

TWIST DRILLS AND COUNTERBORES

Twist drills are rotary end-cutting tools having one or more cutting lips and one or more straight or helical flutes for the passage of chips and cutting fluids. Twist drills are made with straight or tapered shanks, but most have straight shanks. All but the smaller sizes are ground with "back taper," reducing the diameter from the point toward the shank, to prevent binding in the hole when the drill is worn.

Straight Shank Drills: Straight shank drills have cylindrical shanks which may be of the same or of a different diameter than the body diameter of the drill and may be made with or without driving flats, tang, or grooves.

Taper Shank Drills: Taper shank drills are preferable to the straight shank type for drilling medium and large size holes. The taper on the shank conforms to one of the tapers in the American Standard (Morse) Series.

American National Standard.—American National Standard B94.11M-1993 covers nomenclature, definitions, sizes and tolerances for High Speed Steel Straight and Taper Shank Drills and Combined Drills and Countersinks, Plain and Bell types. It covers both inch and metric sizes. Dimensional tables from the Standard will be found on the following pages.

Definitions of Twist Drill Terms.—The following definitions are included in the Standard.

Axis: The imaginary straight line which forms the longitudinal center of the drill.

Back Taper: A slight decrease in diameter from point to back in the body of the drill.

Body: The portion of the drill extending from the shank or neck to the outer corners of the cutting lips.

Body Diameter Clearance: That portion of the land that has been cut away so it will not rub against the wall of the hole.

Chisel Edge: The edge at the ends of the web that connects the cutting lips.

Chisel Edge Angle: The angle included between the chisel edge and the cutting lip as viewed from the end of the drill.

Clearance Diameter: The diameter over the cutaway portion of the drill lands.

Drill Diameter: The diameter over the margins of the drill measured at the point.

Flutes: Helical or straight grooves cut or formed in the body of the drill to provide cutting lips, to permit removal of chips, and to allow cutting fluid to reach the cutting lips.

Helix Angle: The angle made by the leading edge of the land with a plane containing the axis of the drill.

Land: The peripheral portion of the drill body between adjacent flutes.

Land Width: The distance between the leading edge and the heel of the land measured at a right angle to the leading edge.

Lips—Two Flute Drill: The cutting edges extending from the chisel edge to the periphery.

Lips—Three or Four Flute Drill (Core Drill): The cutting edges extending from the bottom of the chamfer to the periphery.

Lip Relief: The axial relief on the drill point.

Lip Relief Angle: The axial relief angle at the outer corner of the lip. It is measured by projection into a plane tangent to the periphery at the outer corner of the lip. (Lip relief angle is usually measured across the margin of the twist drill.)

Margin: The cylindrical portion of the land which is not cut away to provide clearance.

Neck: The section of reduced diameter between the body and the shank of a drill.

Overall Length: The length from the extreme end of the shank to the outer corners of the cutting lips. It does not include the conical shank end often used on straight shank drills, nor does it include the conical cutting point used on both straight and taper shank drills. (For core drills with an external center on the cutting end it is the same as for two-flute

drills. For core drills with an internal center on the cutting end, the overall length is to the extreme ends of the tool.)

Point: The cutting end of a drill made up of the ends of the lands, the web, and the lips. In form, it resembles a cone, but departs from a true cone to furnish clearance behind the cutting lips.

Point Angle: The angle included between the lips projected upon a plane parallel to the drill axis and parallel to the cutting lips.

Shank: The part of the drill by which it is held and driven.

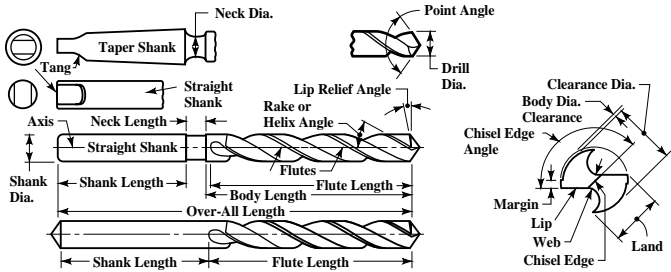
Tang: The flattened end of a taper shank, intended to fit into a driving slot in the socket.

Tang Drive: Two opposite parallel driving flats on the end of a straight shank.

Web: The central portion of the body that joins the end of the lands. The end of the web forms the chisel edge on a two-flute drill.

Web Thickness: The thickness of the web at the point unless another specific location is indicated.

Web Thinning: The operation of reducing the web thickness at the point to reduce drilling thrust.



ANSI Standard Twist Drill Nomenclature

Types of Drill.—Drills may be classified based on the type of shank, number of flutes or hand of cut.

Straight Shank Drills: Those having cylindrical shanks which may be the same or different diameter than the body of the drill. The shank may be with or without driving flats, tang, grooves, or threads.

Taper Shank Drills: Those having conical shanks suitable for direct fitting into tapered holes in machine spindles, driving sleeves, or sockets. Tapered shanks generally have a driving tang.

Two-Flute Drills: The conventional type of drill used for originating holes.

Three-Flute Drills (Core Drills): Drill commonly used for enlarging and finishing drilled, cast or punched holes. They will not produce original holes.

Four-Flute Drills (Core Drills): Used interchangeably with three-flute drills. They are of similar construction except for the number of flutes.

Right-Hand Cut: When viewed from the cutting point, the counterclockwise rotation of a drill in order to cut.

Left-Hand Cut: When viewed from the cutting point, the clockwise rotation of a drill in order to cut.

Table 7. (Continued) ANSI Straight Shank Twist Drills — Jobbers Length through 17.5 mm, Taper Length through 12.7 mm, and Screw Machine Length through 25.4 mm Diameter ANSI/ASME B94.11M-1993

Drill Diameter, D ^a				Jobbers Length				Taper Length				Screw Machine Length			
Fraction No. or Ltr.	mm	Equivalent		Flute		Overall		Flute		Overall		Flute		Overall	
		Decimal In.	mm	F		L		F		L		F		L	
				In.	mm	In.	mm	In.	mm	In.	mm	In.	mm	In.	mm
73		0.0240	0.610	5/16	8	1 1/8	29	...	...	...	...	...	...	...	...
72		0.0250	0.635	5/16	8	1 3/8	29	...	...	...	...	...	...	...	...
	0.65	0.0256	0.650	3/8	10	1 1/4	32	...	...	...	...	...	...	...	...
71		0.0260	0.660	3/8	10	1 1/2	32	...	...	...	...	...	...	...	...
	0.70	0.0276	0.700	3/8	10	1 1/4	32	...	...	...	...	...	...	...	...
70		0.0280	0.711	3/8	10	1 1/4	32	...	...	...	...	...	...	...	...
69		0.0292	0.742	1/2	13	1 3/8	35	...	...	...	...	...	...	...	...
	0.75	0.0295	0.750	1/2	13	1 3/8	35	...	...	...	...	...	...	...	...
68		0.0310	0.787	1/2	13	1 3/8	35	...	...	...	...	...	...	...	...
	0.80	0.0312	0.792	1/2	13	1 3/8	35	...	...	...	...	...	...	...	...
		0.0315	0.800	1/2	13	1 3/8	35	...	...	...	...	...	...	...	...
67		0.0320	0.813	1/2	13	1 3/8	35	...	...	...	...	...	...	...	...
66		0.0330	0.838	1/2	13	1 3/8	35	...	...	...	...	...	...	...	...
	0.85	0.0335	0.850	5/8	16	1 1/2	38	...	...	...	...	...	...	...	...
65		0.0350	0.889	5/8	16	1 1/2	38	...	...	...	...	...	...	...	...
	0.90	0.0354	0.899	5/8	16	1 1/2	38	...	...	...	...	...	...	...	...
64		0.0360	0.914	5/8	16	1 1/2	38	...	...	...	...	...	...	...	...
63		0.0370	0.940	5/8	16	1 1/2	38	...	...	...	...	...	...	...	...
	0.95	0.0374	0.950	5/8	16	1 1/2	38	...	...	...	...	...	...	...	...
62		0.0380	0.965	5/8	16	1 1/2	38	...	...	...	...	...	...	...	...
61		0.0390	0.991	11/16	17	1 5/8	41	...	...	...	...	...	...	...	...
	1.00	0.0394	1.000	11/16	17	1 5/8	41	1 1/8	29	2 1/4	57	1/2	13	1 3/8	35
60		0.0400	1.016	11/16	17	1 3/8	41	1 3/8	29	2 1/4	57	1/2	13	1 3/8	35
59		0.0410	1.041	11/16	17	1 5/8	41	1 1/8	29	2 1/4	57	1/2	13	1 3/8	35
	1.05	0.0413	1.050	11/16	17	1 3/8	41	1 3/8	29	2 1/4	57	1/2	13	1 3/8	35
58		0.0420	1.067	11/16	17	1 5/8	41	1 1/8	29	2 1/4	57	1/2	13	1 3/8	35
57		0.0430	1.092	3/4	19	1 3/4	44	1 1/8	29	2 1/4	57	1/2	13	1 3/8	35
	1.10	0.0433	1.100	3/4	19	1 3/4	44	1 3/8	29	2 1/4	57	1/2	13	1 3/8	35
	1.15	0.0453	1.150	3/4	19	1 3/4	44	1 1/8	29	2 1/4	57	1/2	13	1 3/8	35
56		0.0465	1.181	3/4	19	1 3/4	44	1 1/8	29	2 1/4	57	1/2	13	1 3/8	35
	3/64	0.0469	1.191	3/4	19	1 3/4	44	1 3/8	29	2 1/4	57	1/2	13	1 3/8	35
	1.20	0.0472	1.200	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1.25	0.0492	1.250	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1.30	0.0512	1.300	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
55		0.0520	1.321	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1.35	0.0531	1.350	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
54		0.0550	1.397	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1.40	0.0551	1.400	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1.45	0.0571	1.450	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1.50	0.0591	1.500	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
53		0.0595	1.511	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1.55	0.0610	1.550	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1/16	0.0625	1.588	7/8	22	1 7/8	48	1 3/4	44	3	76	5/8	16	1 5/8	41
	1.60	0.0630	1.600	7/8	22	1 7/8	48	2	51	3 3/4	95	1 1/16	17	1 11/16	43
52		0.0635	1.613	7/8	22	1 7/8	48	2	51	3 3/4	95	1 1/16	17	1 11/16	43
	1.65	0.0650	1.650	1	25	2	51	2	51	3 3/4	95	1 1/16	17	1 11/16	43

Table 7. (Continued) ANSI Straight Shank Twist Drills — Jobbers Length through 17.5 mm, Taper Length through 12.7 mm, and Screw Machine Length through 25.4 mm Diameter ANSI/ASME B94.11M-1993

Drill Diameter, D^a			Jobbers Length				Taper Length				Screw Machine Length				
Fraction No. or Ltr.	mm	Equivalent		Flute		Overall		Flute		Overall		Flute		Overall	
		Decimal In.	mm	F		L		F		L		F		L	
				In.	mm	In.	mm	In.	mm	In.	mm	In.	mm	In.	mm
51	1.70	0.0669	1.700	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
		0.0670	1.702	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
50	1.75	0.0689	1.750	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
		0.0700	1.778	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
49	1.80	0.0709	1.800	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
		0.0728	1.850	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
48	1.85	0.0730	1.854	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
		0.0748	1.900	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
47	1.90	0.0760	1.930	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
		0.0768	1.950	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
46	1.95	0.0781	1.984	1	25	2	51	2	51	3 $\frac{3}{4}$	95	1 $\frac{1}{16}$	17	1 $\frac{1}{16}$	43
		0.0785	1.994	1	25	2	51	2	51	2 $\frac{1}{2}$	57	4 $\frac{1}{4}$	108	1 $\frac{1}{16}$	43
45	2.00	0.0787	2.000	1	25	2	51	2	51	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	1 $\frac{1}{16}$	43
		0.0807	2.050	1 $\frac{1}{8}$	29	2 $\frac{1}{8}$	54	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
44	2.05	0.0810	2.057	1 $\frac{1}{8}$	29	2 $\frac{1}{8}$	54	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
		0.0820	2.083	1 $\frac{1}{8}$	29	2 $\frac{1}{8}$	54	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
43	2.10	0.0827	2.100	1 $\frac{1}{8}$	29	2 $\frac{1}{8}$	54	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
		0.0846	2.150	1 $\frac{1}{8}$	29	2 $\frac{1}{8}$	54	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
42	2.15	0.0860	2.184	1 $\frac{1}{8}$	29	2 $\frac{1}{8}$	54	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
		0.0866	2.200	1 $\frac{1}{4}$	32	2 $\frac{1}{4}$	57	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
41	2.20	0.0886	2.250	1 $\frac{1}{4}$	32	2 $\frac{1}{4}$	57	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
		0.0890	2.261	1 $\frac{1}{4}$	32	2 $\frac{1}{4}$	57	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
40	2.25	0.0895	2.300	1 $\frac{1}{4}$	32	2 $\frac{1}{4}$	57	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
		0.0906	2.300	1 $\frac{1}{4}$	32	2 $\frac{1}{4}$	57	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
39	2.30	0.0925	2.350	1 $\frac{1}{4}$	32	2 $\frac{1}{4}$	57	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
		0.0935	2.375	1 $\frac{1}{4}$	32	2 $\frac{1}{4}$	57	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
38	2.35	0.0938	2.383	1 $\frac{1}{4}$	32	2 $\frac{1}{4}$	57	2 $\frac{1}{4}$	57	4 $\frac{1}{4}$	108	3 $\frac{3}{4}$	19	1 $\frac{3}{4}$	44
		0.0945	2.400	1 $\frac{3}{8}$	35	2 $\frac{3}{8}$	60	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
37	2.40	0.0960	2.438	1 $\frac{3}{8}$	35	2 $\frac{3}{8}$	60	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
		0.0965	2.450	1 $\frac{3}{8}$	35	2 $\frac{3}{8}$	60	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
36	2.46	0.0980	2.489	1 $\frac{3}{8}$	35	2 $\frac{3}{8}$	60	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
		0.0984	2.500	1 $\frac{3}{8}$	35	2 $\frac{3}{8}$	60	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
35	2.50	0.0984	2.500	1 $\frac{3}{8}$	35	2 $\frac{3}{8}$	60	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
		0.0988	2.527	1 $\frac{3}{8}$	35	2 $\frac{3}{8}$	60	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
34	2.52	0.0995	2.527	1 $\frac{3}{8}$	35	2 $\frac{3}{8}$	60	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
		0.1015	2.578	1 $\frac{7}{16}$	37	2 $\frac{1}{2}$	64	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
33	2.60	0.1024	2.600	1 $\frac{7}{16}$	37	2 $\frac{1}{2}$	64	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
		0.1040	2.642	1 $\frac{7}{16}$	37	2 $\frac{1}{2}$	64	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
32	2.70	0.1063	2.700	1 $\frac{7}{16}$	37	2 $\frac{1}{2}$	64	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
		0.1065	2.705	1 $\frac{7}{16}$	37	2 $\frac{1}{2}$	64	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
31	2.80	0.1094	2.779	1 $\frac{1}{2}$	38	2 $\frac{3}{8}$	67	2 $\frac{1}{2}$	64	4 $\frac{3}{8}$	117	1 $\frac{3}{16}$	21	1 $\frac{3}{16}$	46
		0.1100	2.794	1 $\frac{1}{2}$	38	2 $\frac{3}{8}$	67	2 $\frac{3}{4}$	70	5 $\frac{1}{8}$	130	7 $\frac{1}{8}$	22	1 $\frac{3}{8}$	48
30	2.80	0.1102	2.800	1 $\frac{1}{2}$	38	2 $\frac{3}{8}$	67	2 $\frac{3}{4}$	70	5 $\frac{1}{8}$	130	7 $\frac{1}{8}$	22	1 $\frac{3}{8}$	48
		0.1110	2.819	1 $\frac{1}{2}$	38	2 $\frac{3}{8}$	67	2 $\frac{3}{4}$	70	5 $\frac{1}{8}$	130	7 $\frac{1}{8}$	22	1 $\frac{3}{8}$	48
29	2.80	0.1130	2.870	1 $\frac{1}{2}$	38	2 $\frac{3}{8}$	67	2 $\frac{3}{4}$	70	5 $\frac{1}{8}$	130	7 $\frac{1}{8}$	22	1 $\frac{3}{8}$	48
		0.1142	2.900	1 $\frac{3}{8}$	41	2 $\frac{3}{4}$	70	2 $\frac{3}{4}$	70	5 $\frac{1}{8}$	130	7 $\frac{1}{8}$	22	1 $\frac{3}{8}$	48
28	2.90	0.1160	2.946	1 $\frac{3}{8}$	41	2 $\frac{3}{4}$	70	2 $\frac{3}{4}$	70	5 $\frac{1}{8}$	130	7 $\frac{1}{8}$	22	1 $\frac{3}{8}$	48
		0.1181	3.000	1 $\frac{3}{8}$	41	2 $\frac{3}{4}$	70	2 $\frac{3}{4}$	70	5 $\frac{1}{8}$	130	7 $\frac{1}{8}$	22	1 $\frac{3}{8}$	48
27	3.00	0.1200	3.048	1 $\frac{3}{8}$	41	2 $\frac{3}{4}$	70	2 $\frac{3}{4}$	70	5 $\frac{1}{8}$	130	7 $\frac{1}{8}$	22	1 $\frac{3}{8}$	48

Table 7. (Continued) ANSI Straight Shank Twist Drills — Jobbers Length through 17.5 mm, Taper Length through 12.7 mm, and Screw Machine Length through 25.4 mm Diameter ANSI/ASME B94.11M-1993

Drill Diameter, D^a				Jobbers Length				Taper Length				Screw Machine Length			
Fraction No. or Ltr.	mm	Equivalent		Flute		Overall		Flute		Overall		Flute		Overall	
		Decimal In.	mm	F		L		F		L		F		L	
				In.	mm	In.	mm	In.	mm	In.	mm	In.	mm	In.	mm
1/8	3.10	0.1220	3.100	1 5/8	41	2 3/4	70	2 3/4	70	5 3/8	130	7/8	22	1 7/8	48
		0.1250	3.175	1 5/8	41	2 3/4	70	2 3/4	70	5 1/8	130	7/8	22	1 7/8	48
	3.20	0.1260	3.200	1 5/8	41	2 3/4	70	3	76	5 3/8	137	15/16	24	1 5/16	49
		0.1285	3.264	1 5/8	41	2 3/4	70	3	76	5 3/8	137	15/16	24	1 5/16	49
		0.1299	3.300	1 3/4	44	2 7/8	73	3	76	5 3/8	137	15/16	24	1 5/16	49
29	3.40	0.1339	3.400	1 3/4	44	2 7/8	73	3	76	5 3/8	137	15/16	24	1 5/16	49
		0.1360	3.454	1 3/4	44	2 7/8	73	3	76	5 3/8	137	15/16	24	1 5/16	49
28	3.50	0.1378	3.500	1 3/4	44	2 7/8	73	3	76	5 3/8	137	15/16	24	1 5/16	49
		0.1405	3.569	1 3/4	44	2 7/8	73	3	76	5 3/8	137	15/16	24	1 5/16	49
3/64	3.60	0.1406	3.571	1 3/4	44	2 7/8	73	3	76	5 3/8	137	15/16	24	1 5/16	49
		0.1417	3.600	1 7/8	48	3	76	3	76	5 3/8	137	1	25	2 1/16	52
27	3.70	0.1440	3.658	1 3/4	48	3	76	3	76	5 3/8	137	1	25	2 1/16	52
		0.1457	3.700	1 7/8	48	3	76	3	76	5 3/8	137	1	25	2 1/16	52
26	3.80	0.1470	3.734	1 7/8	48	3	76	3	76	5 3/8	137	1	25	2 1/16	52
		0.1495	3.797	1 7/8	48	3	76	3	76	5 3/8	137	1	25	2 1/16	52
25	3.80	0.1496	3.800	1 7/8	48	3	76	3	76	5 3/8	137	1	25	2 1/16	52
		0.1520	3.861	2	51	3 1/8	79	3	76	5 3/8	137	1	25	2 1/16	52
24	3.90	0.1535	3.900	2	51	3 1/8	79	3	76	5 3/8	137	1	25	2 1/16	52
		0.1540	3.912	2	51	3 1/8	79	3	76	5 3/8	137	1	25	2 1/16	52
23	4.00	0.1562	3.967	2	51	3 1/8	79	3	76	5 3/8	137	1	25	2 1/16	52
		0.1570	3.988	2	51	3 1/8	79	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
22	4.00	0.1575	4.000	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
		0.1590	4.039	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
21	4.10	0.1610	4.089	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
		0.1614	4.100	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
19	4.20	0.1654	4.200	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
		0.1660	4.216	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
18	4.30	0.1693	4.300	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
		0.1695	4.305	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
17	4.40	0.1719	4.366	2 1/8	54	3 1/4	83	3 3/8	86	5 3/4	146	1 1/16	27	2 1/8	54
		0.1730	4.394	2 3/16	56	3 3/8	86	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
16	4.50	0.1732	4.400	2 3/16	56	3 3/8	86	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
		0.1770	4.496	2 3/16	56	3 3/8	86	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
15	4.60	0.1772	4.500	2 3/16	56	3 3/8	86	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
		0.1800	4.572	2 3/16	56	3 3/8	86	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
14	4.70	0.1811	4.600	2 3/16	56	3 3/8	86	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
		0.1820	4.623	2 3/16	56	3 3/8	86	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
13	4.80	0.1850	4.700	2 3/16	59	3 1/2	89	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
		0.1875	4.762	2 3/16	59	3 1/2	89	3 3/8	86	5 3/4	146	1 1/8	29	2 3/16	56
12	4.90	0.1890	4.800	2 3/16	59	3 1/2	89	3 3/8	92	6	152	1 3/16	30	2 1/4	57
		0.1910	4.851	2 3/16	59	3 1/2	89	3 3/8	92	6	152	1 3/16	30	2 1/4	57
11	5.00	0.1929	4.900	2 3/16	62	3 3/8	92	3 3/8	92	6	152	1 3/16	30	2 1/4	57
		0.1935	4.915	2 3/16	62	3 3/8	92	3 3/8	92	6	152	1 3/16	30	2 1/4	57
10	5.00	0.1960	4.978	2 3/16	62	3 3/8	92	3 3/8	92	6	152	1 3/16	30	2 1/4	57
		0.1969	5.000	2 3/16	62	3 3/8	92	3 3/8	92	6	152	1 3/16	30	2 1/4	57
9	5.00	0.1990	5.054	2 3/16	62	3 3/8	92	3 3/8	92	6	152	1 3/16	30	2 1/4	57

Table 7. (Continued) ANSI Straight Shank Twist Drills — Jobbers Length through 17.5 mm, Taper Length through 12.7 mm, and Screw Machine Length through 25.4 mm Diameter ANSI/ASME B94.11M-1993

Drill Diameter, D ^a			Jobbers Length				Taper Length				Screw Machine Length				
Fraction No. or Ltr.	mm	Equivalent		Flute		Overall		Flute		Overall		Flute		Overall	
		Decimal In.	mm	F		L		F		L		F		L	
				In.	mm	In.	mm	In.	mm	In.	mm	In.	mm	In.	mm
7	5.10	0.2008	5.100	2 ⁷ / ₁₆	62	3 ³ / ₈	92	3 ³ / ₈	92	6	152	1 ³ / ₁₆	30	2 ¹ / ₄	57
		0.2010	5.105	2 ⁷ / ₁₆	62	3 ³ / ₈	92	3 ³ / ₈	92	6	152	1 ³ / ₁₆	30	2 ¹ / ₄	57
		0.2031	5.159	2 ⁷ / ₁₆	62	3 ³ / ₈	92	3 ³ / ₈	92	6	152	1 ³ / ₁₆	30	2 ¹ / ₄	57
6	5.20	0.2040	5.182	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
		0.2047	5.200	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
5	5.30	0.2055	5.220	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
		0.2087	5.300	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
4	5.40	0.2090	5.309	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
		0.2126	5.400	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
3	5.50	0.2130	5.410	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
		0.2165	5.500	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
3/32	5.60	0.2188	5.558	2 ¹ / ₂	64	3 ³ / ₄	95	3 ³ / ₈	92	6	152	1 ¹ / ₄	32	2 ³ / ₈	60
		0.2205	5.600	2 ³ / ₈	67	3 ⁷ / ₈	98	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₁₆	33	2 ⁷ / ₁₆	62
2	5.70	0.2210	5.613	2 ³ / ₈	67	3 ⁷ / ₈	98	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₁₆	33	2 ⁷ / ₁₆	62
		0.2244	5.700	2 ³ / ₈	67	3 ³ / ₈	98	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₁₆	33	2 ⁷ / ₁₆	62
1	5.80	0.2280	5.791	2 ³ / ₈	67	3 ⁷ / ₈	98	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₁₆	33	2 ⁷ / ₁₆	62
		0.2283	5.800	2 ³ / ₈	67	3 ⁷ / ₈	98	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₁₆	33	2 ⁷ / ₁₆	62
A	5.90	0.2323	5.900	2 ³ / ₈	67	3 ⁷ / ₈	98	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₁₆	33	2 ⁷ / ₁₆	62
		0.2340	5.944	2 ³ / ₈	67	3 ⁷ / ₈	98	...	...	...	...	1 ³ / ₁₆	33	2 ⁷ / ₁₆	62
15/64	6.00	0.2344	5.954	2 ³ / ₈	67	3 ⁷ / ₈	98	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₁₆	33	2 ⁷ / ₁₆	62
		0.2362	6.000	2 ³ / ₄	70	4	102	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₈	35	2 ¹ / ₂	64
B	6.10	0.2380	6.045	2 ³ / ₄	70	4	102	...	...	...	...	1 ³ / ₈	35	2 ¹ / ₂	64
		0.2402	6.100	2 ³ / ₄	70	4	102	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₈	35	2 ¹ / ₂	64
C	6.20	0.2420	6.147	2 ³ / ₄	70	4	102	...	...	...	...	1 ³ / ₈	35	2 ¹ / ₂	64
		0.2441	6.200	2 ³ / ₄	70	4	102	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₈	35	2 ¹ / ₂	64
D	6.30	0.2460	6.248	2 ³ / ₄	70	4	102	...	...	...	...	1 ³ / ₈	35	2 ¹ / ₂	64
		0.2480	6.300	2 ³ / ₄	70	4	102	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₈	35	2 ¹ / ₂	64
E, 1/4	6.40	0.2500	6.350	2 ³ / ₄	70	4	102	3 ³ / ₄	95	6 ¹ / ₈	156	1 ³ / ₈	35	2 ¹ / ₂	64
		0.2520	6.400	2 ³ / ₈	73	4 ¹ / ₈	105	3 ⁷ / ₈	98	6 ¹ / ₄	159	1 ⁷ / ₁₆	37	2 ³ / ₈	67
F	6.50	0.2559	6.500	2 ³ / ₈	73	4 ¹ / ₈	105	3 ⁷ / ₈	98	6 ¹ / ₄	159	1 ⁷ / ₁₆	37	2 ³ / ₈	67
		0.2570	6.528	2 ³ / ₈	73	4 ¹ / ₈	105	...	...	...	...	1 ⁷ / ₁₆	37	2 ³ / ₈	67
G	6.60	0.2598	6.600	2 ³ / ₈	73	4 ¹ / ₈	105	...	...	...	...	1 ⁷ / ₁₆	37	2 ³ / ₈	67
		0.2610	6.629	2 ³ / ₈	73	4 ¹ / ₈	105	...	...	...	...	1 ⁷ / ₁₆	37	2 ³ / ₈	67
H	6.70	0.2638	6.700	2 ³ / ₈	73	4 ¹ / ₈	105	...	...	...	...	1 ⁷ / ₁₆	37	2 ³ / ₈	67
		0.2656	6.746	2 ³ / ₈	73	4 ¹ / ₈	105	3 ⁷ / ₈	98	6 ¹ / ₄	159	1 ⁷ / ₁₆	37	2 ³ / ₈	67
17/64	6.80	0.2660	6.756	2 ³ / ₈	73	4 ¹ / ₈	105	...	...	...	...	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
		0.2677	6.800	2 ³ / ₈	73	4 ¹ / ₈	105	3 ⁷ / ₈	98	6 ¹ / ₄	159	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
I	6.90	0.2717	6.900	2 ³ / ₈	73	4 ¹ / ₈	105	...	...	...	...	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
		0.2720	6.909	2 ³ / ₈	73	4 ¹ / ₈	105	...	...	...	...	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
J	7.00	0.2756	7.000	2 ³ / ₈	73	4 ¹ / ₈	105	3 ⁷ / ₈	98	6 ¹ / ₄	159	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
		0.2770	7.036	2 ³ / ₈	73	4 ¹ / ₈	105	...	...	...	...	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
K	7.10	0.2795	7.100	2 ¹⁵ / ₁₆	75	4 ¹ / ₄	108	...	...	...	...	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
		0.2810	7.137	2 ¹⁵ / ₁₆	75	4 ¹ / ₄	108	...	...	...	...	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
3/32	7.20	0.2812	7.142	2 ¹⁵ / ₁₆	75	4 ¹ / ₄	108	3 ⁷ / ₈	98	6 ¹ / ₄	159	1 ¹ / ₂	38	2 ¹¹ / ₁₆	68
		0.2835	7.200	2 ¹⁵ / ₁₆	75	4 ¹ / ₄	108	4	102	6 ³ / ₈	162	1 ⁹ / ₁₆	40	2 ³ / ₄	70
	7.30	0.2874	7.300	2 ¹⁵ / ₁₆	75	4 ¹ / ₄	108	...	...	...	...	1 ⁹ / ₁₆	40	2 ³ / ₄	70

Table 7. (Continued) ANSI Straight Shank Twist Drills — Jobbers Length through 17.5 mm, Taper Length through 12.7 mm, and Screw Machine Length through 25.4 mm Diameter ANSI/ASME B94.11M-1993

Drill Diameter, D ^a			Jobbers Length				Taper Length				Screw Machine Length				
Fraction No. or Ltr.	mm	Equivalent		Flute		Overall		Flute		Overall		Flute		Overall	
		Decimal In.	mm	F		L		F		L		F		L	
				In.	mm	In.	mm	In.	mm	In.	mm	In.	mm	In.	mm
L	7.40	0.2900	7.366	2 ⁵ / ₁₆	75	4 ¹ / ₄	108	...	...	...	...	1 ⁹ / ₁₆	40	2 ³ / ₄	70
		0.2913	7.400	3 ⁷ / ₁₆	78	4 ³ / ₈	111	...	...	...	...	1 ⁹ / ₁₆	40	2 ³ / ₄	70
M	7.50	0.2950	7.493	3 ⁷ / ₁₆	78	4 ³ / ₈	111	...	...	...	...	1 ⁹ / ₁₆	40	2 ³ / ₄	70
		0.2953	7.500	3 ⁷ / ₁₆	78	4 ³ / ₈	111	4	102	6 ³ / ₈	162	1 ⁹ / ₁₆	40	2 ³ / ₄	70
19/64	7.60	0.2969	7.541	3 ⁷ / ₁₆	78	4 ³ / ₈	111	4	102	6 ³ / ₈	162	1 ⁹ / ₁₆	40	2 ³ / ₄	70
		0.2992	7.600	3 ⁷ / ₁₆	78	4 ³ / ₈	111	...	...	...	...	1 ⁵ / ₈	41	2 ¹³ / ₁₆	71
N	7.70	0.3020	7.671	3 ⁷ / ₁₆	78	4 ³ / ₈	111	...	...	...	...	1 ⁵ / ₈	41	2 ¹³ / ₁₆	71
		0.3031	7.700	3 ⁷ / ₁₆	81	4 ¹ / ₂	114	...	...	...	...	1 ⁵ / ₈	41	2 ¹³ / ₁₆	71
7.80	7.800	0.3071	7.800	3 ⁷ / ₁₆	81	4 ¹ / ₂	114	4	102	6 ³ / ₈	162	1 ⁵ / ₈	41	2 ¹³ / ₁₆	71
		0.3110	7.900	3 ⁷ / ₁₆	81	4 ¹ / ₂	114	...	...	...	...	1 ⁵ / ₈	41	2 ¹³ / ₁₆	71
5/16	8.00	0.3125	7.938	3 ⁷ / ₁₆	81	4 ¹ / ₂	114	4	102	6 ³ / ₈	162	1 ⁵ / ₈	41	2 ¹³ / ₁₆	71
		0.3150	8.000	3 ⁷ / ₁₆	81	4 ¹ / ₂	114	4 ¹ / ₈	105	6 ¹ / ₂	165	1 ¹¹ / ₁₆	43	2 ¹⁵ / ₁₆	75
O	8.10	0.3160	8.026	3 ⁷ / ₁₆	81	4 ¹ / ₂	114	...	...	...	...	1 ¹¹ / ₁₆	43	2 ¹⁵ / ₁₆	75
		0.3189	8.100	3 ⁷ / ₁₆	84	4 ⁵ / ₈	117	...	...	...	...	1 ¹¹ / ₁₆	43	2 ¹⁵ / ₁₆	75
8.20	8.200	0.3228	8.200	3 ⁷ / ₁₆	84	4 ⁵ / ₈	117	4 ¹ / ₈	105	6 ¹ / ₂	165	1 ¹¹ / ₁₆	43	2 ¹⁵ / ₁₆	75
		0.3230	8.204	3 ⁷ / ₁₆	84	4 ⁵ / ₈	117	...	...	...	...	1 ¹¹ / ₁₆	43	2 ¹⁵ / ₁₆	75
P	8.30	0.3268	8.300	3 ⁷ / ₁₆	84	4 ⁵ / ₈	117	...	...	...	...	1 ¹¹ / ₁₆	43	2 ¹⁵ / ₁₆	75
		0.3281	8.334	3 ⁷ / ₁₆	84	4 ⁵ / ₈	117	4 ¹ / ₈	105	6 ¹ / ₂	165	1 ¹¹ / ₁₆	43	2 ¹⁵ / ₁₆	75
21/64	8.40	0.3307	8.400	3 ⁷ / ₁₆	87	4 ³ / ₄	121	...	...	...	...	1 ¹¹ / ₁₆	43	3	76
		0.3320	8.433	3 ⁷ / ₁₆	87	4 ³ / ₄	121	...	...	...	...	1 ¹¹ / ₁₆	43	3	76
Q	8.50	0.3346	8.500	3 ⁷ / ₁₆	87	4 ³ / ₄	121	4 ¹ / ₈	105	6 ¹ / ₂	165	1 ¹¹ / ₁₆	43	3	76
		0.3386	8.600	3 ⁷ / ₁₆	87	4 ³ / ₄	121	...	...	...	...	1 ¹¹ / ₁₆	43	3	76
R	8.60	0.3390	8.611	3 ⁷ / ₁₆	87	4 ³ / ₄	121	...	...	...	...	1 ¹¹ / ₁₆	43	3	76
		0.3425	8.700	3 ⁷ / ₁₆	87	4 ³ / ₄	121	...	...	...	...	1 ¹¹ / ₁₆	43	3	76
11/32	8.70	0.3438	8.733	3 ⁷ / ₁₆	87	4 ³ / ₄	121	4 ¹ / ₈	105	6 ¹ / ₂	165	1 ¹¹ / ₁₆	43	3	76
		0.3465	8.800	3 ⁷ / ₁₆	89	4 ⁷ / ₈	124	4 ¹ / ₄	108	6 ³ / ₄	171	1 ³ / ₄	44	3 ³ / ₁₆	78
S	8.80	0.3480	8.839	3 ¹ / ₂	89	4 ⁷ / ₈	124	...	...	...	...	1 ³ / ₄	44	3 ³ / ₁₆	78
		0.3504	8.900	3 ¹ / ₂	89	4 ⁷ / ₈	124	...	...	...	...	1 ³ / ₄	44	3 ³ / ₁₆	78
9.00	9.000	0.3543	9.000	3 ¹ / ₂	89	4 ⁷ / ₈	124	4 ¹ / ₄	108	6 ³ / ₄	171	1 ³ / ₄	44	3 ³ / ₁₆	78
		0.3580	9.093	3 ¹ / ₂	89	4 ⁷ / ₈	124	...	...	...	...	1 ³ / ₄	44	3 ³ / ₁₆	78
T	9.10	0.3583	9.100	3 ¹ / ₂	89	4 ⁷ / ₈	124	...	...	...	...	1 ³ / ₄	44	3 ³ / ₁₆	78
		0.3594	9.129	3 ¹ / ₂	89	4 ⁷ / ₈	124	4 ¹ / ₄	108	6 ³ / ₄	171	1 ³ / ₄	44	3 ³ / ₁₆	78
23/64	9.20	0.3622	9.200	3 ⁵ / ₈	92	5	127	4 ¹ / ₄	108	6 ³ / ₄	171	1 ¹³ / ₁₆	46	3 ³ / ₈	79
		0.3661	9.300	3 ⁵ / ₈	92	5	127	...	...	...	...	1 ¹³ / ₁₆	46	3 ³ / ₈	79
U	9.30	0.3680	9.347	3 ⁵ / ₈	92	5	127	...	...	...	...	1 ¹³ / ₁₆	46	3 ³ / ₈	79
		0.3701	9.400	3 ⁵ / ₈	92	5	127	...	...	...	...	1 ¹³ / ₁₆	46	3 ³ / ₈	79
9.40	9.400	0.3740	9.500	3 ⁵ / ₈	92	5	127	4 ¹ / ₄	108	6 ³ / ₄	171	1 ¹³ / ₁₆	46	3 ³ / ₈	79
		0.3750	9.525	3 ⁵ / ₈	92	5	127	4 ¹ / ₄	108	6 ³ / ₄	171	1 ¹³ / ₁₆	46	3 ³ / ₈	79
3/8	9.50	0.3770	9.576	3 ⁵ / ₈	92	5	127	...	...	...	...	1 ⁷ / ₈	48	3 ³ / ₄	83
		0.3780	9.600	3 ³ / ₄	95	5 ¹ / ₈	130	...	...	...	...	1 ⁷ / ₈	48	3 ³ / ₄	83
9.60	9.600	0.3819	9.700	3 ³ / ₄	95	5 ¹ / ₈	130	...	...	...	...	1 ⁷ / ₈	48	3 ³ / ₄	83
		0.3858	9.800	3 ³ / ₄	95	5 ¹ / ₈	130	4 ³ / ₈	111	7	178	1 ⁷ / ₈	48	3 ³ / ₄	83
W	9.80	0.3860	9.804	3 ³ / ₄	95	5 ¹ / ₈	130	...	...	...	...	1 ⁷ / ₈	48	3 ³ / ₄	83
		0.3898	9.900	3 ³ / ₄	95	5 ¹ / ₈	130	...	...	...	...	1 ⁷ / ₈	48	3 ³ / ₄	83
25/64	9.90	0.3906	9.921	3 ³ / ₄	95	5 ¹ / ₈	130	4 ³ / ₈	111	7	178	1 ⁷ / ₈	48	3 ³ / ₄	83
		0.3937	10.000	3 ³ / ₄	95	5 ¹ / ₈	130	4 ³ / ₈	111	7	178	1 ¹³ / ₁₆	49	3 ³ / ₁₆	84

Table 7. (Continued) ANSI Straight Shank Twist Drills — Jobbers Length through 17.5 mm, Taper Length through 12.7 mm, and Screw Machine Length through 25.4 mm Diameter ANSI/ASME B94.11M-1993

Drill Diameter, D ^a		Jobbers Length				Taper Length				Screw Machine Length					
Fraction No. or Ltr.	mm	Equivalent		Flute		Overall		Flute		Overall		Flute		Overall	
		Decimal In.	mm	F		L		F		L		F		L	
				In.	mm	In.	mm	In.	mm	In.	mm	In.	mm	In.	mm
X	10.20	0.3970	10.084	3 ³ / ₄	95	5 ¹ / ₈	130	...	...	...	...	1 ¹ / ₁₆	49	3 ³ / ₁₆	84
		0.4016	10.200	3 ⁷ / ₈	98	5 ¹ / ₂	133	4 ³ / ₈	111	7	178	1 ¹ / ₁₆	49	3 ³ / ₁₆	84
		0.4040	10.262	3 ⁷ / ₈	98	5 ¹ / ₄	133	...	...	...	...	1 ¹ / ₁₆	49	3 ³ / ₁₆	84
Y	10.50	0.4062	10.317	3 ⁷ / ₈	98	5 ¹ / ₂	133	4 ³ / ₈	111	7	178	1 ¹ / ₁₆	49	3 ³ / ₁₆	84
		0.4130	10.490	3 ⁷ / ₈	98	5 ¹ / ₄	133	...	...	...	...	2	51	3 ³ / ₈	86
Z	10.80	0.4134	10.500	3 ⁷ / ₈	98	5 ¹ / ₄	133	4 ⁵ / ₈	117	7 ¹ / ₄	184	2	51	3 ³ / ₈	86
		0.4219	10.716	3 ¹ / ₂	100	5 ³ / ₈	137	4 ⁵ / ₈	117	7 ¹ / ₄	184	2	51	3 ³ / ₈	86
1 ¹ / ₃₂	11.00	0.4252	10.800	4 ¹ / ₁₆	103	5 ¹ / ₂	140	4 ⁵ / ₈	117	7 ¹ / ₄	184	2 ¹ / ₁₆	52	3 ³ / ₁₆	87
		0.4331	11.000	4 ¹ / ₁₆	103	5 ¹ / ₂	140	4 ⁵ / ₈	117	7 ¹ / ₄	184	2 ¹ / ₁₆	52	3 ³ / ₁₆	87
7 ¹ / ₁₆	11.20	0.4375	11.112	4 ¹ / ₁₆	103	5 ¹ / ₂	140	4 ⁵ / ₈	117	7 ¹ / ₄	184	2 ¹ / ₁₆	52	3 ³ / ₁₆	87
		0.4409	11.200	4 ¹ / ₁₆	106	5 ⁵ / ₈	143	4 ³ / ₄	121	7 ¹ / ₂	190	2 ¹ / ₈	54	3 ³ / ₁₆	90
2 ¹ / ₆₄	11.50	0.4528	11.500	4 ³ / ₁₆	106	5 ³ / ₈	143	4 ³ / ₄	121	7 ¹ / ₂	190	2 ¹ / ₈	54	3 ³ / ₁₆	90
		0.4531	11.509	4 ³ / ₁₆	106	5 ³ / ₈	143	4 ³ / ₄	121	7 ¹ / ₂	190	2 ¹ / ₈	54	3 ³ / ₁₆	90
1 ¹ / ₈	11.80	0.4646	11.800	4 ⁵ / ₁₆	110	5 ¹ / ₄	146	4 ³ / ₄	121	7 ¹ / ₂	190	2 ¹ / ₈	54	3 ³ / ₈	92
		0.4688	11.908	4 ⁵ / ₁₆	110	5 ³ / ₄	146	4 ³ / ₄	121	7 ¹ / ₂	190	2 ¹ / ₈	54	3 ³ / ₈	92
1 ¹ / ₃₂	12.00	0.4724	12.000	4 ³ / ₈	111	5 ⁷ / ₈	149	4 ³ / ₄	121	7 ³ / ₄	197	2 ³ / ₁₆	56	3 ¹ / ₁₆	94
		0.4803	12.200	4 ³ / ₈	111	5 ⁷ / ₈	149	4 ³ / ₄	121	7 ³ / ₄	197	2 ³ / ₁₆	56	3 ¹ / ₁₆	94
3 ¹ / ₆₄	12.20	0.4844	12.304	4 ³ / ₈	111	5 ⁷ / ₈	149	4 ³ / ₄	121	7 ³ / ₄	197	2 ³ / ₁₆	56	3 ¹ / ₁₆	94
		0.4921	12.500	4 ¹ / ₂	114	6	152	4 ³ / ₄	121	7 ³ / ₄	197	2 ¹ / ₄	57	3 ³ / ₄	95
1/2	12.50	0.5000	12.700	4 ¹ / ₂	114	6	152	4 ³ / ₄	121	7 ³ / ₄	197	2 ¹ / ₄	57	3 ³ / ₄	95
		0.5039	12.800	4 ¹ / ₂	114	6	152	...	...	...	...	2 ³ / ₈	60	3 ³ / ₈	98
13.00	13.00	0.5118	13.000	4 ¹ / ₂	114	6	152	...	...	...	...	2 ³ / ₈	60	3 ³ / ₈	98
		0.5156	13.096	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ³ / ₈	60	3 ³ / ₈	98
3 ¹ / ₆₄	13.20	0.5197	13.200	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ³ / ₈	60	3 ³ / ₈	98
		0.5312	13.492	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ³ / ₈	60	3 ³ / ₈	98
1 ¹ / ₃₂	13.50	0.5315	13.500	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ³ / ₈	60	3 ³ / ₈	98
		0.5433	13.800	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ¹ / ₂	64	4	102
3 ¹ / ₆₄	13.80	0.5469	13.891	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ¹ / ₂	64	4	102
		0.5512	14.000	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ¹ / ₂	64	4	102
14.00	14.00	0.5610	14.250	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ¹ / ₂	64	4	102
		0.5625	14.288	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ¹ / ₂	64	4	102
9 ¹ / ₁₆	14.50	0.5709	14.500	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ⁵ / ₈	67	4 ¹ / ₈	105
		0.5781	14.684	4 ¹ / ₂	122	6 ⁵ / ₈	168	...	...	...	...	2 ⁵ / ₈	67	4 ¹ / ₈	105
3 ¹ / ₆₄	14.75	0.5807	14.750	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ⁵ / ₈	67	4 ¹ / ₈	105
		0.5906	15.000	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ⁵ / ₈	67	4 ¹ / ₈	105
1 ¹ / ₃₂	15.00	0.5938	15.083	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ⁵ / ₈	67	4 ¹ / ₈	105
		0.6004	15.250	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ¹ / ₄	70	4 ¹ / ₄	108
3 ¹ / ₆₄	15.25	0.6094	15.479	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ³ / ₄	70	4 ¹ / ₄	108
		0.6102	15.500	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ¹ / ₄	70	4 ¹ / ₄	108
15.50	15.50	0.6201	15.750	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ¹ / ₄	70	4 ¹ / ₄	108
		0.6250	15.875	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ¹ / ₄	70	4 ¹ / ₄	108
5 ¹ / ₈	16.00	0.6299	16.000	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ³ / ₈	73	4 ¹ / ₂	114
		0.6398	16.250	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ³ / ₈	73	4 ¹ / ₂	114
4 ¹ / ₆₄	16.25	0.6406	16.271	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ³ / ₈	73	4 ¹ / ₂	114
		0.6496	16.500	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ³ / ₈	73	4 ¹ / ₂	114
2 ¹ / ₃₂	16.50	0.6562	16.669	5 ¹ / ₁₆	132	7 ¹ / ₈	181	...	...	...	...	2 ³ / ₈	73	4 ¹ / ₂	114

Table 7. (Continued) ANSI Straight Shank Twist Drills — Jobbers Length through 17.5 mm, Taper Length through 12.7 mm, and Screw Machine Length through 25.4 mm Diameter ANSI/ASME B94.11M-1993

Drill Diameter, D ^a		Jobbers Length				Taper Length				Screw Machine Length					
Fraction No. or Ltr.	mm	Equivalent		Flute		Overall		Flute		Overall		Flute		Overall	
		Decimal In.	mm	F		L		F		L		F		L	
				In.	mm	In.	mm	In.	mm	In.	mm	In.	mm	In.	mm
45/64	16.75	0.6594	16.750	5/8	143	7 3/8	194	...	...	...	...	2 3/8	73	4 1/2	114
	17.00	0.6693	17.000	5/8	143	7 3/8	194	...	...	...	...	2 3/8	73	4 1/2	114
1/16	17.25	0.6791	17.250	5/8	143	7 3/8	194	...	...	...	...	2 3/8	73	4 1/2	114
	17.50	0.6890	17.500	5/8	143	7 3/8	194	...	...	...	...	3	76	4 3/4	121
45/64	18.00	0.7031	17.859	...	...	...	...	...	...	...	...	3	76	4 3/4	121
	18.50	0.7188	18.258	...	...	...	...	...	...	...	...	3	76	4 3/4	121
3/32	18.75	0.7283	18.500	...	...	...	...	...	...	...	...	3 1/8	79	5	127
	19.00	0.7344	18.654	...	...	...	...	...	...	...	...	3 1/8	79	5	127
7/64	19.25	0.7480	19.000	...	...	...	...	...	...	...	...	3 1/8	79	5	127
	19.50	0.7500	19.050	...	...	...	...	...	...	...	...	3 1/8	79	5	127
9/64	19.75	0.7656	19.446	...	...	...	...	...	...	...	...	3 1/4	83	5 1/8	130
	20.00	0.7677	19.500	...	...	...	...	...	...	...	...	3 1/4	83	5 1/8	130
25/32	20.25	0.7812	19.845	...	...	...	...	...	...	...	...	3 1/4	83	5 1/8	130
	20.50	0.7879	20.000	...	...	...	...	...	...	...	...	3 3/8	86	5 1/4	133
3/16	20.75	0.7969	20.241	...	...	...	...	...	...	...	...	3 3/8	86	5 1/4	133
	21.00	0.8071	20.500	...	...	...	...	...	...	...	...	3 3/8	86	5 1/4	133
13/16	21.25	0.8125	20.638	...	...	...	...	...	...	...	...	3 3/8	86	5 1/4	133
	21.50	0.8268	21.000	...	...	...	...	...	...	...	...	3 1/2	89	5 3/8	137
5/64	21.75	0.8281	21.034	...	...	...	...	...	...	...	...	3 1/2	89	5 3/8	137
	22.00	0.8438	21.433	...	...	...	...	...	...	...	...	3 1/2	89	5 3/8	137
27/32	22.25	0.8465	21.500	...	...	...	...	...	...	...	...	3 1/2	89	5 3/8	137
	22.50	0.8594	21.829	...	...	...	...	...	...	...	...	3 1/2	89	5 3/8	137
55/64	22.75	0.8661	22.000	...	...	...	...	...	...	...	...	3 1/2	89	5 3/8	137
	23.00	0.8750	22.225	...	...	...	...	...	...	...	...	3 1/2	89	5 3/8	137
7/8	23.25	0.8858	22.500	...	...	...	...	...	...	...	...	3 1/2	89	5 3/8	137
	23.50	0.8906	22.621	...	...	...	...	...	...	...	...	3 3/8	92	5 3/8	143
57/64	23.75	0.8906	22.621	...	...	...	...	...	...	...	...	3 3/8	92	5 3/8	143
	24.00	0.9055	23.000	...	...	...	...	...	...	...	...	3 3/8	92	5 3/8	143
29/32	24.25	0.9062	23.017	...	...	...	...	...	...	...	...	3 3/8	92	5 3/8	143
	24.50	0.9219	23.416	...	...	...	...	...	...	...	...	3 3/4	95	5 3/4	146
59/64	24.75	0.9252	23.500	...	...	...	...	...	...	...	...	3 3/4	95	5 3/4	146
	25.00	0.9252	23.500	...	...	...	...	...	...	...	...	3 3/4	95	5 3/4	146
15/16	25.25	0.9375	23.812	...	...	...	...	...	...	...	...	3 3/4	95	5 3/4	146
	25.50	0.9449	24.000	...	...	...	...	...	...	...	...	3 3/8	98	5 7/8	149
61/64	25.75	0.9531	24.209	...	...	...	...	...	...	...	...	3 3/8	98	5 7/8	149
	26.00	0.9646	24.500	...	...	...	...	...	...	...	...	3 3/8	98	5 7/8	149
31/32	26.25	0.9688	24.608	...	...	...	...	...	...	...	...	3 3/8	98	5 7/8	149
	26.50	0.9843	25.000	...	...	...	...	...	...	...	...	4	102	6	152
63/64	26.75	0.9844	25.004	...	...	...	...	...	...	...	...	4	102	6	152
	27.00	1.0000	25.400	...	...	...	...	...	...	...	...	4	102	6	152

^aFractional inch, number, letter, and metric sizes.

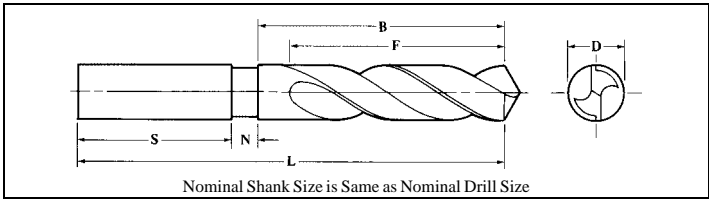


Table 8. ANSI Straight Shank Twist Drills — Taper Length — Over 1/2 in. (12.7 mm) Dia., Fractional and Metric Sizes ANSI B94.11M-1993

Diameter of Drill				Flute Length		Overall Length		Length of Body		Minimum Length of Shk.		Maximum Length of Neck	
D		Decimal	Millimeter	F		L		B		S		N	
Frac.	mm	Inch Equiv.	mm Equiv.	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
3/64	12.80	0.5039	12.800	4 3/4	121	8	203	4 3/8	124	2 3/8	66	1/2	13
	13.00	0.5117	13.000	4 3/4	121	8	203	4 7/8	124	2 3/8	66	1/2	13
		0.5156	13.096	4 3/4	121	8	203	4 7/8	124	2 3/8	66	1/2	13
1/32	13.20	0.5197	13.200	4 3/4	121	8	203	4 7/8	124	2 3/8	66	1/2	13
		0.5312	13.492	4 3/4	121	8	203	4 7/8	124	2 3/8	66	1/2	13
	13.50	0.5315	13.500	4 3/4	121	8	203	4 7/8	124	2 3/8	66	1/2	13
3/64	13.80	0.5433	13.800	4 7/8	124	8 1/4	210	5	127	2 3/4	70	1/2	13
		0.5419	13.891	4 7/8	124	8 1/4	210	5	127	2 3/4	70	1/2	13
	14.00	0.5512	14.000	4 7/8	124	8 1/4	210	5	127	2 3/4	70	1/2	13
9/16	14.25	0.5610	14.250	4 7/8	124	8 1/4	210	5	127	2 3/4	70	1/2	13
		0.5625	14.288	4 7/8	124	8 1/4	210	5	127	2 3/4	70	1/2	13
	14.50	0.5709	14.500	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
3/64	14.75	0.5781	14.684	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
		0.5807	14.750	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
	15.00	0.5906	15.000	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
19/32		0.5938	15.083	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
	15.25	0.6004	15.250	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
		0.6094	15.479	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
3/64	15.50	0.6102	15.500	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
		0.6201	15.750	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
	15.75	0.6250	15.875	4 7/8	124	8 3/4	222	5	127	3 1/8	79	3/8	16
5/8	16.00	0.6299	16.000	5 1/8	130	9	228	5 1/4	133	3 1/8	79	3/8	16
	16.25	0.6398	16.250	5 1/8	130	9	228	5 1/4	133	3 1/8	79	3/8	16
		0.6406	16.271	5 1/8	130	9	228	5 1/4	133	3 1/8	79	3/8	16
4/64	16.50	0.6496	16.500	5 1/8	130	9	228	5 1/4	133	3 1/8	79	3/8	16
		0.6562	16.667	5 1/8	130	9	228	5 1/4	133	3 1/8	79	3/8	16
	16.75	0.6594	16.750	5 3/8	137	9 1/4	235	5 1/2	140	3 1/8	79	3/8	16
17/32	17.00	0.6693	17.000	5 3/8	137	9 1/4	235	5 1/2	140	3 1/8	79	3/8	16
		0.6719	17.066	5 3/8	137	9 1/4	235	5 1/2	140	3 1/8	79	3/8	16
	17.25	0.6791	17.250	5 3/8	137	9 1/4	235	5 1/2	140	3 1/8	79	3/8	16
1/16		0.6875	17.462	5 3/8	137	9 1/4	235	5 1/2	140	3 1/8	79	3/8	16
	17.50	0.6890	17.500	5 3/8	143	9 1/2	241	5 3/4	146	3 1/8	79	3/8	16
		0.7031	17.859	5 3/8	143	9 1/2	241	5 3/4	146	3 1/8	79	3/8	16
45/64	18.00	0.7087	18.000	5 3/8	143	9 1/2	241	5 3/4	146	3 1/8	79	3/8	16
		0.7188	18.258	5 3/8	143	9 1/2	241	5 3/4	146	3 1/8	79	3/8	16
	18.50	0.7283	18.500	5 7/8	149	9 3/4	247	6	152	3 1/8	79	3/8	16
4/64		0.7344	18.654	5 7/8	149	9 3/4	247	6	152	3 1/8	79	3/8	16
	19.00	0.7480	19.000	5 7/8	149	9 3/4	247	6	152	3 1/8	79	3/8	16
		0.7500	19.050	5 7/8	149	9 3/4	247	6	152	3 1/8	79	3/8	16
49/64		0.7656	19.446	6	152	9 7/8	251	6 1/8	156	3 1/8	79	3/8	16
	19.50	0.7677	19.500	6	152	9 7/8	251	6 1/8	156	3 1/8	79	3/8	16
		0.7812	19.842	6	152	9 7/8	251	6 1/8	156	3 1/8	79	3/8	16

Table 8. (Continued) ANSI Straight Shank Twist Drills — Taper Length — Over ½ in. (12.7 mm) Dia., Fractional and Metric Sizes ANSI B94.11M-1993

Diameter of Drill				Flute Length		Overall Length		Length of Body		Minimum Length of Shk.		Maximum Length of Neck	
D		Decimal Inch Equiv.	Millimeter Equiv.	F		L		B		S		N	
Frac.	mm			Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
5/64	20.00	0.7874	20.000	6/8	156	10	254	6/4	159	3/4	79	3/8	16
		0.7969	20.241	6/8	156	10	254	6/4	159	3/8	79	3/8	16
13/16	20.50	0.8071	20.500	6/8	156	10	254	6/4	159	3/8	79	3/8	16
		0.8125	20.638	6/8	156	10	254	6/4	159	3/8	79	3/8	16
5/64	21.00	0.8268	21.000	6/8	156	10	254	6/4	159	3/8	79	3/8	16
		0.8281	21.034	6/8	156	10	254	6/4	159	3/8	79	3/8	16
27/32		0.8438	21.433	6/8	156	10	254	6/4	159	3/8	79	3/8	16
		0.8465	21.500	6/8	156	10	254	6/4	159	3/8	79	3/8	16
5/64	21.50	0.8594	21.829	6/8	156	10	254	6/4	159	3/8	79	3/8	16
		0.8661	22.000	6/8	156	10	254	6/4	159	3/8	79	3/8	16
7/8	22.00	0.8750	22.225	6/8	156	10	254	6/4	159	3/8	79	3/8	16
		0.8858	22.500	6/8	156	10	254	6/4	159	3/8	79	3/8	16
5/64	22.50	0.8906	22.621	6/8	156	10	254	6/4	159	3/8	79	3/8	16
		0.9055	23.000	6/8	156	10	254	6/4	159	3/8	79	3/8	16
29/32		0.9062	23.017	6/8	156	10	254	6/4	159	3/8	79	3/8	16
		0.9219	23.416	6/8	156	10 3/4	273	6/4	159	3/8	98	3/8	16
5/64	23.50	0.9252	23.500	6/8	156	10 3/4	273	6/4	159	3/8	98	3/8	16
		0.9375	23.812	6/8	156	10 3/4	273	6/4	159	3/8	98	3/8	16
6/64	24.00	0.9449	24.000	6 3/8	162	11	279	6 1/2	165	3/8	98	3/8	16
		0.9531	24.209	6 3/8	162	11	279	6 1/2	165	3/8	98	3/8	16
3/32	24.50	0.9646	24.500	6 3/8	162	11	279	6 1/2	165	3/8	98	3/8	16
		0.9688	24.608	6 3/8	162	11	279	6 1/2	165	3/8	98	3/8	16
6/64	25.00	0.9843	25.000	6 3/8	162	11	279	6 1/2	165	3/8	98	3/8	16
		0.9844	25.004	6 3/8	162	11	279	6 1/2	165	3/8	98	3/8	16
1		1.0000	25.400	6 3/8	162	11	279	6 1/2	165	3/8	98	3/8	16
	25.50	1.0039	25.500	6 1/2	165	11 3/8	282	6 5/8	168	3/8	98	3/8	16
1 1/64		1.0156	25.796	6 1/2	165	11 1/8	282	6 5/8	168	3/8	98	3/8	16
	26.00	1.0236	26.000	6 1/2	165	11 3/8	282	6 5/8	168	3/8	98	3/8	16
1 1/32		1.0312	26.192	6 1/2	165	11 1/8	282	6 5/8	168	3/8	98	3/8	16
	26.50	1.0433	26.560	6 3/8	168	11 1/4	286	6 3/4	172	3/8	98	3/8	16
1 3/64		1.0469	26.591	6 3/8	168	11 1/4	286	6 3/4	172	3/8	98	3/8	16
	1 1/16	1.0625	26.988	6 3/8	168	11 1/4	286	6 3/4	172	3/8	98	3/8	16
1 3/64	27.00	1.0630	27.000	6 3/8	168	11 1/4	286	6 3/4	172	3/8	98	3/8	16
		1.0781	27.384	6 3/8	175	11 1/2	292	7	178	3/8	98	3/8	16
1 3/32	27.50	1.0827	27.500	6 3/8	175	11 1/2	292	7	178	3/8	98	3/8	16
		1.0938	27.783	6 3/8	175	11 1/2	292	7	178	3/8	98	3/8	16
1 7/64	28.00	1.1024	28.000	7/8	181	11 3/4	298	7 1/4	184	3/8	98	3/8	16
		1.1094	28.179	7/8	181	11 3/4	298	7 1/4	184	3/8	98	3/8	16
1 1/8	28.50	1.1220	28.500	7/8	181	11 3/4	298	7 1/4	184	3/8	98	3/8	16
		1.1250	28.575	7/8	181	11 3/4	298	7 1/4	184	3/8	98	3/8	16
1 5/64		1.1406	28.971	7 1/4	184	11 7/8	301	7 3/8	187	3/8	98	3/8	16
	29.00	1.1417	29.000	7 1/4	184	11 7/8	301	7 3/8	187	3/8	98	3/8	16
1 3/32		1.1562	29.367	7 1/4	184	11 7/8	301	7 3/8	187	3/8	98	3/8	16
	29.50	1.1614	29.500	7 3/8	187	12	305	7 1/2	191	3/8	98	3/8	16
1 11/64		1.1719	29.766	7 3/8	187	12	305	7 1/2	191	3/8	98	3/8	16
	30.00	1.1811	30.000	7 3/8	187	12	305	7 1/2	191	3/8	98	3/8	16
1 3/16		1.1875	30.162	7 3/8	187	12	305	7 1/2	191	3/8	98	3/8	16
	30.50	1.2008	30.500	7 1/2	190	12 1/8	308	7 5/8	194	3/8	98	3/8	16
1 5/64		1.2031	30.559	7 1/2	190	12 1/8	308	7 5/8	194	3/8	98	3/8	16
	1 1/32	1.2188	30.958	7 1/2	190	12 1/8	308	7 5/8	194	3/8	98	3/8	16
1 5/64	31.00	1.2205	31.000	7 3/8	200	12 1/2	317	8	203	3/8	98	3/8	16
		1.2344	31.354	7 3/8	200	12 1/2	317	8	203	3/8	98	3/8	16
1 15/64	31.50	1.2402	31.500	7 3/8	200	12 1/2	317	8	203	3/8	98	3/8	16

Table 8. (Continued) ANSI Straight Shank Twist Drills — Taper Length — Over 1/2 in. (12.7 mm) Dia., Fractional and Metric Sizes ANSI B94.11M-1993

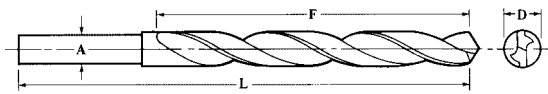
Diameter of Drill				Flute Length		Overall Length		Length of Body		Minimum Length of Shk.		Maximum Length of Neck	
D		Decimal Inch Equiv.	Millimeter Equiv.	F		L		B		S		N	
Frac.	mm			Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
1/4	32.00	1.2500	31.750	7/8	200	12 1/2	317	8	203	3 3/8	98	3/8	16
	32.50	1.2598	32.000	8 1/2	216	14 3/8	359	8 3/8	219	4 7/8	124	3/8	16
1/32	33.00	1.2795	32.500	8 1/2	216	14 3/8	359	8 3/8	219	4 7/8	124	3/8	16
	33.50	1.2812	32.542	8 1/2	216	14 3/8	359	8 3/8	219	4 7/8	124	3/8	16
1/16	33.00	1.2992	33.000	8 3/8	219	14 1/2	362	8 3/4	222	4 7/8	124	3/8	16
	33.50	1.3125	33.338	8 3/8	219	14 3/8	362	8 3/4	222	4 7/8	124	3/8	16
1 1/2	34.00	1.3189	33.500	8 3/4	222	14 3/8	365	8 3/8	225	4 7/8	124	3/8	16
	34.00	1.3386	34.000	8 3/4	222	14 3/8	365	8 3/8	225	4 7/8	124	3/8	16
1 1/2	34.50	1.3438	34.133	8 3/4	222	14 3/8	365	8 3/8	225	4 7/8	124	3/8	16
	34.50	1.3583	34.500	8 3/8	225	14 1/2	368	9	229	4 7/8	124	3/8	16
1 3/8	35.00	1.3750	34.925	8 3/8	225	14 1/2	368	9	229	4 7/8	124	3/8	16
	35.00	1.3780	35.000	9	229	14 3/8	372	9 1/8	232	4 7/8	124	3/8	16
1 1/2	35.50	1.3976	35.500	9	229	14 3/8	372	9 1/8	232	4 7/8	124	3/8	16
	36.00	1.4062	35.717	9	229	14 3/8	372	9 1/8	232	4 7/8	124	3/8	16
1 1/2	36.00	1.4173	36.000	9 1/8	232	14 3/4	375	9 1/4	235	4 7/8	124	3/8	16
	36.50	1.4370	36.500	9 1/8	232	14 3/4	375	9 1/4	235	4 7/8	124	3/8	16
1 7/16	37.00	1.4375	36.512	9 1/8	232	14 3/4	375	9 1/4	235	4 7/8	124	3/8	16
	37.00	1.4567	37.000	9 1/4	235	14 3/8	378	9 3/8	238	4 7/8	124	3/8	16
1 5/8	37.50	1.4688	37.308	9 1/4	235	14 3/8	378	9 3/8	238	4 7/8	124	3/8	16
	37.50	1.4764	37.500	9 3/8	238	15	381	9 1/2	241	4 7/8	124	3/8	16
1 1/2	38.00	1.4961	38.000	9 3/8	238	15	381	9 1/2	241	4 7/8	124	3/8	16
	38.00	1.5000	38.100	9 3/8	238	15	381	9 1/2	241	4 7/8	124	3/8	16
1 3/8	38.00	1.5625	39.688	9 3/8	244	15 1/4	387	9 3/4	247	4 7/8	124	3/8	16
	38.00	1.6250	41.275	9 3/8	251	15 3/8	397	10	254	4 7/8	124	3/4	19
1 3/4	38.00	1.7500	44.450	10 1/2	267	16 1/2	413	10 3/8	270	4 7/8	124	3/4	19

**Table 9. American National Standard Taps for Straight Shank Drills
ANSI/ASME B94.11M-1993**

Nominal Diameter of Drill Shank		Thickness of Tang				Length of Tang	
A		J				K	
Inches	Millimeters	Inches		Millimeters		Inches	Millimeters
		Max.	Min.	Max.	Min.		
1/8 thru 3/16	3.18 thru 4.76	0.094	0.090	2.39	2.29	3/32	7.0
over 3/16 thru 1/4	over 4.76 thru 6.35	0.122	0.118	3.10	3.00	5/16	8.0
over 1/4 thru 5/16	over 6.35 thru 7.94	0.162	0.158	4.11	4.01	11/32	8.5
over 5/16 thru 3/8	over 7.94 thru 9.53	0.203	0.199	5.16	5.06	3/8	9.5
over 3/8 thru 1/2	over 9.53 thru 11.91	0.243	0.239	6.17	6.07	7/16	11.0
over 1/2 thru 5/8	over 11.91 thru 14.29	0.303	0.297	7.70	7.55	1/2	12.5
over 5/8 thru 3/4	over 14.29 thru 16.67	0.373	0.367	9.47	9.32	5/8	14.5
over 3/4 thru 7/8	over 16.67 thru 19.05	0.443	0.437	11.25	11.10	3/4	16.0
over 7/8 thru 1	over 19.05 thru 22.23	0.514	0.508	13.05	12.90	7/8	17.5
over 1 thru 1 1/8	over 22.23 thru 25.40	0.609	0.601	15.47	15.27	1 1/8	19.0
over 1 1/8 thru 1 1/4	over 25.40 thru 30.16	0.700	0.692	17.78	17.58	1 1/4	20.5
over 1 1/4 thru 1 3/8	over 30.16 thru 34.93	0.817	0.809	20.75	20.55	1 3/8	22.0

To fit split sleeve collet type drill drivers. See page 850.

Table 10. American National Standard Straight Shank Twist Drills — Screw Machine Length — Over 1 in. (25.4 mm) Dia. ANSI/ASME B94.11M-1993



Diameter of Drill				Flute Length		Overall Length		Shank Diameter	
D		Decimal Inch Equivalent	Millimeter Equivalent	F		L		A	
Frac.	mm			Inch	mm	Inch	mm	Inch	mm
1 1/16	25.50	1.0039	25.500	4	102	6	152	0.9843	25.00
	26.00	1.0236	26.000	4	102	6	152	0.9843	25.00
1 1/8	28.00	1.1024	28.000	4	102	6	152	0.9843	25.00
	30.00	1.1811	30.000	4 1/4	108	6 5/8	168	0.9843	25.00
1 3/16	32.00	1.2598	32.000	4 3/8	111	7	178	1.2402	31.50
	34.00	1.3386	34.000	4 1/2	114	7 1/8	181	1.2402	31.50
1 1/4	36.00	1.4173	36.000	4 3/4	121	7 3/8	187	1.2402	31.50
	38.00	1.4961	38.000	4 7/8	124	7 1/2	190	1.2402	31.50
1 1/2	40.00	1.5748	40.000	4 7/8	124	7 3/4	197	1.4961	38.00
	42.00	1.6535	42.000	5 1/8	130	8	203	1.4961	38.00
1 5/16	44.00	1.7323	44.000	5 1/8	130	8	203	1.4961	38.00
	46.00	1.8110	46.000	5 3/8	137	8 1/4	210	1.4961	38.00
1 3/8	48.00	1.8898	48.000	5 3/8	137	8 1/4	210	1.5000	38.10
	50.00	1.9685	50.000	5 3/8	143	8 1/2	216	1.4961	38.00
1 7/8	50.00	1.9685	50.000	5 3/8	143	8 1/2	216	1.5000	38.10
	50.00	1.9685	50.000	5 3/8	143	8 1/2	216	1.4961	38.00
2	50.00	1.9685	50.000	5 3/8	143	8 1/2	216	1.4961	38.00
2	50.00	1.9685	50.000	5 3/8	143	8 1/2	216	1.5000	38.10

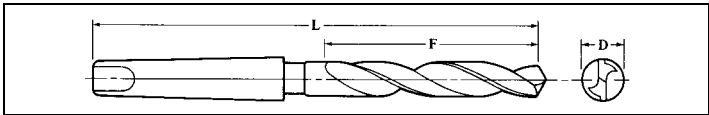


Table 11. American National Taper Shank Twist Drills — Fractional and Metric Sizes ANSI/ASME B94.11M-1993

Drill Diameter, <i>D</i>				Regular Shank						Larger or Smaller Shank*			
Frac-tion	mm	Equivalent		Morse Taper No.	Flute Length		Overall Length		Morse Taper No.	Flute Length		Overall Length	
		Deci. Inch	mm		<i>F</i>		<i>L</i>			<i>F</i>		<i>L</i>	
					Inch	mm	Inch	mm		Inch	mm	Inch	mm
1/8	3.00	0.1181	3.000	1	1 7/8	48	5 7/8	130	...	...	...	...
		0.1250	3.175	1	1 7/8	48	5 7/8	130	...	...	...	...
	3.20	0.1260	3.200	1	2 1/8	54	5 7/8	137	...	...	...	...
3/64	3.50	0.1378	3.500	1	2 1/8	54	5 7/8	137	...	...	...	...
		0.1406	3.571	1	2 1/8	54	5 7/8	137	...	...	...	...
	3.80	0.1496	3.800	1	2 1/8	54	5 7/8	137	...	...	...	...
5/32		0.1562	3.967	1	2 1/8	54	5 7/8	137	...	...	...	...
	4.00	0.1575	4.000	1	2 1/2	64	5 3/4	146	...	...	...	...
	4.20	0.1654	4.200	1	2 1/2	64	5 3/4	146	...	...	...	...
11/64		0.1719	4.366	1	2 1/2	64	5 3/4	146	...	...	...	...
	4.50	0.1772	4.500	1	2 1/2	64	5 3/4	146	...	...	...	...
		0.1875	4.762	1	2 1/2	64	5 3/4	146	...	...	...	...
3/16	4.80	0.1890	4.800	1	2 3/4	70	6	152	...	...	...	...
	5.00	0.1969	5.000	1	2 3/4	70	6	152	...	...	...	...
		0.2031	5.159	1	2 3/4	70	6	152	...	...	...	...
13/64	5.20	0.2047	5.200	1	2 3/4	70	6	152	...	...	...	...
	5.50	0.2165	5.500	1	2 3/4	70	6	152	...	...	...	...
		0.2183	5.558	1	2 3/4	70	6	152	...	...	...	...
7/32	5.80	0.2223	5.800	1	2 7/8	73	6 1/8	156	...	...	...	...
		0.2344	5.954	1	2 7/8	73	6 1/8	156	...	...	...	...
	6.00	0.2362	6.000	1	2 7/8	73	6 1/8	156	...	...	...	...
1/4	6.20	0.2441	6.200	1	2 7/8	73	6 1/8	156	...	...	...	...
		0.2500	6.350	1	2 7/8	73	6 1/8	156	...	...	...	...
	6.50	0.2559	6.500	1	3	76	6 1/4	159	...	...	...	...
17/64		0.2656	6.746	1	3	76	6 1/4	159	...	...	...	...
	6.80	0.2677	6.800	1	3	76	6 1/4	159	...	...	...	...
	7.00	0.2756	7.000	1	3	76	6 1/4	159	...	...	...	...
9/32		0.2812	7.142	1	3	76	6 1/4	159	...	...	...	...
	7.20	0.2835	7.200	1	3 1/8	79	6 3/8	162	...	...	...	...
	7.50	0.2953	7.500	1	3 1/8	79	6 3/8	162	...	...	...	...
19/64		0.2969	7.541	1	3 1/8	79	6 3/8	162	...	...	...	...
	7.80	0.3071	7.800	1	3 1/8	79	6 3/8	162	...	...	...	...
		0.3125	7.938	1	3 1/8	79	6 3/8	162	...	...	...	...
5/16	8.00	0.3150	8.000	1	3 1/4	83	6 1/2	165	...	...	...	...
	8.20	0.3228	8.200	1	3 1/4	83	6 1/2	165	...	...	...	...
		0.3281	8.334	1	3 1/4	83	6 1/2	165	...	...	...	...
21/64	8.50	0.3346	8.500	1	3 1/4	83	6 1/2	165	...	...	...	...
		0.3438	8.733	1	3 1/4	83	6 1/2	165	...	...	...	...
	8.80	0.3465	8.800	1	3 1/2	89	6 3/4	171	...	...	...	...
1/2	9.00	0.3543	9.000	1	3 1/2	89	6 3/4	171	...	...	...	...
		0.3594	9.129	1	3 1/2	89	6 3/4	171	...	...	...	...
	9.20	0.3622	9.200	1	3 1/2	89	6 3/4	171	...	...	...	...
3/8	9.50	0.3740	9.500	1	3 1/2	89	6 3/4	171	...	...	...	...
		0.3750	9.525	1	3 1/2	89	6 3/4	171	2	3 1/2	89	7 3/8	187
	9.80	0.3858	9.800	1	3 3/8	92	7	178	...	...	...	...
25/64		0.3906	9.921	1	3 3/8	92	7	178	2	3 3/8	92	7 1/2	190
	10.00	0.3937	10.000	1	3 3/8	92	7	178	...	...	...	...

Table 11. (Continued) American National Taper Shank Twist Drills — Fractional and Metric Sizes ANSI/ASME B94.11M-1993

Drill Diameter, <i>D</i>				Regular Shank				Larger or Smaller Shank*					
Frac- tion	mm	Equivalent		Morse Taper No.	Flute Length		Overall Length		Morse Taper No.	Flute Length		Overall Length	
		Deci. Inch	mm		<i>F</i>		<i>L</i>			<i>F</i>		<i>L</i>	
					Inch	mm	Inch	mm		Inch	mm	Inch	mm
13/32	10.20	0.4016	10.200	1	3 3/8	92	7	178	...	...	...	...
		0.4062	10.320	1	3 3/8	92	7	178	2	3 3/8	92	7 1/2	190
7/64	10.50	0.4134	10.500	1	3 7/8	98	7 1/4	184	...	...	...	...
		0.4219	10.716	1	3 7/8	98	7 1/4	184	2	3 7/8	98	7 3/4	197
3/16	10.80	0.4252	10.800	1	3 7/8	98	7 1/4	184	...	...	...	...
		0.4331	11.000	1	3 7/8	98	7 1/4	184	...	...	...	...
29/64	11.00	0.4375	11.112	1	3 7/8	98	7 1/4	184	2	3 7/8	98	7 3/4	197
		0.4409	11.200	1	4 1/8	105	7 1/2	190	...	...	...	...
15/32	11.20	0.44528	11.500	1	4 1/8	105	7 1/2	190	...	...	...	...
		0.4531	11.509	1	4 1/8	105	7 1/2	190	2	4 1/8	105	8	203
31/64	11.80	0.4646	11.800	1	4 1/8	105	7 1/2	190	...	...	...	...
		0.4688	11.906	1	4 1/8	105	7 1/2	190	2	4 1/8	105	8	203
1/2	12.00	0.4724	12.000	2	4 3/8	111	8 1/4	210	1	4 3/8	111	7 3/4	197
		0.4803	12.200	2	4 3/8	111	8 1/4	210	1	4 3/8	111	7 3/4	197
5/8	12.20	0.4844	12.304	2	4 3/8	111	8 1/4	210	1	4 3/8	111	7 3/4	197
		0.4921	12.500	2	4 3/8	111	8 1/4	210	1	4 3/8	111	7 3/4	197
33/64	12.50	0.5000	12.700	2	4 3/8	111	8 1/4	210	1	4 3/8	111	7 3/4	197
		0.5034	12.800	2	4 3/8	117	8 1/2	216	1	4 3/8	117	8	203
17/32	13.00	0.5118	13.000	2	4 3/8	117	8 1/2	216	1	4 3/8	117	8	203
		0.5156	13.096	2	4 3/8	117	8 1/2	216	1	4 3/8	117	8	203
35/64	13.20	0.5197	13.200	2	4 3/8	117	8 1/2	216	1	4 3/8	117	8	203
		0.5312	13.492	2	4 3/8	117	8 1/2	216	1	4 3/8	117	8	203
37/64	13.50	0.5315	13.500	2	4 3/8	117	8 1/2	216	1	4 3/8	117	8	203
		0.5433	13.800	2	4 3/8	124	8 3/4	222	1	4 3/8	124	8 1/4	210
9/16	13.80	0.5469	13.891	2	4 3/8	124	8 3/4	222	1	4 3/8	124	8 1/4	210
		0.5572	14.000	2	4 7/8	124	8 3/4	222	1	4 7/8	124	8 1/4	210
5/8	14.25	0.5610	14.250	2	4 3/8	124	8 3/4	222	1	4 3/8	124	8 1/4	210
		0.5625	14.288	2	4 7/8	124	8 3/4	222	1	4 7/8	124	8 1/4	210
39/64	14.50	0.5709	14.500	2	4 3/8	124	8 3/4	222	...	...	...	...
		0.5781	14.684	2	4 3/8	124	8 3/4	222	...	...	...	...
7/8	14.75	0.5807	14.750	2	4 3/8	124	8 3/4	222	...	...	...	...
		0.5807	14.750	2	4 3/8	124	8 3/4	222	...	...	...	...
1 1/8	15.00	0.5906	15.000	2	4 3/8	124	8 3/4	222	...	...	...	...
		0.5938	15.083	2	4 3/8	124	8 3/4	222	...	...	...	...
1 1/4	15.25	0.6004	15.250	2	4 3/8	124	8 3/4	222	...	...	...	...
		0.6094	15.479	2	4 7/8	124	8 3/4	222	...	...	...	...
1 1/2	15.50	0.6102	15.500	2	4 3/8	124	8 3/4	222	...	...	...	...
		0.6201	15.750	2	4 7/8	124	8 3/4	222	...	...	...	...
1 3/8	15.75	0.6250	15.875	2	4 3/8	124	8 3/4	222	...	...	...	...
		0.6299	16.000	2	5 1/8	130	9	229	...	...	...	...
1 1/2	16.25	0.6398	16.250	2	5 1/8	130	9	229	...	...	...	...
		0.6406	16.271	2	5 1/8	130	9	229	3	5 1/8	130	9 3/4	248
1 5/8	16.50	0.6496	16.500	2	5 1/8	130	9	229	...	...	...	...
		0.6562	16.667	2	5 1/8	130	9	229	3	5 1/8	130	9 3/4	248
1 3/4	16.75	0.6594	16.750	2	5 3/8	137	9 1/4	235	...	...	...	...
		0.6693	17.000	2	5 3/8	137	9 1/4	235	...	...	...	...
1 7/8	17.00	0.6719	17.066	2	5 3/8	137	9 1/4	235	3	5 3/8	137	10	254
		0.6791	17.250	2	5 3/8	137	9 1/4	235	...	...	...	...
2	17.25	0.6875	17.462	2	5 3/8	137	9 1/4	235	3	5 3/8	137	10	254
		0.6880	17.500	2	5 3/8	143	9 1/2	241	...	...	...	...
2 1/8	17.50	0.6880	17.500	2	5 3/8	143	9 1/2	241	...	...	...	...
		0.7031	17.859	2	5 3/8	143	9 1/2	241	3	5 3/8	143	10 1/4	260
2 1/4	18.00	0.7087	18.000	2	5 3/8	143	9 1/2	241	...	...	...	...
		0.7188	18.258	2	5 3/8	143	9 1/2	241	3	5 3/8	143	10 1/4	260
2 1/2	18.50	0.7283	18.500	2	5 7/8	149	9 3/4	248	...	...	...	...
		0.7344	18.654	2	5 7/8	149	9 3/4	248	3	5 7/8	149	10 1/2	267

Table 11. (Continued) American National Taper Shank Twist Drills — Fractional and Metric Sizes ANSI/ASME B94.11M-1993

Drill Diameter, <i>D</i>				Regular Shank				Larger or Smaller Shank*					
Frac-tion	Equivalent			Morse Taper No.	Flute Length		Overall Length		Morse Taper No.	Flute Length		Overall Length	
	mm	Deci. Inch	mm		<i>F</i>		<i>L</i>			<i>F</i>		<i>L</i>	
					Inch	mm	Inch	mm		Inch	mm	Inch	mm
3/4	19.00	0.7480	19.000	2	5 3/8	149	9 3/4	248	...	...	...	...
		0.7500	19.050	2	5 7/8	149	9 3/4	248	3	5 7/8	149	10 1/2	267
49/64		0.7656	19.446	2	6	152	9 7/8	251	3	6	152	10 3/8	270
	19.50	0.7677	19.500	2	6	152	9 7/8	251	...	...	...	...
25/32		0.7812	19.843	2	6	152	9 7/8	251	3	6	152	10 3/8	270
	20.00	0.7821	20.000	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
51/64		0.7969	20.241	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
	20.50	0.8071	20.500	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
13/16		0.8125	20.638	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
	21.00	0.8268	21.000	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
53/64		0.8281	21.034	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
		0.8438	21.433	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
27/32		0.8465	21.500	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
	21.50	0.8594	21.829	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
55/64		0.8661	22.000	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
	22.00	0.8750	22.225	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
7/8		0.8858	22.500	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
	22.50	0.8906	22.621	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
57/64		0.9055	23.000	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
	23.00	0.9062	23.017	3	6 1/8	156	10 3/4	273	2	6 1/8	156	10	254
29/32		0.9219	23.416	3	6 1/8	156	10 3/4	273	...	...	...	...
	23.50	0.9252	23.500	3	6 1/8	156	10 3/4	273	...	...	...	...
15/16		0.9375	23.813	3	6 1/8	156	10 3/4	273	...	...	...	...
	24.00	0.9449	24.000	3	6 3/8	162	11	279	...	...	...	...
61/64		0.9531	24.209	3	6 3/8	162	11	279	...	...	...	...
	24.50	0.9646	24.500	3	6 3/8	162	11	279	...	...	...	...
31/32		0.9688	24.608	3	6 3/8	162	11	279	...	...	...	...
	25.00	0.9843	25.000	3	6 3/8	162	11	279	...	...	...	...
63/64		0.9844	25.004	3	6 3/8	162	11	279	...	...	...	...
	1	1.0000	25.400	3	6 3/8	162	11	279	4	6 3/8	162	12	305
1 1/64	25.50	1.0039	25.500	3	6 1/2	165	11 1/8	283	...	...	...	...
		1.0156	25.796	3	6 1/2	165	11 1/8	283	...	...	...	...
1 1/32	26.00	1.0236	26.000	3	6 1/2	165	11 1/8	283	...	...	...	...
		1.0312	26.192	3	6 1/2	165	11 1/8	283	4	6 1/2	165	12 3/8	308
1 1/16	26.50	1.0433	26.500	3	6 3/8	168	11 1/4	286	...	...	...	...
		1.0469	26.591	3	6 3/8	168	11 1/4	286	...	...	...	...
1 1/8		1.0625	26.988	3	6 3/8	168	11 1/4	286	4	6 3/8	168	12 1/4	311
	27.00	1.0630	27.000	3	6 3/8	168	11 1/4	286	...	...	...	...
1 5/64		1.0781	27.384	4	6 3/8	175	12 1/2	318	3	6 3/8	175	11 1/2	292
	27.50	1.0827	27.500	4	6 3/8	175	12 1/2	318	3	6 3/8	175	11 1/2	292
1 3/32		1.0938	27.783	4	6 3/8	175	12 1/2	318	3	6 3/8	175	11 1/2	292
	28.00	1.1024	28.000	4	7 1/8	181	12 3/4	324	3	7 1/8	181	11 3/4	298
1 7/64		1.1094	28.179	4	7 1/8	181	12 3/4	324	3	7 1/8	181	11 3/4	298
	28.50	1.1220	28.500	4	7 1/8	181	12 3/4	324	3	7 1/8	181	11 3/4	298
1 1/2		1.1250	28.575	4	7 1/8	181	12 3/4	324	3	7 1/8	181	11 3/4	298
		1.1406	28.971	4	7 1/4	184	12 7/8	327	3	7 1/4	184	11 7/8	302
1 5/32	29.00	1.1417	29.000	4	7 1/4	184	12 7/8	327	3	7 1/4	184	11 7/8	302
		1.1562	29.367	4	7 1/4	184	12 7/8	327	3	7 1/4	184	11 7/8	302
1 11/64	29.50	1.1614	29.500	4	7 3/8	187	13	330	3	7 3/8	187	12	305
		1.1719	29.797	4	7 3/8	187	13	330	3	7 3/8	187	12	305
1 3/8	30.00	1.1811	30.000	4	7 3/8	187	13	330	3	7 3/8	187	12	305
		1.1875	30.162	4	7 3/8	187	13	330	3	7 3/8	187	12	305
1 13/64	30.50	1.2008	30.500	4	7 1/2	190	13 1/8	333	3	7 1/2	190	12 3/8	308
		1.2031	30.559	4	7 1/2	190	13 1/8	333	3	7 1/2	190	12 3/8	308

Table 11. (Continued) American National Taper Shank Twist Drills — Fractional and Metric Sizes ANSI/ASME B94.11M-1993

Drill Diameter, <i>D</i>				Regular Shank				Larger or Smaller Shank*					
Fraction	mm	Equivalent		Morse Taper No.	Flute Length		Overall Length		Morse Taper No.	Flute Length		Overall Length	
		Deci. Inch	mm		<i>F</i>		<i>L</i>			<i>F</i>		<i>L</i>	
					Inch	mm	Inch	mm		Inch	mm	Inch	mm
1 ¹ / ₃₂	31.00	1.2188	30.958	4	7 ¹ / ₂	190	13 ¹ / ₈	333	3	7 ¹ / ₂	190	12 ¹ / ₈	308
		1.2205	31.000	4	7 ⁷ / ₈	200	13 ¹ / ₂	343	3	7 ⁷ / ₈	200	12 ¹ / ₂	318
1 ¹ / ₁₆	31.50	1.2344	31.354	4	7 ⁷ / ₈	200	13 ¹ / ₂	343	3	7 ⁷ / ₈	200	12 ¹ / ₂	318
		1.2402	31.500	4	7 ⁷ / ₈	200	13 ¹ / ₂	343	3	7 ⁷ / ₈	200	12 ¹ / ₂	318
1 ¹ / ₄	32.00	1.2500	31.750	4	7 ⁷ / ₈	200	13 ¹ / ₂	343	3	7 ⁷ / ₈	200	12 ¹ / ₂	318
		1.2598	32.000	4	8 ¹ / ₂	216	14 ¹ / ₈	359	...	...	...	...	...
1 ⁷ / ₆₄	32.50	1.2656	32.146	4	8 ¹ / ₂	216	14 ¹ / ₈	359	...	...	...	...	...
		1.2795	32.500	4	8 ¹ / ₂	216	14 ¹ / ₈	359	...	...	...	...	...
1 ⁹ / ₃₂	33.00	1.2812	32.542	4	8 ¹ / ₂	216	14 ¹ / ₈	359	...	...	...	...	...
		1.2969	32.941	4	8 ⁵ / ₈	219	14 ¹ / ₄	362	...	...	...	...	...
1 ⁹ / ₁₆	33.50	1.2992	33.000	4	8 ⁵ / ₈	219	14 ¹ / ₄	362	...	...	...	...	...
		1.3125	33.338	4	8 ⁵ / ₈	219	14 ¹ / ₄	362	...	...	...	...	...
1 ⁵ / ₈	34.00	1.3189	33.500	4	8 ⁵ / ₈	222	14 ³ / ₈	365	...	...	...	...	...
		1.3281	33.734	4	8 ³ / ₄	222	14 ³ / ₈	365	...	...	...	...	...
1 ² / ₁₆	34.50	1.3386	34.000	4	8 ³ / ₄	222	14 ³ / ₈	365	...	...	...	...	...
		1.3438	34.133	4	8 ³ / ₄	222	14 ³ / ₈	365	...	...	...	...	...
1 ¹ / ₃₂	34.50	1.3583	34.500	4	8 ⁷ / ₈	225	14 ¹ / ₂	368	...	...	...	...	...
		1.3594	34.529	4	8 ⁷ / ₈	225	14 ¹ / ₂	368	...	...	...	...	...
1 ³ / ₁₆	35.00	1.3750	34.925	4	8 ⁷ / ₈	225	14 ¹ / ₂	368	...	...	...	...	...
		1.3780	35.000	4	9	229	14 ⁵ / ₈	371	...	...	...	...	...
1 ² / ₈	35.50	1.3906	35.321	4	9	229	14 ⁵ / ₈	371	...	...	...	...	...
		1.3976	35.500	4	9	229	14 ⁵ / ₈	371	...	...	...	...	...
1 ¹ / ₁₆	36.00	1.4062	35.717	4	9	229	14 ⁵ / ₈	371	...	...	...	...	...
		1.4173	36.000	4	9 ¹ / ₈	232	14 ³ / ₄	375	...	...	...	...	...
1 ² / ₁₆	36.50	1.4219	36.116	4	9 ¹ / ₈	232	14 ³ / ₄	375	...	...	...	...	...
		1.4370	36.500	4	9 ¹ / ₈	232	14 ³ / ₄	375	...	...	...	...	...
1 ⁷ / ₁₆	37.00	1.4375	36.512	4	9 ¹ / ₈	232	14 ³ / ₄	375	...	...	...	...	...
		1.4531	36.909	4	9 ¹ / ₄	235	14 ⁷ / ₈	378	...	...	...	...	...
1 ³ / ₈	37.50	1.4567	37.000	4	9 ¹ / ₄	235	14 ⁷ / ₈	378	...	...	...	...	...
		1.4688	37.308	4	9 ¹ / ₄	235	14 ⁷ / ₈	378	...	...	...	...	...
1 ⁵ / ₁₆	38.00	1.4764	37.500	4	9 ³ / ₈	238	15	381	...	...	...	...	...
		1.4844	37.704	4	9 ³ / ₈	238	15	381	...	...	...	...	...
1 ³ / ₁₆	38.00	1.4961	38.000	4	9 ³ / ₈	238	15	381	...	...	...	...	...
		1.5000	38.100	4	9 ³ / ₈	238	15	381	...	...	...	...	...
1 ¹ / ₂	39.00	1.5156	38.496	...	...	...	...	4	9 ³ / ₄	238	15	381	...
		1.5312	38.892	5	9 ³ / ₈	238	16 ³ / ₈	416	4	9 ³ / ₈	238	15	381
1 ¹ / ₁₆	39.00	1.5354	39.000	5	9 ³ / ₈	244	16 ³ / ₈	422	4	9 ⁵ / ₈	244	15 ¹ / ₄	387
		1.5469	39.291	...	...	...	...	...	4	9 ⁵ / ₈	244	15 ¹ / ₄	387
1 ³ / ₈	40.00	1.5625	39.688	5	9 ⁵ / ₈	244	16 ³ / ₈	422	4	9 ⁵ / ₈	244	15 ¹ / ₄	387
		1.5748	40.000	5	9 ⁵ / ₈	251	16 ⁷ / ₈	429	4	9 ⁷ / ₈	251	15 ¹ / ₂	394
1 ⁷ / ₁₆	40.00	1.5781	40.084	...	...	...	...	4	9 ⁷ / ₈	251	15 ¹ / ₂	394	
		1.5938	40.483	5	9 ⁷ / ₈	251	16 ⁷ / ₈	429	4	9 ⁷ / ₈	251	15 ¹ / ₂	394
1 ⁹ / ₃₂	41.00	1.6094	40.879	...	...	...	...	4	10	254	15 ⁵ / ₈	397	
		1.6142	41.000	5	10	254	17	432	4	10	254	15 ⁵ / ₈	397
1 ⁵ / ₈	42.00	1.6250	41.275	5	10	254	17	432	4	10	254	15 ⁵ / ₈	397
		1.6406	41.671	...	...	...	...	...	4	10 ⁵ / ₈	257	15 ³ / ₄	400
1 ² / ₁₆	42.00	1.6535	42.000	5	10 ⁵ / ₈	257	17 ¹ / ₈	435	4	10 ⁵ / ₈	257	15 ³ / ₄	400
		1.6562	42.067	5	10 ⁵ / ₈	257	17 ¹ / ₈	435	4	10 ⁵ / ₈	257	15 ³ / ₄	400
1 ⁴ / ₁₆	43.00	1.6719	42.466	...	...	...	...	4	10 ⁵ / ₈	257	15 ³ / ₄	400	
		1.6875	42.862	5	10 ⁵ / ₈	257	17 ¹ / ₈	435	4	10 ⁵ / ₈	257	15 ³ / ₄	400
1 ¹ / ₁₆	43.00	1.6929	43.000	5	10 ⁵ / ₈	257	17 ¹ / ₈	435	4	10 ⁵ / ₈	257	15 ³ / ₄	400
		1.7031	43.259	...	...	...	...	...	4	10 ⁵ / ₈	257	15 ³ / ₄	400
1 ⁴ / ₈	44.00	1.7188	43.658	5	10 ⁵ / ₈	257	17 ¹ / ₈	435	4	10 ⁵ / ₈	257	15 ³ / ₄	400
		1.7323	44.000	5	10 ⁵ / ₈	257	17 ¹ / ₈	435	4	10 ⁵ / ₈	264	16 ¹ / ₄	413

Table 11. (Continued) American National Taper Shank Twist Drills — Fractional and Metric Sizes ANSI/ASME B94.11M-1993

Drill Diameter, <i>D</i>			Regular Shank						Larger or Smaller Shank*				
Fraction	mm	Equivalent		Morse Taper No.	Flute Length		Overall Length		Morse Taper No.	Flute Length		Overall Length	
		Deci. Inch	mm		<i>F</i>		<i>L</i>			<i>F</i>		<i>L</i>	
					Inch	mm	Inch	mm		Inch	mm	Inch	mm
1 ¹ / ₆₄	45.00	1.7344	44.054	4	10 ³ / ₈	264	16 ¹ / ₄	413
		1.7500	44.450	5	10 ³ / ₈	257	17 ¹ / ₈	435	4	10 ³ / ₈	264	16 ¹ / ₄	413
1 ³ / ₃₂	46.00	1.7717	45.000	5	10 ³ / ₈	257	17 ¹ / ₈	435	4	10 ³ / ₈	264	16 ¹ / ₄	413
		1.7812	45.242	5	10 ³ / ₈	257	17 ¹ / ₈	435	4	10 ³ / ₈	264	16 ¹ / ₄	413
1 ¹ / ₁₆	47.00	1.8110	46.000	5	10 ³ / ₈	257	17 ¹ / ₈	435	4	10 ³ / ₈	264	16 ¹ / ₄	413
		1.8125	46.038	5	10 ³ / ₈	257	17 ¹ / ₈	435	4	10 ³ / ₈	264	16 ¹ / ₄	413
1 ⁷ / ₃₂	48.00	1.8438	46.833	5	10 ³ / ₈	257	17 ¹ / ₈	435	4	10 ³ / ₈	264	16 ¹ / ₄	413
		1.8504	47.000	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ¹ / ₂	267	16 ¹ / ₂	419
1 ³ / ₈	49.00	1.8750	47.625	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ¹ / ₂	267	16 ¹ / ₂	419
		1.8898	48.000	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ¹ / ₂	267	16 ¹ / ₂	419
1 ⁵ / ₁₆	50.00	1.9062	48.417	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ¹ / ₂	267	16 ¹ / ₂	419
		1.9291	49.000	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ³ / ₈	270	16 ³ / ₈	422
1 ¹ / ₈	51.00	1.9375	49.212	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ³ / ₈	270	16 ³ / ₈	422
		1.9625	50.000	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ³ / ₈	270	16 ³ / ₈	422
1 ³ / ₁₆	51.00	1.9688	50.008	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ³ / ₈	270	16 ³ / ₈	422
		2.0000	50.800	5	10 ³ / ₈	264	17 ³ / ₈	441	4	10 ³ / ₈	270	16 ³ / ₈	422
2	52.00	2.0079	51.000	5	10 ³ / ₈	264	17 ³ / ₈	441	...	...	...	...
		2.0312	51.592	5	10 ³ / ₈	264	17 ³ / ₈	441	...	...	...	...
2 ¹ / ₁₆	53.00	2.0472	52.000	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
		2.0625	52.388	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
2 ³ / ₁₆	54.00	2.0866	53.000	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
		2.0938	53.183	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
2 ¹ / ₈	55.00	2.1250	53.975	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
		2.1260	54.000	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
2 ³ / ₁₆	56.00	2.1562	54.767	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
		2.1654	55.000	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
2 ¹ / ₄	57.00	2.1875	55.563	5	10 ³ / ₈	260	17 ³ / ₈	441	...	...	...	...
		2.2000	56.000	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
2 ³ / ₈	58.00	2.2188	56.358	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
		2.2441	57.000	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
2 ¹ / ₂	59.00	2.2500	57.150	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
		2.2835	58.000	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
2 ³ / ₄	60.00	2.3125	58.738	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
		2.3228	59.000	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
3	61.00	2.3622	60.000	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
		2.3750	60.325	5	10 ³ / ₈	257	17 ³ / ₈	441	...	...	...	...
3 ¹ / ₁₆	62.00	2.4016	61.000	5	11 ¹ / ₄	286	18 ³ / ₄	476	...	...	...	...
		2.4375	61.912	5	11 ¹ / ₄	286	18 ³ / ₄	476	...	...	...	...
3 ³ / ₁₆	63.00	2.4409	62.000	5	11 ¹ / ₄	286	18 ³ / ₄	476	...	...	...	...
		2.4803	63.000	5	11 ¹ / ₄	286	18 ³ / ₄	476	...	...	...	...
3 ¹ / ₂	64.00	2.5000	63.500	5	11 ¹ / ₄	286	18 ³ / ₄	476	...	...	...	...
		2.5197	64.000	5	11 ³ / ₈	302	19 ¹ / ₂	495	...	...	...	...
3 ³ / ₄	65.00	2.5591	65.000	5	11 ³ / ₈	302	19 ¹ / ₂	495	...	...	...	...
		2.5625	65.088	5	11 ³ / ₈	302	19 ¹ / ₂	495	...	...	...	...
4	66.00	2.5984	66.000	5	11 ³ / ₈	302	19 ¹ / ₂	495	...	...	...	...
		2.6250	66.675	5	11 ³ / ₈	302	19 ¹ / ₂	495	...	...	...	...
4 ¹ / ₁₆	67.00	2.6378	67.000	5	12 ³ / ₄	324	20 ³ / ₈	518	...	...	...	...
		2.6772	68.000	5	12 ³ / ₄	324	20 ³ / ₈	518	...	...	...	...
4 ³ / ₁₆	68.00	2.6875	68.262	5	12 ³ / ₄	324	20 ³ / ₈	518	...	...	...	...
		2.7165	69.000	5	12 ³ / ₄	324	20 ³ / ₈	518	...	...	...	...
4 ¹ / ₂	69.00	2.7500	69.850	5	12 ³ / ₄	324	20 ³ / ₈	518	...	...	...	...
		2.7559	70.000	5	13 ³ / ₈	340	21 ¹ / ₈	537	...	...	...	...
4 ³ / ₄	70.00	2.7953	71.000	5	13 ³ / ₈	340	21 ¹ / ₈	537	...	...	...	...
		2.8125	71.438	5	13 ³ / ₈	340	21 ¹ / ₈	537	...	...	...	...

Table 11. (Continued) American National Taper Shank Twist Drills — Fractional and Metric Sizes ANSI/ASME B94.11M-1993

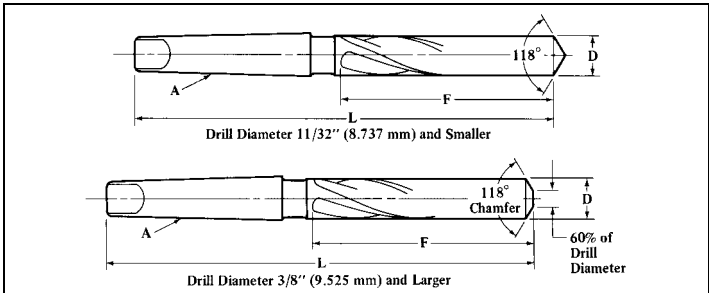
Drill Diameter, <i>D</i>				Regular Shank						Larger or Smaller Shank*					
Frac- tion	Equivalent			Morse Taper No.	Flute Length <i>F</i>		Overall Length <i>L</i>		Morse Taper No.	Flute Length <i>F</i>		Overall Length <i>L</i>			
	mm	Deci. Inch	mm		Inch	mm	Inch	mm		Inch	mm	Inch	mm		
														Inch	mm	Inch	mm
2 $\frac{7}{8}$	72.00	2.8346	72.000	5	13 $\frac{3}{8}$	340	21 $\frac{1}{8}$	537	...	...	...	...
	73.00	2.8740	73.000	5	13 $\frac{3}{8}$	340	21 $\frac{1}{8}$	537	...	...	...	...
	74.00	2.8750	73.025	5	13 $\frac{3}{8}$	340	21 $\frac{1}{8}$	537	...	...	...	...
2 $\frac{5}{16}$	74.00	2.9134	74.000	5	14	356	21 $\frac{3}{4}$	552	...	...	...	...
	75.00	2.9375	74.612	5	14	356	21 $\frac{3}{4}$	552	...	...	...	...
	75.00	2.9528	75.000	5	14	356	21 $\frac{3}{4}$	552	...	...	...	...
3	76.00	2.9921	76.000	5	14	356	21 $\frac{3}{4}$	552	...	...	...	...
	77.00	3.0000	76.200	5	14	356	21 $\frac{3}{4}$	552	...	...	...	...
	77.00	3.0315	77.000	6	14 $\frac{3}{8}$	371	24 $\frac{1}{2}$	622	5	14 $\frac{3}{4}$	362	22	559		
3 $\frac{1}{8}$	78.00	3.0709	78.000	6	14 $\frac{3}{8}$	371	24 $\frac{1}{2}$	622	5	14 $\frac{3}{4}$	362	22	559		
	78.00	3.1250	79.375	6	14 $\frac{3}{8}$	371	24 $\frac{1}{2}$	622	5	14 $\frac{3}{4}$	362	22	559		
	78.00	3.2500	82.550	6	15 $\frac{1}{2}$	394	25 $\frac{1}{2}$	648	5	15 $\frac{1}{4}$	387	23	584		
3 $\frac{1}{2}$	78.00	3.5000	88.900	5	16 $\frac{1}{4}$	413	24	610		

*Larger or smaller than regular shank.

Table 12. American National Standard Combined Drills and Countersinks — Plain and Bell Types ANSI/ASME B94.11M-1993

PLAIN TYPE				BELL TYPE						
Plain Type										
Size Designation	Body Diameter		Drill Diameter		Drill Length		Overall Length			
	A		D		C		L			
	Inches	Millimeters	Inches	Millimeters	Inches	Millimeters	Inches	Millimeters		
00	$\frac{1}{8}$	3.18	.025	0.64	.030	0.76	$1\frac{1}{8}$	29		
0	$\frac{1}{8}$	3.18	$\frac{1}{32}$	0.79	.038	0.97	$1\frac{1}{8}$	29		
1	$\frac{1}{8}$	3.18	$\frac{3}{64}$	1.19	$\frac{3}{64}$	1.19	$1\frac{1}{4}$	32		
2	$\frac{3}{16}$	4.76	$\frac{3}{64}$	1.98	$\frac{3}{64}$	1.98	$1\frac{3}{8}$	48		
3	$\frac{1}{4}$	6.35	$\frac{3}{64}$	2.78	$\frac{3}{64}$	2.78	2	51		
4	$\frac{3}{16}$	7.94	$\frac{1}{8}$	3.18	$\frac{1}{8}$	3.18	$2\frac{1}{8}$	54		
5	$\frac{3}{16}$	11.11	$\frac{3}{16}$	4.76	$\frac{3}{16}$	4.76	$2\frac{3}{4}$	70		
6	$\frac{1}{2}$	12.70	$\frac{7}{32}$	5.56	$\frac{7}{32}$	5.56	3	76		
7	$\frac{5}{8}$	15.88	$\frac{1}{4}$	6.35	$\frac{1}{4}$	6.35	$3\frac{1}{4}$	83		
8	$\frac{3}{4}$	19.05	$\frac{3}{16}$	7.94	$\frac{3}{16}$	7.94	$3\frac{1}{2}$	89		
Bell Type										
Size Designation	Body Diameter		Drill Diameter		Bell Diameter		Drill Length		Overall Length	
	A		D		E		C		L	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
11	$\frac{1}{8}$	3.18	$\frac{3}{64}$	1.19	0.10	2.5	$\frac{3}{64}$	1.19	$1\frac{1}{4}$	32
12	$\frac{3}{16}$	4.76	$\frac{1}{16}$	1.59	0.15	3.8	$\frac{1}{16}$	1.59	$1\frac{3}{8}$	48
13	$\frac{1}{4}$	6.35	$\frac{3}{32}$	2.38	0.20	5.1	$\frac{3}{32}$	2.38	2	51
14	$\frac{3}{16}$	7.94	$\frac{3}{64}$	2.78	0.25	6.4	$\frac{3}{64}$	2.78	$2\frac{1}{8}$	54
15	$\frac{3}{16}$	11.11	$\frac{3}{32}$	3.97	0.35	8.9	$\frac{3}{32}$	3.97	$2\frac{3}{4}$	70
16	$\frac{1}{2}$	12.70	$\frac{3}{16}$	4.76	0.40	10.2	$\frac{3}{16}$	4.76	3	76
17	$\frac{5}{8}$	15.88	$\frac{7}{32}$	5.56	0.50	12.7	$\frac{7}{32}$	5.56	$3\frac{1}{4}$	83
18	$\frac{3}{4}$	19.05	$\frac{1}{4}$	6.35	0.60	15.2	$\frac{1}{4}$	6.35	$3\frac{1}{2}$	89

Table 13. American National Standard Three- and Four-Flute Taper Shank Core Drills — Fractional Sizes Only ANSI/ASME B94.11M-1993



Drill Diameter, <i>D</i>			Three-Flute Drills					Four-Flute Drills				
Inch	Equivalent		Morse Taper No.	Flute Length		Overall Length		Morse Taper No.	Flute Length		Overall Length	
	Deci. Inch	mm		<i>F</i>	mm	<i>L</i>	mm		<i>F</i>	mm	<i>L</i>	mm
1/4	0.2500	6.350	1	2 7/8	73	6 1/8	156	...	...	...	...	...
5/32	0.2812	7.142	1	3	76	6 1/4	159	...	...	...	...	...
3/16	0.3175	7.938	1	3 1/8	79	6 3/8	162	...	...	...	...	...
1/8	0.3438	8.733	1	3 1/4	83	6 1/2	165	...	...	...	...	...
3/8	0.3750	9.525	1	3 1/2	89	6 3/4	171	...	...	...	...	...
13/32	0.4062	10.319	1	3 3/8	92	7	178	...	...	...	...	...
7/16	0.4375	11.112	1	3 3/8	98	7 1/4	184	...	...	...	...	...
15/32	0.4688	11.908	1	4 3/8	105	7 1/2	190	...	...	...	...	...
1/2	0.5000	12.700	2	4 3/8	111	8 1/4	210	2	4 3/8	111	8 1/4	210
17/32	0.5312	13.492	2	4 3/8	117	8 1/2	216	2	4 3/8	117	8 1/2	216
9/16	0.5625	14.288	2	4 3/8	124	8 3/4	222	2	4 3/8	124	8 3/4	222
5/8	0.5938	15.083	2	4 3/8	124	8 3/4	222	2	4 3/8	124	8 3/4	222
23/32	0.6250	15.815	2	4 3/8	124	8 3/4	222	2	4 3/8	124	8 3/4	222
11/16	0.6562	16.668	2	5 1/8	130	9	229	2	5 1/8	130	9	229
3/4	0.6875	17.462	2	5 3/8	137	9 1/4	235	2	5 3/8	137	9 1/4	235
25/32	0.7188	18.258	2	5 3/8	143	9 1/2	241	2	5 3/8	143	9 1/2	241
7/8	0.7500	19.050	2	5 3/8	149	9 3/4	248	2	5 3/8	149	9 3/4	248
27/32	0.7812	19.842	2	6	152	9 3/4	251	2	6	152	9 3/4	251
15/16	0.8125	20.638	3	6 1/8	156	10 1/4	273	3	6 1/8	156	10 1/4	273
29/32	0.8438	21.433	3	6 1/8	156	10 3/4	273	3	6 1/8	156	10 3/4	273
3/4	0.8750	22.225	3	6 1/8	156	10 3/4	273	3	6 1/8	156	10 3/4	273
29/32	0.9062	23.019	3	6 1/8	156	10 3/4	273	3	6 1/8	156	10 3/4	273
15/16	0.9375	23.812	3	6 1/8	156	10 3/4	273	3	6 1/8	156	10 3/4	273
31/32	0.9688	24.608	3	6 3/8	162	11	279	3	6 3/8	162	11	279
1	1.0000	25.400	3	6 3/8	162	11	279	3	6 3/8	162	11	279
1 1/32	1.0312	26.192	3	6 1/2	165	11 1/8	283	3	6 1/2	165	11 1/8	283
1 1/16	1.0625	26.988	3	6 1/2	168	11 1/4	286	3	6 1/2	168	11 1/4	286
1 1/8	1.0938	27.783	4	6 3/8	175	12 1/2	318	4	6 3/8	175	12 1/2	318
1 1/4	1.1250	28.575	4	7 1/8	181	12 3/4	324	4	7 1/8	181	12 3/4	324
1 1/8	1.1562	29.367	4	7 1/4	184	12 3/4	327	4	7 1/4	184	12 3/4	327
1 1/8	1.1875	30.162	4	7 3/8	187	13	330	4	7 3/8	187	13	330
1 1/2	1.2188	30.958	4	7 1/2	190	13 3/8	333	4	7 1/2	190	13 3/8	333
1 1/4	1.2500	31.750	4	7 3/8	200	13 1/2	343	4	7 3/8	200	13 1/2	343
1 3/8	1.2812	32.542	...	...	...	...	...	4	8 1/8	216	14 1/8	359
1 3/8	1.3125	33.338	...	...	...	...	...	4	8 3/8	219	14 1/4	362
1 1/2	1.3438	34.133	...	...	...	...	...	4	8 3/4	222	14 3/8	365
1 3/8	1.3750	34.925	...	...	...	...	...	4	8 7/8	225	14 1/2	368

Drill Diameter, <i>D</i>			Three-Flute Drills				Four-Flute Drills					
Inch	Equivalent		Morse Taper No.	Flute Length		Overall Length		Morse Taper No.	Flute Length		Overall Length	
	Deci. Inch	mm		<i>F</i>	<i>L</i>	<i>F</i>	<i>L</i>		<i>F</i>	<i>L</i>		
											A	Inch	mm	Inch	mm
1 1/32	1.4062	35.717	...	...	...	...	...	4	9	229	14 3/8	371
1 1/16	1.4375	36.512	...	...	...	...	...	4	9 1/8	232	14 3/4	375
1 1/8	1.4688	37.306	...	...	...	...	...	4	9 1/4	235	14 7/8	378
1 1/2	1.5000	38.100	...	...	...	...	...	4	9 3/8	238	15	381
1 7/32	1.5312	38.892	...	...	...	...	...	5	9 3/8	238	16 3/8	416
1 9/16	1.5675	39.688	...	...	...	...	...	5	9 5/8	244	16 3/8	422
1 5/8	1.5938	40.483	...	...	...	...	...	5	9 7/8	251	16 3/8	429
1 3/4	1.6250	41.275	...	...	...	...	...	5	10	254	17	432
1 7/8	1.6562	42.067	...	...	...	...	...	5	10 1/8	257	17 1/8	435
1 15/16	1.6875	42.862	...	...	...	...	...	5	10 1/8	257	17 3/8	435
1 1/2	1.7188	43.658	...	...	...	...	...	5	10 1/8	257	17 3/8	435
1 3/4	1.7500	44.450	...	...	...	...	...	5	10 1/8	257	17 3/8	435
1 29/32	1.7812	45.244	...	...	...	...	...	5	10 1/8	257	17 3/8	435
1 13/16	1.8125	46.038	...	...	...	...	...	5	10 1/8	257	17 3/8	435
1 7/8	1.8438	46.833	...	...	...	...	...	5	10 1/8	257	17 3/8	435
1 5/8	1.8750	47.625	...	...	...	...	...	5	10 3/8	264	17 3/8	441
1 9/8	1.9062	48.417	...	...	...	...	...	5	10 3/8	264	17 3/8	441
1 11/16	1.9375	49.212	...	...	...	...	...	5	10 3/8	264	17 3/8	441
1 3/4	1.9688	50.008	...	...	...	...	...	5	10 3/8	264	17 3/8	441
2	2.0000	50.800	...	...	...	...	...	5	10 3/8	264	17 3/8	441
2 1/8	2.1250	53.975	...	...	...	...	...	5	10 3/4	260	17 3/8	441
2 1/4	2.2500	57.150	...	...	...	...	...	5	10 3/4	257	17 3/8	441
2 3/8	2.3750	60.325	...	...	...	...	...	5	10 3/4	257	17 3/8	441
2 1/2	2.5000	63.500	...	...	...	...	...	5	11 1/4	286	18 3/4	476

British Standard Combined Drills and Countersinks (Center Drills).—BS 328: Part 2: 1972 (1990) provides dimensions of combined drills and countersinks for center holes. Three types of drill and countersink combinations are shown in this standard but are not given here. These three types will produce center holes without protecting chamfers, with protecting chamfers, and with protecting chamfers of radius form.

American National Standard Drill Drivers — Split-Sleeve, Collet Type
ANSI B94.35-1972 (R1995)

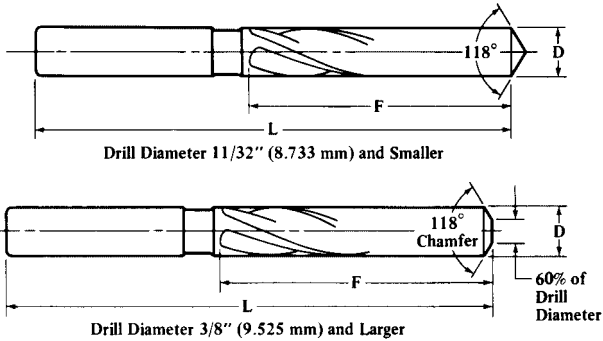
Taper Number	<i>G</i> Overall Length	<i>H</i> Diameter at Gage Line	<i>J</i> Taper per Foot ^a	<i>K</i> Length to Gage Line	<i>L</i> Driver Projection
0 ^b	2.38	0.356	0.62460	2.22	0.16
1	2.62	0.475	0.59858	2.44	0.19
2	3.19	0.700	0.59941	2.94	0.25
3	3.94	0.938	0.60235	3.69	0.25
4	5.00	1.231	0.62326	4.62	0.38

^a Taper rate in accordance with ANSI/ASME B5.10-1994, Machine Tapers.

^b Size 0 is not an American National Standard but is included here to meet special needs.

All dimensions are in inches.

Table 14. ANSI Three- and Four-Flute Straight Shank Core Drills — Fractional Sizes Only ANSI/ASME B94.11M-1993



Nominal Shank Size is same as Nominal Drill Size

Drill Diameter, <i>D</i>			Three-Flute Drills				Four-Flute Drills			
Inch	Equivalent		Flute Length		Overall Length		Flute Length		Overall Length	
	Deci. Inch	mm	<i>F</i>		<i>L</i>		<i>F</i>		<i>L</i>	
			Inch	mm	Inch	mm	Inch	mm	Inch	mm
1/4	0.2500	6.350	3/4	95	6 1/8	156	...	...	...	...
5/32	0.2812	7.142	3 3/8	98	6 1/4	159	...	...	...	...
3/16	0.3125	7.938	4	102	6 3/8	162	...	...	...	...
11/32	0.3438	8.733	4 1/8	105	6 1/2	165	...	...	...	...
3/8	0.3750	9.525	4 3/8	105	6 3/4	171	...	...	...	...
13/32	0.4062	10.317	4 3/8	111	7	178	...	...	...	...
7/16	0.4375	11.112	4 3/8	117	7 1/4	184	...	...	...	...
15/32	0.4688	11.908	4 3/4	121	7 1/2	190	...	...	...	...
1/2	0.5000	12.700	4 3/4	121	7 3/4	197	4 3/4	121	7 3/4	197
17/32	0.5312	13.492	4 3/4	121	8	203	4 3/4	121	8	203
9/16	0.5625	14.288	4 7/8	124	8 1/4	210	4 7/8	124	8 1/4	210
19/32	0.5938	15.083	4 7/8	124	8 3/4	222	4 7/8	124	8 3/4	222
5/8	0.6250	15.875	4 7/8	124	8 3/4	222	4 7/8	124	8 3/4	222
21/32	0.6562	16.667	5 1/8	130	9	229	5 1/8	130	9	229
11/16	0.6875	17.462	5 3/8	137	9 1/4	235	5 3/8	137	9 1/4	235
23/32	0.7188	18.258	...	...	...	...	5 3/8	143	9 1/2	241
3/4	0.7500	19.050	5 7/8	149	9 3/4	248	5 7/8	149	9 3/4	248
25/32	0.7812	19.842	...	...	...	...	6	152	9 7/8	251
13/16	0.8125	20.638	...	...	...	...	6 1/8	156	10	254
27/32	0.8438	21.433	...	...	...	...	6 1/8	156	10	254
7/8	0.8750	22.225	...	...	...	...	6 1/8	156	10	254
29/32	0.9062	23.017	...	...	...	...	6 1/8	156	10	254
15/16	0.9375	23.812	...	...	...	...	6 1/8	156	10 3/4	273
31/32	0.9688	24.608	...	...	...	...	6 3/8	162	11	279
1	1.0000	25.400	...	...	...	...	6 3/8	162	11	279
1 1/32	1.0312	26.192	...	...	...	...	6 1/2	165	11 1/8	283
1 1/16	1.0625	26.988	...	...	...	...	6 3/8	168	11 1/4	286
1 1/32	1.0938	27.783	...	...	...	...	6 3/8	175	11 1/2	292
1 1/8	1.1250	28.575	...	...	...	...	7 1/8	181	11 3/4	298
1 1/4	1.2500	31.750	...	...	...	...	7 3/8	200	12 1/2	318

Drill Drivers—Split-Sleeve, Collet Type.—American National Standard ANSI B94.35-1972 (R1995) covers split-sleeve, collet-type drivers for driving straight shank drills, reamers, and similar tools, without tangs from 0.0390-inch through 0.1220-inch diameter, and with tangs from 0.1250-inch through 0.7500-inch diameter, including metric sizes.

For sizes 0.0390 through 0.0595 inch, the standard taper number is 1 and the optional taper number is 0. For sizes 0.0610 through 0.1875 inch, the standard taper number is 1, first optional taper number is 0, and second optional taper number is 2. For sizes 0.1890 through 0.2520 inch, the standard taper number is 1, first optional taper number is 2, and second optional taper number is 0. For sizes 0.2570 through 0.3750 inch, the standard taper number is 1 and the optional taper number is 2. For sizes 0.3860 through 0.5625 inch, the standard taper number is 2 and the optional taper number is 3. For sizes 0.5781 through 0.7500 inch, the standard taper number is 3 and the optional taper number is 4.

The depth B that the drill enters the driver is 0.44 inch for sizes 0.0390 through 0.0781 inch; 0.50 inch for sizes 0.0785 through 0.0938 inch; 0.56 inch for sizes 0.0960 through 0.1094 inch; 0.62 inch for sizes 0.1100 through 0.1220 inch; 0.75 inch for sizes 0.1250 through 0.1875 inch; 0.88 inch for sizes 0.1890 through 0.2500 inch; 1.00 inch for sizes 0.2520 through 0.3125 inch; 1.12 inches for sizes 0.3160 through 0.3750 inch; 1.25 inches for sizes 0.3860 through 0.4688 inch; 1.31 inches for sizes 0.4844 through 0.5625 inch; 1.47 inches for sizes 0.5781 through 0.6562 inch; and 1.62 inches for sizes 0.6719 through 0.7500 inch.

British Standard Metric Twist Drills.—BS 328: Part I: 1959 (incorporating amendments issued March 1960 and March 1964) covers twist drills made to inch and metric dimensions that are intended for general engineering purposes. ISO recommendations are taken into account. The accompanying tables give the standard metric sizes of Morse taper shank twist drills and core drills, parallel shank jobbing and long series drills, and stub drills.

All drills are right-hand cutting unless otherwise specified, and normal, slow, or quick helix angles may be provided. A “back-taper” is ground on the diameter from point to shank to provide longitudinal clearance. Core drills may have three or four flutes, and are intended for opening up cast holes or enlarging machined holes, for example. The parallel shank jobber, and long series drills, and stub drills are made without driving tenons.

Morse taper shank drills with oversize dimensions are also listed, and Table 15 shows metric drill sizes superseding gage and letter size drills, which are now obsolete in Britain. To meet special requirements, the Standard lists nonstandard sizes for the various types of drills.

The limits of tolerance on cutting diameters, as measured across the lands at the outer corners of a drill, shall be $h8$, in accordance with BS 1916, Limits and Fits for Engineering (Part I, Limits and Tolerances), and Table 3 shows the values common to the different types of drills mentioned before.

The drills shall be permanently and legibly marked whenever possible, preferably by rolling, showing the size, and the manufacturer's name or trademark. If they are made from high-speed steel, they shall be marked with the letters H.S. where practicable.

Drill Elements: The following definitions of drill elements are given.

Axis: The longitudinal center line.

Body: That portion of the drill extending from the extreme cutting end to the commencement of the shank.

Shank: That portion of the drill by which it is held and driven.

Flutes: The grooves in the body of the drill that provide lips and permit the removal of chips and allow cutting fluid to reach the lips.

Web (Core): The central portion of the drill situated between the roots of the flutes and extending from the point end toward the shank; the point end of the web or core forms the chisel edge.

Lands: The cylindrical-ground surfaces on the leading edges of the drill flutes. The width of the land is measured at right angles to the flute helix.

Body Clearance: The portion of the body surface that is reduced in diameter to provide diametral clearance.

Heel: The edge formed by the intersection of the flute surface and the body clearance.

Point: The sharpened end of the drill, consisting of all that part of the drill that is shaped to produce lips, faces, flanks, and chisel edge.

Face: That portion of the flute surface adjacent to the lip on which the chip impinges as it is cut from the work.

Flank: The surface on a drill point that extends behind the lip to the following flute.

Lip (Cutting Edge): The edge formed by the intersection of the flank and face.

Relative Lip Height: The relative position of the lips measured at the outer corners in a direction parallel to the drill axis.

Outer Corner: The corner formed by the intersection of the lip and the leading edge of the land.

Chisel Edge: The edge formed by the intersection of the flanks.

Chisel Edge Corner: The corner formed by the intersection of a lip and the chisel edge.

Table 15. British Standard Drills — Metric Sizes Superseding Gauge and Letter Sizes BS 328: Part 1: 1959 Appendix B

Obsolete Drill Size	Recommended Metric Size (mm)	Obsolete Drill Size	Recommended Metric Size (mm)	Obsolete Drill Size	Recommended Metric Size (mm)	Obsolete Drill Size	Recommended Metric Size (mm)	Obsolete Drill Size	Recommended Metric Size (mm)
80	0.35	58	1.05	36	2.70	14	4.60	I	6.90
79	0.38	57	1.10			13	4.70	J	7.00
78	0.40	56	$\frac{3}{64}$ in.	35	2.80	12	4.80		
77	0.45			34	2.80	11	4.90		
76	0.50			33	2.85			K	$\frac{1}{16}$ in.
		55	1.30	33	2.85			L	7.40
		54	1.40	32	2.95	10	4.90	M	7.50
75	0.52	53	1.50	31	3.00	9	5.00	N	7.70
74	0.58	52	1.60			8	5.10	O	8.00
73	0.60	51	1.70	30	3.30	7	5.10		
72	0.65			29	3.50	6	5.20		
71	0.65			28	$\frac{1}{8}$ in.				
		50	1.80	27	3.70			P	8.20
		49	1.85	26	3.70	5	5.20	Q	8.40
70	0.70	48	1.95			4	5.30	R	8.60
69	0.75	47	2.00	25	3.80	3	5.40	S	8.80
68	$\frac{1}{16}$ in.	46	2.05	24	3.90	2	5.60	T	9.10
67	0.82			23	3.90	1	5.80		
66	0.85	45	2.10	22	4.00			U	9.30
		44	2.20	21	4.00	A	$\frac{1}{64}$ in.	V	$\frac{3}{8}$ in.
65	0.90	43	2.25			B	6.00	W	9.80
64	0.92	42	$\frac{3}{32}$ in.	20	4.10	C	6.10	X	10.10
63	0.95	41	2.45	19	4.20	D	6.20	Y	10.30
62	0.98			18	4.30	E	$\frac{1}{4}$ in.	Z	10.50
61	1.00	40	2.50	17	4.40			...	...
		39	2.55	16	4.50	F	6.50	...	...
60	1.00	38	2.60			G	6.60	...	...
59	1.05	37	2.65	15	4.60	H	$\frac{1}{64}$ in.	...	...

Gauge and letter size drills are now obsolete in the United Kingdom and should not be used in the production of new designs. The table is given to assist users in changing over to the recommended standard sizes.

**Table 1. British Standard Morse Taper Shank Twist Drills and Core Drills —
Standard Metric Sizes BS 328: Part 1: 1959**

Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length
3.00	33	114	16.25			29.50		
3.20	36	117	16.50	125	223	29.75	175	296
3.50	39	120	16.75			30.00		
3.80			17.00			30.25		
4.00	43	123	17.25			30.50		
4.20			17.50	130	228	30.75	180	301
4.50	47	128	17.75			31.00		
			18.00			31.25		
4.80						31.50		
5.00	52	133	18.25					
5.20			18.50	135	233	31.75	185	306
			18.75					
			19.00					
5.50						32.00		
5.80	57	138	19.25			32.50	185	334
6.00			19.50			33.00		
			19.75	140	238	33.50		
6.20	63	144	20.00			34.00		
6.50						34.50	190	339
6.80			20.25			35.00		
7.00	69	150	20.50	145	243	35.50		
7.20			20.75					
7.50			21.00					
7.80						36.00		
8.00	75	156	21.25			36.50	195	344
8.20			21.50			37.00		
8.50			21.75	150	248	37.50		
			22.00					
			22.25					
8.80						38.00		
9.00	81	162	22.50			38.50	200	349
9.20			22.75			39.00		
9.50			23.00	155	253	39.50		
						40.00		
9.80			23.25			40.50		
10.00	87	168	23.50	155	276	41.00	205	354
10.20						41.50		
10.50						42.00		
						42.50		
10.80			23.75					
11.00	94	175	24.00					
11.20			24.25	160	281	43.00	210	359
11.50			24.50			43.50		
11.80			24.75			44.00		
			25.00			44.50		
						45.00		
12.00			25.25			45.50		
12.20	101	182	25.50			46.00	215	364
12.50			25.75	165	286	46.50		
12.80			26.00			47.00		
13.00			26.25			47.50		
13.20			26.50					
13.50						48.00		
13.80	108	189	26.75			48.50	220	369
14.00			27.00			49.00		
			27.25	170	291	49.50		
14.25			27.50			50.00		
14.50	114	212	27.75					
14.75			28.00			50.50	225	374
15.00								
			28.25			51.00		
15.25			28.50			52.00	225	412
15.50	120	218	28.75	175	296	53.00		
15.75			29.00					
16.00			29.25			54.00	230	417
						55.00		

Table 1. British Standard Morse Taper Shank Twist Drills and Core Drills — Standard Metric Sizes BS 328: Part 1: 1959

Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length		
56.00	230	417	71.00	250	437	86.00	270	524		
57.00	235	422	72.00	255	442	87.00				
58.00			73.00			88.00				
59.00			74.00			89.00				
60.00			75.00			90.00				
61.00	240	427	76.00	260	477	91.00	275	529		
62.00			245	432	77.00	260			514	92.00
63.00										78.00	93.00
64.00	79.00	94.00								
65.00	250	437	80.00	265	519	95.00	280	534		
66.00			81.00			96.00				
67.00			82.00			97.00				
68.00			83.00			98.00				
69.00	255	442	84.00	265	519	99.00	280	534		
70.00			85.00			100.00				

All dimensions are in millimeters. Tolerances on diameters are given in the table below.

Table 2, shows twist drills that may be supplied with the shank and length oversize, but they should be regarded as nonpreferred.

The Morse taper shanks of these twist and core drills are as follows: 3.00 to 14.00 mm diameter, M.T. No. 1; 14.25 to 23.00 mm diameter, M.T. No. 2; 23.25 to 31.50 mm diameter, M.T. No. 3; 31.75 to 50.50 mm diameter, M.T. No. 4; 51.00 to 76.00 mm diameter, M.T. No. 5; 77.00 to 100.00 mm diameter, M.T. No. 6.

Table 2. British Standard Morse Taper Shank Twist Drills — Metric Oversize Shank and Length Series BS 328: Part 1: 1959

Dia. Range	Overall Length	M. T. No.	Dia. Range	Overall Length	M. T. No.	Dia. Range	Overall Length	M. T. No.
12.00 to 13.20	199	2	22.50 to 23.00	276	3	45.50 to 47.50	402	5
13.50 to 14.00	206	2	26.75 to 28.00	319	4	48.00 to 50.00	407	5
18.25 to 19.00	256	3	29.00 to 30.00	324	4	50.50	412	5
19.25 to 20.00	251	3	30.25 to 31.50	329	4	64.00 to 67.00	499	6
20.25 to 21.00	266	3	40.50 to 42.50	392	5	68.00 to 71.00	504	6
21.25 to 22.25	271	3	43.00 to 45.00	397	5	72.00 to 75.00	509	6

Diameters and lengths are given in millimeters. For the individual sizes within the diameter ranges given, see Table 1.

This series of drills should be regarded as non-preferred.

Table 3. British Standard Limits of Tolerance on Diameter for Twist Drills and Core Drills — Metric Series BS 328: Part 1: 1959

Drill Size (Diameter measured across lands at outer corners)	Tolerance (h8)
0 to 1 inclusive	Plus 0.000 to Minus 0.014
Over 1 to 3 inclusive	Plus 0.000 to Minus 0.014
Over 3 to 6 inclusive	Plus 0.000 to Minus 0.018
Over 6 to 10 inclusive	Plus 0.000 to Minus 0.022
Over 10 to 18 inclusive	Plus 0.000 to Minus 0.027
Over 18 to 30 inclusive	Plus 0.000 to Minus 0.033
Over 30 to 50 inclusive	Plus 0.000 to Minus 0.039
Over 50 to 80 inclusive	Plus 0.000 to Minus 0.046
Over 80 to 120 inclusive	Plus 0.000 to Minus 0.054

All dimensions are given in millimeters.

**Table 4. British Standard Parallel Shank Jobber Series Twist Drills —
Standard Metric Sizes BS 328: Part 1: 1959**

Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length
0.20	2.5	19	1.75	22	46	5.40	57	93	10.20	87	133
0.22			1.80			5.50			10.30		
0.25			1.85			5.60			10.40		
0.28	3.0	19	1.90	24	49	5.70	63	101	10.50	94	142
0.30			1.95			5.80			10.60		
	4	19	2.00	27	53	6.00	69	109	10.70	101	151
0.32			2.05			6.10			10.80		
0.35			2.10			6.20			10.90		
0.38	5	20		30	57	6.30	75	117	11.00	108	160
0.40			2.15			6.40			11.10		
0.42			2.20			6.50			11.20		
0.45	6	22	2.25	33	61	6.60	81	125	11.30	114	169
0.48			2.30			6.70			11.40		
			2.35			6.80			11.50		
0.50	7	24	2.40	36	65	6.90	91	133	11.60	120	178
0.52			2.45			7.00			11.70		
0.55			2.50			7.10			11.80		
0.58	8	26	2.55	39	70	7.20	101	149	11.90	127	186
0.60			2.60			7.30			12.00		
0.62			2.65			7.40			12.10		
0.65	9	28	2.70	43	75	7.50	111	159	12.20	135	204
0.68			2.75			7.60			12.30		
0.70			2.80			7.70			12.40		
0.72	10	30	2.85	47	80	7.80	121	179	12.50	142	212
0.75			2.90			7.90			12.60		
0.78			2.95			8.00			12.70		
0.80	11	32	3.00	51	85	8.10	131	199	12.80	150	220
0.82			3.10			8.20			12.90		
0.85			3.20			8.30			13.00		
	12	34	3.30	55	90	8.40	141	219	13.10	158	228
0.88			3.40			8.50			13.20		
0.90			3.50			8.60			13.30		
0.92	14	36	3.60	59	95	8.70	151	229	13.40	166	236
0.95			3.70			8.80			13.50		
0.98			3.80			8.90			13.60		
1.00	16	38	3.90	63	100	9.00	161	239	13.70	174	244
1.05			4.00			9.10			13.80		
1.10			4.10			9.20			13.90		
1.15	18	40	4.20	67	105	9.30	171	249	14.00	182	252
			4.30			9.40			14.25		
1.20			4.40			9.50			14.50		
1.25	20	43	4.50	71	110	9.60	181	259	14.75	190	260
1.30			4.60			9.70			15.00		
			4.70			9.80			15.25		
1.35	22	46	4.80	75	115	9.90	191	269	15.50	200	268
1.40			4.90			10.00			15.75		
1.45			5.00			10.10			16.00		
1.50	24	49	5.10	79	120	10.20	201	279	16.25	210	276
1.55			5.20			10.30			16.50		
1.60			5.30			10.40			16.75		
1.65	26	52	5.40	83	125	10.50	211	289	17.00	220	284
1.70			5.50			10.60			17.25		

All dimensions are in millimeters. Tolerances on diameters are given in Table 3.

**Table 5. British Standard Parallel Shank Long Series Twist Drills —
Standard Metric Sizes BS 328: Part 1: 1959**

Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length						
2.00	56	85	6.80	102	156	12.70	134	205						
2.05			6.90			12.80								
2.10			7.00			12.90								
2.15	59	90	7.10			13.00								
			7.20			13.10								
			7.30			13.20								
2.30	62	95	7.40			109			165	13.30	140	214		
2.35			7.50							13.40				
2.40			7.60							13.50				
2.45			7.70							13.60				
2.50			7.80	13.70										
2.55			7.90	13.80										
2.60			8.00	13.90										
2.65	66	100	8.10	14.00										
			8.20	14.25										
			8.30	14.50										
2.80	69	106	8.40	115	175	14.75	144	220						
2.85			8.50			15.00								
2.90			8.60			15.25								
2.95			8.70			15.50								
3.00			8.80			15.75								
3.10			73			112			8.90	16.00				
									9.00	16.25				
									9.10	16.50				
3.20			78			119			9.20	121	184	16.75	154	235
3.30									9.30			17.00		
3.40	9.40	17.25												
3.50	9.50	17.50												
3.60	9.60	17.75												
3.70	9.70	18.00												
3.80	9.80	18.25												
3.90	82	126	9.90	18.50										
			10.00	18.75										
			10.10	19.00										
4.00	87	132	10.20	128	195	19.25	162	247						
4.10			10.30			19.50								
4.20			10.40			19.75								
4.30			82			126			10.50	20.00				
									10.60	19.25				
									10.70	19.50				
4.40			91			139			10.80	134	205	19.75	166	254
4.50									10.90			20.00		
4.60									11.00			20.25		
4.70									11.10			20.50		
4.80	11.20	21.00												
4.90	11.30	21.25												
5.00	11.40	21.50												
5.10	87	132	11.50	21.75										
			11.60	22.00										
			11.70	22.25										
5.20	91	139	11.80	128	195	22.50	176	268						
5.30			11.90			22.75								
5.40			12.00			23.00								
5.50			12.10			23.25								
5.60			12.20			23.50								
5.70			12.30			23.75								
5.80			12.40			24.00								
5.90			12.50			24.25								
6.00			12.60			24.50								
6.10			97			148			12.70	134	205	24.75	185	282
	6.20	12.80		25.00										
	6.30	12.90		25.25										
6.40	13.00	25.50												
6.50	13.10	25.75												
6.60	13.20	26.00												
6.70	13.30	26.25												

All dimensions are in millimeters. Tolerances on diameters are given in Table 3.

Table 6. British Standard Stub Drills — Metric Sizes BS 328: Part 1: 1959

Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length	Diameter	Flute Length	Overall Length
0.50	3	20	5.00	26	62	9.50	40	84	14.00	54	107
0.80	5	24	5.20			9.80			14.50		
1.00	6	26	5.50			10.00	43	89	15.00	56	111
1.20	8	30	5.80	28	66	10.20			15.50	58	115
1.50	9	32	6.00			10.50			16.00		
1.80	11	36									
2.00	12	38	6.20	31	70	10.80			16.50	60	119
2.20	13	40	6.50			11.00			17.00		
2.50	14	43	6.80			11.20	47	95	17.50	62	123
2.80			7.00	34	74	11.50			18.00	64	127
3.00	16	46	7.20			11.80			18.50		
3.20	18	49	7.50			12.00			19.00	64	127
3.50	20	52	7.80			12.20			19.50	66	131
			8.00	37	79	12.50	51	102	20.00		
3.80			8.20			12.80			21.00	68	136
4.00	22	55	8.50			13.00			22.00	70	141
4.20			8.80	40	84	13.20			23.00	72	146
4.50	24	58	9.00			13.50			24.00		
4.80	26	62	9.20			13.80	54	107	25.00	75	151

All dimensions are given in millimeters. Tolerances on diameters are given in Table 3.

Steels for Twist Drills.—Twist drill steels need good toughness, abrasion resistance, and ability to resist softening due to heat generated by cutting. The amount of heat generated indicates the type of steel that should be used.

Carbon Tool Steel: may be used where little heat is generated during drilling.

High-Speed Steel: is preferred because of its combination of red hardness and wear resistance, which permit higher operating speeds and increased productivity. Optimum properties can be obtained by selection of alloy analysis and heat treatment.

Cobalt High-Speed Steel: alloys have higher red hardness than standard high-speed steels, permitting drilling of materials such as heat-resistant alloys and materials with hardness greater than Rockwell 38 C. These high-speed drills can withstand cutting speeds beyond the range of conventional high-speed-steel drills and have superior resistance to abrasion but are not equal to tungsten-carbide tipped tools.

Accuracy of Drilled Holes.—Normally the diameter of drilled holes is not given a tolerance; the size of the hole is expected to be as close to the drill size as can be obtained.

The accuracy of holes drilled with a two-fluted twist drill is influenced by many factors, which include: the accuracy of the drill point; the size of the drill; length and shape of the chisel edge; whether or not a bushing is used to guide the drill; the work material; length of the drill; runout of the spindle and the chuck; rigidity of the machine tool, workpiece, and the setup; and also the cutting fluid used, if any.

The diameter of the drilled holes will be oversize in most materials. The table following provides the results of tests reported by The United States Cutting Tool Institute in which the diameters of over 2800 holes drilled in steel and cast iron were measured. The values in this table indicate what might be expected under average shop conditions; however, when the drill point is accurately ground and the other machining conditions are correct, the resulting hole size is more likely to be between the mean and average minimum values given in this table. If the drill is ground and used incorrectly, holes that are even larger than the average maximum values can result.

Oversize Diameters in Drilling

Drill Dia., Inch	Amount Oversize, Inch			Drill Dia., Inch	Amount Oversize, Inch		
	Average Max.	Mean	Average Min.		Average Max.	Mean	Average Min.
$\frac{1}{16}$	0.002	0.0015	0.001	$\frac{1}{2}$	0.008	0.005	0.003
$\frac{1}{8}$	0.0045	0.003	0.001	$\frac{3}{4}$	0.008	0.005	0.003
$\frac{1}{4}$	0.0065	0.004	0.0025	1	0.009	0.007	0.004

Courtesy of The United States Cutting Tool Institute

Some conditions will cause the drilled hole to be undersize. For example, holes drilled in light metals and in other materials having a high coefficient of thermal expansion such as plastics, may contract to a size that is smaller than the diameter of the drill as the material surrounding the hole is cooled after having been heated by the drilling. The elastic action of the material surrounding the hole may also cause the drilled hole to be undersize when drilling high strength materials with a drill that is dull at its outer corner.

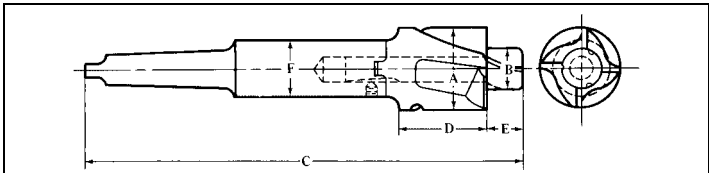
The accuracy of the drill point has a great effect on the accuracy of the drilled hole. An inaccurately ground twist drill will produce holes that are excessively over-size. The drill point must be symmetrical; i.e., the point angles must be equal, as well as the lip lengths and the axial height of the lips. Any alterations to the lips or to the chisel edge, such as thinning the web, must be done carefully to preserve the symmetry of the drill point. Adequate relief should be provided behind the chisel edge to prevent heel drag. On conventionally ground drill points this relief can be estimated by the chisel edge angle.

When drilling a hole, as the drill point starts to enter the workpiece, the drill will be unstable and will tend to wander. Then as the body of the drill enters the hole the drill will tend to stabilize. The result of this action is a tendency to drill a bellmouth shape in the hole at the entrance and perhaps beyond. Factors contributing to bellmouthing are: an unsymmetrically ground drill point; a large chisel edge length; inadequate relief behind the chisel edge; runout of the spindle and the chuck; using a slender drill that will bend easily; and lack of rigidity of the machine tool, workpiece, or the setup. Correcting these conditions as required will reduce the tendency for bellmouthing to occur and improve the accuracy of the hole diameter and its straightness. Starting the hole with a short stiff drill, such as a center drill, will quickly stabilize the drill that follows and reduce or eliminate bellmouthing; this procedure should always be used when drilling in a lathe, where the work is rotating. Bellmouthing can also be eliminated almost entirely and the accuracy of the hole improved by using a close fitting drill jig bushing placed close to the workpiece. Although specific recommendations cannot be made, many cutting fluids will help to increase the accuracy of the diameters of drilled holes. Double margin twist drills, available in the smaller sizes, will drill a more accurate hole than conventional twist drills having only a single margin at the leading edge of the land. The second land, located on the trailing edge of each land, provides greater stability in the drill bushing and in the hole. These drills are especially useful in drilling intersecting off-center holes. Single and double margin step drills, also available in the smaller sizes, will produce very accurate drilled holes, which are usually less than 0.002 inch larger than the drill size.

Counterboring.—Counterboring (called spot-facing if the depth is shallow) is the enlargement of a previously formed hole. Counterbores for screw holes are generally made in sets. Each set contains three counterbores: one with the body of the size of the screw head and the pilot the size of the hole to admit the body of the screw; one with the body the size of the head of the screw and the pilot the size of the tap drill; and the third with the body the size of the body of the screw and the pilot the size of the tap drill. Counterbores are usually provided with helical flutes to provide positive effective rake on the cutting edges. The four flutes are so positioned that the end teeth cut ahead of center to provide a shearing action and eliminate chatter in the cut. Three designs are most common: solid, two-piece, and three-piece. Solid designs have the body, cutter, and pilot all in one piece. Two-piece designs have an integral shank and counterbore cutter, with an interchangeable pilot, and provide true concentricity of the cutter diameter with the shank, but allowing use of various

pilot diameters. Three-piece counterbores have separate holder, counterbore cutter, and pilot, so that a holder will take any size of counterbore cutter. Each counterbore cutter, in turn, can be fitted with any suitable size diameter of pilot. Counterbores for brass are fluted straight.

Counterbores with Interchangeable Cutters and Guides



No. of Holder	No. of Morse Taper Shank	Range of Cutter Diameters, A	Range of Pilot Diameters, B	Total Length, C	Length of Cutter Body, D	Length of Pilot, E	Dia. of Shank, F
1	1 or 2	$\frac{3}{8}$ - $1\frac{1}{16}$	$\frac{1}{2}$ - $\frac{3}{4}$	7 $\frac{1}{4}$	1	$\frac{3}{8}$	$\frac{3}{4}$
2	2 or 3	$1\frac{1}{8}$ - $1\frac{1}{16}$	$1\frac{1}{16}$ - $1\frac{1}{8}$	9 $\frac{1}{2}$	1 $\frac{3}{8}$	$\frac{7}{8}$	1 $\frac{1}{8}$
3	3 or 4	$1\frac{3}{8}$ - $2\frac{1}{16}$	$\frac{7}{8}$ - $1\frac{3}{8}$	12 $\frac{1}{2}$	1 $\frac{1}{4}$	1 $\frac{1}{8}$	1 $\frac{3}{8}$
4	4 or 5	$2\frac{1}{8}$ - $3\frac{1}{2}$	1- $2\frac{1}{8}$	15	2 $\frac{1}{4}$	1 $\frac{3}{8}$	2 $\frac{1}{8}$

Solid Counterbores with Integral Pilot

Counterbore Diameters	Pilot Diameters			Straight Shank Diameter	Overall Length	
	Nominal	+ $\frac{1}{64}$	+ $\frac{1}{32}$		Short	Long
$1\frac{1}{32}$	$\frac{1}{4}$	$\frac{17}{64}$	$\frac{9}{32}$	$\frac{3}{8}$	3 $\frac{1}{2}$	5 $\frac{1}{2}$
$\frac{1}{2}$	$\frac{5}{16}$	$\frac{21}{64}$	$1\frac{1}{32}$	$\frac{3}{8}$	3 $\frac{1}{2}$	5 $\frac{1}{2}$
$\frac{9}{32}$	$\frac{3}{8}$	$\frac{25}{64}$	$1\frac{1}{32}$	$\frac{1}{2}$	4	6
$1\frac{1}{16}$	$\frac{7}{16}$	$\frac{29}{64}$	$1\frac{5}{32}$	$\frac{1}{2}$	4	6
$\frac{25}{32}$	$\frac{1}{2}$	$\frac{33}{64}$	$1\frac{7}{32}$	$\frac{1}{2}$	5	7
0.110	0.060	0.076	...	$\frac{7}{64}$	2 $\frac{1}{2}$	...
0.133	0.073	0.089	...	$\frac{1}{8}$	2 $\frac{1}{2}$	...
0.155	0.086	0.102	...	$\frac{5}{32}$	2 $\frac{1}{2}$	...
0.176	0.099	0.115	...	$1\frac{1}{64}$	2 $\frac{1}{2}$	...
0.198	0.112	0.128	...	$\frac{3}{16}$	2 $\frac{1}{2}$	...
0.220	0.125	0.141	...	$\frac{3}{16}$	2 $\frac{1}{2}$	...
0.241	0.138	0.154	...	$\frac{7}{32}$	2 $\frac{1}{2}$	...
0.285	0.164	0.180	...	$\frac{1}{4}$	2 $\frac{1}{2}$	...
0.327	0.190	0.206	...	$\frac{9}{32}$	2 $\frac{3}{4}$	...
0.372	0.216	0.232	...	$\frac{5}{16}$	2 $\frac{3}{4}$	...

All dimensions are in inches.

Small counterbores are often made with three flutes, but should then have the size plainly stamped on them before fluting, as they cannot afterwards be conveniently measured. The flutes should be deep enough to come below the surface of the pilot. The counterbore should be relieved on the end of the body only, and not on the cylindrical surface. To facilitate the relieving process, a small neck is turned between the guide and the body for clearance. The amount of clearance on the cutting edges is, for general work, from 4 to 5 degrees. The accompanying table gives dimensions for straight shank counterbores.

Three Piece Counterbores.—Data shown for the first two styles of counterbores are for straight shank designs. These tools are also available with taper shanks in most sizes. Sizes of taper shanks for cutter diameters of $\frac{1}{4}$ to $\frac{9}{16}$ in. are No. 1, for $1\frac{9}{32}$ to $\frac{7}{8}$ in., No. 2; for $1\frac{5}{16}$ to $1\frac{3}{8}$ in., No. 3; for $1\frac{1}{2}$ to 2 in., No. 4; and for $2\frac{1}{8}$ to $2\frac{1}{2}$ in., No. 5.

Table 1. American National Standard Sintered Carbide Boring Tools—Style Designations ANSI B212.1-1984 (R1997)

Side Cutting Edge Angle E		Boring Tool Styles			
Degrees	Designation	Solid Square (SS)	Tipped Square (TS)	Solid Round (SR)	Tipped Round (TR)
0	A		TSA		
10	B		TSB		
30	C	SSC	TSC	SRC	TRC
40	D		TSD		
45	E	SSE	TSE	SRE	TRE
55	F		TSF		
90 (0° Rake)	G				TRG
90 (10° Rake)	H				TRH

Table 2. American National Standard Solid Carbide Square Boring Tools—Style SSC for 60° Boring Bar and Style SSE for 45° Boring Bar ANSI B212.1-1984 (R1997)

Tool Designation	Boring Bar Angle, Deg. from Axis	Shank Dimensions, Inches			Side Cutting Edge Angle E , Deg.	End Cutting Edge Angle G , Deg.	Shoulder Angle F , Deg.
		Width A	Height B	Length C			
SSC-58	60	$\frac{5}{32}$	$\frac{5}{32}$	1	30	38	60
SSE-58	45				45	53	45
SSC-610	60	$\frac{3}{16}$	$\frac{3}{16}$	$1\frac{1}{4}$	30	38	60
SSE-610	45				45	53	45
SSC-810	60	$\frac{1}{4}$	$\frac{1}{4}$	$1\frac{1}{4}$	30	38	60
SSE-810	45				45	53	45
SSC-1012	60	$\frac{5}{16}$	$\frac{5}{16}$	$1\frac{1}{2}$	30	38	60
SSE-1012	45				45	53	45

Counterbore Sizes for Hex-head Bolts and Nuts.—Table 2, page 1511, shows the maximum socket wrench dimensions for standard $\frac{1}{4}$ -, $\frac{1}{2}$ - and $\frac{3}{4}$ -inch drive socket sets. For a given socket size (nominal size equals the maximum width across the flats of nut or bolt head), the dimension K given in the table is the minimum counterbore diameter required to provide socket wrench clearance for access to the bolt or nut.

Sintered Carbide Boring Tools.—Industrial experience has shown that the shapes of tools used for boring operations need to be different from those of single-point tools ordinarily used for general applications such as lathe work. Accordingly, Section 5 of American National Standard ANSI B212.1-1984 (R1997) gives standard sizes, styles and

designations for four basic types of sintered carbide boring tools, namely: solid carbide square; carbide-tipped square; solid carbide round; and carbide-tipped round boring tools. In addition to these ready-to-use standard boring tools, solid carbide round and square unsharpened boring tool bits are provided.

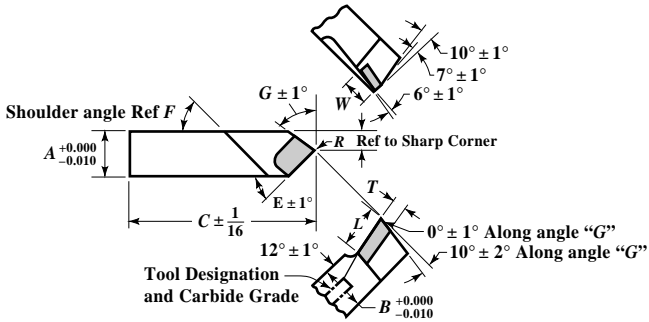


Table 3. American National Standard Carbide-Tipped Square Boring Tools — Styles TSA and TSB for 90° Boring Bar, Styles TSC and TSD for 60° Boring Bar, and Styles TSE and TSF for 45° Boring Bar ANSI B212.1-1984 (R1997)

Tool Designation	Bor. Bar Angle-from Axis, Deg.	Shank Dimensions, Inches				SideCut. Edge Angle E, Deg.	End Cut. Edge Angle G, Deg.	Shoulder Angle F, Deg.	Tip No.	Tip Dimensions, Inches		
		A	B	C	R					T	W	L
TSA-5	90	$\frac{5}{16}$	$\frac{3}{16}$	$1\frac{1}{2}$	$\left(\frac{1}{64} \pm 0.005 \right)$	0	8	90	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSB-5	90	$\frac{5}{16}$	$\frac{3}{16}$	$1\frac{1}{2}$		10	8	90	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSC-5	60	$\frac{5}{16}$	$\frac{3}{16}$	$1\frac{1}{2}$		30	38	60	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSD-5	60	$\frac{5}{16}$	$\frac{3}{16}$	$1\frac{1}{2}$		40	38	60	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSE-5	45	$\frac{5}{16}$	$\frac{3}{16}$	$1\frac{1}{2}$		45	53	45	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSF-5	45	$\frac{5}{16}$	$\frac{3}{16}$	$1\frac{1}{2}$		55	53	45	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSA-6	90	$\frac{3}{8}$	$\frac{3}{8}$	$1\frac{3}{4}$	$\left(\frac{1}{64} \pm 0.005 \right)$	0	8	90	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSB-6	90	$\frac{3}{8}$	$\frac{3}{8}$	$1\frac{3}{4}$		10	8	90	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSC-6	60	$\frac{3}{8}$	$\frac{3}{8}$	$1\frac{3}{4}$		30	38	60	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSD-6	60	$\frac{3}{8}$	$\frac{3}{8}$	$1\frac{3}{4}$		40	38	60	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSE-6	45	$\frac{3}{8}$	$\frac{3}{8}$	$1\frac{3}{4}$		45	53	45	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TSF-6	45	$\frac{3}{8}$	$\frac{3}{8}$	$1\frac{3}{4}$		55	53	45	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$

Table 3. (Continued) American National Standard Carbide-Tipped Square Boring Tools—Styles TSA and TSB for 90° Boring Bar, Styles TSC and TSD for 60° Boring Bar, and Styles TSE and TSF for 45° Boring Bar ANSI B212.1-1984 (R1997)

Tool Designation	Bor. Bar Angle from Axis, Deg.	Shank Dimensions, Inches				Side Cut. Edge Angle E, Deg.	End Cut. Edge Angle G, Deg.	Shoulder Angle F, Deg.	Tip No.	Tip Dimensions, Inches		
		A	B	C	R					T	W	L
TSA-7	90	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{1}{2}$	$\left(\begin{array}{c} \frac{1}{32} \\ \pm \\ 0.010 \end{array} \right)$	0	8	90	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TSB-7	90	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{1}{2}$		10	8	90	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TSC-7	60	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{1}{2}$		30	38	60	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TSD-7	60	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{1}{2}$		40	38	60	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TSE-7	45	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{1}{2}$		45	53	45	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TSF-7	45	$\frac{3}{16}$	$\frac{3}{16}$	$2\frac{1}{2}$		55	53	45	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TSA-8	90	$\frac{1}{2}$	$\frac{1}{2}$	$2\frac{1}{2}$		$\left(\begin{array}{c} \frac{1}{32} \\ \pm \\ 0.010 \end{array} \right)$	0	8	90	2150	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{7}{16}$
TSB-8	90	$\frac{1}{2}$	$\frac{1}{2}$	$2\frac{1}{2}$	10		8	90	2150	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{7}{16}$
TSC-8	60	$\frac{1}{2}$	$\frac{1}{2}$	$2\frac{1}{2}$	30		38	60	2150	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{7}{16}$
TSD-8	60	$\frac{1}{2}$	$\frac{1}{2}$	$2\frac{1}{2}$	40		38	60	2150	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{7}{16}$
TSE-8	45	$\frac{1}{2}$	$\frac{1}{2}$	$2\frac{1}{2}$	45		53	45	2150	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{7}{16}$
TSF-8	45	$\frac{1}{2}$	$\frac{1}{2}$	$2\frac{1}{2}$	55		53	45	2150	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{7}{16}$
TSA-10	90	$\frac{5}{8}$	$\frac{5}{8}$	3	$\left(\begin{array}{c} \frac{1}{32} \\ \pm \\ 0.010 \end{array} \right)$		0	8	90	2220	$\frac{5}{32}$	$\frac{3}{8}$	$\frac{9}{16}$
TSB-10	90	$\frac{5}{8}$	$\frac{5}{8}$	3		10	8	90	2220	$\frac{5}{32}$	$\frac{3}{8}$	$\frac{9}{16}$
TSC-10	60	$\frac{5}{8}$	$\frac{5}{8}$	3		30	38	60	2220	$\frac{5}{32}$	$\frac{3}{8}$	$\frac{9}{16}$
TSD-10	60	$\frac{5}{8}$	$\frac{5}{8}$	3		40	38	60	2220	$\frac{5}{32}$	$\frac{3}{8}$	$\frac{9}{16}$
TSE-10	45	$\frac{5}{8}$	$\frac{5}{8}$	3		45	53	45	2220	$\frac{5}{32}$	$\frac{3}{8}$	$\frac{9}{16}$
TSF-10	45	$\frac{5}{8}$	$\frac{5}{8}$	3		55	53	45	2220	$\frac{5}{32}$	$\frac{3}{8}$	$\frac{9}{16}$
TSA-12	90	$\frac{3}{4}$	$\frac{3}{4}$	$3\frac{1}{2}$		$\left(\begin{array}{c} \frac{1}{32} \\ \pm \\ 0.010 \end{array} \right)$	0	8	90	2300	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{5}{8}$
TSB-12	90	$\frac{3}{4}$	$\frac{3}{4}$	$3\frac{1}{2}$	10		8	90	2300	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{5}{8}$
TSC-12	60	$\frac{3}{4}$	$\frac{3}{4}$	$3\frac{1}{2}$	30		38	60	2300	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{5}{8}$
TSD-12	60	$\frac{3}{4}$	$\frac{3}{4}$	$3\frac{1}{2}$	40		38	60	2300	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{5}{8}$
TSE-12	45	$\frac{3}{4}$	$\frac{3}{4}$	$3\frac{1}{2}$	45		53	45	2300	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{5}{8}$
TSF-12	45	$\frac{3}{4}$	$\frac{3}{4}$	$3\frac{1}{2}$	55		53	45	2300	$\frac{3}{16}$	$\frac{7}{16}$	$\frac{5}{8}$

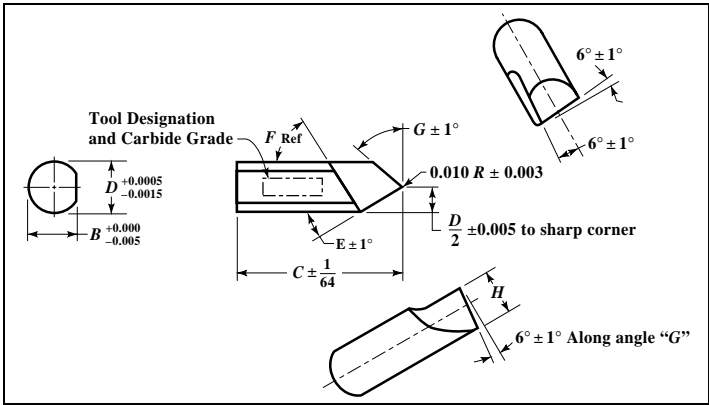


Table 4. American National Standard Solid Carbide Round Boring Tools — Style SRC for 60° Boring Bar and Style SRE for 45° Boring Bar ANSI B212.1-1984 (R1997)

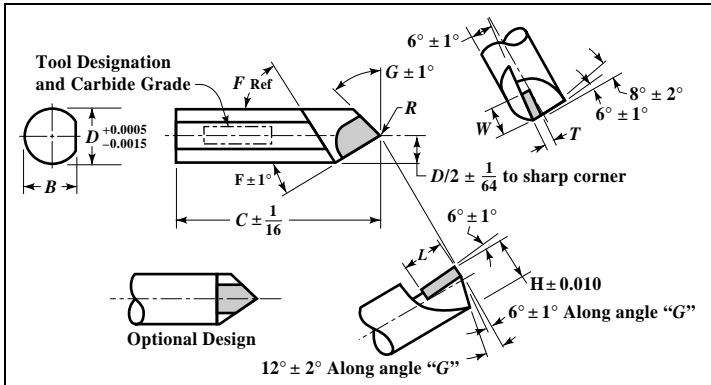
Tool Designation	Bor. Bar Angle from Axis, Deg.	Shank Dimensions, Inches				Side Cut. Edge Angle E, Deg.	End Cut. Edge Angle G, Deg.	Shoulder Angle F, Deg.	
		Dia. D	Length C	Dim. Over Flat B	Nose Height H				
SRC-33	60	$\frac{3}{32}$	$\frac{3}{8}$	0.088	0.070	[+0.000 -0.005]	30	38	60
SRE-33	45	$\frac{3}{32}$	$\frac{3}{8}$	0.088	0.070		45	53	45
SRC-44	60	$\frac{1}{8}$	$\frac{1}{2}$	0.118	0.094	[+0.000 -0.005]	30	38	60
SRE-44	45	$\frac{1}{8}$	$\frac{1}{2}$	0.118	0.094		45	53	45
SRC-55	60	$\frac{5}{32}$	$\frac{5}{8}$	0.149	0.117	±0.005	30	38	60
SRE-55	45	$\frac{5}{32}$	$\frac{5}{8}$	0.149	0.117	±0.005	45	53	45
SRC-66	60	$\frac{3}{16}$	$\frac{3}{4}$	0.177	0.140	±0.005	30	38	60
SRE-66	45	$\frac{3}{16}$	$\frac{3}{4}$	0.177	0.140	±0.005	45	53	45
SRC-88	60	$\frac{1}{4}$	1	0.240	0.187	±0.005	30	38	60
SRE-88	45	$\frac{1}{4}$	1	0.240	0.187	±0.005	45	53	45
SRC-1010	60	$\frac{5}{16}$	$1\frac{1}{4}$	0.300	0.235	±0.005	30	38	60
SRE-1010	45	$\frac{5}{16}$	$1\frac{1}{4}$	0.300	0.235	±0.005	45	53	45

Style Designations for Carbide Boring Tools: Table 1 shows designations used to specify the styles of American Standard sintered carbide boring tools. The first letter denotes solid (S) or tipped (T). The second letter denotes square (S) or round (R). The side cutting edge angle is denoted by a third letter (A through H) to complete the style designation. Solid square and round bits with the mounting surfaces ground but the cutting edges unsharpened (Table 7) are designated using the same system except that the third letter indicating the side cutting edge angle is omitted.

Size Designation of Carbide Boring Tools: Specific sizes of boring tools are identified by the addition of numbers after the style designation. The first number denotes the diameter or square size in number of $\frac{1}{32}$ nds for types SS and SR and in number of $\frac{1}{16}$ ths for types

TS and TR. The second number denotes length in number of 1/8ths for types SS and SR. For styles TRG and TRH, a letter "U" after the number denotes a semi-finished tool (cutting edges unsharpened). Complete designations for the various standard sizes of carbide boring tools are given in Tables 2 through 7. In the diagrams in the tables, angles shown without tolerance are $\pm 1^\circ$.

Table 5. American National Standard Carbide-Tipped Round Boring Tools — Style TRC for 60° Boring Bar and Style TRE for 45° Boring Bar
ANSI B212.1-1984 (R1997)



Tool Designation	Bor. Bar Angle from Axis, Deg.	Shank Dimensions, Inches					Side Cut. Edge Angle E, Deg.	End Cut. Edge Angle G, Deg.	Shoulder Angle F, Deg.	Tip No.	Tip Dimensions, Inches		
		D	C	B	H	R					T	W	L
TRC-5	60	$\frac{5}{16}$	$1\frac{1}{2}$	$\frac{19}{64}$	$\frac{7}{32}$	$\frac{1}{64}$	30	38	60	2020	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{1}{4}$
TRE-5	45	$\frac{5}{16}$	$1\frac{1}{2}$	$\pm .005$	$\frac{7}{32}$	$\pm .005$	45	53	45	2020	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{1}{4}$
TRC-6	60	$\frac{3}{8}$	$1\frac{3}{4}$	$\frac{11}{32}$	$\frac{5}{32}$	$\frac{1}{64}$	30	38	60	2040	$\frac{3}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
TRE-6	45	$\frac{3}{8}$	$1\frac{3}{4}$	$\pm .010$	$\frac{5}{32}$	$\pm .005$	45	53	45	2020	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{1}{4}$
TRC-7	60	$\frac{7}{16}$	$2\frac{1}{2}$	$\frac{13}{32}$	$\frac{5}{16}$	$\frac{1}{32}$	30	38	60	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TRE-7	45	$\frac{7}{16}$	$2\frac{1}{2}$	$\pm .010$	$\frac{5}{16}$	$\pm .010$	45	53	45	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TRC-8	60	$\frac{1}{2}$	$2\frac{1}{2}$	$\frac{15}{32}$	$\frac{3}{8}$	$\frac{1}{32}$	30	38	60	2060	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{3}{8}$
TRE-8	45	$\frac{1}{2}$	$2\frac{1}{2}$	$\pm .010$	$\frac{3}{8}$	$\pm .010$	45	53	45	2080	$\frac{3}{32}$	$\frac{5}{16}$	$\frac{3}{8}$

Examples of Tool Designation: The designation TSC-8 indicates: a carbide-tipped tool (T); square cross-section (S); 30-degree side cutting edge angle (C); and $\frac{5}{16}$ or $\frac{1}{2}$ inch square size (8).

The designation SRE-66 indicates: a solid carbide tool (S); round cross-section (R); 45 degree side cutting edge angle (E); $\frac{5}{32}$ or $\frac{3}{16}$ inch diameter (6); and $\frac{7}{8}$ or $\frac{3}{4}$ inch long (6).

The designation SS-610 indicates: a solid carbide tool (S); square cross-section (S); $\frac{5}{32}$ or $\frac{3}{16}$ inch square size (6); $\frac{10}{8}$ or $1\frac{1}{4}$ inches long (10).

It should be noted in this last example that the absence of a third letter (from A to H) indicates that the tool has its mounting surfaces ground but that the cutting edges are unsharpened.

Table 6. American National Standard Carbide-Tipped Round General-Purpose Square-End Boring Tools — Style TRG with 0° Rake and Style TRH with 10° Rake
ANSI B212.1-1984 (R1997)

Tool Designation		Shank Dimensions, Inches					Rake Angle Deg.	Tip No.	Tip Dimensions, Inches		
Finished	Semi-finished ^a	Dia. <i>D</i>	Length <i>C</i>	Dim. Over Flat <i>B</i>	Nose Height <i>H</i>	Set-back <i>M</i> (Min)			<i>T</i>	<i>W</i>	<i>L</i>
TRG-5	TRG-5U	5/16	1 1/2	19/64	3/16	3/16	0	1025	1/16	1/4	1/4
TRH-5	TRH-5U	5/16	1 1/2	±.005	7/32	3/16	10				
TRG-6	TRG-6U	3/8	1 3/4	11/32	7/32	3/16	0	1030	1/16	5/16	1/4
TRH-6	TRH-6U	3/8	1 3/4	±.010	1/4	3/16	10				
TRG-7	TRG-7U	7/16	2 1/2	13/32	1/4	3/16	0	1080	3/32	5/16	3/8
TRH-7	TRH-7U	7/16	2 1/2	±.010	5/16	3/16	10				
TRG-8	TRG-8U	1/2	2 1/2	15/32	9/32	1/4	0	1090	3/32	3/8	3/8
TRH-8	TRH-8U	1/2	2 1/2	±.010	11/32	1/4	10				

^a Semifinished tool will be without Flat (B) and carbide unground on the end.

Table 7. Solid Carbide Square and Round Boring Tool Bits

Square Bits				Round Bits								
Tool Designation	<i>A</i>	<i>B</i>	<i>C</i>	Tool Designation	<i>D</i>	<i>C</i>	Tool Designation	<i>D</i>	<i>C</i>	Tool Designation	<i>D</i>	<i>C</i>
SS-58	3/32	3/32	1	SR-33	3/32	3/8	SR-55	3/32	3/8	SR-88	1/4	1
SS-610	3/16	3/16	1 1/4	SR-34	3/32	1/2	SR-64	3/16	1/2	SR-810	1/4	1 1/4
SS-810	1/4	1/4	1 1/4	SR-44	1/8	1/2	SR-66	3/16	3/4	SR-1010	5/16	1 1/4
SS-1012	5/16	5/16	1 1/2	SR-46	1/8	3/4	SR-69	3/16	1 1/8	...	...	...
SS-1214	3/8	3/8	1 3/4	SR-48	1/8	1	SR-77	7/32	7/8	...	...	...

All dimensions are in inches.

Tolerance on Length: Through 1 inch, +1/32, -0; over 1 inch, +1/64, -0.

Spade Drills and Drilling

Spade drills are used to produce holes ranging in size from about 1 inch to 6 inches diameter, and even larger. Very deep holes can be drilled and blades are available for core drilling, counterboring, and for bottoming to a flat or contoured shape. There are two principal parts to a spade drill, the blade and the holder. The holder has a slot into which the blade fits; a wide slot at the back of the blade engages with a tongue in the holder slot to locate the blade accurately. A retaining screw holds the two parts together. The blade is usually made from high-speed steel, although cast nonferrous metal and cemented carbide-tipped blades are also available. Spade drill holders are classified by a letter symbol designating the range of blade sizes that can be held and by their length. Standard stub, short, long, and extra long holders are available; for very deep holes, special holders having wear strips to support and guide the drill are often used. Long, extra long, and many short length holders have coolant holes to direct cutting fluid, under pressure, to the cutting edges. In addition to its function in cooling and lubricating the tool, the cutting fluid also flushes the chips out of the hole. The shank of the holder may be straight or tapered; special automotive shanks are also used. A holder and different shank designs are shown in Fig. 1; Figs. 2a through Fig. 2f show some typical blades.

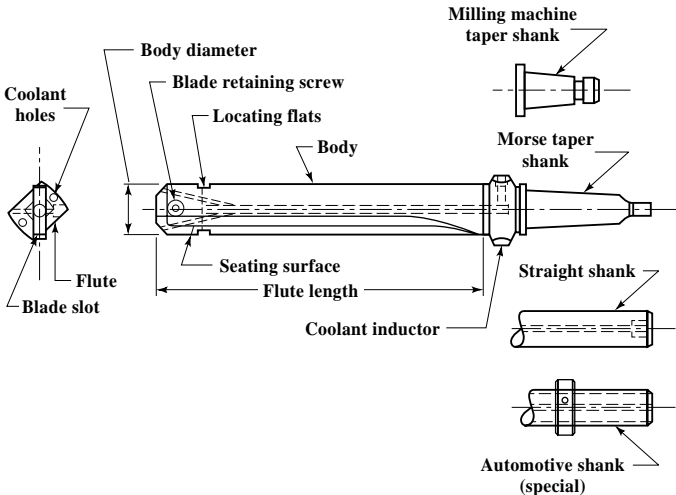


Fig. 1. Spade Drill Blade Holder

Spade Drill Geometry.—Metal separation from the work is accomplished in a like manner by both twist drills and spade drills, and the same mechanisms are involved for each. The two cutting lips separate the metal by a shearing action that is identical to that of chip formation by a single-point cutting tool. At the chisel edge, a much more complex condition exists. Here the metal is extruded sideways and at the same time is sheared by the rotation of the blunt wedge-formed chisel edge. This combination accounts for the very high thrust force required to penetrate the work. The chisel edge of a twist drill is slightly rounded, but on spade drills, it is a straight edge. Thus, it is likely that it is more difficult for the extruded metal to escape from the region of the chisel edge with spade drills. However, the chisel edge is shorter in length than on twist drills and the thrust for spade drilling is less.

Typical Spade Drill Blades

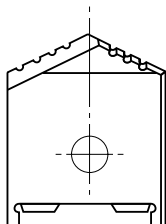


Fig. 2a. Standard blade

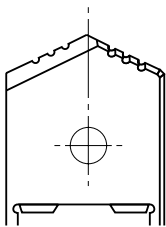


Fig. 2b. Standard blade with corner chamfer

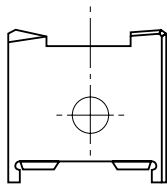


Fig. 2c. Core drilling blade

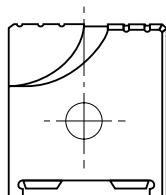


Fig. 2d. Center cutting facing or bottoming blade

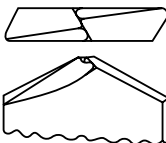


Fig. 2e. Standard blade with split point or crankshaft point

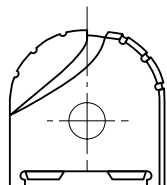


Fig. 2f. Center cutting radius blade

Basic spade drill geometry is shown in Fig. 3. Normally, the point angle of a standard tool is 130 degrees and the lip clearance angle is 18 degrees, resulting in a chisel edge angle of 108 degrees. The web thickness is usually about $\frac{1}{4}$ to $\frac{5}{16}$ as thick as the blade thickness. Usually, the cutting edge angle is selected to provide this web thickness and to provide the necessary strength along the entire length of the cutting lip. A further reduction of the chisel edge length is sometimes desirable to reduce the thrust force in drilling. This reduction can be accomplished by grinding a secondary rake surface at the center or by grinding a split point, or crankshaft point, on the point of the drill.

The larger point angle of a standard spade drill—130 degrees as compared with 118 degrees on a twist drill—causes the chips to flow more toward the periphery of the drill, thereby allowing the chips to enter the flutes of the holder more readily. The rake angle facilitates the formation of the chip along the cutting lips. For drilling materials of average hardness, the rake angle should be 10 to 12 degrees; for hard or tough steels, it should be 5 to 7 degrees; and for soft and ductile materials, it can be increased to 15 to 20 degrees. The rake surface may be flat or rounded, and the latter design is called radial rake. Radial rake is usually ground so that the rake angle is maximum at the periphery and decreases uniformly toward the center to provide greater cutting edge strength at the center. A flat rake surface is recommended for drilling hard and tough materials in order to reduce the tendency to chipping and to reduce heat damage.

A most important feature of the cutting edge is the chip splitters, which are also called chip breaker grooves. Functionally, these grooves are chip dividers; instead of forming a single wide chip along the entire length of the cutting edge, these grooves cause formation of several chips that can be readily disposed of through the flutes of the holder. Chip splitters must be carefully ground to prevent the chips from packing in the grooves, which greatly reduces their effectiveness. Splitters should be ground perpendicular to the cutting lip and parallel to the surface formed by the clearance angle. The grooves on the two cut-

ting lips must not overlap when measured radially along the cutting lip. Fig. 4 and the accompanying table show the groove form and dimensions.

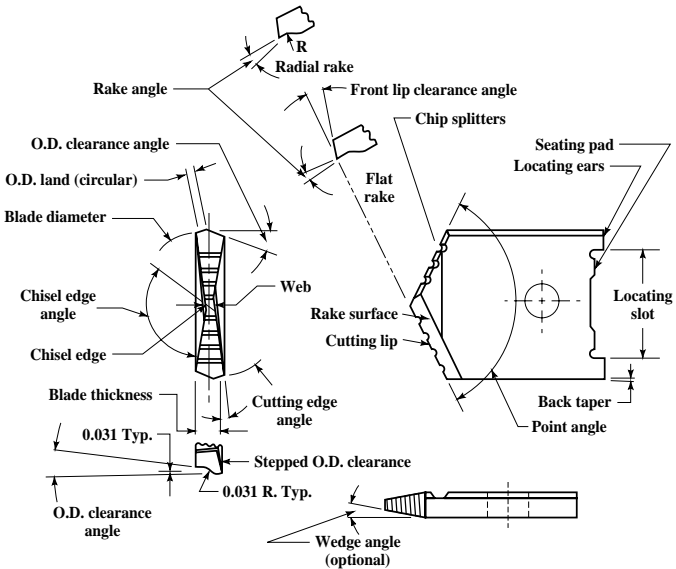


Fig. 3. Spade Drill Blade

On spade drills, the front lip clearance angle provides the relief. It may be ground on a drill grinding machine but usually it is ground flat. The normal front lip clearance angle is 8 degrees; in some instances, a secondary relief angle of about 14 degrees is ground below the primary clearance. The wedge angle on the blade is optional. It is generally ground on thicker blades having a larger diameter to prevent heel dragging below the cutting lip and to reduce the chisel edge length. The outside-diameter land is circular, serving to support and guide the blade in the hole. Usually it is ground to have a back taper of 0.001 to 0.002 inch per inch per side. The width of the land is approximately 20 to 25 per cent of the blade thickness. Normally, the outside-diameter clearance angle behind the land is 7 to 10 degrees. On many spade drill blades, the outside-diameter clearance surface is stepped about 0.030 inch below the land.

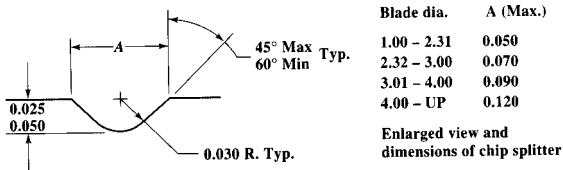


Fig. 4. Spade Drill Chip Splitter Dimensions

Spade Drilling.—Spade drills are used on drilling machines and other machine tools where the cutting tool rotates; they are also used on turning machines where the work

rotates and the tool is stationary. Although there are some slight operational differences, the methods of using spade drills are basically the same. An adequate supply of cutting fluid must be used, which serves to cool and lubricate the cutting edges; to cool the chips, thus making them brittle and more easily broken; and to flush chips out of the hole. Flood cooling from outside the hole can be used for drilling relatively shallow holes, of about one to two and one-half times the diameter in depth. For deeper holes, the cutting fluid should be injected through the holes in the drill. When drilling very deep holes, it is often helpful to blow compressed air through the drill in addition to the cutting fluid to facilitate ejection of the chips. Air at full shop pressure is throttled down to a pressure that provides the most efficient ejection. The cutting fluids used are light and medium cutting oils, water-soluble oils, and synthetics, and the type selected depends on the work material.

Starting a spade drill in the workpiece needs special attention. The straight chisel edge on the spade drill has a tendency to wander as it starts to enter the work, especially if the feed is too light. This wander can result in a mispositioned hole and possible breakage of the drill point. The best method of starting the hole is to use a stub or short-length spade drill holder and a blade of full size that should penetrate at least $\frac{1}{8}$ inch at full diameter. The holder is then changed for a longer one as required to complete the hole to depth. Difficulties can be encountered if spotting with a center drill or starting drill is employed because the angles on these drills do not match the 130-degree point angle of the spade drill. Longer spade drills can be started without this starting procedure if the drill is guided by a jig bushing and if the holder is provided with wear strips.

Chip formation warrants the most careful attention as success in spade drilling is dependent on producing short, well-broken chips that can be easily ejected from the hole. Straight, stringy chips or chips that are wound like a clock spring cannot be ejected properly; they tend to pack around the blade, which may result in blade failure. The chip splitters must be functioning to produce a series of narrow chips along each cutting edge. Each chip must be broken, and for drilling ductile materials they should be formed into a "C" or "figure 9" shape. Such chips will readily enter the flutes on the holder and flow out of the hole.

Proper chip formation is dependent on the work material, the spade drill geometry, and the cutting conditions. Brittle materials such as gray cast iron seldom pose a problem because they produce a discontinuous chip, but austenitic stainless steels and very soft and ductile materials require much attention to obtain satisfactory chip control. Thinning the web or grinding a split point on the blade will sometimes be helpful in obtaining better chip control, as these modifications allow use of a heavier feed. Reducing the rake angle to obtain a tighter curl on the chip and grinding a corner chamfer on the tool will sometimes help to produce more manageable chips.

In most instances, it is not necessary to experiment with the spade drill blade geometry to obtain satisfactory chip control. Control usually can be accomplished by adjusting the cutting conditions; i.e., the cutting speed and the feed rate.

Normally, the cutting speed for spade drilling should be 10 to 15 per cent lower than that for an equivalent twist drill, although the same speed can be used if a lower tool life is acceptable. The recommended cutting speeds for twist drills on Tables 17 through 23, starting on page 1030, can be used as a starting point; however, they should be decreased by the percentage just given. It is essential to use a heavy feed rate when spade drilling to produce a thick chip, and to force the chisel edge into the work. In ductile materials, a light feed will produce a thin chip that is very difficult to break. The thick chip on the other hand, which often contains many rupture planes, will curl and break readily. Table 1 gives suggested feed rates for different spade drill sizes and materials. These rates should be used as a starting point and some adjustments may be necessary as experience is gained.

Table 1. Feed Rates for Spade Drilling

Material	Hardness, Bhn	Feed—Inches per Revolution					
		Spade Drill Diameter—Inches					
		1-1¼	1¼-2	2-3	3-4	4-5	5-8
Free Machining Steel	100-240	0.014	0.016	0.018	0.022	0.025	0.030
	240-325	0.010	0.014	0.016	0.020	0.022	0.025
	100-225	0.012	0.015	0.018	0.022	0.025	0.030
Plain Carbon Steels	225-275	0.010	0.013	0.015	0.018	0.020	0.025
	275-325	0.008	0.010	0.013	0.015	0.018	0.020
	150-250	0.014	0.016	0.018	0.022	0.025	0.030
Free Machining Alloy Steels	250-325	0.012	0.014	0.016	0.018	0.020	0.025
	325-375	0.010	0.010	0.014	0.016	0.018	0.020
	125-180	0.012	0.015	0.018	0.022	0.025	0.030
Alloy Steels	180-225	0.010	0.012	0.016	0.018	0.022	0.025
	225-325	0.009	0.010	0.013	0.015	0.018	0.020
	325-400	0.006	0.008	0.010	0.012	0.014	0.016
Tool Steels							
Water Hardening	150-250	0.012	0.014	0.016	0.018	0.020	0.022
Shock Resisting	175-225	0.012	0.014	0.015	0.016	0.017	0.018
Cold Work	200-250	0.007	0.008	0.009	0.010	0.011	0.012
Hot Work	150-250	0.012	0.013	0.015	0.016	0.018	0.020
Mold	150-200	0.010	0.012	0.014	0.016	0.018	0.018
Special-Purpose	150-225	0.010	0.012	0.014	0.016	0.016	0.018
High-Speed							
	200-240	0.010	0.012	0.013	0.015	0.017	0.018
	110-160	0.020	0.022	0.026	0.028	0.030	0.034
Gray Cast Iron	160-190	0.015	0.018	0.020	0.024	0.026	0.028
	190-240	0.012	0.014	0.016	0.018	0.020	0.022
	240-320	0.010	0.012	0.016	0.018	0.018	0.018
Ductile or Nodular Iron	140-190	0.014	0.016	0.018	0.020	0.022	0.024
	190-250	0.012	0.014	0.016	0.018	0.018	0.020
	250-300	0.010	0.012	0.016	0.018	0.018	0.018
Malleable Iron							
Ferritic	110-160	0.014	0.016	0.018	0.020	0.022	0.024
Pearlitic	160-220	0.012	0.014	0.016	0.018	0.020	0.020
220-280	0.010	0.012	0.014	0.016	0.018	0.018	
Free Machining Stainless Steel							
Ferritic	...	0.016	0.018	0.020	0.024	0.026	0.028
Austenitic	...	0.016	0.018	0.020	0.022	0.024	0.026
Martensitic	...	0.012	0.014	0.016	0.016	0.018	0.020
Stainless Steel							
Ferritic	...	0.012	0.014	0.018	0.020	0.020	0.022
Austenitic	...	0.012	0.014	0.016	0.018	0.020	0.020
Martensitic	...	0.010	0.012	0.012	0.014	0.016	0.018
Aluminum Alloys	...	0.020	0.022	0.024	0.028	0.030	0.040
Copper Alloys	(Soft)	0.016	0.018	0.020	0.026	0.028	0.030
	(Hard)	0.010	0.012	0.014	0.016	0.018	0.018
Titanium Alloys	...	0.008	0.010	0.012	0.014	0.014	0.016
High-Temperature Alloys	...	0.008	0.010	0.012	0.012	0.014	0.014

Power Consumption and Thrust for Spade Drilling.—In each individual setup, there are factors and conditions influencing power consumption that cannot be accounted for in a simple equation; however, those given below will enable the user to estimate power consumption and thrust accurately enough for most practical purposes. They are based on experimentally derived values of unit horsepower, as given in Table 2. As a word of caution, these values are for sharp tools. In spade drilling, it is reasonable to estimate that a dull tool will increase the power consumption and the thrust by 25 to 50 per cent. The unit horsepower values in the table are for the power consumed at the cutting edge, to which must be added the power required to drive the machine tool itself, in order to obtain the horsepower required by the machine tool motor. An allowance for power to drive the machine is provided by dividing the horsepower at the cutter by a mechanical efficiency factor, e_m . This factor can be estimated to be 0.90 for a direct spindle drive with a belt, 0.75 for a back gear drive, and 0.70 to 0.80 for geared head drives. Thus, for spade drilling the formulas are

$$hp_c = uhp \left(\frac{\pi D^2}{4} \right) f N$$

$$B_s = 148,500 uhp f D$$

$$hp_m = \frac{hp_c}{e_m}$$

$$f = \frac{f_m}{N}$$

where hp_c = horsepower at the cutter

hp_m = horsepower at the motor

B_s = thrust for spade drilling in pounds

uhp = unit horsepower

D = drill diameter in inches

f = feed in inches per revolution

f_m = feed in inches per minute

N = spindle speed in revolutions per minute

e_m = mechanical efficiency factor

Table 2. Unit Horsepower for Spade Drilling

Material	Hardness	uhp	Material	Hardness	uhp
Plain Carbon and Alloy Steel	85–200 Bhn	0.79	Titanium Alloys	250–375 Bhn	0.72
	200–275	0.94	High-Temp Alloys	200–360 Bhn	1.44
	275–375	1.00	Aluminum Alloys	...	0.22
	375–425	1.15	Magnesium Alloys	...	0.16
Cast Irons	45–52 Rc	1.44	Copper Alloys	20–80 Rb	0.43
	110–200 Bhn	0.5		80–100 Rb	0.72
	200–300	1.08			
Stainless Steels	135–275 Bhn	0.94			
	30–45 Rc	1.08			

Example: Estimate the horsepower and thrust required to drive a 2-inch diameter spade drill in AISI 1045 steel that is quenched and tempered to a hardness of 275 Bhn. From Table 17 on page 1030, the cutting speed, V , for drilling this material with a twist drill is 50 feet per minute. This value is reduced by 10 per cent for spade drilling and the speed selected is thus $0.9 \times 50 = 45$ feet per minute. The feed rate (from Table 1, page 869) is 0.015 in/rev. and the unit horsepower from Table 2 above is 0.94. The machine efficiency factor is estimated to be 0.80 and it will be assumed that a 50 per cent increase in the unit horsepower must be allowed for dull tools.

Step 1. Calculate the spindle speed from the following formula:

$$N = \frac{12V}{\pi D}$$

where: N = spindle speed in revolutions per minute

V = cutting speed in feet per minute

D = drill diameter in inches

$$\text{Thus: } N = \frac{12 \times 45}{\pi \times 2} = 86 \text{ revolutions per minute}$$

Step 2. Calculate the horsepower at the cutter:

$$\text{hp}_c = \text{uhp} \left(\frac{\pi D^2}{4} \right) f N = 0.94 \left(\frac{\pi \times 2^2}{4} \right) 0.015 \times 86 = 3.8$$

Step 3. Calculate the horsepower at the motor and provide for a 50 per cent power increase for the dull tool:

$$\text{hp}_m = \frac{\text{hp}_c}{e_m} = \frac{3.8}{0.80} = 4.75 \text{ horsepower}$$

$$\text{hp}_m \text{ (with dull tool)} = 1.5 \times 4.75 = 7.125 \text{ horsepower}$$

Step 4. Estimate the spade drill thrust:

$$B_s = 148,500 \times \text{uhp} \times f D = 148,500 \times 0.94 \times 0.015 \times 2$$

$$= 4188 \text{ lb (for sharp tool)}$$

$$B_s = 1.5 \times 4188$$

$$= 6282 \text{ lb (for dull tool)}$$

Trepanning.—Cutting a groove in the form of a circle or boring or cutting a hole by removing the center or core in one piece is called trepanning. Shallow trepanning, also called face grooving, can be performed on a lathe using a single-point tool that is similar to a grooving tool but has a curved blade. Generally, the minimum outside diameter that can be cut by this method is about 3 inches and the maximum groove depth is about 2 inches. Trepanning is probably the most economical method of producing deep holes that are 2 inches, and larger, in diameter. Fast production rates can be achieved. The tool consists of a hollow bar, or stem, and a hollow cylindrical head to which a carbide or high-speed steel, single-point cutting tool is attached. Usually, only one cutting tool is used although for some applications a multiple cutter head must be used; e.g., heads used to start the hole have multiple tools. In operation, the cutting tool produces a circular groove and a residue core that enters the hollow stem after passing through the head. On outside-diameter exhaust trepanning tools, the cutting fluid is applied through the stem and the chips are flushed around the outside of the tool; inside-diameter exhaust tools flush the chips out through the stem with the cutting fluid applied from the outside. For starting the cut, a tool that cuts a starting groove in the work must be used, or the trepanning tool must be guided by a bushing. For holes less than about five diameters deep, a machine that rotates the trepanning tool can be used. Often, an ordinary drill press is satisfactory; deeper holes should be machined on a lathe with the work rotating. A hole diameter tolerance of ± 0.010 inch can be obtained easily by trepanning and a tolerance of ± 0.001 inch has sometimes been held. Hole runout can be held to ± 0.003 inch per foot and, at times, to ± 0.001 inch per foot. On heat-treated metal, a surface finish of 125 to 150 μm AA can be obtained and on annealed metals 100 to 250 μm AA is common.