# The \$50 Pier

### By Jerry Wise

Constructing a Pier need not be intimidating if a person has average "fix it" skills. Matter of fact, I found the process to be a very interesting and a lot of fun. You have to rely on the skills of others for certain steps so some hints on acquiring their help will be included. Many will have better skills and ideas on pier construction. The fit and finish here will not be of Tak/Astro Physics caliber. But, bottom line, my scope is on a very solid pier exactly the way I want it and for very little money.

# **Basics:**

I thought having a pier on the patio would be a pretty neat. Just walk out, slip a mount and OTA on it and observe. No unfolding tripod legs and nothing to trip over in the dark. After pricing piers it just seemed like there was a better way. I decided to build one. It would involve some light welding and drilling but seemed worth a shot. I ended up building three piers out of 4" pipe and putting them at various places I observe (observatory, patio, and father in laws).



Again, bear in mind, I am no welder or machinist, just a hobbiest with average handyman skills. I recently constructed a new pier for a 14" LX200 in the observatory and several Cloudy Nights members asked for an article on pier and wedge construction.

I tried to figure a way to write an article on a pier/wedge project without starting over. Pictures are crucial to success so I bought additional material and now have a backup pier and wedge. The process is involved so there will be two articles, one for the pier and the other for the wedge.

The best material for a low cost pier is mild steel. Steel is very workable with common tools (files, hack saws, etc.) and can be welded with ease. We will start with picking up materials and proceed through the final finish application. As an aside, the cost of materials for both pier and wedge was \$103.00. I priced a pier and wedge for the 14" Meade and it was well over \$1,000. There was some custom fitting required and this was not included. The difference in price would easily buy a Lincoln wire welder, drill press, grinder and an Orion 80ED. The pier construction took about 6 hours of my time including picking up materials and "hanging out" at the welding shop.

## The Welding Shop:

The most important part of the project for a beginner is to find the right help. This will be in the form of a metal working shop. There are two ways to approach them. One is to carry this article with photographs and measurements to them and get them to build it for you. This will work but you won't enjoy the thrill and companionship of getting back to your roots. If this is your choice, go directly to the material list at the end. For the second option you will participate in the full process and make the pier and wedge yourself. I asked around and found a large shop specializing in farm equipment nearby in the country. (Ask car dealers, lawn and garden dealers and tractor dealers for a company good at welding and has a "friendly" staff.) Yes, friendly. Friendly means you learn and can have exactly what you want. Now bear in mind, if you look like a geek, you are a geek (I am a programmer geek fortunate enough to look somewhat like a redneck). You may want to stick with step one if you don't feel comfortable in work clothes.

Before going to the welding shop, get you some steel toed boots, jeans and a denim long sleeve shirt. The older they all look the better. Also pick up a couple "Tootsie Rolls" for graduation. Be sure and wear a tee shirt that covers the vee in the front of the denim shirt. (If you watch or do any welding a brief period of time you can get serious sunburn on your neck in that vee area.) I first went to the welding shop last year for a pier pipe and base. They let me watch them cut it and I asked questions. It was interesting and before long they showed me how to use the band saw. Later they let me use the large metal shear and then the bending brake (more on these later). Now I can go in, walk to the back and pull the material I need. I cut it and put it in my trailer and then tell them what I got. They let me pay for it or "just right it on the book" (an old spiral notebook where you scratch in your name and what you picked up). Most don't take plastic so be prepared. It's very unique in this day and time. When working with them on telescope projects I found it best to use the words Up and Down and Left and Right. Do not mention Altitude and Azimuth or Right Ascension and Declination in the welding shop. You will blow your cover. Stick with Up/Down and Left/Right. I will for the balance of this article.

# The Welding:



Here is what I used for the Pier and Wedge construction

This is the fun part. In the past welding was both an art and science. Today, if you can use a glue gun, you can weld. For a touch over \$300 you can get a Lincoln wire feed welder that plugs into 110v and includes everything you need to get started. Google

search "Lincoln Electric Weld Pak 100HD Wire Feed Welder". They are at Lowes, Home Depot and many other outlets. Just stick with the basic kit. It will do everything you need and more for wedge building, pier building, fixing lawn mowers, trailer repair and honey do projects. Watch the tape included with the welder, play with some scrape pieces and be careful not to look at the spark or touch the hot metal and you will be fine.

Your welds will look bad. Mine do. The secret here is to spend another \$70 for a 4 \_\_\_\_\_ inch grinder. You will grind the welds a bit and then all will look like a professional did the work. The welder comes with a helmet. I decided to get the best helmet I could find that "auto darkened" for around \$220. These helmets let you look at the work through a lightly shaded lens and will sense the arc begin and immediately darken to the proper safety shade. Really handy tool and they look pretty cool.

# The Pier Parts:

A good welding shop will have a huge selection of material for nearly any project imaginable. The great part is, if you select a shop working on farm implements, a lot of what you need for astronomy projects will be in their scrap bins. It's material to be recycled and can be had for much less than fresh cut stock. The pier will need material that will be cut from new stock.

I asked the owner about pipe stiffness verses size. I wanted to use 6 inch \_ wall thickness pipe. He recommended 1/8 wall thickness and 8 inches in diameter. The stiffness of the greater diameter would be much more beneficial than the additional wall thickness.



Here is some of the material available

The other three piers I made were on a flat steel base. Keeping sheets of steel perfectly flat while welding a large pipe in the center proved to be nearly impossible. Since pier flex often comes from the base/plate joint, I decided to go for a very heavy base material. Something that would be nearly impossible to flex,

stand the thermal stress of heavy welding and be very strong. The perfect choice was 10" wide times \_" thick U channel. It looks like \_ of an I beam.

#### The Pipe being cut.

The wedge will weigh 42 pounds and the mount/OTA combination will often weigh well in excess of 100 pounds. I cut the 8" pipe 33 inches long to support this weight. Often cuts on pipe this big will not be "square". When you attach the base the pipe will be at an angle unless you grind it level. The cut being made here later proved to be about inch off.



Wedge, Pier and fittings, \$103

#### The Cap Plate

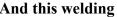
The cap plate will be on top of the pier and the mount or wedge will attach to it. It will also serve to level the wedge and facilitate "left/right" fine adjustment. In looking through the scrap bins, I found the 12 inch circular piece of 3/8 inch steel by the base and pier tube. Some long forgotten piece of farm apparatus needed a 12 inch hole cut in it and this made a perfect pier cap. All the small stuff came from the scrap bins.

#### The right clothes

Clothes are used for protection in welding and grinding. You want a long sleeve cotton shirt, denim jeans, steel toe boots, good gloves (in addition to the long welder's gloves), eye protection (full face), and a base ball cap worn backwards (when grinding that's the only way you can wear it and it keeps the sparks out of your hair).

#### You should look like this grinding







#### Assembling the pier

With all tools close by, you begin by checking the pier for square cuts on each end. This is done with a common carpenters square. Lay the long end alongside the pier and note how the short end intersects the top. It will likely be off a little. In this case it was off by inch and needed grinding. You only need the end going into the base square. The top of the pier will be adjustable so the scope mount can be made level so nothing will rest on that end. Notice the smile as the first step of the project begins. That's usually the last smile until the paint dries at the end. You level the tube base by grinding it with a 4" hand grinder (Lowes or anywhere for around \$70). See picture above on how to



dress for grinding. As a quick aside, the EMS t-shirt is worn by volunteers in case a first response is needed in our area. The pier project was interrupted several times by calls and still came in under 6 hours.

#### **Connecting the base**



First, make sure the base is square on the pier. Once the base is square, you are ready to begin. It is most important to remember one thing in welding. You are using a lot of heat to join two metal parts. This heat is localized in the area you are working and will cause the work to expand. The cooler areas are not subject to the heat and will not expand. This causes the material to warp. To minimize this you "tack" the pieces first. This is putting a small weld on one side, then the opposite site. Then come back and put another tack and move over to the opposite side and do a tack there. This secures the piece from warping as you do the long joining weld.

If you read your manual and watched the tape with the welder then you surely have welded a number of scrap pieces by now. If not, now's a good time to practice a bit. You can do this pier with very little experience but practice making welds awhile first. They are going to look bad, don't worry about it. You just want to make sure they penetrate enough to hold well. On the Lincoln, I use a power setting of "B" and a wire speed of 2. This is not much welding energy but works well on my welder. Yours may be calibrated differently so don't necessarily take my settings as what you should use. The tube is 1/8" thick and can burn through with too much heat.

I use small zigzag motion once the arc starts with more time on the thicker piece. Tack



down the main tube to the base plate in four places opposite each other. Center the tube in the base with the "U" facing up. Notice the metal bars placed beside the tube to center it in the channel.

Be sure and keep a fan running that blows the weld smoke away from your face. It's not poison but it's not something you want to breath for any length of time.

Next you will do a long weld around the base. Start as far back into the side as you can get (remove any spacing bars) and

circle around to the front. Change sides and repeat after doing about \_ the side. It helps cool the piece. Again, be careful and not use too much heat and burn through the thin tube. If you do, reduce heat and weld around the hole you made and "build up" the weld until the hole is filled in. Do not worry about how the



weld looks. You can't reach this area to grind anyway because of the sides of the channel. What you loose in awesome beauty you make up for in strength.

#### **Cross Plates**

The cross plates were initially for attaching additional bracing (see first photo of article). Once installed they added a tremendous strength benefit to the pier. They span the edges

of the U channel and are welded both top and bottom to the tube. This acts in a way similar to triangular braces often seen on piers but it also adds more reinforcing farther up the tube. To make them fit well into the channel (they were cut the same width as the channel) c-clamp them together and grind the bottom edge with the grinder. You want them to slip down into the channel about inch. This gives extra surface to weld the cross plate to the U channel. The inset shows the two cross plates being ground. You grind them together and they will have an identical fit on both sides of the tube. The plates are held in place with a small magnet (Lowes) until the welds are started. (Remember, tack the bottom, top and sides first then run complete beads and the piece will fit better.)





Here is the completed crosspiece welding. You will dress it all up later with the grinder.





Before I started welding the side plates on I "touched up" the welds around the base with the grinder. It was easier then.

Your welds will not look as good as professional welds because you are using "flux core" wire. When metal is welded the arc or flame needs to be protected. This is usually done by using "shielding gas". However, the wire used in these small welders has a shielding agent in it's core that protects the weld from contamination while it is being applied. The flux in the core will, however, make more splatter and residue. Welding with a gas shield would leave very little spatter and residue.

#### The cap plate

Next we move to the other end of the tube. We will make four adjustment brackets and create a way to level the cap plate when the mount or wedge is attached. We will also place the bolts for the wedge to attach to. The attachment method for the wedge we will make in the next article will be constructed. If you are making the pier for another mount or wedge, your plans will differ here. Customize the cap plate to your method of mounting.



The first thing we do is determine the center of the cap plate and how the cap will fit. Notice the smile has faded. This next part is the bad part of the project.

Four bolts will be welded to the bottom of the cap and secured to 4 brackets on the tube. They will be adjustable to level the cap plate and OTA assembly.



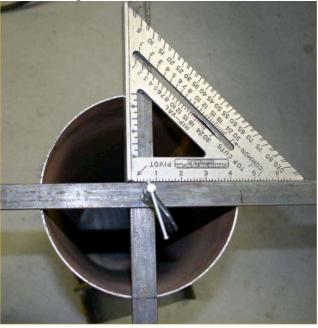
Take four pieces of 2 inch angle iron and drill a 5/8 inch hole in one side in the center. You will use

\_ inch bolts but want the hole large to accommodate any angulations as you adjust the base plate. To determine the exact area to place the brackets, make a "jig" from two pieces of bar with a cclamp at the center. Square up the jig with

your "roofers square" (that little triangular measuring device).

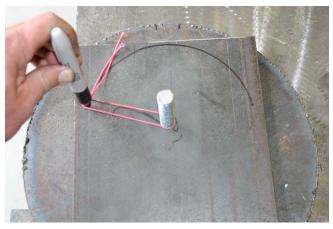
Tack these on each side and then weld them to the inside of the tube. If you weld them to the outside the flat surface of the bracket most likely will not mate with the round surface of the tube and the bracket will misalign.



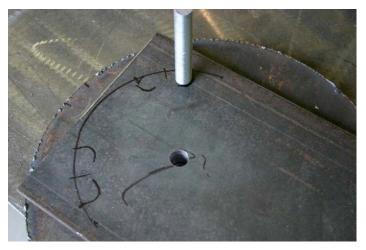


#### Wedge base plate

Now comes the fun. Before the pier can be completed, the base plate to the wedge needs to be started. The Cap Plate and Wedge Base Plate interact and therefore need to be fabricated at the same time. There will be four bolts coming out of the cap plate and going into the brackets above and 3 bolts coming out of the top of the cap plate and holding the wedge base plate. Two of the bolts will come up through large grooves



in the base plate to allow fine alignment of the wedge. First, drill a 5/8" hole in the



could be done with common tools so I did it with a drill and file. It took a little time but worked out ok. Use small drills making a number of holes and then drill with a larger drill bit.

You then will file down the rough edges to look like this. The slots do not have to be snug to the bolts. You will have large washers between the aircraft lock nuts and the slot to secure the left/right position. The "pivot bolt" (to the right of the two slots in the center) should be snug and just fit the hole. center about 1/3 the way from one end of the wedge base plate. Put a 5/8" bolt in the hole. Take a loop of string and draw an arc in from the edge of the base plate as shown. This will be the edge of the cutouts used for the wedge fine adjustment. Take a 5/8" bolt and use it to rough out an outline of the cutouts you will make. It would be much easier to take this to the welding shop once drawn out and have them cut the holes. However, I wanted to show this



#### Mount Base Plate to Cap fabrication

The mount base plate "rides on the Cap of the pier. The Cap has four bolts that adjust level and secure the cap to the pier tube. The four bolts go into the brackets welded above. The bolts can be a bit tedious to align. I recommend turning the pier tube and

base upside down on the base plate, insert the four bolts and tack them into place. Remember, tack on opposite sides or the bolts will warp out from heat expansion.

The bolts are actually aligned correctly but are distorted by the non-Nagler camera lens.





Carefully slip the tip of your wire welder under the edge of the flange and tack the bolts

in place. Then remove the pier and solidly weld the bolt heads to the cap. Have plenty of ventilation, the fumes from coated bolts will be potent. (Do not use galvanized bolts. The fumes can make you sick.) If the bolts look like this in reality, you can tap them into alignment with a soft hammer.



Notice in the picture there are three holes drilled near the center of the cap plate. These three holes will attach the bolts used to secure the mount base plate. I drill 5/8s inch

holes and insert 5/8s inch threaded rod. The threaded rod just fits the hole. I then put nuts on the threaded rod on the other side of the cap plate and adjust until the threaded rod is about 1/16 inch below the rear surface of the cap plate.

This permits welding the bolts to the cap plate securely without bolt heads protruding from the cap plate.



Place the tip of the wire welder at the edge of the hole and weld the bolt to the edge.



Zigzag back and forth across the hole until it is filled in. Then grind the surface flush.

This is how it will look from the top with the mount base plate installed. Note the cap base plate and supporting bracket both have a notch cut into them. This is done with the grinder and helps you quickly align the cap plate and pier tube in the extremely unlikely event the brackets are not absolutely perfectly welded to the pier tube.

#### Finishing

You are new ready to begin the finishing. First, sand the pier tube and all parts lightly with a hand sander. Just enough to remove the rust that will be part of all steel projects

using stored raw material. Wipe down the parts with paint thinner and a soft rag. You can finish the tube to any level you desire. I prefer to use the standard rust preventive spray paints found everywhere. Ace brand does a good job and doesn't cost much. Prime the tube first with the red or gray primer. Spray the inside of the tube as far down as you can get. This will help prevent the inevitable moisture from causing rust.



Next, duct tape all exposed bolts and place the pier and cap on a painting tarp. Apply an even coat of primer.





#### **Final coat**

Next apply the final coats. Use whatever color you like just make sure it is compatible with the primer.

When dry, assemble the top cap to the pier tube brackets. Screw a nut all the way to the top of the adjusting bolts. Place a large washer over the bracket holes on the pier and place the cap on the pier. Screw the securing nuts onto the bolts from the bottom along with another large washer and the pier is done.



You will drill the base holes in the bottom plate of the pier to match the mounting bolts of



your installation setup. When the pier is installed, I remove the cap and place a plastic bag down in the pier tube. I then fill the plastic bag with "play" sand. This gives about 80 bounds of additional dampening stability.

You now have a very solid pier. It took me about six hours with interruptions. I may have violated a number of construction, finishing and design rules here. But hey, the pier is solid, it works and cost under \$100 (way under). For purist wanting drafting documents, elevations and architectural

TO PI TIDE PLAT

drawings, please feel free to copy these. The bottom set of documents is the pier. The top set is the wedge to appear in another article. No charge.

# **Material List**

**Pier Tube** 8 inch x 1/8 inch steel tube. Length 33 inches or

according to your height requirements.

#### **Base Plate**

10 inch x \_ inch steel "U" channel. Length 18 inches

#### Cap Plate

12 inch x 3/8 inch steel circle. May be substituted with 8 inch x 16 inch x 3/8 inch steel plate if circle of steel not available.

#### **Tube Brackets**

4 - 1 \_ inch by 2 inch by \_ inch angle iron

#### **Tube/Base Side Plates**

2 - 5 inch x 5 inch x 3/8 inch steel plate

#### **Cap Leveling Bolts**

4 -\_ inch or 5/8 inch steel bolts with 4 standard nuts, 8 large washers and 4 aircraft style locking nuts.

#### **Mount Base Plate Bolts**

3-2 inch x 5/8 inch cuts of threaded rod or equivalent bolts.