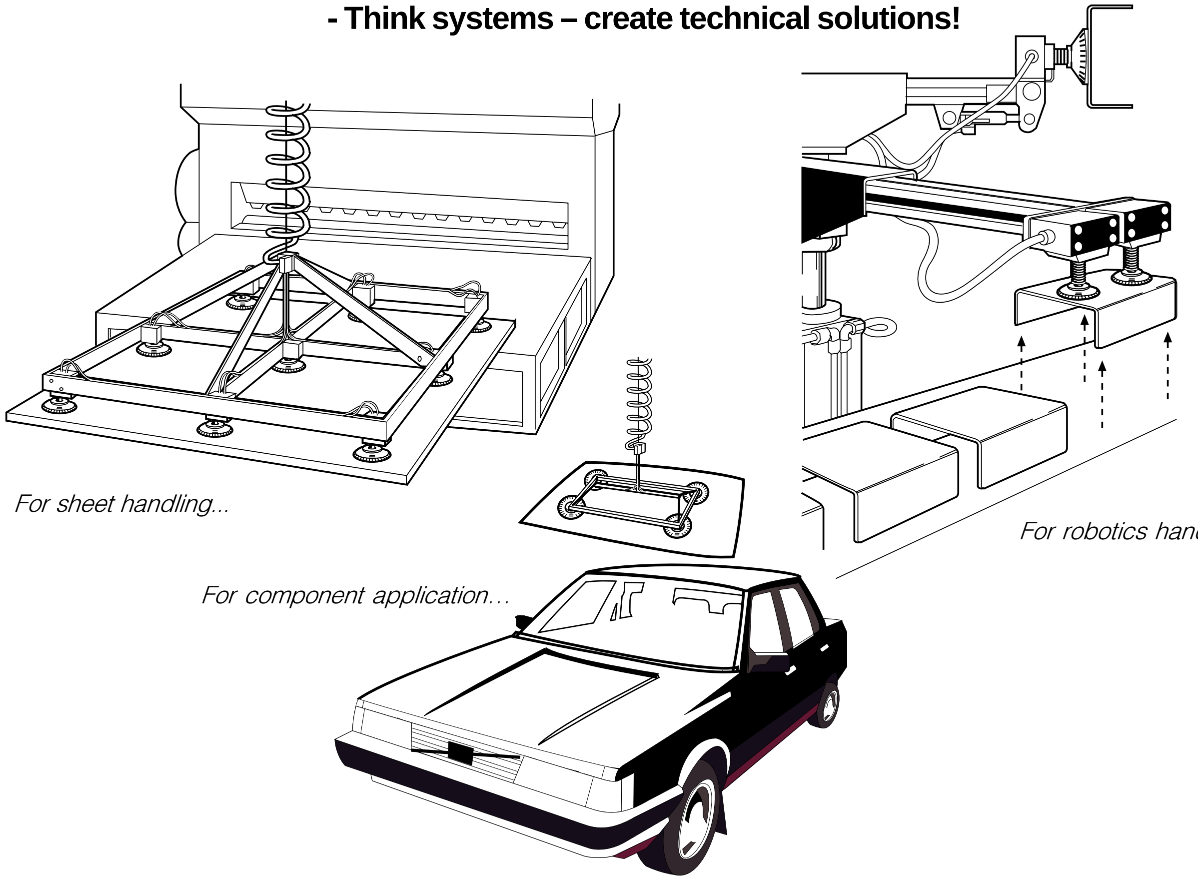
Vacuum components

- Think systems – create technical solutions!



A complete range of vacuum components

Suction cups

About 100 suction cups of varying material and shapes, with attachments for handling in varying environments – with lifting forces varying from 0.1 to 2800N – are always in stock.
For example, bellows cups for level adjustment on components of varying shape and for separating thin elements, oval suction cups for lifting rough and narrow components and flat suction cups for horizontal/vertical lifting of flat or gently curved surfaces.

Accessories connections and attachments

Our wide range of connections and accessories gives the greatest possible flexibility and simplifies attachment of suction cups.
The range includes anchorages with integrated springs, which damp and compensate for level differences, jointed attachments which counteract problems during acceleration and deceleration.
Flow valves, quick release couplings, vacuum switches, union nipples and filters are other accessories completing this offer for increased efficiency.

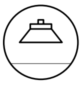
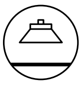
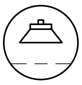
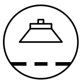
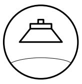
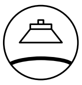
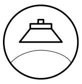
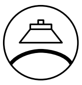
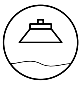
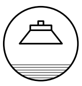
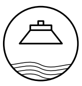
Vacuum generators

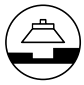
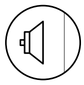
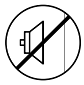
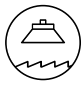
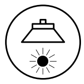
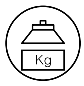
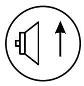
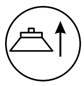
Our generators are designed to reach a high vacuum level quickly and thus reduce machine cycle times.
The range includes everything from small generators for direct connection to suction cups, to generators with built-in latching and blow-off functions and Multi-Function units with built-in automatic air economizers, which save up to 98% of air consumption.
The range offers evacuation times for 1 litre volume at 75% vacuum from 0.25 s to 15s and air consumption at 4 bar varies between 12 – 720 l/min, depending on the generator chosen.

Working units

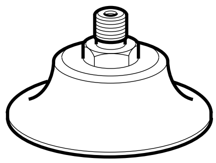
You can easily build up specific working units to suit your own specific requirements, using the various basic units. A simple working unit for example could consist of just the small, easily installed Mini Single and Mini Compact mini-generators and a suction cup or spring attachment which functions together with a suction cup.
In other installations, where the degree of mechanisation is higher and where more advanced solutions are required, a Multi-Function generator could be selected. The built-in solenoids are responsible for both the air supply to the generator and for the blow-off function. Everything to give the quickest precise lifting and disconnection possible.
The Multi-Function generator also has a holding function, which gives very high safety and offers considerable savings in compressed air. An external vacuum switch keeps track of the vacuum level and sends signals to the compressed air supply.
A high technology version of the Multi-Function generator is also available which incorporates a precision vacuum switch for controlling independent adjustable connection and disconnection levels and an alarm signal for the lowest vacuum level for holding objects. This is essential when safety requirements are high, such as press lines in the motor industry.

Index of Vacuum Component Symbols

Symbol	Description
Suction cup icons	
	**Flat surface thin section**
	**Flat surface any section**
	**Soft porous material thin section**
	**Soft porous material any section**
	**Slightly bowed surface thin section**
	**Slightly bowed surface any section**
	**Bowed surface thin section**
	**Bowed surface any section**
	**Soft material**
	**Metal sheet handling**
	**Corrugated sheet handling**

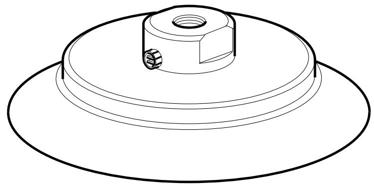
Symbol	Description
Suction cup icons	
	**Differences in heights and levels**
	**Vertical lift**
	**Not for vertical lift**
	**Rough and/or abrasive surfaces**
	**Thin or narrow item handling**
	**Oil resistant**
	**Weather resistant i.e. uv, ozone ...**
	**High lifting force**
	**Vertical lifting force**
	**Horizontal lifting force**

Flat - Simple



P5V-CFF

Flat - Ribbed

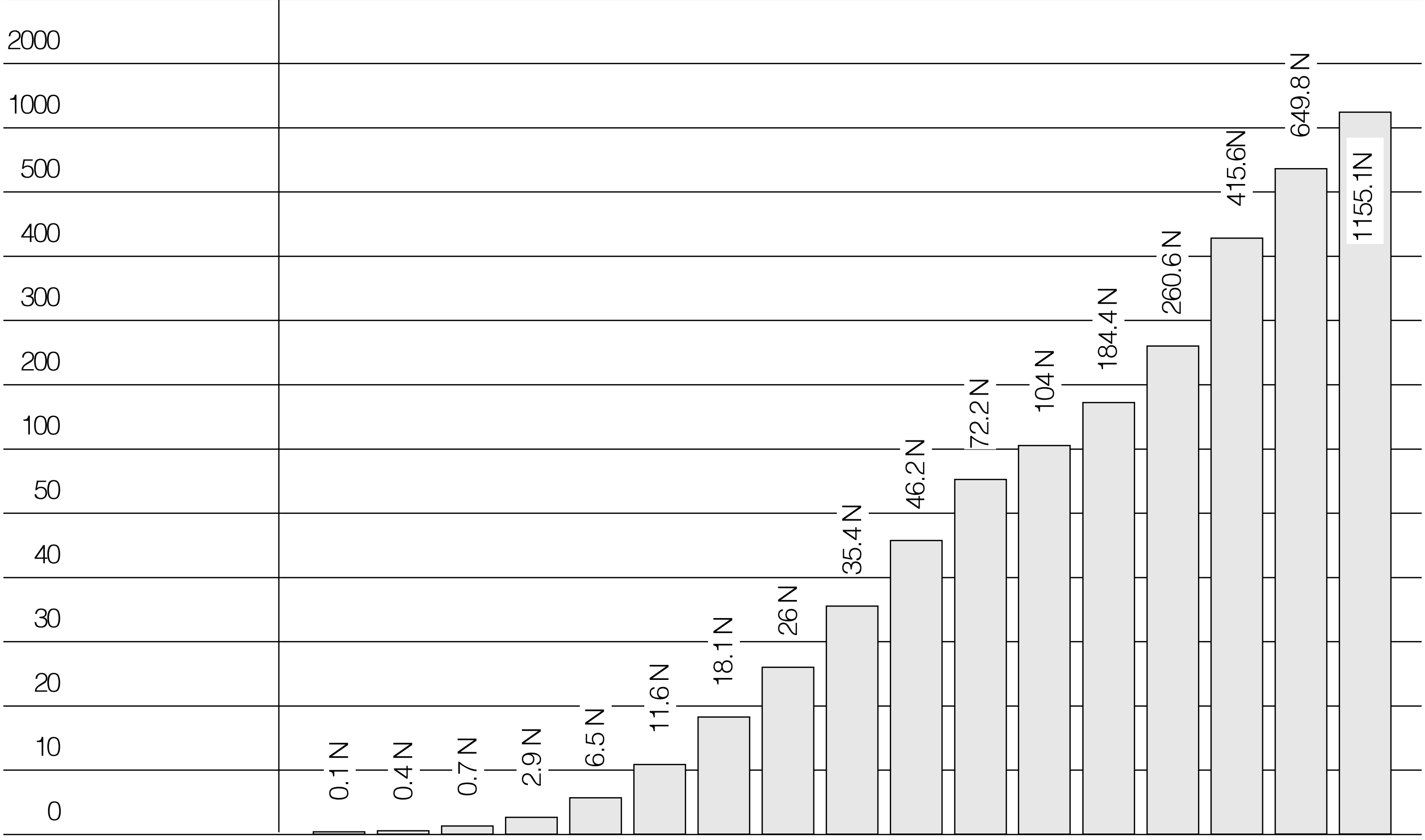


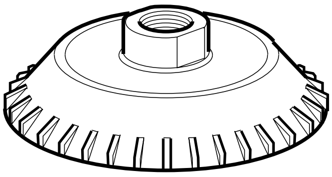
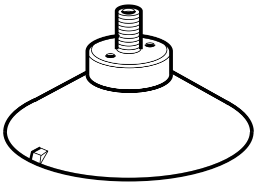
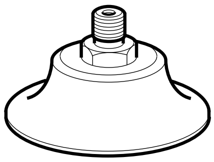
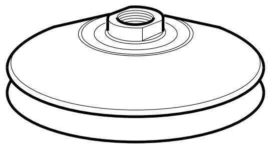
P5V-CFR

Diameter Ø mm		2	3.5	5	10	15	20	25	30	35	40	50	60	80	95	120	150	200
Port size,	Male	M5	M5	M5	M5	G1/8	G1/8	G1/8	G1/8	G1/8	G1/8	G1/8	G1/4	G1/4	G1/4	-	-	-
(Fitting)	Female	-	-	-	-	G1/8	G1/8	G1/8	G1/8	G1/8	G1/8	G1/8	G1/4	G1/4	G1/4	G1/2	G1/2	G1/2
	Male	-	-	-	-	-	-	G1/4	G1/4	G1/4	G1/4	G1/4	-	-	-	-	-	-
	Female	-	-	-	-	-	-	G1/4	G1/4	G1/4	G1/4	G1/4	-	-	-	-	-	-
Standard material:																		
Nitrile, NBR		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Silicone, Si		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Urethane, U																		
Special material:		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

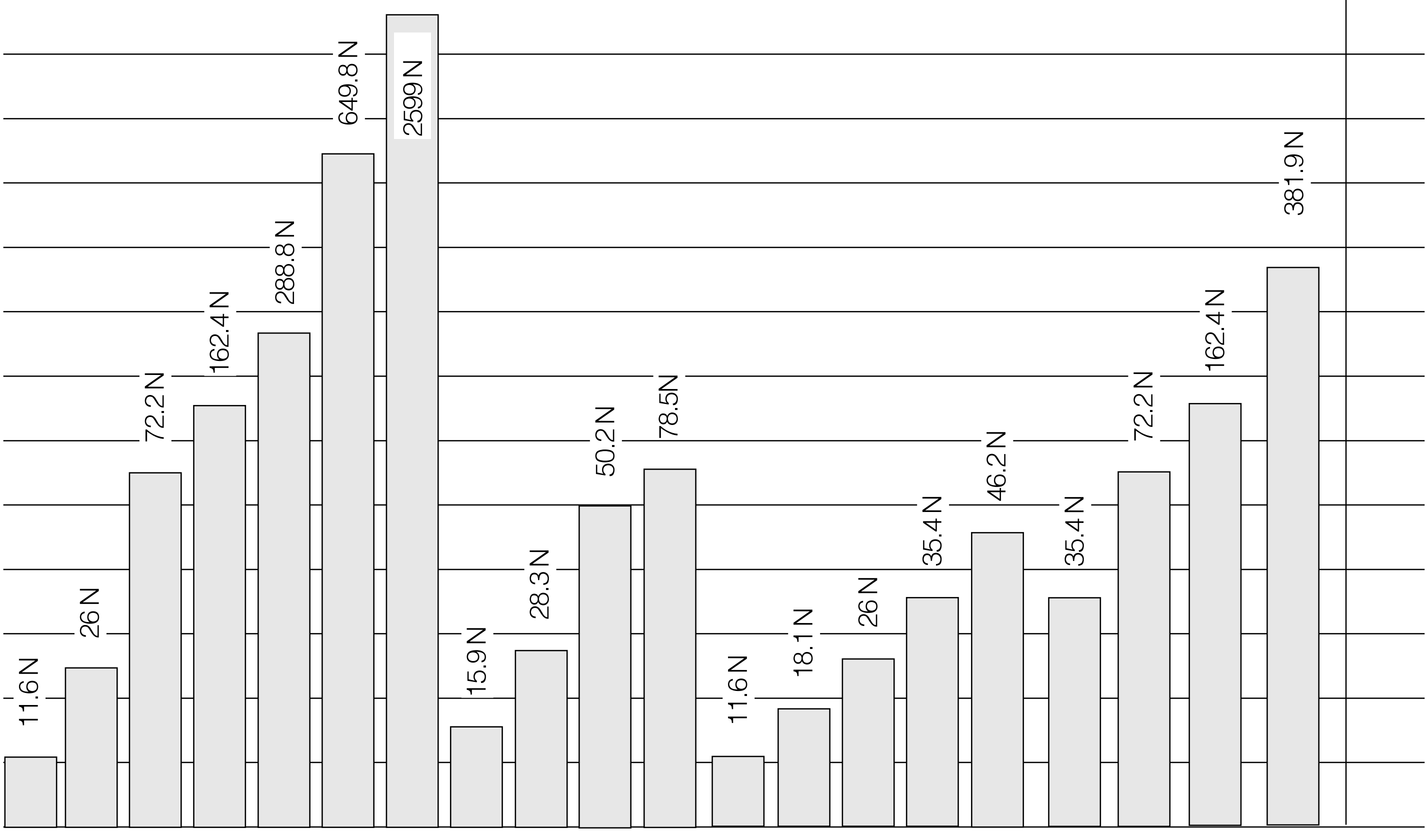
Lifting force in N

Lifting force = Pressure x Area / Safety factor
75% vacuum on a dry surface, safety factor = 2

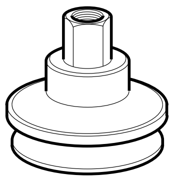


Flat - Strong	Flat - Profiled	Flat - Anti-slip	Bellows- Anti-slip
			
P5V-CFS	**P5V-CFA**	**P5V-CFC**	**P5V-CBC**

20	30	50	75	100	150	300	45	60	80	100	20	25	30	35	40	35	50	75	110
-	-	-	-	-	-	-	M10	M10	M10	M10	G1/8	G1/8	G1/8	G1/8	G1/8	-	-	-	-
M5	M5	G1/8	G1/4	G3/8	G1/2	G1/2	-	-	-	-	G1/8	G1/8	G1/8	G1/8	G1/8	G1/8	G1/8	G1/4	G3/8
-	-	-	-	-	-	-	G1/4	G1/4	G1/4	G1/4	-	G1/4	G1/4	G1/4	G1/4	-	-	-	-
-	-	-	-	-	-	G1	-	-	-	-	-	G1/4	G1/4	G1/4	G1/4	-	-	-	-
●	●	●	●	●	●	●					●	●	●	●	●	●	●	●	●
											●	●	●	●	●	●	●	●	●
							●	●	●	●									



Bellows - short

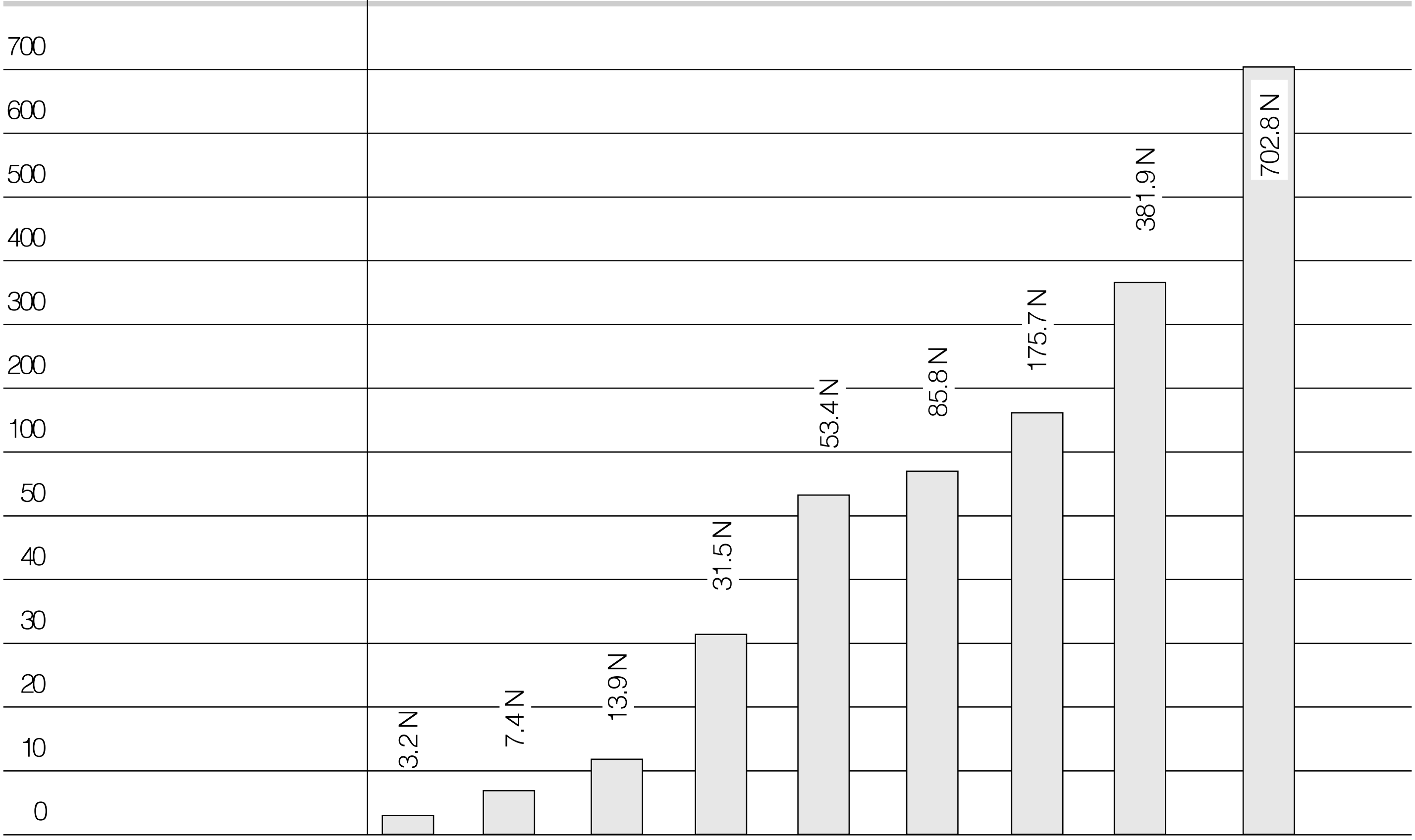


P5V-CBB

Diameter Ø mm		10	15	20	30	40	50	75	110	150
Port size, (Fitting)	Male	M5	M5	G1/8	G1/8	G1/8	G1/8	G1/4	-	-
	Female	-	-	G1/8	G1/8	G1/8	G1/8	-	G1/2	G1/2
	Male	-	-	-	G1/4	G1/4	G1/4	-	-	-
	Female	-	-	-	G1/4	G1/4	G1/4	-	-	-
Standard material:										
Nitrile, NBR		●	●	●	●	●	●	●	●	●
Silicone, Si		●	●	●	●	●	●	●	●	●
Special material:		●	●	●	●	●	●	●	●	●

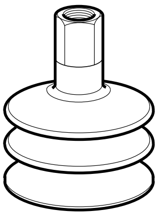
Lifting force in N

Lifting force = Pressure x Area / Safety factor
75% vacuum on a dry surface, safety factor = 2

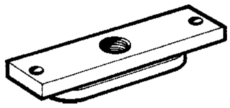


Bellows - Long

Oval - Space Saver

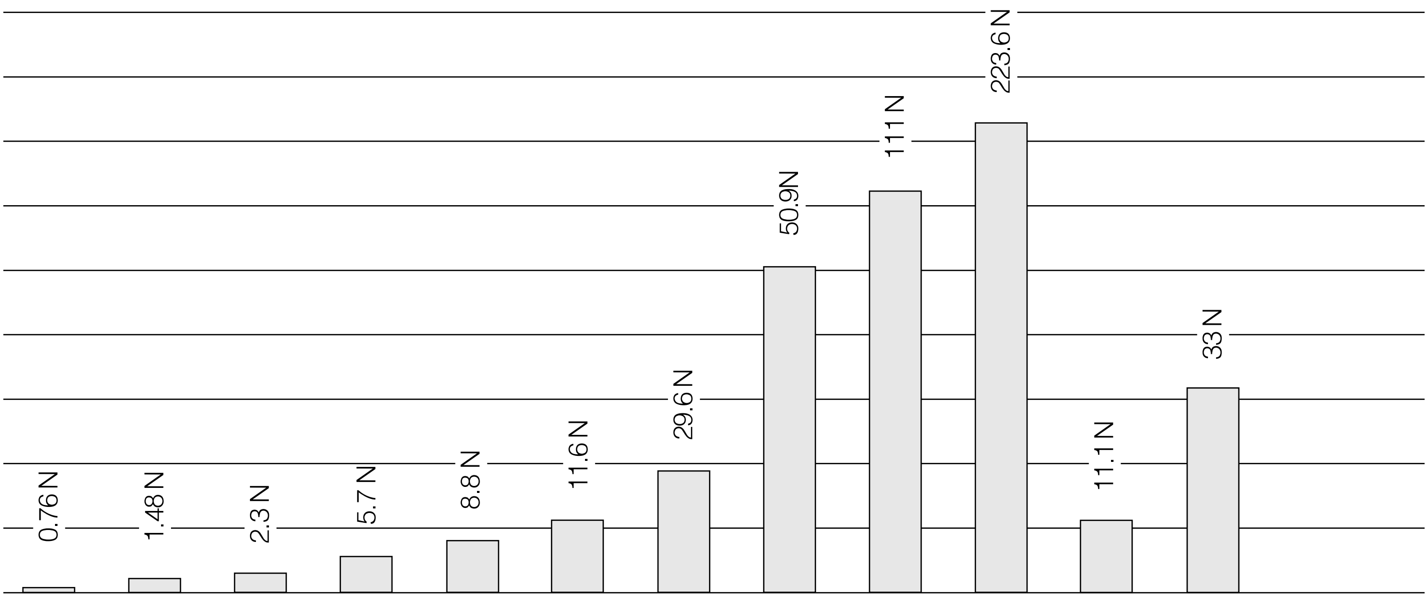


P5V-CBL

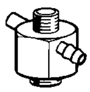
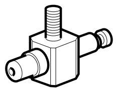
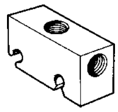
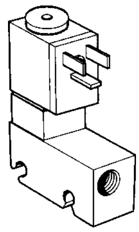


P5V-CVS

	5	7	9	14	18	20	32	42	62	88	60x20	100x32
	G1/8	G1/8	M5	M5	M5	M5	G1/8	G1/8	G1/8	G1/4	-	-
	-	-	M6(Male)	M6(Male)	M6(Male)	M6(Male)	G1/8	G1/8	G1/8	-	G1/8	G1/4
	-	-	G1/8	G1/8	G1/8	G1/8	G1/4	G1/4	G1/4	-	-	-
	-	-	G1/8	G1/8	G1/8	G1/8	G1/4	G1/4	G1/4	-	-	-
	●	●	●	●	●	●	●	●	●	●	●	●
	●	●	●	●	●	●	●	●	●	●		



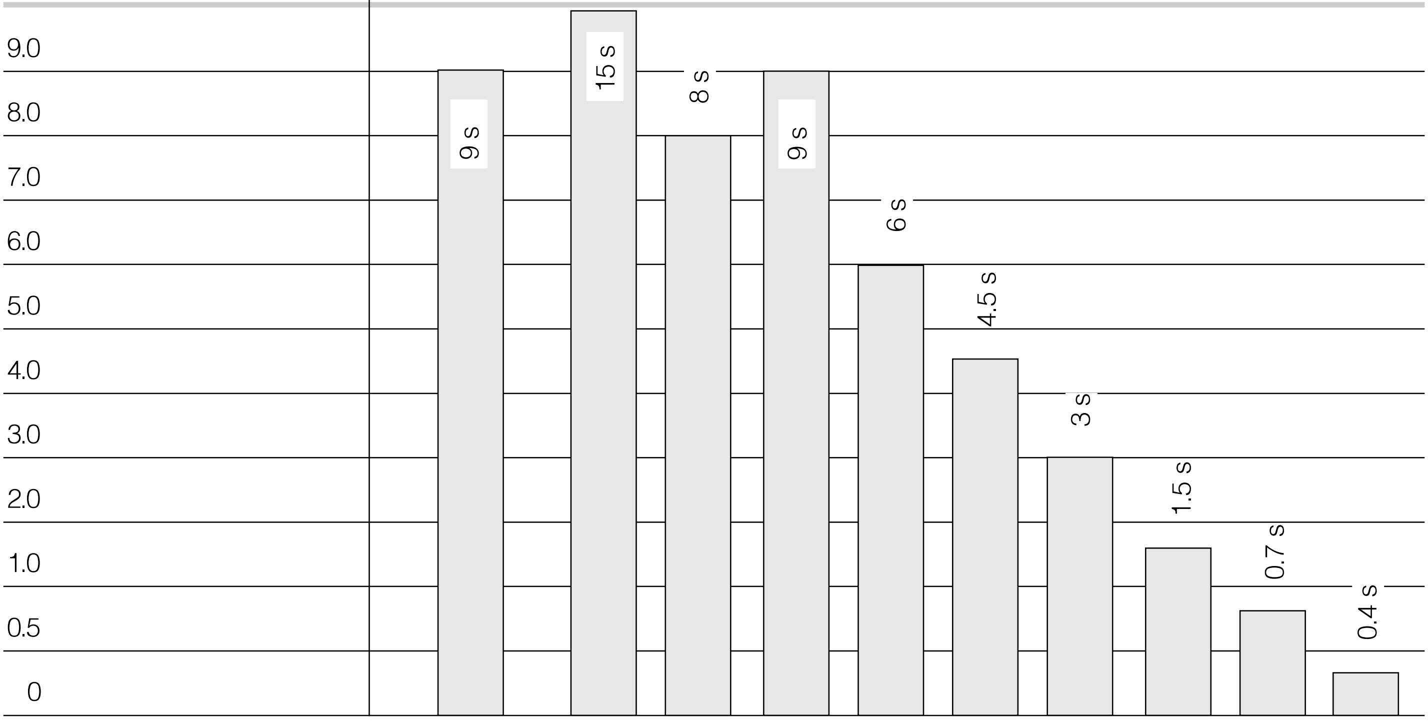
	Mini Single	Mini Compact	Compact - Profiled

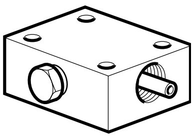
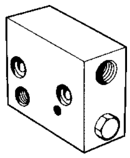
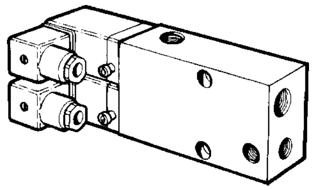





P5V-GS **P5V-GC** **P5V-GP**

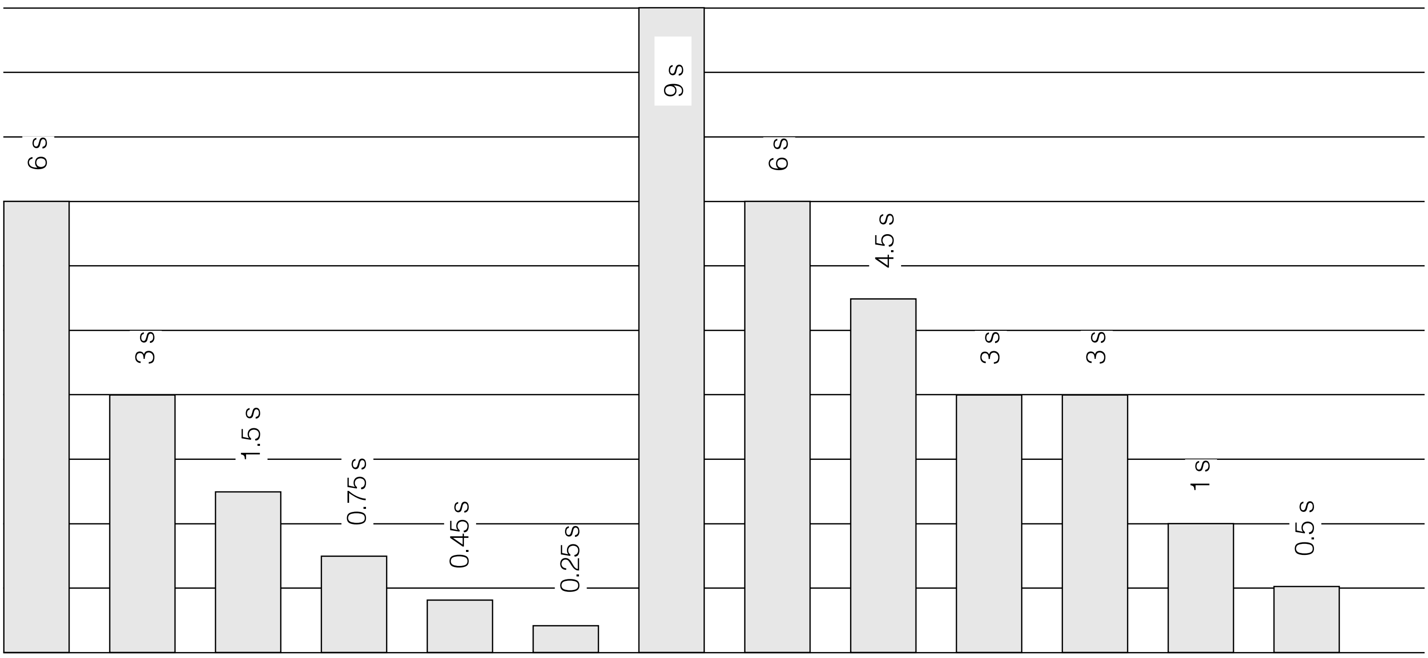
		P5V-GS	P5V-GC		P5V-GP						
Air consumption at 4 bar Nl/min		20	12	20	20	30	40	60	120	240	420
Port size	Male	G1/8	M5	G1/8	-	-	-	-	-	-	-
	Female	G1/8	M5	G1/4	G1/8	G1/4	G1/4	G1/4	G3/8	G1/2	G1/2
Suction cup	Male	G1/4	-	-	-	-	-	-	-	-	-
	Female	-	G1/8	-	-	-	-	G3/8	-	-	-
Air pressure supply, bar		4	4	4	4	4	4	4	4	4	4
Max vacuum level, %		90	80	80	90	90	90	90	90	90	90
Rapid release (R)					●	●	●	●	●	●	●
Solenoid						●		●			
Solenoid + R						●					
Holding valve											

Evacuation time 1litre at 75 % vacuum, s



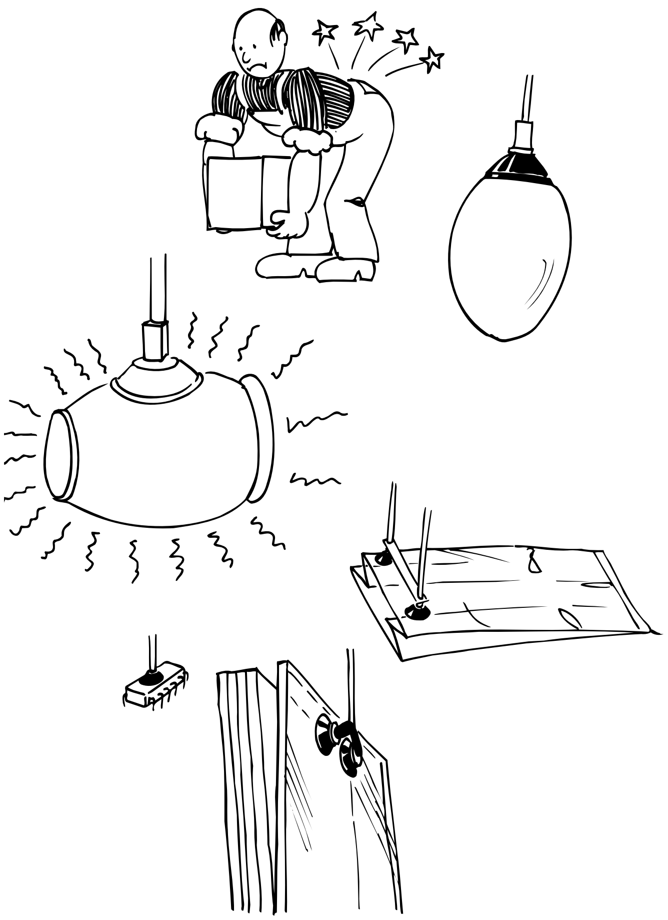
Compact - Solid	Compact - Air Saver	Multi-function
 **P5V-GA**	 **P5V-GW**	 **P5V-GM**

30	60	120	240	420	720	20	30	40	60	60	180	360
-	-	-	-	-	-	-	-	-	-	-	-	-
G1/4	G1/2	G1/2	G1/2	G3/4	G1/2	G1/2	G1/2	G1/2	G1/2	G1/2	G1/2	G1/2
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
4	4	4	4	4	4	4	4	4	4	4.2	4.8	5.5
92	92	92	92	92	92	90	90	90	90	90	90	90
●	●	●	●	●		●	●	●	●	●	●	●
										●	●	●
										●	●	●
	●	●	●	●		●	●	●	●	●	●	●



Vacuum applications

The greatest number of vacuum applications is to be found in industry, where they are only limited by cost and imagination. Typical applications are for holding items to be lifted or worked on; a number of such applications are shown below.



– Heavy lifting – saves backs
– Careful lifting – saves eggs
– Hot lifts – for avoiding burns
– Clean lifts – opening bags
– Small lifts – for memory straps for example
– Perfect lifts – sheets of glass

When making vacuum systems it is important to be very specific in the specifications and choose the basic technology for the installation.

The following parameters should be considered in the specifications
- The effect of the environment on the components
- The effect of the components on the environment
- necessary lifting forces
- Response times
- Permeability of the materials
- How the materials are to be gripped
- Distance between components
- Costs

When selecting components for a vacuum installation, it is generally simplest to proceed in the following order:
- Selection of suction cups
- Selection of generators
- Selection of main control valves
- Selection of hoses
- Selection of valves and fittings
- Selection of mountings and ancillary components.

Suction cups

Two main methods are used when holding parts:

- a mechanical grip, e.g. with a mechanical wedge grip
- securing the part by means of suction with a suction cup and air vacuum.

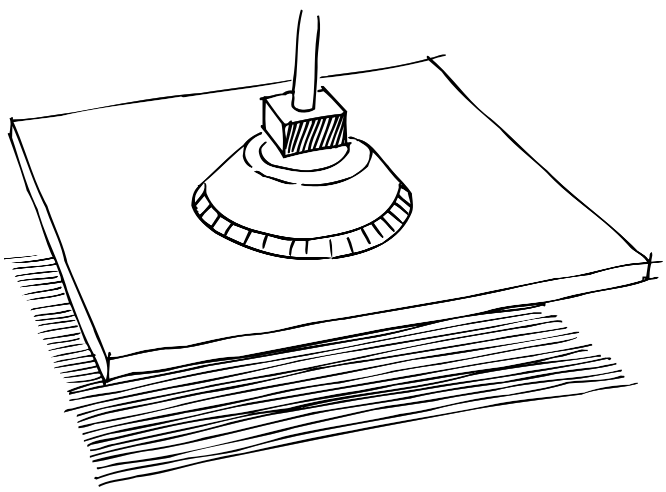
Mechanical gripping with a mechanical wedge grip allows the holding force to be sized and the area gripped to be reduced. On the other hand the part being held can be damaged if the gripper is not correctly sized, if the dimensions of the part vary or if it is made of fragile material. A further drawback of mechanical gripping devices is that they are often expensive to buy, install and maintain.

One of the main advantages of suction cups is that they do not damage the part. Other advantages are low purchase price, low service requirements and quick attachment and release.

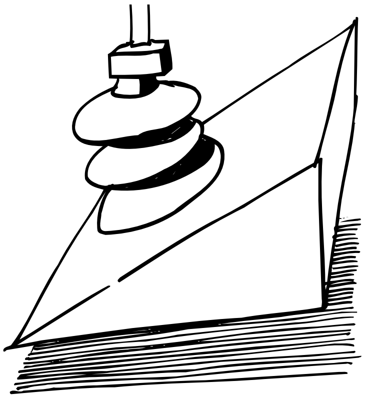
It should be noted among disadvantages that a larger gripping area is required for lifting with a suction cup as the force is proportional to the gripping area. In addition operating costs are often higher as generators normally have to be used with suction cups. However this cost can be reduced by using generators with automatic air economizers.

Very many kinds of suction cups are available depending on their applications. They can be divided into three main types according to their shape.

Standard suction cup: the commonest type for use with flat or slightly curved surfaces

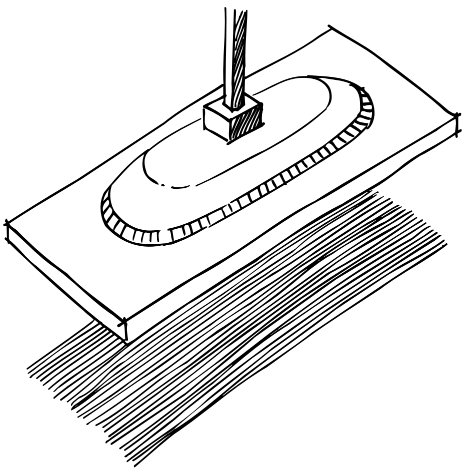


These suction cups can have various shapes depending on their envisaged applications: size, materials, single or double lips, friction grooves, reinforcing springs etc.

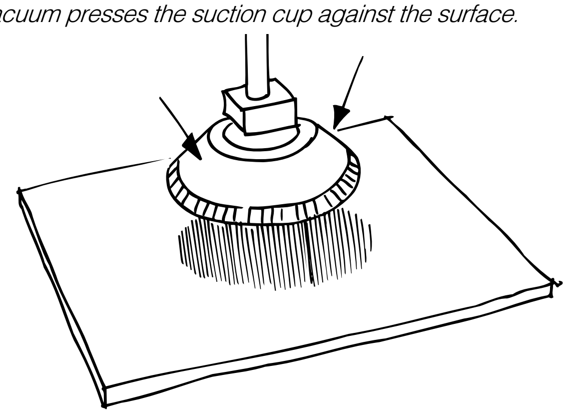


Bellows suction cup. This type of suction cup is particularly suitable for compensating for level differences.

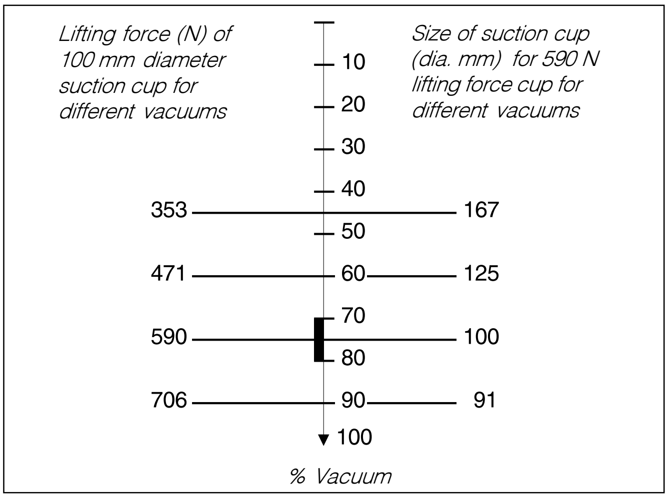
Several bellows suction cups can be fitted to a lifting yoke for handling items with a number of planes and varying shapes, e.g. corrugated sheet. This type of cup also can be utilised to separate thin parts. It may be single or double bellows.
It can also be used where there is a risk of compressing the part to be lifted. This can also be done with standard suction cups but positioning has to be very accurate.
Because of its shape however the bellows suction cup is not suitable for applications involving lifting vertical surfaces.



Suction box. This type of suction cup can be oval, square or rectangular, depending on the shape of the part to be lifted. Vacuum presses the suction cup against the surface.



As mentioned previously, it is the air pressure which presses the suction cup against the surface. This is why it is important to use as high a vacuum as possible to keep the suction area as small as possible.
This diagram illustrates why a vacuum as high as 75% should be used

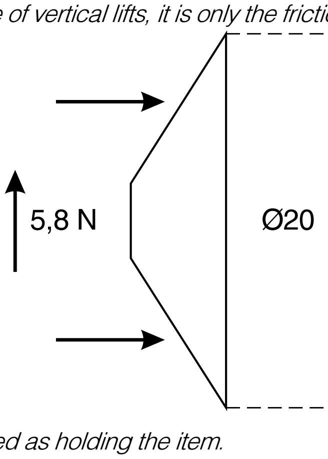


A high vacuum has the following advantages:

- high lifting force for the same area
- reduced diameter for the same lifting force

The choice of vacuum level is then determined by the material of the part and its air porosity.

In the case of vertical lifts, it is only the friction force which can



be regarded as holding the item.

In tables of holding forces exerted by suction cups it can be seen that, when lifting vertical surfaces, holding forces are very much lower than those for lifting horizontal surfaces. As an example, a 20 mm diameter suction cup has a holding force of 11.6 N when lifting a horizontal surface, but only 5.8 N when lifting a vertical surface. The reason for this is of course that the holding force when lifting a vertical surface is converted to a friction force, and it is only the friction force which can be used for lifting the material. For the same reason, a suction cup with internal friction grooves is best suited for lifting vertical surface applications.
The values of vertical surface lifts are calculated for dry steel sheet. As a result, the actual holding force for lifting vertical surfaces could vary, depending on the surface friction of the materials to be lifted.
Refer to the section on suction cups for further details.
Capacity table for flat suction cups, calculated for 75% vacuum and a safety factor of 2. The values shown are theoretical and

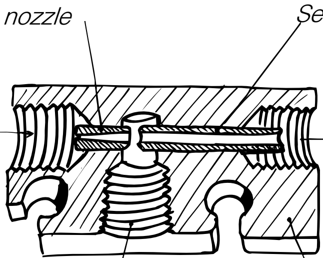
Vacuum technology

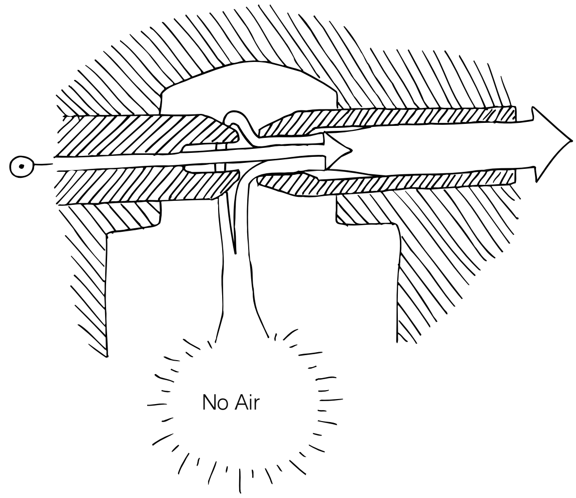
Diameter in mm	Area in cm²	Lifting force Horizontal in N	Lifting force Vertical in N	Volume in cm³
5.0	0.20	0.7	0.4	0.005
10.0	0.79	2.9	1.4	0.07
15.0	1.77	6.5	3.3	0.2
20.0	3.14	11.6	5.8	0.5
25.0	4.91	18.1	9.0	1.1
30.0	7.07	26.0	13.0	1.1
35.0	7.07	35.4	17.7	2.3
40.0	12.56	46.2	23.1	3.0
50.0	19.63	72.2	36.1	7.3
60.0	28.26	104.0	52.0	12.7
80.0	50.24	184.8	92.4	27.3
95.0	70.85	260.6	130.3	39.3
120.0	113.04	415.6	207.9	77.3
150.0	176.63	649.8	324.9	197.0
200.0	314.00	1155.1	577.6	387.0

calculated from the following formula:
Lifting force = (pressure x surface x coefficient of friction) / safety factor at 75% vacuum on a large surface. Safety factor = 2 and coefficient of friction = 0.5.

Vacuum generators

There are several ways of producing a vacuum. See the table below. In this brochure however we shall restrict ourselves to describing generators.
Generators operate on the Venturi principle and are powered by compressed gas, usually compressed air.
Generators 0 – 90% vacuum.
Venturi principle





The Venturi principle consists of sending compressed air, which will expand in one or more nozzles (venturi), into the generator. During expansion, the stored energy – compressed air – is converted into kinetic energy. The velocity of the jet increases, and pressure and temperature drop, creating a negative pressure on the suction side.
The advantages of generators are multiple: reduced size, no moving parts, low maintenance costs and rapid response. Drawbacks generally include their low flow capacity especially compared with that of fans, relatively high compressed air consumption and high noise level of the air exhaust.
There are two types of generators: high vacuum and low vacuum generators.
- High vacuum generators have a high vacuum level and low suction rate.
- Low vacuum generators have low vacuum level and high suction rate.

High vacuum generators are recommended for applications involving glass, metal sheets and other non-porous materials. Low vacuum generators are recommended for porous materials like paper etc.

Generator	Fan	Pump
+ Low purchase price Rapid response to vacuum Low weight and small size make it easy to install. Mounting on or near suction cups results in low air volume and relatively low energy consumption – High exhaust noise	+ Low purchase price Can evacuate large quantities of air (important when lifting very porous materials)	+ Low energy costs Low noise level
Relatively high operating costs if used for continuous operation	– High noise level Low vacuum level	– High purchase price High maintenance costs Central installation and high air volume. Hoses, suction cups and valves included in the system have a negative effect on performance.

Comparative table of generators, fans and pumps

Selection of generator

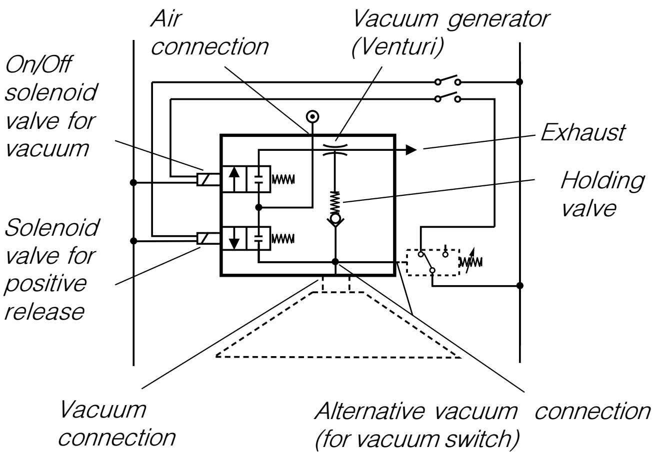
Theoretically even the smallest generator could evacuate the air from an entirely airtight container of any size down to 90% vacuum. The size of the generator does not affect the vacuum value but does affect the time taken
When selecting a generator the total volume of the suction cup (or extra cups) which have to be dealt with by the generator is considered. Consequently the factors determining selection of generators are the time required and acceptable safety level as regards leakage for evacuating the total volume of air.

Generators	Air consumption at 4 bar pressure in Nl/min	Time for evacuating to 75% in secs per litre	Vacuum flow in Nl/min
P5V-GSN02A1	18	9	14
P5V-GPN0312	30	6	32
P5V-GPN0412	42	4.5	37
P5V-GMB06142CP	60	3	88
P5V-GAR1214	120	1.5	121
P5V-GMB18142CP	180	1	161
P5V-GAR2414	240	0.7	284
P5V-GMB36142CP	360	0.5	285
P5V-GPN4214	420	0.4	286
P5V-GAN7214	720	0.25	483

Generator air consumption times table

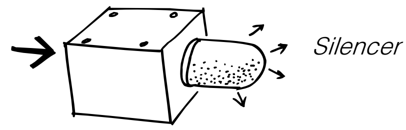
There is a certain volume of air in the hoses and connections. It is often negligible as regards the safety factor used in generator dimensioning as leakage can never be entirely eliminated from the system.
Also the smaller the safety margin for generator specifications, the greater the precision and care devoted to the installation to avoid leakage. Plant inspection should also be more frequent to detect leaks in connections and suction cups. Moreover suction cups are subject to wear and should be regularly replaced.
Generators consume relatively large quantities of air when operated continuously, which can become costly if used for long duration holding of objects.

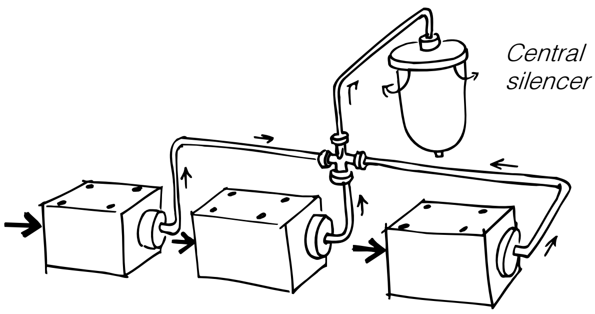
Block diagram of multiple function ejector



In order to save compressed air, components have been developed in recent years, which consume compressed air only when the vacuum drops below a certain level. Compressed air consumption can therefore be reduced to only a few percent of what a standard generator consumes in continuous operation. Compressed air consumption is a function of the airtightness of the circuit and porosity of the material to be lifted.

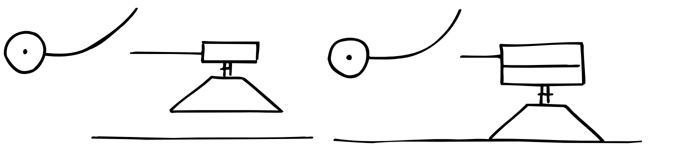
Silencing generator exhausts





According to the Venturi principle, a high air speed in the generator creates underpressure in suction. To reduce the noise level of air evacuated by the generator, the traditional silencer method is most often used. This method however involves a back pressure which reduces the air speed at the generator outlet, leading to lowering of the generator's power. This applies particularly when the air evacuated by the generator is loaded with particles which will block the silencer filter.
To counter this a hole is drilled in the end of plastic silencers. So a tube with porous walls is obtained, in which back pressure cannot be created and which cannot be blocked by dirt particles.

VSA holding valve – block diagram

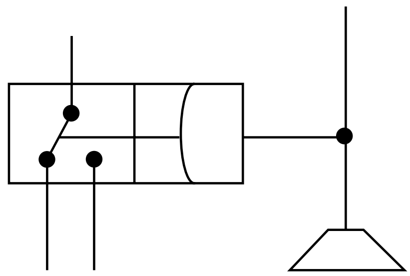


The vacuum is held by continuous air flow through the generator. If this flow is interrupted on account of rupture of a compressed air hose for example, the generator is no longer capable of evacuating air, the vacuum circuit fills with air under the effect of atmospheric pressure and the object is released.
To prevent the suction cup being filled with air in the event of loss of the compressed air supply to the generator, a holding valve is fitted between the generator and the suction cup. This valve operates in the same way as a non-return valve i.e. when the generator stops evacuating air, the surrounding atmospheric pressure presses the ball against its seat and prevents atmospheric air entering the vacuum circuit.
This system however does not ensure airtightness in a durable way. Air in fact can get into the circuit through a worn suction cup, leaks in the system, surface unevenness or porosity of the material. In addition the suction cup's rubber seal becomes worn with time. For sensitive applications, it is therefore important to replace suction cups at regular intervals to prevent loads being dropped in the event of the air supply failing.
As mentioned above component reliability is very important, especially when holding valves are used; if there is any risk of accident in the event of air supply failure, special care should be taken in suction cup selection where the wide range of

shapes available are highly suitable for any material to be handled even if the latter is uneven.
Holding valves are most often used in applications where material porosity is negligible: glass, sheet metal, plastic etc. Holding valves are also fitted with release valves to which air supply signals are connected for releasing objects being handled.

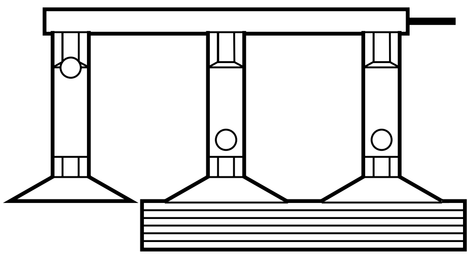
Vacuum switch

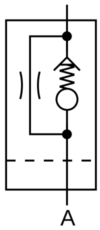
Vacuum switch – block diagram



If a suction cup lifts an object before the generator has reached the required vacuum, there is a risk of the object being dropped. This is why vacuum switches are used for checking that the correct vacuum has been reached. In principle this equipment operates as follows: when a generator starts to evacuate the air from a suction cup the vacuum generated also goes into the pressure switch. Atmospheric pressure will then press against a membrane in the switch so that the pressures are in equilibrium. This membrane is fixed in a piston which by moving cuts off or activates an electric contact enabling an electrical signal to be sent to be sent to the control system. Vacuum switches are designed either with a fixed rating – normally 75% vacuum – or with an adjustable setting.
Flow valve – block diagram

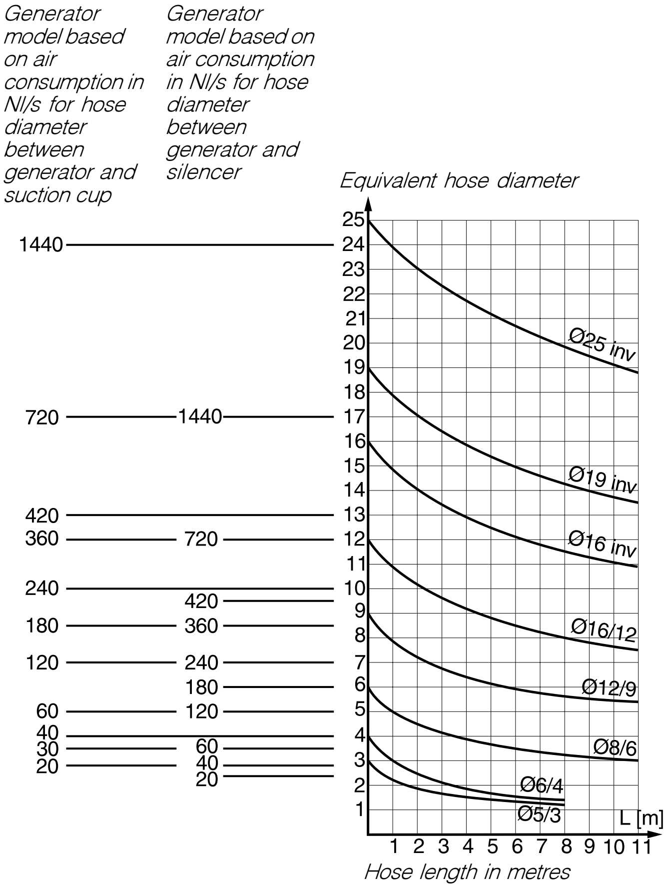
When a suction cup holds an object this valve lets a slight air flow through it. If the load drops it will generate a high air flow and the ball will close the valve.





This component is used particularly in applications using a central vacuum generator for several suction cups. If no such equipment is available the vacuum level shall not be held by the generator and it is all the suction cups which shall be affected.

Choice of hoses



Hose dimensioning between generator and suction cup, and between generator and silencer.
The efficiency of the installation depends on ensuring that all air hoses are correctly dimensioned. If the hose which connects the power valve to the generator is underdimensioned, the generator will not receive enough compressed air and will lose momentum. The outcome will be that the efficiency of the installation will fall even if all other components are correctly dimensioned. The table shows that the length of the hoses is decisive for the amount of air which reaches the components. The longer the hose, the greater the diameter required.
It should be noted that bends and angles reduce air flow and therefore should be avoided as far as possible. Otherwise oversize hoses.
The hose which connects the generator to the suction cup should be dimensioned in accordance with the above table. If it is undersized the air evacuated from the suction cup is restricted and it takes longer to obtain the vacuum in the suction cup than calculated even if the generator is correctly dimensioned. In some cases the generator is mounted on the suction cup and this dimensioning does not have to be considered.
If a centrally located silencer is fitted, the hose which connects the generator to it, should be dimensioned in accordance with the table on the previous page. The Venturi generator needs high air speed through it and everything which brakes this air flow reduces its efficiency. This is why the hoses connecting the generator to the silencer are of large diameter. Even for this hose every angle and elbow slows down the air flow and should be avoided as far as possible.
The silencer, however, is generally connected directly to the generator and dimensioning is not important.

The table below shows the commonest hose diameters and their volume capacities for various lengths:

Diameter in mm		**Area in mm²**	**Air volume in cm³** Hose length			
Ext.	Int.	Int.	1 m	5 m	10 m	100 m
4	2.70	5.7	5.7	28.5	57	570
5	3.15	7.8	7.8	39	78	780
6	4	12.6	12.6	63	126	1260
8	6	28.3	28.3	142	283	2830
12	9	63.6	63.6	318	636	6360
16	12	113	113	565	1130	11300
22	16	201	201	1005	2010	20100

Volumes according to hose diameters

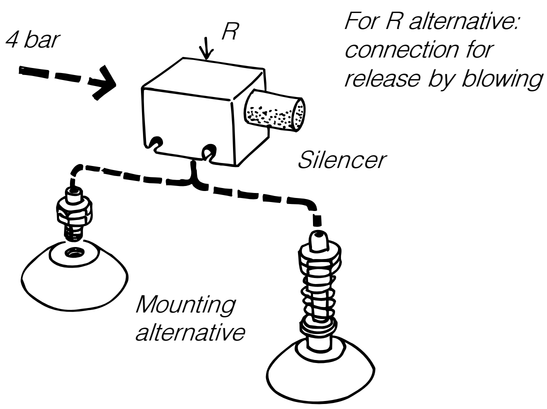
Add the volume of air in the suction cup and the one in the hoses to obtain the total volume of air to be evacuated by the generator.
It should be noted when selecting a hose, that it meets the requirements for tolerance and quality relevant to the environment in which the hoses will be used.

Choice of connections

When selecting fittings the most important criterion is minimizing leakage. Previously nuts were required. Product development today allows quick release connections to be used even for this type of installation. When quick release couplings are chosen, the tolerances of the hoses chosen become even more important so we recommend that users contact their suppliers for advice on optimizing component selection when quick release couplings are used.

Mounting

For each application there is a specific combination of components. Here are the commonest types of combination for vacuum technology components.

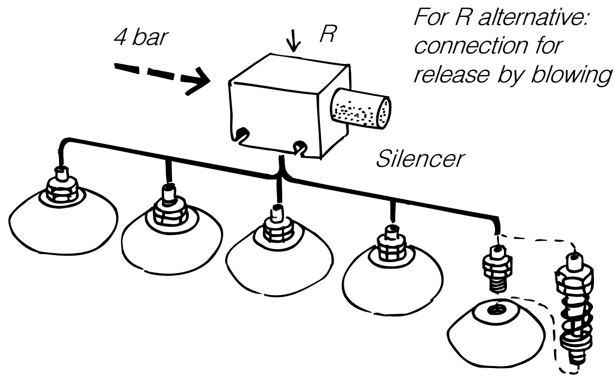


Direct mounting

Direct mounting: standard P5V-GSN, GCN, GP, GA generators

This combination of vacuum components is the basic combination for applications in which the generator produces the vacuum.

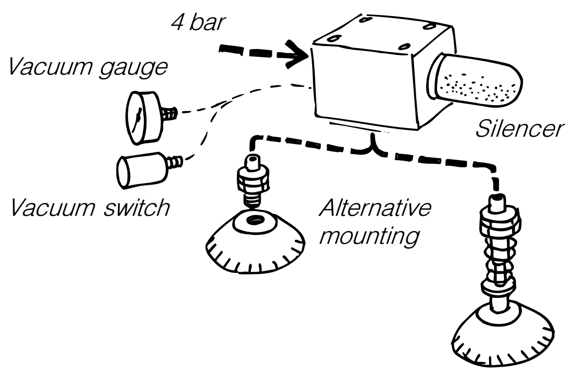
Central mounting



Standard P5V-GSN, GCN, GP, GA generators

This combination is suitable where the shape of the load is such that several suction cups are required and where there is hardly any risk of one or more suction cups losing its grip or where there is no risk of serious damage.

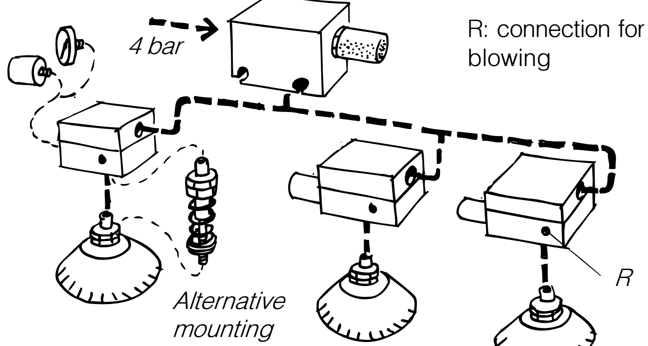
Direct mounting with a P5V-GW Airsaver generator on each suction cup



Direct mounting with a P5V-GW Airsaver generator with integral holding valve for better safety

This combination is used when there is a risk with the suction cups and a risk of an accident involving persons.

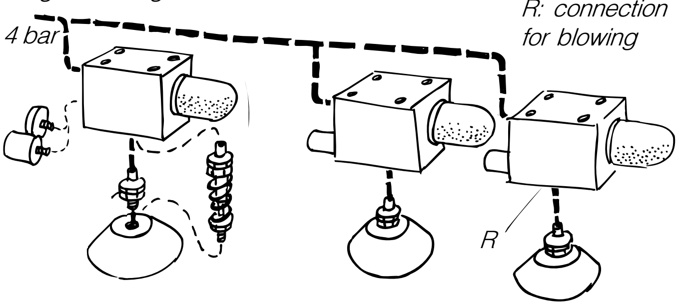
Central mounting with a holding valve for each suction cup
Central mounting with a VSA60 holding valve for each suction cup



This combination is used when several suction cups operate with one single generator and there is a risk of accident involving persons or damage if the object is released.

P5V-GW Airsaver generator with integral holding valve

Central mounting alternative:P5V-GW Airsaver generator with integral holding valve

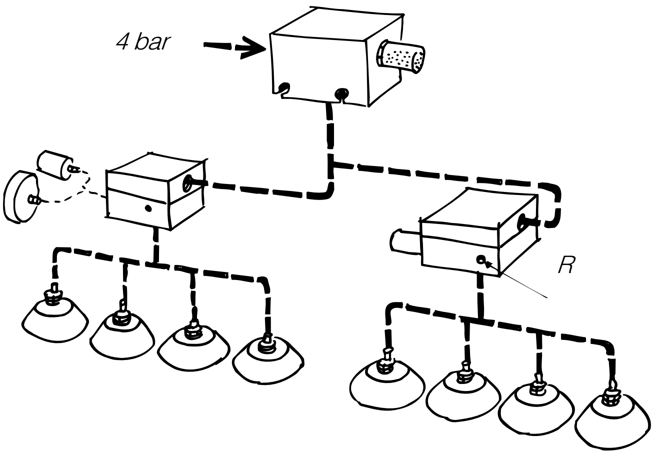


This combination is used like in the previous examples when accidental release of the object could involve serious damage. This alternative offers increased safety due to each suction cup being fitted with a generator.

Simplified safety with holding valves

Simplified safety with VSA60 holding valves

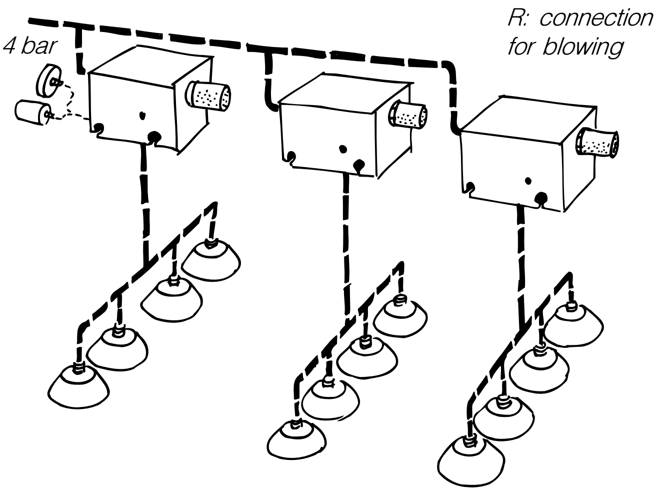
This combination is used when there is only a limited risk of damage.



Simplified safety with P5V-GW Airsaver generator

Simplified safety with P5V-GW Airsaver generator

This combination is used like in the previous example

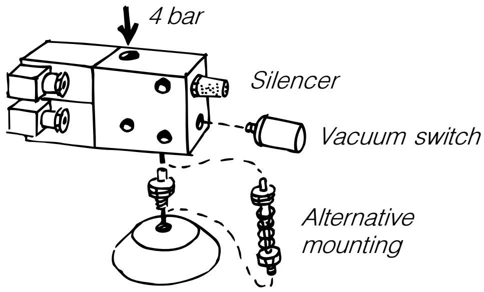


when the risks caused by release are limited. On the other hand better safety is obtained with this alternative since the vacuum is held in various groups of suction cups.

Saving compressed air

Saving compressed air with multi function ejector

This equipment is used to reduce generator air consumption

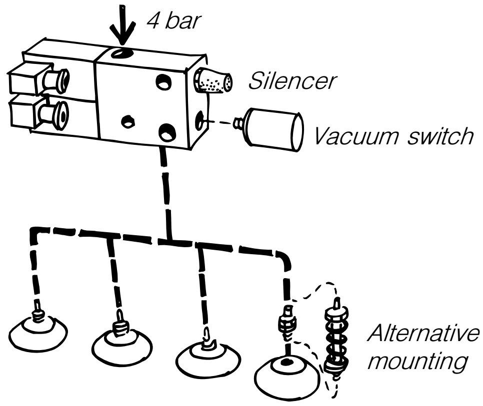


when handling time is long.

Central mounting with air saving

Central mounting with multi function ejector

This mounting is used for applications requiring the use of several suction cups to hold the object, when in principle there is

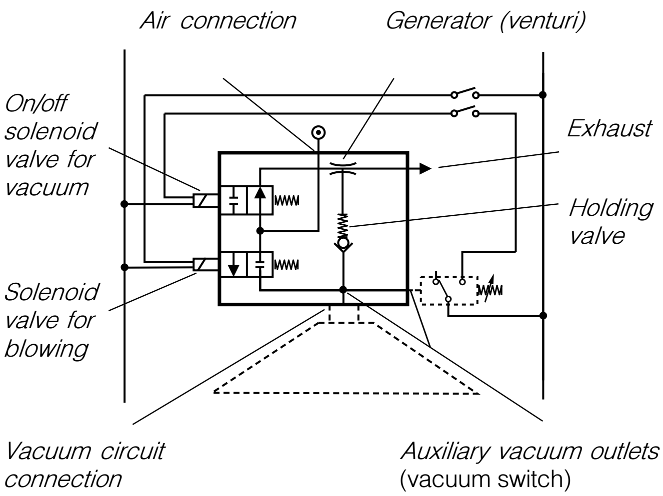


little or no risk of damage if the air supply is cut off or one of the suction cups loses its grip.

Safety in the event of a power cut and loss of compressed air saving

Multi function generator with safety in the event of a power cut – block diagram

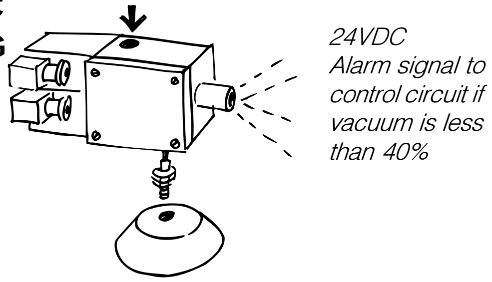
This combination of components is designed for the same



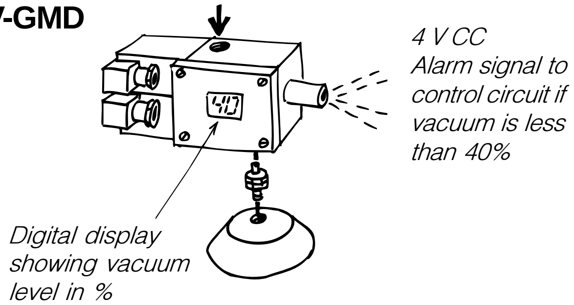
applications as the two previous ones, but also integrates the power cut risk.

Alarm if vacuum falls below safe level

P5V-GMC
P5V-GMG



P5V-GMD

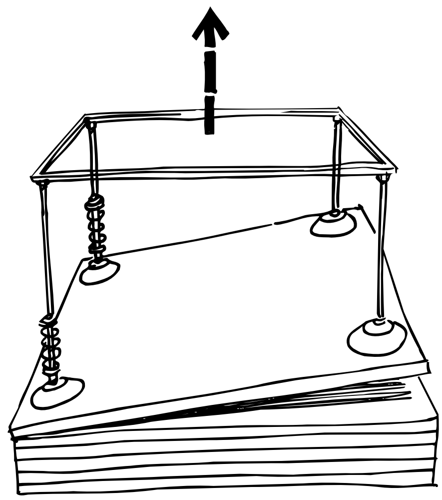


Advanced multi function

This arrangement is used when an alarm signal to the control circuit is wanted if the vacuum level is below a given safe level (generally 40%).
This system operates between cutting off the air compressed supply at 75% (adjustable) and restarting it at 60% (adjustable). In addition an alarm signal can be obtained for a third level, set for example at 40%, which indicates that the safe level has been reached where there is a risk of the objects being dropped.

Using spring mountings for separating stacked sheets

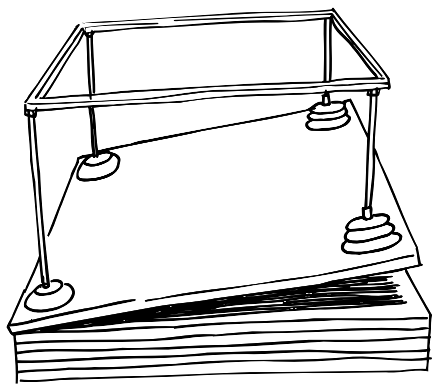
Theoretically a force of ten tonnes would be required for separating two 1m^2 sheets of material it there was no air between them. This problem can be solved in various ways depending on the applications. Below are the commonest alternatives.



Separating sheets, of glass or other material with suction cups mounted on spring mountings

When sheets of non porous material are to be lifted from a pallet, the suction cups are lowered to the surface by pistons. The suction cups are pushed onto the surface of the sheet pressing out any air which may be between the sheets.
This arrangement is used when the object to be lifted can bend slightly without being damaged.

Using bellows suction cups for separating stacked sheets

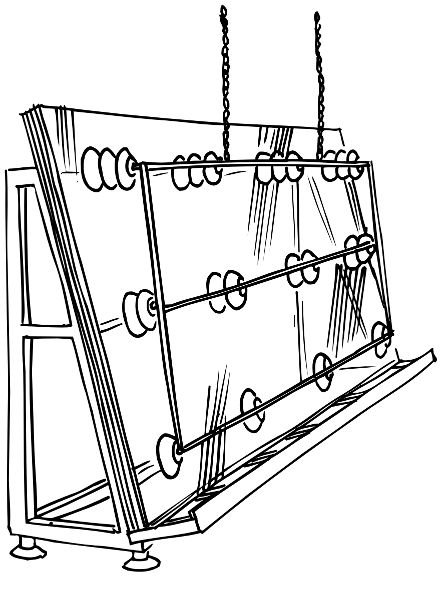


Separating and lifting stacked sheets of metal or glass with bellows suction cups

This arrangement is used, like the previous example, when avoiding lifting several sheets at the same time is desired.
This alternative is more reliable for working. It has however one disadvantage: bellows suction cups tend to wear more quickly which increases maintenance costs.

Using bellows suction cups for lifting vertical sheets

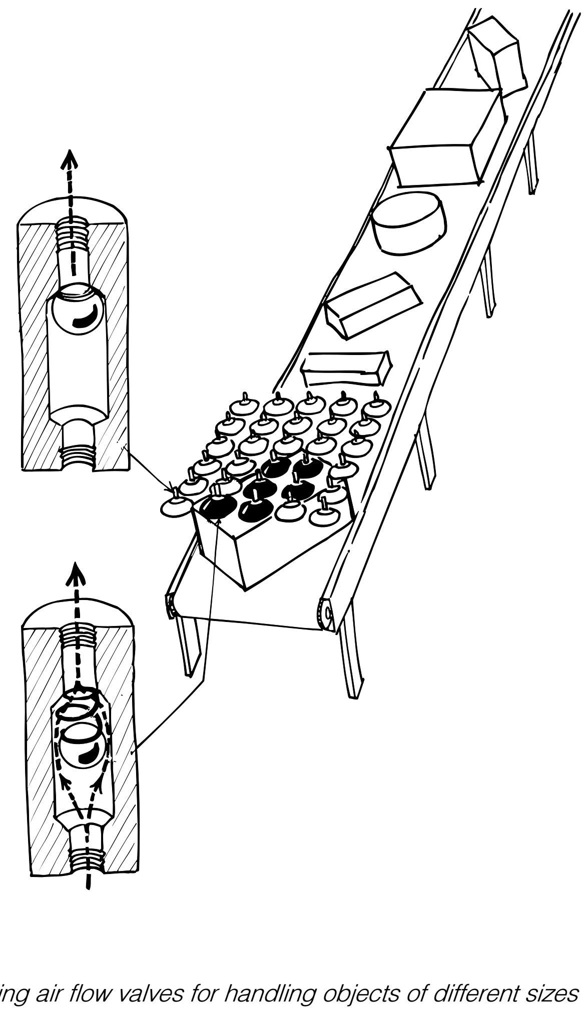
This combination of standard and bellows suction cups is used for separating, lining up and lifting vertically stacked sheets.



Using bellows suction cups for lifting vertically stacked sheets

Using air flow valves

When lifting objects of different sizes, some of the suction cups may be outside the edges of the object, in which case either the other suction cups will also lose their grip (if used with a central generator), or air consumption will be very high (if there is one generator with each suction cup). This can be prevented by fitting an air flow valve on each suction cup to cut off the flow between the generator and the suction cup when it is too high. In other words these air flow valves may be used when objects of different size have to be moved in succession and it is not possible to detect the flow to the suction cups and stop it mechanically. Given that air flow valves react according to the flow, they cannot be used with Multi Function Airsaver generators or VSA60 holding valves



Using air flow valves for handling objects of different sizes

Selection factors for vacuum products

- Weight of the object to be moved
- Direction dof movement
- Material / surface condition of the object
- Shape of the object
- Available air pressure and flow
- Environmental conditions
- Operating speed

Parameter calculations

Size and number of suction cups required.

Theoretical holding force =
= vacuum pressure x suction cup area

To allow for unevenness and porosity of surfaces and to ensure that a constant sufficient holding force is applied, a safety factor "S" is applied. Several suction cups may be required depending on the force required and size of the object to be lifted.

The area of each suction cup is given by the following formula:

$$A = \frac{F \times S \times 10^4}{P \times n} \quad mm^2$$

When circular suction cups are used their diameter is usually measured.

$$D = 113 \times \sqrt{(F \times S)/(P \times n)} \quad mm$$

Where F = Force [N]
A = Area of suction cup [mm^2]
D = Diameter of suction cup [mm]
P = Vacuum pressure [mbar]
n = Number of suction cups
S = Safety Factor
(Normally 4 for vertical lifts
and 2 for horizontal ones)

The Theoretical maximum vacuum pressure available at sea level is 1013 mbar, and 75% of this value is used as a practical and reliable constant or – 750 mbar.
If the vacuum pressure is 750 mbar, the above formula may be written as follows:

$$D = 4.12 \times \sqrt{F \times S/ n} \quad mm$$

If in addition the weight of the load is put in the formula we have:

$$D = 13 \times \sqrt{W \times S/ n} \quad mm$$

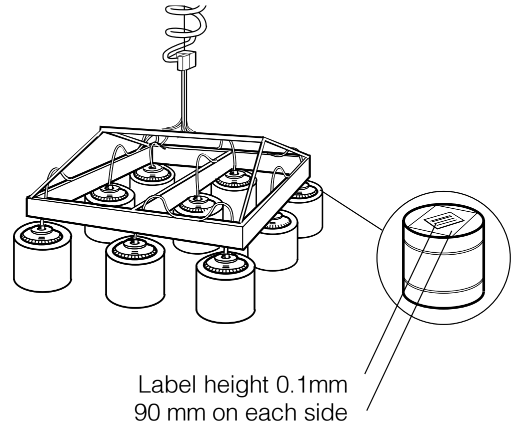
where W = Weight of load in [kg]

Example: To lift a container weighing 25 kg with one single suction cup, 75% vacuum and safety factor of 2, the suction cup diameter should be at least:

$$D = 13 \times \sqrt{25 \times 2/ 1} = 92 \text{ mm}$$

Real life example

Lifting device to lift 9 paint tins each weighing 5 kg.



The label on the lid causes a certain amount of leakage.
The available lifting area (a square of 90mm side per tin) allows an 80mm diameter suction cup to be used. This gives a lifting force of 185N at 75% vacuum (refer to the tables on page 158 and 159). This gives a total of 1665 N for the whole lifting device, which easily exceeds 450 N, but this safety margin is required in the event of acceleration or braking in the vertical direction.
Total volume of suction cups: 9 x 27.3 cm^3 = 245.7 cm^3 or about 0.25 litres.
Estimated volume in pipes and connections using 12/9 pipe:
Pipe = 4m x 64cm^3 = 256cm^3 or about 0.26 litres
Miscellaneous = 0.49 litres
Total volume = 0.25 + 0.26 + 0.49 – 1 litre.
A P5V-GM18 multi function generator with holding valve and ejection system evacuates 1 litre at 75% vacuum in 1 second and consumes 3l/sec in normal operation. The generator is connected to a P5V-SV vacuum switch to reduce air consumption.
Evacuation time for a volume of 1litre is 1l / 1 l/s = 1 second.
Air consumption during application is 3l/s x 1s = 3 litres. If we take a time of 30 seconds and 2-5% leakage caused by the label, we get the following air consumption:
(30s – 1s) x 3l/s x 5% = 4.35 litres
Total air consumption = 3 + 4.35 = 7.35 litres
P5V-GM multi function generators with P5V-SV vacuum switch