

# UNION BUTTERFIELD

Asheville, N.C.

## Why Do Taps Fail?

**The only way to completely eliminate tapping problems is "No Quote." But the problems can be reduced considerably by using these suggestions that were presented at the Twelfth Annual National Technical Conference sponsored by the National Screw Machine Products Association.**

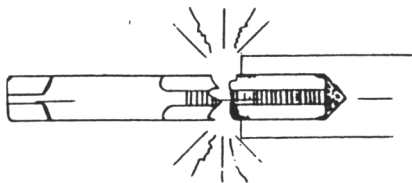
The main causes of tap failure, of course, are breakage, chipping, torn or rough threads, oversize or bell-mouth holes, and excessive wear. The number one cause of tap breakage is drilling the hole size too small. The

remedy, of course, is use the correct drill size. In many cases, a greater percentage of thread than normal is required. But if there is no requirement, use about 65 percent thread—this will provide plenty of strength.



Another cause of tap breakage is bottoming in the hole. There are several things that can be done to eliminate this problem. First, of course, drill the hole deeper if at all possible.

The next thing is to adjust the chamfer angle so that the tap can get close to the bottom without actually bottoming in the hole. Finally, adjust the stroke and use a positive reverse.



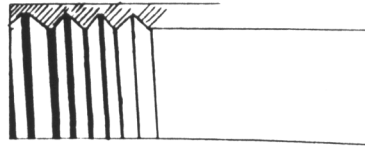
Misalignment of the spindles will contribute to tap breakage. All spindles in all stations should be aligned.

A tap will not tap around a corner although many operators have tried to make one do this very thing.



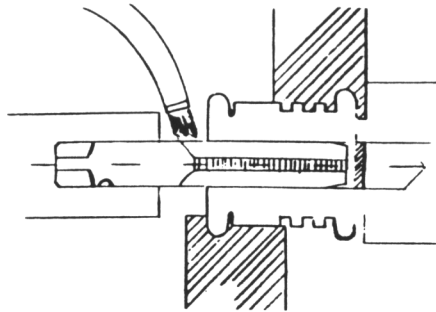
An excellent way to tell if there is misalignment is to cut the workpiece and look at the roots and crests of the

threads. A variation in the truncation of the root and the crest is a very good indication of misalignment.



When coolant cannot get into the hole to lubricate the tap and wash out the chips, tap breakage can be expected.

Be sure to check the setup to allow plenty of coolant in the working area.



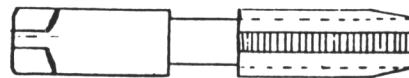
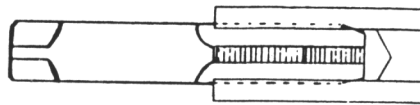
As a tap gets dull, torque builds up and breakage is very probable. Usually, the first indication of a tap getting dull is tight gaging. A tap should be resharpened by machine—not by

hand. The tap chamfer has to be concentric, all the threads must be sharp and, occasionally, it may be necessary to grind the face of the tap if it has been chipped.



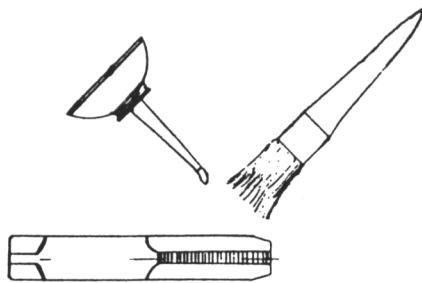
Tapping deep holes can cause taps to break. When taps are manufactured, whether their flutes are milled or ground, the web is heavier in the back due to flute run-out. When tap-

ping deep holes, it may be necessary to machine a neck in the tap, below root diameter, in order to get coolant down into the hole to wash out the chips as well as lubricate the tap.



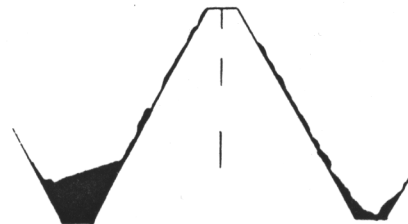
Lubrication is a very, very important factor in tapping. The type of lubricant used in the screw machine is limited because of other tooling. Sometimes it is necessary to sacrifice on the type of lubricant used for tapping because of the benefits obtained

on the other operations. Sulphurized oils are excellent for tapping; however, they cannot be used on aluminum or some other materials because of the staining. Improper lubrication is going to cause chipping and ultimately, of course, the tap will break.



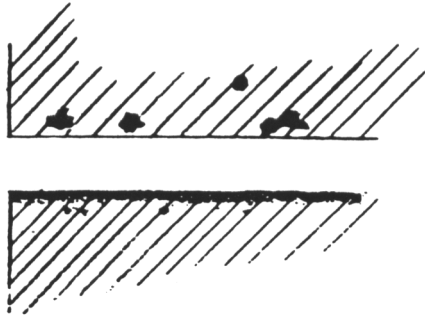
With improper lubrication, loading is visible on the flanks of the thread. The workpiece material becomes welded right to the flanks of the thread. The best remedy, of course, is proper lubrication. Another corrective measure — surface treating the taps — can be provided by the tap manufacturer. There are four basic types of surface treatment, but there may be variations of them. The nitride or cyanide case-hardening is where the tap is immersed in a bath of cyanide salts at a temperature of about 1050°F for a certain amount of time, depending on how deep the case-hardening should be—anywhere from 0.0002 to 0.002 inch. The steam-oxide treatment is really a controlled rusting. If two pieces of steel are to be welded together, they must be absolutely clean in order to get a good weld. Steam oxide is just the reverse—an actual rusting of the tool. In addition, the oxide surface has some porosity and will retain the lubricant.

A third type of surface treatment is chrome plating. This is not chrome plating like a jeweler would use but a flash chrome—a buildup of chrome maybe 30 millionths of an inch thick. Chrome is harder than the base metal and has a low coefficient of friction. However, there are some applications where chrome can be detrimental. Another treatment occasionally used, particularly for pipe tapping and cast iron, is an XL treatment, which is simply a vapor-blast after a nitride treatment. This will take the feather edge off the cutting edges of the tap to eliminate waviness and chatter.



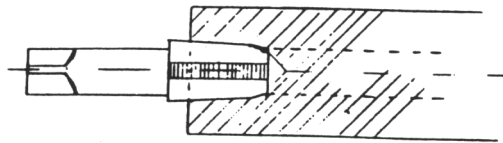
Very fast wear and chipping in a tap can be caused by a workhardened surface or hard spots. The hard spots may be inherent in the material; however, in many cases the surface has been workhardened during the drilling operation. There have been

cases where 316 stainless steel has been workhardened up to 47 to 50 Rc. If workhardening isn't too severe, the geometry of the tool can be adjusted to accommodate the condition; also, more exotic materials can be used in the tap.



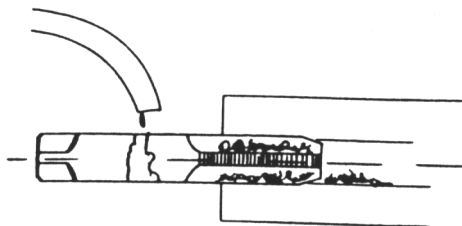
If a tap doesn't break from bottoming in the hole or tapping too close to the bottom of the hole, the threads will probably become chipped. The chips get packed behind the relief on

the chamfer and when the tap is reversed, the chamfered teeth become chipped. Again, adjust the stroke, check the reversing stop and, if possible, deepen the hole.



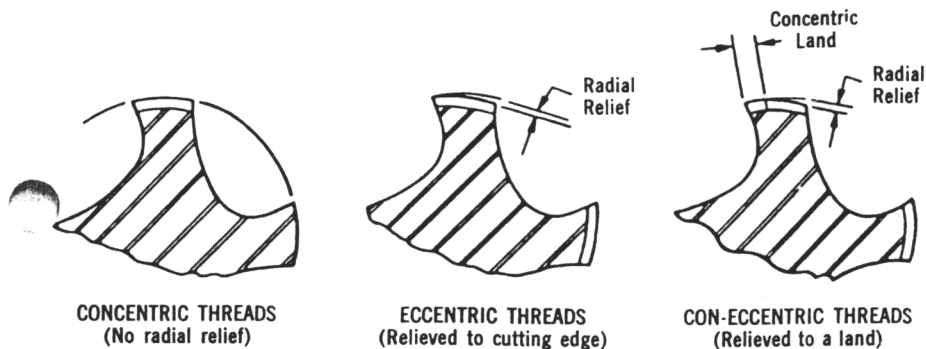
Torn and rough threads are usually caused by loading of the tap. To overcome this problem, increase the flow

of coolant to wash those chips from the cutting area or use a surface-treated tool.



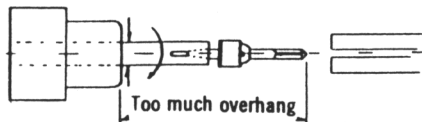
Three basic types of relief are used on taps. The concentric (no relief) is usually found on small-diameter taps and those having narrow lands. The pitch diameter is ground with about 0.001 to 0.0015 inch per inch back taper along the thread. This type relief is found on most standard taps. The eccentric or radial relief provides a very free cutting action; however, the cutting action may be erratic. The danger of using this type relief on standard taps is that chips can become packed behind the relief area and when the tap is reversed, chipping or breakage can occur. But if a spiral-point tap (or gun-style tap as it's sometimes called) is used, the chip is forced ahead of the cutting action and there is no danger of the chip becoming lodged behind the relief area. This type relief is very beneficial

for tapping the harder materials and for use on automatic equipment. A word of caution—when tapping soft materials or when hand tapping or even feeding a tap by hand without a leadscrew, an oversize thread may be produced. Large-diameter taps and those having wide lands are ground with con-eccentric relief as well as back-taper relief. The increased thread contact area associated with the wider lands contribute to heat buildup and rubbing. The full eccentric relief would reduce this contact area but the cutting action would probably be erratic. Therefore, the first one-fifth to one-third of the land is provided with a concentric margin to steady the tap and the remainder of the land has a radial relief to eliminate rubbing and the associated heat buildup.



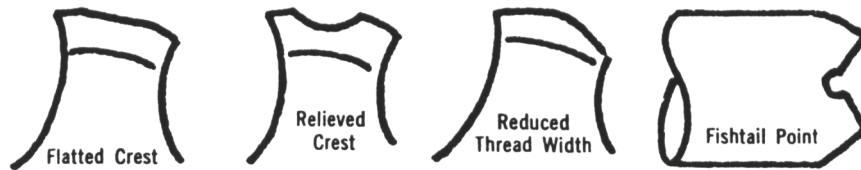
Too much overhang will contribute very heavily to tap breakage. The tap dips down when it approaches the workpiece and it has to be forced up.

It's very destructful to the tap. The remedy, of course, is to repair the spindle to reduce that overhang as much as possible.



Some adjustments can be made to the tap right in the toolroom to reduce rubbing or heat buildup. The flattened crest is achieved by simply running a grinding wheel down the length of the crests on the land of the tap. The relieved crest is similar except a wheel with a radius edge is used. The easiest procedure is to re-

duce the thread width; that is, just thin the land section by grinding off the heel with about a 45-degree angle. The fishtail point is used occasionally for tapping near the bottom of a hole. This configuration will chew up the chip and make it easier to flush out. It isn't used very often but it is effective.



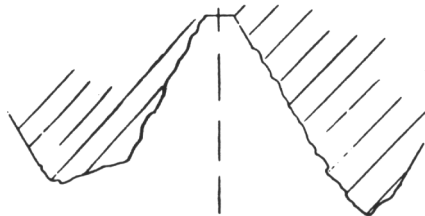
When the problem is tapping oversize or bellmouth holes, make sure the lead cam or leadscrew has the same lead as that of the tap. Otherwise, thin threads will be produced because the tap will try to jump its

lead. This also happens occasionally when air pressure is used on the tapping head or a spring-loaded tapping head is used. It is best to use a head with axial float when a lead cam or a leadscrew is used for tapping.



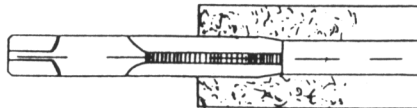
The thread shape will sometimes change because the chamfered threads are trying to find a lead. This

same condition can also be caused by loading. The remedy is adequate lubrication or surface treat the tool.



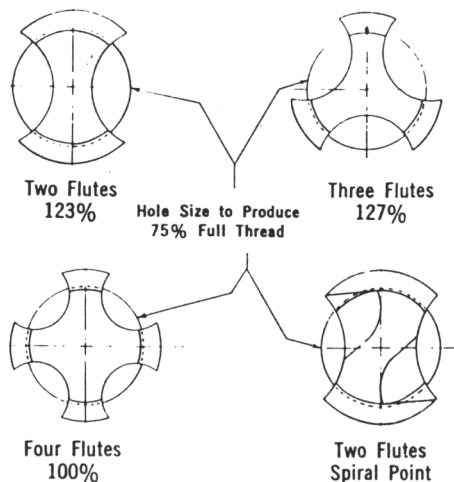
When the more hard and abrasive materials are being cut, rapid wear will take place. This will usually start as a rounding of the crests. To overcome this abrasion, adjust the hook

angle and use a heavy surface treatment. It is also helpful to start with a larger size tap to allow for some of this wear. Use the maximum size possible without exceeding tolerances.



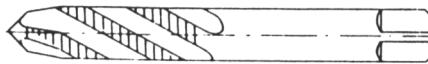
In a small tap, there's a limit as to how many flutes can be employed, but there's a reason for having a different number of flutes besides the size. There is a 27 percent gain in flute space by using a three-flute tap instead of a four-flute. There is one less cutting land, but this extra chip space is beneficial in some cases. With a two-flute tap the gain is only 23 percent. There's an age-old argument — which is the stronger tool, the three-flute or the two-flute? Frankly, torque tests have been inconclusive — they have gone both ways. The author pre-

fers to use a three-flute because it provides maximum chip space and yet has that extra cutting land. Also, a three-flute tap has a tendency to cut closer to size than a four-flute or a two-flute will. However, the spiral-point tap should be used wherever possible in screw machine operation, particularly if there is enough space at the bottom of the hole to receive the chip. This is the strongest cutting tap made and there are no chip problems because the chips are forced out ahead of the tap. They are also available with three flutes.

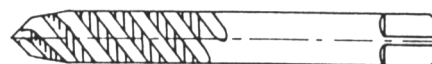


With severe chip problems, sometimes it may be necessary to use a spiral-fluted tap. These are normally recommended for soft ductile materials. The slow spiral is best for screw machine work while the fast spiral is

normally used vertically. These taps will pull the chip out of the hole and get it out of the way so there won't be any problem of too many chips packed in the flutes—a frequent cause of tap breakage.



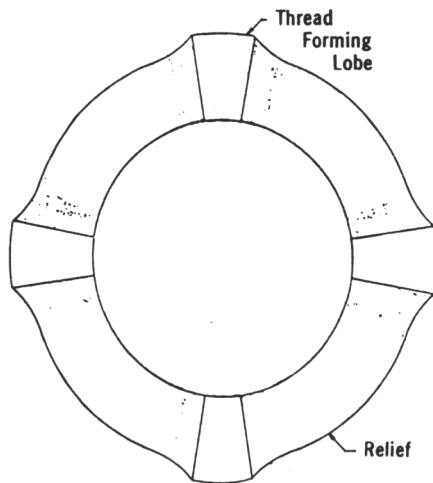
Spiral Flute



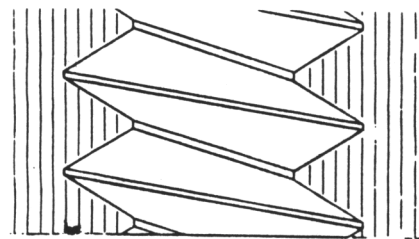
Fast Spiral Flute

The Rol-Form or extruding tap is becoming more and more popular. The smaller ones have two or three lobes while the real large ones might have as many as eight or ten lobes. Now this tap, of course, extrudes the metal by plastic deformation — the thread is formed without any chips—and it is necessary to adjust the hole size. With a cutting tap, the hole size is determined by the root diameter; whereas, with a Rol-Form tap, the hole size is determined by the pitch diameter because the metal is being

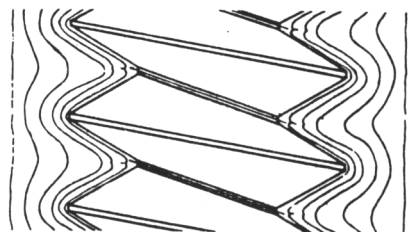
pushed up and down. With these taps, it's almost essential that they be surface treated for given materials because the risk of loading is much greater on these tools than on a cutting tap. These tools can be furnished with a lubrication groove. There's an argument as to whether it is beneficial or not. Some people claim that it is possible to actually explode a casting with a Rol-Form tap by hydraulic pressure if there is no lubrication groove. The groove is located in the relief section.



Cross-Section Showing Relief of Thread-Forming Tap



Threads Made With A Cutting Tap



Threads Made With A Forming Tap