The Chopper Builders Handbook '*Notch-O-Matic*' Tube Notcher

The Design

Back in the seventies and early eighties when I was still building rods, bikes and dragsters on the side while trying to make a living doing general industrial fabrication we had a need to develop a tube notcher that used regular bi-metal hole saw bits.

The original 'Joint-Jigger' and clones that were on the market just didn't do the job for the types of structures and chassis rails we were building. They say that necessity is the mother of invention and in this case the old adage was entirely true.

What we needed was a fixture that would at least perform the following functions:

1. Cut notches in round, square or rectangular tubing as well as in angles and channel sections.
2. Cut notches from 90 degrees to almost flat angles, as tight as just a few degrees.
3. Cut compound notches where the tubes meet 'out of plane'.
4. Cut double compound notches where three members intersect and one or all three of the tubes are out of plane.
5. Notch large members or heavy structures so the notcher had to be portable and be able to clamp onto a partially finished assembly.
6. For light work the notcher needed to be bench mounted in several positions.
7. The notcher had to be easy and cheap to make.
8. The notcher had to be easy to use otherwise coping with a grinder would be a better method of doing the work.
9. The notcher had to be accurate to at least one-quarter degree.

This might sound like a big list of features but in fact these were almost the same requirements we fulfilled on a daily basis when we built temporary welding fixtures to hold parts in position. The only difference was that the notcher needed to be adjustable rather than fixed in place.

At the time we had several dozens of fixtures in the shop for various applications and one we seldom used that I built one day in an attempt to simplify jigging parts up for tacking. That fixture, which nobody liked, was made from two pieces of one-inch angle iron with a little double acting hinge in the middle. It occurred to me that if I just welded another piece of angle to the head of a regular old 'joint jigger' I'd end up with a pretty handy little fully adjustable notching tool. The saw carrier head with an inverted angle base would sit down inside one the fixture legs and slide back and forth or be clamped into position.

The drawings and photos that follow depict a nice little fully adjustable notcher that is just a slight refinement on that old original concept. The key is the double acting hinge.

Limitations

Before going much further however it should be pointed out that notching any material with a hole saw is best limited to material that has a wall or flange thickness of at least an eighth of an inch. These saws have a tendency to simply 'rip' thinner materials. In my opinion the .120 wall tubing we now typically use on cycle frames is about the thinnest that can be successfully cut and still maintain accuracy. It is easier, cleaner and more accurate to cut thinner material the old fashioned way with a hand grinder.
On the other hand if you do a lot of work with materials having wall thickness of .120" or over then hole saw notching can be a very fast, accurate and easy way to cut copes.

In fact the saws perform better as material wall thickness increases. After you reach material of three-eighths thickness it's time to look into milling the fish-mouths. Fortunately about 95% of all the work a general chassis shop does involves materials in the .120 to .313" range, which is perfect for hole saw notching.

Another point that needs mentioning is that 'adjustability' is a far overrated feature unless almost all of the work you do is completely 'custom' one-offs. In most shops the vast majority of work involves the repetitive use of a couple dozen 'angles' or fit-ups. These more or less 'standard' cuts are better done with a permanently set notcher frame so that each and every cut is absolutely identical in all respects.

The notcher shown herein is designed to cope tubing ranging from .75" up to 2" in diameter. For making the extremely shallow 8-degree cuts like you'll find in Girder legs the tubing size is limited to 1" or less. It can be made to cut these very long copes in large diameter tube but the saw shaft will need to be extended.

Keep in mind that what you see here in this article is just a very rough prototype made from scrap so it doesn't look very pretty but it works very well and costs very little. If you cannibalize a pre-manufactured notcher for parts and use scraps for the frame I expect the cost for this type of notcher to be around one hundred dollars. It will outperform notchers costing upwards of five hundred dollars. I don't mean to brag but I seriously doubt that you'll ever find a notcher anywhere that can do as much as this one can.

Size and Scale

The notcher pictured in this article is sized and scaled, as needed, for a wide variety of general fabrication work, not just cycle frames. The unit can be 'downsized' significantly if all you do is bike work and lightweight sand-rails or dune buggies. For the larger projects like rock-crawlers, 4x4's and industrial applications I suggest that you keep the proportions as near to the design drawings as possible.

I do not recommend that you make a notcher from aluminum as the nature of hole-saw coping creates a tremendous amount of vibration and the heavier that the framework is

the better the cuts are. The notcher, as drawn in the plans, is about a light as one would want to make it so if you scale it down in size you might want to go up in the wall thickness of materials or use solid stock to keep the weight as high as possible.

Mounting

This particular notcher can be mounted in four basic manners. The first method is to weld a mount-stub or 'leg' on the fixture-holding arm so that only the saw carriage arm and the hinge are free to move. The second method is to weld a mount-stub on the saw carriage arm so that only the hinge and fixture arm can move. The third method is to weld a mount-stub to the hinge itself so only the saw carriage and fixture arms are free to move. The fourth method is to develop a combination of all of the above methods by using 'detachable' mounting stubs.

This may sound confusing and/or complicated but once you build and use a prototype you'll quickly see the pros and cons of the various mounting methods so I won't dwell in detail on any particular method since the mounting will eventually be a personal preference based upon the type of work you do. Some people prefer the drill motor and saw carrier to be stationary and others prefer the tubing to be fixed. It's six one way and a half dozen the other.

I strongly suggest that you build the basic notcher and hold off on welding in a final mounting system until you've had a chance to see exactly how this thing works in relation to the type of work you're doing.

The Assembly

Links to full size drawings for this notcher are included at the end of the documentation but for now we need to look at the major component parts.

At first glance this seems to be a pretty complicated arrangement but in reality this is actually one of the simplest notchers one can build. The entire structure is designed around what I call a 'point and shoot' principal where there is an almost infinite adjustment range in both the X and Y axis depending on how you decide to mount your particular unit. Fortunately these notchers are so cheap to construct that most shops using them have three of four different versions, each mounted in a different fashion for particular applications. You only need one 'cutting head,' which is the beam that supports the saw drive-shaft carriage, and this can be moved from frame to frame so you don't have to fabricate a lot of separate 'custom' parts to make this particular design a truly customized setup if that's what you need to do.

After a few years of building frames you'll find that the 'point and shoot' method works pretty well if you do a lot of custom work by 'eyeball' as I do. On the other hand the 'perfectionists' out there can set these units up to do precision work with preset 'stops' and other fancy stuff if you have a need for highly repetitive notching.

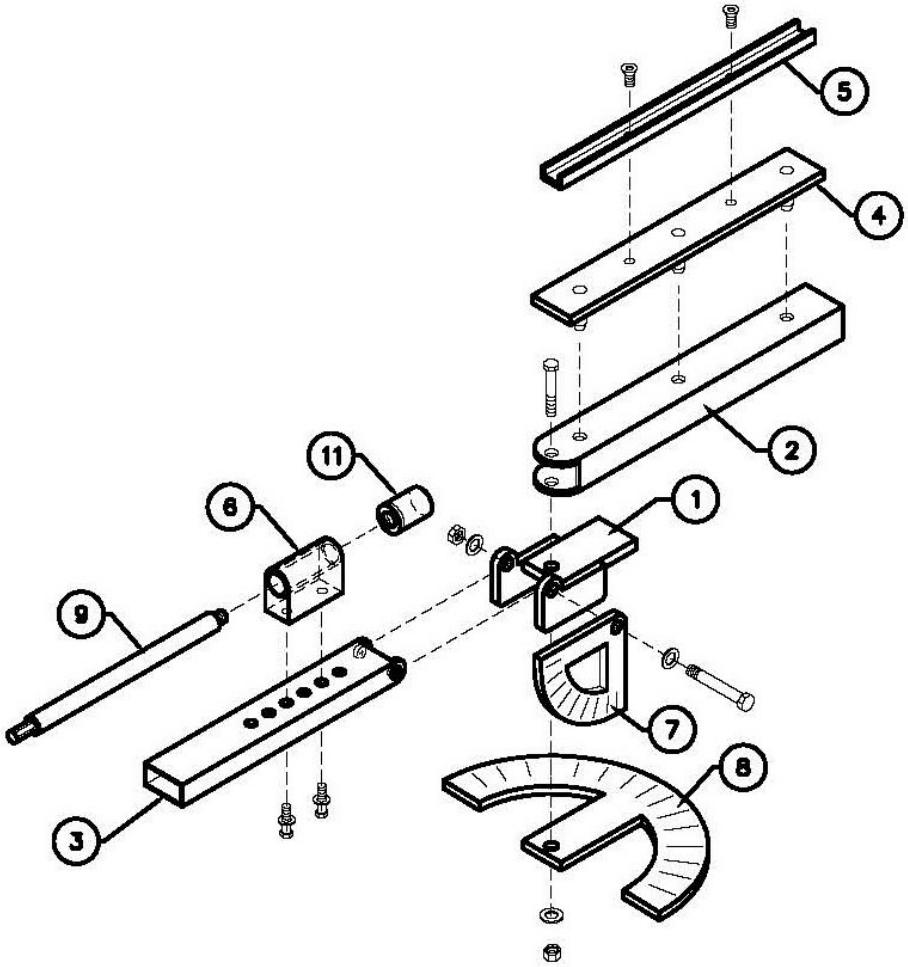

Figure 1

The part numbers shown herein are only those for the major components as tabulated in the schedule on the full size assembly drawings so it may appear as if some part numbers are missing in this particular illustration. The numbers and descriptions for the lesser parts and/or components are shown on the shop drawings that you can download.

It may be easier to visualize the parts as shown in this photograph of the original prototype used to document this article.

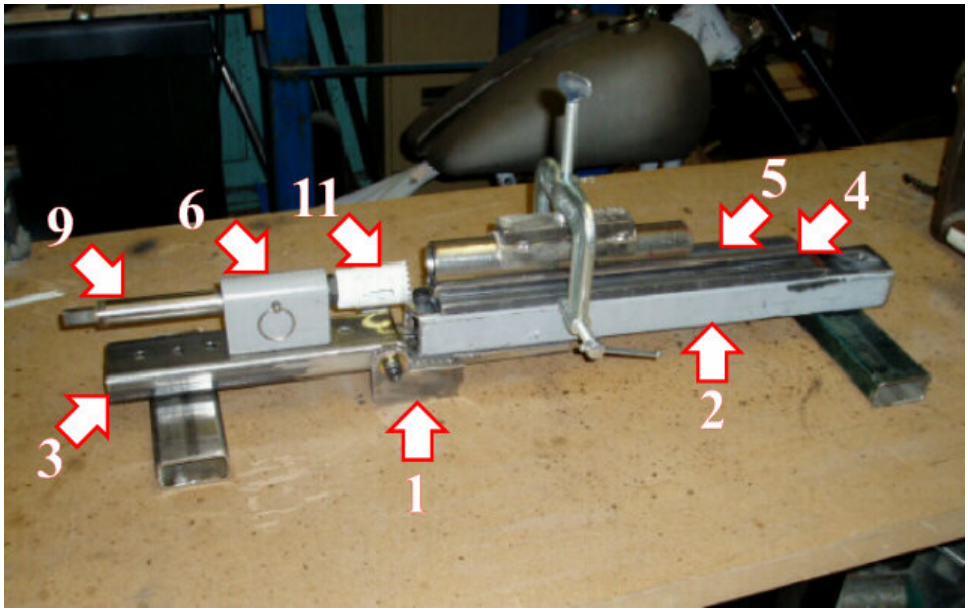

Figure 2

In both of these exhibits the notcher is shown laid out flat so to speak. In reality this is a position that you will never use but it is convenient for presentation purposes.

To explain how this device works we need to understand the nomenclature used in our patent application.

Part number 1 is central to the entire design and it's called a 'Swivel-Hinge'. Basically this is a simple hinge with a pivot pin set at a right angle to the hinge pin. I personally don't know of any notcher made anywhere that incorporates this unique feature and it's incredibly powerful. The swivel hinge allows you to make extremely complicated compound cuts in tubes which no other notcher can even come close to duplicating.

Part number 2 is what we call the 'Fixture Beam' or 'Fixture Arm' and this is the part of the notcher that the tube or other structural member in attached to. This is just a part of the notcher that holds the 'material' to be cut.

Part number 3 is called the 'Saw Carriage Beam' or 'Saw Carriage Arm' since it serves to mount the little block containing the hole saw drive shaft.

Part number 4 is something you won't find on any other notcher ever made. I call this part the 'Fixture Shoe'. This particular part is removable and positioned by several steel dowels that locate it on the Fixture Beam. You can build dozens of different types of Fixture Shoes for specific types of notching applications.

Part number 5 is called the 'Material Positioner'. Basically this is just a piece of 1"x.5" channel stock for holding round tubing. You can have dozens of different 'Positioners'

for different types of materials ranging from round tube or rod stock to channels, angles, rectangular tubing, etc.

It is these two parts, 4 and 5, that give this notcher design it's power and flexibility since you can build a virtually unlimited number of shoes and material holders to handle almost any kind of structural steel shape imaginable and you can do it 'on the fly' or 'adlibbed' for a particular project where you might need some particular offset or notch in some odd shaped object.

Part 6 is the 'Saw Carriage'. This is just a block of solid material bored to house the bearings or bushing for the hole saw drive shaft. I usually don't bother to actually make this part and prefer instead to just use a part from some other cheap notcher like the Harbor Freight models.

Part 9 is just a .75" diameter drive shaft that can be cannibalized from another notcher or made up from solid bar stock or DOM tubing. This notcher needs a shaft with 12 inches of 'free' length. Most pre-manufactured units only provide 8 or 9 inches.

Part 11 is the hole saw bit and I prefer to use those sold under the Milwaukee brand name but virtually any product can be used so long as they are the same length as the Milwaukee's (about 2.5").

Comparisons

It's pretty obvious from the exhibits shown above that this particular design is significantly different than the old conventional 'Joint-Jigger' type of notchers everybody seems to be selling as shown below in Figure 3 which is a fairly typical example, actually one of the better models sold by JD^2.

All notchers of this type, regardless of the brand name, operate on identical principals and are severely limited in their usefulness except for making pretty routine miters in round material so long as the angle between the adjoining tubes isn't much less than 30 degrees. For cycle work this isn't to helpful as you'll find a need to cut copes in a variety of tubes that are much tighter than 30 degrees, sometimes as narrow as only 15 degrees for frames and even as small at 8 degrees on girder forks. If you read the notcher article in the tools section of the Handbook you'll find some tips on how to do some workarounds on these types of notchers for cutting copes in wishbones but even then these various models aren't to well suited for cycle work.

They do have a place in the shop despite their drawbacks. I have about ten versions of such notchers in my own tools collection but there are superior alternatives.

Figure 3 - Joint Jigger Type Notcher

Our design, on the surface, is much more akin to the airframe notcher originally developed by Marvin Story's as shown in Figure 4.

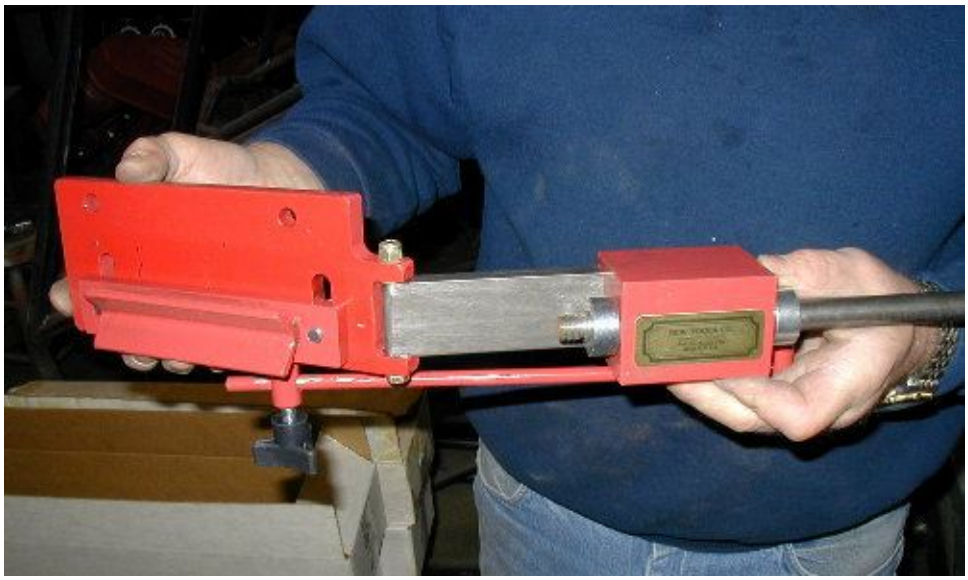

Figure 4

This particular design can be seen in its entirety at:

http://www.kcdawnpartol.com/TubNotcher.htm

Marvin's notcher is certainly unique and many builders and fabricators have copied it but in general it's actually a little lightweight for car or bike chassis work and it doesn't have the ability to cut compound miters as our design incorporates. It's also pretty much limited to cutting relative small diameter thin-walled tubing. Even with these limitations Marvin's design is vast improvement over the old Joint-Jiggers and we all owe him a debt of gratitude for publishing his endeavors for all to benefit from.

Like most custom made notchers this one of Marvin's was designed for a builder's specific needs and in his case it meets those needs perfectly.

Specific needs have lead several fabricators to improve Marvin's basic design for their own applications. We're aware of two excellent examples that follow.

Figure 5 illustrates 'Flame-Phil's' rendition of the Story type notcher adapted specifically for bike work. It's a good improvement in my opinion.

Figure 5

You can easily see that this is a much 'stouter' assembly designed for heavy walled materials more commonly found in car and bike fabrication shops.

Figure 6 is another rendition of this notcher type done by our own 'SuperBob' and he's been posting an article on the discussion board about its construction including the use of a protractor and alternative clamping devices.

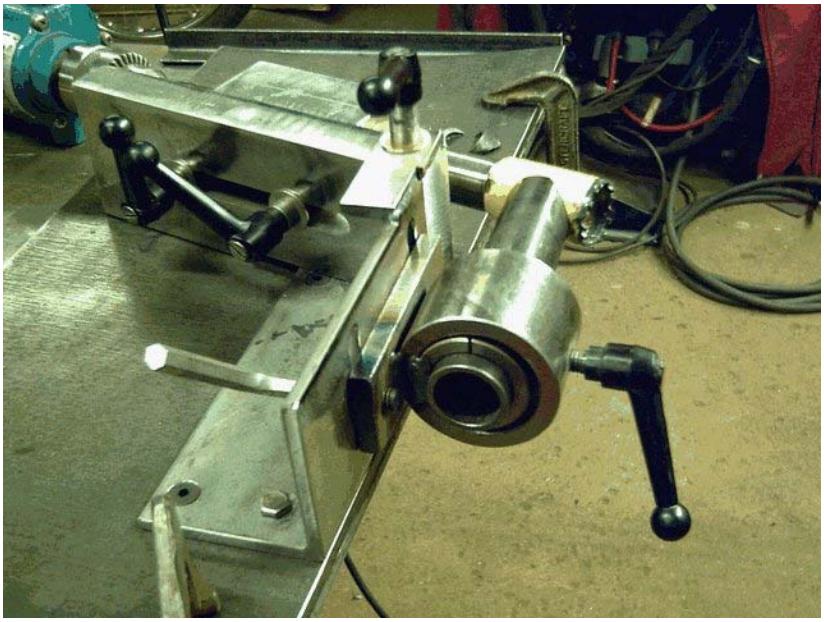

Figure 6

As you can see this is another version of the airframe type notcher but beefed up for chassis work with improvements added by the maker for his particular requirements.

This particular design concept, the 'Story notcher' as I call it, has been rendered by many builders and is no doubt far superior to the old original 'Joint-Jigger' designs but all of them are still limited to cutting notches or miters in only a single plane or at best with an 'offset' but still again in a single plane or along a single axis. That being said I'd still be proud to have any one of these units in my own shop.

The difference between these designs and our own, to my way of thinking, is that these types of designs have come about from the development of '*notchers*' in general.

Our design originated with the development of a '*welding fixture*'. In fact if you remove the 'saw' fixture from our design you can easily see that it's basically just a multi-angular 'clamping' fixture used to hold parts for welding and not notching.

This is what I think separates our design from others. It has its roots in a totally different type of fixture than seen in conventional tube notchers.

If you go back and look at the 'feature list' we established at the beginning of this article you can easily see that no traditional notcher could fulfill these requirements but that a welding fixture could be made pretty simply to met the specifications. All we did was add a cutting head into the equation in place of an adjoining piece of tubing. In effect, in our design, the hole-saw bit is just a 'temporary' substitute for another piece of tubing that appears in the final chassis assembly.

We'll try to describe in pictures some of the flexibility of the CBH Notch-O-Matic as we go along.

Please keep in mind that the unit pictured here was made 'on the fly' out of shop scraps in less than an hour with no effort spent in trying to make it 'pretty'. I just wanted to put something together to illustrate the basic operating principals of this design. When I have more time I'll put something together that looks a little better.

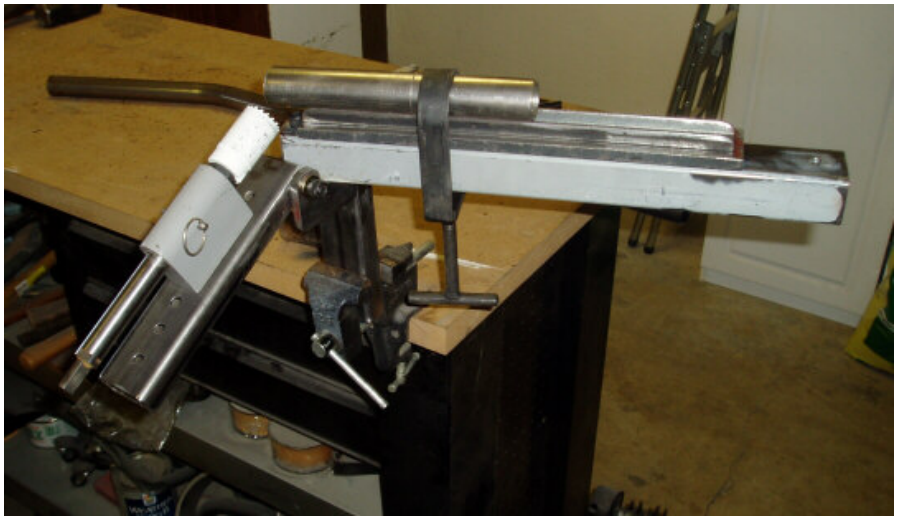

Figure 7

First of all with type of notcher you can cut virtually any cope in any piece of structural material, not just round tubing, at any angle you can imagine by adjusting the two cutting planes of the device. The tubing itself never needs to be repositioned. I don't know of any other notching device that makes this rather complex feat so easy to do.

Almost all notchers on the market today, even the very expensive ones, can only cut a single notch in a single plane at one time. Secondary or tertiary notches require that the tubing be physically repositioned in the notcher and the cutting head angle readjusted for each different notch angle.

Why people will spend up to $500 for such limited notchers is beyond my comprehension but it happens every day. Some of the problem stems from advertisers over-selling the products, making wild claims about the products special design features for chassis work. Another part of the problem is that experienced builders who fashion their own custom notchers do not necessarily want their designs known to the competition.

I'm very proud of the fact that members of the Chopper Builders Discussion Board routinely and openly share their building techniques so that everybody benefits.

Figure 8

Cutting ‘compound’ miters in any piece of material is almost a ‘no-brainer’ with this type of fixture since you have complete control of 180 degrees of movements in two planes at the same time. You can easily do ‘point and shoot’ notches on the ‘fly’ or by ‘eyeball’ which is something I personally like to do.

Before going much further I’d like to go back to a couple of features that are vitally important and to help in examining the details I decided to ‘color-code’ the various parts of the notcher. I painted everything up in a single evening using old rattle cans we had laying around. Unfortunately it was about 35 degrees in the garage so we’re not going to get any painting awards for sure.

Figure 9 shows the freshly painted basic parts of the notcher prior to assembly.

In the upper left is the tubing ‘U-strap’ clamp. Below it in yellow is the swivel hinge with a leg welded on the base for temporary mounting in a bench vice. To the right is the saw carriage mounted to the saw carriage arm (in white). Next to that in red is the fixture shoe. It’s upside-down in this snapshot so you can see the locating dowels on the bottom. The ‘material-positioner’ is shown in gold. The main fixture beam is to the right, painted black.

In my opinion the two most important elements of the design are the removable fixture shoe (red) and the material positioner (gold).

Figure 9

These two parts work in conjunction with one another and since they are removable you can make and use as many combinations of these parts as needed for particular applications or different types of materials needed to be notched.

Figure 10

In Figure 10 we see a representative example of a shoe and material positioner or holder arranged in a pretty conventional manner set up for notching round tube from .75 to 2” in diameter.

Under normal circumstances I’d just weld the small channel to the shoe since this type of combined assembly would see a lot of regular day-to-day use. There might come a time

however when we had a need to hold the tubing in the notcher at some weird angle or even off-center.

Figure 11

One way to do this is to have the tubing holder screwed to the shoe with recessed flathead machine screws. We can then drill and tap a wide variety of holes in the shoe itself to facilitate a huge range of tube positions. In a similar fashion we can make dozens of different types and shapes of material holders that screw onto the shoe so we could do copes in angle iron, channel sections, square or rectangular tubing, etc., etc.

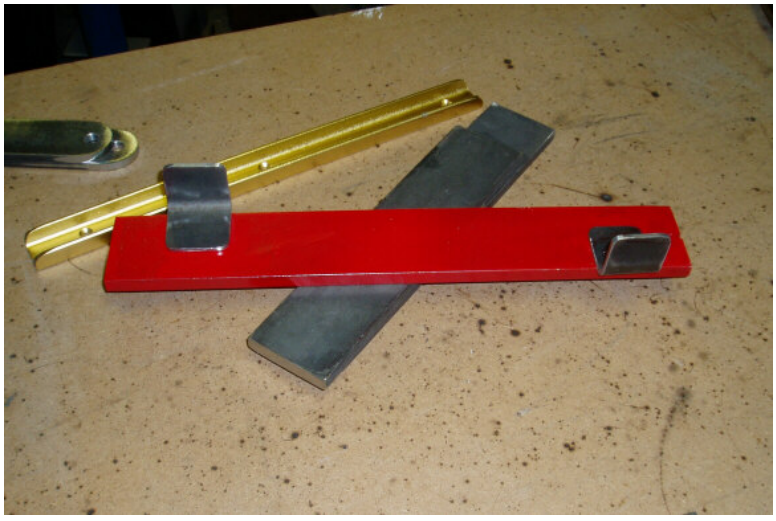

Figure 12

Figure 12 illustrates how a shoe can be combined with ‘fixture positioners’ for oddball applications.

The shoe itself can be virtually any size. It does not have to match the width of the Fixture Beam. For industrial applications I used removable shoes that were large enough to clamp onto 6x6 sections of structural tube steel. For racers and hot rods we had shoes designed to clamp onto 2x3 and 2x4 frame rails.

Figure 13 below shows how the notcher can be clamped on a large member so you can cut angled holes through a frame for the installation of triangulated cross members. In this particular photo the shoe is absent since the paint was still wet when I took the snapshot. I didn't have a long piece of 4x4 material in the shop either so in reality the C-clamp would be clamped to the fixture arm and not the swivel hinge. I think you get the idea despite the poor example I rigged up.

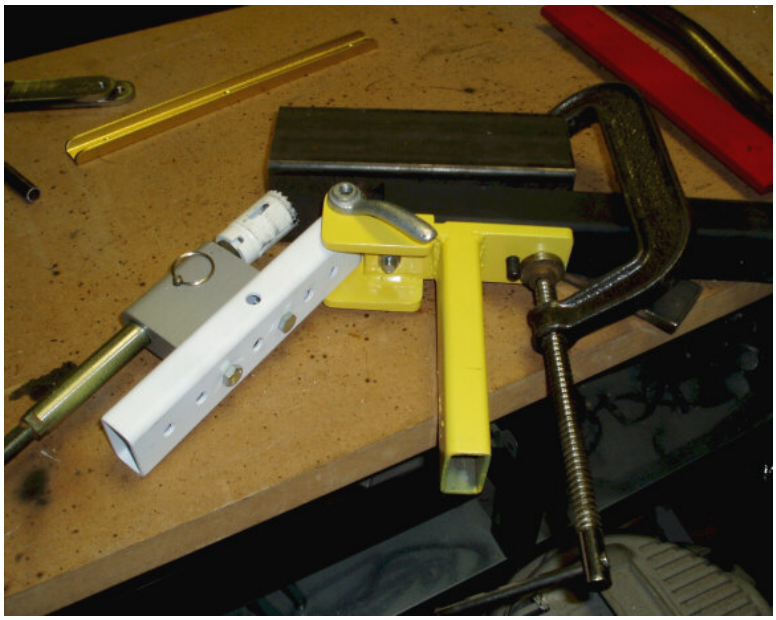

Figure 13

Just keep in mind that the combination of the removable shoe with multiple tubing fixtures can be a tremendously powerful and flexible feature of this notcher. On the other hand however a very simple shoe and tube holder can be welded up that does about 95% of all the work you'll encounter in a Chopper shop.

You'll have no doubt noticed in this article and others that I like to use 1 by 1-1/2" channel as a tubing holder instead of angle sections as you'll see in many fab shops. I was shown this trick decades ago by a top-notch chassis builder and once you try it you'll soon see the advantages. It's good for material as small as 3/4 up to 2 inch round tubing, after that the angle iron works better.

So far you've only seen the notcher mounted vertically or clamped onto a piece of work material but it can be mounted horizontally as well.

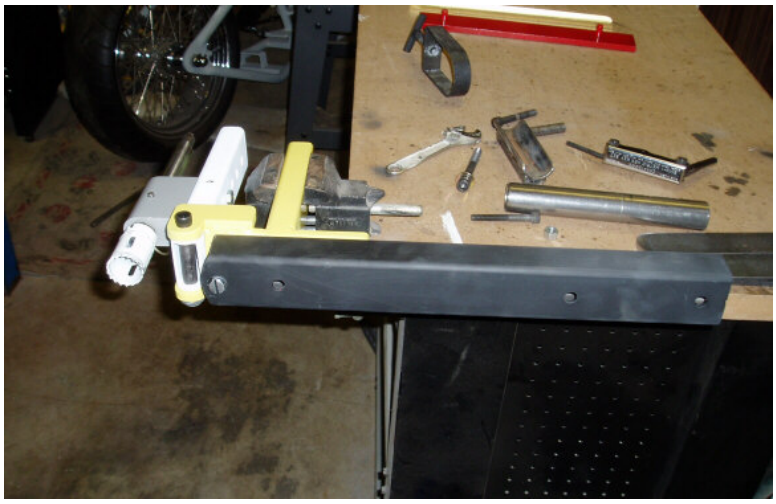

Figure 14

Figure 14 illustrates the notcher clamped into a vice in the horizontal position.

Figure 15

Figure 15 is a little better view of the horizontal mounting position with the saw carriage rotated into position for a cut.

Remember we mentioned earlier that the notcher can be mounted in several different ways with any one of the three main parts being clamped into a vice or even permanently mounted to a bench.

I prefer the vertical mounting with the hinge itself being stationary as in that position I can use my regular bubble protractor to set the angle of the cutting arm and my tube

bender bubble protractor to set the tube rotation in the fixture holder. This way I'm sure that the angular values I get from the jig are duplicated exactly in the notcher. This is just another unique a feature you will only find on this particular type of notcher.

Another unique feature of this notcher is that you can do real multi-angle 'birdmouth' notches in tubing without even having to reposition the tubing in the notcher since the saw carriage rotates through a 180-degree range.

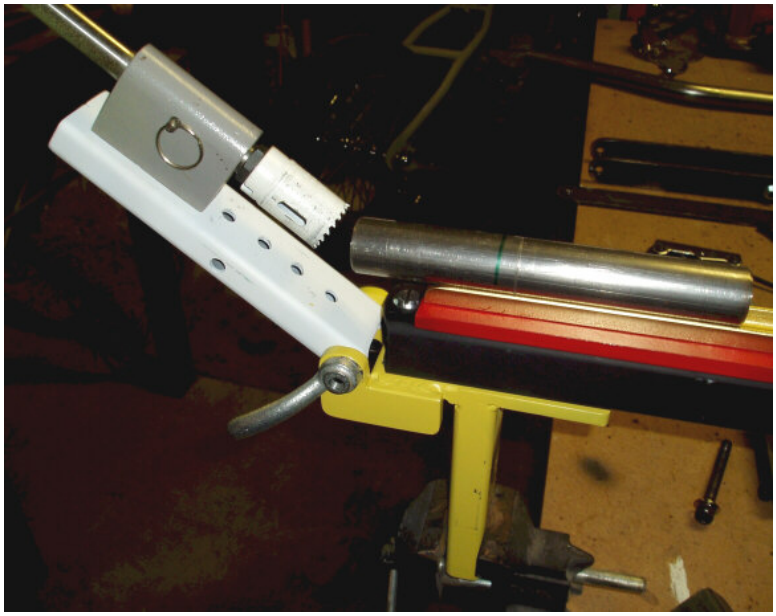

Figure 16

The first half of the birdsmouth is made in the top.

This type of notching operation is a routine operation for industrial fabrication shops but not often encounter in bike work. I decided to show the method of doing this type of notch anyway since it's one of the main features of this notcher that others do not provide for.

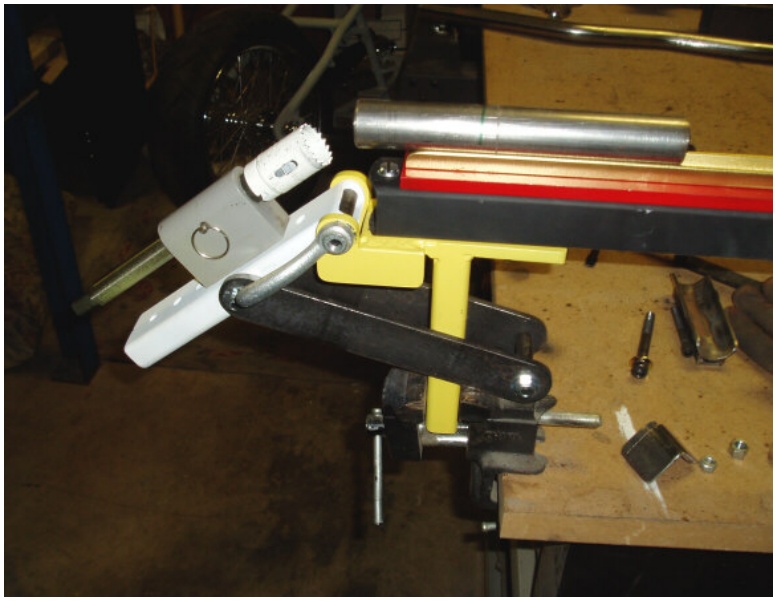

Figure 17

The second half of the cut is made in the bottom.

Figure 18

By simply rotating the fixture beam you can make a third notch in the bird-mouth.

As far as I know this is the only notcher design ever developed that can actually do ‘out-of-plane’ tubing miters or miters where multiple tubes intersect a single point all of which come from differing angles. To top it off all of this can be done without ever moving the tube for each separate notch.

Of course as I mentioned this type of notching isn't seen much on bikes but if you do any space frames like you'd find in Altereds, Sprints, Midgets and old classic road racers this feature is a lifesaving time saver.

If you've ever had to do any restoration work on Birdcage Maserati's or old Group 7 cars you'll quickly appreciate why I developed this particular notcher. It's crude for sure but it does the job superbly and better than ultra high-tech rigs like the one below.

Figure 19

This machine (Figure 19) costs over $3000, which is entry level for horizontal end-mill notchers, and even it can't cut the miters that our little home-brewed notcher can handle.

And yes, before you say it, I realize that our CBH notcher can be motorized and equipped with a milling bit very easily but that version of the notcher is for another article and you should be able to build one for under $250.00 if you want a mechanized version. We're already working on the plans to post at the discussion board.

Getting back to the project at hand however you'll notice in Figure 18 that I've added some 'adjustment' links to the saw carriage arm. In reality the carriage can be fixed into position just by tightening the pivot screw but if you get pretty rough you can knock the arm out of position. To prevent this from happening you just move the saw arm to whatever angle you want and then put a C-clamp over the links where they cross the vice 'leg'. Alternatively if you decide to add a protractor the carriage arm clamps directly to the protractor itself to hold the arm in position.

On the other hand if you just want a simple arrangement you can set up your 'adjustment' links to give more precise control over the angles of the cuts. You can drill 'preset' holes for pop-pins in the notcher frame and adjustment links for your 'standard' cuts to make setups faster. The arms can be slotted and run on pins, etc. etc. There is virtually no limit to the manner in which you can devise clamping systems.

To hold the main fixture arm in position I just typically use a pair of links that I clamp with a C-clamp or vice-grips at the apex as shown in Figure 20 where the arm is rotated only 3 degrees from center.

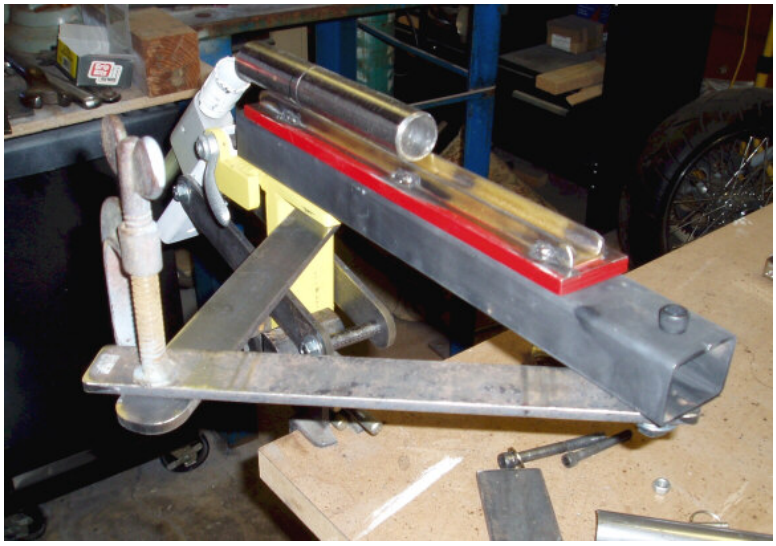

Figure 20

Figure 21 shows a slightly different view with the arm at more extreme angle.

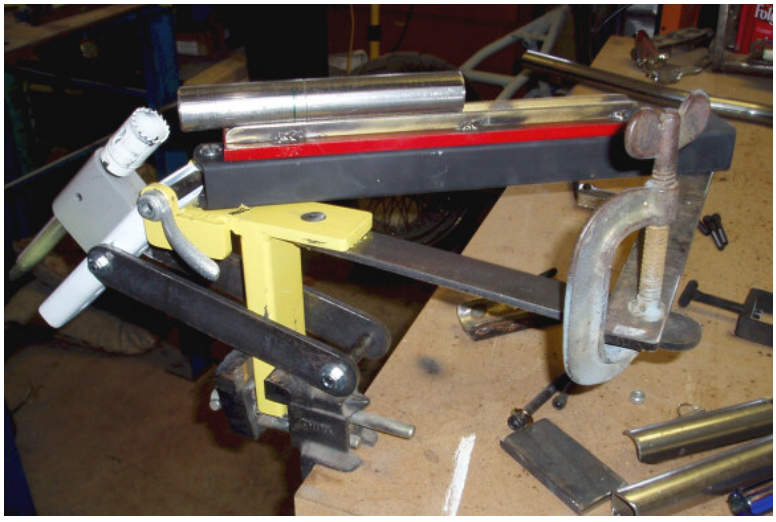

Figure 21

While this arrangement make look weird it is extremely rigid due to the triangulation and very fast and easy to set up. The links can pivot to either side of the arm so they're out of way if you're notching some semi-assembled piece of work for instance.

There are literally dozens of ways to make adjustment links for either of the ‘arms’ on this type notcher but I always prefer the quick and simple methods. Nothing wrong with making something fancy and more accurate if you have the time however.

Tubing Holders

At the beginning of this article in Figure 2 you’ll notice that I was just using a regular old cheap ‘three-way’ clamp to hold the tubing. This arrangement works remarkable well since it’s extremely adjustable for holding various sizes and shapes of material and can be positioned anywhere along the run of the main fixture arm.

Later on as in Figure 7 I’ve illustrated the use of a more traditional type of U-strap tubing clamp. The fact is that you can devise several methods of clamping the materials.

Figure 22

One idea I’m working on is to build a clamp that looks similar to the gear-puller pictured above. In use the clamp slides along the fixture arm and clamps under two pieces of 1/2" square bar stock welded to the sides of the arm.

The advantage is that you don’t have anything running under or completely around the fixture beam so it’s easier to clamp the entire notcher to some other structure if needed.

Figure 23

Another idea is to incorporate one of these quick release Vice-Grip clamps into a similar sliding rail system.

So far we've only touched upon the basic fundamentals of this design and described some of its elementary features. This device is so versatile and flexible that I could literally write an entire book about the various expanded capabilities of this little tool.

With the appropriate fixtures this notcher can largely replace your drill press for a lot of bike building applications where a hole saw is better than a drill bit.

In my old shop we even had a version of this device that used a die-grinder as the cutting head running on a carriage driven by an Acme screw. It was used to mill some specialized aluminum pieces we were making at the time.

We'll be posting more pictures of this remarkable device as time goes on but for now this gives you some idea of the possibilities.

My personal opinion of this assembly is that it serves a need for some who might need more standardization in their notching operations while still maintaining flexibility. It does an excellent job for what's it's designed to do. For others who still prefer the old grinder method of doing miters, like myself, this device offers no advantages whatsoever.

If you plan to build one of these devices I'd strongly suggest that you make a crude prototype to begin with. Work with it awhile and then decide upon the improvements and/or modifications you'd like to incorporate before making a final version.

Notching

We've never really specifically talked anywhere on the site about how to actually use a hole saw notcher of any kind to make the most of the tool or the saw bits themselves.

At the introduction of this article we did mention the limitations of hole-saws in general with respect to material sizes but there are huge numbers of Internet myths and misconceptions about hole-saw notchers in general. Most of these myths come from people who have never used a notcher to begin with or have tried to use a notcher equipped with cheap hole-saws design for cutting wood and not steel.

A common myth, spread mostly by people who want you to buy an expensive End-Mill is that the hole-saws get dulled rapidly and cut slowly. They are economically ineffective.

Some of you may be familiar with the article I did on the cheap tubing bender. On that project we used a very cheap Ace hardware 3/4" hole-saw that cut about 20 holes through 3/8" and 1/2" solid steel strap very rapidly and with accuracy just as good as a real drill bit. I'm still using that hole-saw for a variety of work and it's still just as sharp as when we started. I'd estimate that by now it's cut at least fifty holes in thick steel and it's still going strong. I don't baby these saws either. In fact I'm pretty abusive in that I hardly ever use any lubrication and I run the saws far faster that they are supposed to be operated. I usually end up breaking off a tooth or two long before the saws start getting dull but even then they still cut but not as accurately.

As to speed, you have to factor in the overall time to set up for a cut as well as the time actually spent in doing the sawing. In a race between a guy with an end mill and a guy with a good hole-saw notcher the hole-saw will win every time.

As to economics, I think I could buy a whole heck of a lot of notchers and hole-saws for less than I could buy even a cheap end-mill, around 400 saws to be exact compared to even bottom of the line milling equipment. That works out to about 8000 copes or about 300 frames I could make with a hole-saw notcher before reaching the break-even point of buying a cheap horizontal mill.

The second myth is that hole-saws do not make accurate cuts. Actually a hole saw in a well adjusted notcher will make a cut just as accurate as one made by a drill bit if you're not trying to notch thin-walled materials and you use lubrication and run the saw at the correct speed. Fortunately you don't have to take these precautions since if you're a good fitter-fabricator you'll hand-dress all of your notches during the fitting process anyway so it doesn't really make much difference if the initially cut tube edges aren't surgically precise to begin with.

Like most Chopper myths spread about on the Internet none of them are based on reality or even common sense and the vast majority come from 'experts' who have never actually done any fabrication work to begin with. I still occasionally see posts on the

discussion boards where people insist that it's impossible to cut miters for cycle work in thick-walled tubes with a hole-saw.

There is no 'right' way or 'wrong' way to use a hole-saw based tubing notcher of any type but some ways are perhaps easier than others. The biggest problem with hole-saws in general is that they are relatively short or shallow in physical dimension so the depth of any cut is limited to the length of the saw bit before you have to back off and cut away the excess material that's jamming up inside the bit so you can continue the cut. This is just a fact of life one needs to get used to.

This little detail isn't usually explained in the instructions that come with most notchers so a guy might start making a cut and when the saw reaches the end of it's cut depth he thinks he's up shit creek. He might throw the whole contraption in the trash bin since it won't cut a miter for a typical wishbone connection which is about 5 inches long but the hole-saw only goes to about 2.5 inches and then gets stuck and can't go any deeper.

Figure 24

You can see in the photo how the hole saw can only penetrate the tubing to a limited extent before the interior portion of the tube jams against the back of the hole-saw.

Figure 25

Here's another shot looking right down inside the saw. The dashed green line roughly indicates where the notch is supposed to end up. You can see that the saw has already cut as deeply into the material as possible, about 2.5 inches.

At this point you need to retract the saw bit and using a small cut-off wheel in a hand grinder just cut away that portion of the tube that prevents the saw from going any further forward into the cut.

The picture below shows two sections of tubing. The tube in the lower portion of the picture has been cut as deeply as possible without cutting away the small segment that's hitting the back of the hole-saw.

Figure 26

The shot below shows the slice in tube made by the cut-off wheel. Be extremely careful that you don't accidentally cut to deep and make a groove in the 'good' part of the tubing that you're going to weld to the frame.

Figure 27

You can see that I cut just deep enough to go through the main part of the segment but stopped just short to cutting completely through.

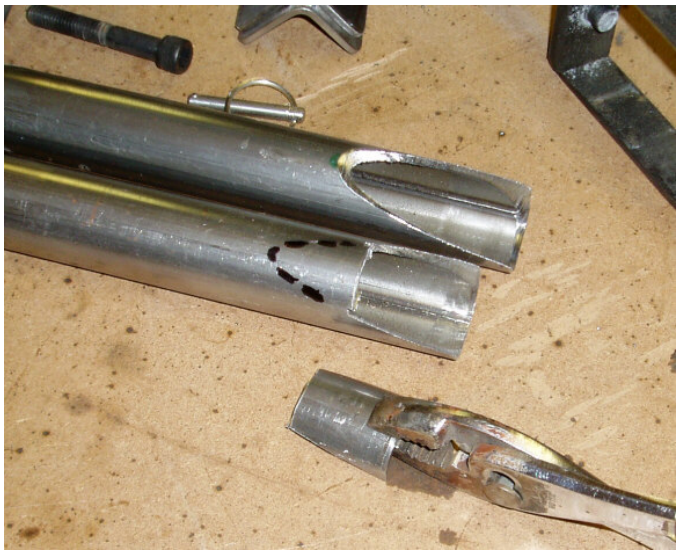

Figure 28

The segment can easily be snapped off using a pair of pliers. These little cut-off segments are what I make the ‘bullets’ out of that you’ve seen me use on tube ends at the axle plates.

Once the segment has been removed you can continue cutting the notch with the hole-saw.

On very shallow and long notches, like you find on Girder legs, you’ll have to repeat the notch and slice routine a couple of times. For notches closer to 90 degrees the saws are usually deep enough to cut completely through.

Note that the slice with the cut-off wheel is actually done while the tubing is still clamped in the notcher. I removed the tubes shown in these pictures for clarity. If you remove the tube in the middle of a notching routine it is often very difficult to get it repositioned accurately.

Design Drawings

The design drawings for the fundamental parts of the notcher illustrated in this article are located at the following links. The drawings are in Adobe .pdf format, drawn at full size on 30x42 inch sheets. They can be plotted full size at almost any print shop of large office supply store.

Keep in mind that the drawing only represent the ‘basic’ parts in their most elemental design stage and are intended to only serve as a guide for building your own concept of this notcher type.

The drawing links are:

Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sheet 5