Use of Diaphragm Chucks

Most of us are familiar with the standard 3-jaw chuck used for either first or second turning operations. This type of chuck has a sliding master jaw that moves to grip the part. This chucking method is adequate for first operation work from a saw cut blank or a forging/casting material. However, using this type of sliding jaw chuck for second operation turning may not be as easy.

Producing a true and concentric second operation can be difficult when holding the part with a standard sliding jaw chuck. What options are there? – A diaphragm chuck.

Diaphragm chucks are similar to old-fashioned diaphragm oil cans. The machine draw bar pushes the face of the diaphragm and bends the plate forward. This results in an outward movement of the jaws, sometimes as much as 1/8", allowing the jaws to open 0.080" in clearance.

Note on this sketch that the face of the chuck is pushed (bent) open, allowing the part to be loaded. When the stroke of the draw bar is reversed the chuck returns to its natural state and grips the part.

Diaphragm chucks are a good choice for more difficult applications where repeatability and minimum concentricity characteristics are a must. Standard sliding jaw chucks often wear, resulting in loss of performance especially in regard to concentricity.

I have always been a fan of the diaphragm chucks produced by Woodworth Chucks, although this type of chuck is available from several sources.

Installing the Chuck

When initially mounted, the master ring is ground true with a grinding attachment. This ensures the best conditions for achieving consistent, near perfect concentricity.

Hardened pads on the jaws grip the individual part to the required size. These hardened insert pads are located on the chuck by means of the ground master location ring. The pads are manufactured to high quality standards, further ensuring the inherent quality of the work holding method.

This type of chuck provides a pull-back effect; as the part is gripped, the chuck pulls the part back against the location face.

The sketch illustrates a 7" long part approximately 4.00" in diameter. The chuck achieves a maximum speed of 2500 RPM and the grip length is only 1.25 long. This part is hanging out a long way and spinning pretty fast -- but the chuck provides a secure gripping performance considering the forces that affect the part.

By its very nature this type of chuck is designed for second operation type work. The machining process must be controlled to limit the amount of facing stock to be removed. A rule of thumb of 0.080" maximum facing stock works well. There should be no situation where a greater amount of facing stock is needed. Remember, the most dangerous point in a facing operation is when the maximum RPM is reached – with the tool at centerline.

Disadvantage of Diaphragm chuck

There is always a down side, so let’s consider a disadvantage of the diaphragm chuck. As the jaws open and close, the face of the diaphragm is consistently flexing. The net result is potential metal fatigue as the steel eventually starts to show hairline cracks.

Some work holding companies make the flexible device from a forged blank instead of a saw-cut billet. The idea is that a forging has a longer life due to the internal grain flow of the material.

The flexible component of the chuck eventually starts to fail. The manufacturer should be able to provide guidance regarding the number of cycles that can be expected prior to failure.

An inspection procedure should be developed and used to regularly look for cracks in the face of the diaphragm. In my experience, it is only a matter of time. The life of the diaphragm is a serious factor to consider when selecting the type of chuck for your application.

The use of this type of work holding provides consistent repeatability and great concentricity. The application shown in the sketch has been in service consistently for over 15 years. This might be a good method if you have a difficult second chucking operation.