Vacuum Tables Hold Down Costs

Precision workholding and greater production efficiency mean increased profits are in the air

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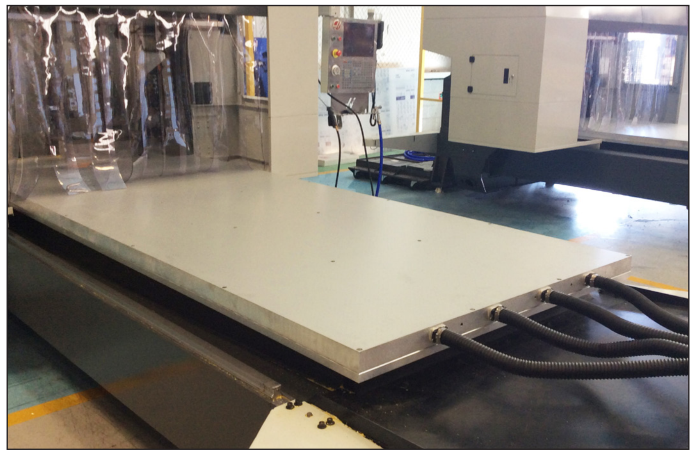
For more than half a century industrial engineers have been utilizing vacuum technology to achieve effective and reliable holddown of various materials for printing, cutting, machining, measuring, application of coatings and adhesives, and many other types of processing without the use of clamps or chucks. The advantages inherent in vacuum workholding are clear: setups are faster and more accurate, the entire surface of the workpiece can be accessed, handling of the material, and potential damage to the material and the machine is minimized. These advantages have driven the expansion of vacuum workholding systems into numerous businesses and industries.

Vacuum technology is efficient, flexible, and adaptable to a wide range of materials and processes. From large industrial facilities cutting and machining steel, to woodworking shops using CNC routers, to cleanrooms recording precise measurements of aerospace grade composites, to museums and art restoration studios, vacuum table systems provide logistical solutions and operational advantages and are regarded as vital tools for success.

Although the principles of operation are the same in all vacuum table systems, the design and construction of vacuum tables varies widely depending on the application. Small tabletop systems may have a vacuum surface area of just one square inch while modular systems for industrial use may be expanded to hundreds of square feet. Stainless steel and aluminum are the most common surface materials and generally preferred for heavy-duty usage, but common variants include anodized aluminum, Formica, and even plastic surfaces to accommodate specific materials and processes.



Vacuum workholding systems have become indispensable to computer-controlled manufacturing processes such as CNC routing, milling, and cutting of metal, wood, plastics, and composite materials.

The precision of computer-controlled industrial processes such as CNC mills, lathes, and routers, plasma cutters, and EDMs has led to an exponential increase in the use of vacuum table systems over the last two decades. At the same time, the development of high-tech composites and synthetic materials has created a demand for clamp-free workholding solutions. It may require on-site adjustment to make a vacuum system perform seamlessly with an existing process, but such system calibration is usually fairly simple and straightforward. Vacuum technology is the state of the art for precision workholding in science and industry and system design continues to evolve as new technologies and markets develop, ensuring its continued dominance.

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Peak performance under pressure

A vacuum table system typically consists of a penetrable flat, rigid work surface, usually perforated or grid-style depending on the application; a plenum or vacuum chamber; and a vacuum pump large enough to create a sufficient pressure differential between the chamber and the ambient or atmospheric pressure at the surface to hold a workpiece in place during processing. Strictly speaking, it is not pure vacuum that holds the part in place but the force (in this case suction) created by this pressure differential.

Hoses and clamps are used to connect the vacuum pump to a port or series of ports on the vacuum table, typically on the sides or bottom of the table. These connections must be tight, unobstructed, and as short as possible for optimal system performance. In a properly configured and calibrated vacuum workholding system a high level of hold down force may be generated with a relatively small pressure differential. Balancing suction and system airflow achieves the best results. Working in only one zone of the vacuum table surface requires effectively blocking the unused zones with gaskets or air dams to eliminate air leakage.

A simple vacuum table system for an industrial application, including vacuum table with perforated surface, multiple ports, manifold, coolant collection barrel, shut-off valve, and vacuum pump.

If the process in question generates excessive heat it may require the application of coolant

VACUUM WORKHOLDING BASICS

Vacuum tables and vacuum table systems increase both quality and output in production settings. They can be used to hold a wide variety of materials in place for printing, cutting, machining, and numerous other industrial and manufacturing processes.

- Eliminate the need for clamps and chucks
- Allow the entire workpiece to be machined in one operation
- Significantly speed up setups and changeovers
- Reduce production downtime and wastage

Vacuum tables ensure work surface flatness, and systems can be configured to meet specific production requirements. A range of system options are available, targeted to various industries and processes.

- Lift and registration pins
- Custom cutouts and pocket positioning
- Anodized and scratch-resistant surfaces
- Custom port placement and configuration

Some vacuum systems may be reversed to blowback mode to achieve floatation of your workpiece. Vacuum tables have become a valuable tool for sensitive substrate holddown for close-tolerance manufacturing and wherever surface flatness is critical.

during processing. If the process generates excessive scrap material it may require cleaning during processing with blasts of compressed air.

In such instances it is advisable to use a grid-style vacuum surface with larger air holes and vacuum ports and integral drainage channels. Because it is vital that no coolant flow back into the vacuum pump, these systems typically utilize some form of coolant collection system to protect the pump from damage.

Most commonly associated with metal processing, woodworking, and the processing of various high grade plastics and composites, vacuum workholding systems have revolutionized production in many industries and disciplines. Large-scale cutting of non-porous fabrics such as sail and tent making is done on vacuum tables. Furniture upholsterers use vacuum systems to compress batting during manufacturing, and vacuum tables are increasingly used in industrial stripping, delamination, ply separation processes, and in the expanding, environmentally-friendly resource recovery and reuse sector.

"I don't even know all of the potential customers, because I regularly hear from people in new industries with new applications," says Michael Green, president of Graphic Parts International, a division of the Chicago-based A.W.T. World Trade Group, which manufactures vacuum tables for a wide range of clients in numerous fields, including many custom designs. "Meeting the specific needs of new customers has led to some of our most important design innovations."

G.P.I.'s customers demonstrate the versatility and variety of vacuum workholding solutions. A local high-end bass guitar maker with an international reputation and elite clientele uses vacuum table systems for complex routing of hardwood guitar bodies. Freedman Seating, a large manufacturer that makes the fittings for the Chicago Transit Authority's buses and trains uses vacuum workholding systems for various metalworking processes at its Chicago plant. Multi-national aerospace and high technology manufacturing corporations such as Boeing, GE, and Agfa utilize vacuum tables in their close-

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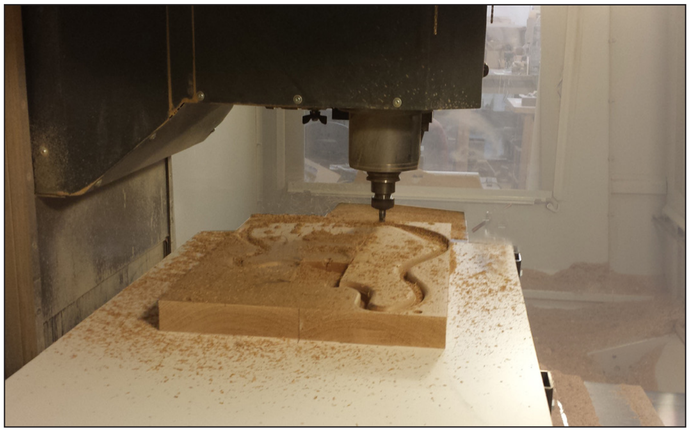
HUNDREDS OF COMMERCIAL, INDUSTRIAL and INSTITUTIONAL APPLICATIONS

Vacuum workholding systems are used to improve countless processes from heavy industry and woodworking to aerospace engineering and scientific research. Vacuum holddown is reliable and stable, simplifying and standardizing production procedures, saving users time and money.

- CNC mills, lathes, cutters, routers, drill presses
- Aerospace developers and research laboratories
- Laser cutting, surface grinding, application of coatings and adhesives
- Fine art restoration and rostrum camera work
- Wood, metal, glass, composites, plastics, fabrics, synthetic materials
- Upholstery, sail making, tent and canopy manufacturing

Vacuum workholding systems are suitable for processing a wide range of materials including sensitive and delicate substrates such as fabrics, glass, and high-grade composites. Clamp-free holddown of workpieces limits damage and reduces production wastage.



Vacuum workholding systems allow several complex operations to be performed in a single setup. Here a guitar body is routed from dense hardwood stock without clamps.

tolerance and highly regulated manufacturing operations both in the US and around the world. Another emerging use for vacuum tables is in the high-quality artistic and photographic restoration conducted by universities, museums, and art galleries. Educational institutions and filmmakers also use vacuum systems for rostrum camera work and image archiving projects. Vacuum tables are also extensively used for precision measurement of both flat and three-dimensional objects. In these instances the systems can be optimized to accommodate delicate materials. Whether a process involves stainless steel, wood, plastics, composites, or even valuable artwork or antiques, there is a vacuum system suitable to the specified material.

Look out for Leaks

The evolving nature of vacuum system technology, combined with the fact that vacuum systems are typically ancillary to larger operations and the fact that vacuum holddown is used so differently across so many different industries, has created a situation in which even as vacuum tables become more ubiquitous there remains a lack of comprehensive information and expertise available to production managers seeking to implement vacuum workholding systems to improve their operations.

Even technicians who understand basic vacuum concepts may fail to appreciate the importance of carefully configuring each system for efficient operation to create adequate hold down force at the work surface. Air leaks and airflow inefficiencies account for the vast majority of problems users encounter when calibrating vacuum workholding systems. These problems will not be solved by simply adding a larger vacuum pump.

A vacuum table system draws air through the spoilboard (usually MDF if one is used), the table surface, the plenum, a sequence of ports, flanges, hoses, valves, and fittings to the vacuum pump. To achieve optimal system operation there must be no air leaks at any juncture in the configuration. Moreover, the hoses and fittings must be connected tightly, with the shortest runs possible, no kinks or obstructions and minimal use of elbows and sharp changes of direction.

Again, efficient holddown of the workpiece is achieved by balancing suction and system airflow. For this reason it is critical that the part be flat against the vacuum table surface. It is also important that the plenum be deep enough and fittings be large enough to prevent reduction of the necessary pressure differential to maintain holdown of the part as it is processed. An improperly configured or installed system may not achieve adequate suction until such errors are corrected. Vacuum table systems should be regularly tested to ensure system integrity. Vacuum gauges and ultrasonic leak detection devices may be used for this purpose.

An airtight case

With an appropriate system properly configured and installed, and all the kinks worked out, business owners and production managers should rapidly reap the many rewards of vacuum workholding technology in the form of tangible workflow improvements and lower costs.

Clamps, chucks, fasteners, and adhesives can be eliminated along with the time-consuming manual processes these items entail. Handling of delicate substrates, production materials, and costly components is minimized or eliminated. Production quality and consistency are enhanced.

For metal processors and woodworkers it means faster setups and changeovers, along with reduced downtime and wastage. In laboratory and nanotechnology settings, microscopic measurements and complex processes can be performed under controlled and replicable conditions. For screen and digital printers this means ultra-precise registration and outstanding image repeatability.

In any application, versatile, safe, stable, and efficient vacuum tables and vacuum workholding systems deliver higher quality results and increased productivity across all platforms, leveraging a reliable technology that is being expanded, improved, and adapted to new industries and processes all the time.

AIRFLOW ANALYSIS AND SYSTEM CALIBRATION

The vast majority of problems users may encounter with vacuum workholding systems during initial setup or subsequent operation are due to improper configuration of the system and/or undetected air leaks. There must be no air leakage for the vacuum to achieve an optimal pressure differential with the ambient atmosphere. Conduct a complete airflow analysis to calibrate the system.

- Analyze airflow and pressure characteristics throughout the system
- Verify holddown (suction) force across all zones
- Measure the efficiency of vacuum distribution across all zones
- Detect and correct system leaks

Air leaks can occur at any insufficiently sealed connection or unused work zone. Follow simple vacuum system protocols to keep your system running efficiently. Seal all unused air holes and work zones.

- Isolate the work zone with approved gasket material
- Seal the edges of MDF spoilboards if required for your operation
- Ensure that all hoses and pipes are the straightest, shortest possible runs, free of holes, and securely clamped or connected
- Check all system fittings, connections, and clamps regularly for airtightness

Systems will perform inefficiently if the surface of the workpiece against the vacuum table is not flat. Use a level or straight edge to check the flatness of the part or the vacuum table surface.