The NEMES Gazette

Vol 3 No 34
February, 1999

The Newsletter of the New England Model Engineering Society,
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Our Next Meeting is at 7:00 PM Feb. 4, 1999 at the Museum, 154 Moody Street, Waltham Ma.

Annual dues is $20.00 - Please make checks payable to"NEMES" and send to the NEMES Treasurer: Kay R. Fisher 80 Fryeville Road Orange, MA 01364

THE MARCH MEETING WILL BE MARCH 11, THE 2ND THURS. OF MARCH

This Months Contents

From the Editor's Desk:

After the last meeting I borrowed the overhead slides Don Strang used so I wouldn't have to worry about getting all the equations and graphs and things into my notes on the meeting. I'd planned on stopping by his house and quickly dropping them off so he could use them in preparing the final part of his talk. Before I knew what had happened my quick stop to drop them off had turned into a very enjoyable couple of hours that have changed my views on 3 phase conversion forever. First we went down into Don's shop and he showed me his setup for evaluating three phase convertors. He's got everything to check out what's going on inside the motor. He's also got a bunch of operating parameters for 3 phase motors. Coming away from his place I was amazed by how much more complicated the issue was than I had expected, while also being much simpler than I expected. What Don has to say at the next meeting is something that you need to know if you want to keep your exotic or expensive 3 phase motor alive for anything close to it's normal lifetime.

This month I read the new book by Lyle Cummins on his father, Clessie Cummins. If you enjoyed the Lindsay reprint of Charles Porter's biography I think you'll like this one too. Another story of a basically self taught genius who persevered his way to great accomplishments. Like Porter he was perhaps a little too trusting of the business half of the business, but after his association with the company bearing his name ended he connected with the folks who made Jacobs drill chucks and licensced his compression brake to them. He got a pretty good sum of money up front plus ongoing royalties and lived long enough to see the "Jake Brake" establish itself in heavy trucks around the world. This one is on my recommended list.

See you next Thursday -- scl.

President's Corner
by Ron Ginger

February Meeting

We will need some time at the meeting to make final plans for the show- see below, and we have 2 members doing short talks. As usual, we will also make time for any Show and tell items (or are you all holding out for the show?)

First, a new member Frank Galler was inspired by David Sticklers great talk at the last meeting to offer to relate some of his interesting experiments in rocketry. Then we will have Don Strang finish up his work on 3 phase conversion.

March Meeting

NOTE: The March meeting will be the SECOND thursday of March.

The new Public Internet Center will be having its grand opening on our regular meeting night, and the place is expected to be much to crowded for us- I understand some big time Washington politicians may even be there. So our meeting is Thursday, March 11.

Our speaker will be another new club member, Morgan Davis. Those of you that were at Roland Gauchers swap meet last fall may remember Morgan as the guy with the gatling gun model. Morgan has collected a lot of information about gatling guns, and has learned about their problems of construction and use. He will talk both about the real gun and his model. Should be another great meeting.

Museum Shop

I have mentioned before that the museum is looking for a few volunteers to help plan a new shop

exhibit. We need 3 or 4 fellows willing to get together at the museum some Saturday to work up a plan, then maybe meet with the museum board for approval. Once approved, we will have a Saturday work session where we can use lots of strong backs to shuffle the machines into the new arrangement.

This could be a fun project. I will work on it, and would like a few more volunteers. Please contact me if you can help.

NEMES SHOW- February 20

This will be the last newsletter before the show, so lots of information to cover here.

First for exhibits. Remember, there is NO restriction on what you can bring- except you have to be able to get it through the door and up about 6 steps (Sorry Howard, your Steam Roller won't fit) We are not looking for just models. Tools, jigs, fixtures, anything of a mechanical interest is welcome. It also does not have to be new- just because you brought it to a previous show don't leave it home- many of the visitors will be new, and most of us like to get a second look at this stuff.

Registration. We would like people to register, not to be restrictive, just to be sure we have enough table space for everyone. Max ben-Aaron is handling the registration and will have a sign up sheet at the meeting. For those out of state members you may call Max or I and let us know you intend to be there. If you can't register, come to the show anyway, we'll fit you in.

Set Up. We will start setting up at 8:00AM on Saturday, Feburary 20. We need a few hands there right at 8 to start setting up tables and rolling out the table covers. We would like to have everyone in place, and all the boxes and stuff put away under the tables at 10:00, our official opening time.

Compressed Air. We have a problem here, our air lines got stored away when the museum started the big renovation project last fall. They are still safely in the storage trailer, and it wont be opened until AFTER the big opening of the new section. So, we have no air lines. If any of you have small compressors or air lines, or a box of pipe fittings, bring them along. We will cobble up some solution to this at the show. Bring along extension cords as well.

Door Prizes. Steve Cushman has been hustling up some more door prizes, and as last year we will have some. Brothers Machinery has again donated a $300 gift certificate to their wonderfull collection. As last year, the door prizes are for EXHIBITORS only, and you must be present to win (Don't plan to leave before the final drwaing at 3:45). Your registration will put a ticket in the box- if you register at the show be sure to get your ticket into the box!

Safety Rules. I think we all understand the hazards of some of our equipment and models. Please be very aware of safety at the show. We are allowed to bring in small amounts of fuel, but be sure to have approved containers, and a fire extinguisher on hand. Be aware of your engines at all times- do not leave them runing unattended- even small steam engines running on air can pinch small fingers! We dont want to make this complicated, but if you have any doubts abut the safety of your exhibit, take the cautious approach.

Refreshments. I hope our small but very active 'Ladies Auxilary' will again help with refreshments, but we could always use a couple more helpers to get some of the supplies. We will have a sign up for this at the meeitng.

See you all at the February meeitng and the February SHOW!

--Ron

Calendar of Events

Jan. 29 1999, Fri noon to Sun noon
3RD Annual Cabin Fever Show
NEMES bus trip to big East Coast model show.
Ron Ginger 508-877-8217

Jan. 30 & 31 Sat & Sun 9AM 5PM
1999 Railroad Hobby Show
West Springfield Ma
Amherst Railway Society

Feb 4, 1999 Thur 7PM
NEMES Monthly club meeting
Waltham, Ma.
Charles River Museum of Industry 617-893-5410

Feb 20, 1999 Sat 10AM to 4PM
New England Model Engineering Show
CRMI Waltham Ma.
Ron Ginger 508-877-8217

March 11, 1999 Thur 7PM
NEMES Monthly club meeting
Waltham, Ma.
Charles River Museum of Industry 617-893-5410

April 1, 1999 Thur 7PM
NEMES Monthly club meeting
Waltham, Ma.
Charles River Museum of Industry 617-893-5410

April 23-25 1999
North American Model Engineering Exposition

NEMES bus trip to Wyandotte, MI
Ron Ginger 508-877-8217

For a listing, please send name and brief description of event, time and place and a person to call for further information to.

Bill Brackett at wbracket@ultranet.com or 508-393-6290

The Meeting, 4 January, 1999

Last spring J. Walter Castrow spoke to us about his dream for an International Model Museum in the Boston area. After over 10 years of work it looks like the museum will finally find a roof, which has been the only thing standing in its way for some time now. Captain Robert Dietz retired from the Navy last May and is now in charge of the Salem at the Fore River Shipyard and the Naval Shipbuilding Museum to be established there. There are many wonderful models out there, many headed to oblivion. If you know of a model that needs a home to keep it from the trashbin, let the Model Museum know. J. Walter will be keeping us up to date on the Museum as further progress is made.

Don Strang gave the second installment of his three part series on electrical power and motors in the shop.

In the 1820 to 1830 period Michael Farraday built the basis for electric motors. It was all very crude then as the meters we take for granted didn't exist yet. In the 1850s James Prescott Joule showed the equivalence of mechanical energy and heat by putting a paddle into water and comparing the mechanical energy into the paddle with the heating of the water.

What Follows is a bit of necessary background in AC Power so that next time he can cover phase conversion and how to protect your 3 phase equipment from failing years before it should.

ENERGY

work = force x distance = #ft
the unit of work (energy) is the joule
POWER is the rate of energy flow.
power = work / time = #ft/sec
work = power x time = the watt hour meter
1 HP = 550 #ft/sec = 33000 #ft/min
Electrical power = Watts
1 HP = 746 Watts
1 Watt is about 3/4 #ft/sec
Energy 1 Joule = 1 Watt Second
Rotative Power

1 REV = $2\pi r$ = Distance
Power = Force x Dist / time = 2 x π x r x Force/time
t = time of rev
1/t = Revs per second = RPS
P = F x r x 2π x RPS
Torque = F x r
Power = Torque x 2π x RPS (#ft/sec)

In the electrical world things are relatively simple for DC power.

EMF = E or V Volts
Current = I Amperes
Resistance = R Ohms
Ohms Law: E = I x R
Power = E x I in Watts

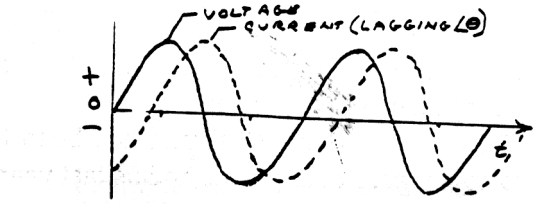
For AC power things get more complicated, with these additions to the equation.

Frequency = f Hertz (CPS)
Wave Shape = Sinusoidal
Capacitance = C Farads
Indutance = L Henries
Angular Frequency = w = 2πf (omega)

For AC power frequencies (60 hertz) capacitors have little loss (except for electrolytics) while inductors have a resistance loss. By convention, when drawing vectors to represent electricty the vectors rotate counter clockwise.

Power is the instantaneous value of E x I. It's simple for DC because other than the transients when you turn it on or off E and I are constants. For AC E and I are not constant. In a resistor the voltage and current are in phase. The power is E x I, or from ohms law I squared R. The I squared part means that the power is positive when the current goes negative, so there are two power pulses for each cycle of current.

For an inductor the current lags behind the voltage:

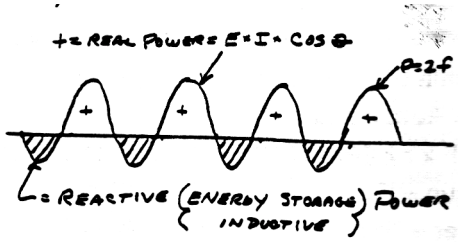


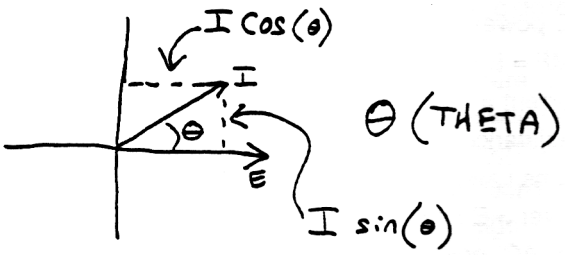
AC power
Volts x Amps = E * I = VA

+/- THETA = Phase Angle between E & I

P = Real Power = E x I x cos(THETA) in Watts

Reactive Power = Energy Storage (VARS) = E x I x sin(THETA)

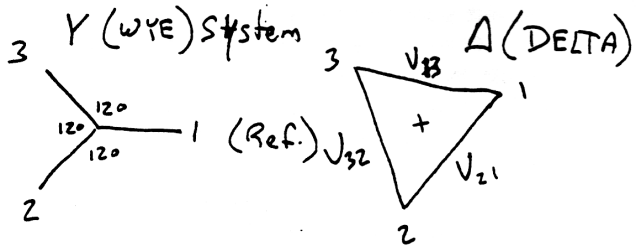




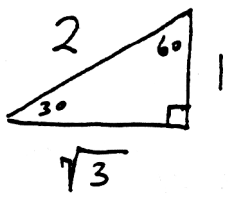
The result here is that for part of the cycle power feeds back into the power line from the inductor. For a single phase motor there are power pulses, two per cycle of the AC current.

Three Phase Power houses can be wired as 3 wire WYE, 4 wire WYE, or 3 wire Delta. Elihu Thompson grounded the 4th wire in the WYE and made AC safe for the world.

Three phase power comes in vectors that are 120 degrees apart.



Everything now becomes based on the 60 degree triangle:



which starts showing up everywhere.

Dave Piper is making good progress on his quick change tool post. He has checked, and for $100 he can get the toolpost and 20 holders case hardened. He's got the drawings in his CAD system and when it's done and he knows that the drawings are correct he'll make them available to us.

A few months back at one of the poster session meetings Dave Stickler brought in a liquid fueled rocket motor from his student days at MIT, along with a tremendous tail about the night they fired it up. From then on it was just a matter of time before we got him to give us a talk on his experiences with Rockets.

With a rocket the goal is high thrust with minumum weight. Hot gasses work better for producing thrust. In a rocke the fuel and the oxidizer are combined to produce energy and hot gas. The hot gas is expelled and provides the ejected mass or exhaust of the rocket.

There are three basic classes of rocket engine, solid, liquid, and hybrid. Solid and liquid rockets are quite familiar. Take the Space Shuttle as an example. The main shuttle engines are liquid engines, and the strap on booster engines are solid engines. The third variety, hybrid engines, have been in there infancy for the last thirty years. The hybrid engine has solid fuel within the case, but the fuel does not contain any oxidizer. As a result the hybrid engine can be stopped and restarted, unlike the solid engine which is started and runs till out of fuel. (Some solid engines can be stopped before they burn out, but the stopping is destructive and they cannot be restarted.)

Rocket propellant Systems have what is known as a Figure of Merit. It is the pounds of thrust that you can obtain for 1 second from a pound of propellant. Some typical figures of merit:

Liquid Propellants:

Liquid Oxygen / Kerosene -- about 330

Liquid Oxygen / Liquid Hydrogen -- about 420

N2O4 / Hydrazine -- High 200s? (both of these are incredibly nasty to deal with as small amounts can do very bad things to the human body)

Solid Propellants:

Ammonium Perchlorate and Aluminum/Rubber -- 255 or so

Hybrid Propellants:

Liquid O2 and Aluminum Rubber Mass – in the 320 to 340 range.

If you want to know how fast a rocket can accelarate to, the following equation is the one to use:

V = C x ln (Mo / Mf)

Where V is the velocity of the Rocket, C is the velocity of the exhaust, Mo is the original mass of the rocket, and Mf is the final mass of the rocket. ln is the natural logarithm. The higher the exhaust velocity, the faster the rocket can go for a given mass ratio.

For liquid O2 / liquid H2 if you solve this equation to determine what the mass ratio is to achieve orbital velocity it comes out about 10. That means that if you start with 5 tons of rocket on the launch pad only about 1000 pounds of it can make it to orbital velocity. That 1000 pounds consists of the mechanical parts of the rocket motor and the structure to support the entire 5 tons on the ground and through the accellaration to orbit. Which explains why it takes a very big rocket to put a relatively small payload into orbit.

The nozzle of the rocket is the “engine” where thermal energy is converted into kinetic energy. Propellant is burned in the combustion chamber and flows through the nozzle, accelerating as the pressure is reduced. The ideal nozzle is not a simple cone, but is shaped to allow the gas to go from the high pressure in the combustion chamber to the low pressure outside the rocket, exiting with the greatest possible speed. Ideally the pressure of the exhaust leaving the rocket is 0, as that will result in the greatest speed.

When we think of burning things we tend to think of complete combustion, but the optimum for a rocket is the mix that gives the maximum exhaust velocity. For the Shuttle it is four to one fuel to oxidizer. Pressure and velocity need to be optimized. More pressure means more velocity, but it means more weight too.

In a liquid fuel rocket typically turbo pumps are used to pump the liquid fuel and oxidizer into the combustion chamber. The turbine in the middle drives two pumps, one for oxidizer and one for fuel, with the pump output supplying fuel and oxidizer to the turbine. This system is prone to going overspeed because an increase in speed will boost pump output, boosting turbo input. The result is that the pump can run away and self destruct. The Thor rocket launch problems in the early 1960s are a good example of this.

Sending the turbine pump exhaust overboard is wasteful. In the Shuttle two pumps are used, one with excess fuel to the turbine, the other with excess oxidizer. The two exhausts go into the combustion chamber and add to the total thrust. Peak pressure in the Shuttle engines is about 6000 psi.

How to Panic a Campus

1. Fire an oversized liquid rocket.
2. use and undersized test cell
3. locate the exhaust from the cell at the junction of two buildings which create and effective accoustic horn aimed at the dorms and the President’s House.
4. Do it at 2 AM on a Quiet Sunday Morning.
5. Have the shutoff valves lock open. (Fortunately only 4 seconds of propellant in the tanks.)

The MIT Police Showed up almost instantly, and it being MIT were understanding. The next morning the visit to the Dean of Students went well too, after all it was part of a masters thesis. Just please don’t do it again in the middle of the night.

The rocket was basically a 304 SS can with a screw in nozzle on the back and a screw in injector plate on the front. The injector plate had eight sets of triple injector elements - two fuel jets and one oxidizer jet placed so that the three liquid streams impinged within 2 or 3 thousandths. Each hole was 30 thousandths of an inch in diameter. The Fuming Red Nitric Acid oxidizer and the Furfuryl Alcohol fuel were pumped into the injectors at 400 psi. Dwell time in the combustion chamber was about 20 milliseconds, and the exit velocity of the exhaust was about 6500 fps.

Solid Rocket motors have carefully designed internal star patterns in them so that as the motor burns the surface area that is burning will stay constant and the burn will reach the wall evenly and go out evenly. The burn rate is proportional to the square root of the pressure, so the nozzle has to be matched carefully to the burn rate to get good performance. If the fuel cracks the burn can go down the crack, increasing the burn rate which will raise the pressure and increase it more. Since the can holding it all in has a 10% safety factor the motor rapidly goes boom.

How to Scare a Seagull

1. Fire a High Thrust sold rocket
2. 16 pounds empty
3. isolated beach
4. Sunny June afternoon
5. no guidance or payload
6. Hope it doesn’t sink a boat when it hits the water at about Mach 2

This rocket was about 4 inches in diameter, with an aluminum tube body, a steel nozzle with graphite inserts, and a 6 point star grain pattern. The 5 charges were cast in quart oil cans, then put on a mandrel in a lathe and turned down to the proper diameter to slide into the rocket tube. They coated the ends and the outsides of the grains to keep the burn confined to the inner star pattern.

Dave missed the fun part, at the isolated Cape Cod Beach on a beautiful summer day. Burn time was six seconds, with reports being that the rocket left the launch rail smoothly and that the smoke trail was straight and true indicating a good flight. Initial accelleration was 10 Gs, going to 20 Gs as the rocket lost mass. So, at burnout it should have been going about 3000 feet per second and 6000 feet from launch. Altitude would have peaked at 100 seconds into the flight at something over 20 miles. Splash-down at 200 seconds somewhere 10 plus miles down range. Presumable the rocket is still out there on the bottom of the North Atlantic slowly corroding away.

Hybrid Rockets

For a hybrid rocket you have a solid fuel and you pump the oxidizer into the front of the fuel. They react, and the exhaust goes out the nozzle to produce thrust. Performance can be made much better by adding a mixing chamber after the fuel and before the nozzle where the fuel and oxidizer can mix together and complete their reactions. Since the burn rate is limited by the rate the fuel can be heated up to boil off the surface, casting Napthalene into the fuel can boost the burn rate by up to 3 times. The Napthalene boils out and burns, leaving a pitted surface with increased surface area.

Dave made a simple hybrid rocket as a demonstation model for the classes he taught at MIT. It had an O2 inlet from a bottle of compressed O2, a screen to diffuse the O2 stream coming in, a methane inlet and spark plug for starting, the fuel section, a graphite flow trip at the beginning of the mixing volume, and a graphite nozzle. The whole thing was held together by six tierods holding the two ends over the fuel section in the middle. The fuel section consists of two Plexiglass tubes. An outer one for the structure and the inner one for the fuel. It ran at about 60 psi gauge pressure and produced a nice blue flame with shock diamonds.

Summary

Rockets are a very simple concept that is at least 1000 years old.

The Goal: Go Whoosh with minumum dead weight.

Too little dead weight goes BANG!

TIPS AND TECHNIQUES

by Ed Kingsley

ESCHEW OBFUSCATION

Ever been caught in a swarf tornado? Many's the time, as the old tool bit struggles up to that final moment of truth, the monotonous chip, heretofore spiraling steadily AWAY from tool and work -- goes berserk!, instantly enshrouding the cutting area in a whirling cocoon, and keeping me from watching those last (and fateful) few thousandths of cut. In a panic, I hit the brakes, and wind down the spindle as quickly as reflex permits. Sometimes I win, sometimes I don't. At best, there's some mark on the work, at the panic point. At worst - let's not go there.

Some materials show more predisposition than others to shed this blizzard of blinding swarf. Aluminum and several plastics share this uncanny ability. Delrin is particularly annoying, with Acrylic and Polycarbonate close behind. Generally, the finer the cut, the greater the tumult. I have employed several techniques to combat this swarf creep-and-attack syndrome, but few have proven very effective.

Occasionally, however, lateral thinking helps. If you can't see the work, use a surrogate stop line.

The Cross-Slide. I have a dial indicator set up to monitor the cross slide, for finish cuts. For roughing cuts, I clean off the top surface of the cross slide dovetail with some alcohol, and make a "permanent marker" line across it to show how far the cross slide should travel. Coordinate this point with a number on the crossfeed dial, and you can usually avoid over, or under, cutting the diameter by <multiples of> .1000".

Carriage travel. If you don't have a Trav-a-dial (me neither...) or a DRO, then a carriage stop is left handy. Right handy, too, because you can use it on both sides of the carriage, although you may have to remove the threading dial to use it on the right side. If the length of the carriage feed cut is short enough, a dial indicator on a mag-base will work. I sometimes rig up a 6" or 12" scale, on a magnet, and stick it on the bed, or to the carriage. I line it up to a reference thingy, mark(er) off a line across the scale, at the desired distance, and make my cut with full confidence that at least I won't run into the chuck during the blackout. Usually anyway.

Although it is often suggested that high velocity air is Bob's uncle around machine tools, I have found, especially when machining Delrin, that a steady stream of air, directed down the spindle, will keep most of the "hairs" downwind, and away from your target area. This, of course, works much better with a 3 or 4 jaw chuck than it does with a collet, unless you are boring the workpiece. Be sure to wear goggles if you try this. (Windsocks are optional)

I've become accustomed to using these strategies, on aluminum and plastic, and now I use them almost all the time, with every material I'm machining. It's so easy to be distracted for a moment (now where did I put that %#*!& ....), then return your attention to the work, and suddenly realize that you have no idea how close you are to smashing into the headstock. A quick glance at your "finish line gage," gives you an instant status report, and lets you start breathing again. Or, you smash into the headstock, anyway. Nothing's perfect.

"Gravity's so heavy dude, it always brings me down .....
and, like friction's a total drag!"

ON THE OTHER HAND(S)

I once knew a fellow who said he'd give his right arm to be ambidextrous. Most of us wouldn't go quite that far, but the more I put tool to metal, the more I get his point. What we need are three arms, (or hands), or a dedicated helper just off the port bow. What most of us will have to settle for are a few hours of "dumb-hand" training.

I have acquired the dexterity to dip and brush oil with my left hand whilst my right hand is raising and lowering a quill, and to turn the carriage feed wheel with my left hand, whilst my right hand is slathering it on a lathe object. I admit I fought this for a long time, it's like rubbing your tummy and tapping your head at the same time, only harder, but it's REALLY worth the effort. Once you get the hang of it, it's like really having two useful hands.

When you get good at this, you may begin wondering what other sorts of split brain hijinks you could also pull off, and this can engender truly great stupidity. Does the left hand know what the right hand is doing, and is it entitled to under the separation of powers doctrine? Let's not go there, either.

Moebius Strippers never show you their backsides.

QUICKIES

1) Gather up all those odd sheets and scraps of sandpaper, in various grits, and make yourself a "pad". Fasten them together with a binder clip, and hang the clip on a nail, somewhere that's handy. This helps clean up the shop, too.

2) If you insist on using drill chucks that require a key, consider attaching the key to a spring loaded, retractable key holder, (the kind that clips to your belt and holds a big ring of keys) Mount the case on your drill press, or tailstock. This keeps the key from "going missing" and keeps it out of harms way when not needed. Starrett makes these, and they're available at most hardware stores. I used one for years, until I saw the light and went all-keyless.

3) The Styrofoam 'flats' ground meat comes on, and the clear boxes mushrooms are packed in, make excellent "round-up" containers to corral all those small bits and pieces that belong together. Use them to tote the smaller tools you work with, on the lathe, at the mill or drill press; such as: drills, taps, countersinks, endmills, etc. I find them indispensable for keeping all of the constituent parts of a project from becoming separated. .

Blame St. Andreas, it's all his fault.

ALIEN TOOL ABDUCTIONS

"I'm sure I put it down right there". "I know I heard it hit the floor and roll over that way". "I never moved - how the #@%+* could I have lost that *^#%@ .... !!" All too familiar words, I'm sure. They go to join our socks, I think, but just where do our socks go? Alas, only Heisenberg knows, and without immunity, he's not talking.

But, luckily for us, there was a thread on this very topic on Rec.Crafts.Metalworking, last month, and here are a few of the suggestions offered there to help you forestall the inevitable.

1) Put a roll of butcher paper at one end of the bench. Roll out a fresh sheet, across the length and width of the bench. This will help enable you to see small objects that might otherwise get lost amongst the "war decorations" on your benchtop. (This hint, of course, presumes that you can both find your workbench and that, if you can, the top is clear. Possibly a dubious proposition at best, for most of us.) .

2) Assemble and disassemble parts inside of a large (clear) kitchen storage bag. Presumably, they will all remain inside, until you take them out. (Then all bets are off)

3) Make, and install, "skirts" to fill-in the spaces underneath benches and tool stands, thus preventing fugitives from entering potential abduction zones. (I like this one ...)

4) If you lose something small on a carpet, or perforated rubber mat:

a) If it's magnetic, try sweeping the area with a magnetic tool strip - one of those 6" to 30" long bars you stick your screwdrivers, or kitchen cutlery to, that fastens to the wall.

b) If it's not magnetic, try putting panty hose, or an old T-shirt, over the end of the vacuum hose, and snuffling about for it. Both of these methods will find stuff you didn't know you'd lost. ('Sometimes' this is a good thing...)

5) In a similar vein, somebody suggested that videotaping the disassembly of a workpiece would help you recognize the relevant parts, later. (Perhaps a surveillance camera left running in the shop would clear up a mystery or two. Then again, maybe there are just some things that we were not intended to know.)

Sign on University Physics Building, "Heisenberg may have slept here".

--Ed

Classifieds

FOR SALE-'Millrite" vertical milling machine w/collets and swivel vice. Excellent condition and very clean. Call Dave @ Butler & McMaster-207 623-8895. Located just off the Maine pike @ Augusta.

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The NEMES Gazette

c/o Stephen C. Lovely
Post Office Box 277
Milford, Ma. 01757-0277
newsletter of The New England Model Engineering Society