# Drill troubles - Causes and remedy, drill kinds

**Objectives:** At the end of this lesson you shall be able to
- **state the common drilling defects**
- **identify the causes of drilling defects**
- **suggest remedial steps for preventing drill failures.**

The common defects in drilling are listed below.

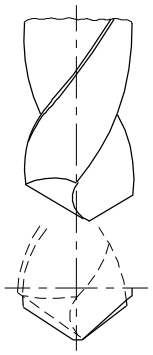
- Oversized holes
- Overheated drills
- Rough holes
- Unequal and interrupted flow of chips
- Split webs or broken drills

### Oversized holes

Oversized holes can be due to:

- The unequal length of the cutting edges (Fig 1)

Fig 1



UNEQUAL LIP LENGTH

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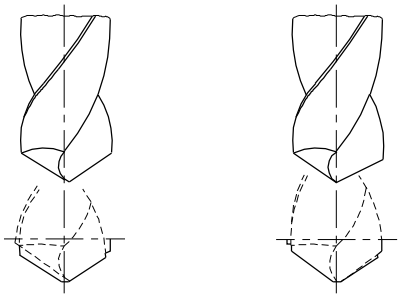
- The unequal angle of the cutting edges (Fig 2)

Fig 2



UNEQUAL ANGLE

UNEQUAL ANGLE AND LENGTH

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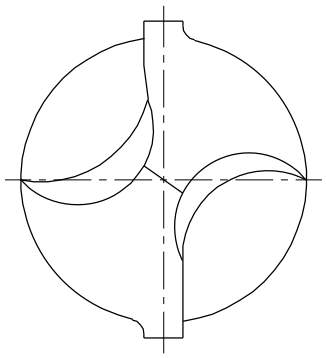
- The unequal thinning of the point (Fig 3)
- The spindle running out of centre
- The drill point not being in centre. (Fig 4)

Fig 3



UNEQUAL POINT THINNING

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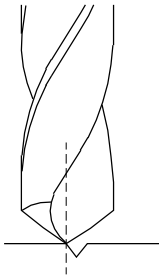
Fig 4



DRILL POINT NOT IN THE CENTRE OF THE JOB

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### Overheated drills

The drills may get overheated if the:

- Cutting speed is too high
- Feed rate is too high
- Clearance angle is incorrect
- Cooling is ineffective
- Point angle is incorrect
- Drill is not sharp.

### Rough holes

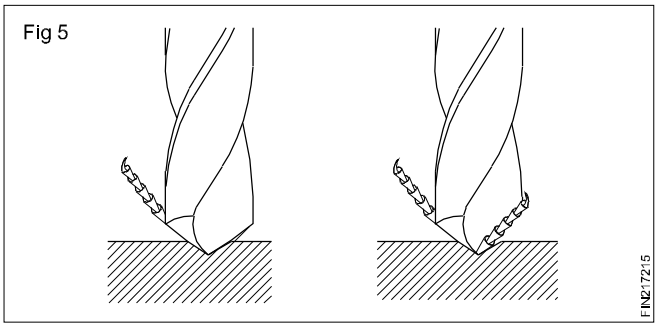
Rough holes are caused if the:

- Feed rate is too much
- Drill cutting edges are not sharp
- Cooling is ineffective.

**Unequal flow of chips** (Fig 5 )

Unequal flow of chips is caused if the cutting edges are not equal and the point angle is not in the centre of the drill.

Fig 5




**Broken drill or split web**

Broken drill or split web occurs when the:

- Cutting speed is too high
- Feed rate is too high
- Work is not held rigidly
- Drill is not held correctly
- Drill is not sharp
- Point angle is incorrect
- Cooling is insufficient
- Flutes are clogged with chips.

## Letter and number drills

**Objectives:** At the end of this lesson you shall be able to
- **state the range of drill sizes in number and letter drill series**
- **determine the number and letter drills for given diameters referring to the chart.**

Generally drills are manufactured to standard sizes in the metric system. These drills, are available in specified steps. The drills, which are not covered under the above category, are manufactured in number and letter drills.

These drills are used where odd sizes of holes are to be drilled.

**Letter drills:**

The letter drill series consists of drill sizes from 'A' to 'Z'. The letter 'A' drill is the smallest with 5.944 mm diameter, and the letter 'Z' is the largest, with a 10.490 mm diameter. (Table 1)

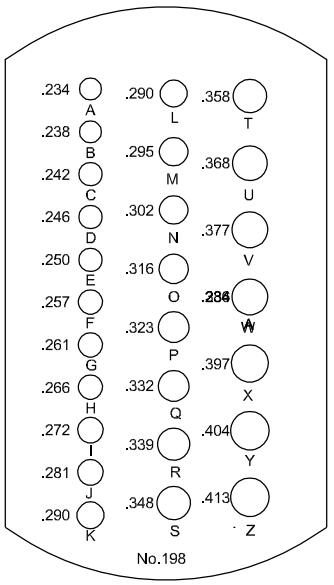
**TABLE 1**

**Letter drill sizes**

| Letter | Diameter | |
|---|---|---|
| | Inches | mm |
| A | .234 | 5.944 |
| B | .238 | 6.045 |
| C | .242 | 6.147 |
| D | .246 | 6.248 |
| E | .250 | 6.35 |
| F | .257 | 6.528 |
| G | .261 | 6.629 |
| H | .266 | 6.756 |
| I | .272 | 6.909 |
| J | .277 | 7.036 |
| K | .281 | 7.137 |
| L | .290 | 7.366 |
| M | .295 | 7.493 |
| N | .302 | 7.671 |
| O | .316 | 8.026 |
| P | .323 | 8.204 |
| Q | .332 | 8.433 |
| R | .339 | 8.611 |
| S | .348 | 8.839 |
| T | .358 | 9.093 |
| U | .368 | 9.347 |
| V | .377 | 9.576 |
| W | .386 | 9.804 |
| X | .397 | 10.084 |
| Y | .404 | 10.262 |
| Z | .413 | 10.490 |

In the number drill and the letter drill series, the correct diameter of the drill is gauged with the help of the respective drill gauges. A drill gauge is a rectangular or square shaped metal piece containing a number of different diameter holes. The size of the hole is stamped against each hole. (Fig 1)

Fig 1




**Number drills:**

The number drill series consists of drills numbered from 1 to 80. The No.1 drill is the largest, with 5.791 mm diameter, and the No.80 drill is the smallest, with 0.35 mm diameter. (Table 2). There is no uniform variation in the drill diameters from number to number. To find the correct diameter of a number drill, refer to a drill Size Chart or a Hand-book. Number drill series are also known as 'wire gauge' series.

**TABLE 2**

**Number drill sizes**

| No | Diameter | |
|---|---|---|
| | Inches | mm |
| 1 | 228 | 5.791 |
| 2. | .221 | 5.613 |
| 3 | .213 | 5.410 |
| 4 | .209 | 5.309 |
| 5 | .2055 | 5.220 |
| 6 | .204 | 5.182 |
| 7 | .201 | 5.105 |
| 8 | .199 | 5.055 |
| 9 | .196 | 4.978 |
| 10 | .1935 | 4.915 |
| 11 | .191 | 4.851 |
| 12 | .189 | 4.801 |
| 13 | .185 | 4.699 |
| 14 | .182 | 4.623 |
| 15 | .180 | 4.572 |
| 16 | .177 | 4.496 |
| 17 | .173 | 4.394 |
| 18 | .1695 | 4.305 |
| 19 | .166 | 4.216 |
| 20 | .161 | 4.089 |
| 21 | .159 | 4.039 |
| 22 | .157 | 3.988 |
| 23 | .154 | 3.912 |
| 24 | .152 | 3.861 |
| 25 | .1495 | 3.797 |
| 26 | .147 | 3.734 |
| 27 | .144 | 3.658 |
| 28 | .1405 | 3.569 |
| 29 | .136 | 3.454 |
| 30 | .1285 | 3.264 |
| 31 | .120 | 3.048 |
| 32 | .116 | 2.946 |
| 33 | .113 | 2.870 |
| 34 | .111 | 2.819 |
| 35 | .110 | 2.794 |
| 36 | .1065 | 2.705 |
| 37 | .104 | 2.642 |
| 38 | .1015 | 2.578 |
| 39 | .0995 | 2.527 |
| 40 | .098 | 2.489 |
| 41 | .096 | 2.438 |
| 42 | .0935 | 2.375 |
| 43 | .089 | 2.261 |
| 44 | .086 | 2.184 |
| 45 | .082 | 2.083 |
| 46 | .081 | 2.057 |
| 47 | .0785 | 1.994 |
| 48 | .076 | 1.930 |
| 49 | .073 | 1.854 |
| 50 | .070 | 1.778 |
| 51 | .067 | 1.702 |
| 52 | .0635 | 1.613 |
| 53 | .0595 | 1.511 |
| 54 | .055 | 1.395 |

| No | Diameter | |
|---|---|---|
| | Inches | mm |
| 55 | .052 | 1.321 |
| 56 | .0465 | 1.181 |
| 57 | .043 | 1.092 |
| 58 | .042 | 1.067 |
| 59 | 0.41 | 1.041 |
| 60 | .040 | 1.016 |
| 61 | 0.0390 | 1.00 |
| 62 | 0.0380 | 0.98 |
| 63 | 0.0370 | 0.95 |
| 64 | 0.0360 | 0.92 |
| 65 | 0.0350 | 0.90 |
| 66 | 0.033 | 0.85 |
| 67 | 0.032 | 0.82 |

| No | Diameter | |
|---|---|---|
| | Inches | mm |
| 68 | 0.031 | 0.79 |
| 69 | 0.0292 | 0.75 |
| 70 | 0.0280 | 0.70 |
| 71 | 0.0260 | 0.65 |
| 72 | 0.0240 | 0.65 |
| 73 | 0.0240 | 0.60 |
| 74 | 0.0225 | 0.58 |
| 75 | 0.0210 | 0.52 |
| 76 | 0.0200 | 0.50 |
| 77 | 0.0180 | 0.45 |
| 78 | 0.0160 | 0.40 |
| 79 | 0.0145 | 0.38 |
| 80 | 0.0135 | 0.35 |

## Sharpening of drills (Grinding of drill)

**Objective:** At the end of this lesson you shall be able to
**• sharpen drills on an off hand grinder .**

Why cutting angle should be checked and resharpened?

Drills will lose the sharpness of the cutting edges due to continuous use.

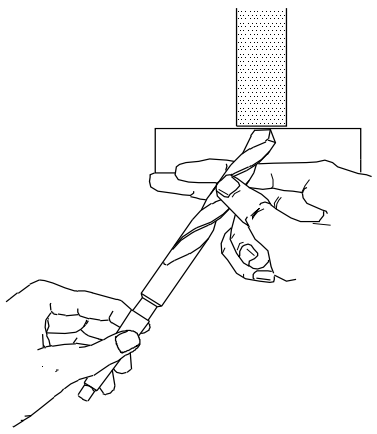
Improper use of drills can also spoil the cutting edges.Worn out drills are to be re-sharpened on a grinder.

**How to grind drills?**

Before grinding, check for loading, glazing, and truenes of wheels and cracks or other damages. Dress and true the wheel, if necessary.

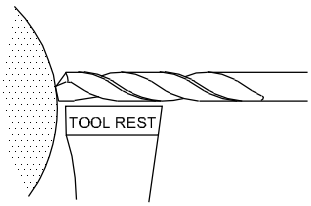
While grinding the shank, the other end of the drill is held lightly between the thumb and the first finger. (Fig 1)

Fig 1




The hand near the point should be pivoted lightly on the tool-rest for easy manipulation. (Fig 2)

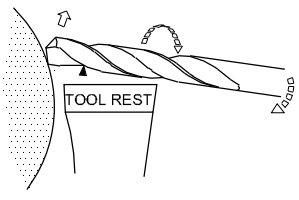
Fig 2




Hold the drill level and turn it to 59° to the face of the weel so that the cutting edge is horizontal and parallel to the grinding wheel-face. (Fig 1)

Swing the shank of the drill slightly downward and towards the left. (Fig 3)

Fig 3

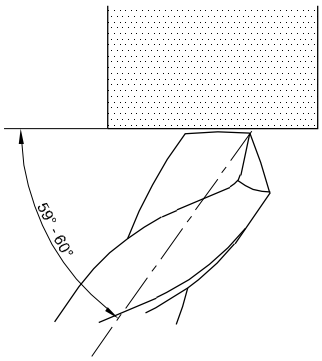


Rotate the drill to the right by turning it between the thumb and the finger.

**This turning movement is not necessary for small drills.**

While swinging down, apply a slight forward motion. This will help to form the clearance angle. (Fig 4)

Fig 4

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**While swinging and turning the drill make sure you do not grind the other cutting edge.**

All movements made to the drill i.e. angular turning swinging and forward movements, should be well coordinated. (Fig 5)

It should result in one smooth movement to produce a uniformly finished surface.

Repeat the process to re-sharpen the second cutting edge, using the same amount of drill movement uniformly.

How to check the angles of the cutting edges?

Check both the cutting edges with a drill angle gauge, for correctness of the lip angle and equality of the lip length. (Fig 6)

Fig 5

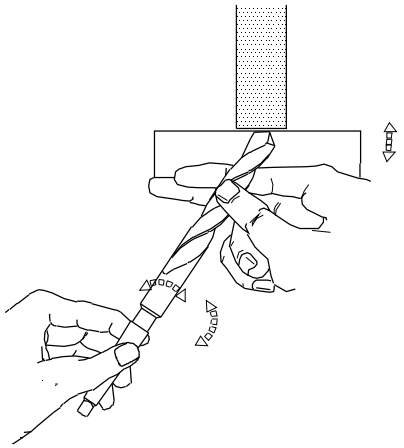

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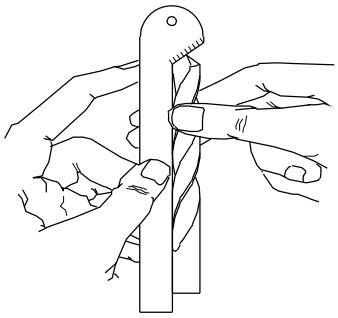
Fig 6



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Check the lip clearance angle visually. The angle should be between 8° to 12°.

## Fraction & Metric sizes of drills conversion table

Inches and millimeteres

(a) Inches to millimteres  Basic: 1 inch = 25.4 millimetres

| Inch | 0 | 1/16 | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 |
|---|---|---|---|---|---|---|---|---|
| 0 | | 1.59 | 3.18 | 4.76 | 6.35 | 7.94 | 9.53 | 11.11 |
| 1 | 25.40 | 26.98 | 25.58 | 30.16 | 31.75 | 33.34 | 34.93 | 36.51 |
| 2 | 50.80 | 52.39 | 53.97 | 55.56 | 57.15 | 58.74 | 60.33 | 61.91 |
| 3 | 76.20 | 77.79 | 79.38 | 80.96 | 82.55 | 84.14 | 85.73 | 87.31 |
| 4 | 101.60 | 103.19 | 104.78 | 106.36 | 107.95 | 109.54 | 111.13 | 112.71 |
| 5 | 127.00 | 128.59 | 130.18 | 131.76 | 133.35 | 134.94 | 136.53 | 138.11 |
| 6 | 152.40 | 153.99 | 155.58 | 157.16 | 158.75 | 160.34 | 161.93 | 163.51 |
| 7 | 177.80 | 179.39 | 180.98 | 182.56 | 184.15 | 185.74 | 187.33 | 188.91 |
| 8 | 203.20 | 204.79 | 206.38 | 207.96 | 209.55 | 211.14 | 212.73 | 214.31 |
| 9 | 228.60 | 230.19 | 231.78 | 233.36 | 234.95 | 236.54 | 238.13 | 239.71 |
| 10 | 254.00 | 255.59 | 257.18 | 258.76 | 260.35 | 261.94 | 263.53 | 265.11 |
| Inch | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 |
| 0 | 12.70 | 14.29 | 15.88 | 17.46 | 19.05 | 20.64 | 22.23 | 23.81 |
| 1 | 38.10 | 39.69 | 41.28 | 42.86 | 44.45 | 46.04 | 47.63 | 49.21 |
| 2 | 63.50 | 65.09 | 66.68 | 68.26 | 69.85 | 71.44 | 73.03 | 74.61 |
| 3 | 88.90 | 90.49 | 92.08 | 93.66 | 95.25 | 96.84 | 98.43 | 100.01 |
| 4 | 114.30 | 115.89 | 117.48 | 119.06 | 120.65 | 122.24 | 123.83 | 125.41 |
| 5 | 139.70 | 141.29 | 142.88 | 144.46 | 146.05 | 147.64 | 149.23 | 150.81 |
| 6 | 165.10 | 166.69 | 168.28 | 169.86 | 171.45 | 173.04 | 174.63 | 176.21 |
| 7 | 190.50 | 192.09 | 193.68 | 195.26 | 196.85 | 198.44 | 200.03 | 201.61 |
| 8 | 215.90 | 217.49 | 219.08 | 220.66 | 222.25 | 223.84 | 225.43 | 227.01 |
| 9 | 241.30 | 242.89 | 244.48 | 246.06 | 247.65 | 249.24 | 250.83 | 252.41 |
| 10 | 266.70 | 268.29 | 269.88 | 271.46 | 273.05 | 274.64 | 276.23 | 277.81 |

Example: 25 3/4" = { 20' = (10 x 2" = 10 x 50.8 =) 508.0( ; 5 3/4" = 146.05 } = 654.05 mm

(b) Millimteres to Inches  Basic: 1 Millimetre = 0.039369 inch

| mm | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 0.039 | 0.079 | 0.118 | 0.157 | 0.197 | 0.236 | 0.276 | 0.315 | 0.354 |
| 10 | 0.394 | 0.433 | 0.472 | 0.512 | 0.551 | 0.591 | 0.630 | 0.669 | 0.700 | 0.748 |
| 20 | 0.787 | 0.827 | 0.866 | 0.905 | 0.945 | 0.984 | 1.024 | 1.063 | 1.102 | 1.142 |
| 30 | 1.181 | 1.220 | 1.259 | 1.299 | 1.338 | 1.378 | 1.417 | 1.457 | 1.496 | 1.535 |
| 40 | 1.575 | 1.614 | 1.653 | 1.693 | 1.732 | 1.772 | 1.811 | 1.850 | 1.890 | 1.929 |
| 50 | 1.968 | 2.007 | 2.047 | 20.87 | 2.126 | 2.165 | 2.205 | 2.244 | 2.283 | 2.323 |
| 60 | 2.362 | 2.401 | 2.441 | 2.480 | 2.520 | 2.559 | 2.598 | 2.638 | 2.677 | 2.716 |
| 70 | 2.756 | 2.795 | 2.835 | 2.874 | 2.913 | 2.953 | 2.992 | 3.031 | 3.074 | 3.110 |
| 80 | 3.149 | 3.189 | 3.228 | 3.268 | 3.307 | 3.346 | 3.386 | 3.425 | 3.464 | 3.504 |
| 90 | 3.543 | 3.583 | 3.622 | 3.661 | 3.701 | 3.740 | 3.779 | 3.819 | 3.858 | 3.897 |
| mm | 0 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 |
| 0 | | 3.94 | 7.87 | 11.81 | 15.75 | 19.68 | 23.62 | 27.56 | 31.49 | 35.43 |
| 1000 | 39.37 | 43.30 | 47.24 | 51.18 | 55.12 | 59.05 | 62.99 | 66.93 | 70.86 | 74.80 |
| 2000 | 78.74 | 82.67 | 86.61 | 90.55 | 94.48 | 98.42 | 102.36 | 106.30 | 110.23 | 114.17 |
| 3000 | 118.11 | 122.04 | 125.98 | 129.92 | 133.85 | 137.79 | 141.73 | 145.66 | 149.60 | 153.54 |
| 4000 | 157.47 | 161.41 | 165.35 | 169.20 | 173.22 | 177.16 | 181.10 | 185.03 | 188.97 | 192.91 |
| 5000 | 196.84 | 204.71 | 212.59 | 220.38 | 228.34 | 236.21 | 244.09 | 251.96 | 259.83 | 267.71 |

Example: 2256 mm = { 2200 mm = 86.61' ; 56 mm = 2.204" } =88.814"