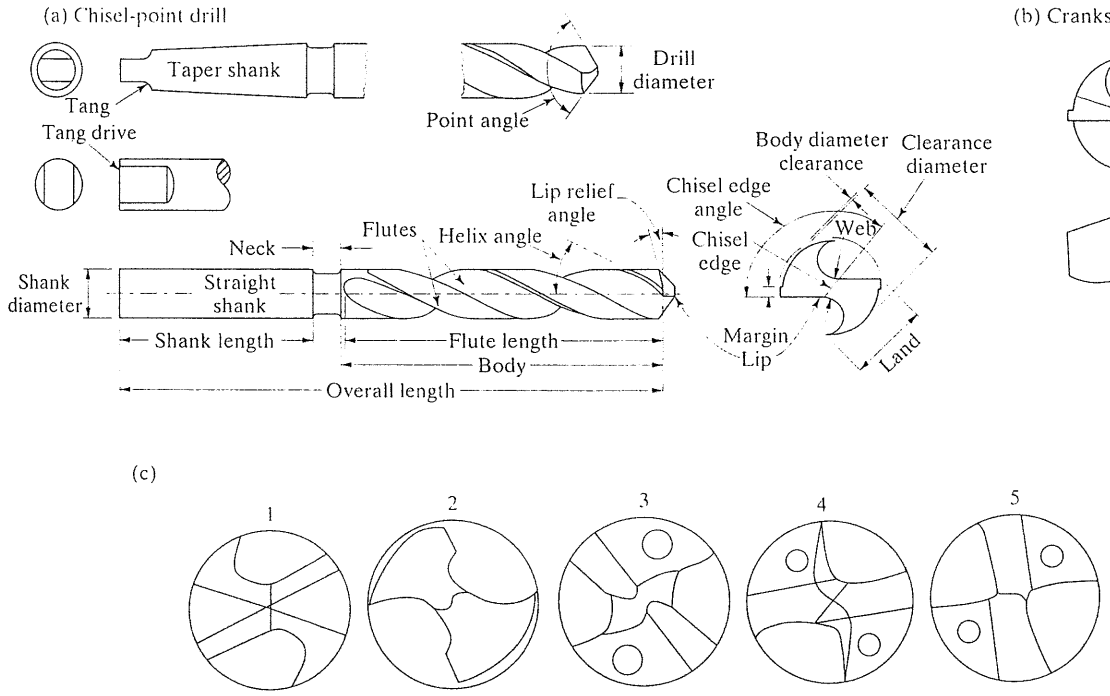

FIGURE 22.23 (a) Standard chisel-point drill indicating various features. The function of the pair of margins is to provide a bearing surface for the drill against walls of the hole as it penetrates into the workpiece; drills with four margins (**double-margin**) are available for improved drill guidance and accuracy. Drills with chip-breaker features are also available. (b) Crankshaft-point drill. (c) Various drill points and their manufacturers: 1. Four-facet split point, by Komet of America. 2. SE point, by Hertel. 3. New point, by Mitsubishi Materials. 4. Hosoi point, by OSG Tap and Die. 5. Helical point.

Drills are available with a **chip-breaker** feature ground along the cutting edges. This feature is important in drilling with automated machinery where disposal of long chips without operator assistance is necessary.

General drill geometry recommendations for various workpiece materials are given in Table 22.10. These angles are based on experience in drilling operations and are designed to produce accurate holes, minimize drilling forces and torque, and optimize drill life.

Drill Point Geometries. Small changes in drill geometry can have a significant effect on the drill's performance, particularly in the chisel-edge region, which accounts for about 50% of the thrust force in drilling. For example, too small a lip relief angle (Fig. 22.23a) increases the thrust force, generates excessive heat, and increases wear. Conversely, too large an angle can cause chipping or breaking of the cutting edge. Consequently, in addition to conventional point drills, several other drill-point geometries have been developed to improve drill performance and increase the penetration rate (Fig. 22.23c). Special grinding techniques and equipment are used to produce these geometries.

Other Types of Drills. Several types of drills are shown in Figs. 22.24. A *step drill* produces holes of two or more different diameters. A *core drill* is used to make an existing hole larger. *Counterboring* and *countersinking drills* produce depressions on the surface to

TABLE 22.10 General Recommendations for Drill Geometry for High-Speed Twist Drills

Workpiece material	Point angle	Lip-relief angle	Chisel-edge angle	Helix angle	Point
Aluminum alloys	90–118	12–15	125–135	24–48	Standard
Magnesium alloys	70–118	12–15	120–135	30–45	Standard
Copper alloys	118	12–15	125–135	10–30	Standard
Steels	118	10–15	125–135	24–32	Standard
High-strength steels	118–135	7–10	125–135	24–32	Crankshaft
Stainless steels, low strength	118	10–12	125–135	24–32	Standard
Stainless steels, high strength	118–135	7–10	120–130	24–32	Crankshaft
High-temp. alloys	118–135	9–12	125–135	15–30	Crankshaft
Refractory alloys	118	7–10	125–135	24–32	Standard
Titanium alloys	118–135	7–10	125–135	15–32	Crankshaft
Cast irons	118	8–12	125–135	24–32	Standard
Plastics	60–90	7	120–135	29	Standard

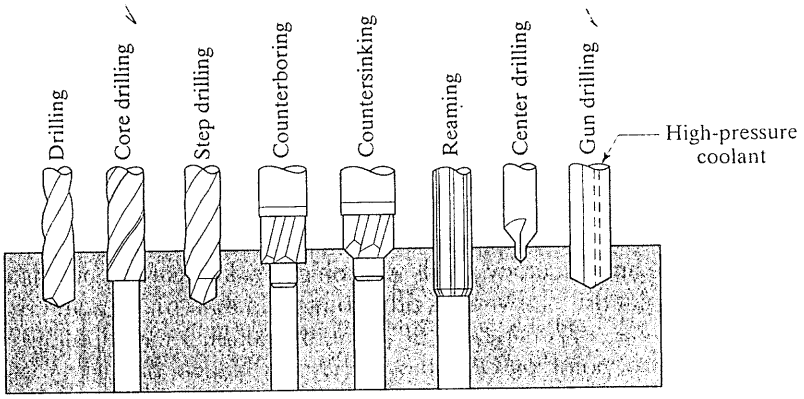

FIGURE 22.24 Various types of drilling and reaming operations.

accommodate the heads of screws and bolts. A *center drill* is short and is used to produce the hole at the end of a piece of stock so that it may be mounted between centers in a lathe (between the headstock and the tailstock, Fig. 22.2). A *spot drill* is used to spot (to start) a hole at the desired location on a surface.

Spade drills have removable tips or bits and are used to produce large and deep holes. They have the advantages of higher stiffness (because of the absence of flutes in the body of the drill), ease of grinding the cutting edges, and lower cost. *Crankshaft drills* (Fig. 22.23b) have good centering ability, and because chips tend to break up easily, these drills are suitable for producing deep holes.

Gun Drilling. Developed originally for drilling gun barrels, *gun drilling* is used for drilling deep holes and requires a special drill (Figs. 22.22e and 22.25a). The depth-to-diameter ratios of holes produced can be 300 : 1 or even higher. The thrust force (the radial force that tends to push the drill sideways) is balanced by bearing pads on the drill that slide along the inside surface of the hole (Fig. 22.25a). Therefore, a gun drill is self-centering, an important feature when drilling straight, deep holes.

Cutting speeds in gun drilling are usually high and feeds are low. The cutting fluid is forced under high pressure through a longitudinal hole in the body of the drill (Fig. 22.25b).

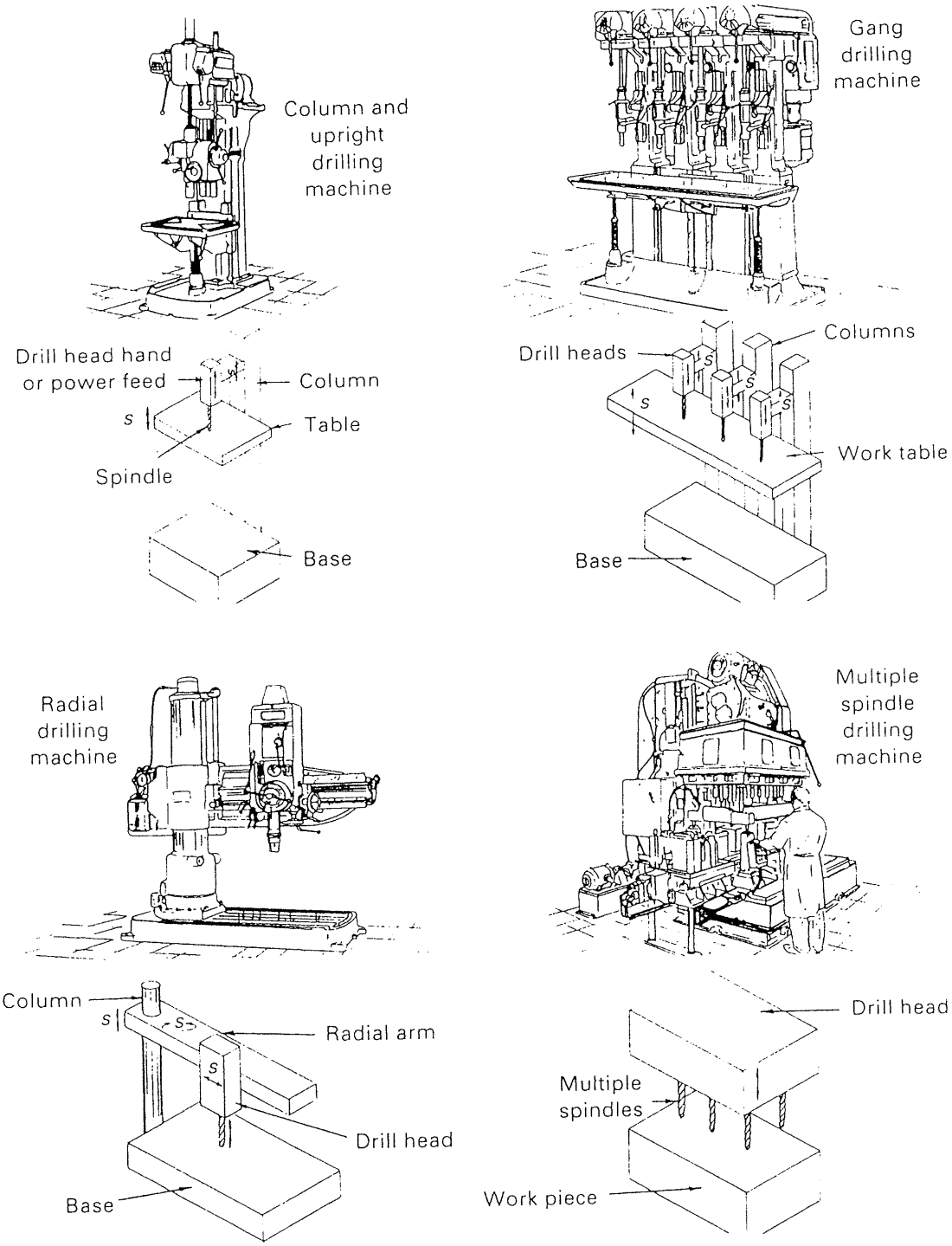

FIGURE 24-17 Four principal types of drilling machines. *(From Manufacturing Producibility Handbook, courtesy of General Electric Company.)*

CLEVELAND TWIST DRILL
P.O. Box 91839 • Cleveland, Ohio 44101
Customer Service: (216) 431-5050

MACHINE SCREW AND FRACTIONAL

TAP DRILL SIZES

AND PERCENTAGE OF THREADS

FORMULA FOR OBTAINING TAP DRILL SIZES

$$\text{Outside Diam. of Thread} - \frac{.01299 \times \text{Amt. of Percentage of Full Thread}}{\text{No. of Threads per inch}} = \text{Drilled Hole Size}$$

Note: Select nearest commercial stock drill

PERCENTAGE OF FULL THREAD FOR OTHER DRILL SIZES

$$\text{No. of Threads per Inch} \times \left(\frac{\text{Outside Diam. of Thread} - \text{Selected Drill Diam.}}{.01299} \right) = \text{Percentage of Full Thread}$$

TAP NOM. SIZE	TAP T.P.I.	TAP DRILL	DECIM. EQUIV.	THEOR. % OF THREAD	TAP NOM. SIZE	TAP T.P.I.	TAP DRILL	DECIM. EQUIV.	THEOR. % OF THREAD	TAP NOM. SIZE	TAP T.P.I.	TAP DRILL	DECIM EQUIV	THEOR % OF THREAD
0	80	56	.0465	83	1/4	28	7/32	.2188	67	7/8	12	51/64	.7969	72
		3/64	.0469	81			2	.2210	63	7/8	14	51/64	.7969	84
1	64	54	.0550	89	1/4	32	7/32	.2188	77			13/16	.8125	67
		53	.0595	67	5/16	18	F	.2570	77	7/8	16	13/16	.8125	77
1	72	53	.0595	75			G	.2610	71	7/8	20	53/64	.8281	72
		1/16	.0625	58			17/64	.2656	65	15/16	12	55/64	.8594	72
2	56	51	.0670	82	5/16	20	17/64	.2656	72	15/16	16	7/8	.8750	77
		50	.0700	69	5/16	24	I	.2720	75	15/16	20	57/64	.8906	72
		49	.0730	56			J	.2770	66	1	8	7/8	.8750	77
2	64	50	.0700	79	5/16	32	9/32	.2812	77			57/64	.8906	67
		49	.0730	64	3/8	16	5/16	.3125	77	1	12	59/64	.9219	72
3	48	5/64	.0781	77			O	.3160	73			15/16	.9375	58
		47	.0785	76			P	.3230	64	1	14	59/64	.9219	84
		46	.0810	67	3/8	20	21/64	.3281	72			15/16	.9375	67
3	56	46	.0810	78	3/8	24	Q	.3320	79	1	16	15/16	.9375	77
		45	.0820	73			R	.3390	67	1	20	61/64	.9531	72
		44	.0860	56	3/8	32	11/32	.3438	77	1-1/8	7	63/64	.9844	76
4	40	43	.0890	71	7/16	14	U	.3680	75			1	1.0000	67
		42	.0935	57			3/8	.3750	67	1-1/8	12	1-1/32	1.0312	87
4	48	42	.0935	68			V	.3770	65			1-3/64	1.0469	72
		3/32	.0938	68	7/16	20	W	.3860	79	1-1/8	16	1-1/16	1.0625	77
5	40	39	.0995	79			25/64	.3906	72	1-1/8	18	1-1/16	1.0625	87
		38	.1015	72	7/16	24	X	.3970	75	1-1/4	7	1-3/32	1.0938	84
5	44	38	.1015	79	7/16	28	Y	.4040	72			1-7/64	1.1094	76
		37	.1040	71	1/2	13	27/64	.4219	78			1-1/8	1.1250	67
6	32	36	.1065	78			7/16	.4375	63	1-1/4	12	1-5/32	1.1562	87
		7/64	.1094	70	1/2	20	29/64	.4531	72			1-11/64	1.1719	72
		35	.1100	69	1/2	24	29/64	.4531	87					
6	40	33	.1130	77	1/2	28	15/32	.4688	67	1-1/4	16	1-3/16	1.1875	77
		32	.1160	68	9/16	12	15/32	.4688	87	1-1/4	18	1-3/16	1.1875	87
8	32	29	.1360	69			31/64	.4844	72	1-3/8	6	1-3/16	1.1875	87
		28	.1405	58	9/16	18	1/2	.5000	87			1-13/64	1.2031	79
8	36	29	.1360	78			33/64	.5156	65			1-7/32	1.2188	72
		28	.1405	68	9/16	24	33/64	.5156	87			1-15/64	1.2344	65
		9/64	.1406	68	5/8	11	17/32	.5312	79	1-3/8	12	1-9/32	1.2812	87
10	24	25	.1495	75			35/64	.5469	66			1-19/64	1.2969	72
		24	.1520	70	5/8	12	35/64	.5469	72	1-3/8	16	1-5/16	1.3125	77
		23	.1540	67	5/8	18	9/16	.5625	87	1-3/8	18	1-5/16	1.3125	87
10	32	22	.1570	81			37/64	.5781	65	1-1/2	6	1-5/16	1.3125	87
		21	.1590	76	5/8	24	37/64	.5781	87			1 21/64	1.3281	79
		20	.1610	71	11/16	12	39/64	.6094	72			1 11/32	1.3438	72
12	24	17	.1730	79	11/16	24	41/64	.6406	87			1-23/64	1.3594	65
		16	.1770	72	3/4	10	41/64	.6406	84	1-1/2	12	1-13/32	1.4062	87
		15	.1800	67			21/32	.6562	72			1-27/64	1.4219	72
12	28	15	.1800	78	3/4	12	43/64	.6719	72	1-1/2	16	1-7/16	1.4375	77
		14	.1820	73	3/4	16	11/16	.6875	77	1-1/2	18	1-7/16	1.4375	87
		13	.1850	67	3/4	20	45/64	.7031	72	1-3/4	16	1 11/16	1.6875	77
1/4	20	7	.2010	75	13/16	12	47/64	.7344	72	2	16	1-15/16	1.9375	77
		13/64	.2031	72	13/16	16	3/4	.7500	77	2 1/4	16	2-3/16	2 1875	77
		6	.2040	71	13/16	20	49/64	.7656	72	2-1/2	16	2-7/16	2.4375	77
		5	.2055	69	7/8	9	49/64	.7656	76	2-3/4	16	2-11/16	2 6875	77
1/4	24	4	.2090	76			25/32	.7812	65	3	16	2-15/16	2.9375	77