2

end of arm vacuum

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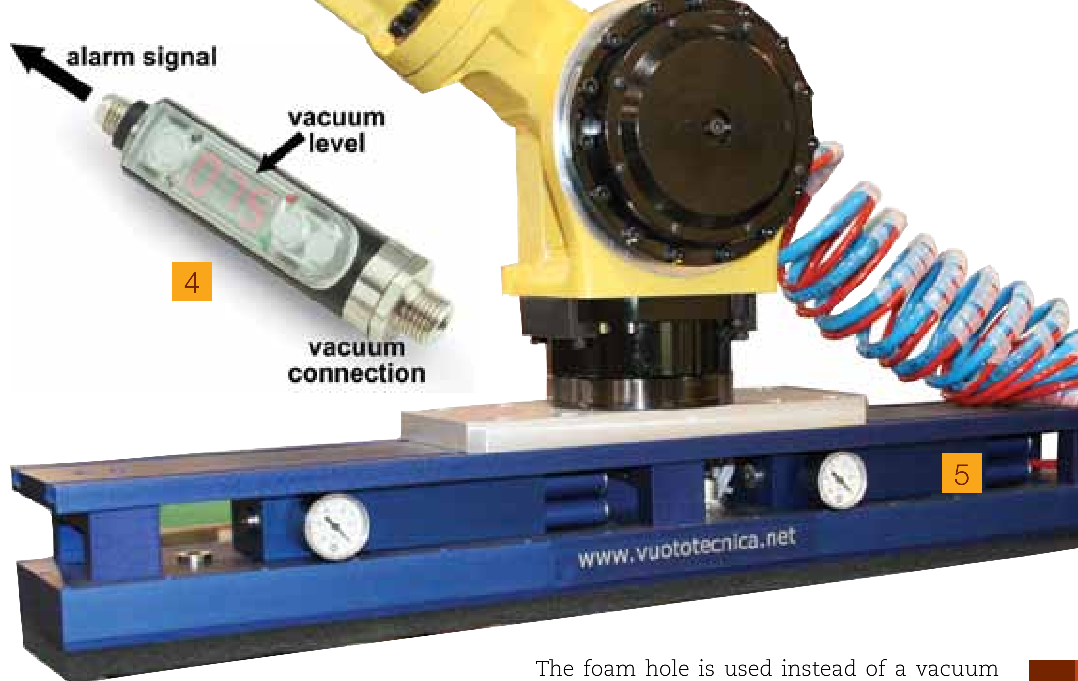
The selection of vacuum components is, of course, the most important part of any vacuum-handling system: venturi or pump, vacuum cup size, vacuum cup style, vacuum level sensing, and so on. However, many applications dictate the choice of vacuum components based on the actual mechanical method being used for the actual physical handling. This could be a 3-axis gantry crane, a 5-axis robot, or a simple pneumatic cylinder X-, Y-, and Z-axis setup.

End of arm tooling, or EOAT, refers to the device that contains the vacuum components and is normally the most visible part of a handling system. Fig 1 shows a typical end of arm tool that utilizes an extruded aluminum profile, which is very popular due to the ease of assembly and the modular components available, such as brackets and swivel joints, and also its ability to be adjusted and modified in the future. The connection plate highlighted is connected to the motive device such as a gantry robot. The blue-colored devices shown are the vacuum grip tools.

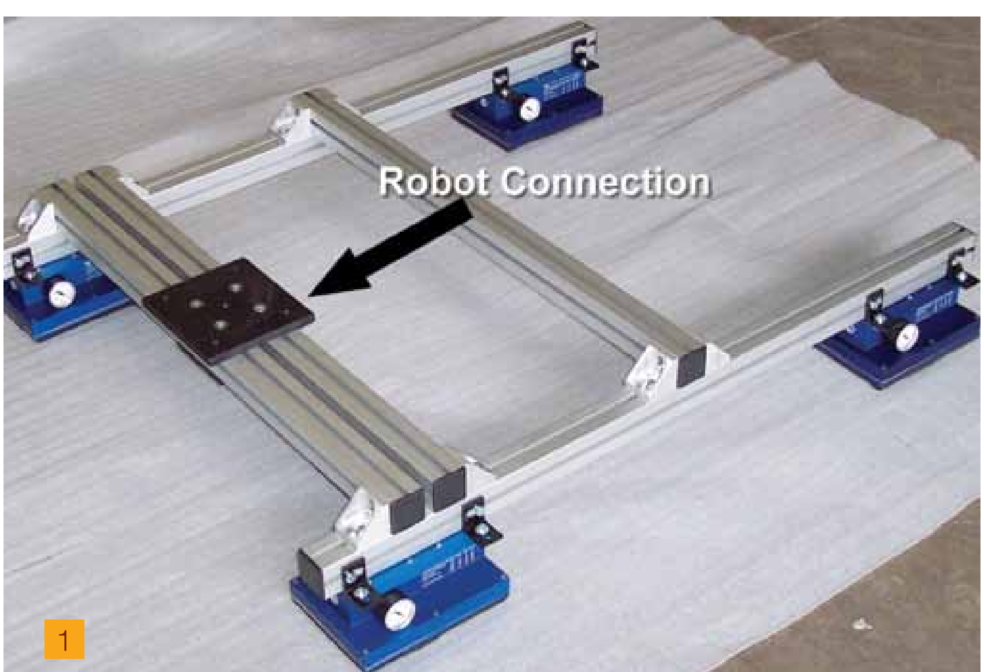
On this type of EOAT, where it is used on a long travel gantry crane, consideration needs to be made to the vacuum-generating device. If this crane was traveling the length of a workshop, which was some 100-feet long, a compressed air-driven venturi would probably not be suitable because the compressed air lines would need to travel with the crane along its main axis of travel. In these types of applications, the user would normally prefer a vacuum pump with electric motor as the crane can then carry the complete vacuum system with the EOAT. It is very rare that a user can utilize compressed air because of this travel distance. Therefore, the complete EOAT tool is self-contained, running off the main power (460 V or 110 V) and utilizing a 24 VDC control circuit for the operation of vacuum valves and sensing equipment, such as switches and so on.

Fig 2 shows a typical "spider" EOAT. This type of EOAT is very common in steel-stamping applications. The vacuum cup's position can be adjusted to suit different steel blanks and are supplied in this particular application by a single compressed air vacuum venturi. Because the tool is mounted directly to a 5-axis robot, the compressed air is piped through the robot arm to the venturi. From the venturi, vacuum lines are connected along the spider arms to the individual vacuum cups. This system is very popular and is effective in reducing energy costs with regards to compressed air consumption. The single venturi is normally a multifunction unit as shown in Fig 3, which has an automatic on/off vacuum cycle depending on the demand requirement. This type of venturi is available from numerous manufacturers.

However, many steel-stamping applications still utilize single-stage venturi on each vacuum cup. The reasons for this are simple. It is very easy to install, and it is a low cost investment. Also, as compressed air is supplied to each vacuum cup venturi, and if that vacuum cup fails due to wear or misalignment to the steel blank, it does not affect the remaining vacuum cup, which would be the case if they were being supplied by a single point venturi. However, it could be argued that if the vacuum cup does fail, how does the user know that this cup is not being effective in handling the steel blank? The first time this is apparent is when the system fails by dropping the load. If the system was utilizing a single venturi to supply all vacuum cups, the system vacuum level would decay if one or more of the cups were not sealing, and the user could be notified by a low vacuum alarm via a suitable vacuum switch, such as the model shown in Fig 4. Furthermore, having individual vacuum venturi on each cup means that the compressed air consumption is extremely high. Depending on the model used, these single-point venturi systems can use in excess of 4 CFM of compressed air per cup. If the EOAT is using 10 cups, that's a consumption of 40 CFM whereas a single good quality central point venturi would use about a quarter of that if selected and installed correctly.



The blue-colored EOAT shown in Fig 5 is a self-contained vacuum lifting head. This head incorporates all the items needed to provide the user a vacuum-gripping device. This particular unit utilizes vacuum "foam" instead of traditional vacuum cups. This vacuum foam is shown in greater detail in Fig 6.



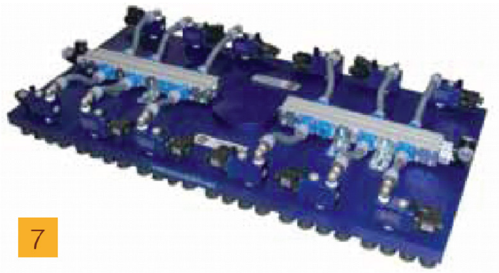
The foam hole is used instead of a vacuum cup. The foam offers potentially better sealing on corrugated or uneven surfaces. This unit includes the vacuum venturi, vacuum gauges, vacuum switch, and of course the actual hardware to mount the unit onto the arm of the robot. This solution saves the user time and money in both the design and installation of the EOAT. However, compared to a spider type EOAT, this system cannot easily be modified for different applications.

Fig 7 shows a much larger purpose-built EOAT that utilizes a vacuum pump at the base of the robot for its vacuum source. This particular head consists of 12 zones each controlled by a vacuum valve. The user's control program determines which zones are used at what time. This particular head consists of nearly 500 vacuum cups, but the vacuum pump is considerably smaller than would be expected as only the cups needed for handling different size loads are being used, and therefore, compensation for open orifices in the cups does not have to be considered. If this system utilized traditional EOAT components such as aluminum profile bars, the assembly of 500 vacuum cups would be virtually impossible inside such a small footprint, and the installation of all these components would take a considerable amount of time.

Fig 8 shows another purpose-built EOAT, but this unit utilizes "self closing valves." Therefore, this head can handle various size loads without the need to compensate for flow loss through open vacuum cups. The brass-colored self-closing valves are highlighted. When these valves sense a flow of air, which means the individual cup is not in contact with the load, they close, isolating the vacuum cup (in the picture this is a foam vacuum "cup") from the rest of the head.

Large EOAT requires significant fabrication in some cases. Applications such as wood or drywall handling, for example, will normally utilize welded box section steel or extruded aluminum profile and could be as large as 8 × 20 feet in some cases. Even larger structures are used for aircraft skin handling, for example. In such applications, the user would utilize an electrical vacuum pump that in

6



7

turn would supply vacuum to large diameter vacuum cups that are connected to the lifting frame via level compensators as shown in Fig 9. These level compensators allow for the difference in height across such large areas. Fig 9 shows the unit assembled to a bracket, which in turn attaches to the main structure. As the vacuum cup makes contact with the load, the support rod can elevate upwards (as indicated by the arrow) through the bushing, allowing all vacuum cups to seal before the lift cycle starts.

If this large EOAT is being used for various size loads, certain cups will be outside the footprint on smaller work pieces and therefore not seal, affecting the vacuum level in the entire system. In applications such as these, plunger valves can be installed on the vacuum cups. Therefore, when the plunger is activated by the load as the cups approach, only these cups will be used and the rest of the cups will remain isolated from the system. Fig 10 shows this type of cup and plunger valve assembly.

Often on large EOAT, electrical vacuum pumps are used due to the better efficiency offered at higher vacuum levels compared with compressed air venturi. The usual safety features are also included in case of power failure or vacuum cup damage as they should be with any vacuum system. As explained before, on particularly large systems, the vacuum pump and all control equipment are often mounted on the EOAT to facilitate long travel paths.

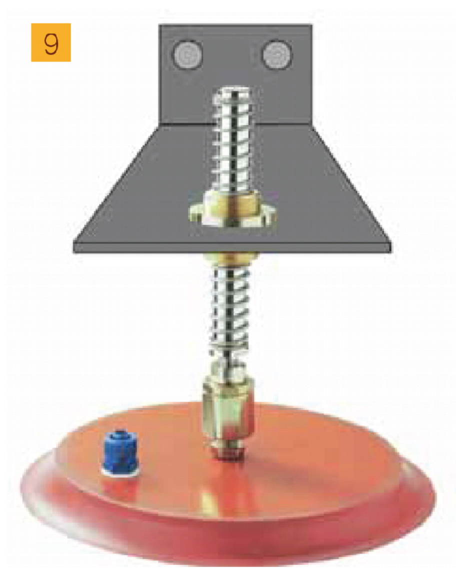
Building an EOAT from scratch offers the user many challenges in respect to what material to use for the basic structure, such as extruded aluminum profile or welded steel, strength and safety considerations of the structure, and of course what vacuum components should be selected.

Each application is different and the purpose of this article is to highlight different approaches to selection and avenues of investigation by the reader. Of course, cost is often a determining factor, but consideration should be made to initial cost versus ongoing operational cost, and a good productivity rate of the production line it is destined for. Professional advice should be sought before undertaking the building of any material-handling device.

For further information please contact Daniel Pascoe at www.vacuforce.com. Vuototecnica USA is a brand of Vacuforce Inc.

8

9



10