The Multimachine $150, 12" Swing, Metal Lathe/Mill/Drill

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The Lucien Yeomans “secret” that was almost lost.

Metalworking lathes are necessary to the production of almost everything but are very expensive. In 1915, special lathes made from concrete were developed to quickly and cheaply produce millions of cannon shells needed for World War I. Lucien Yeomans, the inventor, won the nation's highest engineering award for it but sadly the technique was almost forgotten after the war. We re-discovered it as a way to quickly make inexpensive but accurate machine tools for use in developing countries and in trade schools and shops everywhere.

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Drawings by Tyler Disney, flowxrg.com

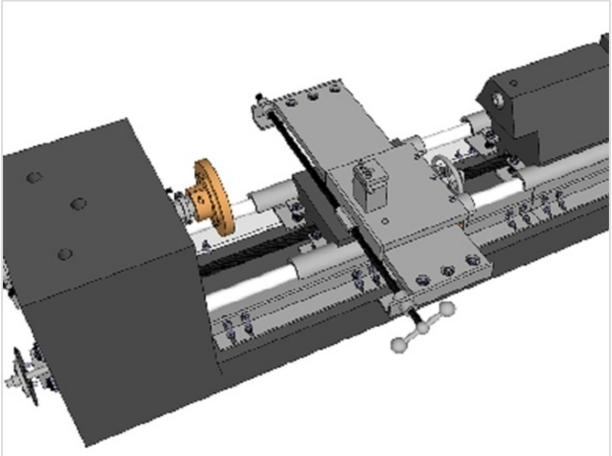
Research by Shannon DeWolfe and David LeVine

Dimensioned drawings and support at:

http://groups.yahoo.com/group/multimachi...

Many supporting files are at:

http://concretelathe.wikispaces.com/Curr...



Step 1 — The Multimachine $150, 12" Swing, Metal Lathe/Mill/Drill

Bottom-up development for emerging economies: Making machine tools accessible to the developing world with a concrete lathe that can be easily and inexpensively built. The machine tools that fueled the Industrial Revolution in the Western World have become too expensive to be used in the places that most need small industries now. This concrete lathe can change that. Based on a proven early 20th-century design, it can be made in any size and the same techniques can be used to make many different kinds of machine tools.

MAKERS NEED METAL LATHES AND MILLING MACHINES TOO!

Easily made from scrap, steel bar and concrete mix. Built using common hand tools, a drill along with a few small welds. Easily converted to drilling and milling.

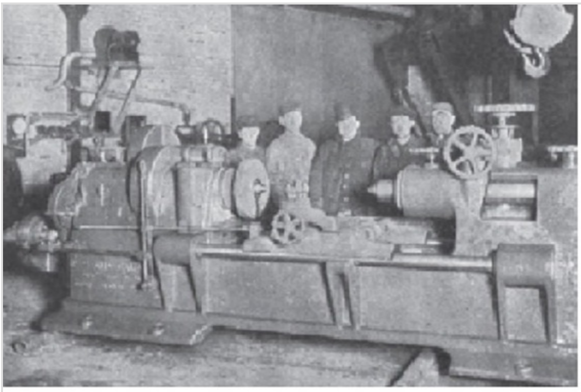
Lathe cost is determined by the kinds of good junk you have available. The only "new" stuff needed could be a few sacks of concrete mix and some of the non-shrinking grout used by tile workers.

Step 2

A metal lathe or metalworking lathe is a large class of lathes designed for precisely machining relatively hard materials. They were originally designed to machine metals; however, with the advent of plastics and other materials, and with their inherent versatility, they are used in a wide range of applications and a broad range of materials. This is a 100-year-newer, industrial version of the type shown below but this one, ours and the one below all work in exactly the same way.

METAL LATHES ARE THE ESSENTIAL TOOL IN PRODUCING ALMOST EVERYTHING!

Ours COULD be made in a size that would dwarf this one.

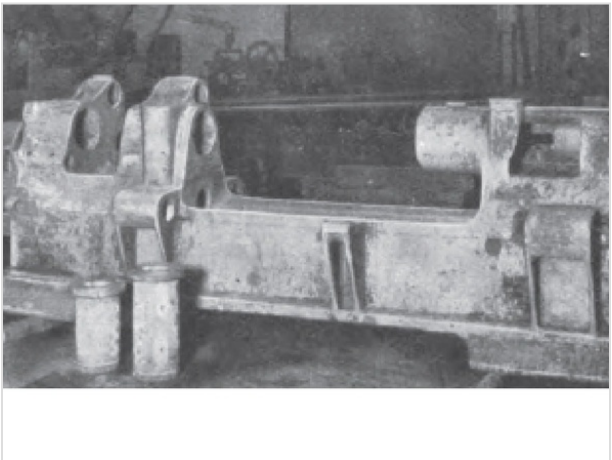


Step 3

Our idea started with this. What Lucien Yeomans did in 1915 (and we also do) is extremely simple. It is well known that concrete shrinks as it sets up. This is not important when you pour your sidewalk but this shrinkage would force a concrete machine tool out of alignment as the concrete casting dried. He solved this problem by casting a concrete frame or “bed” with oversize cavities where the parts would normally go and then let the concrete season and shrink. He would then align the metal parts and hold them in place by pouring a non-shrinking, low-temperature metal alloy over them.

In our version the component size is similar to a typical 250kg 225mm swing lathe but it has the capacity to mount a grinder that can be used to re-surface 300mm diameter clutches and brakes. It was specifically designed to be transportable so it could be taken to Maker Faires and could also be used in rural areas of developing countries. A better choice for many would have ways 300mm between centers and a 400mm swing. Other parts could be scaled up accordingly and would add little to the total cost. A larger lathe would be even easier to build since there would be more room for components.

The foreman's top hat is the official project head gear and logo!



Step 4

We use the long-proven Yeomans technique or a small variation of it for almost every part of our lathe:

Fitting the ways to the bed.

Fitting the “shoes” to the ways and the carriage and then grouting them together.

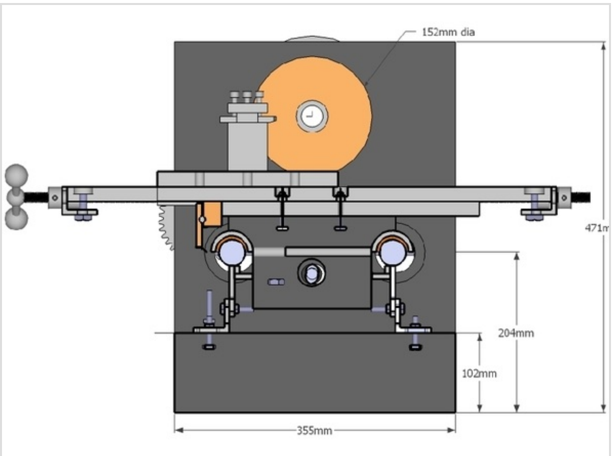
Fitting the cross slide to the carriage.

Fitting the tail stock to the ways.

Fitting the Morse Taper socket in the tail stock.

Fitting the spindle cartridge to the headstock.

Fitting the thread follower spindle cartridge in the head stock.



Step 5

Every part of our lathe can be replaced as parts wear or as improvements are needed.

The all-thread type lead screws can be replaced by Acme type.

Spindle bushings can be replaced by ball or roller bearings.

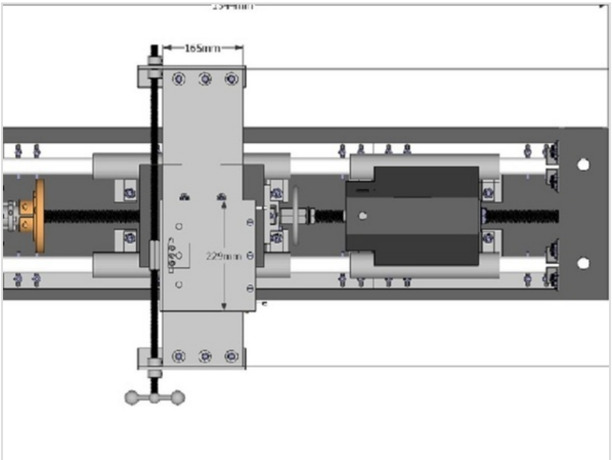
The carriage can be a milling or boring type.

A compound slide can be added.

CNC or change gear type threading could replace the simple “thread follower” type.

Steady- and follow-rests can be be added, as can a turret tailstock.

The box type cross slide can be replaced by a dovetail type machined on the lathe itself.



Step 6

The goal: not the best tool, but one that will work with reasonable accuracy and that can be built by a skilled mechanic using common tools and at the absolute lowest cost.

This is my effort to get prototypes built. I am 76 and can't walk well anymore so I can't build one to take pictures of. Since I cannot build one, I designed the lathe as a simple combination of long-proven technologies. The machine is based on 5 ideas that have been around for nearly a hundred years or are obvious to someone who works with machines. They are:

The Yeomans concrete technique.

The cartridge type spindle assembly.

Carriage mounting shoes that are connected only by concrete.

Supported round ways.

Thread-follower threading with wooden clamp jaws that close on a thread that is to be duplicated.

Material needed

Step 7

2 pieces of round, straight steel pipe or bar for the "ways" (the round shiny things that the carriage slides on).

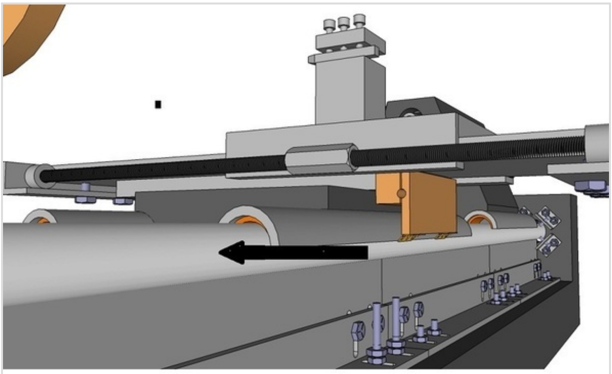
Steel bar for the cross slide.

Scrap pieces of angle iron and pipe for the spindle cartridge, carriage frame and supports for the ways.

Junk pistons to be melted and cast into adapters and bushings or bearing housings. Casting simple shapes is very easy and gives the machine builder the ability to make thousands of different, useful devices or products.

Concrete mix, re-bar, fiber additive for concrete and non-shrinking grout.

These are the materials needed to build a 300mm swing (maximum length that would fit on the faceplate) screwcutting lathe that would fit on a workbench. A desktop lathe half this size could also be built. Our optimal “shop size” lathe would have ways 300mm (centers) apart, swing of 450 mm and would weigh at least a thousand pounds. A lathe the size of a railroad car could be built using the same basic design.

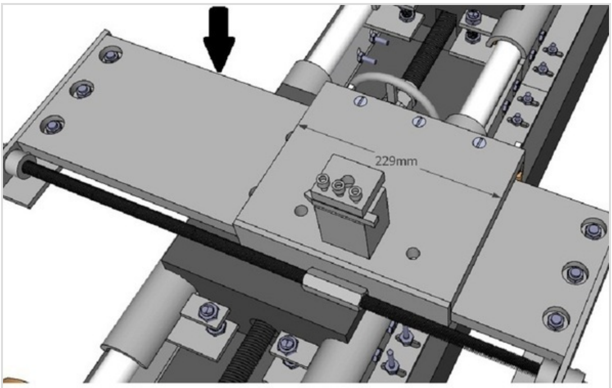


Step 8

Steel for the ways will probably require a careful search. Needed are (2) 40mm x 1.5 meter (approx) very straight steel rods or pipes (scrap hydraulic cylinder piston rods?) Check them for straightness by putting the round bars or pipe side by side and shining a bright light between them as you first rotate one, then the other.

A known-good lathe could be used to turn the ways round and straight. If you do have ways turned, be sure to check the ways very carefully afterwards because machining a long piece to an accurate diameter can be difficult.

Imperfect ways can (slowly!) be corrected by the "3 rounds" method that can be found at: http://concretelathe.wikispaces.com/Curr...

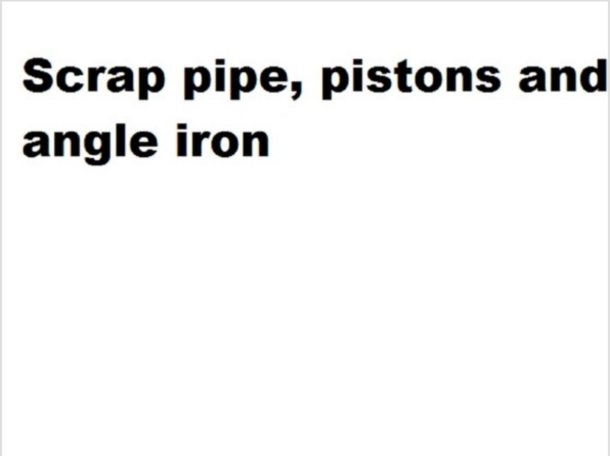


Step 9

The cross slide can be made using 3 pieces of steel of different widths or built in a more simple version that requires steel of only one width (150mm by 19mm). The 3-piece design is superior because wear is easily adjusted for but it may require cutting a piece of heavy plate to a more narrow width, a job that would be very difficult for many machine builders.

Finding used steel bars may be difficult. Whatever your source of bar, be certain that the ends have been sawed and not sheared. Shearing distorts the bar ends.

A more simple way of building the slide will be shown on slide 59.



Step 10

Besides the pipe and bar, shorter pieces of steel angle iron and pipe will be needed. The sizes of these shorter pieces depend on the diameter of the ways and the distance between the ways of the machine you are going to use.

Used pistons will be a source of metal for bushings and adapters because piston metal alloy has been proven durable in steel engine cylinders.

Construction and alignment sequence of operations

Step 11

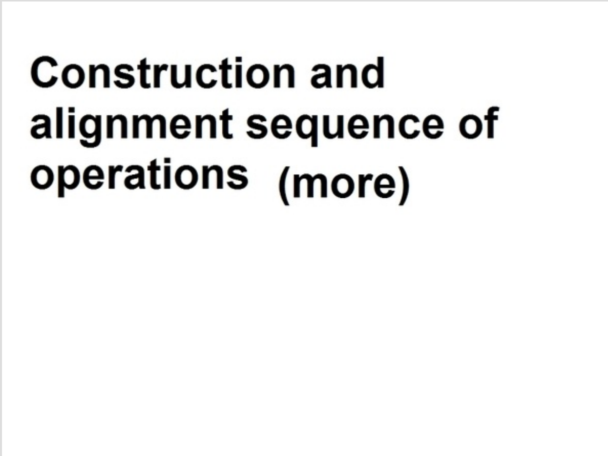
Building the wooden form and casting the concrete bed comes first.

Next comes installing and aligning the ways. A carefully-held spacer can be used to set the distance between the ways. A piece of float glass plate can be used to put the ways in the same plane. A ball bearing on the plate glass can make the ways level enough for our use here.

Making the carriage shoes (the parts that actually slide on the ways) and firmly clamping them in place is next because the form for the concrete carriage is built around them. Firmly clamping the carriage shoes to the ways before pouring the carriage concrete will align the carriage with the ways.

Fit the form for the carriage around the shoes and pour concrete. Let it season.

If necessary, make a temporary lathe out of an auto wheel hub assembly mounted on the headstock and use it to machine spindle bushings or bearing adapters. Later, mount the hub assembly on the rear of the headstock and use it as a spindle brake.



Step 12

Make the spindle cartridge assembly, clamp it in place and align it with a dial indicator mounted on the carriage. Grout the spindle assembly in place. A dial indicator used to measure from the left, right and center of the carriage can be used to align the spindle

Build the cross slide, mount it on the carriage, align it with a dial indicator mounted on the spindle then grout and bolt it in place.

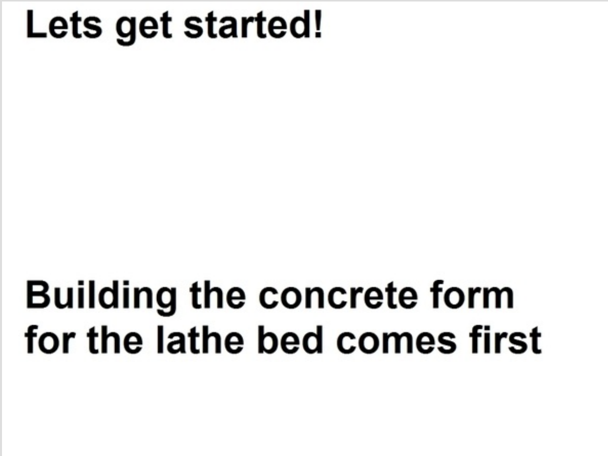
The tailstock is made in the same way as the carriage (though in a different shape!). A Morse Taper drill bit held in the spindle can be used to align the Morse Taper socket in the tailstock.

Add the smaller parts like the lead screw and handwheel mechanism, pulleys, motor, thread follower and tool post.

Step 13

If you or people you know are interested in international development, tell them about this. And please let me know if you do.

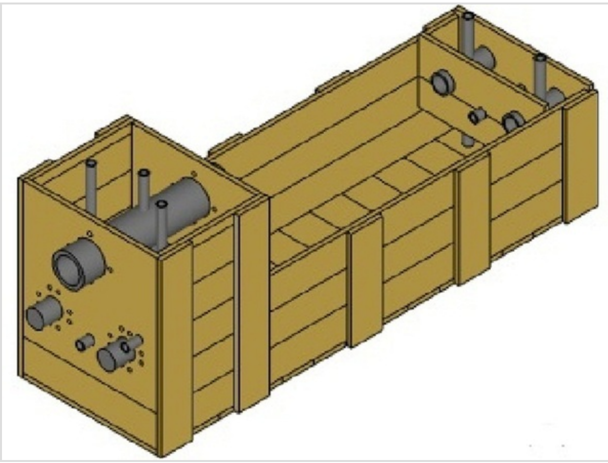
If you decide to build one, please take lots of pics for us.

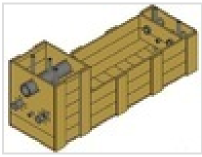


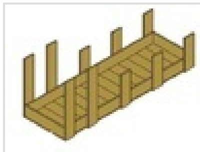
Step 14

Rule #1 is to PAY INFINITE ATTENTION TO DETAIL! If you don't, errors will compound and you will end up with an expensive boat anchor!

Build a mock-up first (especially of the carriage). Know the source of every bolt, nut and nail. Don't make a stupid mistake with something that is this big and heavy.

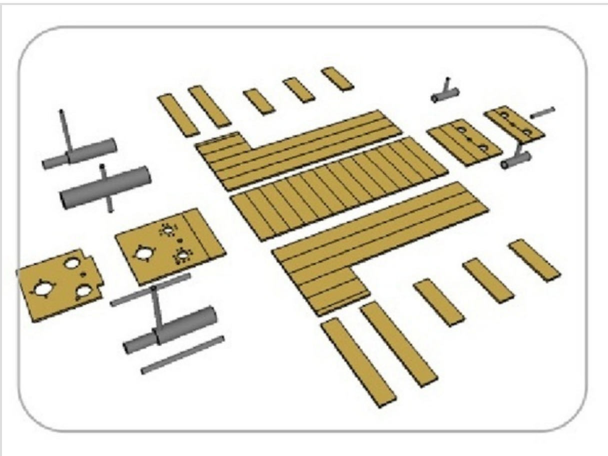






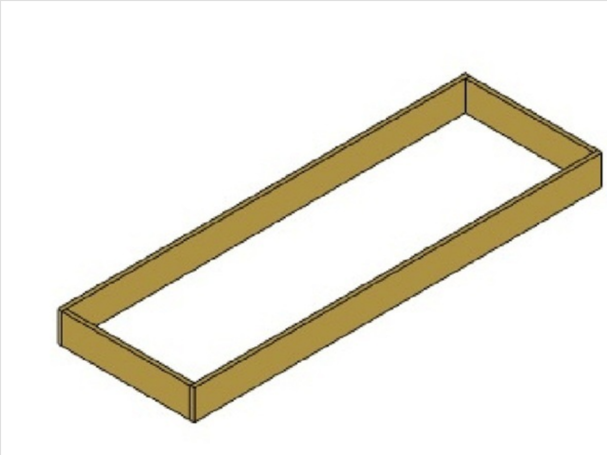
Step 15

The completed form will look like this.



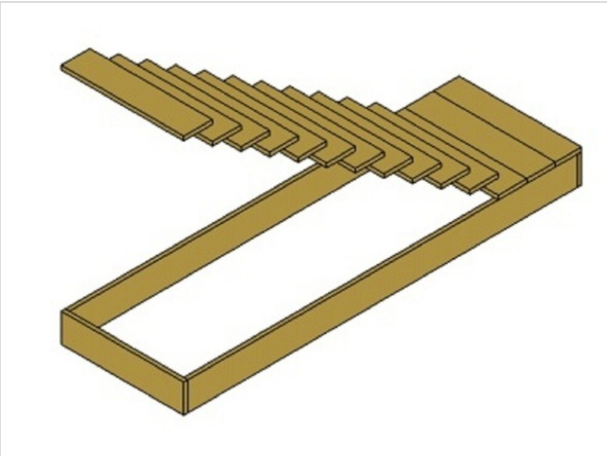
Step 16

Materials can be as simple as pallet wood and cardboard or plastic tubing.



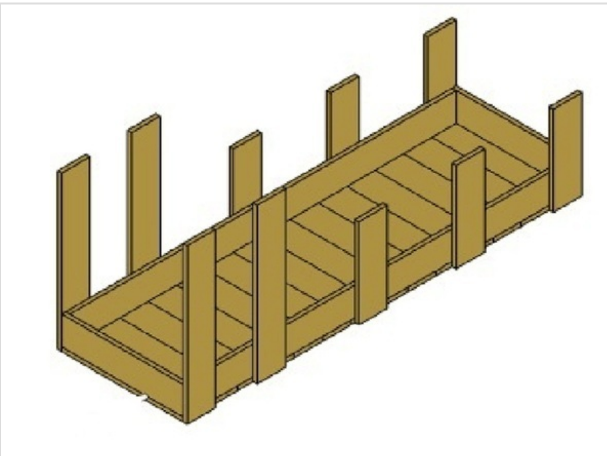
Step 17

Start with a simple box.



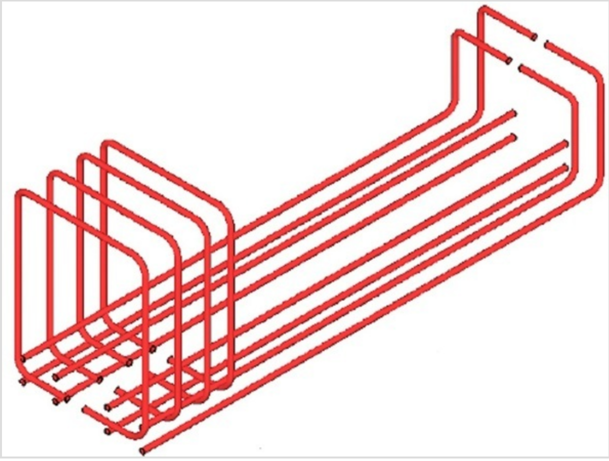
Step 18

Close up the base!



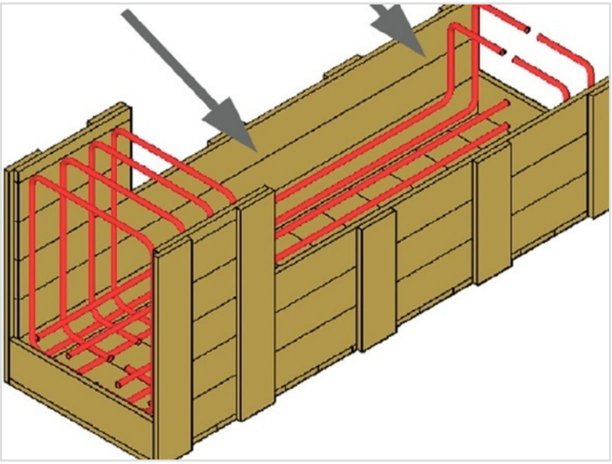
Step 19

Add the sides.



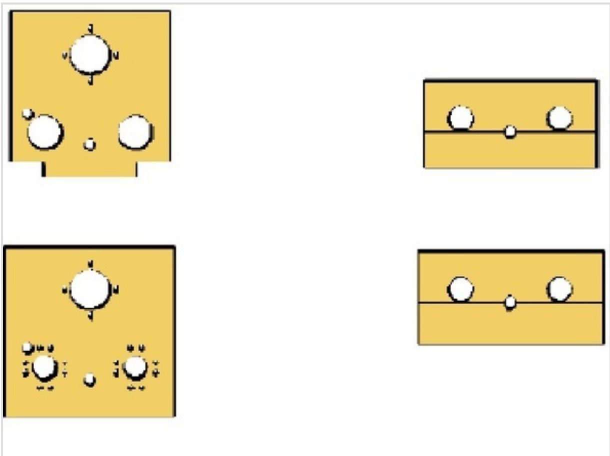
Step 20

Bend the re-bar.



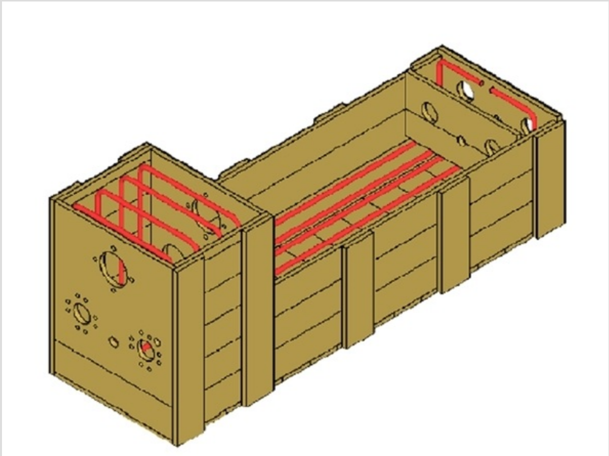
Step 21

Fit the re-bar into the form.



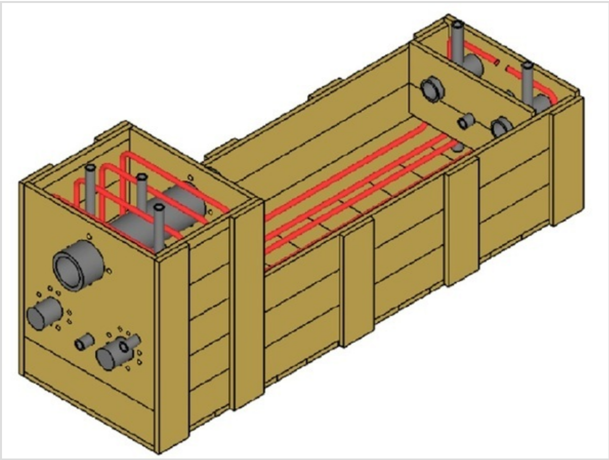
Step 22

Insert the end pieces into the form.



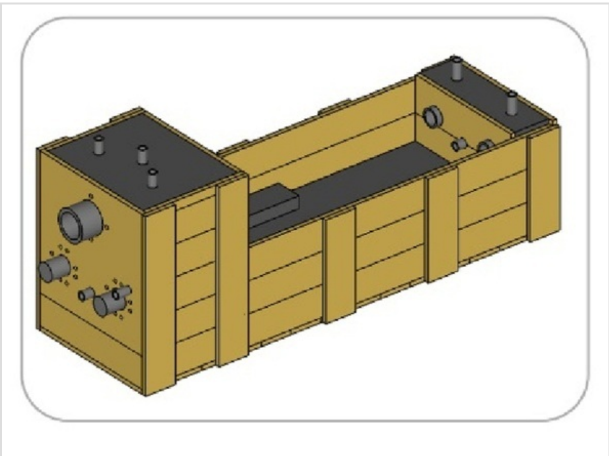
Step 23

Like this.



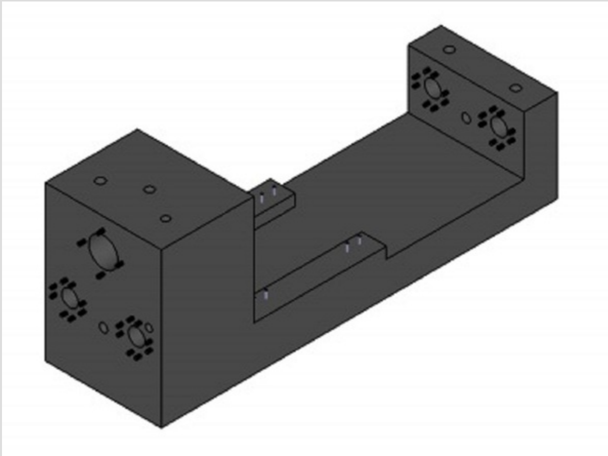
Step 24

Detail of inserted plastic tubes and bolts. The vertical tubes must be large enough to pour grout through later.



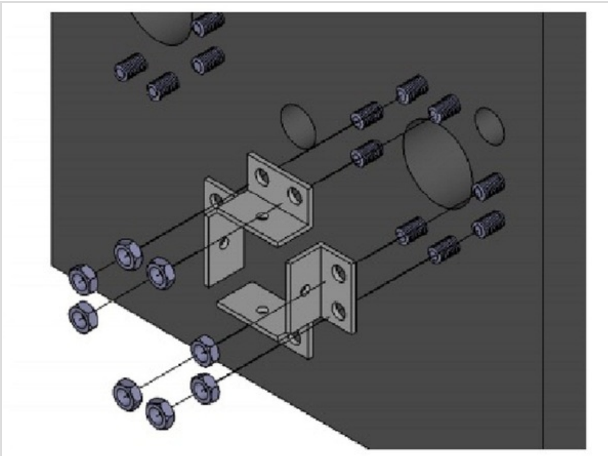
Step 25

Pour the concrete, embed the way stabilizer bolts and then add the concrete needed here. The way stabilizer base shown here should actually extend the full length of the bed except for a gap that will be used as a coolant drain and to remove chips.



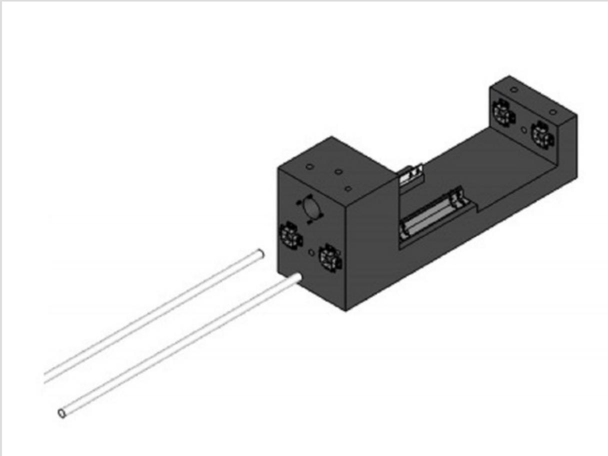
Step 26

The concrete lathe “bed.”



Step 27

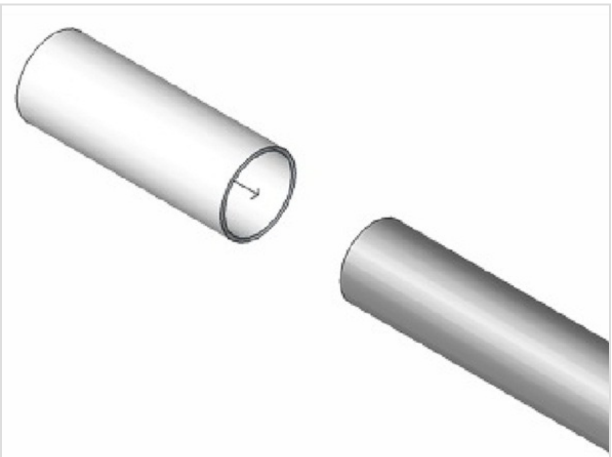
Bolt on the way adjusters. If necessary, the adjusters could be replaced with hardwood wedges but accurate way adjustments would be much more difficult.



Step 28

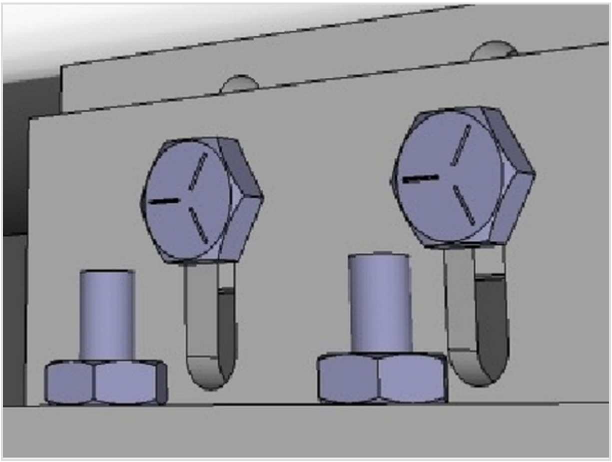
The Ways: The ways are the most critical component of an accurate lathe. Selection of the steel and accurate alignment are all-important. Yeomans' lathe used specially ground and hardened round bars that would be too expensive for our machines. Pipe should be made more rigid by filling it with non-shrinking grout. If your budget allows for machining the ways in an existing lathe then certainly do it but don't expect perfect results because many lathes will be too worn to machine the way to the exact size over its entire length.

Pipe, round bar and hydraulic piston rods come in a great variety: Imperial, metric, straight, bent, chrome plated, rusty, etc. You will need 2 the same size. Any steel must be checked for straightness. A good way to do this is to put the 2 pieces side by side, rotate one while pressed against the other and use a feeler gauge or bright light from behind to check for a gap.



Step 29

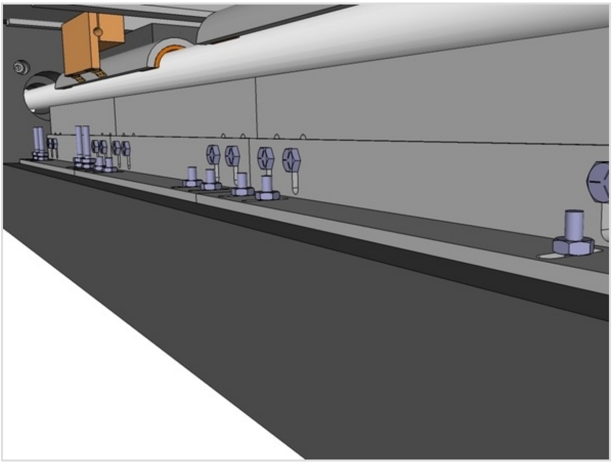
The way ends are very tightly wrapped in greased sheet metal so that the ways can later be rotated to unworn areas if necessary. The sheet metal should be tightly kept in place by wire or hose clamps.



Step 30

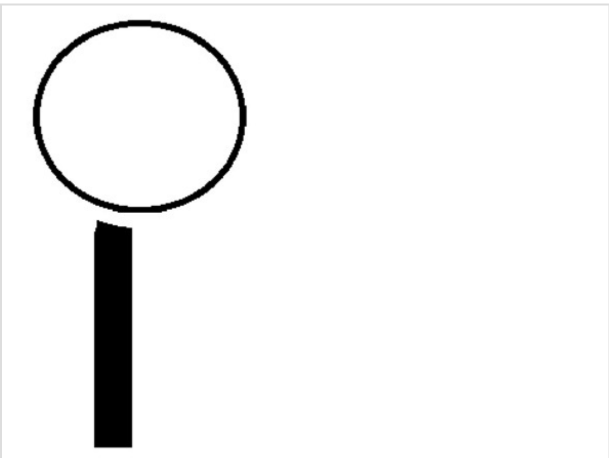
Strong support under the ways makes the use of round ways practical.

The angle iron and bar stock should be the heaviest that will fit.



Step 31

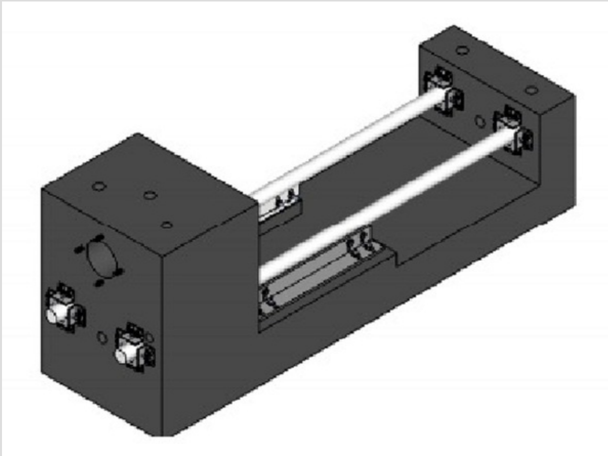
Round ways are used here because they can be more easily and accurately made than other possible choices. However, they must be supported from below to avoid sag and vibration.



Step 32

Start with a square-edged way support and once the lathe is running use a flycutter to machine a heavier (1/2”, 12mm or larger) bar to fit the radius of the way. The inner edge of the support bar should be at the center of the way. Heavier supports could be especially useful near the chuck where the heaviest cuts will most likely be made.

If the lathe (and carriage) is large enough so there is little danger of the carriage being lifted by cutting or knurling forces, no carriage clamp is necessary. This will allow the use of even thicker (radius-shaped 25mm?) way supports in the event they are found necessary to handle high horizontal cutting forces.

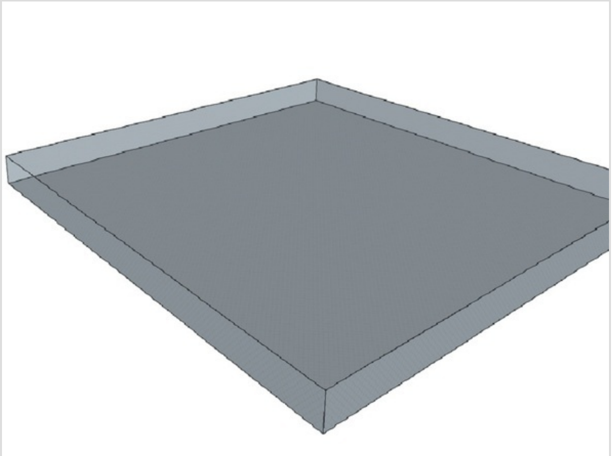


Step 33

Insert the ways and lightly clamp in place. The supports under the ways are made from angle iron and steel bar. A longer lathe (recommended) should have full length way support. Round lathe ways will both sag and vibrate but a rigid support like this is a simple cure. After the machine is complete, the adjustment devices that are bolted to the concrete could be removed and used to build another lathe.

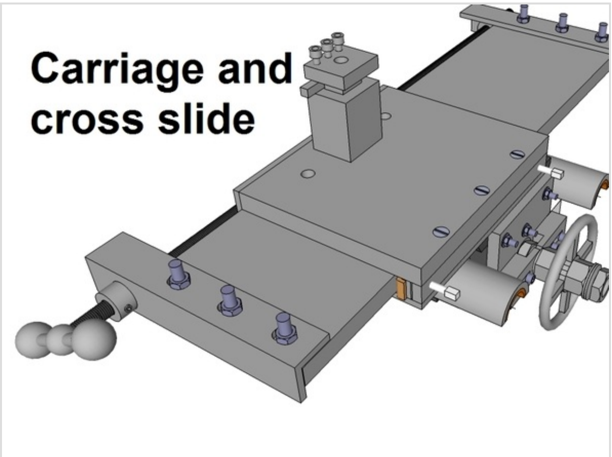
Step 34

Great care must be taken in aligning the ways but the process is actually quite simple. A machinist-type level will make alignment much easier (this is a Grizzly.com $68 model, a great bargain) but you can do without one if necessary. Use a carpenter's level to set the ways as level as possible. Use a spacer between the ways to accurately set the separation between the ways. This spacer must be kept level, at the center and at exact right angles to the ways. Build a bracket to hold the spacer in a consistent position. Use a dial indicator to measure the exact distance between the ways.



Step 35

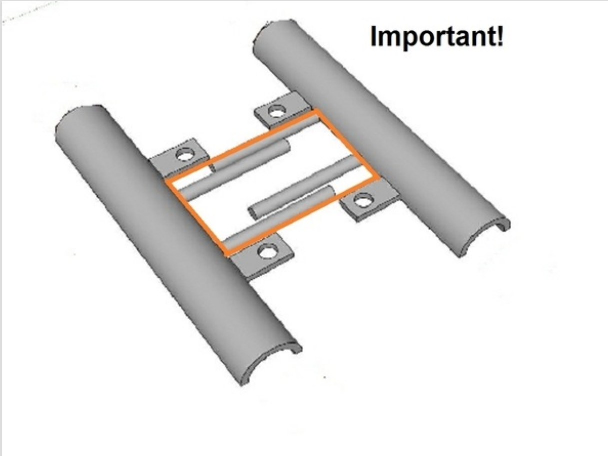
Consider the thickness of a thin piece of paper as an accuracy goal. Use a thick, square piece of plate glass (float glass is best) laid across the ways to check (with a feeler gauge) for even contact on all 4 corners. Rotate the glass and check again (the glass plate may not be perfectly flat). Move the glass plate from one end of the ways to the other to make certain everything is correct. Adjust the way supports for even contact under the ways.



Step 36

The cross slide can be made in several different ways. The method shown requires steel plate in 3 different widths which may be hard to find in the developing world. An alternate way would be to invert the clamping device. Only 2 pieces of the steel the same width would then be needed but care would have to be taken to keep the exposed sliding parts free of steel cuttings.

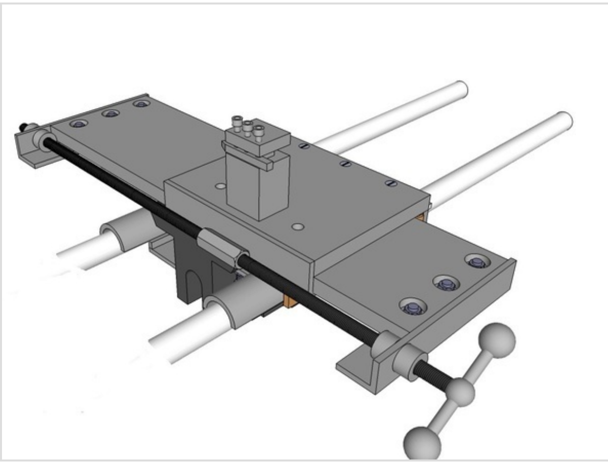
An accurately built carriage is critical to lathe accuracy and will take thought and care in construction. I suggest you study this section extremely carefully so that you will be able to adapt components to the sizes of low cost materials that are available.



Step 37

Using a pre-cast, seasoned concrete bed is critical to the project and SO is the steel frame for the carriage. Most machine builders would find it difficult to build a welded or bolted carriage frame that would have the vital even contact on the ways. We avoid the problem by making the frame in 2 pieces, clamping them to the ways, and then using concrete to fix the 2 sides in place permanently.

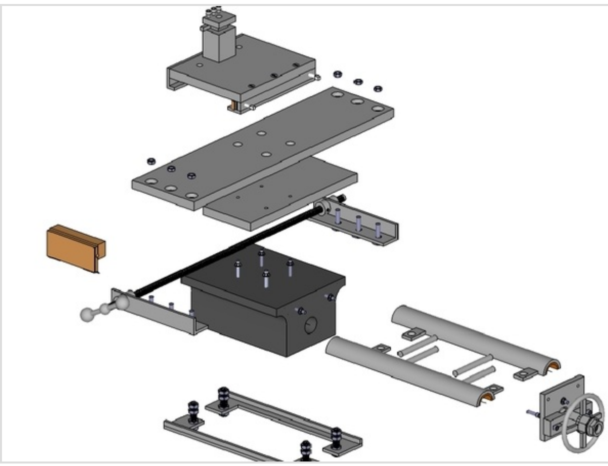
When the carriage is cast, the concrete links the 2 pre-aligned sides together.



Step 38

Another view.

The cross slide lead screw could be either on the leading or trailing edge of the cross slide. If on the leading edge it is closer to the center of cutting forces (good) and more susceptible to chips from machining (bad). If used in the leading edge position, it should have some kind of a plastic cover.

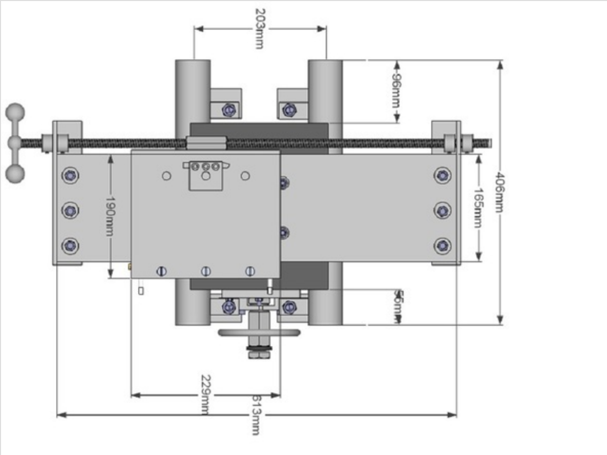


Step 39

How everything goes together.

Every fit is critical, however if things turn out poorly you can just make a better carriage and swap it out.

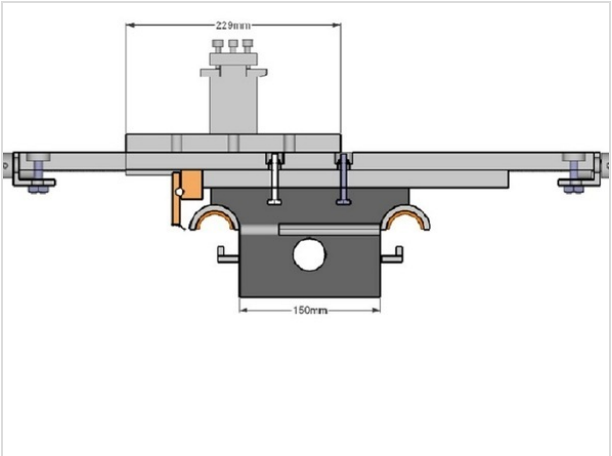
As long as the ways are accurately made and aligned, everything else is made to be improved upon once the machine runs and has been well tested.



Step 40

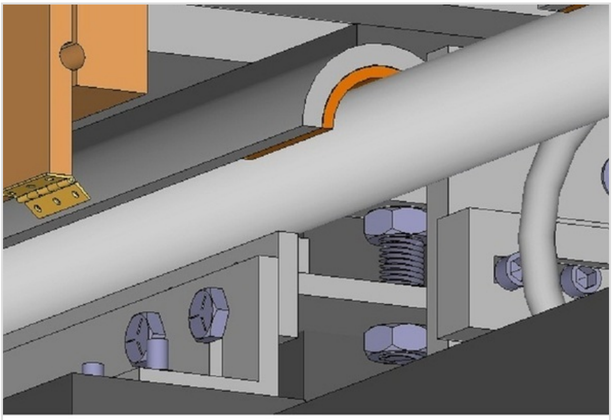
Top view.

Actual dimensions are better seen in the http://concretelathe.wikispaces.com/Curr... Multimachine Concrete Lathe 11.27.11 ver. 1.10.pdf



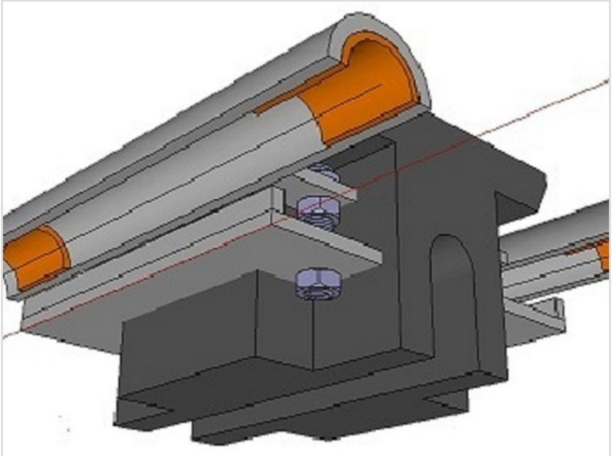
Step 41

The bolts that hold the top slide down must be very strong (use cylinder head studs?) and should be welded to bars embedded deeper in the concrete than is shown.



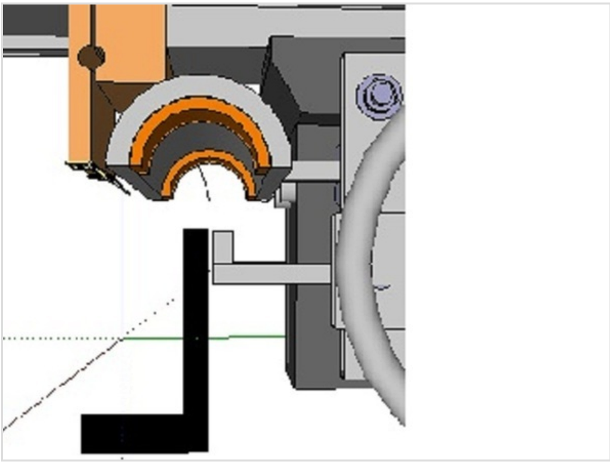
Step 42

The round ways are supported by a bar that is slightly off center so that there will be room for a carriage clamping device. Since a flat surface can only contact a round surface in a very small area, we take advantage of this fact by using just the edges of two flat surfaces to support the ways and to hold the carriage in place. Normally, cutting forces tend to press the carriage downwards but occasionally the clamps will be very necessary.



Step 43

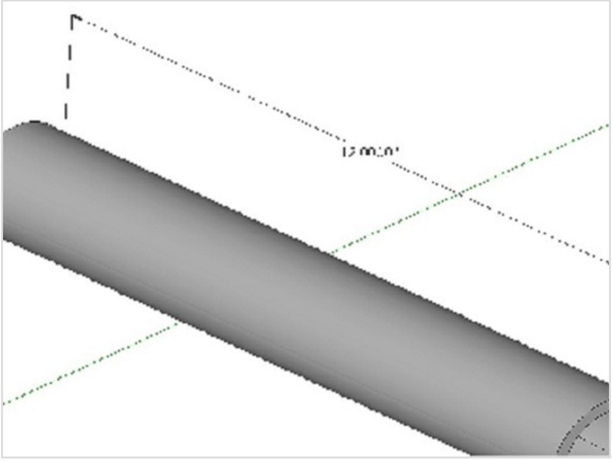
On a carriage for a lathe with shorter ways.space saving techniques must be used. These clamp bolts fit into notches cast into the carriage. A longer carriage will be easier to make because the clamps can be external and the inner parts not so crowded together.



Step 44

The way support bars and the carriage clamps meet at the center of the ways. The way support bar should actually be shown as a heavy vertical support bolted to a piece of angle iron.

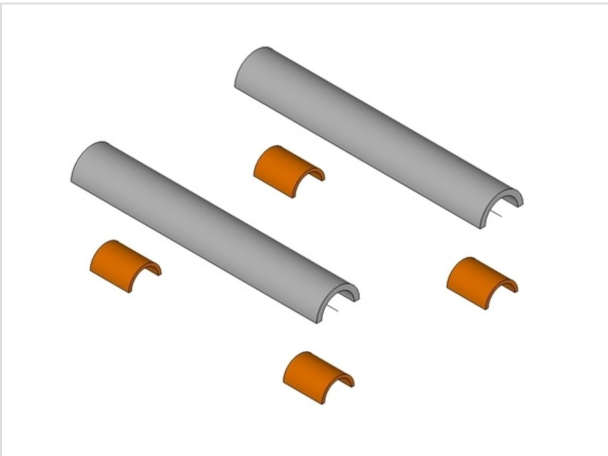
The carriage is, in effect, pre-aligned. The two shoes are first leveled and then firmly clamped to the ways. They are not mechanically connected until concrete is poured into the form so that it connects the shoes on each side. Any slight distortion from concrete shrinkage can be adjusted for by putting shims between the shoe and the bushings. The bushings should then be lightly epoxied in place.



Step 45

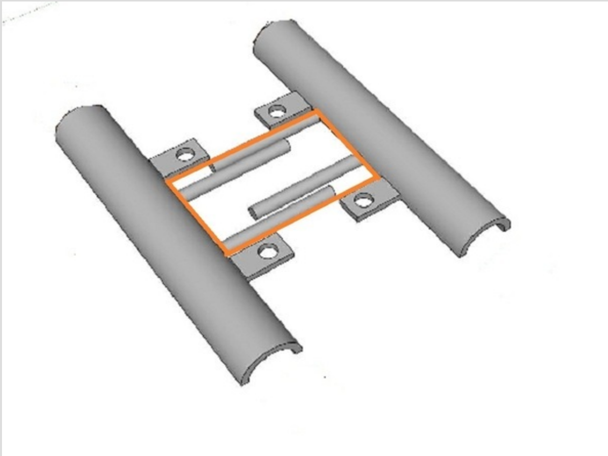
The width of the carriage is determined by the space between the shoes and that is determined by the diameter of the pipe used for the shoes and the distance between the ways. The pipe can be split with a hacksaw or an angle grinder with a cutoff disk. It is very important that length of the shoe should be between 1.5 and 2 times the distance between the way centers.

The headstock has oversize cavities so that long shoes can slide inside if this proves necessary to keep the optimal carriage length/width ratio. Just extend the shoes past the clamp mounting tabs and adjust the length of the grouted areas in the headstock so that the longer shoes will slide inside the headstock.



Step 46

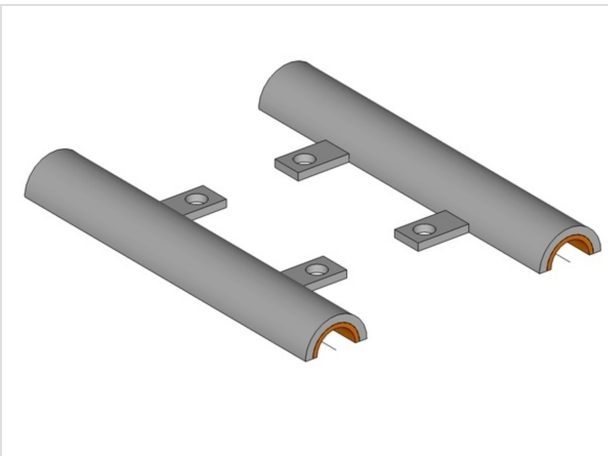
These replaceable bushings are lightly held in place by a small spot of epoxy.



Step 47

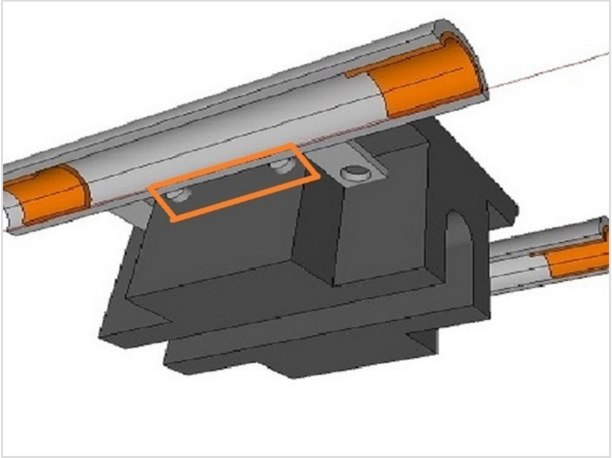
The carriage frame and shoes. The shoes are split pieces of heavy-wall pipe. The inside diameter of the pipe should be about 12mm to 25mm larger than the outside diameter of the way. The bushings will take up this space and could be made from cast iron, bronze or piston metal alloy. The holes in the tabs are used to mount the clamps that contact the bottom of the ways. These holes should be at least 12mm (1/2”). The welded-on cross bars (made from re-bar?) should be large enough to have enough contact area so that they will not flex.

The placement of the drilled tabs and pieces of re-bar depend on the size of lathe. Adding a foot to the bed length will allow both a longer carriage and a longer tail stock base. A longer carriage and tailstock will let you spread out the tabs and re-bar. The re-bar should be covered by at least an inch of concrete at the side. The concrete should have a fiber additive mixed in. The larger carriage will make construction easier and the carriage heavier and less likely to vibrate and cause tool chatter.



Step 48

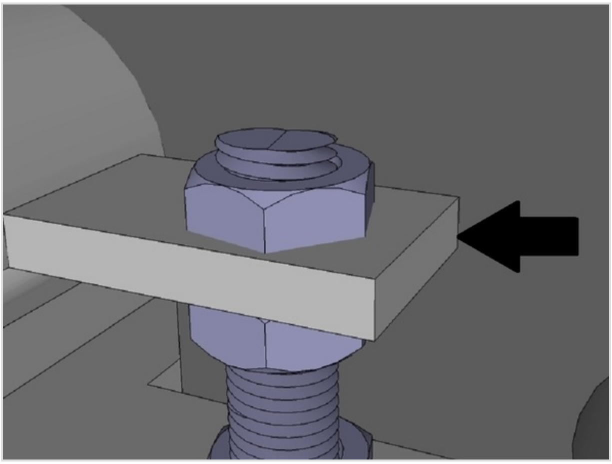
Tab placement again. The safest way to determine tab placement is to actually model the shoes on the ways. The rear tabs will probably be much closer to the end of the shoes than is shown in the drawing. because they will probably have to extend past the handwheel mechanism. (model it!)



Step 49

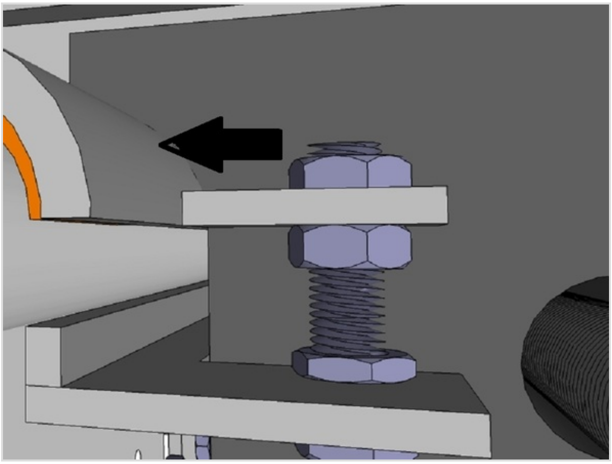
Where the welded re-bar pieces fit into the concrete.

You can see here that the internal clamps (needed on a short bed lathe) cause a little crowding.



Step 50

Build the wooden form for the carriage before the way clamps are attached. Use the clamp mounting tabs to support the carriage (and tailstock) form.

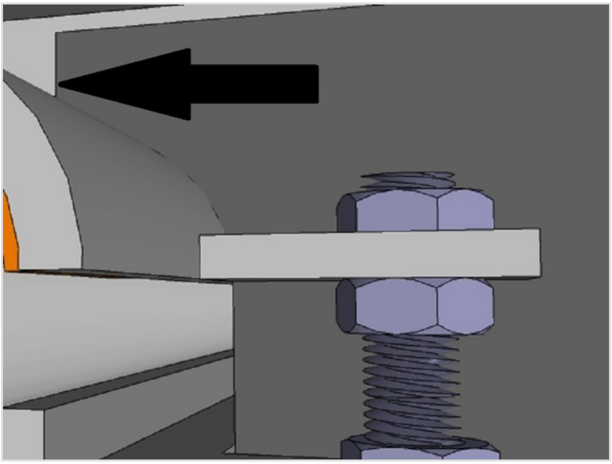


Step 51

Cast the concrete over the surface of the shoe in this area.

Start the sides of the form at the bottom edge of the "shoe" that slides on the way.

The tabs that are welded to the shoes make good attachment points for wooden blocks used to hold the form in place.

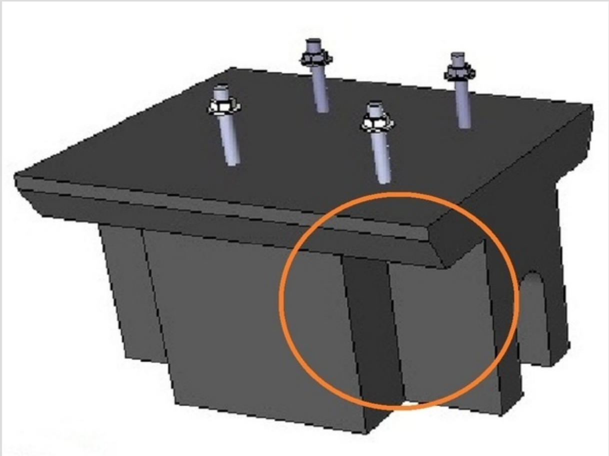


Step 52

Close in the edge of the form here. Use the widest possible carriage width to support the base of the cross slide.

Maximum cross slide support area is necessary because the cross slide mounting bolts are closer together than they really should be. Every design is a series of trade-offs, in this case the trade off is caused by having to surround the cross slide bolts with enough concrete so that it will not crack if the cross sllde hold down bolts are over tightened.

A fiber additive should be added to the concrete mix and the concrete mixed for maximum strength.



Step 53

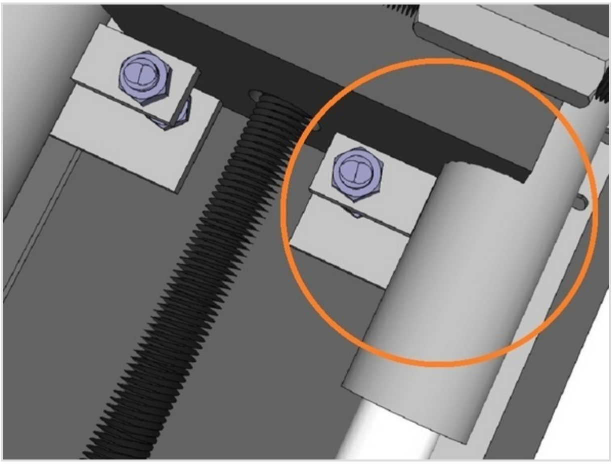
For clarity, the concrete casting is shown without the embedded re-bar pieces that are welded to the shoes. This particular carriage design can be dropped over the lead screw so that it would be easy to replace it with a different or specialized (milling, for example) carriage. Four threaded rods are used to mount the base of the cross slide. These must be of very good quality steel that is firmly anchored in the concrete. Engine head studs would be a good choice here. They should be cut to the proper length and welded to bars that will anchor them in the concrete below the embedded re-bar.

On a small lathe, great care will have to be taken to fit the steel parts that come from 3 directions! This was the only big problem In scaling the Yeomans lathe down 95%!

This "cut out" will not be necessary for a long bed lathe that has externally-mounted clamps.

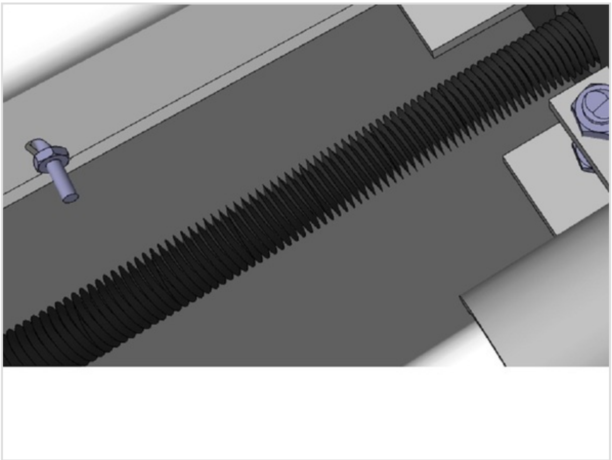
The inverted "U" shaped cutout is used only if an easily-removed carriage is desired.

Cored holes should be placed so that the milling attachment and the base of the handwheel mechanism can be connected by pieces of all-thread.



Step 54

An overhead view of an externally-mounted way clamp.

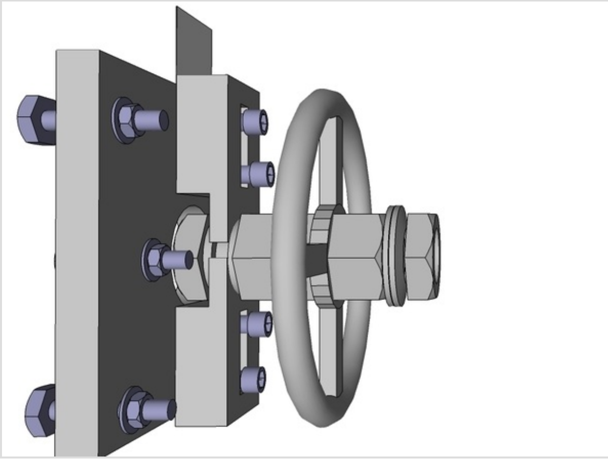


Step 55

The main lead screw is a piece of threaded rod that does not rotate. The carriage and the tailstock are moved forward by turning nuts that move along the screw. The lead screw is secured by nuts at the foot (end) of the lathe. The carriage and tail stock can be the “drop on” type that is easily removed and replaced. The size of the lead screw could be anything between 18mm and 25mm for this 300mm swing version of the lathe.

Backlash can be compensated for by adding 2 opposed spring (Belleville) washers and an extra nut. The most common lead screw source is the all-thread rods found in metal shops and hardware stores. Commercial all-thread screws with a black finish seem to be of a higher quality. Cross slide lead screws can also come from auto seat adjusters and auto jacks.

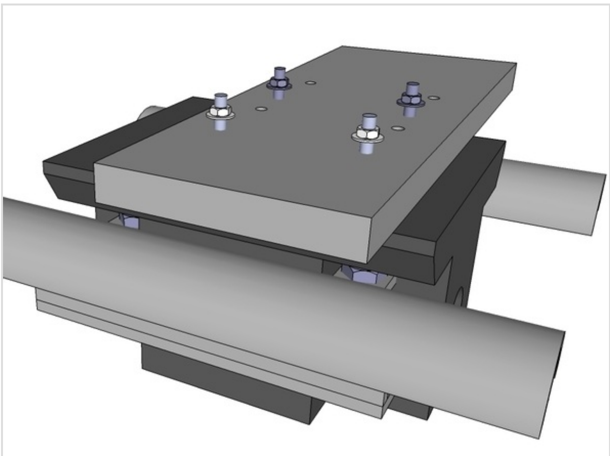
The quality of the leadscrews are vital to lathe accuracy. Replace the all-thread type with higher quality screws if possible.



Step 56

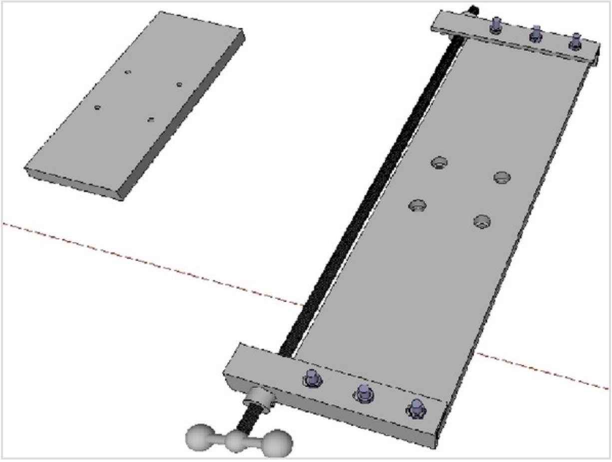
This carriage mechanism is quite simple. Unlike most lathes that have complex "aprons" with many parts, this one just has 5 simple parts that can be built using just a drill, hacksaw and file. The handwheel can be replaced by a bicycle sprocket that later can be linked to another sprocket in an easier-to-reach location. Or, to get the lathe up and running in a hurry (so it can make its own parts), just make the mounting plate, add a nut that can be turned by a wrench to move the carriage forward and heavy springs to pull it back.

The clamp parts, grooved nut and handwheel adapter could be easily made at this stage. One side of the clamps (above) can be shimmed to reduce backlash in the carriage hand wheel clamp device. The coupling nut could have a larger grooved hub pressed over It to make a larger clamp contact area. If a milling attachment is going to be added, the base can be made longer so that a bolt can go below the leadscrew and connect to it to the milling adapter.



Step 57

The base plate of a 3-piece cross slide. It is made at least 25mm more narrow than the part above so that there will be clearance for the slide clamps.

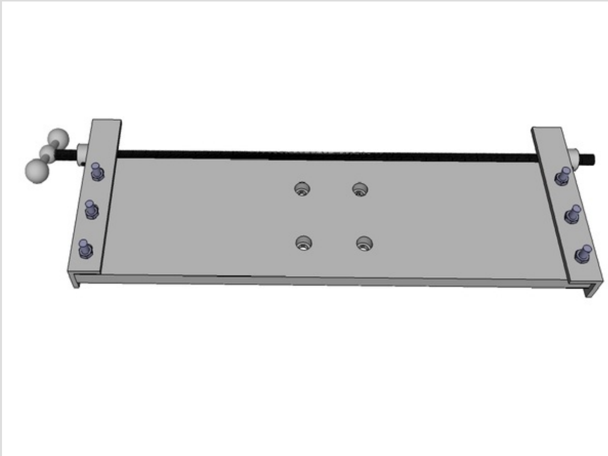


Step 58

When grinding an optical flat (or other kind of flat), three disks are used. Let's call them "A", "B" and "C". Put A on B with some fine grinding compound. Grind until a frosted finish is seen on both surfaces. Now do the same with B on C. Now repeat with C on A until the surfaces have 100% contact. Repeat this process until it takes little (or no) work to get 100% surface contact in all three combinations. The surfaces will then be very flat. It works on steel as well as on glass.

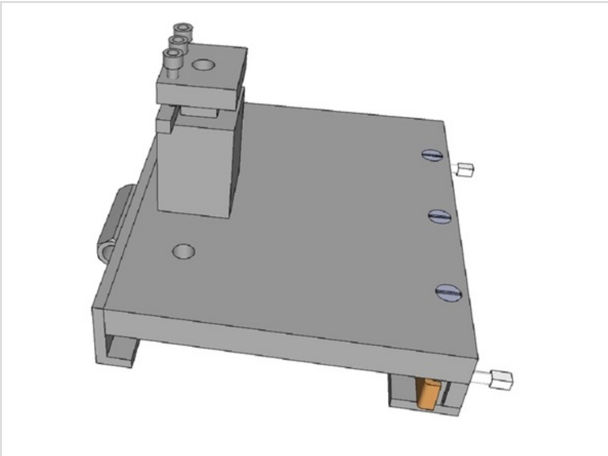
How does it work? A on B results in a spherical surface, B on C results in a less spherical (closer to flat) surface, C on A results in an even closer to flat surface after grinding. Each pass results in flatter spheres. If A is concave, B is convex and C is concave. When A and C are ground to each other, they hit the high points first. Now either A or C is concave and the other is convex. Grinding both against B results in the flats being averaged. Eventually they are flat enough. Gravestones and monuments are often VERY flat. They make good layout tables!

The plate edges are also important since the clamps are screwed to them. Edges of hot-rolled steel plate are not flat and this has to be corrected since clamp parts are screwed to them. Carefully file the edges flat while constantly checking with a square. Keep flipping plates over and end-for-end while checking them side by side until you get them filed to identical widths, with parallel sides and flat edges. Thanks to Dave LeVine for this.



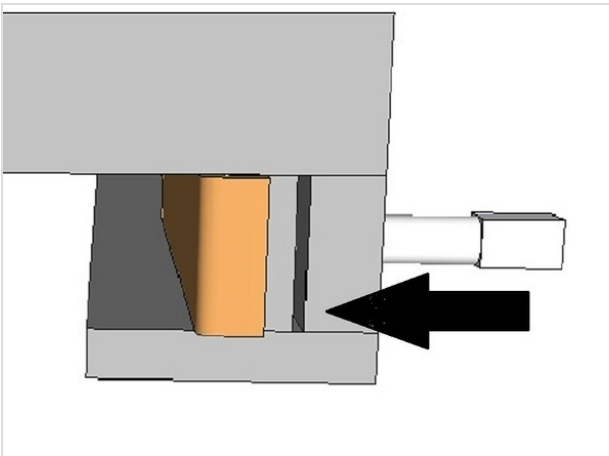
Step 59

Mounting holes are counter bored 25mm for the nuts that hold it down.



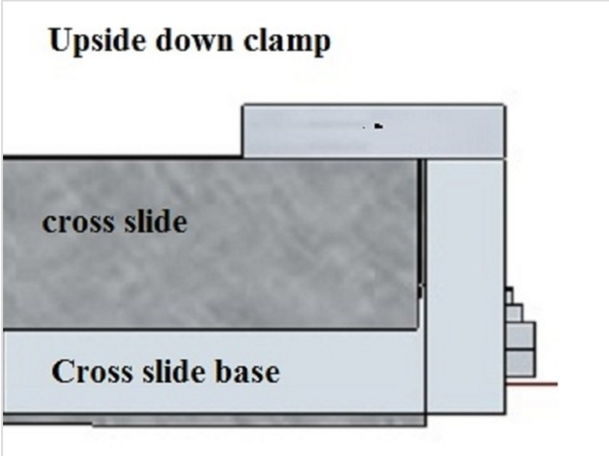
Step 60

The top slide should be at least 1.5 times as long as it is wide in order for it not to jam when it is advanced under pressure.



Step 61

An easily made slide adjuster. The arrow points to a cut in the steel bar. The outer part of the bar is threaded and as the screw is tightened it bends the thinner part of the bar in toward the cross slide. The brass bar is optional.



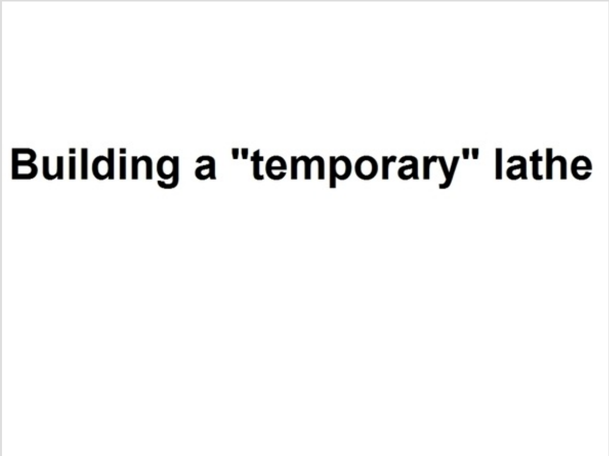
Step 62

Another way to build machine slides is to invert the clamp. This lets you build the cross slide assembly using just two pieces of steel of the same width. This may be more economical and in some areas might be the only way practical. The disadvantage is that metal particles from machining may get between the clamp and the slide. Leather wipers attached to the edges of the top pieces of the clamp should help with this. Wear could be adjusted for by judicious filing or adding a thin shim.

A common way to build something like this is to fit it a little too tight and add very thin shims to make things move smoothly. The shims can be removed as the parts wear in and play develops. Another difficulty with inverted clamps is that an additional “compound” slide is made harder to mount because of the more narrow mounting surface. A temporary, light-duty clamp could be made from carefully fitted angle iron.

Step 63

Cross slide alignment: Use the dial test indicator to measure from the end of the spindle to the top and the edge of the cross slide is it is moved from one end to the other. Be certain that the spindle does not turn as you do this.



Step 64

Building any kind of a low cost machine tool takes a lathe of some kind. The aluminum or zinc/aluminum alloy castings could be turned on a good wood lathe but it would be much easier to use your concrete lathe bed and carriage as a "temporary" lathe. Huge savings are possible by casting and turning your own bushings and adapters.

Step 65

A great many front wheel drive and four wheel drive vehicles (but not all), use a complete spindle assembly which includes wheel bearings, wheel mounting studs, and mounting structures.

Be aware that some are held together by a center bolt; often the end of a stub axle which is splined. The splines do not matter. The mount can go into the concrete (if the bolts are put in place first), and the faceplate can mount where the brake and wheel did. The old stub axle can complete the drive system.

While this will not make a hollow spindle (one with a through hole for long workpieces), it is a fine spindle for making the relatively short pieces for a good spindle capsule and for pulleys.

Using cast aluminum pulley blanks, you can make drive and reduction pulleys for "serpentine" belts (multi-groove type K belts are common in automobiles) which have lower losses and less slippage than more common "V" belts. The pulleys are simple if you can grind a 40-degree tool and the belts can be run "inside out" for initial machining of the final drive parts.

While building a lathe to make a lathe is not the only way to make a good lathe, it is often beneficial and the less-desirable lathe can still be used to do maintenance when the better lathe is finished. While it lacks a lot of utility (like the ability to turn long workpieces), it is much better then no lathe.

If the spindle used a disk brake, reversing the disk makes a good faceplate and, if the "hat" is deep enough, a cup chuck.

Step 66

This is typical of a drum brake setup used on many vehicles. The drum will come off the spindle without too much trouble in many cases. Reverse the drum, add screws (for jaws) and a simple 3- or 4-jaw "cup chuck" can be made. As with the prior spindle design, while it is far from perfect it will work to make parts and train operators.

Machining pressure plates, brake rotors, etc. does not need a hollow spindle.

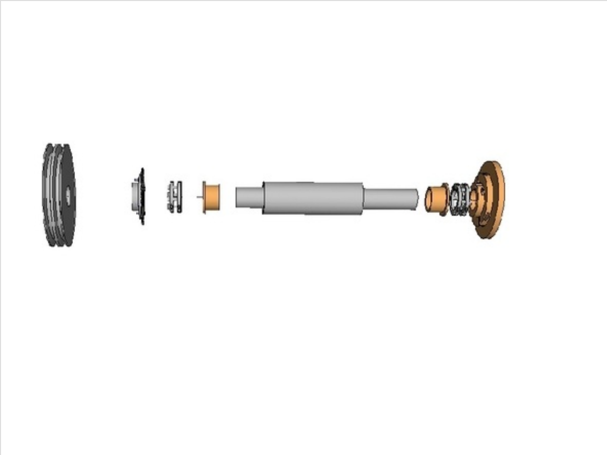
The main spindle and cartridge assembly

Step 67

Many kindle of lathe spindles can be used but for our purposes they should all be enclosed in an outer pipe "cartridge" that could be embedded in concrete after it is aligned.

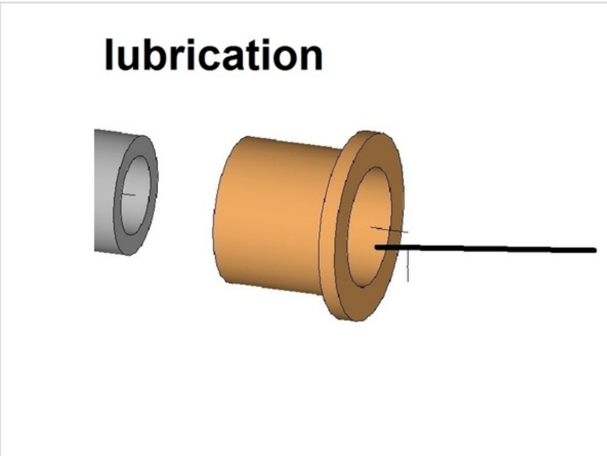
Step 68

The outer part of the spindle cartridge can be made from a piece of pipe (like the outer part of a hydraulic cylinder), bushings you cast yourself out of piston metal, a thrust device to keep the spindle from moving back and forth and a hollow or solid spindle (like the piston rod of a hydraulic cylinder). The whole assembly is first aligned in the headstock and then (naturally) locked in place by pouring in non-shrinking grout.



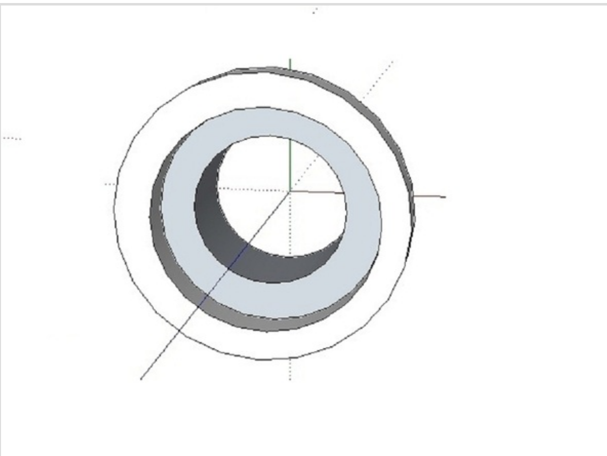
Step 69

The outer tube protects the spindle and bushings from the concrete. If the outer tube is large enough, the bushings can later be replaced with ball or roller bearing adapters so that a higher speed spindle can replace the initial slower speed bushing type spindle. Adjusters are shown here but the front adjuster could be replaced with a steel washer between the bushing and the chuck backplate, and the rear adjuster replaced with a simple steel collar that could be moved in order to eliminate end play.



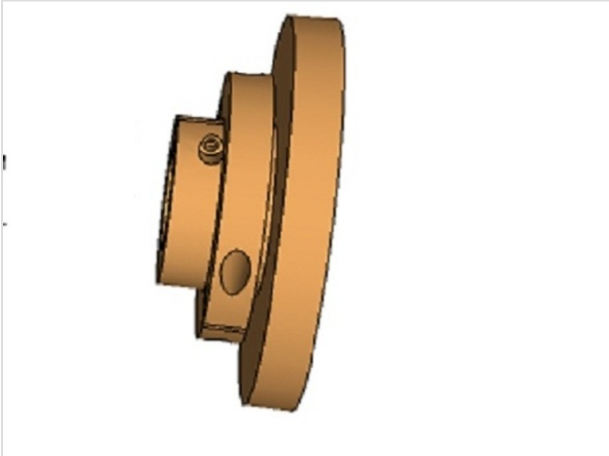
Step 70

Spindle lubrication: On the main and on the thread follower spindle bushings, cut an “O” ring groove here. Drill and tap the outer body of the cartridges for a 90-degree fitting for an oil line and grout the oil line in place with the spindle.



Step 71

The "universal" shape for for every casting used on the lathe. It can be used for spindle bushings, ball or roller bearing housings, adjusters and a chuck back plate. It is very simple and easily cast.



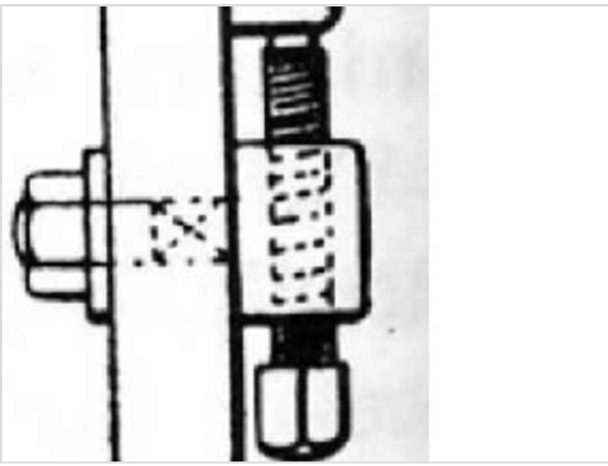
Step 72

The chuck back plate (mount) is seemingly simple, but if you have to buy one it could cost more than the lathe itself! If you make your own, the two most common choices may be either a piece of cast iron that could be turned down to size or to make one from an aluminum casting. A cast aluminum back plate should have two clamp bolts and nuts (not tapped) on each side and an added steel safety collar. The hub will have to have a large enough diameter so that there will be clearance for the nuts.

Step 73

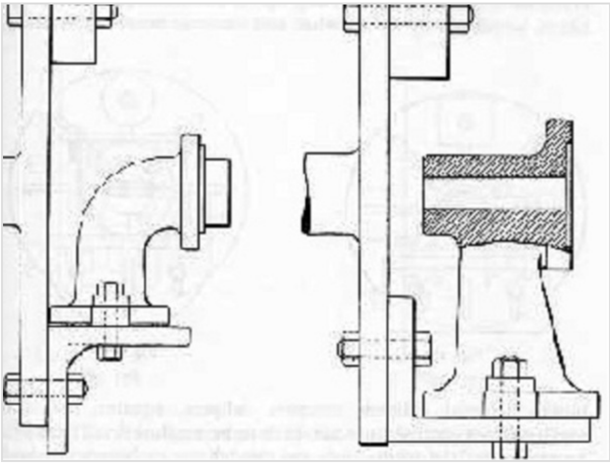
Use an old flywheel as a combination faceplate and chuck.

A slow speed lathe drive could be a shaft with a starter pinion gear and the flywheel ring gear.



Step 74

A simple clamp like this can be used on the flywheel/faceplate.



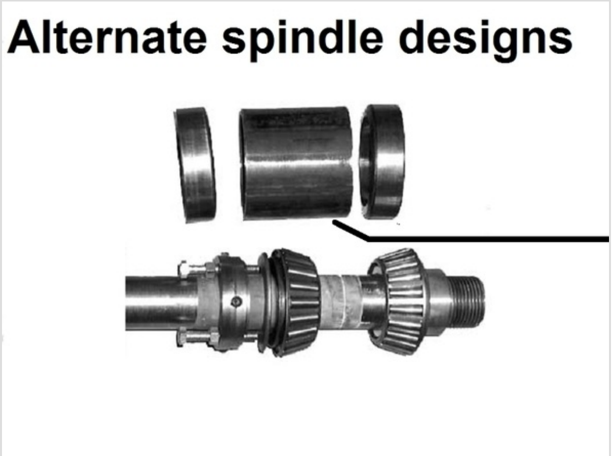
Step 75

Or this.

Step 76

A scrapped hydraulic cylinder could provide both the spindle and the outer part pf the spindle cartridge.

The piston rod should be at least 37mm (50 to 100mm is much better) in diameter. It should be 200mm longer than the headstock.

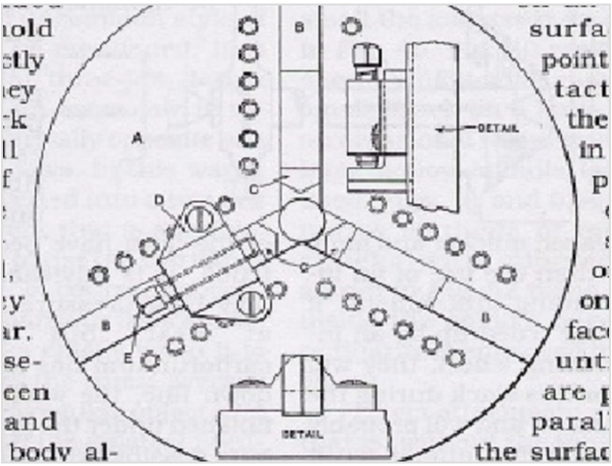


Step 77

An original Multimachine spindle design that is heavy duty and very accurate. You may recognize it as the common bicycle front axle type. Spindle size could be based around the sizes of inexpensive automotive tapered roller bearings.

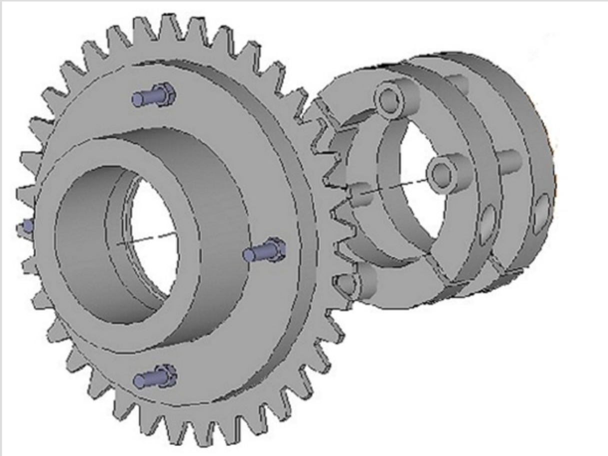
This type of spindle will require more machine work but, if this spacer was bored on the ends to accept the outer part of the roller bearings and then used as the outer part of the bushing-type spindle cartridge, the simple bushing-type spindle could be made to "bootstrap" this more complex, high-speed spindle at very low cost.

A bushing type spindle should be replaced by a ball or roller type if the lathe is to get much use as a milling machine since milling speeds are higher than normal (home-made) lathe spindle speeds.



Step 78

An accurate home-built chuck. Plans are at http://concretelathe.wikispaces.com/Curr...

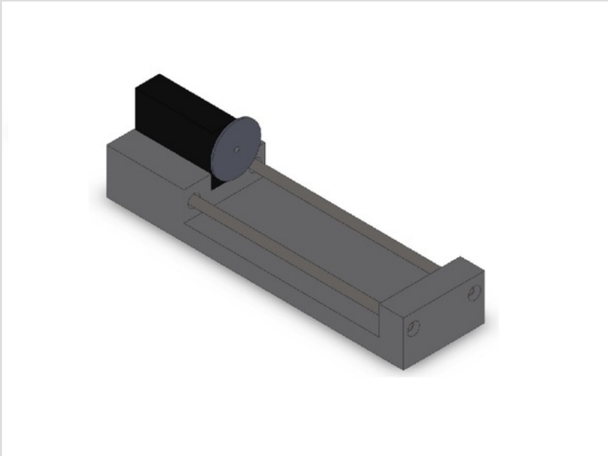


Step 79

Temporarily, the adjuster could be replaced by the sprocket hub if a steel washer was used between them.

Step 80

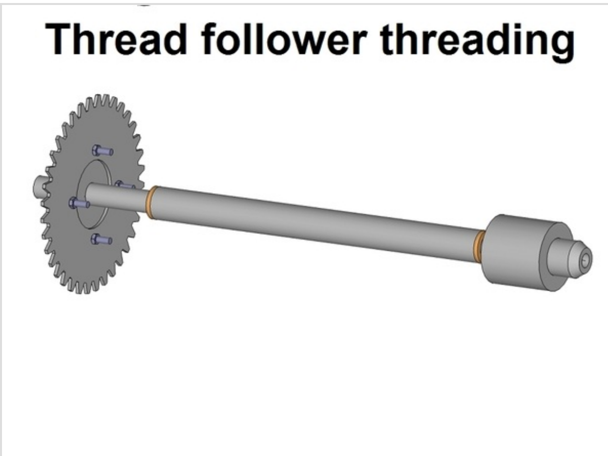
Spindle alignment. Slide the spindle so at least 8” sticks out the front of the headstock, then use a dial test indicator to measure to the spindle to both sides and the center of the carriage as the carriage is moved forward and backward. After the spindle has been accurately aligned, pour in the grout to lock it in place. This makes the spindle parallel to the ways, which is all-important.



Step 81

The headstock, spindle and flywheel/faceplate assembly can be as simple as an inverted engine block, crank and flywheel that has had the main bearing inserts carefully drilled and the main bearing caps drilled and tapped for grease fittings. A lathe with a 600mm to 900mm (or larger) swing could be easily made this way. Just remember that the largest Yeomans shell-making lathe weighed 9000 Kg, so scale accordingly!

An engine block headstock should probably kept at under 200 rpm since the bearing inserts were meant to be used with a pressurized oil system. Grease every few hours at first until you make sure that nothing overheats.

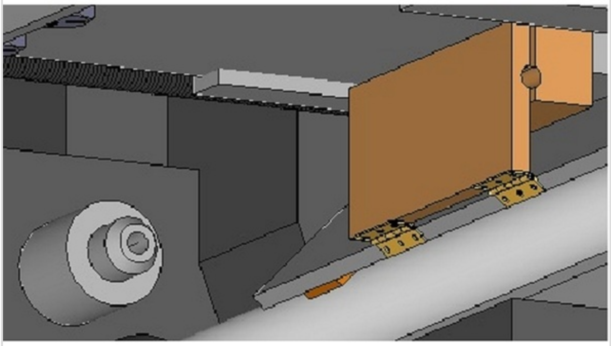


Step 82

The thread follower chuck rotates at the spindle speed and is driven by bicycle sprockets and chain. An idler should be added so that the chain can be adjusted or removed when not needed. There is a limit to bicycle chain speeds so use a motorcycle chain for speeds much over 70 RPM (which is 3 times the speed you should start threading with anyway).

To cut a thread, a sample piece of threaded rod is held by the follower chuck and is manually clamped in the wooden or plastic block clamp that is attached to the carriage. This pulls the carriage at the proper speed for cutting a duplicate of the sample thread.

The follower spindle cartridge is first aligned and then grouted into the headstock.



Step 83

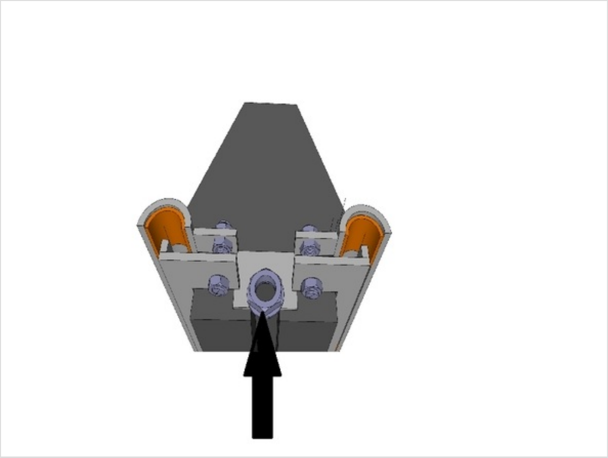
The thread that is cut could be unusually accurate because the wooden block should average out imperfections in the sampled thread. Special note: Threading on a lathe always requires practice even if you use the best equipment. Threading usually takes multiple passes with the threading tool. Our device will require extra practice to learn how to “pick up” the existing thread on subsequent passes but this should not be too difficult because the wooden clamp can be “eased on” instead of suddenly engaged.

You won't find a device like this described anywhere else but I have built and used one on the original Multimachine. The follower spindle should have an oil line run to it as was described for the main spindle. Half-inch water pipe is about 5/8” ID so this, 2 bushings and a piece of 12mm rod either threaded or epoxied into a discarded drill chuck should work well.

Compressed air help will be needed if this is to be used on a large lathe. An air cylinder could be used the clamp the thread follower and a carefully regulated air cylinder used to add a little push to the other side of the other side of the carriage

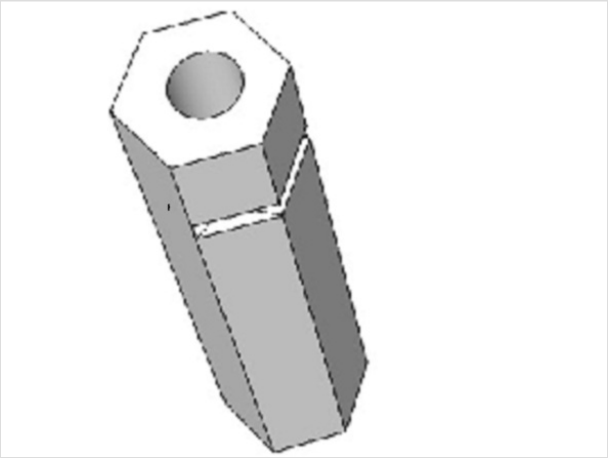
Step 84

The tailstock has a frame that is exactly like the carriage. Except for the difference in shape, construction is similar.



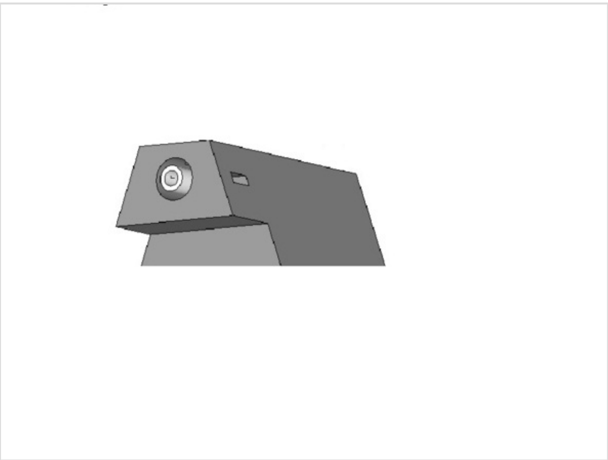
Step 85

A long nut or handwheel should be added here.



Step 86

An all-thread coupling nut can be cut in this way and then be pressed slightly closed in order to reduce backlash to a minimum.

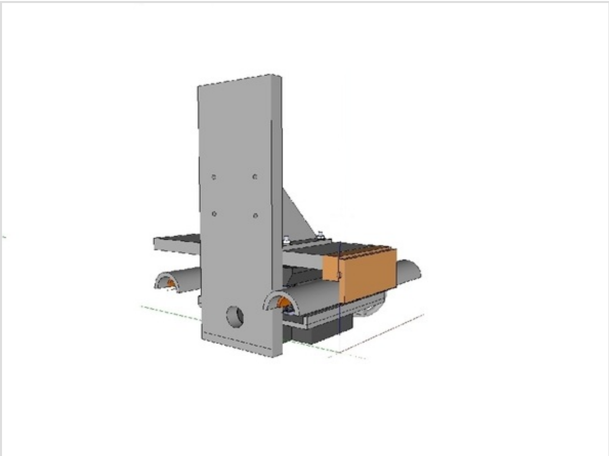


Step 87

If you use a Morse Taper socket, a slot should be cast into the tailstock concrete so that a wedge can be used to knock loose a Morse Taper tool. Naturally, the slots should line up! Something should be welded to the back of the MT socket or grooves cut into it so it will not turn or pull loose from the grout.

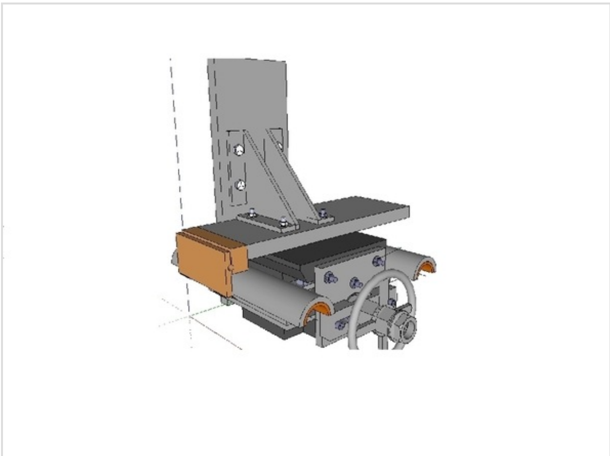
Step 88

Align the socket before grouting by using a Morse Taper drill accurately held in the headstock chuck.



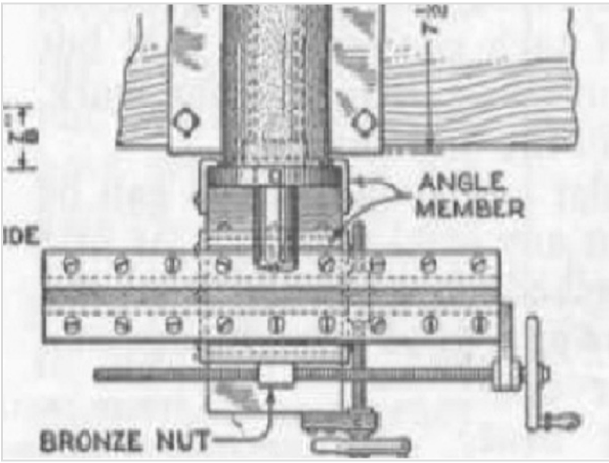
Step 89

Adapter for a milling cross slide.



Step 90

Rear view that shows attachment points.



Step 91

A J.V. Romig milling cross slide design. We mount it vertically instead of horizontally .

Original plans for this design are bench-mill.pdf
at:
http://concretelathe.wikispaces.com/Curr...

But wait, there's more!

Step 92

Dimensioned plans;

Chucks and clamping devices;

Cutting tools and fluids;

And more are at:
http://groups.yahoo.com/group/multimachi...

Why no photos?

Step 93

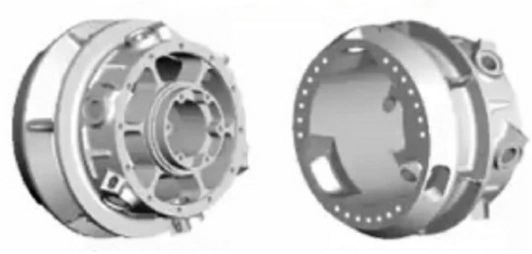
Several lathes are about to be built but are not yet at the photo stage.

Be careful; work safely!

Making a powered auxiliary spindle ascessory device that can turn the lathe into a "Super Machine" that can do very complex jobs (a little slowly) at low cost.

Step 94

Really study everything at the wiki site before you start this!

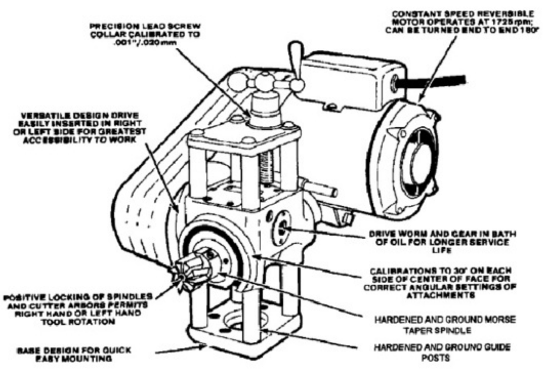


Step 95

The goal is to make a workpiece like this using the Multimachine lathe, an accessory powered spindle and no extra (very expensive) vises or chucks.

See the part being made by a half million dollar machine at: http://www.youtube.com/watch?v=139z62o6O...

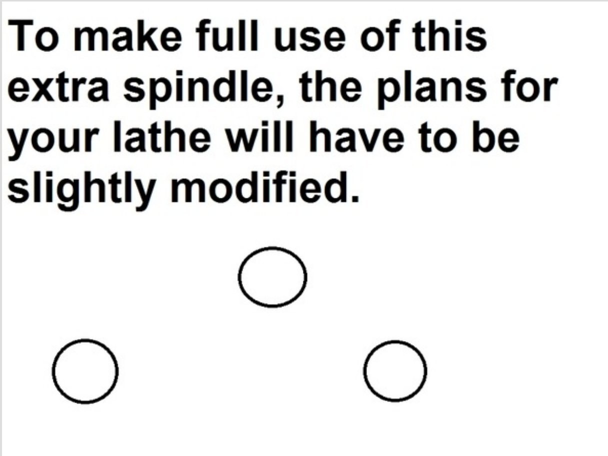
Why would you need something this complex? An otherwise unobtainable part or an experimental device that would be too expensive to have made.



Step 96

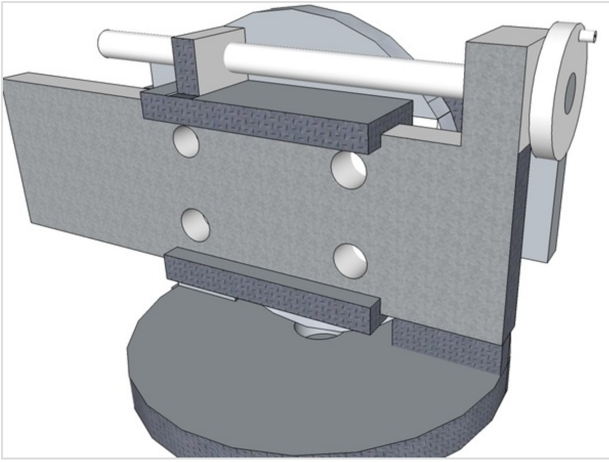
You could almost do it with this Versa-mil. This $10,000 device used to be available and could have done many of the needed operations. The manual for this wonderful machine is in the Multimachine newsgroup "files" section.

Our job is to do it for 50 bucks.



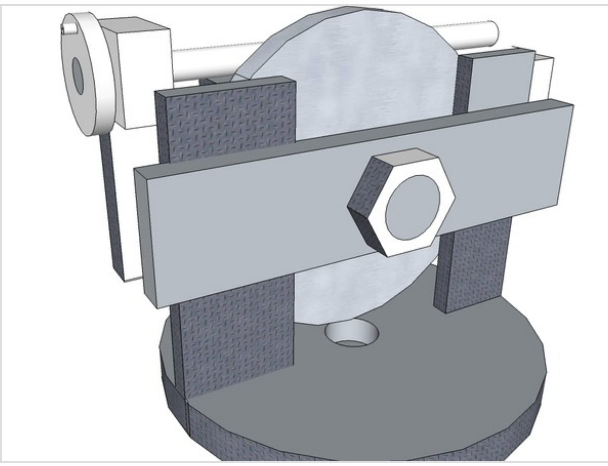
Step 97

For full access to the workpiece, the carriage should be low enough to fit below it and be wide enough to mount a 12" powered auxiliary tool so that it can reach the the side of the workpiece.



Step 98

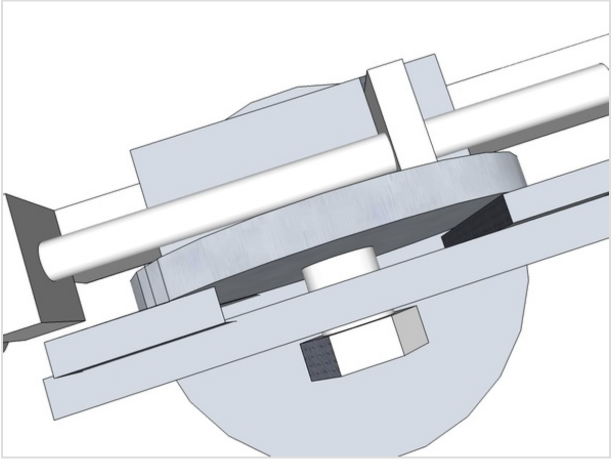
The cross slide mount for the powered spindle.



Step 99

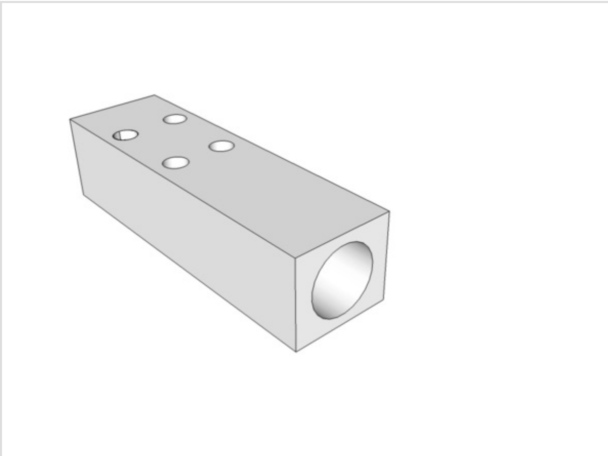
Rear view.

The base is simply clamped in place.



Step 100

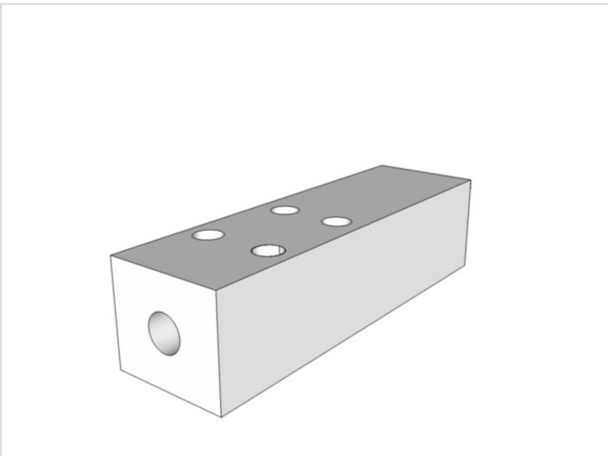
Top view



Step 101

The front end of the piston-metal casting that is used for the spindle housing. Oil holes will have to be added. This end is bored to fit a solid Morse Taper socket adapter.

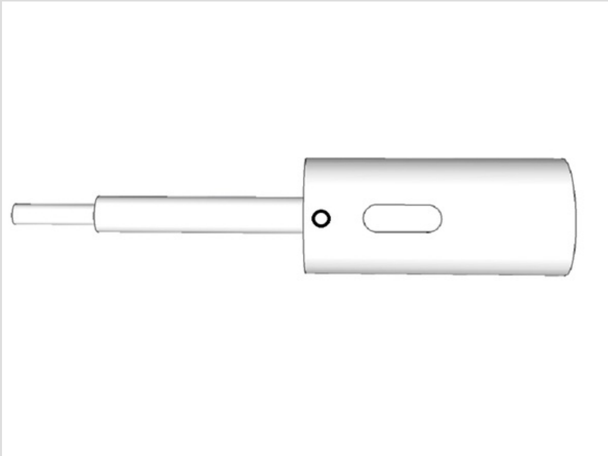
As the housing wears it can be replaced or bored out so a bronze bushing could be fitted.



Step 102

The back end of the spindle housing should be bored to the size of shaft that is pinned in the back of the Morse Taper socket.

These sockets are usually hardened so the rear of the socket will have to be annealed so that it can be drilled for the cross pin.



Step 103

The spindle could be a solid Morse taper socket that has been drilled to accept a pinned shaft that has been turned down on the end to fit the drill chuck.

The MT socket could be replaced by a simple steel cylinder if necessary. It could be made longer and a drill chuck or milling cutter could be retained by a large set screw. The common Weldon flat is used for this purpose in many tooling schemes.

Step 104

The spindle must be able to move in every direction to reach the front and side of the workpiece, The spindle needs at least 75mm of vertical travel, to tilt up and down at least 45 degrees and move in and out at least 75mm. It also needs at least 1/2 hp to power larger mills and drills. The only economical solutions are air-powered drill motors that can run at both high and low speeds.

These drill motors will require a LARGE volume of compressed air for many kinds of work and especially with a steel workpiece. A good choice for some may be a relatively small air compressor and a very large air tank bought as scrap. However, with this setup it may take a long time to get sufficient air pressure for a big cutting job.

Another choice could be a variable speed electric motor but this would be both expensive and hard to mount. A frame 48, 3600 rpm motor and a VFD would be a good choice for a larger lathe and auxiliary spindle combination but could easily cost more than the lathe itself.

The most common solution will be a variable speed drill motor.

IS THIS EXTRA SPINDLE WORTH ALL THE TROUBLE?

For what it is worth, my personal opinion.

Step 105

It is my personal (only) opinion that less than expert machinists are likely to lose workpiece accuracy if they have to move it between different kinds of machine tools. If you have watched the MAZAK video you have seen the power of doing many kinds of operations with just one machine tool.

The MAZAK machine uses two chucks to do this. Our machine would require that the part be reversed in the chuck and "dialed in" just once.

If a four (independent) jaw chuck was used, the workpiece could be almost any shape and could have almost any machining operation performed on it without much loss of accuracy.

This document was last generated on Jan 28, 2012.