The NEMES Gazette

New England Model Engineering Society Inc.

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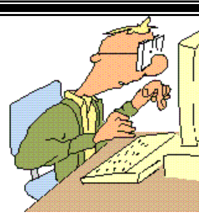

Editor's Desk

Frank Hills

The Ultimate Vacuum

"Vacuum". This word has been a source of confusion for most of my life. As a kid a vacuum sucked dirt out of a carpet. When my brother was a kid it helped him suck the milk from his bottle. I went to school and it became a space from which air has been drawn. Then things changed. The teacher began saying that a vacuum was actually a space of lower pressure. "Lower pressure than what?" I asked. "Some place else!" they said. Then came Chemistry class. A vacuum is still a space of lower pressure but the difference is due to fewer molecules bouncing around inside the space than outside. Ok. If you say so. Among other things, I now work with high vacuums. Though it has taken a long time for the above educational progression to make sense, it has finally sunk in. And good thing too, because now I know that you can't just use mommies Dust Buster to get a good vacuum.

What is the difference between having a vacuum and having a good, a high, or even an ultrahigh vacuum? I hate to say it, but it actually is having fewer molecules are bouncing around. Very few. That's not important if you're just trying to clean you rug or purge your air conditioner so you can recharge it. But if you're trying to aluminize a mirror or run an atom smasher, it's a difference story. Why?

Continued next page.

Next Meeting

Thursday, Mar. 1st 2012

7:00 PM. Meetings held at:
Charles River Museum of Industry
154 Moody Street
Waltham, Massachusetts

Membership Info

New members welcome! Annual dues are $25 (mail applications and/or dues checks, made payable to "NEMES", to our Treasurer Richard Koolish, see right) Annual dues are for the calendar year and are due by December 31st of the prior year (or with application).

Missing a Gazette? Send mail or email to our publisher.

Addresses are in the left column.

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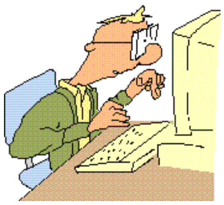


Editor's Desk

-continued from page 1

Because those molecules can chemically react, get in the way, transfer heat, and cause other problems. When making a mirror, you vaporize aluminum and the resulting cloud settles on your mirror surface. If there is oxygen in the chamber, it will combine with the cloud to form aluminum oxide and the mirror will be shiny black instead of bright. If you're running an atom smasher, the beam of electrons you're shooting will hit oxygen, nitrogen, argon, and water molecules and deflect everywhere but on the target. If you're trying to keep your liquid nitrogen cold, those molecules will transfer heat to the container you're storing it in and it will vaporize. Bummer!

So not all vacuums are alike and sometimes you need a better vacuum than at other times. Logic would dictate that to get a better vacuum you need a bigger pump. Well, yes and no. Because a vacuum is fewer molecules bouncing around, you have to consider how to catch them to really create a good vacuum. Yes, I said catch! When you initially turn on a vacuum pump, there are many of those little bouncing molecules. They bounce off the container walls, each other, even the surfaces of the pump. It's easy to trap the ones near the pump when they're knocking each other into it. But as the vacuum becomes greater, there are fewer things for the molecules to bounce off of and it takes longer to get them to the pump. Eventually there are so few that they rarely make it there, and when they do, they bounce off. Not all is lost however. Ever heard of a vacuum chamber being "baked out"? This is when the chamber is heated up, which adds energy to the molecules and makes them bounce around faster and get to the pump sooner. Baking out not only helps evacuate the chamber but vaporizes fingerprint oils, chemical dirt, and the like, which add to the stuff you need to pump out. But we're not done yet. There are molecules that will continue to bounce around. Some will even flow backward through the pump! How do you catch those?

It's at this point that we've crossed the invisible line from having a simple vacuum to having a high or ultrahigh vacuum. To pump your space down any more requires a means of physically trapping molecules. Before they were knocking each other into the pump, now there is nothing to stop them from bouncing back out. Ultrahigh vacuum pumps work by trapping the molecules and giving them only one way to travel…out. There are three primary kinds: the turbo-pump, the diffusion pump, and the ion pump.

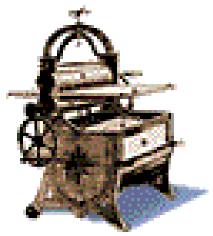
The inside of a turbo-pump looks like a jet engine with rows of closely fitting fans. But the fans don't scoop up the molecules and push them out of the pump like they do in a jet engine. They work by allowing the molecules to pass through the slots between the fan blades where there's a good change they'll hit the next fan and bounce back up. All this would be a waste of time except that they then bounce off the bottom of the first fan and down through the slots in the second to bounce off the third! And so it goes. Eventually the molecule bounces all the way to the bottom of the pump and out of the system. Spinning at up to 100,000 RPM, those blades catch a lot of molecules!

Instead of using turbo pumps, some prefer to use diffusion pumps. Diffusion pumps spray a mist of hot oil toward the output port. The molecules are trapped in the flow of the mist and travel with it. At the bottom of the pump the oil is condensed (cooled) back into a liquid. The entrained air molecules are released there and are pushed out by the molecules following them. This is simple, with no moving parts and very expensive oil that won't vaporize in the vacuum but can be turned into a mist by heating and/or spraying. Unfortunately you need to keep the oil from getting into your vacuum space. To do this you need chillers and screens and traps to catch the mist! Now a simple idea sounds more complicated.

Last is the ion pump. I've never personally worked with one of these, but the concept is simple. A cathode/anode arrangement charges the molecules as they enter the pump. Because cathode/anode arrangements create an electric potential (think magnet), anything charged at the cathode wants to travel to the anode, and it does, and flows right out the system. Again, no moving parts, but they use a lot of power.

Note that some pumps work better on one type of gas than others. Also these pumps don't work alone. High vacuum systems have a "roughing" pump to draw the pressure down to levels where these special pumps won't be overwhelmed and stop working…if they can even get started. Roughing pumps are simple devices that most of us would recognize like piston pumps and rotary vane pumps. These pumps tremendously speed up the process of generating a true high vacuum. But still, between the roughing, the bake out, and the high vacuum pumping process, it can take quite some time for the system to really drop pressure down to where you want it. Is nothing ever easy?

Next month, "What the heck is a Laser?"



NEMES Gazette Editorial Schedule

Issue	closing date for contributions
April 2012	March 23, 2012
May 2012	April 20, 2012
June 2012	May 25, 2012
July 2012	June 22, 2012
August 2012	July 20, 2012

President's Corner

Dick Boucher

The Meeting

Norm and I, mostly Norm I must admit, have been rather busy this month working on a new source of compressed air for our show in three days. With Norm taking his spring vacation, we only gave a passing thought to the need for a speaker for the March meeting. This also falls into the category of the sign on my shop wall “Caution: The dates on the calendar are closer than they appear.” If anyone is interested in speaking to our group please let Norm or myself know.

Miscellaneous Ramblings

There is not much in the line of rambling this month. I have been substitute teaching at the North Shore Technical High School, covering for an instructor in collision repair who had back surgery. I don’t know if any of the students are getting as much of an education as I am, but I have been watching the other instructor real carefully sucking up as much as I can. I am getting ready to repair a couple or rust spots on my MGB so Bea and I can be back on the road this spring, never leaving Essex county but putting 100+ miles on the car on a Sunday afternoon. What I am picking up at the school is well worth the price of admission. Yes, I don’t pay admission…they pay me to be there. Man, life is sweet!

I guess the big thing since my last column is our February show. By the time you read this it will be history for another year but all indications are it will continue to be a success.

One ramble I didn’t get to go to this year was the Ford Model “T” snowmobile meet at Meredith New Hampshire. Check out Errol’s report on our web site at www.neme-s.com

That just about covers it for this month. It has been a great winter for those of us who no longer enjoy clearing snow off our driveways. Winter really isn’t over yet I know and we could get blasted but so far so good. Last year at this time we had new neighbors and we never met them until springtime because there was so much snow piled up between our houses.

Dick B.

Aircraft Engines

By Jim Johnson

Early air-cooled engines included the one V-8 by Curtis, the B8, used in a motorcycle to break 100 MPH. Detroit Aero did a small business with an opposed twin. However, the US was not into the manufacture of airplane engines before WW1. What little else the US did in air-cooled engines was imported, with France in the lead. Figure 1 is a Renault V-8, today located in the museum at old Rhinebeck.

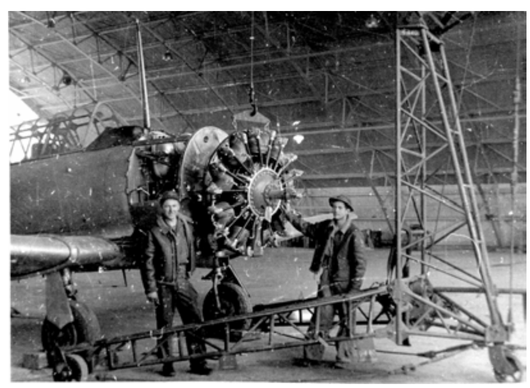
Anzani offered many radials but these were generally custom built and very restricted in performance. During WW1 and for the next 10 years, Great Britain, notably the RAF's ABC factory, Cosmos Engineering, and Bristol, developed air-cooled radials. Bristol's Jupiter series were quite large and very well developed in the sense of materials, lubrication, vibration etc. Most such engines both in England, France and the US employed something called the "poultice head". This was a steel cylinder closure with the valve seats, the cylinder threaded into the aluminum block and with the aluminum head bolted to clamp it to the steel closure. It is purported to have been said by Sam Heron, these engines should have been advertised and compared in terms of "Pounds of valves per hour" instead of gallons per hour. That's not a very pleasant thought at 5,000 feet over the African bush.

Readers may recall from my previous article that Sam Heron and Professor Gibson developed a set of principles and the practicalities of air-cooled cylinder design, with an actual model and operating engine just at the end of WW1. Some features included manufacturing methods, such as attaching the head to the cylinder hot, with threads on the cylinder larger than threads in the head. If you see some minor confusion between authors over these principles, it may be because there were several different designs. It languished for 8-10 years under "not invented here" social rules. However, by the mid 1920s, Armstrong-Siddeley developed both a 7 cylinder 150 HP, and a 14 cylinder 360 HP radial, named the Jaguar. It employed Heron and Gibson's' design principles. It was between wars, and there was very little demand for them. Bristol's Jupiter continued to languish in design and Sam Heron emigrated to the US to work for the US Army at Wright Field. His first activity was to join forces with Charles Lawrence at Wright Aeronautical Company, in the development of the Whirlwind J-5. The Navy had already purchased numerous J-1 to J-4 engines, had heard of the Jaguar's success and Sam Heron, and had already concluded that they wanted air-cooled engines. The J-5 Whirlwind was an immediate and major success. Frederich B. Rentschler, president of Wright Aeronautical, put Heron in charge of Charles Lindberg's preparations with the J-5 engine. Lindberg's trans-atlantic flight made the J-5's reliability very obvious. Rentschler then quit to rebuild Pratt and Whitney, acquired Navy contracts and proceeded to develop the Wasp, an engine we have all heard about. It too was an immediate and obvious success, notably in carrier landings which received a lot of attention then. Not so obvious was the impact of gasoline.

Today's gasoline has 18 paraffins, 11 octanes (not proportional to Octane rating) and probably hundreds of additives as well as thousands of important by-products, even aspirin. Refineries count H, C and N atoms and numerically define the molecular linkage in math simulations. Apparently, these have been tied/linked to the engine parameters and specifications and literally millions of engine tests were run with the Waukesha engine. This parametric data and equations defining it were collected by the Cooperative Fuel Research group, CRF, a sub-committee of the American Society of Automotive Engineers and the American Society of Mechanical engineers. So now, refineries swap gasoline components and no longer flare-off undesirables; (we do the disposal in our cars? Does your car have computer controlled mixture?). In the mid 20s, some features of gasoline were known by people like Kettering and Midgley of GM and others like Sam Heron. Jointly they brought "California" gas into existence and created some standards of gasoline. Also in 1927, the Ethyl Corporation introduced tetraethyl lead with immediate success. Back then, these actions allowed developers of both radials and liquid-cooled engines to concentrate on super charging. Today, aviation gas (Avgas) necessarily remains separate from cars and does include a significant amount of tetraethyl lead which is today insignificant in terms of earth pollution. There is nothing like it otherwise and both the fuel system and engine design of aircraft require it (think vapor lock! Otherwise, think of 5000 foot engine failures!). Air-cooled engine development was even more directly connected to fuel quality than liquid-cooled engines.

The 1926/1930 era saw the last of the Liberty engines, a surge in radials, and attempts to develop and market large in-line air-cooled engines. There was even a Liberty V-12 air-cooled conversion. When looking at the Renault V-8 at Old Rhinebeck aerodrome, turn around and there in a corner, almost hidden, is a big Ranger (or Continental?) air-cooled, inverted V-12.

Perhaps the most notable evolutionary chain belonged to the Wright Aeronautical Company. The Whirlwind J-5 (at 1650 cubic inch) enlarged to become the F-series up to about 1750 cubic inch and then the G series Cyclone at R-1820 and increasing horsepower up to 1200. The nine cylinder single-row G series was used in almost 100 different types of aircraft including the B-17. Perhaps the single most important early 1926/1930 era development, however, was Pratt and Whitney's Wasp R-1340 used in the DC-3/C-47. Readers can get an idea of the extent and rapidity of development from "coffee-table" books and realization that most cylinder designs and principles go back to Heron and Gibson, coupled with emerging gasoline standards. The author's personal acquaintance with radials is shown below, where he was helping his mentor change the R-1340 Wasp engine in an advanced trainer AT-6 aircraft (there were 17,000 of these and SN's and Harvard aircraft built for WW2).



The author has elected not to describe all the activity in radials nor in-lines of this era due to the immensity of the subject, not even starting to consider the French and Italian contributions.

Next time, we will look at the Allison and the Merlin engines, and the author will try to make some comparisons. His qualification, besides books, included assisting in a Packard V-1650 engine change and he got to fly piggyback in a P-51D once, all the time thinking about 5000 feet! The author will also compare the R-2600 air-cooled and the Merlin liquid-cooled engines in operating aircraft. The Allison started combat service life at 1000 HP, the Merlin at 900 HP. So, it wasn't initially as lopsided as we might hear in the popular press!

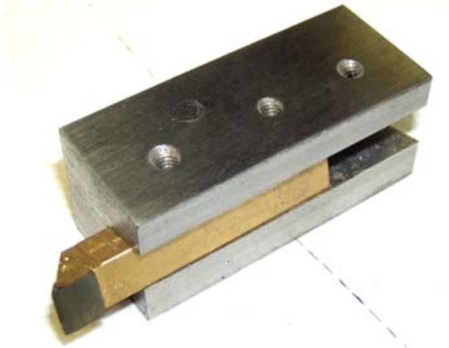
Tool Corner

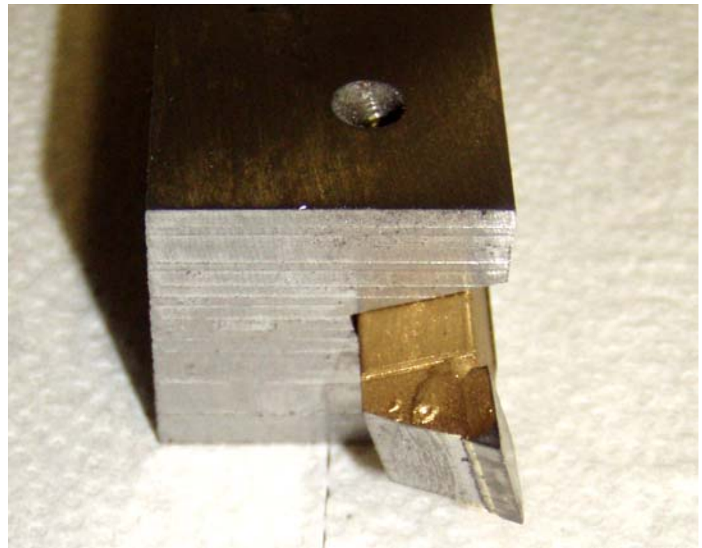
By Frank Dorion

Here's a very neat idea from Jim Paquette on setting up and using what's become known as the "contrary tool" for use on the lathe. If you've not heard of this tool before, it is a tool bit configuration that will give you a superbly smooth finish. Used properly it is limited to very shallow cuts, typically from .001" to .005". The chips come off as small strings of tightly curled wisps, and the resulting cut is comparable to a ground finish. This tool has been widely discussed on the net, but many are still confused by its unusual shape and not sure how to approach grinding it to shape. Also, because of its unusual shape, the contrary tool has been limited to HSS tool bits. Jim's idea addresses both of those issues.

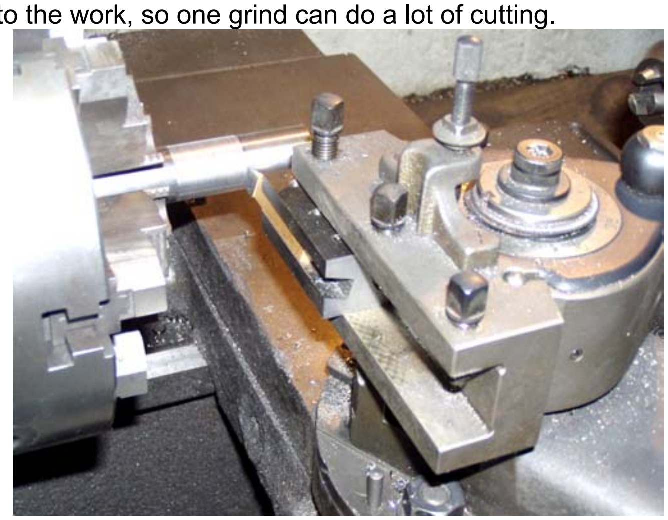
Jim has devised a simple tool holding block that can be easily made and modified to fit any lathe. By using Jim's tool block, grinding the contrary tool becomes about as easy as it could be. The other equally important element of Jim's idea is that it becomes possible to use a carbide-tipped tool bit as a contrary tool. Even if you stay with an HSS tool bit, grinding is still greatly simplified.

The following photos show Jim's tool block in side and end views. The tool bit itself is simply ground on its end to a 60^{o} included angle. The slot in the block tips the tool back at an 18^{o} angle, and, there you have it, a contrary tool ready to go!



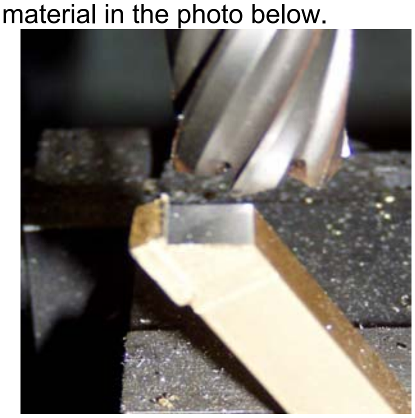


To give a clear picture of how this tool works, below is the tool cuting in Jim's lathe. Jim's lathe is a big Monarch and his Multi-fix tool holder will accept a tool about an inch high. If your tool holder has less capacity, mill down the back edge of the contrary tool block to fit the holder. This tool cuts along its diagonal edge, not on its top like a conventional tool. By adjusting the tool height up or down, you can present a fresh cutting edge to the work, so one grind can do a lot of cutting.



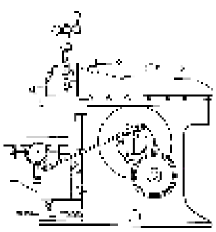
Making the contrary tool block is simple but Jim used a technique for milling the angled cut that's worth talking about. There are many tilting vises and chances are you own one or several of them. Unfortunately, most of them are not up to anything more than the lightest of milling cuts. Now take a look at Jim's setup below. It's quick and easy to do, solid as a rock, and precise enough for the large majority of angled cuts we make. He just clamped a smaller conventional vise in his Kurt vise and set the 18^{o} angle with a protractor. In addition to its rigidity, a major advantage of this setup is that you don't have to take your big vise off the mill to make way for a tilting vise.

As mentioned above, whether you are using an HSS or a carbide-tipped tool bit, the grinding is greatly simplified by Jim’s tool block. However, if you use the carbide-tipped version, Jim suggests a neat and easy way to remove the bulk of the steel backing material in the photo below.



To get the finest finish on your work, take time to hone the contrary tool on a stone or a fine diamond lap before use. You will be amazed at the results you get.

Thanks, Jim for some great shop tips!



Metal Shapers

By Kay Fisher

R. G. Sparber’s Gingery Shaper - Part 22

Machining the Feed Crank

The feed crank is one of the simplest parts on the shaper. That does not mean I machined it without a hitch.

Things started off well. I used the protractor pattern plus a 1¼” diameter sprue with center pin for the feed crank pattern. The resulting casting was $3^{5}/_{8}$” diameter so would need to be turned down to $3^{1}/_{8}$”. The shank would be less than the $1^{7}/_{8}$” specified by Gingery but I didn't see this as a problem.

Feed Crank Casting Photo by R. G. Sparber

The casting came out usable. The center of the bottom was a little higher than around the end. This is probably because the melt dropped down the sprue and struck the sand at the bottom of the mold. That pushed down the sand resulting in a bulge in the casting.

The broken edge of the mold permitted a small amount of melt to flow out at the perimeter along the cope/drag line.

After Sanding Photo by R. G. Sparber

First, I smoothed the bulged face on my belt sander. Then I sawed and sanded off the blobs around the perimeter.

Minus Sprue Photo by R. G. Sparber

The sprue was sawed off at about ¾". That leaves plenty of room for a finished length of ½".

Crank in Chuck Photo by R. G. Sparber

Next it was time to assess how best to machine the casting. Someplace inside this rough casting is a perfect feed crank. The trick is to find it.

I mounted the casting by its shank and used my cutter to see how far out the plate is to the OD of the shank. It was out 0.1". The plate is a little under 0.5" and I must cut a ¼" slot in it. That doesn't leave much extra metal for truing it up. Even though there is not a lot of extra metal on the shank, I decided to preserve as much of the plate as possible at the expense of the shank.

Remounted on Ref Plane Photo by R. G. Sparber

The sanded face became my reference surface. I will later re-cut it to be true. I step drilled the hole to $^5/_8$" and then bored out to 0.8". It should have been 0.750" but by the time I had my boring bar set right, I was over. I also ended up with the hole not centered in the hub. This was not a big deal and I was able to turn it to my advantage (no pun intended). The thick part would hold a ¼-28 set screw.

After screwing up the bore, I mounted the casting on a ¾" mandrel. This isn't the best approach since the cutting force did tilt the casting a little. I ended up having to do clean up cuts after repositioning the casting and re-tightening the set screw.

Milling Slot Photo by R. G. Sparber

The next step was to machine the ¾" slot. This is an easy task on a mill/drill. Since Gingery just used the cast slot, I figure this is not a critical machining task so I just eyeballed it.

Finished Crank Bottom Photo by R. G. Sparber

Above you see the finished feed crank. Note that the bore is not centered in the hub. What is important is that the bore is perpendicular to the bottom face. You can see some surface imperfections which are not pretty but the part is usable. These are not gas bubbles.

Finished Crank Top Photo by R. G. Sparber

I took more metal from this face and you don't see any surface imperfections. That is why I claim I don't have gas bubbles in the casting.

All that is left is to bolt down two strips of CRS to form a ¼" wide T-slot and make a sliding nut. Then, as Gingery says on page 70, "On to Bigger and Better Things". The tool head and down feed are next.

Stay Tuned for part 23 from R. G. Sparber next month.

Keep sending me email with questions and interesting shaper stories.

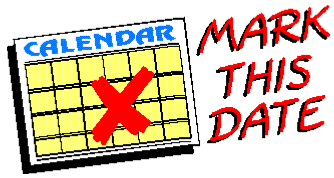
My email address is:
KayPatFisher@gmail.com

Kay

NEMES Shop Apron

Look your best in the shop! The NEMES shop apron keeps clothes clean while holding essential measuring tools in the front pockets. The custom strap design keeps weight off your neck and easily ties at the side. The apron is washable blue denim with an embroidered NEMES logo on top pocket.

Contact Rollie Gaucher 508-885-2277



Upcoming Events

Bill Brackett

Calendar of Events
To add an event, please send a brief description, time, place and a contact person to call for further information to Bill Brackett at thebracketts@verizon.net or 508-393-6290.

March 1st Thursday 7PM
NEMES Monthly club meeting
Charles River Museum of Industry
Waltham, MA 781-893-5410
http://www.neme-s.org

March 24-25th Midcoast Model Festival
Owls Head Transportation Museum Owls ME
http://www.ohtm.org/

April 5th Thursday 7PM
NEMES Monthly club meeting
Charles River Museum of Industry
Waltham, MA 781-893-5410
http://www.neme-s.org

April 21-22 NAMES Expo
Toldeo, OH
http://www.namesexposition.com/

April 15th 9:00am The Flea at MIT
Albany Street Garage at the corner of Albany and Main Streets in Cambridge
http://www.mitflea.com/