

WELLS



Special and Standard
Taps and Dies

Greenfield, MA



THE WELLS LEGACY

Greenfield, Massachusetts, founded in 1763, with 365 residents, grew quickly due to its strategic location at the junction of the Deerfield and Connecticut rivers. Northampton resident John J. Grant moved to Greenfield with plans for a new die that would make a better screw. This die was patented in 1871 as the "two pieced die". Prior to the creation of this invention, nuts and bolts were crushed into shape with little chance of a perfect fit. The new two pieced die cut the metal rather than compressing it to shape in the old manner. Grant's two pieced die removed all imperfections and guaranteed a perfect fit every time.

In 1874, the Wells brothers, Fredrick E. and Frank O., left the Wiley & Russell tap & die company. In a small building along the Green River in Greenfield, MA, they, along with their father, Elias, started Wells Brothers, a tap and die manufacturing business. Because of a fire, the Wells brothers were forced to relocate to the B. B. Noyes Foundry on Hope Street while they rebuilt their company. Here, the first adjustable die was invented. Their new building was their home for the next ten years. In 1900 the elder brother, Fredrick, split from his brother and began manufacturing pipe tools. By 1910 he and his son, Fred W. Wells, combined forces with the E.F. Reece company and prospered until 1922 when the company was absorbed by his brother's company, Greenfield Tap & Die.

In 1928, Fredrick founded the Wells Tool Company in the same B. B. Noyes building he resided in during 1889. Although his company was small, it survived because its foundations were laid by the man who virtually founded the tap & die industry. He emphasized the necessity of high quality and customer satisfaction. The company gained fame by being able to provide its customers with a variety of quality standard and specialty items.

In 1946, Mr. Harold A. Gardner and Mr. Joseph Ballard acquired Wells Tool. Both men were former employees of the company and were well acquainted with how to make a quality tap based on the foundations of its previous owner. They also brought fresh and innovative ideas. The first of these ideas was to include alternative "H" limits not found in other catalogs at the time.

In 1977, Robert Malloy, a former salesperson for the Bendix Tap Co., took over as Owner and President. It was his belief to give his customers top quality taps at the absolute lowest prices. Despite the fact that some consumers believed the lowest prices equated with the lowest quality, they quickly discovered that with Wells taps, this was not true. Constantly on the road, he peddled his taps and greatly broadened the Wells Tool customer base. Unfortunately, in 1994, he fell ill and passed away shortly after. Left to his family, Wells continued for almost five more years. However, during those years, the company slowly began to decline. In the fall of 1999, after almost 72 years of making taps, the company closed its doors. It seemed that the legacy known as the Wells Tool Company had ended.



On January 2, 2000, my father, Philip Duda, reopened the doors of the all-new Wells Tool Company. Having been in the cutting tool industry his entire life with my grandfather John, it was important for him to keep the company alive and to continue the 130-year heritage. From the history above, you can see that Greenfield, Massachusetts was the center for the tap and die industry in America for well over 100 years. His vision was keep the tap industry going strong in Greenfield. In keeping his vision alive, my father has passed the torch to me to carry on the legacy of Wells Tool.

I am proud to provide you with our brand new catalog and website. If what you are looking for is not within these pages, please call (413) 773-3465 or visit us www.wellstool.com.

Cort Duda
President
Wells Tool Company Inc.

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HAND TAPS GROUND THREAD HSS

MACHINE SCREW SIZES TAPER PLUG BOTTOM



Nominal Size	H Limits	# of Flutes	Thread Length	Overall Length	Taper Part No.	Plug Part No.	Bottom Part No.	Set Part No
0-80 UNC	1	2	5/16	1 5/8	30650-11	30650-21	30650-31	30650-41
0-80 UNC	2	2	5/16	1 5/8	30650-12	30650-22	30650-32	30650-42
1-64 UNC	1	2	3/8	1 11/16	30651-11	30651-21	30651-31	30651-41
1-64 UNC	2	2	3/8	1 11/16	30651-12	30651-22	30651-32	30651-42
1-72 UNF	1	2	3/8	1 11/16	30672-11	30672-21	30672-31	30671-41
1-72 UNF	2	2	3/8	1 11/16	30672-12	30672-22	30672-32	30672-42
2-56 UNC	1	3	7/16	1 3/4	30652-11	30652-21	30652-31	30652-41
2-56 UNC	2	3	7/16	1 3/4	30652-12	30652-22	30652-32	30652-42
2-64 UNF	2	3	7/16	1 3/4	30653-12	30653-22	30653-32	30653-42
3-48 UNC	2	3	1/2	1 13/16	30654-12	30654-22	30654-32	30654-42
3-56 UNF	2	3	1/2	1 13/16	30655-12	30655-22	30655-32	30655-42
4-40 UNC	1	2	9/16	1 7/8	30656-11	30656-21	30656-31	30656-41
4-40 UNC	2	2	9/16	1 7/8	30656-12	30656-22	30656-32	30656-42
4-40 UNC	1	3	9/16	1 7/8	30601-11	30601-21	30601-31	30601-41
4-40 UNC	2	3	9/16	1 7/8	30601-12	30601-22	30601-32	30601-42
4-48 UNF	1	3	9/16	1 7/8	30602-11	30602-21	30602-31	30602-41
4-48 UNF	2	3	9/16	1 7/8	30602-12	30602-22	30602-32	30602-41
4-36 NS	2	3	9/16	1 7/8	30600-12	30600-22	30600-32	30600-42
5-40 UNC	1	3	5/8	1 15/16	30603-11	30603-21	30603-31	30603-41
5-40 UNC	2	2	5/8	1 15/16	30657-12	30657-22	30657-32	30657-42
5-40 UNC	2	3	5/8	1 15/16	30603-12	30603-22	30606-32	30603-42
5-44 UNF	2	3	5/8	1 15/16	30604-12	30604-22	30604-32	30604-42
6-32 UNC	1	2	11/16	2	30658-11	30658-21	30658-31	30658-41
6-32 UNC	1	3	11/16	2	30605-11	30605-21	30605-31	30605-41
6-32 UNC	2	2	11/16	2	30658-12	30658-22	30658-32	30658-42
6-32 UNC	2	3	11/16	2	30605-12	30605-22	30605-32	30605-42
6-32 UNC	3	2	11/16	2	30658-13	30658-23	30658-33	30658-43
6-32 UNC	3	3	11/16	2	30605-13	30605-23	30605-33	30605-43
6-32 UNC	7	3	11/16	2	30605-17	30605-27	30605-37	30605-47
6-40 UNF	1	3	11/16	2	30606-11	30606-21	30606-31	30606-41
6-40 UNF	2	2	11/16	2	30659-12	30659-22	30659-32	30659-42
6-40 UNF	2	3	11/16	2	30606-12	30606-22	30606-32	30606-42

HAND TAPS GROUND THREAD HSS



MACHINE SCREW SIZES



Nominal Size	H Limits	# of Flutes	Thread Length	Overall Length	Taper Part No.	Plug Part No.	Bottom Part No.	Set Part No.
8-32 UNC	1	4	3/4	2 1/8	30607-11	30607-21	30607-31	30607-41
8-32 UNC	2	2	3/4	2 1/8	30660-12	30660-22	30660-32	30660-42
8-32 UNC	2	3	3/4	2 1/8	30661-12	30661-22	30661-32	30661-42
8-32 UNC	2	4	3/4	2 1/8	30607-12	30607-22	30607-32	30607-42
8-32 UNC	3	2	3/4	2 1/8	30660-13	30660-23	30660-33	30660-43
8-32 UNC	3	3	3/4	2 1/8	30661-13	30660-23	30661-33	30661-43
8-32 UNC	3	4	3/4	2 1/8	30607-13	30607-23	30607-33	30607-43
8-32 UNC	7	4	3/4	2 1/8	30607-17	30607-27	30607-37	30607-47
8-36 UNF	1	4	3/4	2 1/8	30608-11	30608-21	30608-31	30608-48
8-36 UNF	2	4	3/4	2 1/8	30608-12	30608-22	30608-32	30608-42
10-24 UNC	1	4	7/8	2 3/8	30609-11	30609-21	30609-31	30609-41
10-24 UNC	2	2	7/8	2 3/8	30662-12	30662-22	30662-32	30662-42
10-24 UNC	2	3	7/8	2 3/8	30663-12	30663-22	30663-32	30663-42
10-24 UNC	2	4	7/8	2 3/8	30609-12	30609-22	30609-32	30609-42
10-24 UNC	3	2	7/8	2 3/8	30662-13	30662-23	30662-33	30662-42
10-24 UNC	3	3	7/8	2 3/8	30663-13	30663-23	30663-33	30663-42
10-24 UNC	3	4	7/8	2 3/8	30609-13	30609-23	30609-33	30609-43
10-24 UNC	7	4	7/8	2 3/8	30609-17	30609-27	30609-37	30609-47
10-32 UNF	1	2	7/8	2 3/8	30664-11	30664-21	30664-31	30664-41
10-32 UNF	1	4	7/8	2 3/8	30610-11	30610-21	30610-31	30610-41
10-32 UNF	2	2	7/8	2 3/8	30664-12	30664-22	30664-32	30664-42
10-32 UNF	2	3	7/8	2 3/8	30665-12	30665-22	30665-32	30665-42
10-32 UNF	2	4	7/8	2 3/8	30610-12	30610-22	30610-32	30610-42
10-32 UNF	3	2	7/8	2 3/8	30664-13	30664-23	30664-33	30664-43
10-32 UNF	3	3	7/8	2 3/8	30665-13	30665-23	30665-33	30665-43
10-32 UNF	3	4	7/8	2 3/8	30610-13	30610-23	30610-33	30610-43
10-32 UNF	7	4	7/8	2 3/8	30610-17	30610-27	30610-37	30610-47
12-24 UNC	1	4	15/16	2 3/8	30611-11	30611-21	30611-31	30611-41
12-24 UNC	3	4	15/16	2 3/8	30611-13	30611-23	30611-33	30611-43
12-28 UNF	1	4	15/16	2 3/8	30612-11	30612-21	30611-31	30612-41
12-28 UNF	3	4	15/16	2 3/8	30612-13	30612-23	30612-33	30612-43



HAND TAPS GROUND THREAD HSS



FRACTIONAL SIZES

Nominal Size	H Limits	# of Flutes	Thread Length	Overall Length	Taper Part No.	Plug Part No.	Bottom Part No.	Set Part No.
1/4-20 UNC	1	3	1	2 1/2	30666-11	30666-21	30666-31	30666-41
1/4-20 UNC	1	4	1	2 1/2	30613-11	30613-21	30613-31	30613-41
1/4-20 UNC	2	3	1	2 1/2	30666-12	30666-22	30666-32	30666-42
1/4-20 UNC	2	4	1	2 1/2	30613-12	30613-22	30613-32	30613-42
1/4-20 UNC	3	2	1	2 1/2	30667-13	30667-23	30667-33	30667-43
1/4-20 UNC	1	3	1	2 1/2	30666-13	30666-23	30666-33	30666-43
1/4-20 UNC	3	4	1	2 1/2	30613-13	30613-23	30613-33	30613-43
1/4-20 UNC	5	3	1	2 1/2	30666-15	30666-25	30666-35	30666-45
1/4-20 UNC	5	4	1	2 1/2	30613-15	30613-25	30613-35	30613-45
1/4-28 UNF	1	4	1	2 1/2	30614-11	30614-21	30614-31	30614-41
1/4-28 UNF	2	4	1	2 1/2	30614-12	30614-22	30614-32	30614-42
1/4-28 UNF	3	2	1	2 1/2	30688-13	30688-23	30688-33	30688-43
1/4-28 UNF	3	3	1	2 1/2	30668-13	30668-23	30668-33	30668-43
1/4-28 UNF	3	4	1	2 1/2	30614-13	30614-23	30614-33	30614-43
1/4-28 UNF	4	4	1	2 1/2	30614-14	30614-24	30614-34	30614-44
5/16-18 UNC	1	4	1 1/8	2 23/32	30615-11	30615-21	30615-31	30615-41
5/16-18 UNC	2	4	1 1/8	2 23/32	30615-12	30615-22	30615-32	30615-42
5/16-18 UNC	3	2	1 1/8	2 23/32	30669-13	30669-23	30669-33	30669-43
5/16-18 UNC	3	3	1 1/8	2 23/32	30670-13	30670-23	30670-33	30670-43
5/16-18 UNC	3	4	1 1/8	2 23/32	30615-13	30615-23	30615-33	30615-43
5/16-18 UNC	5	4	1 1/8	2 23/32	30615-15	30615-25	30615-35	30615-45
5/16-24 UNF	1	4	1 1/8	2 23/32	30616-11	30616-21	30616-31	30616-41
5/16-24 UNF	2	4	1 1/8	2 23/32	30616-12	30616-22	30616-32	30616-42
5/16-24 UNF	3	3	1 1/8	2 23/32	30671-13	30671-23	30671-33	30671-43
5/16-24 UNF	3	4	1 1/8	2 23/32	30616-13	30616-23	30616-33	30616-43
5/16-24 UNF	4	3	1 1/8	2 23/32	30671-14	30671-24	30671-34	30671-44
5/16-24 UNF	4	4	1 1/8	2 23/32	30616-14	30616-24	30616-34	30616-44
3/8-16 UNC	1	4	1 1/4	2 15/16	30617-11	30617-21	30617-31	30617-41
3/8-16 UNC	2	4	1 1/4	2 15/16	30617-12	30617-22	30617-32	30617-42
3/8-16 UNC	3	3	1 1/4	2 15/16	30673-13	30673-23	30673-33	30673-43
3/8-16 UNC	3	4	1 1/4	2 15/16	30617-13	30617-23	30617-33	30617-43
3/8-16 UNC	5	4	1 1/4	2 15/16	30617-15	30617-25	30617-35	30617-45
3/8-24 UNF	1	4	1 1/4	2 15/16	30618-11	30618-21	30618-31	30618-41
3/8-24 UNF	2	4	1 1/4	2 15/16	30618-12	30618-22	30618-32	30618-42
3/8-24 UNF	3	3	1 1/4	2 15/16	30674-13	30674-23	30674-33	30674-43
3/8-24 UNF	3	4	1 1/4	2 15/16	30618-13	30618-23	30618-33	30618-43
3/8-24 UNF	4	4	1 1/4	2 15/16	30618-14	30618-24	30618-34	30618-44
7/16-14 UNC	3	3	1 7/16	3 5/32	30675-13	30675-23	30675-33	30675-43
7/16-14 UNC	3	4	1 7/16	3 5/32	30619-13	30619-23	30619-33	30619-43
7/16-14 UNC	5	4	1 7/16	3 5/32	30619-15	30619-25	30619-35	30619-45
7/16-20 UNF	3	3	1 7/16	3 5/32	30676-13	30676-23	30676-33	30676-43
7/16-20 UNF	3	4	1 7/16	3 5/32	30620-13	30620-23	30620-33	30620-43
7/16-20 UNF	5	4	1 7/16	3 5/32	30620-15	30620-25	30620-35	30620-45
1/2-13 UNC	1	4	1 21/32	3 3/8	30621-11	30621-21	30621-31	30621-41
1/2-13 UNC	3	3	1 21/32	3 3/8	30677-13	30677-23	30677-33	30677-43
1/2-13 UNC	3	4	1 21/32	3 3/8	30621-13	30621-23	30621-33	30621-43
1/2-13 UNC	5	4	1 21/32	3 3/8	30621-15	30621-25	30621-35	30621-45
1/2-20 UNF	1	4	1 21/32	3 3/8	30622-11	30622-21	30622-31	30622-41
1/2-20 UNF	3	3	1 21/32	3 3/8	30678-13	30678-23	30678-33	30678-43
1/2-20 UNF	3	4	1 21/32	3 3/8	30622-13	30622-23	30622-33	30622-43

HAND TAPS GROUND THREAD HSS



FRACTIONAL SIZES

Nominal Size	H Limits	# of Flutes	Thread Length	Overall Length	Taper Part No.	Plug Part No.	Bottom Part No.	Set Part No.
1/2-20 UNF	5	4	1 21/32	3 3/8	30622-15	30622-25	30622-35	30622-45
9/16-12 UNC	2	4	1 21/32	3 19/32	30623-12	30623-22	30623-32	30623-42
9/16-12 UNC	3	4	1 21/32	3 19/32	30623-13	30623-23	30623-33	30623-43
9/16-12 UNC	5	4	1 21/32	3 19/32	30623-15	30623-25	30623-35	30623-45
9/16-18 UNF	2	4	1 21/32	3 19/32	30624-12	30624-22	30624-32	30624-42
9/16-18 UNF	3	4	1 21/32	3 19/32	30624-13	30624-23	30624-33	30624-43
9/16-18 UNF	5	4	1 21/32	3 19/32	30624-15	30624-25	30624-35	30624-45
5/8-11 UNC	2	4	1 13/16	3 13/16	30625-12	30625-22	30625-32	30625-42
5/8-11 UNC	3	4	1 13/16	3 13/16	30625-13	30625-23	30625-33	30625-43
5/8-11 UNC	5	4	1 13/16	3 13/16	30625-15	30625-25	30625-35	30625-45
5/8-18 UNF	2	4	1 13/16	3 13/16	30626-12	30626-22	30626-32	30626-42
5/8-18 UNF	3	4	1 13/16	3 13/16	30626-13	30626-23	30626-33	30626-43
5/8-18 UNF	5	4	1 13/16	3 13/16	30626-15	30626-25	30626-35	30626-45
11/16-11 NS	3	4	1 13/16	4 1/32	30627-13	30627-23	30627-33	30627-43
11/16-16 NS	3	4	1 13/16	4 1/32	30628-13	30628-23	30628-33	30628-43
3/4-10 UNC	1	4	2	4 1/4	30629-11	30629-21	30629-31	30629-41
3/4-10 UNC	2	4	2	4 1/4	30629-12	30629-22	30629-32	30629-42
3/4-10 UNC	3	4	2	4 1/4	30629-13	30629-23	30629-33	30629-43
3/4-10 UNC	5	4	2	4 1/4	30629-15	30629-25	30629-35	30629-45
3/4-16 UNF	1	4	2	4 1/4	30630-11	30630-21	30630-31	30630-41
3/4-16 UNF	2	4	2	4 1/4	30630-12	30630-22	30630-32	30630-42
3/4-16 UNF	3	4	2	4 1/4	30630-13	30630-23	30630-33	30630-43
3/4-16 UNF	5	4	2	4 1/4	30630-15	30630-25	30630-35	30630-45
7/8-9 UNC	2	4	2 7/32	4 11/16	30631-12	30631-22	30631-32	30631-42
7/8-9 UNC	4	4	2 7/32	4 11/16	30631-14	30631-24	30631-34	30631-44
7/8-9 UNC	6	4	2 7/32	4 11/16	30631-16	30631-26	30631-36	30631-46
7/8-14 UNF	2	4	2 7/32	4 11/16	30632-12	30632-22	30632-32	30632-42
7/8-14 UNF	4	4	2 7/32	4 11/16	30632-14	30632-24	30632-34	30632-44
7/8-14 UNF	6	4	2 7/32	4 11/16	30632-16	30632-26	30632-36	30632-46
1-8 UNC	2	4	2 1/2	5 1/8	30633-12	30633-22	30633-32	30633-42
1-8 UNC	4	4	2 1/2	5 1/8	30633-14	30633-24	30633-34	30633-44
1-8 UNC	6	4	2 1/2	5 1/8	30633-16	30633-26	30633-36	30633-46
1-12 UNF	4	4	2 1/2	5 1/8	30634-14	30634-24	30634-34	30634-44
1-14 NS	2	4	2 1/2	5 1/8	30635-12	30635-22	30635-32	30635-42
1-14 NS	4	4	2 1/2	5 1/8	30635-14	30635-24	30635-34	30635-44
1-14 NS	6	4	2 1/2	5 1/8	30635-16	30635-26	30635-36	30635-46
1 1/8-7 UNC	4	4	2 9/16	5 7/16	30636-14	30636-24	30636-34	30636-44
1 1/8-12 UNF	4	4	2 9/16	5 7/16	30637-14	30637-24	30637-34	30637-44
1 1/4-7 UNC	4	4	2 9/16	5 3/4	30638-14	30638-24	30638-34	30638-44
1 1/4-12 UNF	4	4	2 9/16	5 3/4	30679-14	30679-24	30679-34	30679-44
1 3/8-6 UNC	4	4	3	6 1/6	30640-14	30640-24	30640-34	30640-44
1 3/8-12 UNF	4	6	3	6 1/6	30680-14	30680-24	30680-34	30680-44
1 1/2-6 UNC	4	4	3	6 3/8	30644-14	30644-24	30644-34	30644-44
1 1/2-12 UNF	4	6	3	6 3/8	30681-14	30681-24	30681-34	30681-44
1 3/4-5 UNC	4	6	3 3/16	7	30682-14	30682-24	30682-34	30682-44
2-4 1/2 UNC	4	6	3 9/16	7 5/8	30683-14	30683-24	30683-34	30683-44



HAND TAPS

Hi - Carbon Steel - Cut Thread

MACHINE SCREW SIZES



Nominal Size	# of Flutes	Thread Length	OAL	Taper Part No.	Plug Part No.	Bottom Part No.	Set Part No.
4-40 UNC	3	9/16	1 7/8	10602-10	10602-20	10602-30	10602-40
4-48 UNF	3	9/16	1 7/8	10603-10	10603-20	10603-30	10603-40
4-32 NS	3	9/16	1 7/8	10600-10	10600-20	10600-30	10600-40
4-36 NS	3	9/16	1 7/8	10601-10	10601-20	10601-30	10601-40
5-40 UNC	3	5/8	1 15/16	10604-10	10604-20	10604-30	10604-40
5-44 UNF	3	5/8	1 15/16	10605-10	10605-20	10605-30	10605-40
6-32 UNC	3	11/16	2	10606-10	10606-20	10606-30	10606-40
6-40 UNF	3	11/16	2	10608-10	10608-20	10608-30	10608-40
6-36 NS	3	11/16	2	10607-10	10607-20	10607-30	10607-40
6-48 NS	3	11/16	2	10609-10	10609-20	10609-30	10609-40
8-32 UNC	4	3/4	2 1/8	10610-10	10610-20	10610-30	10610-40
8-36 UNF	4	3/4	2 1/8	10611-10	10611-20	10611-30	10611-40
8-40 NS	4	3/4	2 1/8	10612-10	10612-20	10612-30	10612-40
10-24 UNC	4	7/8	2 3/8	10613-10	10613-20	10613-30	10613-40
10-32 UNF	4	7/8	2 3/8	10615-10	10615-20	10615-30	10615-40
10-30 NS	4	7/8	2 3/8	10614-10	10614-20	10614-30	10614-40
12-24 UNC	4	15/16	2 3/8	10616-10	10616-20	10616-30	10616-40
12-28 UNF	4	15/16	2 3/8	10617-10	10617-20	10617-30	10617-40
12-32 NS	5	15/16	2 3/8	10618-10	10618-20	10618-30	10618-40
14-20 NS	4	1	2 1/2	10619-10	10619-20	10619-30	10619-40
14-24 NS	4	1	2 1/2	10620-10	10620-20	10620-30	10620-40

FRACTIONAL SIZES

Nominal Size	# of Flutes	Thread Length	OAL	Taper Part No.	Plug Part No.	Bottom Part No.	Set Part No.
1/16-64 NS	2	5/16	1 5/8	10685-10	10685-20	10685-30	10685-40
3/32-48 NS	3	1/2	1 13/16	10686-10	10686-20	10686-30	10686-40
3/32-50 NS	3	1/2	1 13/16	10687-10	10687-20	10687-30	10687-40
1/8-40 NS	3	5/8	1 15/16	10621-10	10621-20	10621-30	10621-40
5/32-32 NS	4	3/4	2 1/8	10622-10	10622-20	10622-30	10622-40
5/32-36 NS	4	3/4	2 1/8	10623-10	10623-20	10623-30	10623-40
3/16-24 NS	4	7/8	2 3/8	10624-10	10624-20	10624-30	10624-40
3/16-32 NS	4	7/8	2 3/8	10625-10	10625-20	10625-30	10625-40
1/4-20 UNC	4	1	2 1/2	10628-10	10628-20	10628-30	10628-40
1/4-28 UNF	4	1	2 1/2	10630-10	10630-20	10630-30	10630-40
1/4-24 NS	4	1	2 1/2	10629-10	10629-20	10629-30	10629-40
1/4-32 NS	4	1	2 1/2	10631-10	10631-20	10631-30	10631-40
5/16-18 UNC	4	1 1/8	2 23/32	10632-10	10632-20	10632-30	10632-40
5/16-24 UNF	4	1 1/8	2 23/32	10633-10	10633-20	10633-30	10633-40
5/16-32 NS	4	1 1/8	2 23/32	10634-10	10634-20	10634-30	10634-40
3/8-16 UNC	4	1 1/4	2 15/16	10635-10	10635-20	10635-30	10635-40
3/8-24 UNF	4	1 1/4	2 15/16	10636-10	10636-20	10636-30	10636-40

Hi - Carbon Steel - Cut Thread

FRACTIONAL SIZES

Nominal Size	# of Flutes	Thread Length	OAL	Taper Part No.	Plug Part No.	Bottom Part No.	Set Part No.
7/16-14 UNC	4	1 7/16	3 5/32	10637-10	10637-20	10637-30	10637-40
7/16-20 UNF	4	1 7/16	3 5/32	10638-10	10638-20	10638-30	10638-40
1/2-13 UNC	4	1 21/32	3 3/8	10639-10	10639-20	10639-30	10639-40
1/2-20 UNF	4	1 21/32	3 3/8	10640-10	10640-20	10640-30	10640-40
9/16-12 UNC	4	1 21/32	3 19/32	10641-10	10641-20	10641-30	10641-40
9/16-18 UNF	4	1 21/32	3 19/32	10642-10	10642-20	10642-30	10642-40
5/8-11 UNC	4	1 13/16	3 13/16	10643-10	10643-20	10643-30	10643-40
5/8-18 UNF	4	1 13/16	3 13/16	10644-10	10644-20	10644-30	10644-40
11/16-11 NS	4	1 13/16	4 1/32	10645-10	10645-20	10645-30	10645-40
11/16-16 NS	4	1 13/16	4 1/32	10646-10	10646-20	10646-30	10646-40
3/4-10 UNC	4	2	4 1/4	10647-10	10647-20	10647-30	10647-40
3/4-16 UNF	4	2	4 1/4	10648-10	10648-20	10648-30	10648-40
7/8-9 UNC	4	2 7/32	4 11/16	10649-10	10649-20	10649-30	10649-40
7/8-14 UNF	4	2 7/32	4 11/16	10650-10	10650-20	10650-30	10650-40
7/8-18 NS	4	2 7/32	4 11/16	10651-10	10651-20	10651-30	10651-40
1-8 UNC	4	2 1/2	5 1/8	10652-10	10652-20	10652-30	10652-40
1-12 UNF	4	2 1/2	5 1/8	10653-10	10653-20	10653-30	10653-40
1-14 NS	4	2 1/2	5 1/8	10654-10	10654-20	10654-30	10654-40
1 1/8-7 UNC	4	2 9/16	5 7/16	10655-10	10655-20	10655-30	10655-40
1 1/8-12 UNF	4	2 9/16	5 7/16	10656-10	10656-20	10656-30	10656-40
1 1/4-7 UNC	4	2 9/16	5 3/4	10657-10	10657-20	10657-30	10676-40
1 1/4-12 UNF	6	2 9/16	5 3/4	10658-10	10658-20	10658-30	10658-40
1 3/8-6 UNC	4	3	6 1/6	10660-10	10660-20	10660-30	10660-40
1 3/8-12 UNF	6	3	6 1/6	10674-10	10674-20	10674-30	10674-40
1 1/2-6 UNC	4	3	6 3/8	10662-10	10662-20	10662-30	10662-40
1 1/2-12 UNF	6	3	6 3/8	10663-10	10663-20	10663-30	10663-40
1 3/4-5 UNC	6	3 3/16	7	10675-10	10675-20	10675-30	10675-40
2-4 1/2 UNC	6	3 9/16	7 5/8	10661-10	10661-20	10661-30	10661-40

TAPER PIPE TAPS

Generally used for pipe fittings and couplings. Designed to provide pressure-tight joints and for threading a wide variety of materials. Has a chamfer of 2 1/2 - 3 1/2 threads.

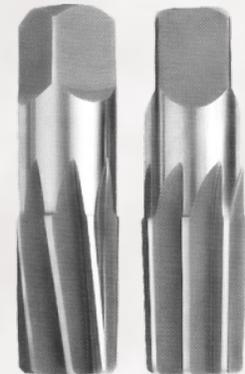


Pipe Size	Threads Per Inch	# of Flutes	Thread Length	OAL	Carbon Cut NPT	HSS Ground NPT
1/16	27	4	11/16	2 1/8	11400-00	31400-00
1/8	27	4	3/4	2 1/8	11401-00	31401-00
1/4	18	4	1 1/16	2 7/16	11402-00	31402-00
3/8	18	4	1 1/16	2 9/16	11403-00	31403-00
1/2	14	4	1 3/8	3 1/8	11404-00	31404-00
3/4	14	5	1 3/8	3 1/4	11405-00	31405-00
1	11 1/2	5	1 3/4	3 3/4	11406-00	31406-00
1 1/4	11 1/2	5	1 3/4	4	11407-00	31407-00
1 1/2	11 1/2	6	1 3/4	4 1/4	11408-00	31408-00
2	11 1/2	6	1 3/4	4 1/2	11409-00	31409-00
2 1/2	8	8	2 3/4	5 1/2	11410-00	31410-00
3	8	8	2 3/4	6	11411-00	31411-00
3 1/2	8	8	2 3/4	6 1/2	11412-00	-
4	8	8	3	7	11413-00	-

HSS TAPER PIPE REAMERS

Taper 3/4" per foot
Tapered 3/4" per foot and used for reaming holes to be tapped with standard Taper Pipe Taps

Size	Small Dia	Large Dia	Flute Length	OAL	Straight Flute EDI #	Spiral Flute EDI
1/16	-	.291	3/4	2	914016	101401
1/8	.316	.362	3/4	2-1/8	914017	101402
1/4	.406	.472	1-1/16	2-7/16	914018	101403
3/8	.540	.606	1-1/16	2-9/16	914019	101404
1/2	.665	.751	1-3/8	3-1/8	914020	101405
3/4	.876	.962	1-3/8	3-1/4	914021	101406
1	1.103	1.212	1-3/4	3-3/4	914022	101407
1 1/4	1.444	1.553	1-3/4	4	914023	104708
1 1/2	1.684	1.793	1-3/4	4-1/4	914024	104709
2	2.159	2.268	1-3/4	4-1/2	914025	104710
2 1/2	2.561	2.717	2 9/16	5-1/2	914026	104710



TAPER PIPE TAP 6 PIECE SET

Furnished in a plastic pouch. High Speed Steel taps last longer than carbon steel taps. Ground-thread taps have a more precise tolerance than cut thread. Contains one each of NPT pipe tap sizes 1/8", 1/4", 3/8", 1/2", 3/4", 1".

	EDI #
Carbon-Steel Cut-Thread Set	2765A42
High-Speed Steel Ground-Thread Set	2765A44





H.S. ROUND ADJUSTABLE DIES

STANDARD SIZES MACHINE SCREW

Style 700 Style 701

Size	13/16" OD	1" OD
	Part No.	Part No.
#0-80	700-00080	701-00080
1-64	700-00164	701-00164
1-72	700-00172	701-00172
2-56	700-00256	701-00256
2-64	700-00264	701-00264
3-48	700-00348	701-00348
3-56	700-00356	701-00356
4-40	700-00440	701-00440
4-48	700-00448	701-00448
5-40	700-00540	701-00540
5-44	700-00544	701-00544
6-32	700-00632	701-00632
6-40	700-00640	701-00640
8-32	700-00832	701-00832
8-36	700-00836	701-00836
10-24	700-01024	701-01024
10-32	700-01032	701-01032
12-24	700-01224	701-01224
12-28	700-01228	701-01228
14-20	700-01420	701-01420
14-24	700-01424	701-01424

STANDARD SIZES FRACTIONAL

Style 704 Style 705

Size	2 1/2" OD	3" OD
	Part No.	Part No.
1 - 8	704-06408	705-06408
1 - 12	704-06412	705-06412
1 - 14	704-06414	705-06414
1 1/8-7	704-07207	705-07207
1 1/8-12	704-07212	705-07212
1 1/4-7	704-08007	705-08007
1 1/4-12	704-08012	705-08012
1 3/8-6	704-08806	705-08806
1 3/8-12	704-08812	705-08812
1 1/2-6	704-09606	705-09606
1 1/2- 12	704-09612	705-09612
1 3/4-5	-	705-11205
1 3/4-12	-	705-11212
2-4 1/2	-	705-12805
2-12	-	705-12812

STANDARD SIZES FRACTIONAL



Style 700 Style 701 Style 702 Style 703

Size	13/16" OD	1" OD	1 1/2"	2" OD
	Part No.	Part No.	Part No.	Part No.
1/4 - 20	700-01620	701-01620	702-01620	703-01620
1/4 - 28	700-01628	701-01628	702-01628	703-01628
5/16- 18	700-02018	701-02018	702-02018	703-02018
5/16-24	700-02024	701-02024	702-02024	703-02024
3/8 - 16	-	701-02416	702-02416	703-02416
3/8 - 24	-	701-02424	702-02424	703-02424
7/16-14	-	701-02814	702-02814	703-02814
7/16-20	-	701-02820	702-02820	703-02820
1/2 - 13	-	701-03213	702-03213	703-03213
1/2 - 20	-	701-03220	702-03220	703-03220
9/16- 12	-	-	702-03612	703-03612
9/16-18	-	-	702-03618	703-03618
5/8-11	-	-	702-04011	703-04011
5/8- 18	-	-	702-04018	703-04018
11/16- 11	-	-	702-04411	703-04411
11/16-16	-	-	702-04416	703-04416
3/4-10	-	-	702-04810	703-04810
3/4-16	-	-	702-04816	703-04816
7/8-9	-	-	-	703-05609
7/8- 14	-	-	-	703-05614
1 - 8	-	-	-	703-06408
1 - 12	-	-	-	703-06412
1 - 14	-	-	-	703-06414

HSS HEXAGON DIES

Style 716

Size	Part No.
4-40	716-00440
6-32	716-00441
8-32	716-00442
10-24	716-00443
10-32	716-00444
12-24	716-00445
1/4 - 20	716-00446
1/4 - 28	716-00447
5/16 - 18	716-00448
5/16 - 24	716-00449
3/8 - 16	716-00450
3/8 - 24	716-00451
7/16 - 14	716-00452
7/16 - 20	716-00453
1/2 - 13	716-00454
1/2 - 20	716-00455
9/16 - 12	716-00456
9/16 - 18	716-00457
5/8 - 11	716-00458
5/8 - 18	716-00459
3/4 - 10	716-00460
3/4 - 16	716-00461
7/8 - 9	716-00462
7/8 - 14	716-00463
1 - 8	716-00464
1 - 12	716-00465
1 - 14	716-00466
1 1/8 - 7	716-00467
1 1/8 - 12	716-00468
1 1/4 - 7	716-00469
1 1/4 - 12	716-00470
1 3/8 - 6	716-00471
1 3/8 - 12	716-00472
1 1/2 - 6	716-00473
1 1/2 - 12	716-00474



C.S. HEX DIES

STANDARD

Style 216

Size	Part No.
4-40	216-00440
4-48	216-00441
5-40	216-00442
5-44	216-00443
6-32	216-00444
6-40	216-00445
8-32	216-00446
8-36	216-00447
10-24	216-00448
10-32	216-00449
12-24	216-00450
12-28	216-00451
1/4 - 20	216-00452
1/4 - 28	216-00453
5/16 - 18	216-00454
5/16 - 24	216-00455
3/8 - 16	216-00456
3/8 - 24	216-00457
7/16 - 14	216-00458
7/16 - 20	216-00459
1/2 - 13	216-00460
1/2 - 20	216-00461
9/16 - 12	216-00462
9/16 - 18	216-00463
5/8 - 11	216-00464
5/8 - 18	216-00465
11/16 - 11	216-00466
11/16 - 16	216-00467
3/4 - 10	216-00468
3/4 - 16	216-00469
7/8 - 9	216-00470
7/8 - 12	216-00471
1-8	216-00472
1-12	216-00473
1-2	216-00474
1 1/8 - 7	216-00475
1 1/8 - 12	216-00476
1 1/2 - 7	216-00477
1 1/2 - 8	216-00478
1 1/4 - 12	216-00479
1 3/8 - 6	216-00480
1 3/8 - 12	216-00481
1 1/2 - 6	216-00482
1 1/2 - 12	216-00483
1 5/8 - 5 1/2	216-00484
1 5/8 - 12	216-00485
1 3/4 - 5	216-00486
1 3/4 - 12	216-00487
2 - 4 1/2	216-00488
2 - 12	216-00489
2 1/4 - 4 1/2	216-00490
2 1/2 - 4	216-00491
2 3/4 - 4	216-00492
3-4	216-00493
3 1/4 - 4	216-00494
3 1/2 - 4	216-00495
3 3/4 - 4	216-00496
4-4	216-00497



TAP AND DIE HOLDERS

T-HANDLE TAP WRENCHES

PLAIN TYPE

- For hand tapping and for driving Screw Extractors
- Heavily knurled cap for better grip

Catalog EDI-Number	Hand Inches	Machine Screw	Length Inches
38328	1/16-1/4	0-14	2 3/4
38329	1/16-1/4	0-14	2 3/4
38333	7/32-1/2	12-14	3 5/8
38336	7/32-1/2	12-14	3 5/8
38337	1/16-1/4	0-14	8 3/4
38338	7/32-1/2	12-14	10 5/8
38339	1/16-1/4	0-14	3 3/4
38340	7/32-1/2	12-14	5



ADJUSTABLE TAP & REAMER WRENCHES

List No. 1825

These wrenches are made of tool steel, with carefully hardened and tempered jaws used for taps or reamers



Catalog EDI-Number	Hand Inches	Machine Screw	Pipe	Hand Reamer Inches	Length Inches	Weight
33743	1/16-1/4	0-14	-	1/8-17/64	5	2 oz.
33744	1/16-1/4	0-14	-	1/8-21/64	7	4 oz.
33745	1/16-3/8	0-14	-	1/8-25/64	9	7 oz.
33746	5/32-1/2	7-14	1/8	11/64-7 1/16	11	11 oz.
33747	5/32-3/4	7-14	1/8-1/4	11/64-4 1/64	15	1 lb. 10 oz.
33748	1/4-1 1/8		1/8-3/4	9/32-29/32	19	2 lb. 14 oz.
33749	1/2-1 3/8		1/8-1	3/8-1 5/32	31	4 lb. 8 oz.
33750	3/4-1 5/8		3/8-1 1/4	37/64-1 11/32	40	8 lbs.

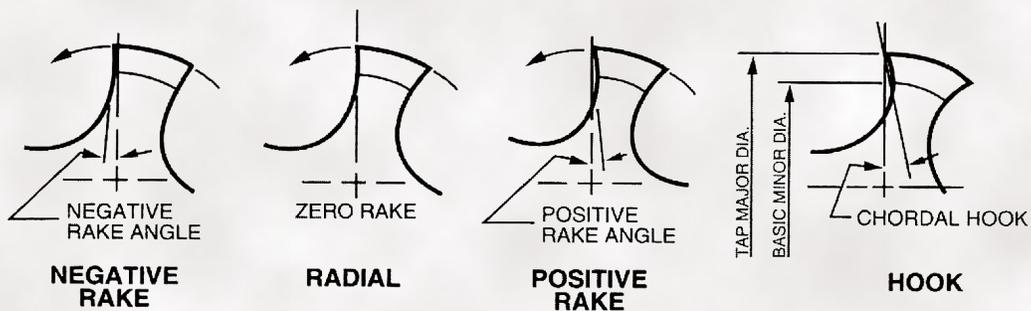
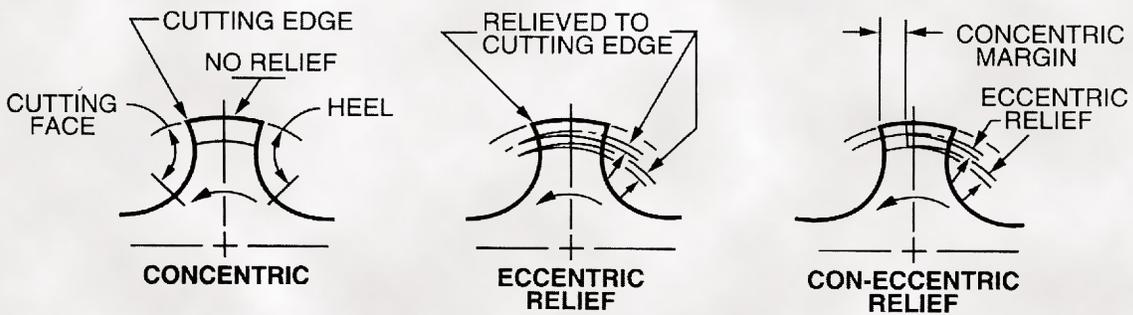
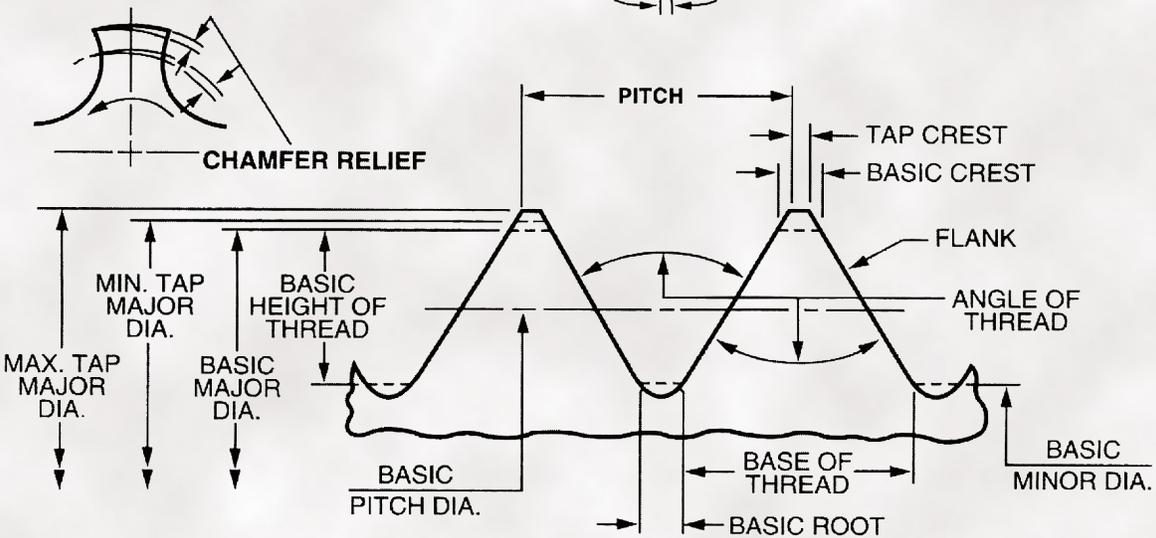
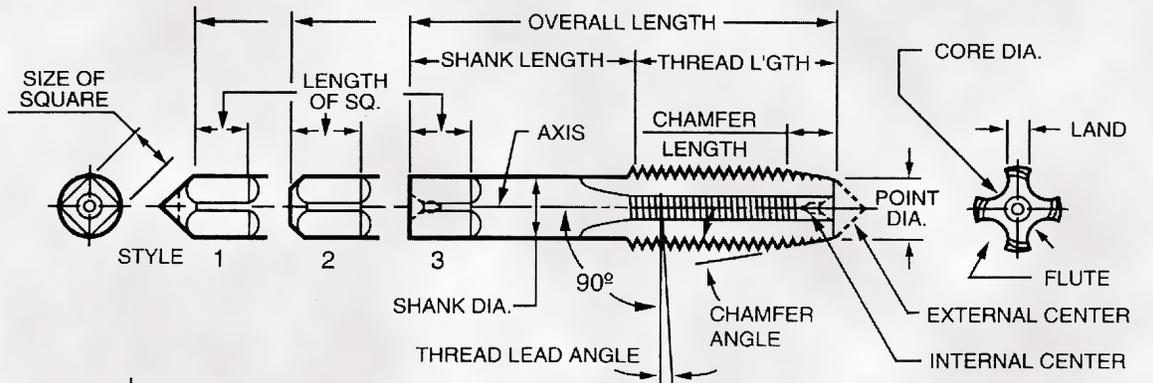
STOCKS FOR ADJUSTABLE ROUND SPLIT DIES

These die stocks are designed to accommodate the round screw adjustable dies listed on page 28-40.

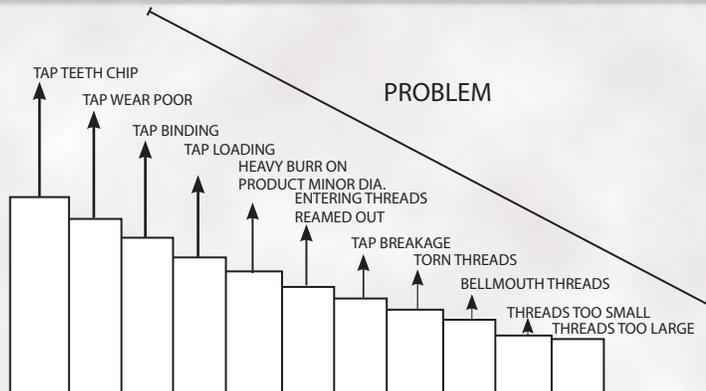
Catalog EDI-Number	Takes Dies Outside Dia Inches	Length Inches	Weight lbs
381850	5/8	5	1/16
381851	13/16	6 1/4	1/8
381852	1	9	5/16
381853	1 1/2	14	1 1/4
381857	2	23	1 7/8
381858	2 1/2	29	2 1/2
381859	3	40	2 7/8



TAP NOMENCLATURE



TROUBLE-SHOOTING



HELPFUL HINTS FOR SUCCESSFUL TAPPING INSTRUCTIONS

- 1 - Locate your "Problem" in upper-left corner
- 2 - In the column below follow each checked line horizontally through the "Possible Cause" to the "Suggested Correction." Eliminate each in sequence.

										POSSIBLE CAUSE	SUGGESTED CORRECTION
X	X	X					X		X	Misalignment	Align Tap Properly with Hole.
X	X						X	X		Tap Runout in Holder	Correct or Replace Holder.
X							X			Tap Bottoming in Blind Hole	Drill Deeper or Tap Shallower.
									X	Thin Walled Part Closing In	Use next Larger Size Standard Tap. Use New, Sharp Taps without Worn Edges.
							X	X		Tap Overcutting and Undercutting Its Lead	Decrease Forward Pressure for Overcut Increase for Undercut, Eliminate Lead Screw Backlash.
								X		Tap Cutting on Reversal	Reduce Withdrawal Pressure, Eliminate all Lead Screw Backlash.
X		X	X				X	X		Loading On Tap Teeth Metal welds on tap	Check Tapping Fluid & Speeds, Reduce Speed, Increase Fluid.
X	X	X	X				X	X		Wrong or Insufficient Tapping Fluid	Check for Suggested Tapping Fluids. Increase Flow.
X	X	X					X	X		Drilled Hole too Small	Use Properly Sharpened Drills of Size Suggested in Table.
X	X	X					X			Hole Work Hardened in Drilling	Feed Properly Sharpened Drill into Work with Copious Lubricant. Keep Drill Cutting.
X	X	X					X			Hard Spots in Material	Use Slower Speed, Anneal Material if Possible.
									X	Gage Worn Undersize	Check Gages Frequently. Replace if Doubtful.
X	X	X	X				X	X		Chips Packed in Tap Flute	Withdraw Tap More Often to Clear Chips. Recheck for Proper Tap.
X							X	X		Chipped Teeth on Tap	Replace Tap or Omit Surface Treatment.
	X	X	X	X					X	Incorrect Flute Hook for Material Being Tapped	Recheck for Proper Tap.
									X	Tap Too Large	Recheck for Proper Tap. Drop to Next Smaller Standard Tap if Necessary.
									X	Tap Too Small	Recheck for Proper Tap. Use Next Larger Standard Tap if Necessary.
X		X	X	X	X	X	X	X	X	Tap Worn on Cutting Edge Crest, or Pitch Diameter	Replace Tap. If you have Proper Chamfering Equipment, Rechamfer Taps over 1/2" Diameter.
X	X	X	X				X			Incorrect Chamfer	Recheck for Proper Tap. Bottom Chamfer is too Severe for Some Materials.
			X				X	X		Excess Speed	Speeds are Valid Only with Correct Tapping Fluid Properly Applied.
X										Nitride Treatment Not Needed	Try Taps Without Nitride. Nitride is NOT Recommended for Hand Tapping.
	X	X	X							Surface Treatment Needed	Treated ONLY for stable machine applications where, a history of chipping is not present.



TAP DRILL SIZES

Tap	Tap Drill	Decimal Equiv. of Tap Drill	Theoretical % of Thread	Probable Oversize (Mean)	Probable Hole Size	Percentage of Thread
7/8-14	51/64	.7969	84	.0052	.8021	79
	13/16	.8125	67	.0052	.8177	62
1"-8	55/64	.8594	87	.0059	.8653	83
	7/8	.875	77	.0059	.8809	73
	57/64	.8906	67	.0059	.8965	64
	29/32	.9063	58	.0059	.9122	54
1"-12	29/32	.9063	87	.0060	.9123	81
	59/64	.9219	72	.0060	.9279	67
	15/16	.9375	58	.0060	.9435	52
1"-14	59/64	.9219	84	.0060	.9279	78
	15/16	.9375	67	.0060	.9435	61
1 1/8-7	31/32	.9688	84	.0062	.9750	81
	63/64	.9844	76	.0067	.9911	72
	1	1.000	67	.0070	1.007	64
	1 1/64	1.0156	59	.0070	1.0226	55
1 1/8-12	1 1/32	1.0313	87	.0071	1.0384	80
	1 3/64	1.0469	72	.0072	1.0541	66

Tap	Tap Drill	Decimal Equiv. of Tap Drill	Theoretical % of Thread	Probable Oversize (Mean)	Probable Hole Size	Percentage of Thread
1 1/4-7	1 3/32	1.0938	84			
	1 7/64	1.1094	76			
	1 1/8	1.125	67			
1 1/4-12	1 5/32	1.1563	87			
	1 11/64	1.1719	72			
1 3/8-6	1 3/16	1.1875	87			
	1 13/64	1.2031	79			
	1 7/32	1.2188	72			
	1 15/64	1.2344	65			
1 3/8-12	1 9/32	1.2813	87			
	1 19/64	1.2969	72			
1 1/2-6	1 5/16	1.3125	87			
	1 21/64	1.3281	79			
	1 11/32	1.3438	72			
	1 23/64	1.3594	65			
1 1/2-12	1 13/32	1.4063	87			
	1 27/64	1.4219	72			

Reaming Recommended

TAP DRILL SIZE FORMULAE

$$\text{Major Diam. of Thread} - \frac{.01299 \times \text{Amt. of percentage of full thread}}{\text{No. of threads per inch}} = \text{Drilled Hole Size}$$

Percentage of Full Thread for Other Drill Sizes

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

TAP THREAD DESIGNATION SYMBOLS*		American Standard Ref. No.
NC	American National Coarse Thread Series	B1.1
*UNC	Unified Coarse Thread Series	B1.1
NF	American National Fine Thread Series	B1.1
*UNF	Unified Fine Thread Series	B1.1
NEF	American National Extra-Fine Thread Series	B1.1
*UNEF	Unified Extra-Fine Thread Series	B1.1
N	American National 8, 12 and 16 Thread Series	
*UN	Unified Constant - Pitch Thread Series	B1.1
MS	American National Thread - Special	B1.1
*UNS	Unified Thread - Special	B1.1
UNM	Unified Miniature Thread Series	B1.10
NR	American National Thread with a 0.108p to 0.144p Controlled Root Radius	MIL-B-7838
PTF	Dryseal SAE Short Taper Pipe Thread	
ACME	Acme Thread - Centralizing	B1.5
ACME-G	Acme Thread - General Purpose	B1.5
STUB ACME	Stub Acme Thread	B1.8
AMO	American Standard Microscope Objective Thread	B1.11
N BUTT	American Buttress Thread	B1.9
V	A 60° "V" thread with Truncated Crest and Root	
	The theoretical "V" Form is usually flatted to the user's specifications	
SB	Manufacturers Stovebolt Standard Thread	
STI	Special Thread for Helical Coil Wire Screw Thread Inserts	
SGT	Special Gas Taper Thread	B57.1
SPL-PTF	Dryseal Special Taper Thread	B2.2

*Taps are not marked with "U" but with the symbol for the corresponding American Standard thread form with which it is compatible.

THREAD SERIES DESIGNATIONS

STANDARD TAP MARKING	PRODUCT THREAD DESIGNATION	THREAD SERIES	REFERENCES AMERICAN NATIONAL STANDARDS (ANSI/ASME)
ACME-C	ACME-C	Acme threads, centralizing	B1.5
ACME-G	ACME-G	Acme thread, general purpose (See also "STUB ACME")	B1.5
AMO	AMO	American Standard microscope objective threads	B1.11
NPT	ANPT	Aeronautical National Form taper pipe threads	(MIL-P-7105B)
BUTT	BUTT	Buttress Threads, pull type	B1.9
PUSH-BUTT	PUSH-BUTT	Buttress Threads, push type	B1.9
F-PTF	F-PTF	Dryseal fine taper pipe thread series	B1.20.3 (Appendix C)
M	M	Metric Screw Threads - M Profile with basic ISO 68 profile	B1.13M, B1.18M
MJ	MJ	Metric Screw Threads - MJ Profile with rounded root of radius 0.15011P to 0.18042P	B1.21M
MJS	MJS	Metric Screw Threads - MJ Profile, special series Class 5 interference fit Internal Threads	B1.12
NC	NC5IF	- Entire ferrous material range	
NC	NC5INF	- Entire nonferrous material range	
NGO (RH or LH)	NGO	National gas outlet threads	ANSI/CGAV-1 (B57.1)
NGS	NGS	National gas straight threads	ANSI/CGAV-1 (B57.1)
NGT	NGT	National gas taper threads	ANSI/CGAV-1 (B57.1)
NH	NH	American Standard hose coupling threads of full form	B2.4
NPS	NPSC	American Standard straight pipe threads in pipe couplings	B1.20.1
NPSF	NPSF	Dryseal American Standard fuel internal straight pipe threads	B1.20.3
NPSH	NPSH	American Standard straight hose coupling threads for joining to American Standard Taper pipe threads	B2.4
NPSI	NPSI	Dryseal American Standard intermediate internal straight pipe threads	B1.20.3
NPSL	NPSL	American Standard straight pipe threads for loose-fitting mechanical joints with locknuts	B1.20.1
NPS	NPSM	American Standard straight pipe threads for free-fitting mechanical joints for fixtures	B1.20.2
NPT	NPT	American Standard taper pipe threads for general use	B1.20.1
NPTF	NPTF	Dryseal American Standard taper pipe threads	B1.20.3
NPTR	NPTR	American Standard taper pipe threads for railing joints	B1.20.1
PTF SHORT	PTF-SAE SHORT	Dryseal SAE short taper pipe threads	B1.20.3
PTF SPL SHORT PTF SPL	PTF-SPL SHORT PTF-SPL EXTRA	Dryseal special short taper pipe threads	B1.20.3 (Appendix C)
X-SHORT	SHORT	Dryseal special extra short taper threads (See also "SPL-PTF")	B1.20.3 (Appendix C)
M	S	ISO Miniature screw threads 0.25 to 1.4mm inc.	
SGT	SGT	Special gas taper threads	ANSI/CGAV-1 (B57.1)
SPL-PTF	SPL-PTF	Dryseal special taper pipe threads	B1.20.3 (Appendix C)
STUB ACME	STUB ACME	Stub Acme threads	B1.8
STUB ACME M1	STUB ACME M1	Stub Acme Modified Form 1	B1.8
STUB ACME M2	STUB ACME M2	Stub Acme Modified Form 2	B1.8
N	UN	Unified inch screw thread, constant-pitch series	B1.1
NC	UNC	Unified inch screw thread, coarse-pitch series	B1.1
NF	UNF	Unified inch screw thread, fine-pitch series	B1.1
NEF	UNEF	Unified inch screw thread, extra-fine pitch series	B1.1
N	UNJ	Unified inch screw thread, constant-pitch series, with rounded root of radius 0.15011P to 0.18042P. (Ext. thd. only)	B1.15 (Draft) MIL-S-8879A
NC	UNJC	Unified inch screw thread, coarse-pitch series, with rounded root of radius 0.15011P to 0.18042P. (Ext. thd. only)	B 1.15 (Draft) MIL-S-8879A

Applying to Screw Threads, Taps, and Dies

Allowance. An allowance is an intentional difference in correlated dimensions of mating parts. It is the minimum clearance (positive allowance) or maximum interference (negative allowance) between such parts.

Angle of Thread. The angle included between the flanks of the thread, measured in an axial plane.

Axis. The longitudinal central line through the screw or tap.

Back Taper. A slight axial relief on the thread of the tap which makes the pitch diameter of the thread near the shank somewhat smaller than that at the chamfered end. (See Relief)

Basic. The theoretical or nominal standard size from which all variations are made. (See Size)

Chamfer. The tapering of the end of the thread on a tap by cutting away and relieving the crest of the first few teeth to distribute the cutting action over several teeth. It also acts as a guide in starting the tap. When this tapering amounts to 8 to 10 threads, the tap is called a taper tap; when 3 to 5 threads, a *plug* tap; and with 1 1/2 threads chamfer, a *bottoming* tap.

Core Diameter. The diameter of an imaginary cylinder tangent to the deepest part of the flute.

Crest. The top surface joining the two flanks of a thread. The crest of an external thread is at its major diameter, while the crest of an internal thread is at its minor diameter.

Crest Clearance. The space between the crest of a thread and the root of its component.

Cutting Edge. The leading side of the land in the direction of rotation for cutting and which does the actual cutting.

Depth of Thread. The distance between the crest and the base of the thread measured normal to the axis.

Dryseal. A fuel connection for both external and internal application designed for use where the assembled product must withstand high fluid or gas pressures without the use of a sealing compound or where a sealer is functionally objectionable.

Flank. The surface of the thread, sometimes referred to as side of thread, which connects the crest with the root.

Flutes. The longitudinal channels formed in a tap to create cutting edges on the thread profile and to provide chip spaces and cutting-fluid passages.

Flute Lead. The axial advance of a helical or spiral cutting edge in one turn around the tool axis.

Heel. The face of the tap land trailing the cutting edge during forward rotation.

Height of Thread. The distance between the crest and the base of thread measured normal to the axis.

Helix Angle — Flute. Flutes of taps are sometimes cut helically instead of straight. This helix angle is the angle made by the flute with the axis of the tap. (Helical flutes are sometimes called spiral flutes.)

Helix Angle — Thread. The angle made by the helix of a thread at the pitch diameter with a plane perpendicular to the axis.

Hook. The concave cutting face of a tap land between the crest and the root of thread.

Interrupted Thread. A tap having an odd number of lands, with every other tooth along the thread helix removed.

Land. One of the threaded sections between the flutes on a tap.

Lead. The distance a screw thread advances axially in one complete turn. On a single-thread screw or tap, the lead and pitch are identical. On a double-thread, the lead is twice the pitch; on a triple-thread, the lead is three times the pitch, etc.

Lead Error. The amount the actual lead of the screw thread differs from the specified lead.

Lead — Drunken. Irregular advance of the thread helix, or lead. Usually called "drunken thread."

Length of Engagement. The length of contact between two mating threaded parts measured axially.

Limits. The maximum and minimum sizes permissible for a specific dimension. (See Allowance and Tolerance.)

Major Diameter. The largest diameter of a straight thread. On a taper thread, the largest diameter at any given plane normal to the axis. The term "major diameter" replaces the term "outside diameter" as applied to the thread of a screw or tap and also the term "full diameter" as applied to the thread of a nut or die.

Minor Diameter. The smallest diameter of a straight thread. On a taper thread, the smallest diameter at any given plane normal to the axis. The term "minor diameter" replaces the terms "root diameter" and "core diameter" as applied to the thread of a screw or tap and also the term "inside diameter" as applied to the thread of a nut or die.

Percent of Thread. One-half the difference between the basic major diameter and the actual minor diameter of an internal thread, divided by the basic thread height, expressed as percentage.

Pitch. The distance from a point on a screw thread to a corresponding point on the next thread, measured parallel to the axis and on the same side of the axis. The pitch equals one divided by the number of threads per inch.

Pitch Diameter. On a straight screw thread, the diameter of an imaginary cylinder, the surface of which would pass through the threads at such points as to make equal the width of the threads and the width of the spaces cut by the surface of the cylinder. On a taper screw thread, the diameter, at a given distance from a reference plane perpendicular to the axis of an imaginary cone, the surface of which would pass through the threads at such points as to make equal the width of the threads and the width of the spaces cut by the surface of the cone.

Pitch Line. A generator of the imaginary cylinder or cone specified in the definition of PITCH DIAMETER.

Rake. On a tap, any deviation of a straight cutting face of the tooth from a radial line. Positive rake means that the crest of the cutting face is angularly advanced ahead of the balance of the face of the tooth. Negative rake means that the same point is angularly behind the balance of the cutting face of the tooth. Zero rake means that the cutting face is directly on the center line.

Relief — Radial. The clearance produced by removal of metal from behind the cutting edge. Taps should have the chamfer relieved and should have back taper, but may or may not have relief in the angle and on the major diameter of the threads. When the thread angle is relieved from heel to cutting edge, the tap is said to have eccentric relief. If relieved from heel for only a portion of land width (usually %) the tap is said to have "con-eccentric" relief (See Back Taper.)

WORD AND TERM DEFINITIONS (Cont.)

Root. The bottom surface joining the flanks of two adjacent threads. The root of an external thread is at its minor diameter, while the root of an internal thread is at its major diameter.

Screw Thread. A ridge of uniform section in the form of a helix on the external or internal surface of a cylinder, or in the form of a conical spiral on the external or internal surface of a cone or frustum of a cone. A thread formed on a cylinder is known as a "straight" or "parallel" thread, to distinguish it from a "taper" thread which is formed on a cone or frustum of a cone. All left-hand threads are designated LH.

Spiral Point. A supplementary fluting, cut at an angle to the main fluting, in the cutting face of the land. It is slightly longer than the chamfer on the tap and in the opposite hand to that of cutting rotation.

Size — Basic. The theoretical size from which the limits of size for that dimension are derived by the application of the allowance and tolerances.

Size — Nominal. The designation used for general identification.

Thread — Single. A thread in which the lead is equal to the pitch.

Thread — Multiple. A thread in which the lead is an integral multiple of the pitch. On a double thread, the lead is equal to twice the pitch; on a triple thread the lead is equal to three times the pitch, etc. Such threads have starting points relative to their multiple equally spaced around their circumference. For example, a double thread has two starting points 180° apart, etc.

Thread — Drunken. A thread in which the advance of the thread helix is irregular.

Tolerance. The amount of variation permitted in any dimension. Tolerance may be expressed as plus, minus, or both. A total tolerance is the sum of a plus and minus tolerance. Complete tolerances on threads include those for major diameter, minor diameter, pitch diameter, lead, half angle, and full angle. (See Allowance and Limits.)

Truncation — Crest. The distance, measured perpendicular to the axis, between the sharp crest (or crest apex) and the cylinder or cone which bounds the crest.

Truncation — Root. The distance, measured perpendicular to the axis, between the sharp root (or root apex) and the cylinder or cone which bounds the root.

SPEEDS FOR TAPS

Conversion Chart - fpm to rpm

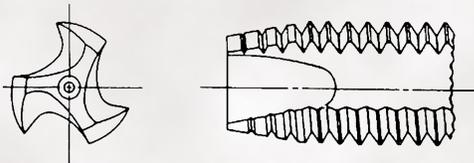
Feet Per Minute			20'	25'	30'	35'	40'	50'	55'	60'	65'	70'	80'	90'	100'	110'	160'	180'	200'	220'
No. Size	Frac. Size, Inch	Size Dec.	Revolutions Per Minute																	
0		.062	1230	1540	1850	2150	2460	3080	3390	3700	4000	4300	4925	5525	6150	6770	9850	11,050	12,300	13,540
1		.075	1020	1275	1530	1780	2040	2550	2700	3060	3310	3560	4070	4580	5085	5600	8145	9170	10,170	11,200
2		.089	855	1070	1290	1500	1710	2140	2360	2580	2790	3000	3420	3860	4280	4720	6870	7730	8580	9440
3		.102	750	940	1125	1310	1500	1880	2060	2250	2435	2620	3000	3360	3760	4120	5980	6230	7490	8230
4		.115	665	830	995	1160	1330	1660	1825	1990	2160	2320	2660	2980	3320	3650	5310	5975	6640	7300
5	1/8	.128	595	745	895	1045	1190	1490	1640	1790	1940	2090	2380	2680	2980	3280	4760	5360	5960	6560
6		.141	540	680	815	950	1080	1360	1490	1630	1760	1900	2160	2440	2720	2980	4320	4880	5440	5960
8		.168	455	570	680	795	910	1140	1250	1360	1480	1590	1820	2040	2280	2500	3640	4080	4560	5000
10		.194	395	490	590	690	790	980	1080	1180	1280	1380	1580	1770	1960	2160	3160	3540	3920	4320
12		.220	345	435	520	610	690	870	955	1040	1130	1220	1380	1560	1740	1910	2760	3120	3430	3820
14		.247	310	385	465	540	620	770	850	930	1000	1080	1240	1390	1540	1700	2480	2780	3080	3400
	1/4	.255	300	375	450	525	600	750	825	900	975	1050	1200	1350	1500	1650	2400	2700	3000	3300
	5/16	.318	240	300	360	420	480	600	660	720	780	840	960	1080	1200	1320	1920	2160	2400	2640
	3/8	.381	200	250	300	350	400	500	550	600	650	700	800	880	1000	1100	1600	1760	2000	2200
	7/16	.444	170	215	260	300	340	430	475	520	560	600	680	770	860	950	1360	1540	1720	1990
	1/2	.507	150	190	225	265	300	380	415	450	490	530	600	680	760	830	1200	1360	1520	1660
	5/8	.633	120	150	180	210	240	305	335	365	395	425	490	550	610	670	975	1100	1220	1340
	3/4	.759	100	125	155	180	205	255	280	305	330	355	405	460	510	560	815	920	1020	1120
	7/8	.885	85	110	130	155	175	220	240	260	275	305	350	395	435	480	700	785	870	960
	1	1.011	76	95	114	135	155	190	210	230	250	270	305	345	380	420	610	685	765	840

A Tap is a tool used to produce internal (female) threads to receive screws, bolts or threaded parts in accordance with established classes of fit. Taps are manufactured to slightly varying limits for producing holes to meet the established classes of fit. No tap, however, is guaranteed to produce a thread of a given size.

Taps that become dull cut oversize; require more power to drive; cause rough threads or breakage, and generally slow the tapping operation. However, it is not always profitable to re-sharpen taps unless the proper tap grinding equipment is available.

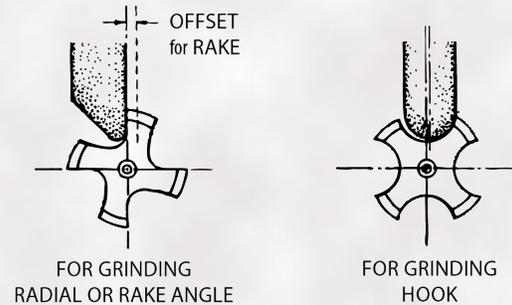
Sharpening is usually restricted to the chamfer and must have great accuracy to minimize torque load, produce accurately sized holes, and promote longer life. For recommended length of chamfer and angles for taper, plug, and bottoming taps see page ____.

In sharpening spiral pointed taps, care must be exercised to maintain the original angle and shape of the spiral point. The spiral point flute should extend approximately 2 threads beyond the chamfer. When ends of lands become thin, grind end of tap straight back until lands are of normal thickness. It is good practice to refer to a new spiral pointed tap of the same size for guidance in sharpening. See sketch below.



In re-sharpening the cutting faces, or in refitting a regular tap with a different rake angle or hook for a special material, a cutter grinder should be used. However, this operation can be performed by hand on a bench grinder if precautions are taken to properly shape the wheel.

The sketches below show wheel shapes for grinding in flutes.



Excessive breakage and other tap failures can usually be attributed to: faulty tap holder, machine spindle, fixture, or work alignment; wrong tapping speed; wrong type or lack of lubricant; improperly designed tap for operation; peculiarities of the material being tapped; and condition of hole, finish and size.

FORMULA FOR OBTAINING TAP DRILL SIZES FOR CUTTING TAPS

$$\text{*Drilled Hole Size (inches)} = \text{Basic Major Dia. Of thread (Inch)} - .0130 \times \frac{\text{Percentage of Full Thread}}{\text{No. of Threads per Inch}}$$

$$\text{*Drilled Hole Size (mm)} = \text{Basic Major Dia. Of thread (mm)} - \frac{\text{Percentage of Full Thread} \times \text{mm Pitch}}{76.98}$$

FORMULA FOR OBTAINING TAP DRILL SIZES FOR THREAD FORMING TAPS

$$\text{*Drilled Hole Size (inches)} = \text{Basic Major Dia. Of thread (Inch)} - .0068 \times \frac{\text{Percentage of Full Thread}}{\text{No. of Threads per Inch}}$$

$$\text{*Drilled Hole Size (mm)} = \text{Basic Major Dia. Of thread (mm)} - \frac{\text{Percentage of Full Thread} \times \text{mm Pitch}}{147.06}$$

FORMULA FOR OBTAINING PERCENTAGE OF FULL THREAD FOR OTHER DRILL SIZES

$$\text{Percentage of Full Thread} = \frac{\text{No. of Threads per inch}}{\text{Basic Major Dia. of Thread (inch)}} \times \left(\frac{\text{Drill Hole Size (Inch)}}{\text{No. of Threads per Inch}} \right)$$

$$\text{Percentage of Full Thread} = \frac{76.98}{\text{Pitch (mm)}} \times \left(\frac{\text{Drill Hole Size (mm)}}{\text{Basic Major Dia. (mm)}} \right)$$

Note: Drill size should be smaller than hole size by the probable amount the drill will cut oversize.



DECIMAL CHART

DRILL SIZE	DEC. INCHES	TAP SIZE	DRILL SIZE	DEC. INCHES	TAP SIZE	DRILL SIZE	DEC. INCHES	TAP SIZE	DRILL SIZE	DEC. INCHES	TAP SIZE	DRILL SIZE	DEC. INCHES	TAP SIZE
.97	.0059	-	.58	.0420		.27	.1440		H	.2660		17/32	.5312	5/8-11
.15mm	.0059	-	.57	.0430		3.7mm	.1457			.2677		13.5mm	.5315	
.96	.0063	-	1.1mm	.0433		.26	.1470		6.9mm	.2717		35/64	.5469	
.16mm	.0063	-	1.15mm	.0453		3.75mm	.1476	m4.5x0.75	I	.2720	5/16-24NF	14mm	.5512	m16x2
.95	.0067	-	.56	.0465		.25	.1495	#10-24	7mm	.2756	m8x1	9/16	.5625	
.17mm	.0067	-	3/64	.0469	#0-80	3.8mm	.1496		J	.2770		14.5mm	.5709	m16x1.5
.94	.0071	-	1.2mm	.0472		.24	.1520		7.1mm	.2795		37/64	.5781	3/8-1 8NPT 5/8-1 8NF
.18mm	.0071	-	1.25mm	.0492	m1.6x0.35	3.9mm	.1535		K	.2810		15mm	.5906	
.93	.0075	-	1.3mm	.0512		.23	.1540		9/32	.2812	5/16-32NS	19/32	.5938	3/8-18 NPS PIPE
.19mm	.0075	-	.55	.0520		5/32	.1562		7.2mm	.2835		39/64	.6094	
.92	.0079	-	1.35mm	.0531		.22	.1570	3/16-32NS	7.25mm	.2854		15.5mm	.6102	m18x2.5
.2mm	.0079	-	.54	.0550		.4mm	.1575		7.3mm	.2874		5/8	.6250	11/16-16NS
.91	.0083	-	1.4mm	.0551		.21	.1590	#10-32	L	.2900		16mm	.6299	m18x2.0
.21mm	.0083	-	1.45mm	.0571	m1.8x0.35	.20	.1610		7.4mm	.2913		41/64	.6406	
.90	.0087	-	1.5mm	.0591		4.1mm	.1614		M	.2950		16.5mm	.6496	
.22mm	.0087	-	.53	.0595	#1-64.72	4.2mm	.1654	m5x0.8	7.5mm	.2953		21/32	.6562	3/4-10NC
.89	.0091	-	1.55mm	.0610		.19	.1660		19/64	.2969		17mm	.6693	
.23mm	.0091	-	1/16	.0625		4.25mm	.1673		7.6mm	.2992		43/64	.6719	
.24mm	.0094	-	1.6mm	.0630	m2x0.4	4.3mm	.1693		N	.3020		11/16	.6875	3/4-16NF
.88	.0095	-	.52	.0635		.18	.1695		7.7mm	.3031		17.5mm	.6890	m20x2.5
.25mm	.0098	-	1.65mm	.0650		11/64	.1719		7.75mm	.3051	m9x1.25	45/64	.7031	
.87	.0100	-	1.7mm	.0669		.17	.1730		7.8mm	.3071		18mm	.7087	m20x2.0
.26mm	.0102	-	.51	.0670	#2-56	1.44mm	.1732		7.9mm	.3110		23/32	.7188	1/2-14NPT PIPE
.86	.0105	-	1.75mm	.0689	m2.2x0.45	.16	.1770	#12-24	5/16	.3125	3/8-16NC	18.5	.7283	m20x1.5
.27mm	.0106	-	.50	.0700	#2-64	1.45mm	.1772		8mm	.3150		47/64	.7344	1/2-14NPS PIPE
.85	.0110	-	1.8mm	.0709		.15	.1800		O	.3160		19mm	.7480	
.28mm	.0110	-	1.85mm	.0728		4.6mm	.1811		8.1mm	.3189		3/4	.7500	
.29mm	.0114	-	.49	.0730		.14	.1820	#12-28	8.2mm	.3228		49/64	.7656	7/8-9NC
.84	.0115	-	1.9mm	.0748	m2.3x.04	.13	.1850		P	.3230		19.5mm	.7677	m22x2.5
.3mm	.0118	-	.48	.0760		4.7mm	.1850		8.25mm	.3248		25/32	.7812	
.83	.0120	-	1.95mm	.0768		4.75mm	.1870		8.3mm	.3268		20mm	.7874	m22x2.0
.82	.0125	-	5/64	.0781		3/16	.1875		21/64	.3281		51/64	.7969	
.32mm	.0126	-	.47	.0785	#3-48	4.8mm	.1890		8.4mm	.3307		20.5mm	.8071	m22x1.5
.81	.0130	-	.2mm	.0787		.12	.1890	7/32-32NS	Q	.3320	3/8-24NF	13/16	.8125	7/8-14NF
.34mm	.0134	-	2.05mm	.0807	m2.5x0.45	.11	.1910		8.5mm	.3346	m10x1.5	21mm	.8268	m24x3
.80	.0135	-	.46	.0810		4.9mm	.1929		8.6mm	.3386		53/64	.8281	
.35mm	.0138	-	.45	.0820	#3-56	.10	.1935		R	.3390	1/8-27NPT PIPE	27/32	.8438	
.36mm	.0142	-	2.1mm	.0827		.9	.1960		8.7mm	.3425		21.5mm	.8465	
.79	.0145	-	2.15mm	.0846	m2.6x0.45	.5mm	.1969	m6x1	11/32	.3438		55/64	.8594	
.38mm	.0150	-	.44	.0860	#4-36	.8	.1990		8.75mm	.3445	m10x1.25	22mm	.8661	m24x2
1/64	.0156	-	2.2mm	.0866		5.1mm	.2008		8.8mm	.3465		7/8	.8750	1-8NC
4mm	.0157	-	2.25mm	.0886		.7	.2010	1/4-20	S	.3480	1/8-27NPT PIPE	22.25mm	.8760	
.78	.0160	-	.43	.0890	#4-40	13/64	.2031		8.9mm	.3504		22.5mm	.8858	m24x1.50
.42mm	.0165	-	2.3mm	.0906		.6	.2040		9mm	.3543	m10x1.00	57/64	.8906	
.44mm	.0173	-	2.35mm	.0925		5.2mm	.2047		T	.3580		23mm	.9055	
.45mm	.0177	-	.42	.0935	#4-48	.5	.2055		9.1mm	.3583		29/32	.9062	
.77	.0180	-	3/32	.0938		5.25mm	.2067	m6x0.75	23/64	.3594		59/64	.9219	3/4-14NPT PIPE
.46mm	.0181	-	2.4mm	.0945		5.3mm	.2087		9.2mm	.3622		23.5mm	.9252	
.48mm	.0189	-	.41	.0960		.4	.2090	1/4-24	9.25mm	.3642		15/16	.9375	3/4-14 NPS 1-14 NF
.5mm	.0197	-	2.45mm	.0965		5.4mm	.2126		9.3mm	.3661		24mm	.9449	m27x3
.76	.0200	-	.40	.0980		.3	.2130	1/4-28	U	.3680	7/16-14NC	61/64	.9531	
.75	.0210	-	2.5mm	.0984	m3x0.5	5.5mm	.2165		9.4mm	.3701		24.5mm	.9646	
.55mm	.0217	-	.39	.0995		7/32	.2188		9.5mm	.3740	m11x1.50	31/32	.9688	
.74	.0225	-	.38	.1015	#5-40	5.6mm	.2205		3/8	.3750		25mm	.9843	m27x2
.6mm	.0236	-	2.6mm	.1024		.2	.2210		V	.3770		8 63/64	.9844	1-1/8-7NC
.73	.0240	-	.37	.1040	#5-44	5.7mm	.2244		9.6mm	.3780		1	1.0000	
.72	.0250	-	2.7mm	.1063		5.75mm	.2264		1 9/7mm	.3819		25.5mm	1.0039	
.65mm	.0256	-	.36	.1065	#6-32	.1	.2280		9.75mm	.3839		1-1/64	1.0156	
.71	.0260	-	2.75mm	.1083		5.8mm	.2283		8.9.8mm	.3858		9 26mm	1.0236	
.7mm	.0276	-	7/64	.1094		5.9mm	.2323		W	.3860		1-1/32	1.0312	
.70	.0280	-	.35	.1100		A	.2340		9.9mm	.3898		26.5mm	1.0433	m30x3.5
.69	.0292	-	2.8mm	.1102		15/64	.2344		25/64	.3906	7/16-20	1-3/64	1.0469	1-1/8-12NF
.75mm	.0295	-	.34	.1110		6mm	.2362	m7x1	10mm	.3937	m12x1.75	1-1/16	1.0625	
.68	.0310	-	.33	.1130	#6-40	B	.2380		X	.3970		27mm	1.0630	
1/32	.0312	-	2.9mm	.1142	m3.5x0.6	6.1mm	.2402		Y	.4040		1-5/64	1.0781	
.8mm	.0315	-	.32	.1160		C	.2420		13/32	.4062		27.5mm	1.0827	
.67	.0320	-	.3mm	.1181		6.2mm	.2441		Z	.4130		1-1-3/32	1.0938	
.66	.0330	-	.31	.1200		D	.2460		10.5mm	.4134	m12x1.25	28mm	1.1024	m30x2.0
.85mm	.0335	-	3.1mm	.1220		6.25mm	.2461	1/16-27NPT PIPE	27/64	.4219	1/2-13	1-7/64	1.1094	1-1/4-7NC
.65	.0350	-	1/8	.1250	5/32-32NS	6.3mm	.2480		11mm	.4331		28.5mm	1.1220	
.9mm	.0354	-	3.2mm	.1260		E	.2500	1/16-27 NPS PIPE	7/16	.4375	1/4-18NPT PIPE	1-1/8	1.1250	
.64	.0360	-	3.25mm	.1280		1/4	.2500		11.5mm	.4528		1-9/64	1.1406	
.63	.0370	-	.30	.1285	5/32-36NS	6.4mm	.2520		29/64	.4531	1/4-18 NPS PIPE 1/2-20	29mm	1.1417	
.95mm	.0374	-	3.3mm	.1299	m4x.07	6.5mm	.2559		15/32	.4688		1-5/32	1.1562	1-11/12NPT PIPE
.62	.0380	-	3.4mm	.1339		F	.2570	5/16-18NC	12mm	.4724		29.5mm	1.1614	
.61	.0390	-	.29	.1360	#8-32	6.6mm	.2598		31/64	.4844	m14x2	9/16-12	1.1719	1-1/4-12NF
1mm	.0394	-	3.5mm	.1378		G	.2610		12.5mm	.4921	m14x1.5			
.60	.0400	-	.28	.1405		6.7mm	.2638		1/2	.5000				
.59	.0410	-	9/64	.1406		17/64	.2656		13mm	.5118	m14x1.25			
1.05mm	.0413	-	3.6mm	.1417		6.75mm	.2657	m8x1.25	33/64	.5156	9/16-18			

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