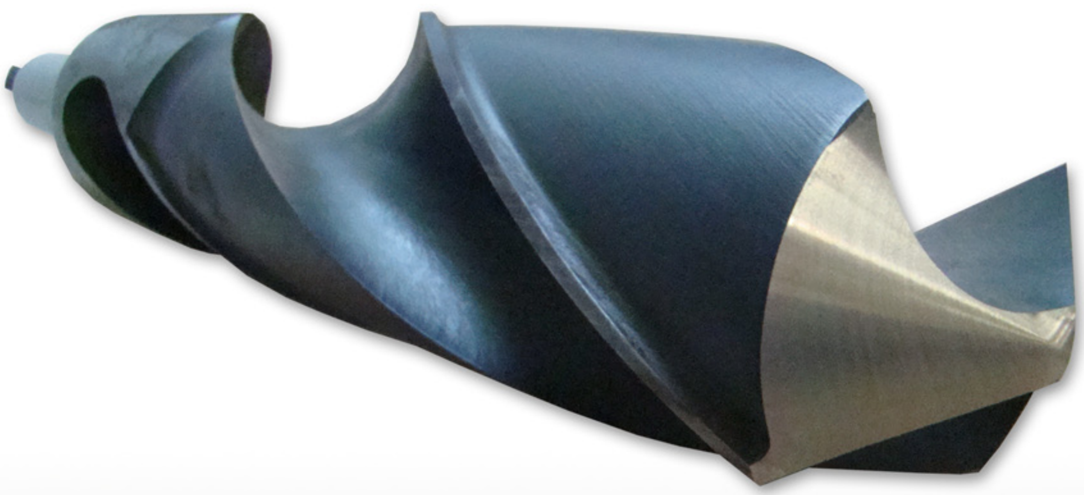
OLIVER OF ADRIAN

HOW TO GET MORE & BETTER HOLES FROM YOUR TWIST DRILLS



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IT'S THE POINT!

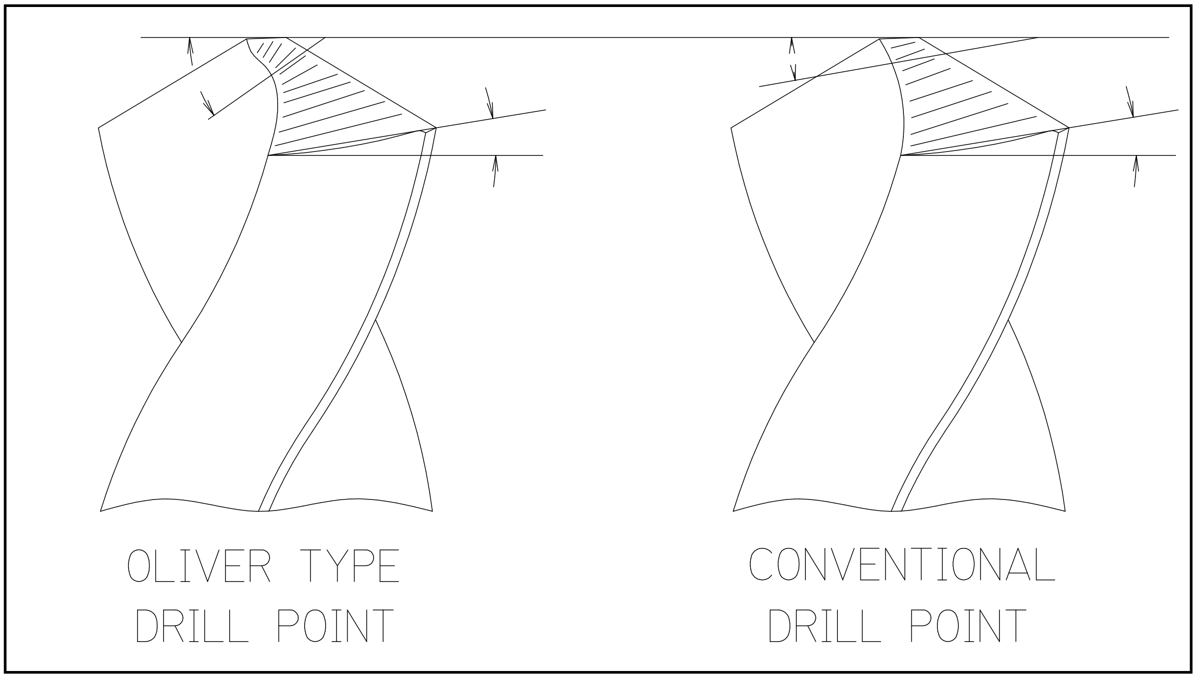


FIG. 1 – Comparison between Oliver drill point and conventional drill point.

The angle of the point, the cutting lip and its clearance must be kept right at every grinding to secure top results

PART I.

The success or failure of a twist drill is measured by the ability of the tool to penetrate the material being drilled as rapidly as possible and at the same time satisfactorily withstand the ensuing breakdown at the point for as long a period as possible. Since the bulk of all difficulties encountered in drilling are caused by faulty grinding of the point the importance of twist drill sharpening cannot be over-emphasized.

Basically, a good drill point consists of proper geometry together with correct clearances and concentricity. For this particular story we will not go into the matter of the various included point angles or clearance angles required for the many materials which are encountered in every day drilling operations. Most of the better commercial drill pointing machines which are available have provisions for varying the point angles and clearances. There are, however, many refinements which must be considered regardless of the included point angle or material being drilled.

Let us first consider the matter of lip clearance. The two locations where proper clearance is all-important is in the area near the leading edge of the cutting lip and at the chisel edge.

Generally, when viewing the drill point from the side to determine whether or not a proper lip relief angle has been secured, the user is confronted with an optical illusion. In many instances the line formed at the juncture of the land and the relief angle will actually seem to turn upwards at the trailing edge. This all too frequently gives the user considerable concern over the problem.

The remedy employed by drill users far too often in this situation is to either increase the degree of clearance or add some type of secondary clearance. The use of more clearance to produce a satisfactory looking trailing edge in most instances will result in too much clearance at the vital leading edge.

The real source of worry is usually found in the section near the leading edge of the cutting lip as previously indicated. Our engineering department has had the opportunity of checking many drill points that are being produced in the tool rooms of industry. In all too many of the cases, when the drill point has been indicated, we have found little or no clearance and even reverse clearance at varying locations behind the leading edge of the cutting lip. There is of course a definite relationship between the rate of feed and the lip relief required. In the situations just mentioned insufficient clearance, too heavy a feed or a combination of both will set up an interference which will result in the poorest of drilling conditions and at the same time will cause damage to the drill prematurely.

A necessary evil on any drill point is the chisel edge.

In theory this portion of the drill does not function as efficiently as the cutting lips. Therefore, some attempt must be made to make this central portion of the drill point more effective as a cutting agent. If no attention was given to this central portion of the point the result would be highly disastrous and could be compared with an attempt to push a broom handle through a cement floor.

The cutting ability of the chisel edge is controlled by three different dimensions. They are the thickness of the web at the point, the chisel edge angle and the relief or clearance angle on the chisel edge. The matter of the front web will be discussed in succeeding paragraphs.

The chisel edge angle on drills can be varied at will. Common practice places this dimension at from 105° to 135°. Obviously, the smaller angle would reduce the length of the chisel edge. As an example, by changing the chisel edge angle from 135° to 110°, the length of the chisel edge is reduced 25.75%.

A chisel edge angle of approximately 110° will afford the user of twist drills a two-fold advantage.

First, more of the cutting action is transferred to the positive acting cutting lips. This, in turn, reduces the work load normally assigned to the chisel edge. Secondly, the usually all-important matter of hole size receives favorable treatment. Experience has shown that a reduction in the chisel edge angle will permit closer tolerances on drilled hole size.

A further development which has succeeded in making the chisel edge a highly practical cutting agent has been the introduction, by Oliver of Adrian, Inc., of a drill pointer that produces increased amounts of clearance toward the center of the drill. You will note in the illustration (see figure No. 1) a comparison between the normal point and the Oliver type point.

For a drill to be theoretically perfect, it is absolutely necessary that the clearance or lip relief angle be increase as the center of the drill is approached.

The reason that the lip relief angle must be different at every point along the cutting edge is illustrated diagrammatically in Fig. 2.

The rate of feed, or spindle and drill advance per revolution, is constant and is shown in exaggerated form by the distance X, indicated by a series of broken parallel lines. The helical path traversed by a point B on the periphery of the drill in one revolution is indicated by the projection BAC. The helical path traversed by a point E near the center is indicated by the projection EGF.

Since distance X, or the pitch of these two helical paths, is the same in both cases, angle Y of the smaller diameter helix EGF is greater than angle Z of the larger diameter helix BAC. The minimum theoretical clearance necessary for the drill to penetrate is one-half the angle of the helices; therefore, the clearance or lip relief angle must increase from the periphery to the center of the drill. This essential variation in lip relief angle is one of the principal objections to hand grinding.

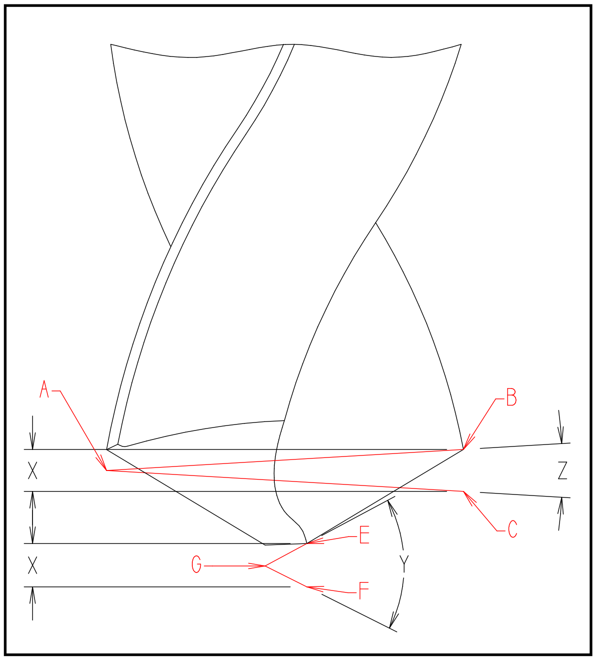


FIG. 2 – LIP RELIEF ANGLE must be different at every point along the cutting edge.

The lip relief angle commonly found at the periphery of the drill is generally greater than necessary.

This, of course, results in a thin projecting edge which is readily susceptible to an early breakdown. A reduced clearance at the periphery is much more satisfactory as long as the necessary provision is made to increase the clearance as the center of the drill is approached. Figure 1 illustrates this feature quite well. This increased clearance at the chisel edge combined with a 110° chisel angle and proper lip clearance at the leading edge gives the drill user the fundamental requirements for easier penetration and longer drill life when coupled with proper front web thickness.

The experimental laboratory of one of our American universities ran a test to enable them to make a comparison between the ordinary point and the Oliver type point. The comparison was made by measuring both torque and thrust.

The chart shown in figure No. 3 is typical and was based on using a 1" diameter drill in cold rolled steel. A similar test was run with 1" diameter drills in cast iron with almost identical results obtained. The ordinary type points in this test consisted of 118° included point angles, 7° clearance or lip relief and a 135° chisel edge angle. The Oliver points were 118° at the included angle and had chisel angles of 110°. The lip relief angle was varied as the center of the drill was approached in accordance with the previous recommendations.

The average reduction in torque afforded by use of the Oliver type point was 22.0%; the average reduction in thrust was 25.2%. The drilling machine requires far less horsepower and is subjected to considerably less wear and tear. The twist drill is also freer cutting. This, of course, results in more holes drilled per grind and less down time on the machine. In the next installment the author will discuss the importance of keeping webs on center and the lands equally spaced.

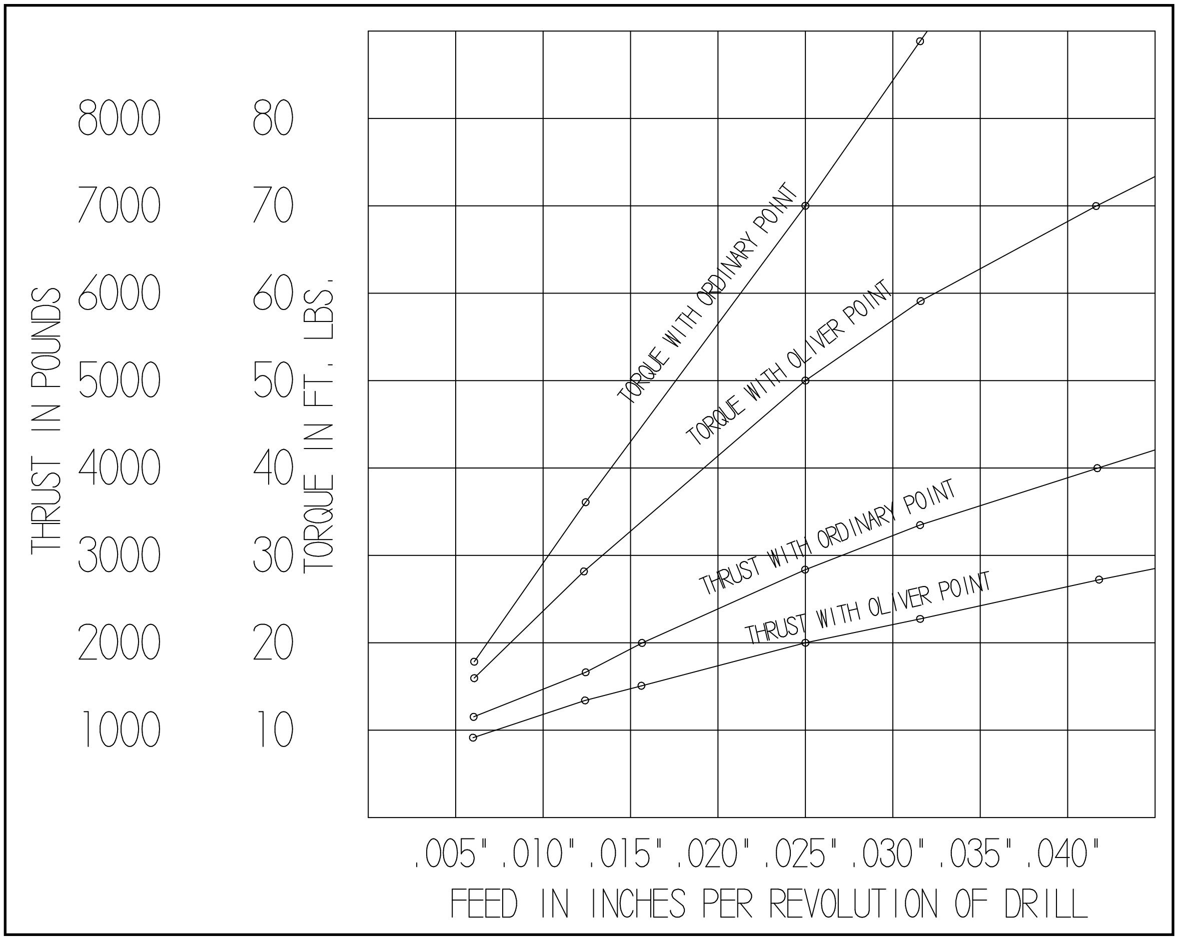


FIG. 3 – TORQUE AND THRUST TESTS

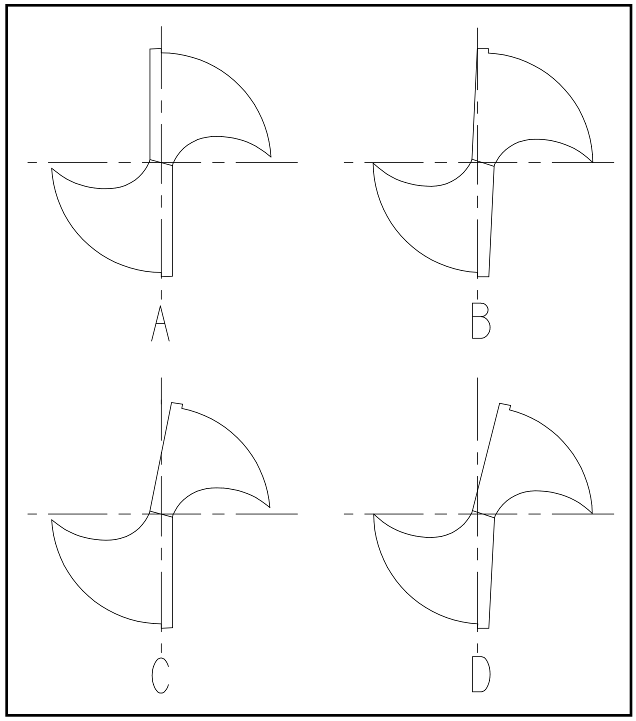
Variations obtained when grinding drills by machine and hand, and the importance of the drill pointer and point thinner

PART II.

The geometry incorporated in the twist drill at the time of manufacture or by regrinding performed in the tool room of the user plays a very important part in the life of the drill. The three conditions in this field which contribute the most to ineffective drilling are webs off center, unequally spaced lands (not 180° apart) or a combination of both.

The illustrations (Fig. 1) are representative of these conditions. View A shows the ideal twist drill. The web is central, the lands are equally spaced, chisel edge is through center and the cutting lips are of equal length. View B illustrates a twist drill with the web off center. Even though the lands are equally spaced and the chisel edge is through center the faulty location of the web causes the cutting lips to become unequal in length. View C represents a twist drill with the lands unequally spaced. The web is central and the chisel edge is through center. The incorrect spacing of the lands has caused the cutting lips to assume unequal lengths in this instance also. View D shows a drill with both unequal spacing of the lands and an off center web. While the chisel edge is through center the cutting lips are once again of unequal length.

In all the preceding instances it is to be noted that the chisel edge has passed through the center. This is characteristic of most mechanically ground points. At this time we should also consider the variations which can be obtained when grinding drills by hand.

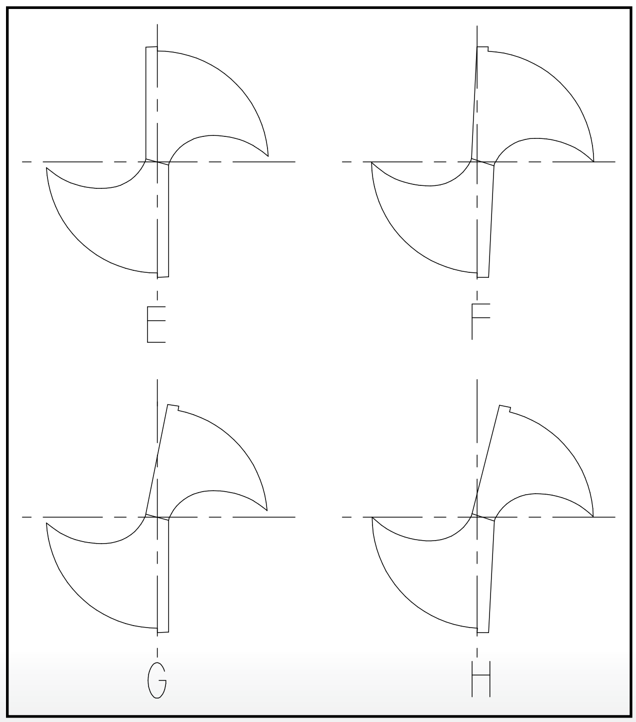


1-CONDITIONS CONTRIBUTING to ineffective drilling shown in B, C, and D.

Hand drill pointing permits the operator to use a great deal of flexibility.

Most of this flexibility is highly undesirable and any effort to correct one existing fault simply produces another. Once again we show illustrations (see figure 2) of drills with the three basic faults previously mentioned. This time, however, our thinking is confined to hand grinding of the drill points.

View E shows the desired results. The web is central, lands are equally spaced, the chisel edge is through center and the cutting lips are of equal length. View F represents a twist drill with the web off center. The lands are equally spaced. The user in this instance was able to obtain cutting lips of equal length, however, this resulted in the chisel edge failing to pass through the center. View G illustrates a twist drill with the lands unequally spaced. The web is centrally located. Here again the user was able to secure cutting lips of equal length but only at the expense of having the chisel edge off center. View H shows a drill with both off center web and unequally spaced lands. Once again it is only possible to obtain cutting lips of equal length by having the chisel edge off center.



2-BASIC FAULTS OF HAND GROUND DRILLS SHOWN IN F, G, AND H.

Unequally spaced lands on twist drills will also contribute to another highly undesirable condition.

The incorrect land spacing shown in View C of Figure 1 will cause a difference in the height of the cutting lips. Where this difference exists only one lip will do the majority of the work or at the very least will be subjected to a much greater work load. This will result in an increased rate of wear for the higher cutting lip and consequently a much shorter life for the twist drill.

Generally, you will only find drills with lands unequally spaced in the larger size range. The matter of off center webs is more often caused by the users in their own tool room. In an attempt to thin the front web to the proper thickness by hand (which will be discussed in subsequent paragraphs) it is extremely difficult for the user to keep the web evenly spaced. All of these circumstances i.e., webs off centers, lands unequally spaced or both, will cause ineffective drilling resulting in oversize holes, an unequal work load for the drill and of course an early breakdown of the drill.

The recommended solution to this problem is the use of both a mechanical drill pointer and a mechanical point thinner.

The drill pointer will give assurance that the chisel edge will pass through center. The point thinner is also an ideal tool for correcting unequally spaced lands.

In such a case the drill is ground across the entire front face of the cutting lip from the center to the outside corner of the point. The Oliver point thinner not only has provisions for correcting out of index lands but also assures the customer of securing the proper rake angle and flute shape.

This point thinning of twist drills is an art which is becoming extremely popular. The basic function of point thinning is of course to bring the front web back to a normal thickness after the drill has been repointed a few times. This is caused by the fact that the web increases in thickness towards the shank. The other contributing factor to the popularity of web thinning is the fact that standard drills can be altered in shape at the point to do a better job on many of the materials which must be drilled in our production shops.

The web thickness at the point is not a constant percentage but varies with the diameter of the drill until the larger sizes are reached. On an 1/8" diameter drill the normal front web supplied by the drill manufacturers is .025" or 20% of the diameter. On an ¼" diameter drill the normal front web is .044" or 17.6% of the diameter. On an ½" diameter drill the normal front web is .078" or 12.8% of the diameter. On an 1" diameter drill the normal front web is .128" or 12.8% of the diameter. It is common practice in the modern tool room to thin the front web of the twist drill to one-eighth of the diameter for average drilling conditions.

It should be noted that a twist drill is one of the most economical tools that can be purchased. To determine whether or not a drill should be thinned after the preliminary usage it is best to compare the thinning cost against the cost of a new drill. The resulting economics generally eliminate the thinning of small diameter drills. The minimum drill diameter for thinning from a practical standpoint is usually around 3/8".

The exception to this rule is the fact that even small diameter drills must be thinned at the point for certain drilling operations. The notable examples are the drills which are destined for use in the stainless steel family of materials. Stainless steel is work hardening and it is therefore desirable to thin the web at the point to permit the maximum amount of penetration before withdrawing the twist drill to clear the chips. The recommended procedure in this instance is to thin the web at the center of the flute. Heavy duty drills should be used and the web should be thinned at the point to about 40% of the normal thickness. This will increase the ability of the drill to penetrate to greater depths before clearing the chips. This will result in less frequent contact with the work hardened surfaces.

Commercial point thinning machines are extremely versatile. In thinning drills for cast iron or steel the grinding is usually confined to the central portion of the point. In thinning drills for some of the nonferrous family of metals such as brass or bronze the grinding is done along the leading edge of the cutting lips as well as the central portion. This, of course, reduces the rake angle and produces the same action as found in the use of slow spiral drills. Unfortunately, slow spiral drills are only available on a standard basis in the smaller sizes. Therefore, this type of thinning on the larger sizes will produce the desired results without purchasing special drills.

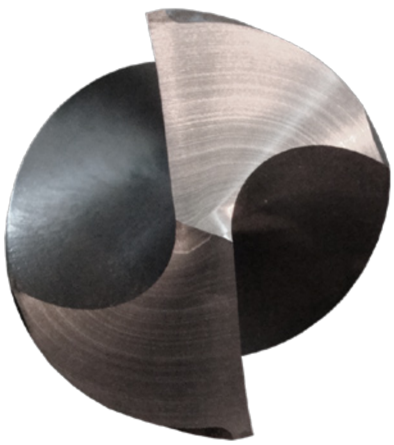
The drilling of laminated plastics is best accomplished by drills having zero degree rake.

Once again this feature is readily obtainable by using any of the better point thinners now available. Another advantage in having a point thinning machine in the tool room is the ability of the machine to grind full notch points for deep hole drilling. The machine can also be used to add chip breakers which are oftentimes necessary in the drilling of some of the tougher materials.

Here are six helpful drill sharpening hints:

1. ***Avoid operating twist drills until they are excessively dull.*** Minimum wear speeds resharpening and increases drill life.
2. ***Use chisel edge angle of approximately 110°.*** This will produce holes closer to size.
3. ***Increase clearance on cutting lips as center of drill is approached.*** This will permit easier penetration of the material being drilled.
4. ***Make certain the front web thickness does not exceed manufacturer's standards.*** Thick webs will increase the amount of thrust and torque required.
6. ***Check drills to make certain web is central.*** Off center webs will produce lips of unequal length.
7. ***Be sure the lands are equally spaced.*** Lands that are not 180° apart will produce lips of unequal length and unequal height.

The true value of the expenditures made for twist drills can only be obtained by incorporating accurate point angles, correct clearances and proper web thicknesses. The installation and use of drill pointing and point thinning equipment in your tool room is one of the soundest investments you can make in your plant.

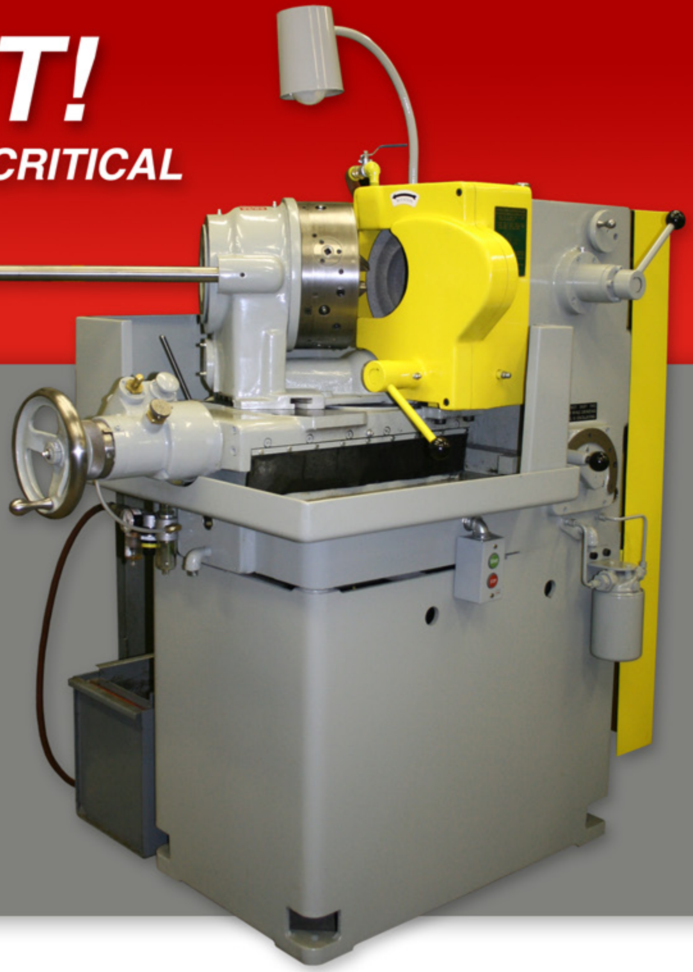


End view of the well known Oliver Point showing increased clearance at the center of the drill to reduce torque and thrust requirements while drilling.

Side view of drill with the "Double Oliver Grind" to produce a chisel angle complete with a central projection to aid in centering when used with numerically controlled drilling systems.

IT'S THE POINT!

When Sharpening Drills, PRECISION IS CRITICAL



OLIVER MODEL 600

The Oliver Model 600 Drill Point Grinder is the ideal machine for sharpening large diameter bits from 1/2" to 3" (76 mm), with the option to increase the maximum drill size to 4" (102 mm). The machine easily handles two flute, three flute and four flute drill bits. Variable included point angels are readily obtained and variable clearance or lip relief angles can be dialed in. The geometry that is best suited for your manufacturing procedures can be added to your drills easily and quickly.

The Oliver 600 creates a precision helical drill point, which provides superior penetration and longevity in comparison to a point created by a typical "swing grind" style grinder. In many applications, the Oliver helical point reduces the torque and thrust required by over 20%, resulting not only in a longer lasting bit, but a longer lasting drill machine as well due to less wear and tear. More holes drilled per grind means less downtime that can result in a substantial cost savings. This heavy duty, powerful and rigid grinder will cover a wide range of applications and provide many years of reliable service.

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