



Self-Advancing Step-Tap Drills

It is not necessary to apply axial drilling forces.

Lyndon B. Johnson Space Center, Houston, Texas

Self-advancing tool bits that are hybrids of drills and stepped taps make it possible to form threaded holes wider than about 1/2 in. (about 13 mm) without applying any more axial force than is necessary for forming narrower pilot holes. These self-advancing stepped-tap drills were invented for use by space-suited astronauts performing repairs on reinforced carbon/carbon space-shuttle leading edges during space walks, in which the ability to apply axial drilling forces is severely limited. Self-advancing stepped-tap drills could also be used on Earth for making wide holes without applying large axial forces.

A self-advancing stepped-tap drill (see figure) includes several sections having progressively larger diameters, typically in increments between 0.030 and 0.060 in. (between about 0.8 and about 1.5 mm). The tip section, which is the narrowest, is a pilot drill bit that typically has a diameter be-

tween 1/8 and 3/16 in. (between about 3.2 and about 4.8 mm). The length of the pilot-drill section is chosen, according to the thickness of the object to be drilled and tapped, so that the pilot hole is completed before engagement of the first tap section. Provided that the cutting-edge geometry of the drill bit is optimized for the material to be drilled, only a relatively small axial force [typically of the order of a few pounds (of the order of 10 newtons)] must be applied during drilling of the pilot hole. Once the first tap section engages the pilot hole, it is no longer necessary for the drill operator to apply axial force: the thread engagement between the tap and the workpiece provides the axial force to advance the tool bit.

Like the pilot-drill section, each tap section must be long enough to complete its hole before engagement of the next, slightly wider tap section. The precise values of the increments in diameter, the

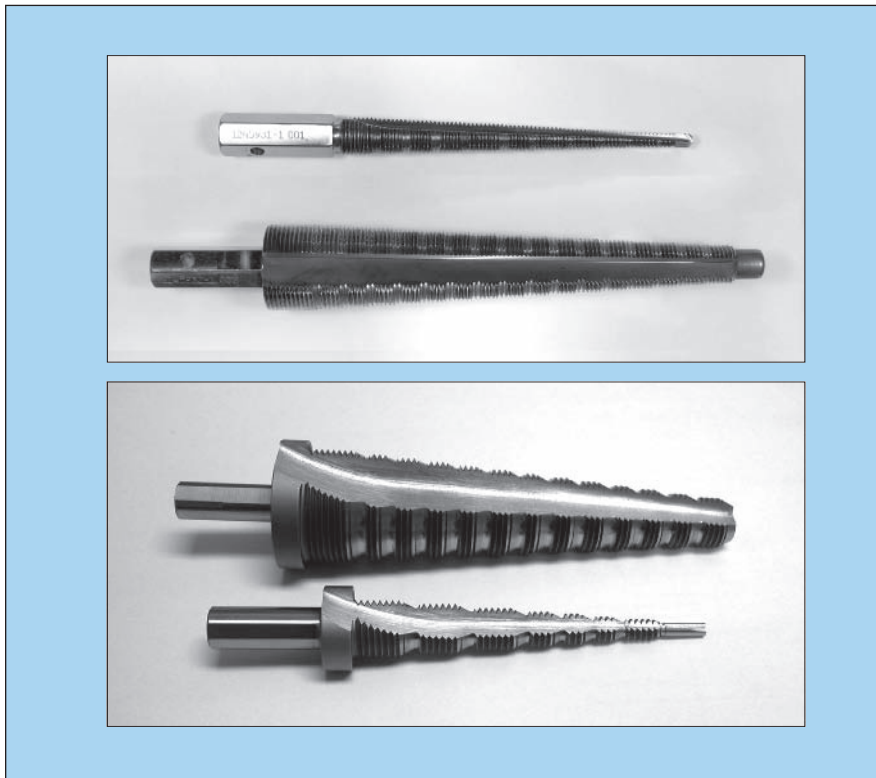
thread pitch, the rake angle of the tap cutting edge, and other geometric parameters of the tap sections must be chosen, in consideration of the workpiece material and thickness, to prevent stripping of threads during the drilling/tapping operation. A stop-lip or shoulder at the shank end of the widest tap section prevents further passage of the tool bit through the hole.

There is a large potential market for self-advancing stepped-tap drills in settings in which hand-held drills are used. Applied axial drilling forces can be quite large: it is not unusual to exert axial forces as much as 75 lb (≈ 330 N) when drilling holes up to about 1 in. (≈ 25 mm) in diameter. A person usually bears down on a drill with body weight to facilitate downward drilling, and drilling upward is extremely fatiguing. Repetitive drilling, which is often done in the construction industry, is fatiguing and limits worker productivity. Moreover, applying a large axial force with a hand-held drill can be dangerous: the drill bit can grab the workpiece, causing the workpiece to spin or tearing the drill from the worker's hand.

By making it unnecessary to apply large axial drilling forces, self-advancing stepped-tap drills could reduce fatigue while contributing to safety and productivity. Self-advancing stepped-tap drills could be made in a variety of designs optimized for making holes of specific diameters in specific workpiece materials having specific thicknesses. For applications in which the threads were not merely incidental to making the holes but were also needed to engage bolts, the tool bits would also be optimized for specific thread geometries.

This work was done by Donald R. Pettit and Charles J. Camarda of Johnson Space Center, Ronald K. Penner of Langley Research Center, and Larry D. Franklin of Action Tool Service, Inc. Further information is contained in a TSP (see page 1).

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23954.



These Tool Bits are examples of many variations on the basic theme of a self-advancing stepped-tap drill.