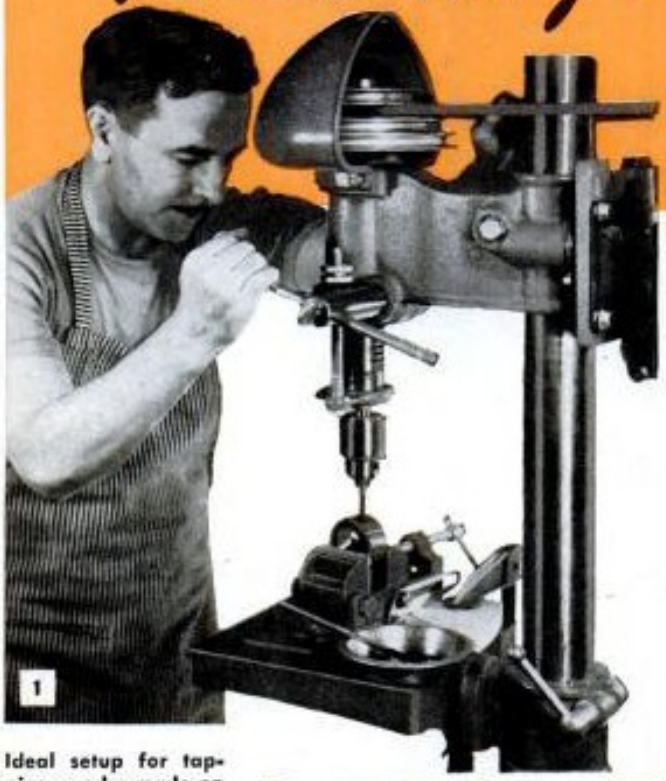
Threading with TAPS and DIES

By Sam Brown



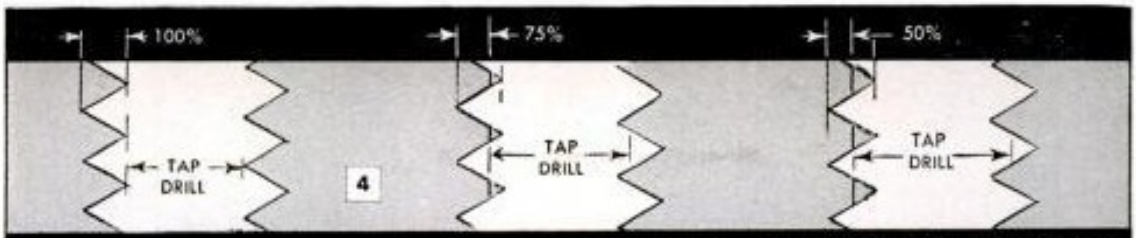
Ideal setup for tapping can be made on drill press. Tap is turned by hand, by pulling on belt or by using tap wrench

HAND TAPS and dies provide a simple, fast method of cutting internal and external threads in metal or plastic. Even in shops where screw-cutting lathes are available, the faster method of threading with a hand tap or die is used almost universally for small diameters. Procedure is quite simple and precise work is easy to accomplish with the extensive range of sizes and supplemental data that are available on related tap-and-drill sizes and thread systems. Tables No. 1 and 2, and the typical examples worked out below, show how to go about selecting a tap and the proper tap drill. They also show how to determine the correct thread system to use for the job at hand.

A practical setup for many tapping jobs can be made on the drill press. Drill the tap hole in the work and then chuck the tap to cut the thread. In this operation the important thing is to allow sufficient room to remove the drill and insert the tap without disturbing the setup. The spindle is turned by pulling on the belt by hand as in Fig. 1. The feed lever is held down with just sufficient pressure to overcome the tension of the quill spring. This method can be used with taps up to ¼ in., but larger tap sizes will require turning the chuck as in Figs. 3 and 5.

How to Use Tables

Example No. 1: Selecting tap when size of screw is not known. Measure diameter of screw as in Fig. 6. Assuming that it measures .137 in., run down third column in Table No. 1 to the nearest value which is .138 in. Note in the first column that this is the diameter of a No. 6 screw. Then check with a pitch gauge to determine the number of threads per inch. Common threads on a No. 6 screw are 32, 36 and 40. Thus a 6-32, 6-36 or 6-40 tap would be selected for the job. If 6-32 tap is required, run down first column in Table No. 1 to 6-32. Right-hand column shows No. 36 drill for 75% thread

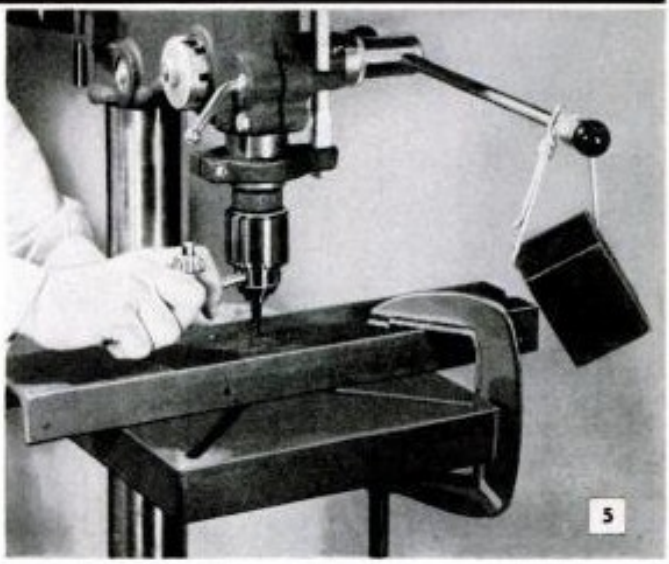


FULL THREAD TAKES MORE EFFORT TO CUT. IT IS HARD ON TAPS AND IS ONLY 5% STRONGER THAN A 75% THREAD

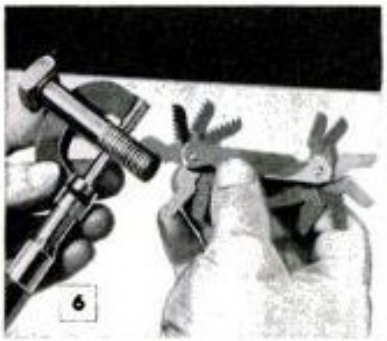
75% THREAD IS RECOMMENDED STANDARD FOR MOST WORK EXCEPT MACHINE TAPPING, WHICH IS DONE BEST WITH 50-60% THREAD

50% THREAD IS 80% AS STRONG AS 75% THREAD. IT IS EASY TO CUT AND GOOD FOR ALL JOBS EXCEPT THIN WORK LESS THAN ONE TAP DIA. THICK

Although individual taps and dies can be purchased as you need them, it is better to obtain a standard tap-and-die set in the sizes most commonly used. Taps in the set can be ordered with either taper or plug ends as in Fig. 2, and the bottom taps for blind holes can be added as they are needed. Bottom taps are used to run the thread to the bottom of a blind hole. They are not used ordinarily in through holes. The taper tap is used instead, as it is easier to start, cuts freely and is easy to turn. When purchasing taps individually, keep in mind that machine taps cut threads for numbered machine screws while the hand taps cut threads of fractional-inch sizes.



When the chuck wrench is used to turn the chuck when tapping in drill press, attach a weight to the drill-press feed lever

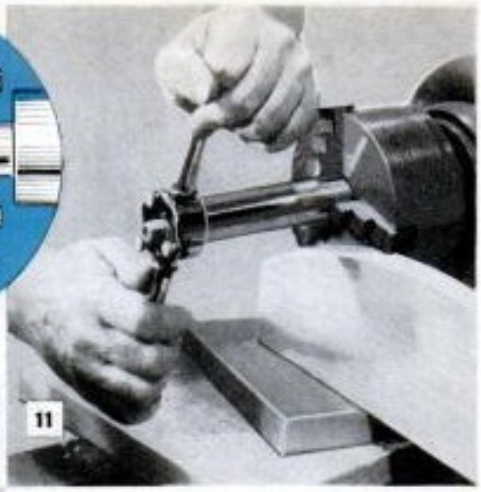


Thread diameter and pitch are determined with mike and pitch gauge

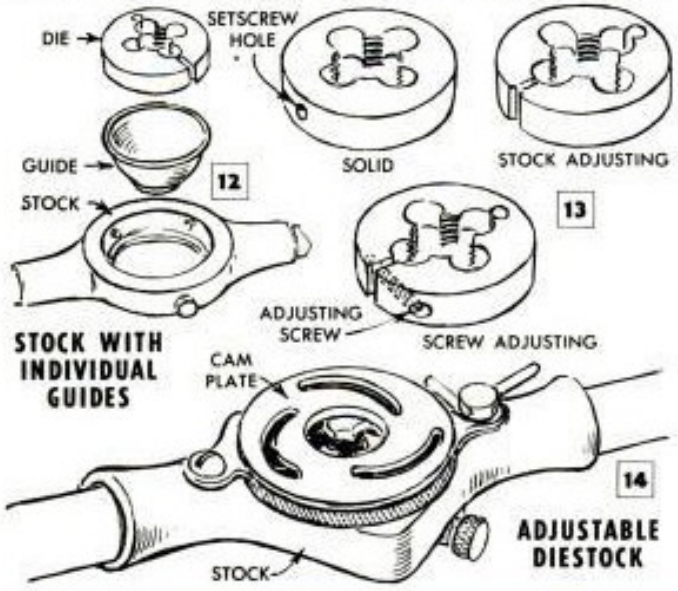
Without a pitch gauge, count the threads per inch or half inch

Lacking other means, determine size of internal thread with tap drill

Example No. 2: Same as Example No. 1 except that a No. 36 tap drill is not available. In Table No. 1 note that any size of drill between .097 in. and .117 in. in diameter can be used as a tap drill for a 6-32 tap. Consult Table No. 2 and locate drill in this size range. From this it can be seen that a 7/64-in. (fractional-size) drill is the size nearest to that required. In a decimal size this is about .109 in., and will give approximately a 70-percent thread as in the figures at left showing range of tap drills for a 6-32 thread

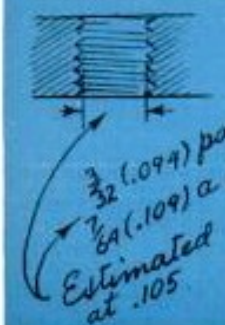


Threading with a round die held in a stock can be done in a lathe. Stock and die are reversed when threading to shoulder



When it is necessary to determine specific threads, a micrometer caliper and a screw-pitch gauge, Fig. 6, are required. Lacking the pitch gauge you can count screw threads per inch or half inch as in Fig. 7 and, when the length of the screw will permit, the tap also can be used as a gauge. On some internal threads where the mike and gauge cannot be used, one method is to check with drills as in Fig. 8, then determine the thread as explained in example No. 3 on the use of tables. Experienced machinists often can determine standard thread sizes accurately by eye alone. Also the nature of the job generally provides a fairly accurate clue. For example, in most machine assemblies N.C. (National Coarse) threads are commonly found. In automotive and airplane work N.F. (National Fine) threads are used, and on precision jobs and in instrument building N.F. or N.S. (National Special) threads are generally found.

Tap-drill sizes which will permit tapping 50, 75 and 100-percent threads are commonly used, Fig. 4. A 75-percent thread is a good



How to Use Tables

(Continued from page 215)

Example No. 3: In tapped holes too small to mike or check with a pitch gauge, insert drills until the hole stops a given size. Suppose, as an illustration, that the hole passes a 3/32-in. (.094) drill but stops a 7/64-in. (.109) drill. It is reasonably accurate to estimate the size of the hole as .105 in. which would be the tap-drill size used originally. Using the figures at the left, locate the nearest values in the 75-percent column in Table No. 1. With these it is possible to determine the thread size required

TABLE No. 1

THREADS and TAP DRILL SIZES

TAP or SCREW	THREAD SYSTEM	OUTSIDE DIA.	TAP DRILL 50%	TAP DRILL 75%	TAP DRILL 100%	DRILL for 75%
0-80	N.F.	.060	.052	.048	.044	3/64
1/16-64	N.S.	.063	052	.047	.042	3/64
72	Obs.	.063	.054	.049	.044	3/64
1-56	N.S.	.073	.061	.055	.050	54
64	N.C.	.073	.063	.058	.053	53
72	N.F.	.073	.064	.060	.055	53
5/64-60	N.S.	.078	.067	.061	.056	1/16
72	Obs.	.078	.069	.065	.060	52
2-56	N.C.	.086	.074	.068	.063	50
64	N.F.	.086	.076	.071	.066	50
3/32-48	N.S.	.094	.080	.073	.066	49
50	Obs.	.094	.081	.074	.067	49
3-48	N.C.	.099	.086	.079	.072	47
56	N.F.	.099	.087	.081	.076	45
7/64-48	N.S.	.109	.096	.089	.082	43
4-32	N.S.	.112	.092	.081	.071	45
36	N.S.	.112	.094	.085	.076	44
40	N.C.	.112	.096	.088	.080	43
48	N.F.	.112	.098	.091	.085	42
1/8-32	Stove	.125	.108	.099	.091	42
32	N.S.	.125	.105	.094	.084	3/32
40	N.S.	.125	.109	.100	.092	38
5-36	N.S.	.125	.107	.098	.089	40
40	N.C.	.125	.109	.100	.092	38
44	N.F.	.125	.110	.102	.095	37
6-32	N.C.	.138	.117	.107	.097	36
36	N.S.	.138	.120	.110	.101	34
40	N.F.	.138	.122	.113	.105	33
9/64-40	N.S.	.141	.124	.116	.108	32
7-30	N.S.	.151	.129	.118	.107	31
32	A.S.M.E.	.151	.131	.120	.110	31
36	N.S.	.151	.133	.124	.114	1/8
5/32-32	N.S.	.156	.136	.125	.115	1/8
36	N.S.	.156	.138	.129	.120	30
28	Stove	.163	.144	.135	.125	1/8
8-30	N.S.	.164	.142	.131	.120	30
32	N.C.	.164	.144	.133	.123	29
36	N.F.	.164	.146	.137	.127	29
40	N.S.	.164	.148	.139	.131	28
11/64-32	N.S.	.172	.152	.141	.131	9/64
9-24	N.S.	.177	.150	.136	.122	29
30	N.S.	.177	.155	.144	.133	27
32	N.S.	.177	.157	.146	.136	26
3/16-24	N.S.	.187	.160	.147	.133	26
32	N.S.	.187	.167	.156	.146	22
24	Stove	.195	.173	.162	.151	24
10-24	N.C.	.190	.163	.149	.135	25
28	N.S.	.190	.167	.155	.143	23
30	N.S.	.190	.168	.157	.146	22
32	N.F.	.190	.170	.159	.149	21
13/64-24	N.S.	.203	.176	.163	.149	20
12-24	N.C.	.216	.189	.175	.161	16
28	N.F.	.216	.193	.181	.169	14
32	N.S.	.216	.196	.185	.175	13
7/32-24	N.S.	.219	.192	.178	.164	16
32	N.S.	.219	.199	.188	.178	12
22	Stove	.222	.198	.186	.174	16
15/64-24	N.S.	.234	.207	.194	.180	10
14-20	N.S.	.242	.210	.193	.177	10
24	N.S.	.242	.215	.201	187	7
1/4-18	Stove	.250	224	.211	198	8
20	N.C.	.250	.218	.201	185	7
24	N.S.	.250	.223	.209	195	4
27	N.S.	.250	.226	.213	.201	3
28	N.F.	.250	.227	.215	.203	3
32	N.S.	.250	.230	.220	.209	7/32
5/16-18	N.C.	.312	.276	.258	.240	F
20	N.S.	.312	.280	.263	.247	17/64
24	N.F.	.312	.285	.272	.258	I
27	N.S.	.312	.288	.276	.264	J
32	N.S.	.312	.292	.281	.271	9/32
3/8-16	N.C.	.375	.334	.313	.293	5/16
20	N.S.	.375	.343	.326	.310	21/64
24	N.F.	.375	.348	.334	.320	Q
27	N.S.	.375	.351	.338	.326	R
7/16-14	N.C.	.437	.391	.368	.344	U
20	N.F.	.437	.405	.388	.372	25/64
24	N.S.	.437	.410	.397	.383	X
27	N.S.	.437	.413	.201	.389	Y
1/2-12	N.S.	.500	.446	.419	.391	27/64
13	N.C.	.500	.450	.425	.400	27/64
20	N.F.	.500	.467	.451	.435	29/64
24	N.S.	.500	.473	.459	.445	29/64
27	N.S.	.500	.476	.463	.451	15/32
9/16-12	N.C.	.562	.508	.471	.454	31/64
18	N.F.	.562	.526	.508	.490	33/64
27	N.S.	.562	.538	.526	.514	17/32
5/8-11	N.C.	.625	.566	.536	.506	17/32
12	N.S.	.625	.571	.544	.516	35/64
18	N.F.	.625	.589	.570	.552	37/64
27	N.S.	.625	.601	.588	.576	19/32
11/16-11	N.S.	.687	.629	.599	.569	19/32
16	N.S.	.687	.647	.626	.606	5/8
3/4-10	N.C.	.750	.685	.652	.620	21/32
12	N.S.	.750	.696	.673	.641	43/64
16	N.F.	.750	.709	.688	.668	11/16
27	N.S.	.750	.726	.713	.701	23/32
13/16-10	N.S.	.812	.748	.715	.682	23/32
7/8-9	N.C.	.875	.803	.766	.730	49/64
12	N.S.	.875	.821	.793	.766	51/64
14	N.F.	.875	.829	.806	.782	13/16
18	N.S.	.875	.839	.820	.802	53/64
27	N.S.	.875	.851	.838	.826	27/32
15/16-9	N.S.	.937	.865	.829	.793	53/64
1-8	N.C.	1.000	.919	.878	.837	7/8
12	N.S.	1.000	.946	.918	.891	59/64
14	N.F.	1.000	.954	.931	.907	15/16
27	N.S.	1.000	.976	.963	.951	31/32

N.C.—National Coarse (formerly U.S.S.)
N.F.—National Fine (formerly S.A.E.)
N.S.—National Special (various threads from older systems)

Stove—Stove bolts, Manufacturers Standard
A.S.M.E.—American Society of Mechanical Engineers. Most threads in this older system are included in the National system.

TABLE No. 2

DRILL SIZES

INCH	DECIMAL	WIRE	INCH	DECIMAL	WIRE	INCH	DECIMAL	WIRE or LETTER	INCH	DECIMAL	LETTER
	.014	80		.089	43		.199	B	25/64	.390	
	.015	79		.093	42		.201	7		.397	X
1/64	.016		3/32	.094		13/64	.203			.404	Y
	.016	78		.096	41		.204	6	13/32	.406	
	.018	77		.098	40		.205	5		.413	Z
	.020	76		.099	39		.209	4	27/64	.422	
	.021	75		.101	38		.213	3	7/16	.437	
	.023	74		.104	37	7/32	.219		29/64	.453	
	.024	73		.106	36		.221	2	15/32	.469	
	.025	72	7/64	.109			.228	1	31/64	.484	
	.026	71		.110	35		.234	A	1/2	.500	
	.028	70		.111	34	15/64	.234		33/64	.515	
	.029	69		.113	33		.238	B	17/32	.531	
	.031	68		.116	32		.242	C	35/64	.547	
1/32	.031			.120	31		.246	D	9/16	.562	
	.032	67	1/8	.125		1/4	.250	E	37/64	.578	
	.033	66		.128	30		.257	F	19/32	.594	
	.035	65		.136	29		.261	G	39/64	.609	
	.036	64		.140	28	17/64	.265		5/8	.625	
	.037	63	9/64	.141			.266	H	41/64	.640	
	.038	62		.144	27		.272	I	21/32	.656	
	.039	61		.147	26		.277	J	43/64	.672	
	.040	60		.149	25		.281	K	11/16	.687	
	.041	59		.152	24	9/32	.281		45/64	.703	
	.042	58		.154	23		.290	L	23/32	.719	
	.043	57	5/32	.156			.295	M	47/64	.734	
	.046	56		.157	22	19/64	.297		3/4	.750	
3/64	.047			.159	21		.302	N	49/64	.766	
	.052	55		.161	20	5/16	.312		25/32	.781	
	.055	54		.166	19		.316	O	51/64	.797	
	.059	53		.169	18		.323	P	13/16	.812	
1/16	.062		11/64	.172		21/64	.328		53/64	.828	
	.063	52		.173	17		.332	Q	27/32	.844	
	.067	51		.177	16		.339	R	55/64	.859	
	.070	50		.180	15	11/32	.344		7/8	.875	
	.073	49		.182	14		.348	S	57/64	.891	
	.076	48		.185	13		.358	T	29/32	.906	
5/64	.078		3/16	.187		23/64	.359		59/64	.922	
	.079	47		.189	12		.368	U	15/16	.937	
	.081	46		.191	11	3/8	.375		61/64	.953	
	.082	45		.193	10		.377	V	31/32	.969	
	.086	44		.196	9		.386	W	63/64	.984	

average for hand tapping but in machine tapping 50 to 60-percent threads are common. Cutting a 100-percent thread requires extremely careful work with a hand tap to avoid breakage of the tap and damage to the thread. When joining pipe in mechanical assemblies a 50-percent tap drill is commonly used. An example of this is the use of a ⅜-in. drill for a 50-percent thread in ⅛-in. pipe as in Table No. 3. If a free-running thread is required, mechanics sometimes use steel wool, as in Fig. 15, to cut the thread slightly oversize. First the hole is tapped in the usual manner, then the tap is withdrawn and wrapped with one full turn of fine steel wool. After the tap is restarted in the threaded hole, it is turned in to its full length. The steel-wool wrapping in effect "rolls" the thread to a slightly larger diameter.

Thread-cutting dies take the place of the screw-cutting lathe for ordinary work in both large and small shops where accurate duplication is not required. Frequently the work involves a turning or shouldering operation in the lathe and here the lathe can be used as a holding device for starting the die, Fig. 9. Corners of squared work should be broken to permit the die to start readily. Note when using ordinary round dies of the split type that the threads are chamfered from one side of the die. Always start the die from the chamfered side as in Fig. 10 and when a die holder, or stock, is used as in Fig. 11, where the thread is to be run up to a shoulder, the die is reversed in the stock.

The various types of common round dies are shown in Figs. 12, 13 and 14. The inexpensive solid die is suitable for average work but either the stock-adjusting or screw-adjusting die should be used where any variation in the thread may be required. Fig. 16 pictures a plug tap being started with the aid of a wooden guide, and Fig. 18 shows how to use a piece of tape as a depth stop. Machine screws, in Fig. 17, can be made from wood screws.

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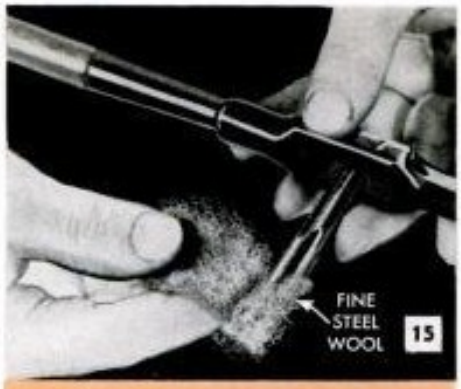
Straight and Taper PIPE THREADS

TABLE No. 3

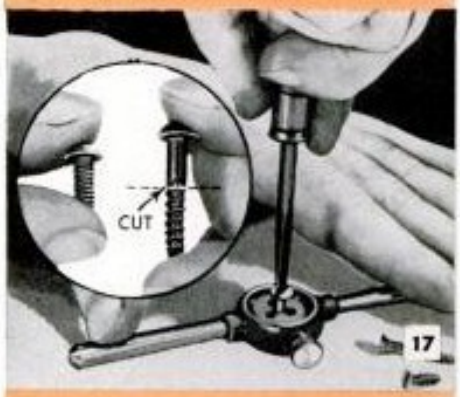
Pipe Size	Threads per Inch	Actual Outside Dia.	Outside Of St. Thread	TAP DRILL 50%	TAP DRILL 75%	TAP DRILL 100%	Regular Tap Drill
⅛"	27	.405	.404	.375	.360	.345	11/32
¼"	18	.540	.534	.490	.467	.445	7/16
⅜"	18	.675	.671	.627	.604	.582	37/64
½"	14	.640	.835	.778	.749	.721	23/32
¾"	14	1.050	1.046	.989	.960	.932	59/64
1"	11½	1.315	1.308	1.239	1.204	1.169	1-5/32
1¼"	11½	1.660	1.653	1.583	1.549	1.514	1-1/2
1½"	11½	1.900	1.892	1.822	1.788	1.753	1-47/64
2"	11½	2.375	2.366	2.296	2.262	2.227	2-7/32

Tap-drill size in right-hand column permits full thread for straight or taper tap. Plumbing requires taper tap

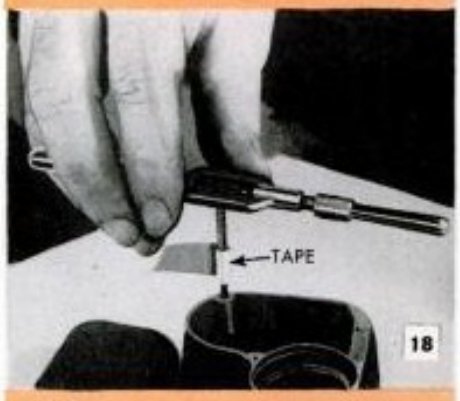


Steel wool forms free-running thread

Start plug tap through wooden guide



Make machine screws of wood screws



Adhesive tape can serve as depth stop