sequence valve reverses both power valves via the shuttle valve (2V2). Both cylinders return.

# Example 12: Clamping camera housings

## Training aims

-Indirect activation of two cylinders with two final control valves

- Limitation of the maximum piston thrust through adjustment of working pressure

- Use of 3/2-way roller lever valve with idle return for signal cut-out

- Utilization of a pneumatically actuated optical indicator

- (Recognizing the problems arising from locked-on pilot signals – (signal cut-out)

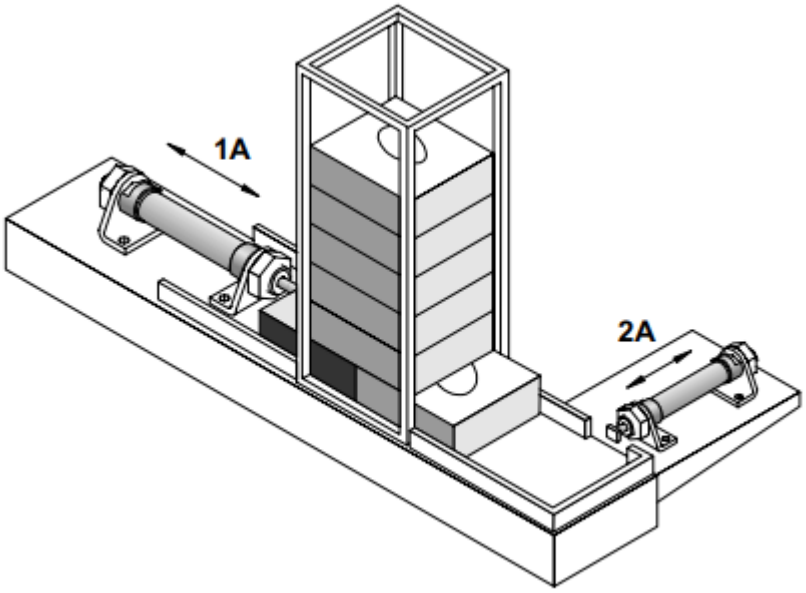
- (Unassisted recording of the displacement-time diagram)

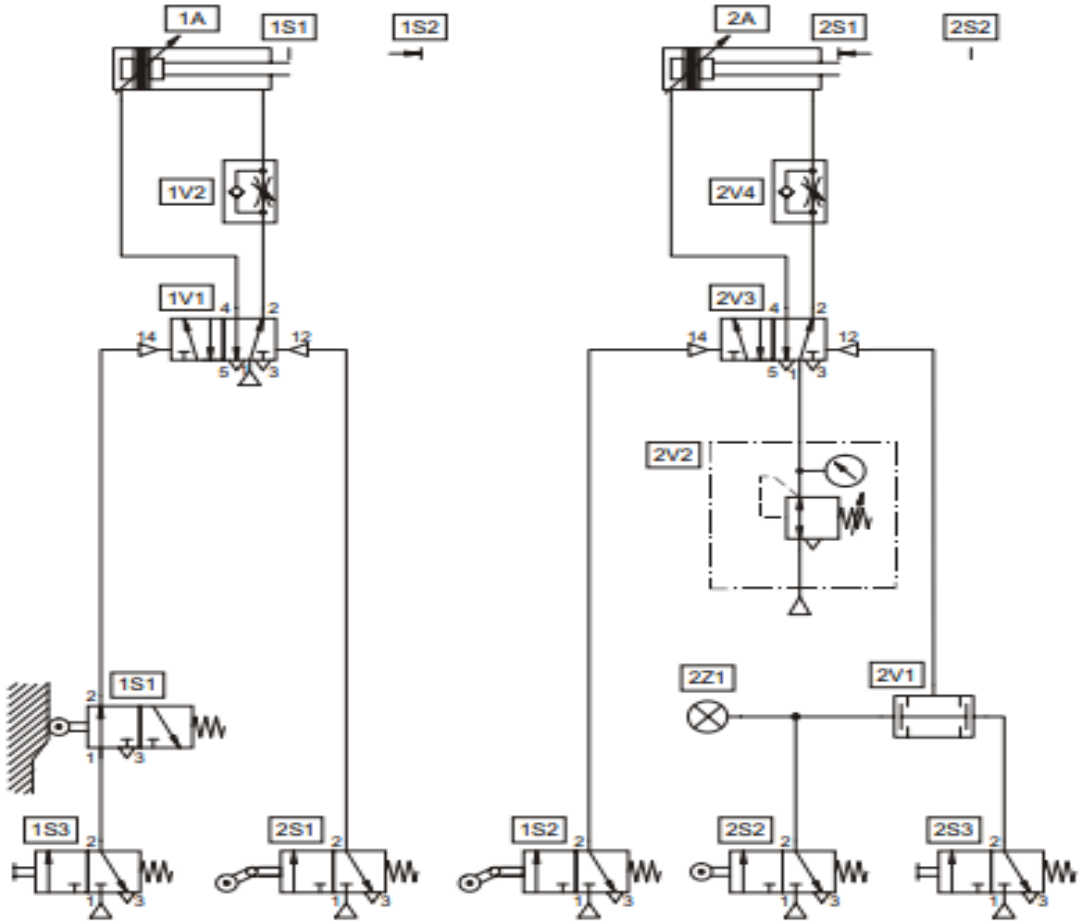
- (Recognizing the functioning of a reversing valve).

## Problem description

When a push-button is operated, a pressure die-cast housing for a surveillance camera is fed from a magazine to a machining station by a double-acting cylinder (1A) and clamped. A second, pressure restricted, double-acting cylinder (2A) then clamps the thin-walled

housing from a direction of 90° to the first cylinder. The pressure regulator is set to p = 4 bar = 400 kPa. The cylinders move forward in t1 = t2 = 1. The completed clamping action is signalled by a pneumatically actuated optical indicator. When the machining of the housing is finished, a second push button is operated. This causes an un throttled return stroke of both cylinders in the reverse sequence.






## Solution description

Initial position In the initial position, the two cylinders (1A) and (2A) assume the retracted end position. The roller lever valve (1S1) is activated. The roller lever valve with idle return (2S1) is not activated.

Step 1-2 When push button (1S3) is operated, a one-signal goes out to directional control valve (1V1) via the depressed roller lever

valve (1S1). After the reversal of the 5/2-way double pilot valve (1V1), the cylinder (1A) advances with exhaust air restricted (1V2). Shortly before reaching the forward end position, the 3/2-way idle return roller lever valve (1S2) becomes actuated.

Step 2-3 The actuation of the idle return roller lever valve (1S2) reverses power valve (2V3); cylinder (2A) advances with its exhaust air restricted (2V4). With the actuation of roller lever valve (2S2) in the forward end position, the pneumatically activated optical indicator (2Z1) displays the onesignal. The control system remains in this position. The pressure regulator (2V2) limits the piston thrust (pressure limitation p = 4 bar = 400 kPa).

Step 3-4 With the operation of push button (2S3), power valve (2V3) is reversed through dual-pressure valve (2V1). The cylinder (2A) returns. Just before the retracted end position is reached, the trip cam triggers the roller lever (2S1).

Step 4-5 Power valve (1V1) is reversed through the actuation of idle return roller lever valve (2S1). Cylinder (1A) returns. In the returned end position, the trip cam switches the start interlock (1S1).

| *Components* | *Description* |
|---|---|
| 0Z1 | Service unit with on-off valve |
| 0Z2 | Manifold |
| 1A | Double-acting cylinder |
| 1S1 | 3/2-way valve with push button, normally closed |
| 1S2 | 3/2-way roller lever valve, normally closed |
| 1S3 | 3/2-way roller lever valve with idle return, normally closed |
| 1V1 | 5/2-way double pilot valve |
| 1V2 | One-way flow control valve |
| 2A | Double-acting cylinder |
| 2S1 | 3/2-way roller lever valve with idle return, normally closed |
| 2S2 | 3/2-way roller lever valve, normally closed |
| 2S3 | 3/2-way valve with push button, normally closed |
| 2V1 | Dual-pressure valve |
| 2V2 | Pressure regulator with pressure gauge |
| 2V3 | 5/2-way double pilot valve |
| 2V4 | One-way flow control valve |
| 2Z1 | Optical display |