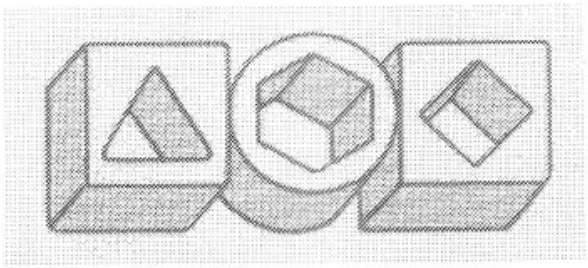

# WATTS

## FULL FLOATING CHUCKS AND DRILLS

FOR DRILLING SQUARE, HEXAGON AND OCTAGON HOLES

PRICES EFFECTIVE ..... 2004


**WATTS BROS. TOOL WORKS**

ESTABLISHED 1916

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# INTRODUCTION

It is our goal to make this catalog as informative as possible. It provides all of our expert knowledge on the subject of angular hole machining. With over 85 years of experience in this field we feel well-qualified and able to meet your special needs. If you require additional information, do not hesitate to contact us.

# EVOLUTION OF THE DRILL

In the days of our forefathers a round hole, as used in the mechanical field, was drilled by the use of a flat drill which was hammered out by a blacksmith. After being hardened and drawn to the proper temper, it was then ground to the size required.

In 1861, Steven A. Morse developed a twist drill for the drilling of round holes and in 1864, the Morse Twist Drill & Machine Company was founded. This was the beginning of the manufacture and sale of Morse drill from stock. In 1914, Harry J. Watts, now operating as Watts Brothers Tool Works, in Wilmerding, PA introduced angular drills for drilling polygonal holes (square, hexagon, and octagonal) by rotary motion. These ingenious tools have been successfully manufacture and supplied by Watts Brothers continuously since 1916.

# THE WATTS METHOD OF DRILLING

The perfection of broaching some years ago made the inexpensive production of through broaching practical. This was true only if the quantity was large enough to warrant the making of a special broach or tool. However, there was still no method of machining through angular holes where the quantity was not large. The same was true of blind angular holes until the Watts method was developed. Before the advent of the Watts method, such holes were make by the tedious "chip and file" method.

The tools for drilling by the Watts method consists of the Watts Full Floating Chuck, Angular drill, and Guide Plate. These tools may be used in an ordinary drill press, hand screw machine, engine lath, turret lath, or milling machine. In fact, they may be used in any place where a twist drill is used with the exception of automatics. The set-up time necessary on any machine for drilling holes by the Watts method is no longer than the time necessary to set up for drilling round holes using a twist drill.

**May want to rework this section because the drawing is not with the text.

# DRILING ANGULAR HOLES BY ROTARY MOTION

Perhaps the easiest way to understand how the Watts method of drilling angular holes by rotary motion works is to study the drawing below. The principles employed in drilling round holes are also followed in drilling angular holes. In other words, it is an accepted fact that the evolution of a circle is based on a series of minute chords of which there are 360 degrees to a complete circle. The cut shows the various positions of the cutting lips on the Square Drill as it rotates in the Guide Plate. It can then be noted that its center will not follow a circle, but a series of minute alternate cycloid-like curves whose chords are parallel to the sides of the hole being drilled. The Watts Full Floating Chuck is of such construction that it takes up this DRIVING and FLOATING motion and allows the drill to operate as freely as an ordinary twist drill.

While the rotary motion principle simplifies the operation of these tools, the depths obtainable are limited. The maximum depth for a particular drill is twice the distance across the flats; that is, a ½ inch drill will drill 1 inch deep, a 1 inch drill will drill 2 inches deep, etc. This however, will not affect the usual run of work, as the average angular hole is seldom deeper than once the distance across flats. Watts Angular Drills are available in a wide range of sizes which can be found in the price listing.

When drilling in steel and harder materials, a round lead hole is required. When drilling brass, copper, wood, and other soft metals, the lead hold is not necessary. PLEASE SEE THE "HOW TO OPERATE" SECTION FOR EXACT LEAD HOLE SIZE.

# USES FOR WATTS DRILLS

Angular holes are being drilled by the Watts Method in every conceivable industry including aerospace and automobile manufacturing, machinery manufacturing of every description including steel makers, job shops, railroad shops, and nut and bolt manufacturing. Angular holes would be of considerable advantage in many places instead of round holes but they have been studiously avoided because of the high production costs. Designers are realizing that angular holes may be used in many places such as a lock for hexagon and square head bolts. Our tools are especially adapted for producing the square and hexagon recess in cold heading dies. By drilling the recess you do not create any stress in the metal, thus eliminating a great percentage of the cracking in the corners of the dies.

Chuck screw can be completed in several minutes after the threads are chased by drilling the square holes, avoiding the tendency to batter up the threads which is the usual practice when attempting to drift out the holes at the vise. There are times when a hollow head square or hexagon set screw is urgently desired. It is not uncommon for users to take a standard stud or bolt with the required thread and cut off the head so that they have threads the total length, then drill the square or hex hole they require.

# BROACHING

These tools are not intended to take the place of the broaching operation. They were developed for the commercial production of blind angular holes where the broaching operation could not be used. They should be considered in comparison to broaching when quantities are limited, or the hole is of a size of depth making broaching difficult. In most cases special size drills are readily available.

# COUNTERBORING

If square and hexagon bolt heads were counter bored, considerable time could be saved in assembling. Instead of two wrenches, only one would be required and shorter bolts could be used. Counterbored bolts cannot work loose as it is impossible for them to turn. In addition, the work is much neater and more substantial. FOR COUNTERBORING WORK, IT IS ADVISABLE TO ORDER TOOLS SLIGHTLY LARGER TO INSURE A LOOSE FIT.

# SOCKET WRENCHES

A drilled socket wrench is invariably superior to a punched or drawn wrench. The metal being cut away cleanly avoids any possibility of setting up fractures, which is not always the case by other methods. In addition, the added strength results in holes that have smooth sides and bottoms and are much neater than those that are punched or forged. For an odd socket wrench, the tools are generally used on a lath so that it can be made complete with one set-up. On production work the blanks can be turned on automatic machines and the angular holes drilled by jigging to multiple spindle drill presses.

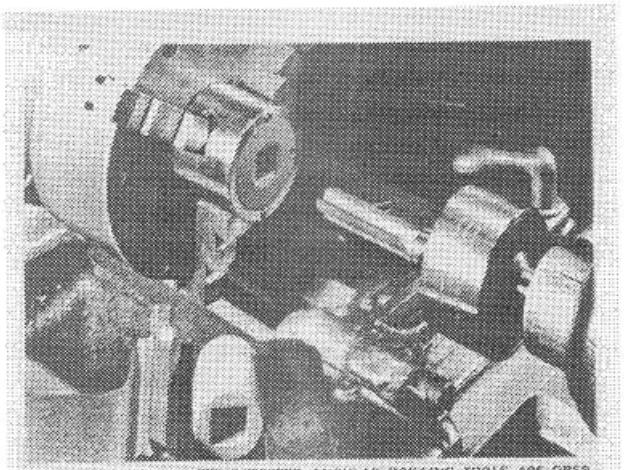
Socket wrenches require a loose fit and it is therefore advisable to order tools as follows: 0.005 oversize on holes up to ¾ across flats; .010 oversize form 49/64 to 1-¼; .015 from 1-17/64 to 1-¾ and .030 oversize from 1-49/64 to 2-¼ across flats. SOCKET WRENCHES MUST BE DRILLED WITH OVERSIZE EQUIPMENT.

# LIFE OF THE TOOLS

In checking records of regular customers it is interesting to find that chucks are seldom replaced in less than five years, particularly when they are used on general lines of work. On continuous work in tough metals such as tool steel and high alloy material, job life is usually several years. While no guarantees are made concerning tool life, if they should break down due to defects in material or workmanship, the tools will be repaired free of charge.

The drills are made in a generous length, over three times their distance across flats, so it is possible to sharpen the drill many times. All of the cutting is done on the end of the drill similar to an end mill in operation. The number of holes which can be drilled with each drill is hard to estimate, as the different types of material they are used on, as well as the care they receive in operation, controls their life. It is safe to assume several hundred holes when drilling in steel, and up to a thousand holes when drilling softer materials.

Guide plates will usually outwear three or four angular drills. The wear on them is held to a minimum as they are only subject to friction when the drill is starting into the metal. After the drill has started it leaves the walls of the guide plate and follows the walls in the opening made, thus assuring that the lands of the drills are also subject to very little wear.



SHOWING HOW THE WATTS PATENTED ANGULAR DRILLING TOOLS ARE OPERATED IN AN ENGINE OR TURRET LATHE. THE IDEAL SET UP FOR DRILLING. SOCKET WRENCHES, SPRING COLLETS AND FEEDING FINGERS.

# DESCRIPTION OF THE EQUIPMENT

## WATTS FULL FLOATING CHUCK

This is a mechanical device arranged so as to allow the drill perfect freedom in turning the corners of the guide plate. The various parts are designed so that the chuck can be held in a fixed position, as in the tail stock of a lathe, and still allow the drill to follow the path of the hole being drilled. The chucks are made of suitable steel with all working parts thoroughly hardened making them absolutely fool proof. The best grade of steel balls are used to assure perfect alignment and freedom of float at all times. The only care required is keeping them lubricated. An easily accessible oil hole is provided in the shank. A good grade of light lubricating oil should be used. This is important as heavy or gummy oils will retard the freedom of the float.

Chucks are furnished in five sizes to float all angular drills from ¼ to 2-¼. Chucks are furnished with Morse Taper Shanks and special shanks are furnished upon request. Please see pricing section for the table showing range of each chuck.

## WATTS ANGULAR DRILLS

Watts drills are specialized multi-flute cutters made of M-2 high speed steel and designed for use with the Watts guide plate and floating chuck.

## WATTS GUIDE PLATES

Guide plates are necessary for each different size and type of Angular Drill, as they control the path of the drill when starting into the metal. Without some means of guiding, the drill would produce a nameless and odd hole, providing it did not break when out of control.

In order to obtain maximum efficiency from these tools as well as simplifying their application, it is important that careful attention be shown in purchasing the most suitable style of guide plate for the work. This is because it is necessary to have the guide plate RIGHT ON THE WORK. If the work is of such a nature and sufficient quantity that a drilling jig or plate would be an advantage, then the guide plate should be ordered step-cut. The step-cut will place the bottom of the guide on the work and also permit easy doweling to any size or shape of plate desired. By using a jig, an indefinite set-up of the

tools can be made under the drill press spindle. Incidentally, the jig should be of such nature that the work could be rapidly locked and unlocked as it is placed under the guide plate.

Inquiries are often received requesting special guide plates with various groves, flanges, and shapes in order to fit over odd shaped parts. Special tools add to the cost, delay shipments on the initial purchase, and are unnecessary if the step-cut guide plate is used properly. There are, however, exceptional cases where special guide plates can hardly be avoided and in these cases, we are pleased to quote them.

When using the standard type guide plate on drill press work, it is usually necessary to clamp to each piece to be drilled. This is unless they are pressed into a soft ring, which in turn is step-cut. This practice is not encouraged, as the guide plate should be firmly located on the work. Neither the guide plate nor the work should move once the power is applied.

When using the tools on a lathe set up, the standard guide plate is usually satisfactory. However, if there is any later intention of using the tools on drill press production work, it would be wise to order them step-cut. The reason for this is that then all tools would be interchangeable to any jig or plates which might be developed.

PLEASE SEE PRICING SECTION FOR COMPLETE DIMENSIONS

## WATTS GUIDE HOLDERS

The guide holders are the means employed to secure the guide plates to the part into which you drill the angular hole. There is a recess in the top of the guide holder to accommodate the guide plate, which is held in place by two dowel pins and two screws. The work is inserted into the bottom and secured by a set screw.

Care should be exercised when ordering the guide holders, as interchangeability with other guide plates is limited to those sizes where guide plate and guide holder correspond. In other words, a No. 1 guide plate is used in a No. 1 guide holder, a No. 2 guide plate is for a No. 2 guide holder, etc.

There are cases when the bore required would not be consistent with the size of the guide holder needed. For example, if a 3/8 angular hole was to be drilled into stock 3 inches in diameter, it would be necessary to use a No. 4 step-cut guide holder with a recess for a No. 1 step cut guide plate. The step cutting would allow a shoulder in the

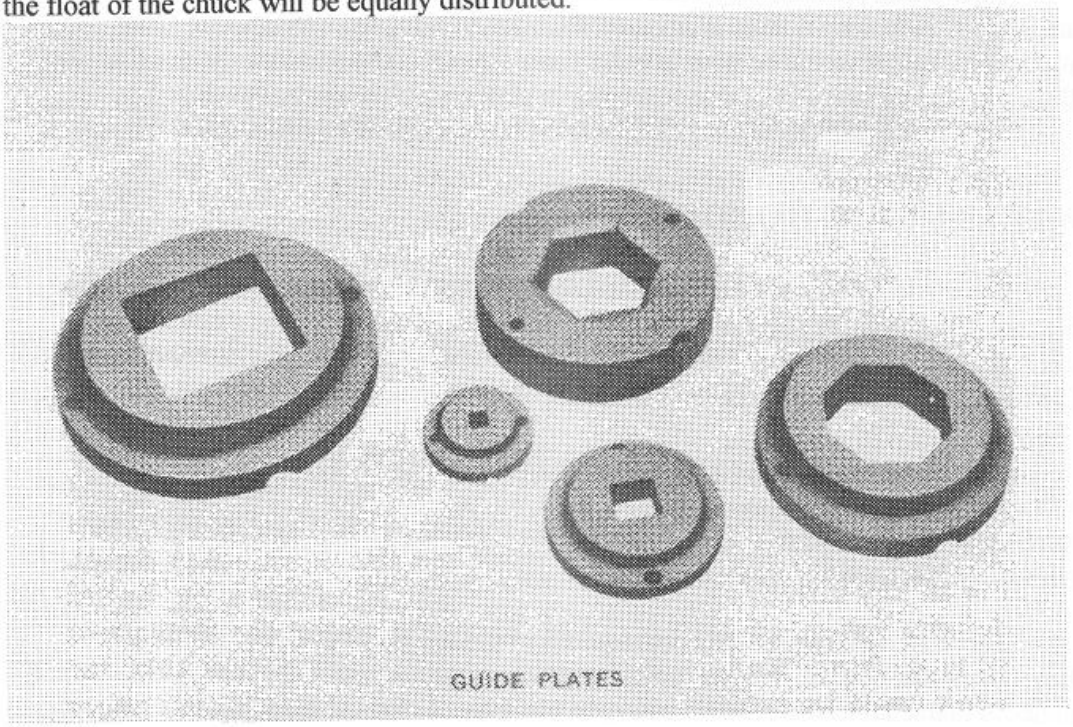
guide holder for the guide plate to rest on, bringing the bottom of the guide plate flush with the face of the work to be drilled.

When step-cut guide plates are ordered for drill press work with the intention of later using the tools on a lathe, then the guide holder should also be ordered step-cut for interchangeability. A step cut guide plate cannot be used in a standard guide holder or vice versa.

PLEASE SEE PRICING SECTION FOR GUIDE HOLDER DIMENSIONS

## SLIP BUSHINGS

The slip bushing fits into the guide plate and is designed to eliminate the necessity of laying out the lead hole. It also facilitates setting up the tools for drill press work. By their design, the lead hole is automatically located in the center of the angular hole and in turn the angular hole is located in the center of the drill press spindle, thus assuring that the float of the chuck will be equally distributed.



GUIDE PLATES

# HOW TO OPERATE WATTS ANGULAR DRILLS

Angular drills are operated in much the same manner as twist drills. However, angular drills are fed and driven at a slower pace. Users should follow these instruction until they are familiar with the tools.

1. Line and square up work to be drilled under the center of the drill press spindle.

2. Securely fasten the guide plate and the work to be drilled in the required position to the drill press table.

3. Insert the slip bushing into the hole in the guide plate and drill the lead hole. This is important as it allows the chips to clear from the center, and gives the drill perfect freedom to turn the corners. FOR EXACT LEAD HOLE SIZE SEE CHART ON PAGES #-#.

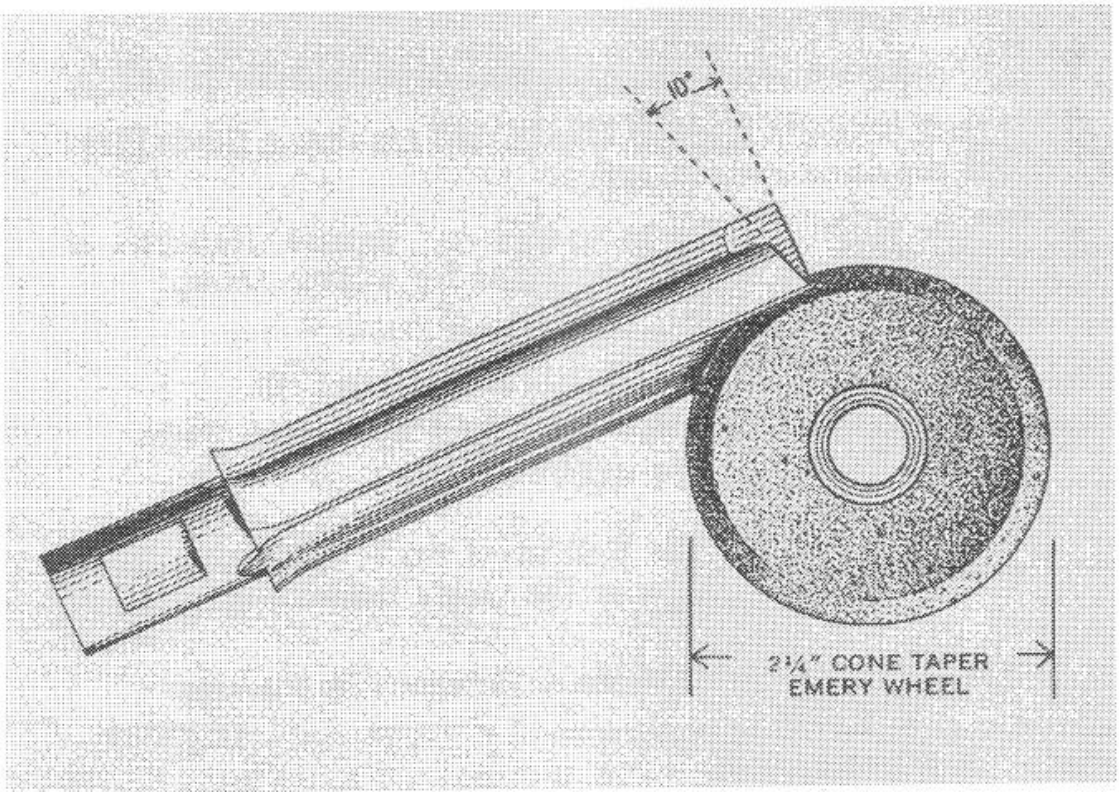
4. Insert the drill in the full floating chuck, being careful that the flat on the shank of the drill comes in line with the set screw, which should now be tightened.

5. Insert the chuck into the driving mechanism in the usual manner.

6. Insert the drill in the guide plate and see that it turns freely.
   Apply the power and use a good grade of cutting fluid.
   FOE EXACT SPEED AND FEED SEE CHART ON PAGE 14-15.

# HOW TO SHARPEN WATTS ANGULAR DRILLS

Care should be taken when grinding the end or cutting lips square with the sides of the drill. Giving about 10 degrees clearance back from the cutting edge will give good results. After the drill has been ground on the end, use a 2-¼ cone tapered wheel to grind the front of the cutting lips up to the center of the radius and the land for about 5/16 inch up from the end (this is on a ½ inch drill, larger or smaller sizes proportionately). This gives the drill a small lip to curl the ships and allows it to cut a clean corner. DO NOT grind back the center of the radius on the land. A drill ground in this fashion will not cut to size. DO NOT ALTER THE SIDES OR LANDS OF THE DRILL, DO NOT CIRCLE GRIND, AND ALWAYS KEEP THE DRILL SHARP.



# HOW TO ORDER

1. Use the names provided in this catalog.

2. Be sure the chuck range and drills ordered correspond.

3. Each different size drill requires a separate guide plate of the same size.

EXAMPLE: Ordering 5/8 square equipment for drilling holes in the end of round stock on a lathe.

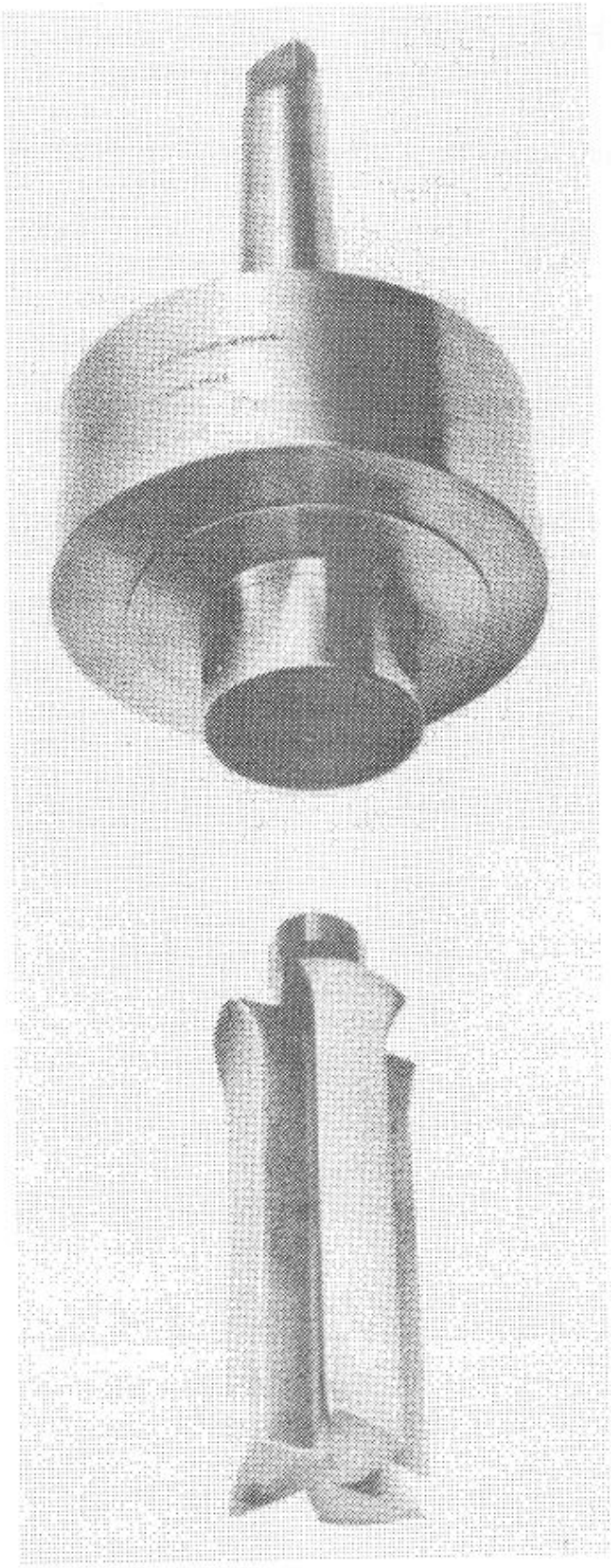
1- No. 2 Watts full floating chuck
1- 5/8 square drill
1- 5/8 square guide plate
1- No. 2 Step-cut guide holder

EXAMPLE: Ordering 5/8 square equipment for drilling holes on a drill press.

1- No. 2 Watts full floating chuck
1- 5/8 square drill
1- 5/8 square guide plate
1- 5/8 square slip bushing

# TROUBLESHOOTING COMMON PROBLEMS

| PROBLEM | POSSIBLE CAUSE |
|---|---|
| Persistent chipping of drill | 1. Pilot hole too small<br>2. Spindle speed too slow<br>3. Feed is too high<br>4. Improper sharpening<br>5. Chuck out of adjustment |
| Socket undersize | 1. Pilot hole too small<br>2. Improper sharpening<br>3. Speed and feed too high<br>4. Drill requires sharpening |
| Socket oversize | 1. Part not against guide<br>2. Guide worn out<br>3. Tooling not on center |
| Drill dull after small number of holes | 1. Spindle speed too high<br>2. Material too hard or abrasive. Drill will require frequent sharpening. |



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# PILOT HOLE SIZES, SPEEDS, AND FEEDS
# STAINLESS STEEL

**BASED ON 304 STAINLESS STEEL, SLIGHT CHANGES MAY BE REQUIRED FOR OTHER GRADES.**

| HEXAGON SIZE | PILOT HOLE | SPEED RPM | FEED TPR | SQUARE SIZE | PILOT HOLE | SPEED RPM | FEED TPR |
|---|---|---|---|---|---|---|---|
| 3\16 | 1\8 | 800 | 0.001 | | | | |
| 1\4 | 3\16 | 400 | 0.001 | 1\4 | 3\16 | 375 | 0.001 |
| 5\16 | 1\4 | 350 | 0.001 | 5\16 | 1\4 | 325 | 0.001 |
| 3\8 | 5\16 | 300 | 0.002 | 3\8 | 5\16 | 300 | 0.001 |
| 7\16 | 3\8 | 260 | 0.002 | 7\16 | 3\8 | 250 | 0.001 |
| 1\2 | 13/32 | 230 | 0.002 | 1\2 | 13/32 | 200 | 0.001 |
| 9\16 | 1\2 | 200 | 0.002 | 9\16 | 1\2 | 180 | 0.001 |
| 5\8 | 17/32 | 175 | 0.002 | 5\8 | 9\16 | 150 | 0.002 |
| 3\4 | 5\8 | 160 | 0.002 | 3\4 | 11\16 | 130 | 0.002 |
| 7\8 | 11\16 | 130 | 0.002 | 7\8 | 3\4 | 100 | 0.002 |
| 1 | 13/16 | 100 | 0.002 | 1 | 7\8 | 90 | 0.002 |
| 1-1/8 | 15/16 | 90 | 0.002 | 1-1/8 | 15/16 | 90 | 0.002 |
| 1-1/4 | 1-1/16 | 80 | 0.002 | 1-1/4 | 1-1/16 | 80 | 0.002 |
| 1-3/8 | 1-3/16 | 80 | 0.002 | 1-3/8 | 1-1/4 | 80 | 0.002 |
| 1-1/2 | 1-5/16 | 80 | 0.002 | 1-1/2 | 1-3/8 | 70 | 0.002 |
| 1-5/8 | 1-7/16 | 70 | 0.002 | 1-5/8 | 1-1/2 | 60 | 0.002 |
| 1-3/4 | 1-1/2 | 70 | 0.002 | 1-3/4 | 1-9/16 | 50 | 0.002 |
| 1-7/8 | 1-5/8 | 70 | 0.002 | 1-7/8 | 1-11/16 | 50 | 0.002 |
| 2 | 1-13/16 | 60 | 0.002 | 2 | 1-13/16 | 40 | 0.002 |
| 2-1/8 | 1-3/4 | 50 | 0.002 | 2-1/8 | 1-15/16 | 40 | 0.002 |
| 2-1/4 | 2 | 50 | 0.002 | 2-1/4 | 2-1/16 | 40 | 0.002 |

# PILOT HOLE SIZES, SPEEDS, AND FEEDS

**4140, 4340, 1018, MATERIALS HEAT TREATED TO 25-28 ROCKWELL C**

| HEXAGON **SIZE** | PILOT **HOLE** | SPEED **RPM** | FEED **TPR** | SQUARE **SIZE** | PILOT **HOLE** | SPEED **RPM** | FEED **TPR** |
|---|---|---|---|---|---|---|---|
| 3\16 | 1\8 | 900 | 0.001 | | | | |
| 1\4 | 3\16 | 500 | 0.001 | 1\4 | 3\16 | 400 | 0.001 |
| 5\16 | 1\4 | 450 | 0.001 | 5\16 | 1\4 | 350 | 0.001 |
| 3\8 | 9\32 | 400 | 0.001 | 3\8 | 5\16 | 325 | 0.001 |
| 7\16 | 11\32 | 350 | 0.002 | 7\16 | 3\8 | 300 | 0.001 |
| 1\2 | 3\8 | 300 | 0.002 | 1\2 | 13/32 | 270 | 0.001 |
| 9\16 | 15/32 | 275 | 0.002 | 9\16 | 7\16 | 270 | 0.001 |
| 5\8 | 1\2 | 260 | 0.002 | 5\8 | 1\2 | 250 | 0.002 |
| 3\4 | 9\16 | 230 | 0.002 | 3\4 | 5\8 | 200 | 0.002 |
| 7\8 | 11\16 | 200 | 0.003 | 7\8 | 11\16 | 160 | 0.002 |
| 1 | 13/16 | 150 | 0.003 | 1 | 13/16 | 140 | 0.002 |
| 1-1/8 | 7\8 | 130 | 0.003 | 1-1/8 | 7\8 | 130 | 0.002 |
| 1-1/4 | 1 | 130 | 0.003 | 1-1/4 | 1-1/16 | 120 | 0.002 |
| 1-3/8 | 1-1/8 | 110 | 0.003 | 1-3/8 | 1-3/16 | 100 | 0.002 |
| 1-1/2 | 1-1/4 | 100 | 0.003 | 1-1/2 | 1-5/16 | 90 | 0.002 |
| 1-5/8 | 1-3/8 | 90 | 0.003 | 1-5/8 | 1-7/16 | 80 | 0.002 |
| 1-3/4 | 1-1/2 | 80 | 0.003 | 1-3/4 | 1-9/16 | 70 | 0.002 |
| 1-7/8 | 1-5/8 | 70 | 0.003 | 1-7/8 | 1-11/16 | 60 | 0.002 |
| 2 | 1-3/4 | 60 | 0.003 | 2 | 1-3/4 | 50 | 0.002 |
| 2-1/8 | 1-7/8 | 50 | 0.003 | 2-1/8 | 1-15/16 | 40 | 0.002 |
| 2-1/4 | 2 | 50 | 0.003 | 2-1/4 | 2-1/16 | 40 | 0.002 |

# BODY LENGTHS OF DRILLS

**EXCLUSIVE OF SHANKS**

| SIZE | LENGTH | SIZE | LENGTH |
|---|---|---|---|
| 3\16 | 1-1/4 | 1-3/16 | 3-7/8 |
| 1\4 | 1-7/8 | 1-1/4 | 4 |
| 5\16 | 2-1/8 | 1-5/16 | 4-1/8 |
| 3\8 | 2-1/4 | 1-3/8 | 4-1/4 |
| 7\16 | 2-3/8 | 1-7/16 | 4-3/8 |
| 1\2 | 2-1/2 | 1-1/2 | 4-1/2 |
| 9\16 | 2-5/8 | 1-9/16 | 4-3/4 |
| 5\8 | 2-3/4 | 1-5/8 | 5 |
| 11\16 | 2-7/8 | 1-11/16 | 5-1/4 |
| 3\4 | 3 | 1-3/4 | 5-1/2 |
| 13/16 | 3-1/8 | 1-13/16 | 5-3/4 |
| 7\8 | 3-1/4 | 1-7/8 | 6 |
| 15/16 | 3-3/8 | 1-15/16 | 6-1/4 |
| 1 | 3-1/2 | 2 | 6-1/2 |
| 1-1/16 | 3-5/8 | 1-1/8 | AS ORDERED |
| 1-1/8 | 3-3/4 | 1-1/2 | AS ORDERED |

**NOTE: EXTRA LENGTH IS AVAILABLE ON ALL DRILLS. 10% PER INCH**