December 2020

Newsletter

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http://www.homemetalshopclub.org/

The Home Metal Shop Club has brought together metal workers from all over the Southeast Texas area since its founding by John Korman in 1996.

Our members' interests include Model Engineering, Casting, Blacksmithing, Gunsmithing, Sheet Metal Fabrication, Robotics, CNC, Welding, Metal Art, and others. Members enjoy getting together and talking about their craft and shops. Shops range from full machine shops to those limited to a bench vise and hacksaw.

If you like to make things, run metal working machines, or just talk about tools, this is your place. Meetings generally consist of ***general announcements***, an ***extended presentation*** with Q&A, a ***safety moment***, ***show and tell*** where attendees share their work and experiences, and ***problems and solutions*** where attendees can get answers to their questions or describe how they approached a problem. The meeting ends with ***free discussion*** and a ***novice group*** activity, where metal working techniques are demonstrated on a small lathe, grinders, and other metal shop equipment.

President *Brian Alley*	Vice President *Ray Thompson*	Secretary *Joe Sybille*	Treasurer *Gary Toll*	Librarian *Ray Thompson*
Webmaster/Editor *Dick Kostelnicek*	Photographer *Jan Rowland*	CNC SIG *Martin Kennedy*	Casting SIG *Tom Moore*	Novice SIG *John Cooper*

This newsletter is available as an electronic subscription from the front page of our website. We currently have over 1027 subscribers located all over the world.

About the Upcoming 09 January 2021 Meeting

The next general meeting will be held on 09 January 2021 at 1:00 P. M. on-line via Zoom. A week before the meeting invitees will receive from the webmaster the meeting ID and passcode to join the on-line meeting. Club member, Dick Kostelnicek, will deliver a presentation on Pitch Diameter and the Unified Thread System.

Visit our website for up-to-the-minute details, date, location maps, and presentation topic for the next meeting.

General Announcements

Video of the December meeting's presentation can be viewed on-line prior to the January meeting. The HMSC has a large library of metal shop related books and videos available for members to check out at each meeting. These books can be quite costly and are not usually available at local public libraries. Access to the library is one of the many benefits of club membership. The club has funds to purchase new books for the library. If you have suggestions, contact the Vice-President *Ray Thompson*.

We need more articles for the monthly newsletter! If you would like to write an article, or would like to discuss writing an article, please contact the Webmaster *Dick Kostelnicek*. Think about your last project. Was it a success, with perhaps a few 'uh ohs' along the way? If so, others would like to read about it. And, as a reward for providing an article, you'll receive a free year's membership the next renewal cycle!

Ideas for programs at our monthly meeting are always welcomed. If you have an idea for a meeting topic, or if you know someone that could make a presentation, please contact Vice-President *Ray Thompson*.

Members are requested to submit to the club secretary the name, address, telephone number, and website address, if any, of any metal or other material stock supplier with whom the member has had any favorable dealings. A listing of the suppliers will appear on the homepage of the club website. Suppliers will be added from time to time as appropriate.

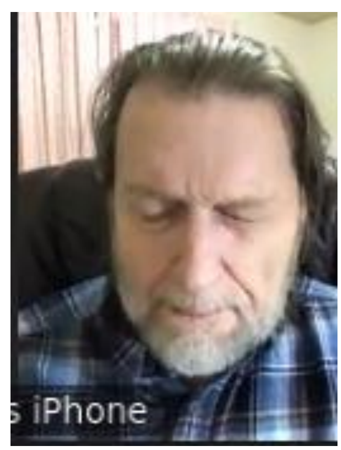
The club is looking for a member to serve as webmaster. After over ten years of service, our current webmaster would like to pass the webmaster torch to a successor.

Recap of the 12 December 2020 General Meeting

By *Joe Sybille*

Ten members attended the 1:00 P.M. virtual meeting on Zoom. One visitor, William Swann, attended. There are twenty members in good standing with the club.

Vice-President, Ray Thompson, led the meeting (right photo).



Presentation

Jon LeGrand gave a presentation on his experience with powder coating. With ten years of experience under his belt, he has enjoyed powder coating metallic items for both himself and friends alike.

LeGrand began by emphasizing safety first. Safety glasses and a respirator are must have items. LeGrand does not recommend the use of dust masks because the powder medium is too fine for the filtering provided by masks. These items will protect one from the errant mist of the powder coating medium. Suggested required equipment for powder coating includes electrostatic powder spray gun, thermosetting powder, air compressor, air pressure regulator, air filter, electric oven, and the part to be powder coated.

Typically, the process for powder coating is as follows. Clean the item of dirt, oil, and rust. Spray onto the item an electrically charged powder. Then bake the item in an oven at 400º Fahrenheit to 450º Fahrenheit for so many minutes until the powder melts and begins to flow creating a uniformly thick surface. Then add another twenty minutes or so to ensure complete curing or bonding of the metal.

LeGrand has used two methods to powder coat items, cold way and hot way. After gaining experience with both methods, he prefers the hot way. The difference between the two methods lies in the different temperature of the item during application of the powder coating.

In the cold way, the item to be powder coated is at ambient temperature. A power supply connected to the sprayer gun sends a high voltage electrical charge to an emitter rod at the sprayer gun nozzle. In turn, the air immediately in front of the sprayer gun becomes an electrically charged field. Compressed air at about 5 psig to 10 psig forces powder through this high voltage electrically charged field. In so doing, the powder becomes electrically charged and is attracted to the grounded item to be powder coated. A diagram of the process is shown below-right.

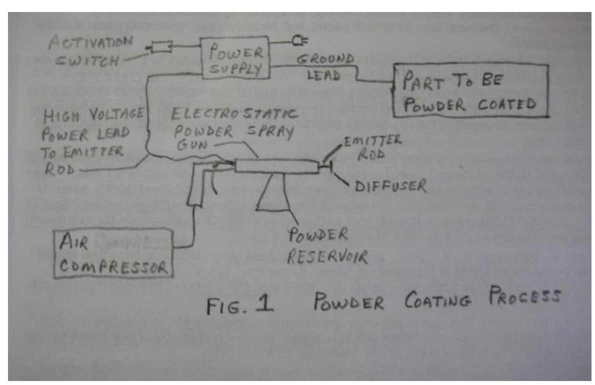


FIG. 1 POWDER COATING PROCESS

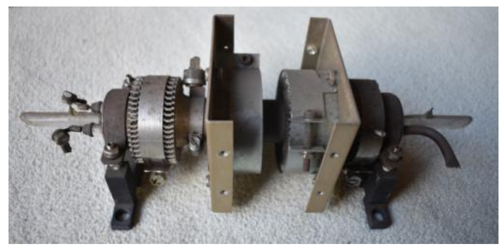
In the hot way, the electrically charged powder coating is applied to a metal item that has been pre-heated. As in the cold way, the metal item is made part of an electrical circuit to facilitate bonding of the powder coating. After the powder has been applied, the item is placed in an oven and heated until the powder melts, flows, and is bonded to the metal. Heating time in the oven is reduced when the hot way is used.

Heating times vary according to the size of the item undergoing powder coating. Experience with heating different sized items is the best teacher for determining heating or curing times. Items that can be powder coating are limited by the size of the oven available.

LeGrand's experience with powder coating has revealed it produces a durable finish that is difficult to remove. It is best to fill the powder reservoir no more than two-thirds to three fourths full. The finished color is usually darker than the color of the powder as received in the package. The powder appears to have a long shelf life, for he has used powder that has been on his shelf for at least ten years. Color mixing is possible. High temperature tape is used to mask areas on a part where powder coating is not wanted. It is best to plug tapped holes on a part undergoing powder coating. Lastly, during application of the powder, pay close attention to interior bends and areas facing away from the spray nozzle, for adherence of the electrically charged powder is sometimes incomplete.

Show and Tell

John Cooper showed the internal gearing for a laser platter. See photo at right. He also showed a Shars Tool Company caliper that works well for him. See photo at left.



Phil Lipoma exhibited a completed governor for his Corliss engine. See photos below.




Dick Kostelnicek showed a tool that removes pointers on pressure gauges (right photo).

Problems and Solutions

A member requested help understanding why, when using a new counter bore bit of high grade tool steel, it dulls after counter boring one hole in 1018 mild steel. Several suggestions including not pecking to prevent work hardening from repeated restarting of the cut were offered.

Articles

Close Enough Metric Threading

By *Dick Kostelnicek*

Each revolution of a lathe's spindle causes its lead screw to translate the tool bit by the pitch **P** of the thread being turned. **P** = (1,0 / **TPI**) inches for an imperial lathe, where **TPI** is an abbreviation for **T**hreads **P**er **I**nch and is determined by making a selection on the lathe's threading gear box or by mounting appropriate change gears.

Exact Metric Threading

A lathe with an imperial lead screw can be made to cut exact metric threads. This is accomplished by inserting an additional meshed pair of gears with the appropriate ratio **R** in the spindle-to-lead-screw gear train. Now, each turn of the spindle advances the cut by the pitch **P** of a metric thread measured in mm (millimeters). Since two gears iare inserted, the carriage's direction of travel is unaltered. I won't cover where to place these gears as each lathe differs. But, keep them as close as possible to the spindle's power take-off or reversing gears.

The carriage movement or pitch for each thread in mm is then:

$$\mathbf{P} = (1.0 / \mathbf{TPI}) * \mathbf{R} * 25.4 \qquad (1)$$

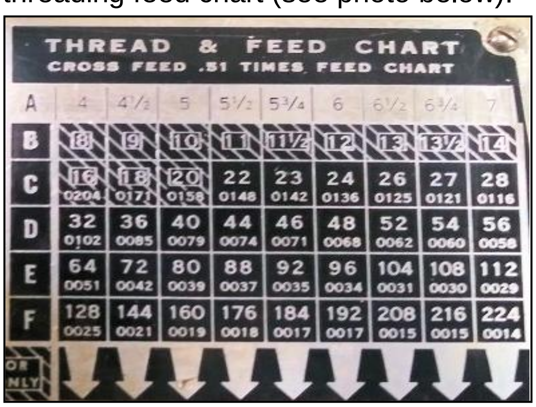
Solving for the inserted gear ratio:

$$\mathbf{R} = \mathbf{P} * \mathbf{TPI} / 25.4 \qquad (2)$$

Today, there are exactly 25.4 mm to an inch. But, this hasn't always been the case, which will be considered later in this article. So, one of the gears making up **R** must be a multiple of 25.4. Since gears have a whole number of teeth, the smallest usable gear has 5 * 25.4 = **127** teeth. Hence, **R** = **N** / **127**, so the number of teeth on the other gear is:

$$\mathbf{N} = \mathbf{P} * \mathbf{TPI} * 5 \qquad (3)$$

We also choose **N** as a whole number, and **TPI** from the 54 or more choices provided by the lathe's threading feed chart (see photo below).



Exact Metric Threading

P (mm)	**TPI**	**R**(N / **127**)	**P** (mm)	**TPI**	**R**(N / **127**)
6.00	4	120/127	0.90	28	126/127
5.00	4	100/127	0.80	28	112/127
4.00	6	120/127	0.75	32	120/127
3.50	6	105/127	0.70	32	112/127
3.00	8	120/127	0.60	40	120/127
2.50	8	100/127	0.50	48	120/127
2.00	12	120/127	0.45	56	126/127
1.75	12	105/127	0.40	56	112/127
1.50	16	120/127	0.35	64	112/127
1.25	16	100/127	0.25	96	120/127
1.00	24	120/127	0.20	112	112/127

Appendix 1 at the end of this article provides more gears that can be used for Exact Metric Threading.

In order to thread all ISO metric threads up to diameter M48 in both the coarse and fine series, you'll need the following 5 gears having teeth **N**: 126, 120, 112, 105, 100, along with the **127** tooth gear. The above table shows the **TPI** setting and the gear ratio **R** needed for each metric pitch **P**. The colors are used to prompt awareness of a gear's frequency of use in the above table.

To good approximation, the 0.45 and 0.90 mm pitch thread can be cut without the use of the 126/**127 tooth** gears. These threads would be in error by just 1 thread in 127 or 0.8%.

Close Enough Metric Threading

Here's an alternative or *close enough* method for cutting all of the common metric pitches. The following table shows gear pairs N_1 / N_2 that lead to metric threads with a fractional pitch error better than 6.6 parts in 10000. And, without the use of a **127**- tooth gear. This is better than the accuracy provided by many lathe lead screws. With five gears, **45**, **51**, **54**, **56**, and **61** teeth, you can create all common metric threads. These gears, all similar in size, have less than half the diameter of the **127**-tooth gear's discussed above.

Close Enough Metric Threading

P (mm)	**TPI**	N_1 / N_2	**error**	**P** (mm)	**TPI**	N_1 / N_2	**error**
6.00	4	51/54	-0.00046	0.90	32	51/45	-0.00046
5.00	4.5	54/61	-0.00066	0.80	28	45/51	+0.00053
4.00	6	51/54	-0.00046	0.75	32	51/54	-0.00046
3.50	7	54/56	-0.00029	0.70	32	45/51	+0.00053
3.00	8	51/54	-0.00046	0.60	40	51/54	-0.00046
2.50	9	54/61	-0.00066	0.50	48	51/54	-0.00046
2.00	12	51/54	-0.00046	0.45	64	51/45	-0.00046
1.75	14	54/56	-0.00029	0.40	56	45/51	+0.00053
1.50	16	51/54	-0.00046	0.35	64	45/51	+0.00053
1.25	18	54/61	-0.00066	0.25	96	51/54	-0.00046
1.00	24	51/54	-0.00046	0.20	112	45/51	+0.00053

The metric pitch fractional **error** is calculated as:

$$\textbf{error} = (N_1 / N_2) / R - 1.0 \tag{4}$$

Here **R** is determined by equation (2). A positive **error** means an oversize pitch while negative is undersize.

You won't be able to disengage the lathe's lead screw between metric threading passes. Furthermore, the threading dial is no longer effective. So, you'll have to keep the half nut continuously engaged.

Why use Close Enough Metric Threading

You're cautious about using approximate gearing to produce metric threads on your imperial lathe. You want to make the best thread that your skill and equipment allows! But, there are always errors that accompany the manufacturing process. Some are designed-in because of economics while others result from inaccurate machines. The various causes are immaterial. It's the amount of error that's of concern, for we ultimately want to make a part that fits or is interchangeable with others made to the same standard. So, you should ask, is an error that is less than 7 parts in 10000 acceptable given your costs in time, money and pride?

As an example, suppose you cut a common M10 x 1.5 x 50 mm long screw by the *close enough metric threading* method. There are about 33 threads on the screw. The amount that the threads would be off spec. over the entire screw's 50 mm length would be 4.6 parts in 10000 or 0.023 mm (less than one thousand of an inch) or 0.015 threads. Don't you think that a store bought M10 x 1.5 nut, which is 8 mm thick, would easily run back and forth along this slightly inaccurate 50 mm long screw?

The accuracy of a screw's pitch cut on a lathe depends directly on the accuracy of the lead screw. If it is malformed or worn by let's say 5 parts in 10000, it will produce imperfect threads even though you use the proper **127**- tooth gearing. Furthermore, the definition of an inch was changed to be exactly 25.4000000…. mm per inch during the adoption of the 'International Yard and Pound' in July of 1959. That probably happened after your imperial lathe was manufactured. So, your lathe's *perfectly manufactured* lead screw, along with age related wear, is probably off by at least 5 parts in 10000. Even by using the proper **127**– tooth gear, discussed above, you'll get inaccurate metric threads from your aging imperial lathe.

How to Choose N_1 N_2 and TPI for Close Enough Metric Threading

The defining equation, where ≈ means *as close as possible*, is:

$$\mathbf{N_1 / N_2 \approx R} \qquad (5)$$

R is determined by equation (2). For a desired metric pitch **P**, this represents one equation with three unknowns; **N_1, N_2, and TPI**. Furthermore, there are constraints that **N_1** and **N_2** are integers while **TPI** must be selected from an imperial gear box whose settings are sparse in number, such as ,…, 26, 32, 36, 40,…, etc. To simplify this problem, I wanted all the gears to have similar size. I thought that over the 22 or so metric pitches in the above *close enough metric threading* table, some of the **N_1** or **N_2** gears, might be shared among several of the pitches. Therefore, setting **$N_1 \approx N_2$** means that **TPI** ≈ 25.4 / **P** = 16.9333**...** So, I chose the closest available value on the gear box **TPI** = 16. That's how I got one of the three unknowns.

Obviously, **N_1** can't equal **N_2**. Rather, it is the ratio **N1 / N1** being close to 1 that causes the gears to be similar in size. For the example thread mentioned above, **P** = 1.5 and the choice **TPI** = 16, we find that **R** = 0.9448… from equation (2). We could search all rational numbers **N1 / N2** and determine the value that is closest to 0.9448… Here's where a computer program could be most appropriately employed.

In this case, $\mathbf{N_1}$ is close to $\mathbf{N_2}$ but also $\mathbf{N_1} < \mathbf{N_2}$, because ratio **R** is 0.9448… So, try $\mathbf{N_1} = \mathbf{N_2} - k$, where **k** = 1, 2, 3… Recall, gears must have an integer number of teeth. But, now there are two equations with two unknowns, $\mathbf{N_1}$ and $\mathbf{N_2}$:

$$\mathbf{N_1} = \mathbf{R} * \mathbf{N_2} \qquad \mathbf{(6)}$$
$$\mathbf{N_1} = \mathbf{N_2} - k \qquad (7)$$

The solution is:

$$\mathbf{N_1} = \mathbf{k} * \mathbf{R} / (1.0 - \mathbf{R}) \qquad (8)$$
$$\mathbf{N_2} = \mathbf{k} / (1.0 - \mathbf{R}) \qquad (9)$$

Eqn. (5) shows that the ratio of the gear sizes is **R**, which is determined from the product (**TPI** * **P**), see eqn. (2). The diameter of the gears is directly proportional to **k,** as shown in eqns.(8) and (9).

This brings up the concept of fractional **error** for judging the best $\mathbf{N_1}$ and $\mathbf{N_2}$ for a given pitch **P** and chosen **TPI**.

error = (Actual Pitch - Desired Pitch) / (Desired Pitch)

$$\text{error} = (\mathbf{N_1} / \mathbf{N_2}) / \mathbf{R} - 1.0 \qquad (4)$$

For our example M10 x 1.5 threaded screw we'll determine $\mathbf{N_1}$ and $\mathbf{N_2}$ for various **k** values and see how the fractional pitch error changes. Our screw has **P** = 1.5 mm and I selected the gear box setting **TPI** = 16. So, **R** = 0.94488188976, meaning the gears are about the same size. The calculation of $\mathbf{N_1}$ **and** $\mathbf{N_2}$ for various **k** values is show in the following table.

k	$\mathbf{N_1}$ **(eqn. 8)**	$\mathbf{N_2}$ **(eqn. 9)**	**integer ($\mathbf{N_1}$)**	**integer ($\mathbf{N_2}$)**	**error (eqn. 4)**
1	17.14	18.14	17	18	-0.00046
2	34.29	36.29	34	36	-0.00046
3	51.43	54.43	51	54	-0.00046
4	68.57	72.57	69	73	+0.00034
5	85.71	90.71	86	91	+0.00018
6	102.86	108.86	103	109	+0.00008
7	120.00	127.00	120	127	0
8	137.14	145.14	137	145	-0.00006

When **k** = 7, we have the solution with the 120 / 127 tooth Exact Metric Threading result having zero error. We could use any of the **k** = 1, 2, or 3 solutions since, after reducing the number of gear teeth to integers, $\mathbf{N_1}$ and $\mathbf{N_2}$ have the same gear ratios and yield an identical errors of -0.00046. We could also chose the **k** = 6 solution with 103 / 109 gearing having an error of 8 parts per 100000, almost 6 times better than the **k** = 3 result. I picked gears having around 50 teeth, **k** = 3, to match the size of gearing used for other metric pitches. Also, this suits the scale of gearing on my 9-inch Rockwell lathe.

An Excel spreadsheet that computes $\mathbf{N_1}$, $\mathbf{N_2}$, and **error** for various **P** and **TPI** over a broad range of **k** can be downloaded from this link.

Appendix 1

There are additional gears **N** for the ratio **R = N / 127** that can be used for Exact Metric Threading of various pitches **P**. Those gears that have fewer than **127** teeth, along with the **TPI** setting, are shown in the following extended table. Note that **N** = **P** * **TPI** * 5 (eqn. 3) applies for each table row as the other gear is special having **127** teeth.

Extended Exact Metric Threading

P(mm)	TPI	N	P(mm)	TPI	N	P(mm)	TPI	N1
6.00	4	120	0.90	22	97	0.45	44	97
5.00	4	100		24	108		48	108
	5	125		26	117		52	117
4.00	5	100		28	126		56	126
	5.5	110	0.80	24	96	0.40	48	96
	5.75	115		26	104		52	104
	6	120		27	108		54	108
3.50	6	105		28	112		56	112
3.00	7	105	0.75	28	105	0.35	56	98
	8	120		32	120		64	112
2.50	8	100	0.70	28	98		72	126
	10	125		32	112	0.25	80	100
2.00	10	100		36	126		88	110
	11	110	0.60	32	96		92	115
	11.5	115		36	108		96	120
	12	120		40	120	0.20	96	96
1.75	12	105	0.50	40	100		104	104
1.50	14	105		44	110		108	108
	16	120		46	115		112	112
1.25	16	100		48	120			
	20	125						
1.00	20	100						
	22	110						
	23	115						
	24	120						