CHAPTER 4

HARDWARE

The installation of electronic equipments necessitates the use of a great many different kinds and types of hardware items to include screws, nuts, bolts, fasteners, pins, clamps, etc. There is a wide variety of hardware items to meet every requirement of size, shape, strength, and material and this paragraph presents a representative sampling of those items frequently encountered in installation work. Commercial catalogs are available from most sources listed and activities should obtain them to assist in the selection of the correct hardware items to meet particular needs. It is recommended that within budgetary constraints, the guidelines in Handbook H-28 be followed in the selection of screw threads on installation hardware. (Note that MIL-STD-454 requires that threaded fasteners and related parts with tapped holes conform with either H-28 or MIL-S-7742 requirements.)

4.1 SCREWS AND BOLTS

Representative types of common screws and bolts are shown in figures 4-1 and 4-2. Information on types and manufacturers of set screws is presented in figure 4-3. Table 4-1 gives the head dimensions for a group of common machine screws, Table 4-2 lists the standard threads per inch for national fine and national coarse threads and Table 4-3 shows the available lengths in brass machine screw and bolt lengths.

4.2 THREADED STUDS

Types of threaded studs used to anchor or mount equipment are illustrated in figure 4-4. The installation of studs requires special knowledge and tools and would not ordinarily be performed in the field. The installer should have a knowledge of the various types of studs available and installation techniques in the event it becomes necessary to replace one.

4.3 NUTS, CLINCH NUTS, AND INSERTS

Extreme care must be taken in selecting the correct type and size nut from the great variety available to fasten equipment. Premature equipment failure and hazardous operations may result from the use of improper fastening methods and hardware. Figures 4-5 and 4-6 illustrate a variety of nuts and clinch nuts. Inserts are used to change the threaded diameter of a hole or to provide strong screw threads in soft material or sheet metal. They can be installed with standard shop tools in holes punched or drilled to normal tolerances. Figure 4-7 depicts several different types of inserts.

4.4 PINS

Figure 4-8 illustrates a variety of pins which are commonly used for installation work, together with information on hole and pin sizes and shear strength. When replacing pins the installer must be careful not to exceed the prescribed shear strength as the pin may also function as a safety device.

4.5 RIVETS

A representative group of various types of rivets used in the installation of electronic equipment is illustrated in figure 4-9.

4.6 FASTENERS

Fasteners come in a great variety of types, sizes, and materials. Fasteners provide a handy means of attaching panels and removable access doors and prevent their loosening under stress or vibration. Since each type has special features, care must be taken in the selection of a particular one so that maximum utilization is obtained. Figure 4-10 illustrates some of the many types in common use.

4.7 WASHERS AND RETAINING RINGS

Washers serve to provide a proper seating of the screw head and to keep the screw head from scarring the panel surfaces. Figure 4-11 illustrates four common type washers and the dimensions for various sizes. Retaining rings are used where a loose fitting pin must be kept from falling out of the hole or where it is necessary to keep a device on its mounting shaft. See figure 4-12.

4.8 THICKNESS GAUGES

Several systems are used to denote the standard thicknesses for wire and sheet metal. Table 4-4 provides a cross reference between these systems.

4.9 DRILL AND TAP SIZES

Tables 4-5, 4-6, and 4-7 list the drill and tap sizes to be used when holes must be drilled and tapped for standard machine screws, pipe, and bolts, respectively. The dimensions for hexagonal nuts are provided in Table 4-8.

4.10 DECIMAL EQUIVALENTS

Table 4-9 presents a cross reference between fractional inches, millimeters, wire gages and letter size drills, and decimal inches. This cross reference is especially useful when comparing sizes of drill bits. Some assortments of drill bits use the traditional inch system of numbering (1/64-inch steps between drills) while other assortments use the wire gage system (80, 79, 78, etc.).

Table 4-1. Machine Screw Head-Dimensions

HEAD DIMENSIONS OF MACHINE SCREWS (INCHES)														
	#0 (.060)		#2 (.086)		#4 (.112)		#6 (.138)		#8 (.164)		#10 (.190)		1/4" (.250)	
	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.
Round	.113	.053	.162	.069	.211	.086	.260	.103	.309	.120	.359	.137	.472	.175
Flat (82°)	.119	.035	.172	.051	.225	.067	.279	.083	.332	.100	.385	.116	.507	.153
Flat (100°)	----	----	----	----	.225	.048	.279	.060	.332	.072	.385	.083	.507	.110
Oval	.119	.056	.172	.080	.225	.104	.279	.128	.332	.152	.385	.176	.507	.232
Fillister	.096	.059	.140	.083	.183	.107	.226	.132	.270	.156	.313	.180	.414	.237
Truss	----	----	.194	.053	.257	.069	.321	.086	.384	.102	.448	.118	.573	.150
Binding	----	----	.181	.046	.235	.063	.290	.080	.344	.097	.399	.118	.513	.153
Pan	----	----	.167	.053	.219	.068	.270	.082	.322	.096	.373	.110	.492	.144
Cross Recessed	----	----	.167	.062	.219	.080	.270	.097	.322	.115	.373	.133	.492	.175
Hex	----	----	.145	.050	.217	.060	.287	.080	.287	.110	.361	.120	.433	.190
*In the case of the Hex Head machine screw the head diameter is actually the across-corners dimension.														

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Table 4-2 Screw Threads per Inch National Fine and Coarse

NO. OR FRACTIONAL SIZE	THREADS PER INCH		NO. OR FRACTIONAL SIZE	THREADS PER INCH	
	FINE	COARSE		FINE	COARSE
0(0.080)	80	--	9/16	18	12
1(0.073)	72	64	5/8	18	11
2(0.086)	64	56	3/4	16	10
3(0.099)	56	48	7/8	14	9
4(0.112)	48	40	1	14	8
5(0.125)	44	40	1-1/8	12	7
6(0.138)	40	32	1-1/4	12	7
8(0.164)	36	32	1-1/2	12	6
10(0.190)	32	24	1-3/4	12	5
12(0.216)	28	24	2	12	4-1/2
1/4	28	20	2-1/4	12	4-1/2
5/16	24	18	2-1/2	12	4
3/8	24	16	2-3/4	12	4
7/16	20	14	3	10	4
1/2	20	13			

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Table 4-3. Brass Machine Screws and Bolt Lengths

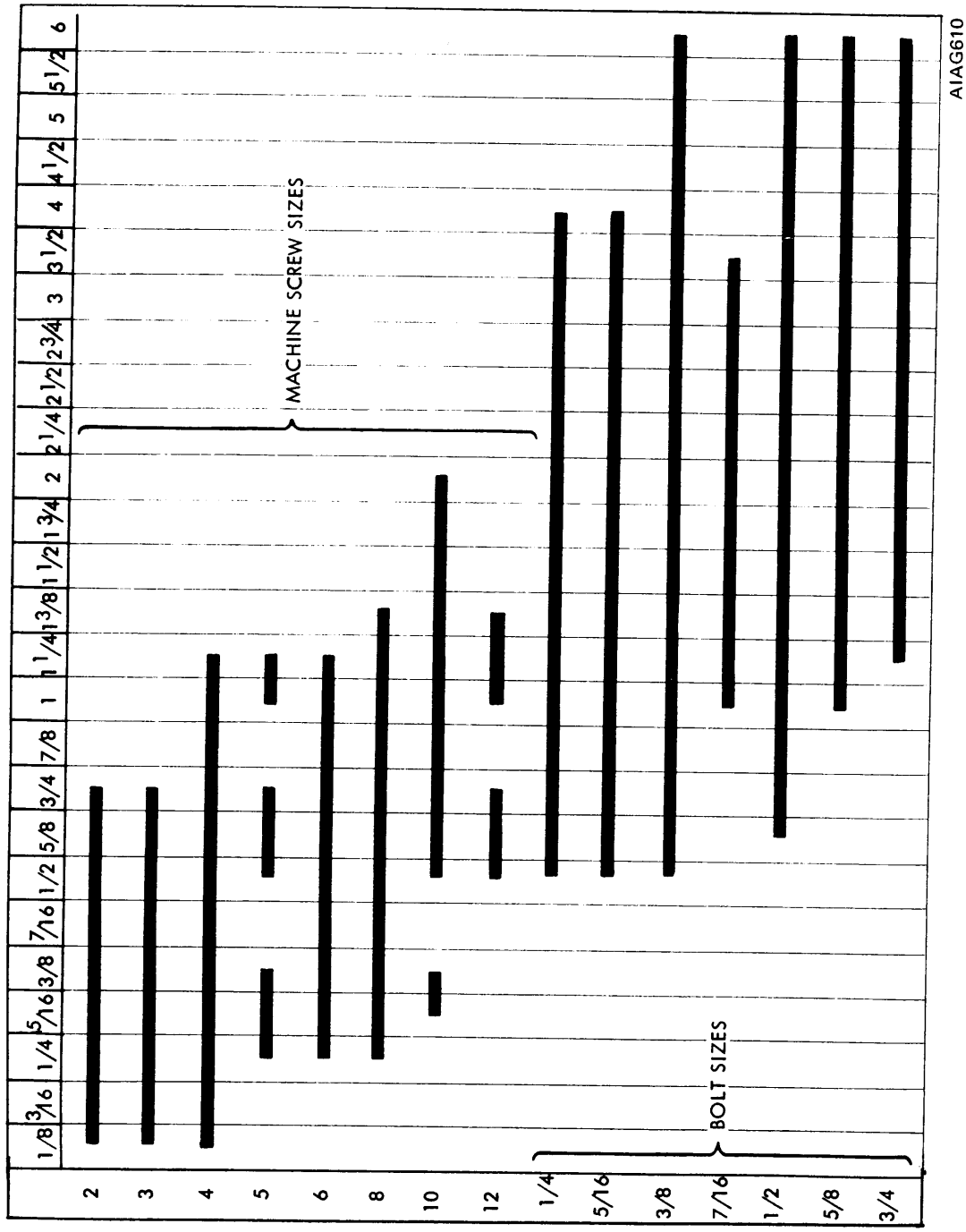

Table 4-4. Standard Wire and Sheet Metal Gages

GAGE NO.	AMERICAN OR B & S (NOTE 1)	U.S. STANDARD (NOTE 2)	BIRMINGHAM OR STUBS (NOTE 3)
1	.2893	.28125	.300
2	.2576	.265625	.284
3	.2294	.25	.259
4	.2043	.234375	.238
5	.1819	.21875	.220
6	.1620	.203125	.203
7	.1443	.1875	.180
8	.1285	.171875	.165
9	.1144	.15625	.148
10	.1019	.140625	.134
11	.09074	.125	.120
12	.08081	.109375	.109
13	.07196	.09375	.095
14	.06408	.078125	.083
15	.05707	.0703125	.072
16	.05082	.0625	.065
17	.04526	.05625	.058
18	.04030	.05	.049
19	.03589	.04375	.042
20	.03196	.0375	.035
21	.02846	.034375	.032
22	.02535	.03125	.028
23	.02257	.028125	.025
24	.02010	.025	.022
25	.01790	.021875	.020
26	.01594	.01875	.018
27	.01420	.0171875	.016
28	.01264	.015625	.014
29	.01126	.0140625	.013
30	.01003	.0125	.012
31	.008928	.0109375	.010
32	.007950	.01015626	.009
33	.007080	.009375	.008
34	.006350	.00859375	.007
35	.005615	.0078125	.005
36	.005000	.00703125	.004
37	.004453	.006640626	----
38	.003965	.00625	----
39	.003531	----------	----
40	.003145	----------	----

NOTE 1: Used for aluminum, copper, brass, and nonferrous alloy sheets, wire, and rods.

NOTE 2: Used for iron, steel, nickel, and ferrous alloy sheets, wire, and rods.

NOTE 3: Used for seamless tubes; also by some manufacturers for copper and brass.

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Table 4-5. Tap Drill Sizes - Machine Screws

SIZE	THREADS/IN	SERIES	TAP DRILL	CLEARANCE DRILL
0	80	NF	No. 56	No. 52
1	64	NC	No. 53	No. 48
	72	NF	No. 53	No. 48
2	56	NC	No. 50	No. 43
	64	NF	No. 50	No. 43
3	48	NC	No. 47	No. 38
	56	NF	No. 45	No. 38
4	40	NC	No. 43	No. 32
	48	NF	No. 42	No. 32
5	40	NC	No. 38	No. 30
	44	NF	No. 37	No. 30
6	32	NC	No. 36	No. 27
	40	NF	No. 33	No. 27
8	32	NC	No. 29	No. 18
	36	NF	No. 29	No. 18
10	24	NC	No. 25	No. 9
	32	NF	No. 21	No. 9

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Table 4-6. Tap Drill Sizes - Pipe

SIZE (NORMAL)	OD (ACTUAL)	THREADS PER INCH	TAP DRILL	CLEARANCE DRILL
1/8	.405	27	11/32	7/16
1/4	.540	18	7/16	9/16
3/8	.675	18	37/64	3/4
1/2	.84	14	23/32	7/8
3/4	1.05	14	59/64	13/16
1	1.315	11-1/2	15/32	17/16
1-1/4	1.66	11-1/2	1-1/2	1-3/4
1-1/2	1.9	11-1/2	1-87/64	2
2	2.375	11-1/2	2-7/32	2-1/2
2-1/2	2.875	8	2-5/8	3
3	3.5	8	3-1/4	3-3/4
3-1/2	4.0	8	3-3/4	4-1/4
4	4.5	8	4-1/4	4-3/4

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Table 4-7. Tap Drill Sizes - Bolts

SIZE	THREAD/IN	SERIES	TAP DRILL	CLEARANCE DRILL
1/4	20	NC	No. 7	17/64
	28	NF	No. 3	17/64
5/16	18	NC	No. F	21/64
	24	NF	No. I	21/64
3/8	16	NC	5/16	25/64
	24	NF	No. Q	25/64
7/16	14	NC	No. V	29/64
	20	NF	25/64	29/64
1/2	13	NC	27/64	17/32
	20	NF	29/64	17/32
9/16	12	NC	31/64	19/32
	18	NF	33/64	19/32
5/8	11	NC	17/32	21/32
	18	NF	37/64	21/32
3/4	10	NC	21/32	25/32
	16	NF	11/16	25/32
7/8	9	NC	49/64	29/32
	14	NF	13/16	29/32

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Table 4-8. Hexagonal Nuts - Dimensions

THREAD SIZE	WIDTH ACROSS FLATS	HEIGHT STANDARD	THREAD SIZE	WIDTH ACROSS FLATS	HEIGHT STANDARD
0	5/32	3/64	5/16	1/2	17/64
1	5/32	3/64	3/8	9/16	21/64
2	3/16	1/16	7/16	11/16	3/8
3	3/16	1/16	1/2	3/4	7/16
4	1/4	3/32	9/16	7/8	31/64
5	5/16	7/64	5/8	15/16	35/64
6	5/16	7/64	3/4	1-1/8	41/64
8	11/32	1/8	7/8	1-5/16	3/4
10	3/8	1/8	1	1-1/2	55/64
1/4	7/16	7/32			

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Table 4-9. Decimal Equivalent of Tool Sizes
(Sheet 1 of 4)

INCH	MM	WIRE GAGE	DECIMALS OF AN INCH
		80	.0135
		79	.0145
1/64			.015625
	.4		.015748
		78	.016
		77	.018
	.5		.019685
		76	.02
		75	.021
	.55		.021653
		74	.0225
	.6		.023622
		73	.024
		72	.025
	.65		.02559
		71	.026
	.7		.027559
		70	.028
		69	.02925
	.75		029527
		68	.031
1/32			.03125
	.8		.031496
		67	.032
		66	.033
	.85		.033464
		65	.035
	.9		.035433
		64	.036
		63	.037
	.95		.037401
		62	.038
		61	.039
	1		.03937
		60	.04
			.041
	1.05		.041338
		58	.042
		57	.043
	1.1		.043307
	1.15		.045275
		56	.0465
3/64			.046875
	1.2		.047244
	1.25		.049212
	1.3		.051181
		55	.052
	1.35		.053149
		54	.055
	1.4		.055118
	1.45		.057086
	1.5		.059055
		53	.0595
	1.55		.061023
1/16			.0625
	1.6		.062992
		52	.0635
	1.65		.06496
	1.7		.066929
		51	.067
	1.75		.068897
		50	.07
	1.8		.070866
	1.85		.072834
		49	.073
	1.9		.074803
		48	.076
	1.95		.076771
5/64			.078125
		47	.0785
	2		.07874
	2.05		.080708
		46	.081
		45	.082
	2.1		.082677
	2.15		.084645
		44	.086
	2.2		.086614
	2.25		.088582
		43	.089
	2.3		.090551
	2.35		.092519
		42	.0935
3/32			.09375
	2.4		.094488
		41	.096
	2.45		.096456
		40	.098
	2.5		.098425
		39	.0995
		38	.1015
	2.6		.102362
		37	.104
	2.7		.106299
		36	.1065
	2.75		.108267
7/64			.109375
		35	.11
	2.8		.110236
		34	.111
		33	.113
	2.9		.114173
		32	.116
	3		.11811
		31	.12
	3.1		.122047
1/8			.125
	3.2		.125984
	3.25		.127952
		30	.1285
	3.3		.129921
	3.4		.133858
		29	.136
	3.5		.137795
		28	.1405
9/64			.140625
	3.6		.141732
		27	.144
	3.7		.145669
		26	.147
	3.75		.147637
		25	.1495
	3.8		.149606
		24	.152
	3.9		.153543
		23	.154
5/32			.15625
		22	.157
	4		.15748
		21	.159
		20	.161
	4.1		.161417
	4.2		.165354
		19	.166
	4.25		.167322
	4.3		.169291
		18	.1695
11/64			.171875
		17	.173
	4.4		.173228
		16	.177
	4.5		.177165
		15	.18
	4.6		.181102
		14	.182
		13	.185
	4.7		.185039
	4.75		.187007
3/16			.1875
	4.8		.188976
		12	.189
		11	.191
	4.9		.192913
		10	.1935
		9	.196
	5		.19685
		8	.199
	5.1		.200787
		7	.201
13/64			.203125
		6	.204
	5.2		.204724
		5	.2055
	5.25		.206692
	5.3		.208661
		4	.209

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Table 4-9. Decimal Equivalent of Tool Sizes
(Sheet 2 of 4)

INCH	MM	WIRE GAGE	DECIMALS OF AN INCH
	5.4		.212598
		3	.213
	5.5		.216535
7/32			.21875
	5.6		.220472
		2	.221
	5.7		.224409
	5.75		.226377
		1	.228
	5.8		.228346

INCH	MM	LETTER SIZES	DECIMALS OF AN INCH
	5.9		.232283
		A	.234
15/64			.234375
	6		.23622
		B	.238
	6.1		.240157
		C	.242
	6.2		.244094
		D	.246
	6.25		.246062
	6.3		.248031
1/4		E	.25
	6.4		.251968
	6.5		.255905
		F	.257
	6.6		.259842
		G	.261
	6.7		.263779
17/64			.265625
	6.75		.265747
		H	.266
	6.8		.267716
	6.9		.271653
		I	.272
	7		.27559
		J	.277
	7.1		.279527
		K	.281
9/32			.28125
	7.2		.283464
	7.25		.285432
	7.3		.287401
		L	.29
	7.4		.291338
		M	.295
	7.5		.295275
19/64			.296875
	7.6		.299212
		N	.302
	7.7		.303149
	7.75		.305117
	7.8		.307086
	7.9		.311023

INCH	MM	WIRE GAGE	DECIMALS OF AN INCH
5/16			.3125
	8		.31496
		O	.316
	8.1		.318897
	8.2		.322834
		P	.323
	8.25		.324802
	8.3		.326771
21/64			.328125
	8.4		.330708
		Q	.332
	8.5		.334645
	8.6		.338582
		R	.339
	8.7		.342519
11/32			.34375
	8.75		.344487
	8.8		.346456
		S	.348
	8.9		.350393
	9		.35433
		T	.358
	9.1		.358267
23/64			.359375
	9.2		.362204
	9.25		.364172
	9.3		.366141
		U	.368
	9.4		.370078
	9.5		.374015
3/8			.375
		V	.377
	9.6		.377952
	9.7		.381889
	9.75		.383857
	9.8		.385826
		W	.386
	9.9		.389763
25/64			.390625
	10		.3937
		X	.397
		Y	.404
13/32			.40625
		Z	.413
	10.5		.413385
27/64			.421875
	11		.43307
7/16			.4375
	11.5		.452755
29/64			.453125
15/32			.46875
	12		.47244
31/64			.484375
	12.5		.492125
1/2			.5
	13		.51181
33/64			.515625
17/32			.53125

INCH	MM	DECIMALS OF AN INCH
	13.5	.531495
35/64		.546875
	14	.55118
9/16		.5625
	14.5	.570865
37/64		.578125
	15	.59055
19/32		.59375
39/64		.609375
	15.5	.610235
5/8		.625
	16	.62992
41/64		.640625
	16.5	.649605
21/32		.65625
	17	.66929
43/64		.671875
11/16		.6875
	17.5	.688975
45/64		.703125
	18	.70866
23/32		.71875
	18.5	.728345
47/64		.734375
	19	.74803
3/4		.75
49/64		.765625
	19.5	.767715
25/32		.78125
	20	.7874
51/64		.796875
	20.5	.807085
13/16		.8125
	21	.82677
53/64		.828125
27/32		.84375
	21.5	.846455
55/64		.859375
	22	.86614
7/8		.875
	22.5	.885825
57/64		.890625
	23	.90551
29/32		.90625
59/64		.921875
	23.5	.925195
15/16		.9375
	24	.94488
61/64		.953125
	24.5	.964565
31/32		.96875
	25	.98425
63/64		.984375
1		1.
	25.5	1.003935
1-1/64		1.015625
	26	1.02362
1-1/32		1.03125

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Table 4-9. Decimal Equivalent of Tool Sizes
(Sheet 3 of 4)

INCH	MM	DECIMALS OF AN INCH	INCH	MM	DECIMALS OF AN INCH	INCH	MM	DECIMALS OF AN INCH
	26.5	1.043305		39.5	1.555115		52.5	2.066925
1-3/64		1.046875	1-9/16		1.5625	2-5/64		2.078125
1-1/16		1.0625		40	1.5748		53	2.08661
	27	1.06299	1-37/64		1.578125	2-3/32		2.09375
1-5/64		1.078125	1-19/32		1.59375		53.5	2.106295
	27.5	1.082675		40.5	1.594485	2-7/64		2.109375
1-3/32		1.09375	1-39/64		1.609375	2-1/8		2.125
	28	1.10236		41	1.61417		54	2.12598
1-7/64		1.109375	1-5/8		1.625	2-9/64		2.140625
	28.5	1.122045		41.5	1.633855		54.5	2.145665
1-1/8		1.125	1-41/64		1.640625	2-5/32		2.15625
1-9/64		1.140625		42	1.65354		55	2.16535
	29	1.14173	1-21/32		1.65625	2-11/64		2.171875
1-5/32		1.15625	1-43/64		1.671875		55.5	2.185035
	29.5	1.161415		42.5	1.673225	2-3/16		2.1875
1-11/64		1.171875	1-11/16		1.6875	2-13/64		2.203125
	30	1.1811		43	1.69291		56	2.20472
1-3/16		1.1875	1-45/64		1.703125	2-7/32		2.21875
	30.5	1.200785		43.5	1.712595		56.5	2.224405
1-13/64		1.203125	1-23/32		1.71875	2-15/64		2.234375
1-7/32		1.21875		44	1.73228		57	2.24409
	31	1.22047	1-47/64		1.734375	2-1/4		2.25
1-15/64		1.234375	1-3/4		1.75		57.5	2.263775
	31.5	1.240155		44.5	1.751965	2-17/64		2.265625
1-1/4		1.25	1-49/64		1.765625	2-9/32		2.28125
	32	1.25984		45	1.77165		58	2.28346
1-17/64		1.265625	1-25/32		1.78125	2-19/64		2.296875
	32.5	1.279525		45.5	1.791335		58.5	2.303145
1-9/32		1.28125	1-51/64		1.796875	2-5/16		2.3125
1-19/64		1.296875		46	1.81102		59	2.32283
	33	1.29921	1-13/16		1.8125	2-21/64		2.328125
1-5/16		1.3125	1-53/64		1.828125		59.5	2.342515
	33.5	1.318895		46.5	1.830705	2-11/32		2.34375
1-21/64		1.328125	1-27/32		1.84375	2-23/64		2.359375
	34	1.33858		47	1.85039		60	2.3622
1-11/32		1.34375	1-55/64		1.859375	2-3/8		2.375
	34.5	1.358265		47.5	1.870075		60.5	2.381885
1-23/64		1.359375	1-7/8		1.875	2-25/64		2.390625
1-3/8		1.375		48	1.88976		61	2.40157
	35	1.37795	1-57/64		1.890625	2-13/32		2.40625
1-25/64		1.390625	1-29/32		1.90625		61.5	2.421255
	35.5	1.397635		48.5	1.909445	2-27/64		2.421875
1-13/32		1.40625	1-59/64		1.921875	2-7/16		2.4375
	36	1.41732		49	1.92913		62	2.44094
1-27/64		1.421875	1-15/16		1.9375	2-29/64		2.453125
	36.5	1.437005		49.5	1.948815		62.5	2.460625
1-7/16		1.4375	1-61/64		1.953125	2-15/32		2.46875
1-29/64		1.453125		50	1.9685		63	2.48031
	37	1.45669	1-31/32		1.96875	2-31/64		2.484375
1-15/32		1.46875	1-63/64		1.984375		63.5	2.499995
	37.5	1.476375		50.5	1.988185	2-1/2		2.5
1-31/64		1.484375	2		2.	2-23/64		2.515625
	38	1.49606		51	2.00787		64	2.51968
1-1/2		1.5	2-1/64		2.015625	2-17/32		2.53125
1-33/64		1.515625		51.5	2.027555		64.5	2.539365
	38.5	1.515745	2-1/32		2.03125	2-35/64		2.546875
1-17/32		1.53125	2-3/64		2.046875		65	2.55905
	39	1.53543		52	2.04724	2-9/16		2.5625
1-35/64		1.546875	2-1/16		2.0625	2-37/64		2.578125

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Table 4-9. Decimal Equivalent of Tool Sizes
(Sheet 4 of 4)

INCH	MM	DECIMALS OF AN INCH	INCH	MM	DECIMALS OF AN INCH	INCH	MM	DECIMALS OF AN INCH
	65.5	2.578735		67	2.63779		68	2.67716
2-19/32		2.59375	2-41/64		2.640625	2-11/16		2.6875
	66	2.59842	2-21/32		2.65625		68.5	2.696845
2-35/64		2.609375		67.5	2.657475	2-45/64		2.703125
	66.5	2.618105	2-43/64		2.671875		69	2.71653
2-5/8		2.625						

AIAG618A

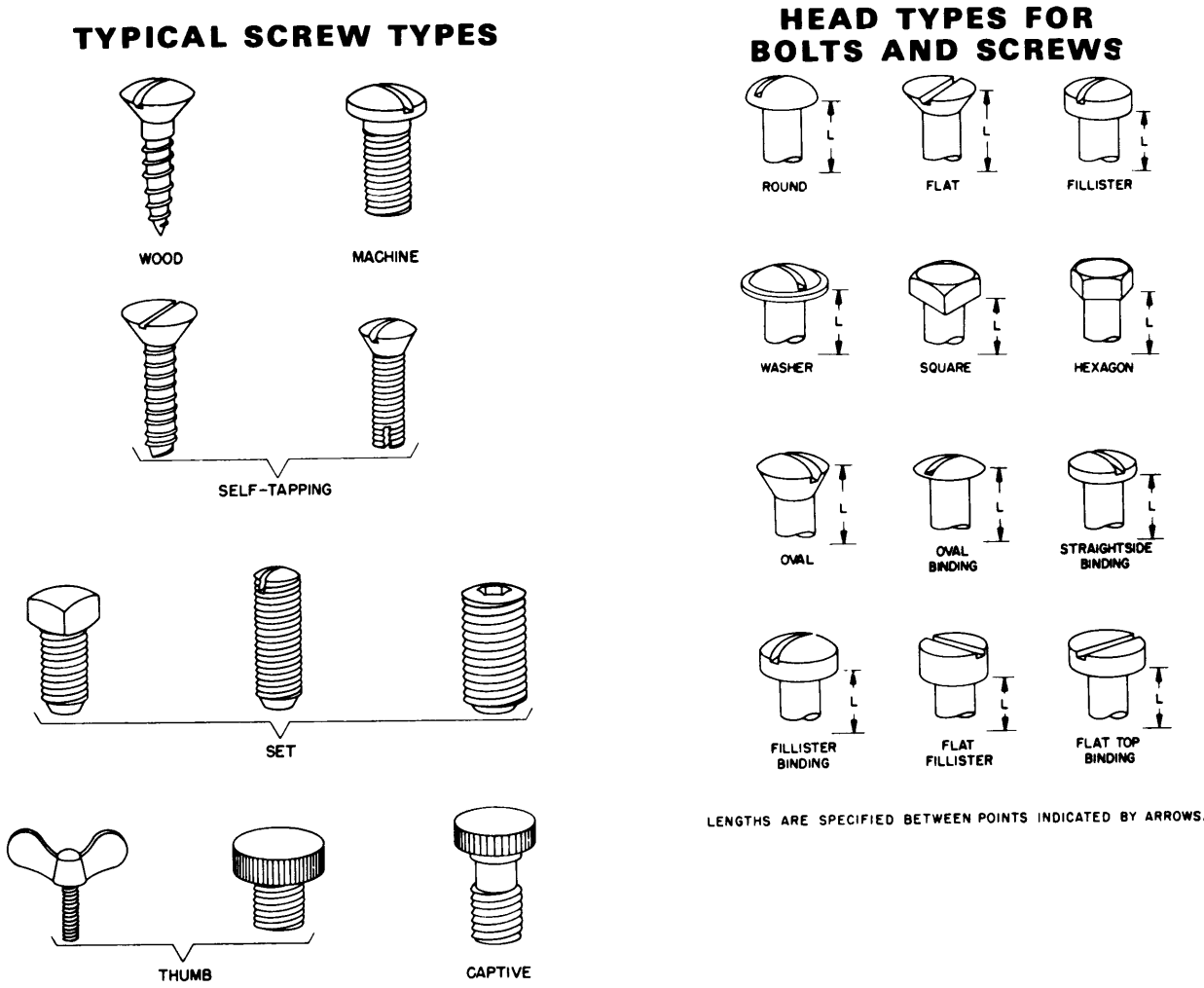


Figure 4-1. Types of Screws

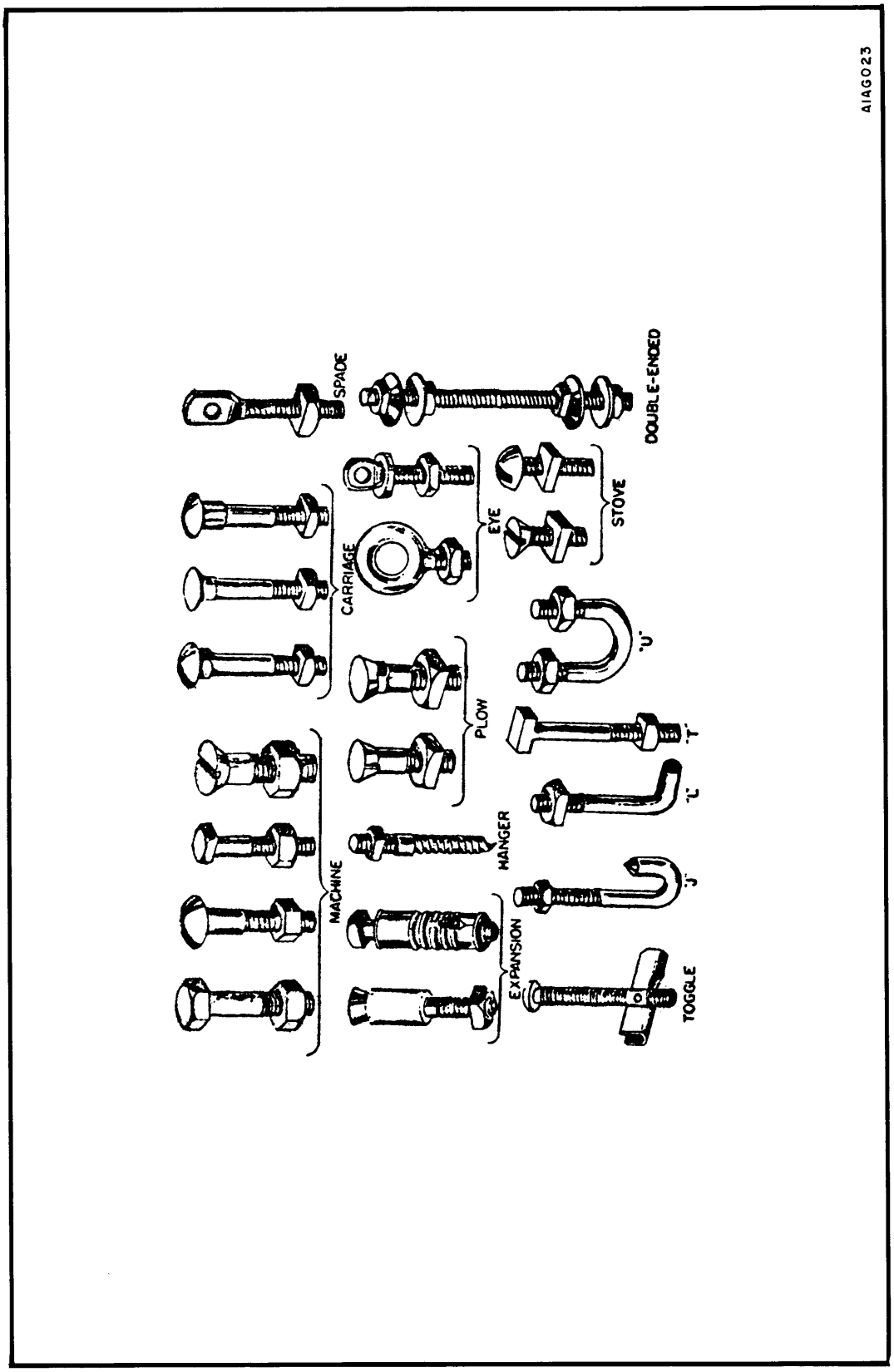


Figure 4-2. Types of Bolts

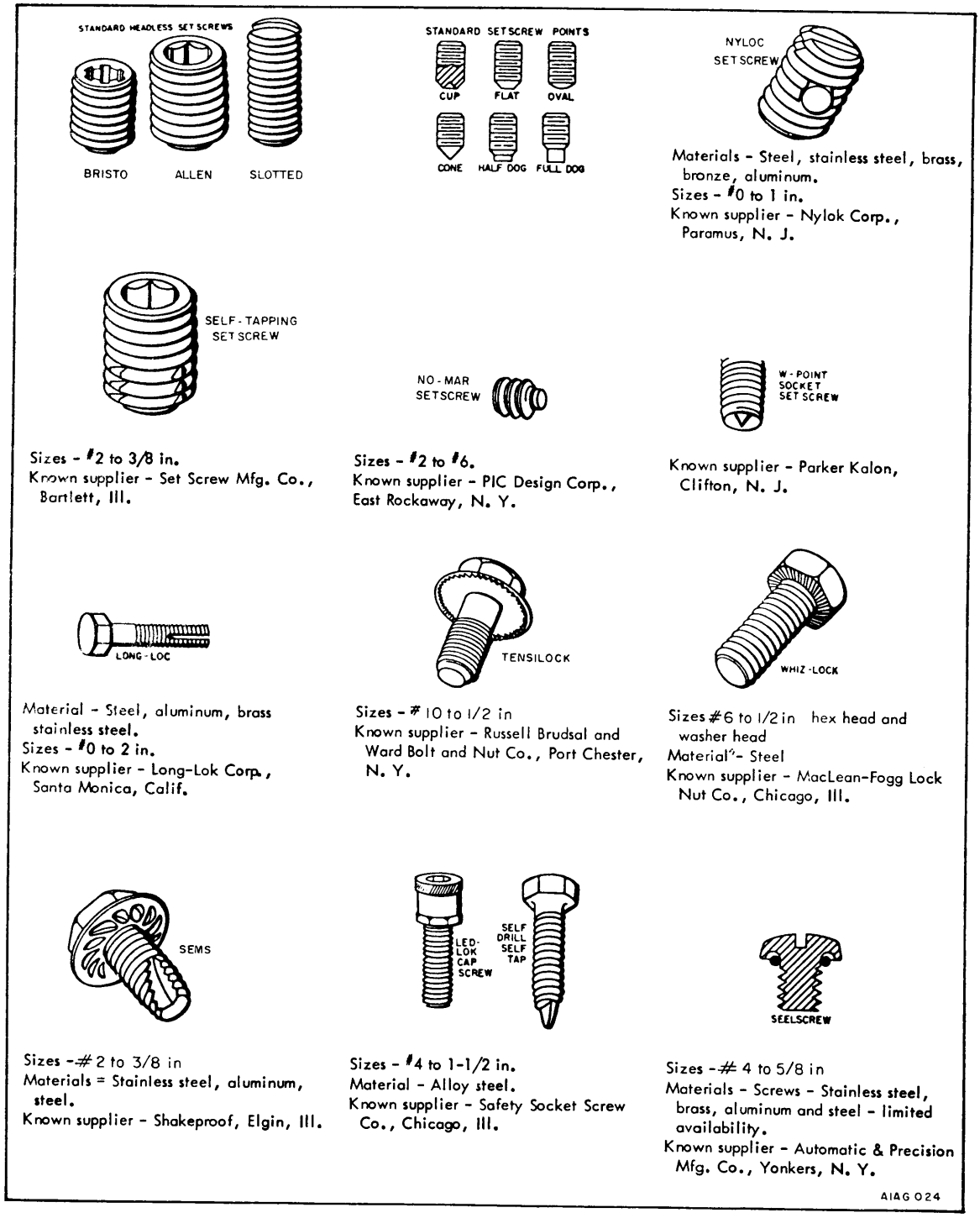


Figure 4-3. Set Screws

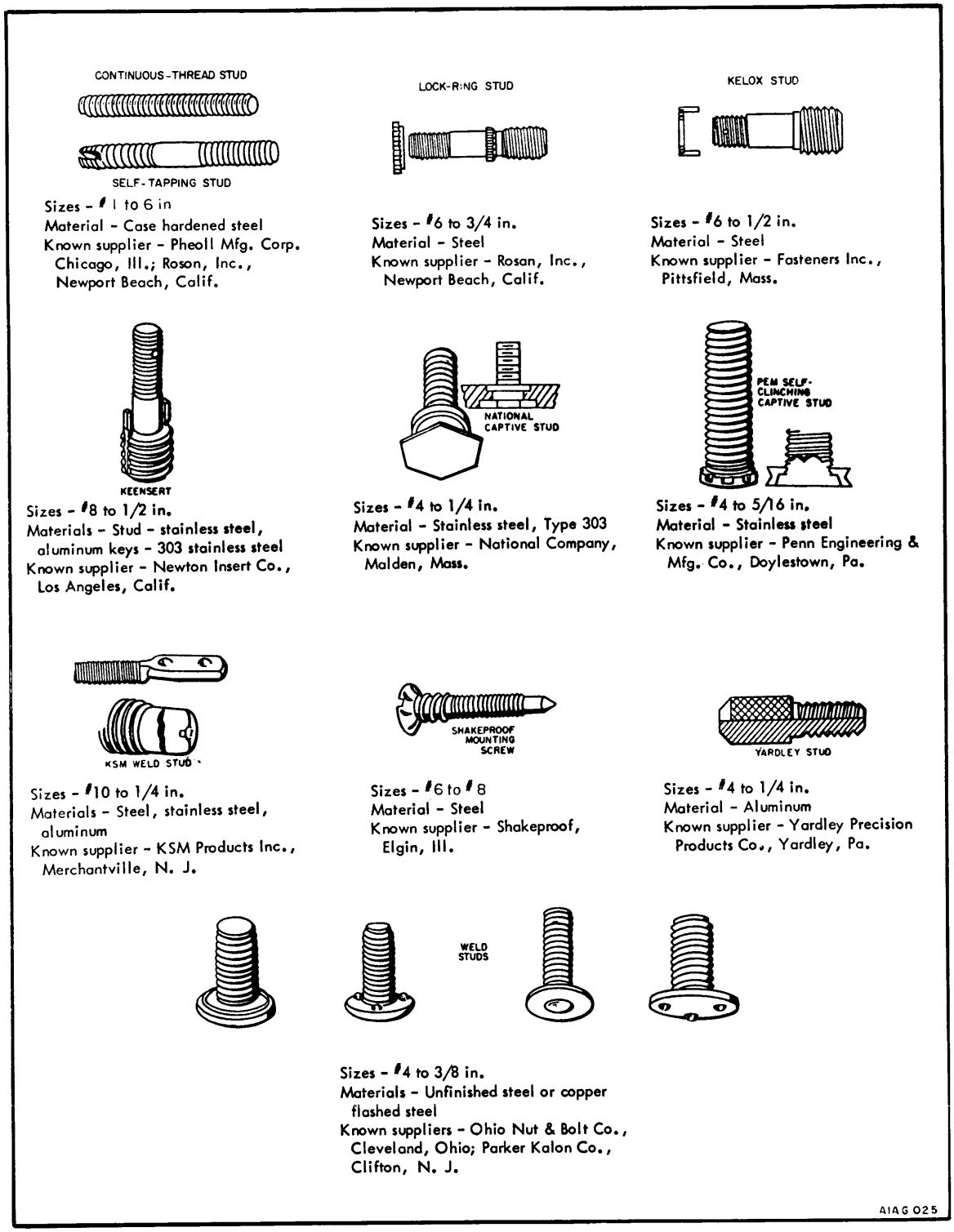


Figure 4-4. Threaded Studs

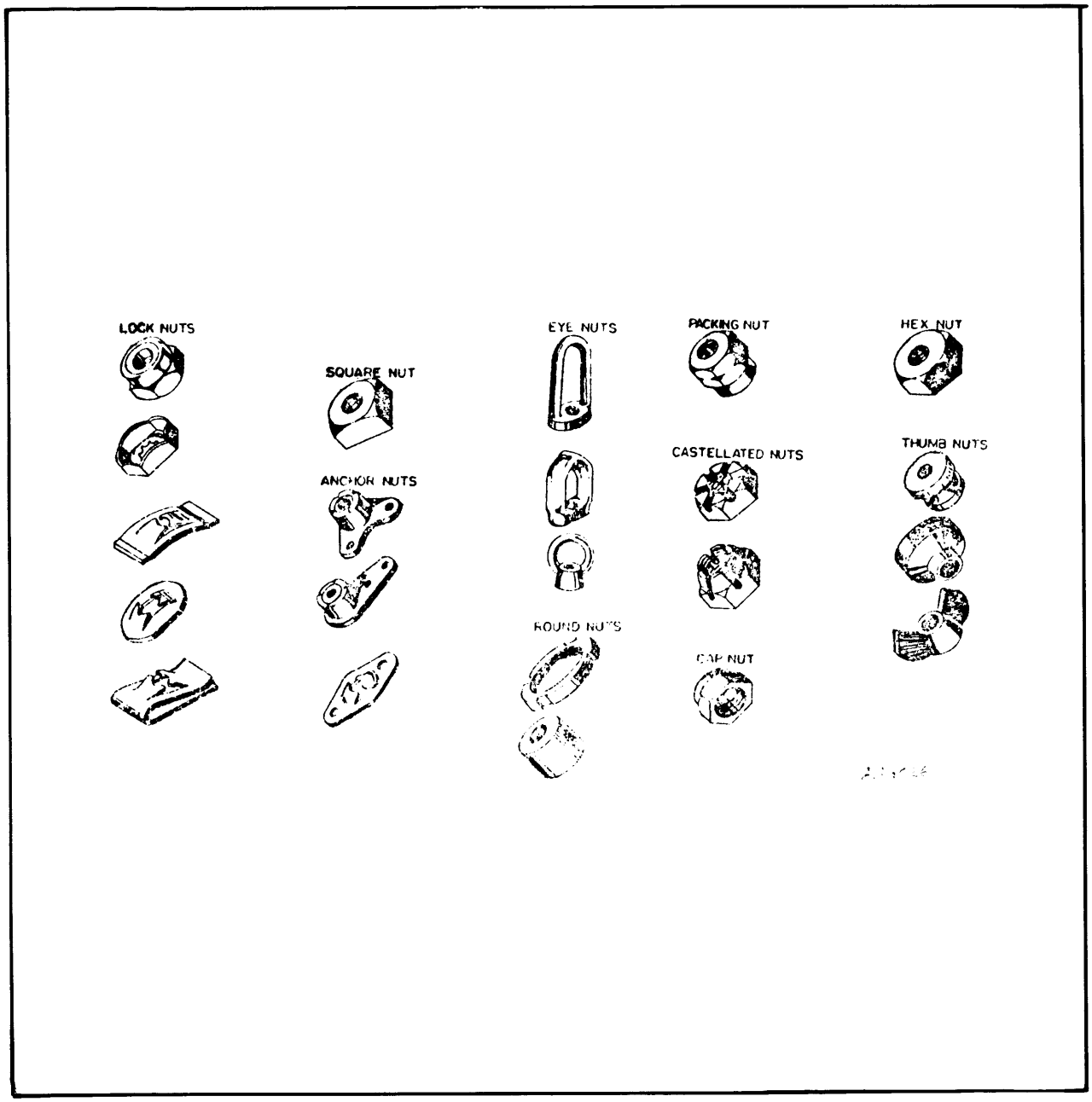
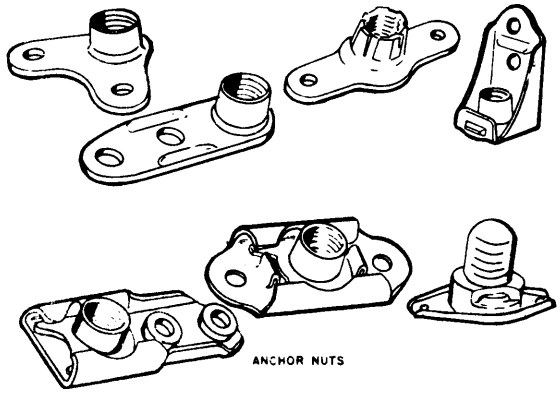
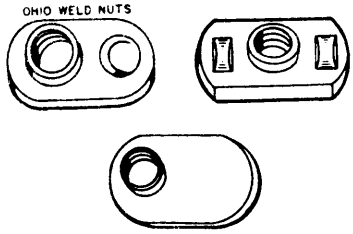


Figure 4-5. Nuts (Sheet 1 of 3)

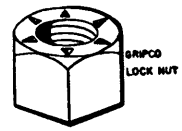


Sizes - #4 to 3/8 inch thread size
Material - Steel, stainless steel
Known suppliers - Kaynar Mfg. Co., Los Angeles, Calif.
ESNA, Union, N. J.
Boots Aircraft Nut Corp., Norwalk, Conn.
Nutt-Shel Co., Glendale, Calif.

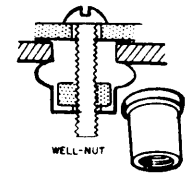
Sizes - #0 to 1-1/4 inch thread
Material - Steel, brass, zinc, aluminum monel, stainless steel, lucite (colored or plain)



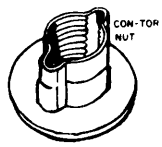
Sizes - #6 to 3/8 inch thread size
Material - Steel
Known supplier - Ohio Nut and Bolt Co., Berea, Ohio.



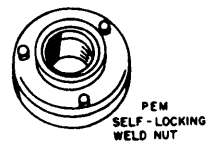
Sizes - #6 to 1-1/2 inch thread size
Materials - Steel, stainless steel, brass
Known supplier - Grip Nut Co., South Whitley, Ind.



Sizes - #6 to 1/4 inch screw size
Materials - Rubber with brass nut
Known supplier - Rockwell Products Corp., Newark, N. J.



Sizes - #2 to 3/8 inch thread size
Material - Steel
Known supplier - Con-Torq Inc., New Britain, Conn.



Sizes - #2 to 1/4 inch thread size
Material - Steel, stainless steel
Known supplier - Penn Engineering and Mfg. Corp., Doylestown, Pa.

Sizes - #6 to #10
Material - Steel
Known supplier - Jacobson Mfg.Co., Kenilworth, N.J.

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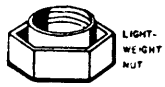
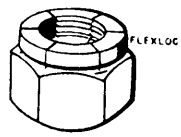
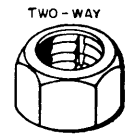
Figure 4-5. Nuts (Sheet 2 of 3)



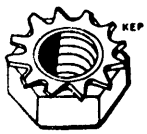
Sizes - #4 to 1/2-inch thread size
Materials - Steel, stainless steel (A-286)
Known suppliers - Kaynar Mfg. Co., Inc., Los Angeles, Calif., Elastic Stop Nut Corp. of America, Union, N. J.; Boots Aircraft Nut Corp., Norwalk, Conn.; The Nutt-Shel Co., Glendale, Calif.



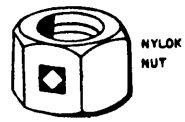
Sizes - #2 to 2-inch thread size
Material - Steel, stainless steel, aluminum, brass, bronze
Known supplier - Standard Pressed Steel Co., Jenkintown, Pa.



Sizes - #6 to over 1 inch thread size
Materials - Stainless Steel
Known supplier - MacLean-Fogg Lock Nut Co., Mundelein, Ohio

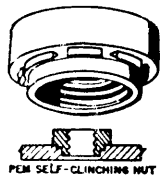


Sizes - #4 to 3/8-inch thread size
Material - Steel
Known supplier - Shakeproof, Div., Illinois Tool Works, Elgin, Ill.;



Size - #0 to 1-inch thread size
Material - Steel, stainless steel, aluminum, brass
Known supplier - Nylok Corp., Paramus, N. J.

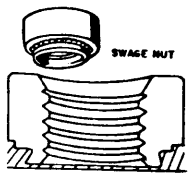
Sizes - #0 to 4-1/2-inch thread size
Materials - Steel, brass, aluminum, stainless steel
Known suppliers - Elastic Stop Nut Corp. of America, Union, N. J.;



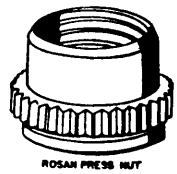
Sizes - #2 to 3/4-inch
Material - Steel, stainless steel, monel aluminum
Known supplier - Penn Engineering and Manufacturing Co., Doylestown, Pa.

Sizes - #4 to 1/2-inch
Material - Hardened steel
Known supplier - Lamson and Sessions Co., Cleveland, Ohio

Sizes - #2 to 1/4-inch
Material - Steel, stainless steel (303)
Known supplier - MacLean-Fogg Lock Nut Co., Mundelein, Ohio



Sizes - #2 to 1/2-inch
Material - Steel
Known supplier - Standard Pressed Steel Co., Jenkintown, Pa.



Sizes - #2 to 3/8-inch
Material - Steel, stainless steel (303)
Known supplier - Rosan Inc., Newport Beach, Calif.

Sizes - #2 to 10
Material - Stainless steel (303)
Known supplier - Penn Engineering and Manufacturing Corp., Doylestown, Pa.

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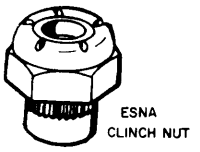
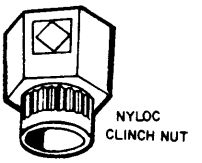
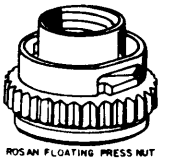
Figure 4-5. Nuts (Sheet 3 of 3)



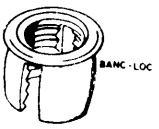
Sizes - #4 to 5/16 inch
Material - Steel, aluminum, brass
Known supplier - Elastic Stop Nut Corp., of America, Union, N. J.



Sizes - #4 to 5/16 inch
Material - Steel, Stainless steel, aluminum, brass
Known supplier - Nylok Corp., Paramus, N. J.

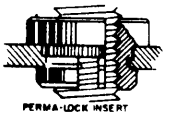


Sizes - #4 to 1/2 inch
Material - Steel
Known supplier - Rosan Inc., Newport Beach, Calif.

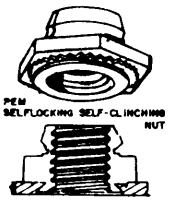


Sizes - #4 to 1/4 inch
Material - Aluminum, brass, steel, stainless steel
Known supplier - Boots Aircraft Nut Corp., Norwalk, Conn.

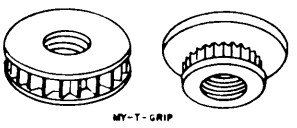
Sizes - #1/4 to 1/2 inch
Material - Steel
Known supplier - MacLean-Fogg Lock Nut Co., Mundelein, Ohio



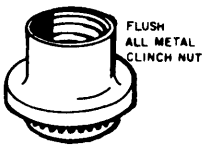
Sizes - #4 to 9/16 inch
Material - Steel, brass, aluminum
Known supplier - J. B. Plevyak Mfg. Co., Newton, N. J.



Sizes - #4 to 10
Material - Stainless steel (303), steel, aluminum
Known supplier - Penn Engineering and Manufacturing Corp., Doylestown, Pa.



Sizes - #2 to 10
Material - Stainless steel (303), steel
Known supplier - My-T-Grip Mfg. Co. Inc., New York, N. Y.



Sizes - #2 to 1/4 inch
Material - Steel - heat-treated, stainless steel
Known suppliers - Kaynar Mfg. Co. Inc., Los Angeles, Calif.; Elastic Stop Nut Corp. of America, Union, N. J.

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Figure 4-6. Clinch Nuts

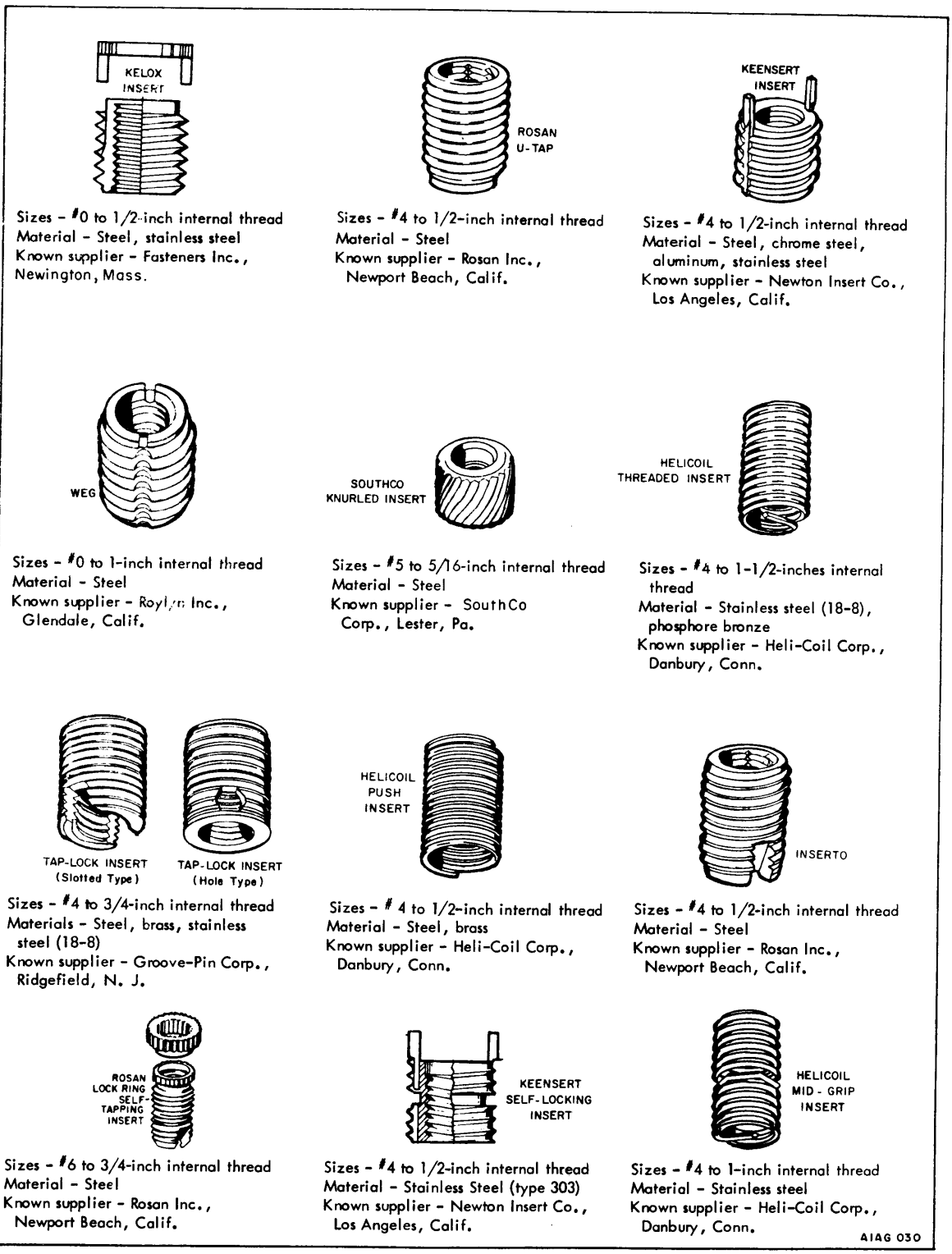
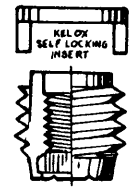


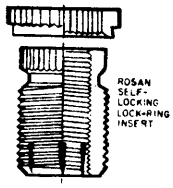
Figure 4-7. Inserts (Sheet 1 of 2)

Sizes - #6 to 3/8-inch internal thread
Material - Steel
Known supplier - Elastic Stop Nut Corp., of America, Union, N. J.

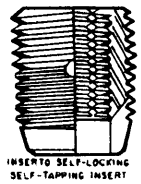
Sizes - #10 to 3/8-inch internal thread
Material - Steel
Known supplier - Elastic Stop Nut Corp., of America, Union, N. J.



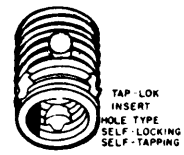
Sizes - #10 to 1-inch internal thread
Material - Steel
Known supplier - Fasteners Inc., Newington, Mass.



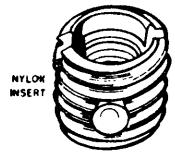
Sizes - #4 to 1/2 inch internal thread
Material - Steel
Known supplier - Rosan Inc., Newport Beach, Calif.



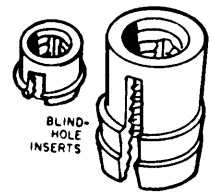
Sizes - #4 to 1/2 inch internal thread
Material - Steel
Known supplier - Rosan Inc., Newport Beach, Calif.



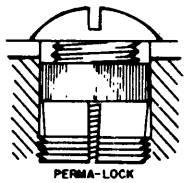
Sizes - #4 to 1/2-inch internal thread
Material - Steel, brass, stainless steel
Known supplier - Groov -Pin Corp., Ridgefield, N. J.



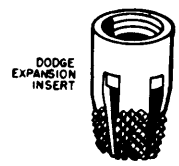
Sizes - #0 to 1/2-inch internal thread
Material - Stainless steel, steel, brass
Known supplier - Nylok Corp., Paramus, N. J.



Sizes - #4 to 3/8-inch internal thread for use in thin and thick panels
Material - Brass, aluminum, steel, stainless steel
Known suppliers - Boots Aircraft Nut Corp., Norwalk, Conn.



Sizes - #4 to 3/8-inch internal thread
Material - Steel, brass, aluminum
Known supplier - SouthCo Corp. Lester, Pa.



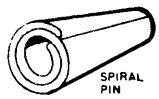
Sizes #4 to 10
Material - Brass
Known supplier - Phelps Manufacturing Co. Westport, Conn.

AIAG 031

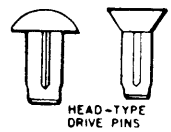
Figure 4-7. Inserts (Sheet 2 of 2)

HOLE SIZE AND SHEAR VALUES FOR SPIRAL PINS

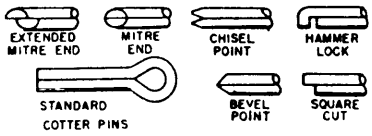
Pin Dia	Recommended Hole Size Min	Max	Double Shear in Lbs (Steel & Stainless 8A Steel Pins) Heavy Duty	Medium Duty	Light Duty
0.031	0.031	0.0325	-----	75	-----
0.039	0.039	0.405	-----	115	-----
0.047	0.047	0.485	-----	170	-----
0.052	0.052	0.535	-----	230	-----
0.062	0.062	0.065	460	300	160
0.078	0.078	0.081	720	480	260
0.094	0.094	0.097	1030	690	370
0.109	0.109	0.112	1410	940	510
0.125	0.125	0.129	1840	1230	660
0.156	0.156	0.160	2880	1920	1040
0.187	0.187	0.192	4140	2760	1500
0.219	0.219	0.224	5640	3760	2040
0.250	0.250	0.256	7360	4900	2660
0.312	0.312	0.318	11500	7670	4160
0.375	0.375	0.382	16580	11040	8000
0.437	0.437	0.345	22540	15020	8160
0.500	0.500	0.510	29440	19600	10640



Sizes - 0.037-in. to 1/2-in. dia, 1/8-in. to 4-in. long,varying with dia
Material - Heat-treated 1070 steel (1/16 in. and over), stainless steel
Known supplier - C. E. M. Co., Danielson, Conn.



Size - 0.067-in. to 0.250-in. dia, 1/8- to 1/2-in. long,varying with dia
Material - Steel
Known supplier - Groov Pin Corp., Ridgefield, N. J.; Driv-Lok Pin Co., Sycamore, Ill.



Sizes - 0.031-in. dia to 0.750-in. dia
Material - Steel, brass, bronze, stainless steel, aluminum

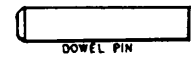
HOLE AND PIN SIZES FOR COTTER PINS

Thread or Shaft Size (in.)	Cotter Pin Size (in.)	Hole Size (in.)	Distance of Hole Center from Shaft End
1/8	1/32	3/64	3/64
3/16	3/64	1/16	5/64
1/4	1/16	5/64	7/64
5/16	5/64	3/32	7/64
3/8	3/32	7/64	9/64
7/16	3/32	7/64	11/64
1/2	1/8	7/64	11/64

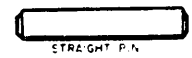
AIAG032

Figure 4-8. Pins (Sheet 1 of 2)

Sizes - 0.062-in. to 0.500-in. dia,1/8- to 5-1/2-in. long varying with dia
Material - Heat-treated carbon steel stainless steel, beryllium copper
Known suppliers - Standard Pressed Steel Jenkintown, Pa.; Elastic Stop-Nut Co., Union, N. J.



Sizes - 1/8 to 7/8, 1/2 to 5- 1/2 in. long,varying with dia
Material - Heat-treated alloy steel Rockwell C 60 to 62

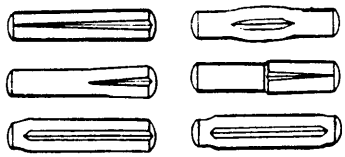


Size - 0.062 to 0.500 (12 standard diameters)
Material - Steel, brass, bronze

Sizes - #8/0 (0.047-in. dia) to #13 (1.523-in. dia) large end dia
Material - Steel, brass, stainless steel

PIN INSTALLATION INFORMATION

Pin Size	Hole Size Min	Hole Size Max	Double Shear Strength Lbs (Steel Pins)
0.062	0.062	0.065	425
0.078	0.078	0.081	650
0.094	0.094	0.097	1000
0.125	0.125	0.129	2100
0.156	0.156	0.160	3000
0.187	0.187	0.192	4400
0.219	0.219	0.224	5700
0.250	0.250	0.256	7700
0.312	0.312	0.318	11500
0.375	0.375	0.382	17600
0.500	0.500	0.510	25800



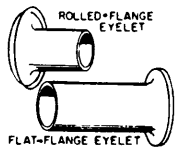
Sizes 3/64-in. diameter to 1/2-in. diameter, 1/4-in. long to 4-1/2-in. long,varying with dia
Material - B1112 steel
Known suppliers - Groov Pin Corp., Ridgefield, N. J.; Driv-Lok Pin Co., Sycamore, Ill.

RECOMMENDED HOLE DIAMETERS FOR GROOVED PINS

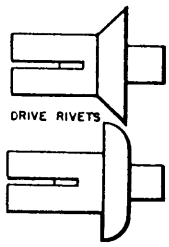
Pin Size	3/64	1/16	5/64	3/32	7/64	1/8	5/32
Hole Size Max	0.0478	0.640	0.0798	0.0956	0.1113	0.1271	0.1587
Hole Size Min	0.0465	0.0625	0.0781	0.938	0.1094	0.1250	0.1563
Pin Size	3/16	7/32	1/4	5/16	3/8	7/16	1/2
Hole Size Max	0.1903	0.2219	0.2534	0.3166	0.3797	0.4428	0.5040
Hole Size Min	0.1875	0.2188	0.2500	0.3125	0.3750	0.4375	0.5000

AIAG033

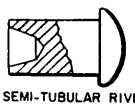
Figure 4-8. Pins (Sheet 2 of 2)



Size - 0.060-in. to 0.500-in. OD with length 0.093 to 3/4-in.
Material - Brass, aluminum,and plastic

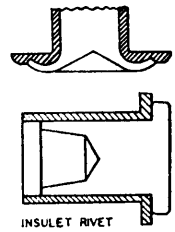


Sizes - 1/8-in. dia to 1/4-in. dia, grip lengths 1/32-in. to 1-in.
Materials - Aluminum, steel
Known suppliers - SouthCo Corp., Lester, Pa.; Star Expansion Industries, New York City, N. Y.; Olympis Screw & Rivet Co., Downey, Calif.; Deutsch Fastener Corp., Los Angeles, Calif.

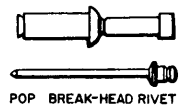


Size - 1/16-in. dia to 5/16-in. dia, lengths 3/16 to 1-1/4,varying with dia.
Material - Brass, steel, aluminum

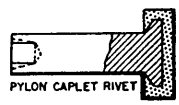
HOLE SIZE AND CLINCH ALLOWANCE FOR SEMI-TUBULAR RIVETS		
Rivet Dia	Hole Dia Min	Clinch Allowance
1/16	0.064	0.032 - 0.038
3/32	0.093	0.046 - 0.055
0.099	0.104	0.051 - 0.061
1/8	0.128	0.064 - 0.077
9/64	0.154	0.076 - 0.092
3/16	0.199	0.098 - 0.188
7/32	0.234	0.109 - 0.141
1/4	0.265	0.130 - 0.159



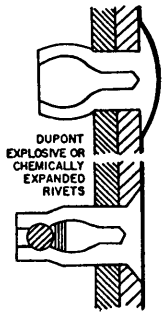
Sizes - 3/32 - 3/16-in. dia, 1/8 to 1/4-in. length
Material - Aluminum, brass, steel
Known supplier - Pylon Co., Attleboro, Mass.



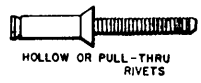
Sizes - 3/32-in. dia to 0.200-in. dia. Grip lengths 0.010 in. to 0.625 in.
Material - Aluminum and monel
Known supplier - United Shoe Machinery Corp., Shelton, Mass.



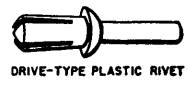
Sizes - 1/16-in. dia to 3/16-in. dia
Material - Rivet steel, brass, aluminum headcycoloc
Known supplier - Pylon Co., Attleboro, Mass.



Sizes - 1/8 to 1/4-in. dia grip length 0.010 to 0.510
Material - Brass, aluminum, nickel
Known supplier - E. I. DuPont De Nemours & Co., Wilmington, Del.



Sizes - 1/32 to 1/4-dia. Grip length 0.020 to 1 in.
Materials - Monel, aluminum, stainless steel, brass
Known suppliers - Olympic Screw & Rivet Corp., Downey, Calif.; Townsend Co., W. Newton Pa.; Huck Mfg. Co. Detroit, Mich.

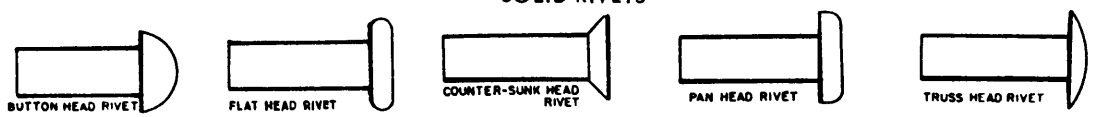


Sizes - 1/8 to 3/8-in. dia with grip length 1/64-in. to 5/8-in.
Material - Nylon, acetate, butyrate, polystyrene
Known supplier - Illinois Tool Works Des Plaines, Ill.; United-Carr Fastener Corp., Cambridge, Mass.

AIAG034

Figure 4-9. Rivets (Sheet 1 of 2)

SOLID RIVETS



Sizes - 1/16-in. to 7/16-in. dia
1/8-in. to 4-in. long,varying with dia
Material - Steel, Stainless steel, brass, copper, monel, aluminum

Rivet Hole Sizes

Rivet Size	Hole Size Min	Hole Size Max
3/32	0.093	0.096
1/8	0.128	0.134
5/32	0.160	0.167
3/16	0.191	0.199
1/4	0.255	0.264

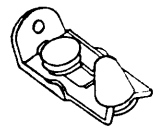
Solid Rivet Dimensions

Body Dia	Max Head Diameter: Flat HD	CSK HD	Button HD	Pan HD	Truss HD	Max Head Height: Flat HD	CSK HD	Button HD	Pan HD	Truss HD
1/16	0.140	0.118	0.122	0.118	-----	0.027	0.027	0.052	0.040	-----
3/32	0.200	0.176	0.182	0.173	0.226	0.038	0.040	0.077	0.060	0.038
1/8	0.260	0.235	0.235	0.225	0.297	0.048	0.053	0.100	0.078	0.048
5/32	0.323	0.293	0.290	0.279	0.368	0.059	0.066	0.124	0.096	0.059
3/16	0.307	0.351	0.348	0.334	0.442	0.069	0.079	0.147	0.114	0.069
7/32	0.453	0.413	0.405	0.391	0.515	0.080	0.094	0.172	0.133	0.080
1/4	0.515	0.469	0.460	0.444	0.590	0.091	0.106	0.196	0.151	0.091

AIAG035

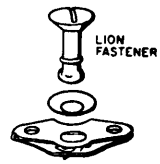
Figure 4-9. Rivets (Sheet 2 of 2)

Sizes - 200, 500 and 700 lb with rivet spacing 3/4, 1 and 1-3/8 in, respectively, and stud diameter - 0.167, 1/4 and 3/16 in, respectively.
Head styles - flush, oval and wing
Known supplier - Fastex Div. Illinois Tool Works, Des Plaines, Ill.

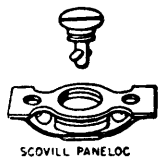


SNAP SLIDE

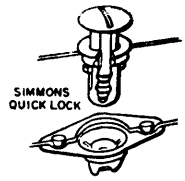
Known suppliers - Aircraft Radio Corp., Boonton, N. J.; Dimco-Gray Co., Dayton, Ohio



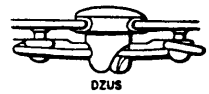
Sizes - 200 and 500 lb and stud diameter 0.156 and 0.195 in, respectively, with rivet spacing of 3/4 in. and 1 in, respectively.
Head styles - flush, oval, wing, ring, knurled
Known supplier - SouthCo Corp. Lester, Pa.



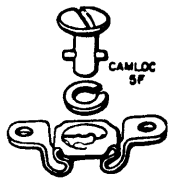
Sizes - 500 and 700 lbs with rivet spacing of 1 and 1-3/8 in, respectively and stud diameter of 5/16 and 3/8 in, respectively.
Head styles - flush, oval and wing
Known supplier - Scovill Mfg. Co., Waterbury, Conn.



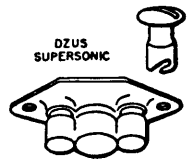
Sizes - 200, 500 and 700 lb and stud diameter 5/16, 3/8 and 7/16 in. with receptacle spring of 3/4, 1 and 1-3/8 in, respectively.
Head styles - oval, flush, wing
Known supplier - Simmons Fastener Corp., Albany, N. Y.



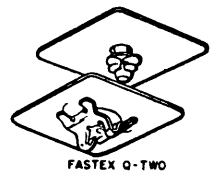
Sizes - 3/16 to 7/16 dia studs for loads from 359 to 1800 lb
Head styles - oval, flush, hex, wing, knob
Known supplier - Dzus Fastener Co., Babylon, N. Y.



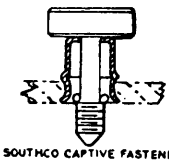
Size - 100 lb with 3/4 in. rivet spacing and 1/8 in. diameter stud.
Head styles - wing, pan, and flush
Known supplier - Camloc Fastener Corp., Paramus, N. J.



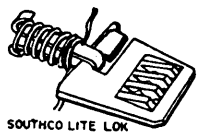
Sizes - 200, 500, 700 lb with rivet opening of 3/4, 1 and 1-3/8 in.
Head styles - oval, wing and flush
Known supplier - Dzus Fastener Corp., Babylon, N. Y.



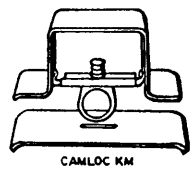
Sizes - 1/4 in. stud
Head styles - flush, wing
Known supplier - Illinois Tool Works, Des Plaines, Ill.



Size - 10-24, 10-32, 12-24, and 1/4-20 with varying lengths.
Known supplier - SouthCo Corp. Lester, Pa.



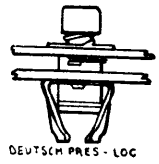
Size - one part for grips up to 5/32
Style - as shown
Known supplier - SouthCo Corp. Lester, Pa.



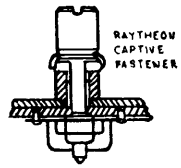
Style as shown
Known supplier - Camloc Fastener Corp., Paramus, N. J.

AIAG 036

Figure 4-10. Fasteners (Sheet 1 of 2)

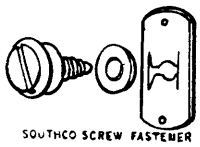


Sizes - 0.386, 0.453 and 0.515 in. stud diameter with 7/8 in. rivet spacing
Head styles - protruding and flush
Known supplier - Deutsch Fastener Corp., Los Angeles, Calif.

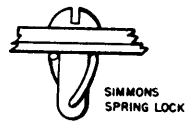


Size - 8-32, 10-24, 1/4-20 and 5/16-18 with rivet spacing of 11/32, 7/16, 7/16, 7/16 and 11/16 respectively. The grip range is 0.048 to 0.250.
Known supplier - Raytheon Mfg. Co., Waltham, Mass.

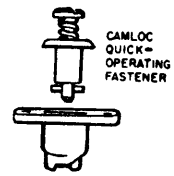
Sizes - Stud assembly 5/16 and 1/2 in. diameter
Head styles - flush, button, wing, knob, cushion and handle
Known suppliers - Vibrex Fastener Corp., Mt. Kisco, N. Y.; General Tire and Rubber Co., Wabash, Ind.



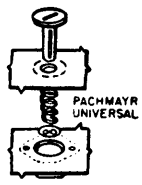
Size - screw diameters 0.2330 and 0.312 in. - length 0.486 to 1.501 in.
Head styles - knurled, wing and slotted
Known supplier - SouthCo Corp. Lester, Pa.



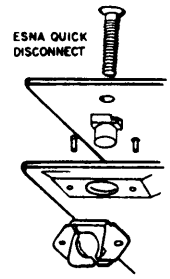
Sizes - 1/8, 5/32, 3/16, 1/4 in. diameters
Head styles - round, hex, wing
Known supplier - Simmons Fastener Corp., Albany, N. Y.



Sizes - 200, 500 and 700 lbs with rivet spacing of 3/4, 1 and 1-3/8 in.
Head styles - flush, wing, oval
Known source - Camloc Fastener Corp., Paramus, N. J.



Sizes - 200, 500, 700 lbs with rivet spacing of 3/4, 1 and 1-3/8 in. respectively.
Head styles - flush and round
Known suppliers - Pachmayr Corp., Los Angeles, Calif.; Airtex Dynamics Inc., Los Angeles, Calif.



Sizes - 1/4-20 thread - 7/8 in. rivet spacing
Head styles - any style screw (supplied by customer)
Known supplier - Elastic Stop Nut Corp., Union, N. J.

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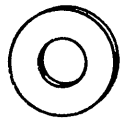
Figure 4-10. Fasteners (Sheet 2 of 2)



FLAT WASHER

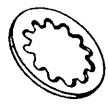
FLAT WASHER DIMENSIONS (ASA-B-27-2)

	Size	#0	#2	#4	#6	#8	#10	1/4
		0.060	0.086	0.112	0.138	0.164	0.190	0.250
	I. D. Min	0.063	0.089	0.120	0.151	0.183	0.203	0.271
O. D. Max	Small Pattern	0.130	0.193	0.255	0.318	0.380	0.411	0.505
	Regular Pattern	0.193	0.255	0.380	0.443	0.505	0.568	0.744
Thickness Max	Small Pattern	0.028	0.028	0.036	0.036	0.045	0.045	0.071
	Regular Pattern	0.028	0.028	0.045	0.045	0.045	0.045	0.071

HELICAL SPRING WASHER

DIMENSIONS OF HELICAL SPRING LOCKWASHERS

	Size	#2	#4	#6	#8	#10	1/4
		0.86	0.112	0.138	0.164	0.190	0.250
	I. D. Min	0.88	0.115	0.141	0.168	0.194	0.255
O. D. Max	Light Series	0.165	0.202	0.239	0.280	0.323	0.489
	Medium Series	0.175	0.212	0.253	0.296	0.337	0.493
Thickness Max	Light Series	0.015	0.020	0.025	0.031	0.040	0.047
	Medium Series	0.020	0.025	0.031	0.040	0.047	0.062



INTERNAL TOOTH LOCKWASHER

DIMENSIONS OF INTERNAL TOOTH LOCKWASHERS

	Size	#2	#4	#6	#8	#10	1/4
		0.086	0.112	0.138	0.164	0.190	0.250
	I. D. Min	0.089	0.115	0.141	0.168	0.195	0.256
	O. D. Max	0.200	0.270	0.295	0.340	0.381	0.478
	Thickness Max	0.015	0.019	0.021	0.023	0.025	0.028

EXTERNAL TOOTH LOCKWASHER

DIMENSIONS OF EXTERNAL TOOTH LOCKWASHERS

	Size	#4	#6	#8	#10	1/4
		0.112	0.138	0.164	0.190	0.250
	I. D. Min	0.115	0.141	0.168	0.195	0.256
	O. D. Max	0.260	0.320	0.381	0.410	0.475
	Thickness Max	0.019	0.022	0.023	0.025	0.028

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Figure 4-11. Flat Washer Dimensions

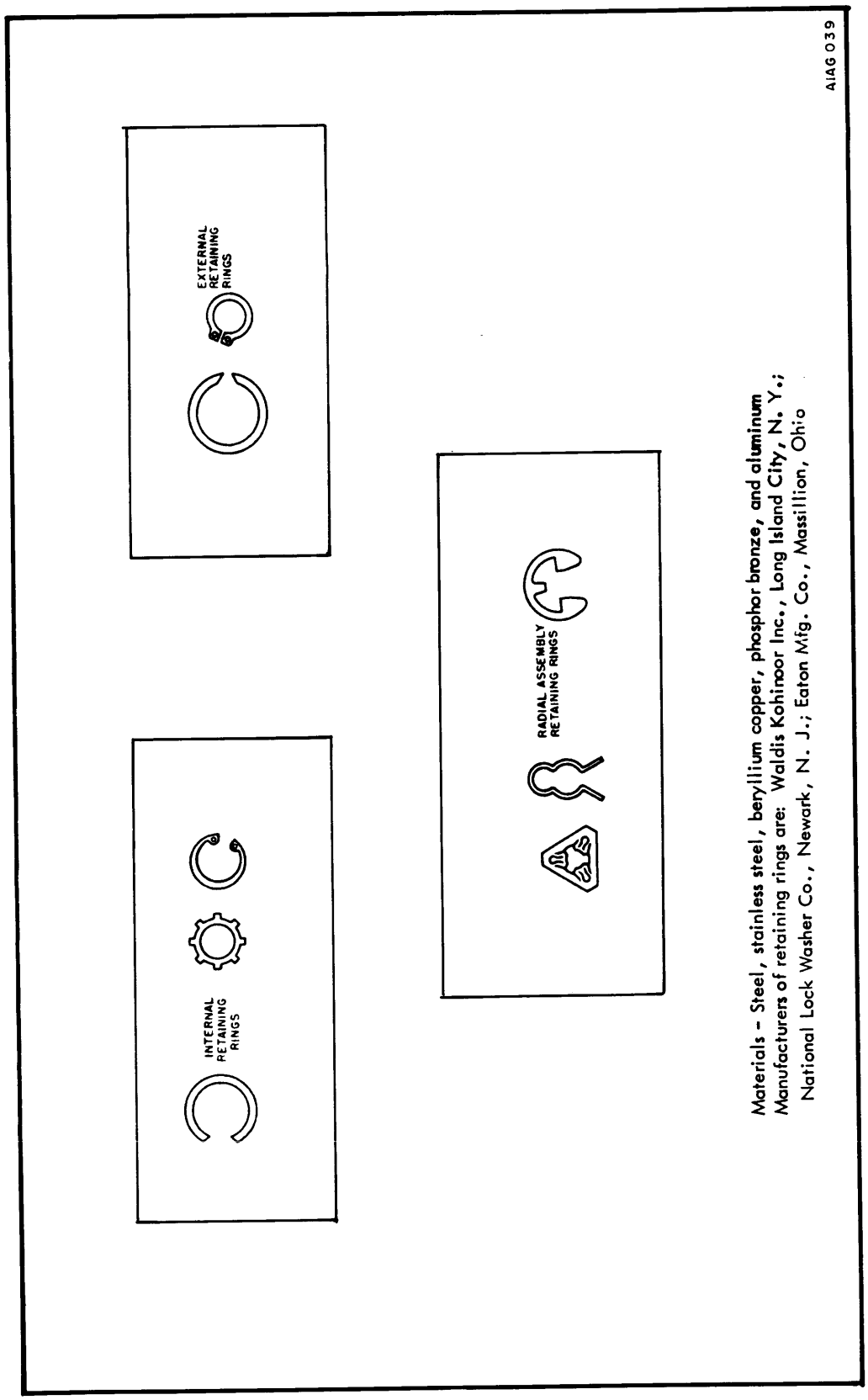

Figure 4-12. Retaining Rings