

TABLE 1. DIMENSIONS - CONTINUED

Ø S SHAFT (REF)	Ø D FREE	B LUG HEIGHT		E LARGE SECTION HEIGHT		J SMALL SECTION HEIGHT		THICKNESS		Ø G RECOMMENDED GROOVE (REF)		W WIDTH		Ø K 3/ CLEAR		R 5/ OF RETAINED PART (REF)		CH 5/ (REF)
		BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	
17.5	.688	.635		.084		.048		.042		.646		.047		.779		.042		.025
19.0	.750	.693		.092		.051		.042		.704		.047		.850		.046		.027
19.8	.781	.722		.094		.052		.042		.733		.047		.883		.047		.028
20.6	.812	.751	+.005	.096		.054	+.005	.042		.762	+.003	.047	+.003	.914		.047		.028
22.2	.875	.810	-.010	.104		.057		.042		.821		.047		.987		.051		.030
23.8	.938	.867		.110		.063		.042		.882		.047		1.054		.055		.033
25.0	.984	.910		.114		.064		.042		.926		.047		1.106		.056		.033
25.4	1.000	.925		.116		.065		.042		.940		.047		1.122		.057		.034
26.0	1.023	.946		.118		.066		.042		.961		.047		1.147		.058		.035
27.0	1.062	.982		.122		.069		.050		.998		.056		1.192		.060		.036
28.6	1.125	1.041		.128		.071		.050		1.059		.056		1.261		.063		.038
30.2	1.188	1.098		.132		.072		.050		1.118	+.004	.056		1.325		.064		.038
31.7	1.250	1.156	+.010	.140		.076		.050		1.176		.056		1.396		.068		.041
33.3	1.312	1.214	-.015	.146		.076		.050		1.232		.056		1.458		.068		.041
34.9	1.375	1.272		.152		.082		.050		1.291		.056		1.529		.072		.043
36.5	1.438	1.333		.160		.086		.050		1.350		.056		1.600		.076		.045
38.1	1.500	1.387		.168		.091		.050		1.406		.056		1.668		.079		.047
39.7	1.562	1.446		.172		.093		.062		1.468		.068		1.740		.082		.049
41.3	1.625	1.503		.180		.097		.062		1.529		.068		1.812		.087		.052
42.9	1.688	1.560		.184		.099		.062		1.589		.068		1.877		.090		.054
44.4	1.750	1.618	+.013	.188		.101		.062		1.650	+.005	.068		1.945		.091		.054
45.0	1.772	1.637	-.020	.190		.102		.062		1.669		.068		1.967		.092		.055
46.0	1.812	1.675		.192		.102		.062		1.708		.068		2.010		.092		.055
47.6	1.875	1.735		.196		.104		.062		1.769		.068		2.076		.094		.056
50.0	1.969	1.819		.200		.106		.062		1.857		.068		2.170		.094		.056
50.8	2.000	1.850		.204		.108		.062		1.886		.068		2.205		.096		.057
52.4	2.062	1.906		.208		.111		.078		1.946		.086		2.275		.098		.059
54.0	2.125	1.964		.212		.113		.078		2.003	+.003	.086		2.337		.098		.059
54.8	2.156	1.993		.212		.113		.078		2.032		.086		2.366		.097		.058
57.1	2.250	2.081	+.015	.220		.116		.078		2.120		.086		2.466		.100		.060
58.7	2.312	2.139	-.025	.222		.118		.078		2.178		.086		2.528		.100		.060
60.3	2.375	2.197		.224		.119		.078		2.239		.086		2.591		.100		.060
61.9	2.438	2.255		.228		.120		.078		2.299		.086		2.657		.102		.061
63.5	2.500	2.313		.232		.122		.078		2.360	+.006	.086		2.724		.104		.062
65.0	2.559	2.377		.238		.125		.078		2.419		.086		2.792		.108		.065
66.7	2.625	2.428		.242		.127		.078		2.481		.086		2.860		.109		.066
68.3	2.688	2.485	+.020	.246		.129		.078		2.541		.086		2.926		.111		.067
69.8	2.750	2.543	-.030	.248		.131		.093		2.602		.103		2.992		.112		.067
73.0	2.875	2.659		.256		.133		.093		2.721		.103		3.122		.115		.069

FED SUP C1481
5365

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PA
NAVY - OS

Other Cust

ARMY - AR
AIR FORCE - 99INTERNATIONAL
INTERESTRING, RETAINING, EXTERNAL, BASIC
(TAPERED SECTION TYPE)

MILITARY STANDARD

MS16624

PROCUREMENT SPECIFICATION
MIL-R-21248

SUPERSEDES

MS9012 (ASG) AND MS9013 (ASG)

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DD FORM 672-1 (COORDINATED)

5365-0140

ARMY - AV, ER, ME, MI
AIR FORCE - 82
DLA - IS

Selection for all new engineering and design applications and for repetitive use shall be made from this document when applicable.

ARMY - AT
NAVY - AS, MC

FED SUPPL CLASS
5365USER ACTIVITIES:
ARMY - AT
NAVY - AS, MCREVIEWER ACTIVITIES:
ARMY - AV, ER, ME, MI
AIR FORCE - B2
DLA - ISThe military standard is approved for use by all Departments and Agencies of the Department of Defense.
Selection for all new engineering and design applications and for repetitive use shall be made from this document when applicable.

TABLE 1. DIMENSIONS - CONTINUED

Ø S SHAFT (REF)	Ø D FREE	B LUG HEIGHT		E LARGE SECTION HEIGHT		J SMALL SECTION HEIGHT		THICKNESS		Ø G RECOMMENDED GROOVE (REF)		W WIDTH		Ø K 3/ CLEAR	R 5/ OF RETAINED PART (REF)	Ø H 5/ OF RETAINED PART (REF)
		BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL	BASIC	TOL			
2.938	74.6	2.717		.260	±.007	.136	±.007	.093		2.779		.103		3.640	.116	.070
3.008	76.2	2.775		.264		.138		.093		2.838		.103		3.690	.117	.070
3.062	77.8	2.832		.252		.131		.093		2.898		.103		3.740	.107	.064
3.125	79.4	2.892		.272		.141		.093		2.957		.103		3.820	.120	.072
3.156	80.2	2.920		.274		.143		.093		2.986		.103		3.850	.120	.072
3.250	82.0	3.006	±.005	.280	±.008	.145		.093		3.076		.103		3.950	.123	.074
3.346	85.0	3.092		.286		.147		.093		3.166		.103		4.040	.126	.076
3.438	87.3	3.179		.292		.148		.093		3.257		.103		4.140	.129	.077
3.500	88.9	3.237	±.020 -.030	.285		.148		.109		3.316	±.006	.120		4.250	.122	.073
3.543	90.0	3.277		.288		.149		.109	±.003	3.357		.120	±.005	4.290	.123	.074
3.625	92.0	3.352		.296		.153		.109		3.435	±.006 2/ FIM 2/	.120	-.000	4.370	.127	.076
3.688	93.7	3.410		.302		.156		.109		3.493		.120		4.430	.129	.078
3.750	95.2	3.468		.310		.160		.109		3.552		.120		4.500	.133	.080
3.875	98.4	3.584		.318		.163		.109		3.673		.120		4.600	.137	.082
3.938	100.0	3.642		.318		.163		.109		3.734		.120		4.700	.137	.082
4.000	101.6	3.700		.318		.163		.109		3.792		.120		4.780	.135	.081
4.250	108.0	3.989		.318		.176		.109		4.065		.120		5.090	.146	.088
4.375	111.1	4.106		.318		.181		.109		4.190		.120		5.220	.146	.088
4.500	114.3	4.223		.285		.128		.109		4.310		.120		5.370	.102	.061
4.750	120.6	4.458		.303		.136		.109		4.550		.120		5.670	.115	.069
5.000	127.0	4.692		.360	±.010	.194		.109		4.790		.120		5.960	.165	.099
5.250	133.3	4.927		.372		.211		.125		5.030		.139	±.006	6.270	.169	.101
5.500	139.7	5.162	±.020 -.040	.390		.209		.125	±.004	5.265		.139	-.000	6.570	.175	.105
5.750	146.0	5.396		.408		.220		.125		5.505	±.006 2/ FIM 2/	.139		6.860	.184	.110
6.000	152.4	5.631		.381		.171		.125		5.745		.174		7.160	.143	.086
6.250	158.7	5.866		.396		.176		.156		5.985		.174		7.460	.148	.089
6.500	165.1	6.100	±.020 -.050	.438		.236		.156		6.225		.174		7.870	.191	.114
6.750	171.4	6.335		.608		.246		.156		6.465	±.008	.174	±.008	8.060	.200	.120
7.000	177.8	6.570		.474		.256		.156		6.705		.174	-.000	8.360	.208	.125
7.500	190.5	7.009	±.012	.507	±.015	.277		.187	±.005	7.180		.209		8.960	.220	.132
8.000	203.2	7.478		.735		.294		.187		7.660	±.006 2/ FIM 2/	.209		9.600	.235	.141
8.500	215.9	7.947	±.050	.573		.314		.187		8.140		.209		10.100	.250	.150
9.000	228.6	8.415	±.130	.609		.333		.187		8.620		.209		10.600	.267	.160
9.500	241.3	8.885		.735		.350		.187		9.100		.209		11.100	.281	.168
10.000	254.0	9.355		.642		.367		.187		9.575		.209		11.600	.294	.176

FOR FOOTNOTES SEE PAGE 4

PA
NAVY - OS
Other Cust
ARMY - AR
AIR FORCE - 99INTERNATIONAL
INTEREST

TITLE

RING, RETAINING, EXTERNAL, BASIC
(TAPERED SECTION TYPE)

MILITARY STANDARD

MS16624

PROCUREMENT SPECIFICATION
MIL-R-21248

SUPERSEDES

MS9012 (ASG) AND MS9013 (ASG)

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FED SUP CLASS
5365

- 1/ T - THICKNESS "T" APPLIES TO UNPLATED RINGS. FOR CORROSION RESISTANT STEEL AND PLATED RINGS, +.002 SHOULD BE ADDED TO THE MAXIMUM TOLERANCE, i.e. $\pm .002$ SHOULD BE $\pm .004/- .002$.
- 2/ FIM - (FULL INDICATOR MOVEMENT) IS THE MAXIMUM ALLOWABLE DEVIATION OF CONCENTRICITY BETWEEN THE GROOVE AND THE SHAFT.
- 3/ R - MAXIMUM DIAMETER WHEN THE RING IS PROPERLY SEATED IN THE GROOVE. (DESIGN REFERENCE DIMENSION).
- 4/ C - ACTUAL CLEARANCE DIAMETER WHEN THE RING IS SPRUNG OVER THE SHAFT PRIOR TO INSTALLATION INTO THE GROOVE. (DESIGN REFERENCE DIMENSION).
- 5/ R AND CH - RADII OR CHAMFERS ALLOWABLE ON PARTS TO BE RETAINED BY THE RINGS. ALLOWABLE THRUST LOADS FOR RINGS RETAINING PARTS WITH MAXIMUM CORNER RADII OR CHAMFERS ARE LISTED IN TABLE VII ON PAGE 9.

REQUIREMENTS:

- CLASSIFICATION:** RETAINING RINGS FURNISHED UNDER THIS STANDARD SHALL BE TYPE 1, CLASS 2 OF THE PROCUREMENT SPECIFICATION.
- MATERIAL:** CARBON SPRING STEEL, GRADE 1060 THRU 1095 (UNS G10600 THRU G10950) IN ACCORDANCE WITH ASTM A 568 OR ASTM A 682.
CORROSION RESISTANT STEEL, IN ACCORDANCE WITH AMS 5520 (UNS S15700).
BERYLLIUM COPPER, ALLOY NUMBER 170 (UNS C17000) OR ALLOY NUMBER 172 (UNS C17200) IN ACCORDANCE WITH ASTM B 194.
- HARDNESS:**

TABLE II. HARDNESS

Ø SHAFT (REF)	CARBON STEEL	CORROSION RESISTANT STEEL	BERYLLIUM COPPER
.125 TO .236 .250 TO .669 .688 TO 1.500 1.562 TO 3.437 3.500 & ABOVE .250 TO .812 .875 & ABOVE .250 TO 1.023 1.062 & ABOVE	68.5-73.0 HR30N 52.5-59.0 HR45N 46.0-51.0 HRC 44.0-49.0 HRC	63-69.5 HR30N 44-51 HRC	77 TO 82 HR15N 56.5 TO 62 HR30N 37 TO 43 HRC

4. PROTECTIVE FINISH OR SURFACE TREATMENT:

- CARBON STEEL - SHALL BE (SEE TABLE III, IV OR V):
 - CADMIUM PLATE IN ACCORDANCE WITH QQ-P-416, TYPE II, CLASS 3 OR ASTM B 696, TYPE II, CLASS 5.
 - ZINC COAT IN ACCORDANCE WITH ASTM B633, TYPE II, CLASS Fe/Zn 5 OR ASTM B 695, TYPE II, CLASS 5.
 - PHOSPHATE COAT IN ACCORDANCE WITH DOD-P-16232, TYPE 2, CLASS 2.
- CORROSION RESISTANT STEEL - SHALL BE CLEANED, DESCALED AND PASSIVATED IN ACCORDANCE WITH QQ-P-35.
- BERYLLIUM COPPER - CADMIUM PLATE IN ACCORDANCE WITH QQ-P-416, TYPE II, CLASS 3 OR ASTM B 696, TYPE II, CLASS 5.

- PART NUMBER:** THE BASIC MS PART NUMBER IS FOLLOWED BY A DASH NUMBER TAKEN FROM TABLE III, IV OR V.

EXAMPLE: MS16624-1100 IS THE PART NUMBER FOR A CARBON STEEL CADMIUM PLATE, EXTERNAL BASIC RETAINING RING FOR USE ON A 1.000 SHAFT DIAMETER.

NOTES:

- UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES.
- IN THE EVENT OF A CONFLICT BETWEEN THE TEXT OF THIS STANDARD AND THE REFERENCES CITED HEREIN, THE TEXT OF THIS STANDARD SHALL TAKE PRECEDENCE.
- REFERENCED GOVERNMENT (OR NON-GOVERNMENT) DOCUMENTS OF THE ISSUE LISTED IN THAT ISSUE OF THE DEPARTMENT OF DEFENSE INDEX OF SPECIFICATIONS AND STANDARDS (DODISS) SPECIFIED IN THE SOLICITATION FORM A PART OF THIS STANDARD TO THE EXTENT SPECIFIED HEREIN.

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11 DEC 1958

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PA NAVY - OS Other Cust ARMY - AR AIR FORCE - 99	INTERNATIONAL INTEREST	TITLE RING, RETAINING, EXTERNAL, BASIC (TAPERED SECTION TYPE)	MILITARY STANDARD MS16624
PROCUREMENT SPECIFICATION MIL-R-21248	SUPERSEDES MS9012 (ASG) AND MS9013 (ASG)	PAGE 4	OF 9

This military standard is approved for use by all Departments and Agencies of the Department of Defense.
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REVIEWER ACTIVITIES:
ARMY - AV, ER, ME, MI
AIR FORCE - B2
DLA - IS

USER ACTIVITIES:
ARMY - AT
NAVY - AS, MC

TABLE III. DASH NUMBERS FOR MS16624

O/S SHAFT (REF)	CARBON STEEL OLD PLATE	CARBON STEEL ZINC COAT	CARBON STEEL PHOSPHATE COAT	CRES	Be COPPER OLD PLATE	Be COPPER OLD PLATE	CRES	CARBON STEEL PHOSPHATE COAT	CARBON STEEL ZINC COAT	CARBON STEEL OLD PLATE	CRES	O/S SHAFT (REF)	CARBON STEEL ZINC COAT	CARBON STEEL PHOSPHATE COAT	CARBON STEEL OLD PLATE
	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO	DASH NO
1.75	1025	2025	3025	4025	5025	5025	4025	3025	2025	1025	4312	3.125	2312	3312	4312
1.56	1027	2027	3027	4027	5027	5027	4027	3027	2027	1027	4315	3.156	2315	3315	4315
1.188	1028	2028	3028	4028	5028	5028	4028	3028	2028	1028	4325	3.250	2325	3325	4325
1.197	1029	2029	3029	4029	5029	5029	4029	3029	2029	1029	4334	3.146	2334	3334	4334
1.219	1030	2030	3030	4030	5030	5030	4030	3030	2030	1030	4343	3.438	2343	3343	4343
1.234	1031	2031	3031	4031	5031	5031	4031	3031	2031	1031	4350	3.500	2350	3350	4350
1.250	1032	2032	3032	4032	5032	5032	4032	3032	2032	1032	4354	3.543	2354	3354	4354
1.276	1033	2033	3033	4033	5033	5033	4033	3033	2033	1033	4362	3.625	2362	3362	4362
1.281	1034	2034	3034	4034	5034	5034	4034	3034	2034	1034	4368	3.688	2368	3368	4368
1.312	1035	2035	3035	4035	5035	5035	4035	3035	2035	1035	4375	3.750	2375	3375	4375
1.344	1036	2036	3036	4036	5036	5036	4036	3036	2036	1036	4387	3.875	2387	3387	4387
1.354	1037	2037	3037	4037	5037	5037	4037	3037	2037	1037	4393	3.938	2393	3393	4393
1.375	1038	2038	3038	4038	5038	5038	4038	3038	2038	1038	4400	4.000	2400	3400	4400
1.394	1039	2039	3039	4039	5039	5039	4039	3039	2039	1039	4425	4.250	2425	3425	4425
1.406	1040	2040	3040	4040	5040	5040	4040	3040	2040	1040	4437	4.375	2437	3437	4437
1.438	1041	2041	3041	4041	5041	5041	4041	3041	2041	1041	4450	4.500	2450	3450	4450
1.469	1042	2042	3042	4042	5042	5042	4042	3042	2042	1042	4475	4.750	2475	3475	4475
1.500	1043	2043	3043	4043	5043	5043	4043	3043	2043	1043	4500	5.000	2500	3500	4500
1.551	1044	2044	3044	4044	5044	5044	4044	3044	2044	1044	4525	5.250	2525	3525	4525
1.562	1045	2045	3045	4045	5045	5045	4045	3045	2045	1045	4550	5.500	2550	3550	4550
1.594	1046	2046	3046	4046	5046	5046	4046	3046	2046	1046	4575	5.750	2575	3575	4575
1.625	1047	2047	3047	4047	5047	5047	4047	3047	2047	1047	4600	6.000	2600	3600	4600
1.669	1048	2048	3048	4048	5048	5048	4048	3048	2048	1048	4625	6.250	2625	3625	4625
1.672	1049	2049	3049	4049	5049	5049	4049	3049	2049	1049	4650	6.500	2650	3650	4650
1.688	1050	2050	3050	4050	5050	5050	4050	3050	2050	1050	4675	6.750	2675	3675	4675
1.701	1051	2051	3051	4051	5051	5051	4051	3051	2051	1051	4700	7.000	2700	3700	4700
1.781	1052	2052	3052	4052	5052	5052	4052	3052	2052	1052	4750	7.500	2750	3750	4750
1.812	1053	2053	3053	4053	5053	5053	4053	3053	2053	1053	4800	8.000	2800	3800	4800
1.875	1054	2054	3054	4054	5054	5054	4054	3054	2054	1054	4850	8.500	2850	3850	4850
1.938	1055	2055	3055	4055	5055	5055	4055	3055	2055	1055	4900	9.000	2900	3900	4900
1.964	1056	2056	3056	4056	5056	5056	4056	3056	2056	1056	4950	9.500	2950	3950	4950
1.000	1100	2100	3100	4100	5100	5100	4100	3100	2100	1100	5000	10.000	3000	4000	5000
1.023	1102	2102	3102	4102	5102	5102	4102	3102	2102	1102					

1/ SUBSTITUTED COMPRESSION RESISTANCE STEEL. WHEN USED IN FOOD PROCESSING MACHINERY, OR IN FUEL OR LUBRICATION SYSTEMS,
OR WHEN USED AT TEMPERATURES OVER 450°F (233°C).

P.A. NAVY - OS Other Cust ARMY - AR AIR FORCE - 99	INTERNATIONAL INTEREST	TITLE RING, RETAINING, EXTERNAL, BASIC (TAPERED SECTION TYPE)	MILITARY STANDARD MS16624
PROCUREMENT SPECIFICATION MIL-R-21248	SUPERSEDES MS9012 (ASG) AND MS9013 (ASG)	PAGE 5 OF 9	

USER ACTIVITIES:
ARMY - AT
NAVY - AS, MC

REVIEWER ACTIVITIES:
ARMY - AV, ER, ME, MI
AIR FORCE - 82
DLA - IS

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TABLE IV. SUBSTITUTION TABLE CROSS REFERENCE OF PART NUMBERS

Q.S. SHAFT (REF)	INACTIVE	SUBST	INACTIVE	SUBST	INACTIVE	SUBST	INACTIVE	SUBST	Q.S. SHAFT (REF)	INACTIVE	SUBST	INACTIVE	SUBST	Q.S. SHAFT (REF)	INACTIVE	SUBST	INACTIVE	SUBST
MS9013	MS16624	MS16624	MS9013	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624	MS16624
250	01	1025	25	1025	1125	2125	1125	2125	1.250	30	1125	2125	1125	1.250	30	1125	2125	1125
276	02	1027	27	1027	1127	2127	1127	2127	1.312	31	1127	2127	1127	1.312	31	1127	2127	1127
281	03	1028	28	1028	1128	2128	1128	2128	1.375	32	1128	2128	1128	1.375	32	1128	2128	1128
312	04	1031	31	1031	1131	2131	1131	2131	1.438	33	1131	2131	1131	1.438	33	1131	2131	1131
344	05	1034	34	1034	1134	2134	1134	2134	1.500	34	1134	2134	1134	1.500	34	1134	2134	1134
354	06	1035	35	1035	1135	2135	1135	2135	1.562	35	1135	2135	1135	1.562	35	1135	2135	1135
375	07	1037	37	1037	1137	2137	1137	2137	1.625	36	1137	2137	1137	1.625	36	1137	2137	1137
394	08	1039	39	1039	1139	2139	1139	2139	1.688	37	1139	2139	1139	1.688	37	1139	2139	1139
406	09	1040	40	1040	1140	2140	1140	2140	1.750	38	1140	2140	1140	1.750	38	1140	2140	1140
438	10	1043	43	1043	1143	2143	1143	2143	1.772	39	1143	2143	1143	1.772	39	1143	2143	1143
465	11	1046	46	1046	1146	2146	1146	2146	1.812	40	1146	2146	1146	1.812	40	1146	2146	1146
469	12	1049	49	1049	1149	2149	1149	2149	1.875	41	1149	2149	1149	1.875	41	1149	2149	1149
531	13	1055	55	1055	1155	2155	1155	2155	1.969	42	1155	2155	1155	1.969	42	1155	2155	1155
562	14	1056	56	1056	1156	2156	1156	2156	2.000	43	1156	2156	1156	2.000	43	1156	2156	1156
594	15	1059	59	1059	1159	2159	1159	2159	2.062	44	1159	2159	1159	2.062	44	1159	2159	1159
625	16	1062	62	1062	1162	2162	1162	2162	2.125	45	1162	2162	1162	2.125	45	1162	2162	1162
669	17	1066	66	1066	1166	2166	1166	2166	2.156	46	1166	2166	1166	2.156	46	1166	2166	1166
672	18	1067	67	1067	1167	2167	1167	2167	2.250	47	1167	2167	1167	2.250	47	1167	2167	1167
688	19	1068	68	1068	1168	2168	1168	2168	2.312	48	1168	2168	1168	2.312	48	1168	2168	1168
750	20	1075	75	1075	1175	2175	1175	2175	2.375	49	1175	2175	1175	2.375	49	1175	2175	1175
781	21	1078	78	1078	1178	2178	1178	2178	2.438	50	1178	2178	1178	2.438	50	1178	2178	1178
812	22	1081	81	1081	1181	2181	1181	2181	2.500	51	1181	2181	1181	2.500	51	1181	2181	1181
875	23	1087	87	1087	1187	2187	1187	2187	2.559	52	1187	2187	1187	2.559	52	1187	2187	1187
938	24	1093	93	1093	1193	2193	1193	2193	2.625	53	1193	2193	1193	2.625	53	1193	2193	1193
984	25	1099	99	1099	1199	2199	1199	2199	2.688	54	1199	2199	1199	2.688	54	1199	2199	1199
1,000	26	1100	100	1100	1200	2200	1200	2200	2.750	55	1200	2200	1200	2.750	55	1200	2200	1200
1,071	27	1102	102	1102	1202	2202	1202	2202	2.875	56	1202	2202	1202	2.875	56	1202	2202	1202
1,062	28	1106	106	1106	1206	2206	1206	2206	2.938	57	1206	2206	1206	2.938	57	1206	2206	1206
1,125	29	1112	112	1112	1212	2212	1212	2212	3.000	58	1212	2212	1212	3.000	58	1212	2212	1212
1,188		1118	118	1118	1218	2218	1218	2218	3.062	59	1218	2218	1218	3.062	59	1218	2218	1218

✓ SUBSTITUTE CONNECTION MS16624 STEEL WHEN USED IN FOOD PROCESSING MACHINERY, OR IN FUEL OR LUBRICATION SYSTEMS, OR WHEN USED AT TEMPERATURES OVER 150°F (213°C).

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TABLE V. SUBSTITUTION TABLE (CROSS REFERENCE OF PART NUMBERS)

Ø s SHAFT (REF)	INACTIVE	INACTIVE	SUBST	Ø s SHAFT (REF)	INACTIVE	SUBST
	BERYLLIUM 1/2 COPPER	BERYLLIUM 1/2 COPPER	BERYLLIUM 1/2 COPPER		BERYLLIUM 1/2 COPPER CAD PLATE	BERYLLIUM 1/2 COPPER CAD PLATE
	MS9012	MS16624	MS16624		MS16624	MS16624
.125	01	12	5012	.125	1012	5012-1
.156	02	15	5015	.156	1015	5015-1
.188	03	18	5018	.188	1018	5018-1
.197	04	19	5019	.197	1019	5019-1
.219	05	21	5021	.219	1021	5021-1
.236	06	23	5023	.236	1023	5023-1

1/ SUBSTITUTE CORROSION RESISTANT STEEL WHEN USED IN FOOD PROCESSING MACHINERY, OR IN FUEL OR LUBRICATION SYSTEMS, OR WHEN USED AT TEMPERATURES OVER 450°F (233°C).

RECOMMENDED DESIGN LIMITATIONS AND USAGE

- (a) INTENDED USE - TO PROVIDE SHOULDERS FOR POSITIONING AND RETAINING MACHINE COMPONENTS ON SHAFTS. TAPERED DESIGN PRINCIPLE PERMITS RINGS TO MAINTAIN PRACTICALLY CONSTANT CIRCULARITY AND PRESSURE AGAINST BOTTOM OF GROOVE, COUNTERACTING CONSIDERABLE CENTRIFUGAL FORCE (SEE TABLE VI). RINGS FOR SHAFT DIAMETERS OVER 4 INCHES ARE SPECIALLY DIMENSIONED TO MAINTAIN BALANCE IN ROTATION. THE USE OF THE FOLLOWING FORMULAS ARE BASED ON THE FACT THAT THE RING WILL NOT FAIL IN COMPRESSION.

LIMITATION ON USE - THE FOLLOWING FORMULAS ARE NOT TO BE USED FOR BRITTLE MATERIALS SUCH AS CAST IRON, ETC.

WARNING - RINGS SHOULD NOT BE OVER EXPANDED DURING INSTALLATION SINCE THIS WILL LEAD TO RING FAILURE. IF RING HAS PLAY BETWEEN THE GROOVE DIAMETER AND THE INSIDE RING DIAMETER THIS INDICATES THAT THE RING HAS BEEN OVER EXPANDED, (PROVIDING GROOVE HAS BEEN MACHINED TO RECOMMENDED DIMENSIONS).

FOR APPROXIMATE SAFETY RPM LIMITS SEE TABLE VI.

TABLE VI. APPROXIMATE SAFETY RPM LIMITS

Ø SHAFT (INCHES)		.125	.500	1	2	3	4	6	8	10
CARBON STEEL AND CORROSION RESISTANT STEEL	RPM LIMIT	80,000	40,000	20,000	10,000	6,700	5,000	3,400	2,500	2,000
BERYLLIUM COPPER	RPM LIMIT	50,000	25,000	13,000	6,400					

- (b) ALLOWABLE THRUST LOAD CAPACITY OF THE RINGS. ABUTTING COMPONENTS TO HAVE SHARP CORNERS -

$$P = \frac{NSTX}{F}$$

WHERE:

P = ALLOWABLE THRUST LOAD (POUNDS)

S = SHAFT DIAMETER (INCHES)

T = RING THICKNESS (INCHES)

X = ULTIMATE SHEAR STRENGTH OF THE RING MATERIAL (PSI) ✓

F = FACTOR OF SAFETY

A SAFETY FACTOR, $F = 4$, IS RECOMMENDED, SINCE THE RING UNDER LOAD IS SUBJECTED NOT ONLY TO THE PURE SHEAR STRESSES, BUT ALSO TO BENDING STRESSES.

- (c) ALLOWABLE LOAD CAPACITY OF GROOVE WALL -

$$P = \frac{\pi S d Y}{E}$$

WHERE:

P = ALLOWABLE COMPRESSION LOAD (POUNDS)

S = SHAFT DIAMETER (INCHES)

d = GROOVE DEPTH (INCHES)

Y = YIELD STRENGTH IN COMPRESSION OF THE GROOVE MATERIAL (PSI)

F = FACTOR OF SAFETY

TO INSURE A SAFE WORKING LOAD, A SAFETY FACTOR, $F = 2$, IS RECOMMENDED.

- (d) MINIMUM DISTANCE BETWEEN OUTER GROOVE WALL AND END OF SHAFT -

Z = 3d

WHERE:

2 = MINIMUM DISTANCE BETWEEN OUTER GROOVE AND END OF SHAFT (INCHES)

d = GROOVE DEPTH (INCHES)

- 1/ X = 120,000 PSI ULTIMATE SHEAR STRENGTH FOR RINGS UP TO AND INCLUDING .672 INCH SHAFT DIAMETER OF CARBON STEEL OR CORROSION RESISTANT STEEL.
X = 150,000 PSI ULTIMATE SHEAR STRENGTH FOR RINGS .688 INCH AND OVER SHAFT DIAMETER OF CARBON STEEL OR CORROSION RESISTANT STEEL.
X = 110,000 PSI ULTIMATE SHEAR STRENGTH FOR RINGS OF ALL SHAFT DIAMETERS AND OF BERYLLIUM COPPER.

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(e) DIFFERENTIAL ROTATION =

THE CONDITIONS UNDER WHICH A RETAINING RING MAY BE USED WHEN ADJACENT PARTS ROTATE RELATIVE TO IT, FALL INTO TWO CATEGORIES:

1. WHERE NO THRUST IS EXERTED BY ADJACENT PART; IN THIS CASE, DIFFERENTIAL ROTATION OF RING AND ADJACENT PART CREATES NO ELEMENT OF RISK IN THE APPLICATION OF THE RINGS BECAUSE NO FRICTIONAL TORQUE IS EXERTED BY THE MACHINE PART ON THE RING.
2. CONSIDERATION MUST BE GIVEN TO THE MAGNITUDE OF THE THRUST INVOLVED. THE FRICTION MOMENT MAY NOT EXCEED THE BENDING MOMENT, WHICH THE RING CAN TOLERATE WITHOUT RELEASING ITS PRESSURE AGAINST THE BOTTOM OF THE GROOVE, FORMULATED AS FOLLOWS:

$$FPM \leq \frac{STE^2}{18}$$

OR

$$P \leq \frac{STE^2}{f18N}$$

WHERE:

P = ALLOWABLE THRUST LOAD EXERTED BY ADJACENT PART (POUNDS)
f = COEFFICIENT OF FRICTION
S = WORKING STRESS OF RING UNDER MAXIMUM EXPANSION (PSI)^{2/}
T = RING THICKNESS (INCHES)
E = GREATEST WIDTH SECTION OF RING (INCHES)
N = NEUTRAL RING DIAMETER (INCHES), FREE DIAMETER PLUS 3/4 E DIMENSION

IN SUCH CASES WHERE DIFFERENTIAL ROTATION OCCURS, THE CALCULATION SHOULD BE BASED ON THE MAXIMUM POSSIBLE VALUE OF THE COEFFICIENT OF FRICTION.

(f) IMPACT CAPACITY OF RING OR GROOVE WALL =

$$I_R = \frac{PT}{2} - \text{FOR THE RING (INCH POUNDS), ABUTTING COMPONENTS TO HAVE SHARP CORNERS.}$$

$$I_G = \frac{Pd}{2} - \text{FOR THE GROOVE (INCH POUNDS)}$$

WHERE:

P = ALLOWABLE THRUST LOAD OF RINGS OR GROOVES (POUNDS)
T = RING THICKNESS (INCHES)
I_G = IMPACT CAPACITY OF GROOVE WALL (INCH POUNDS)
d = GROOVE DEPTH (INCHES)
I_R = IMPACT CAPACITY OF RING (INCH POUNDS)

(g) LOAD CAPACITY, WITH THE RETAINED PART RADIUS OR CHAMFERED =

WHEN THE RADIUS OR CHAMFER OF THE RETAINED PART DOES NOT EXCEED THE MAXIMUM RADIUS ALLOWED FOR THE BOTTOM OF THE RING GROOVE, THE LESSER LOAD CAPACITY COMPUTED FROM THE FORMULAS ON PAGES 7 AND 8 WILL APPLY. THE CORNER RADIUS AND CHAMFERS LISTED ON PAGES 1 THRU 3 WERE CHOSEN AS LARGE AS POSSIBLE FOR THE RING SIZES INVOLVED AND ARE RELATED TO THE MAXIMUM THRUST LOADS LISTED IN THE TABLE ON PAGE 9. IF THE CORNER RADIUS OR CHAMFERS ARE SMALLER THAN THOSE LISTED, THEN THE THRUST LOADS INCREASE PROPORTIONALLY, IN ACCORDANCE WITH THE FOLLOWING FORMULAS:

$$P^1 = \frac{P \cdot CH}{CH^1}$$

OR

$$P^1 = \frac{P \cdot R}{R^1}$$

WHERE:

P¹ = NEW ALLOWABLE THRUST LOAD
P = LISTED ALLOWABLE THRUST LOAD
CH¹ = NEW (SMALLER) CHAMFER
CH = LISTED CHAMFER
R¹ = NEW (SMALLER) CORNER RADIUS
R = LISTED CORNER RADIUS

- ^{2/} S = 250,000 PSI WORKING STRESS FOR RINGS OF CARBON STEEL OR CORROSION RESISTANT STEEL
S = 200,000 PSI WORKING STRESS FOR RINGS OF BERYLLIUM COPPER.

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LIMIT LOADS LISTED BELOW ARE BASED ON RINGS OF BERYLLIUM COPPER (WORKING STRESS 180,000 PSI) FOR SIZES BELOW .250 INCH AND ON RINGS OF STEEL (WORKING STRESS 250,000 PSI) FOR SIZES .250 INCH AND OVER. IF THE ALLOWABLE GROOVE CAPACITY LOADS AS CALCULATED BY USING THE FORMULA ON PAGE 7 ARE LESS, THEN THEY SHOULD BE USED.

TABLE VII. LIMIT LOADS.

NOMINAL RING SIZE		ALLOWABLE THRUST LOAD FOR RING ASSEMBLIES WITH PARTS HAVING MAXIMUM CORNER RADIUS OR CHAMFERS	
FROM	TO	CARBON STEEL OR CRES	BERYLLIUM COPPER
.125	.156		45 LB
.188	.236		105 LB
.250	.469	470 LB	340 LB
.500	.672	910 LB	650 LB
.688	1.023	1340 LB	950 LB
1.062	1.500	1950 LB	1400 LB
1.562	2.000	3000 LB	2100 LB
2.062	2.688	5000 LB	
2.750	3.438	7350 LB	
3.500	5.000	10500 LB	
5.250	6.000	13500 LB	
6.250	7.000	21000 LB	
7.500	10.000	30000 LB	

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