PORTABLE BACKHOE

CONSTRUCTION AND ASSEMBLY MANUAL

The Portable Backhoe

WARNING

THE AUTHOR OF THIS MANUAL IS NOT A PROFESSIONAL ENGINEER. THIS MANUAL REPRESENTS A BACKHOE DESIGN THAT HAS BEEN CONSTRUCTED BY THE AUTHOR AND HAS GIVEN THE AUTHOR SATISFACTORY SERVICE.

THE TOOLS AND METHODS USED IN CONSTRUCTION AND ASSEMBLY OF THIS BACKHOE ARE NOT WITHOUT POTENTIAL DANGERS.

BE SURE TO KNOW HOW YOUR TOOLS WORK AND UTILIZE ANY NECESSARY SAFETY DEVICES.

DO NOT ALTER ANY MATERIALS OR DIMENSIONS GIVEN UNLESS THE PLANS SPECIFICALLY STATE THAT SUBSTITUTION IS ACCEPTABLE.

IT IS YOUR RESPONSIBILITY TO SEE THAT PROPER MATERIALS ARE USED, PROPER CONSTRUCTION TECHNIQUES ARE USED AND THAT THE MACHINE IS OPERATED WITHIN ITS MEANS.

BE SAFE AND ENJOY.

Revised June, 2004.

The Portable Backhoe

The Portable backhoe is a small freestanding, fully functional backhoe. It is designed for light duty digging of trenches and holes and light duty uprooting of small shrubs and trees. It would be a valuable asset to any landscapes plumber, electrician or homeowner.

While quite powerful for it's size, please do not attempt to push this machine beyond its intended capacity. If you feel the machine tipping or lifting, reverse the handles and rethink your actions. Your safety is the first concern. A rip-cord style kill switch might be a useful addition.

I have spent countless hours pouring over these materials. I have tried to include all necessary information. I have even consulted an unbiased party to measure and compare bis findings to my plans. If you find that you are having difficulty interpreting a step or you feel something is missing, please send an email to vfp@vintagefarmplans.com.

Inside, you will find short hints on many areas where money can be saved. You will also find areas where no substituting is highly stressed. This is for your safety. Substituting or make-do is encouraged to save money as long as safety is not compromised. The one area I cannot help you in is the hydraulics. Unless you have access to a hydraulic "bone yard", the hydraulics will account for more than half of the project costs. You may find, though, that careful digging in junkyards and even your own back yard may save you hundreds on the rest of the items.

When reviewing the steel requirements on the materials list, please note that the steel is given in bulk stock dimension. Individual pieces will be cut from the stock as specified in each construction step. The bulk lengths account for material wasted in cuts. Pay close attention to the 3" x 3" x'/»" square tube. It would be advised to mark out all lengths prior to cutting to ensure that all necessary lengths will be provided.

Before you start, I would like to stress safety one more time. Please use the proper tools and then-appropriate safety equipment If you have an area that you are not comfortable with, please get help.

Hydraulic Materials List

Ouantitv	Product	Item Number	Supplier
4	3" bore x 16" stroke, tie-rod cylinders, double acting	9-5569-S	SC
or	alternate brand	9-4302-16-S	SC
1	Barnes 6 GPM hydraulic gear pump	10566	NT
1	Briggs/Stratton 8 HP horizontal motor	2102573	TSC
1	pump to motor bracket	1-1580	SC
2	keyed pump to motor couplings	1-2019	SC
1	flexible insert for couplings	1-2052	SC
1	5 gallon hydraulic tank	9-1510	SC
1	3/4" NPT in/out return line filter	9-077	SC
1	Gresen 4 spool valve block, double acting	9-2108	SC
00	SAE8 to 1/2" NPT right angle fitting	9-1944	SC
00	NPT 1/2" to NPT 1/2" right angle fitting	9-1039	SC
4	SAE12 to 3/4" NPT swivel fitting	9-4597	SC
1	3" long 3/4" male/male pipe coupling	NA	Hardware
1	1-1/2" NPT to 3/4" NPT reducing bushing	NA	Hardware
1	24" hose with 3/4" NPT male ends	9-078-24	SC
1	96" hose with 3/4" NPT male ends	9-078-96	SC
1	60" hose with 1/2" NPT male ends	9-078-60	SC
2	60" hoses with 1/2" NPT male ends	905-1260	SC
2	48" hoses with 1/2" NPT male ends	905-1248	SC
1	96" hose with 1/2" NPT male ends	905-1296	SC
1	108" hose with 1/2" NPT male ends	905-12108	SC
	180" hoses with $^{1}/_{2}$" NPT male ends	905-12180	SC

SOSurplus Center (www.surpluscenter.com) NT=Northern Tool (www.northerntool.com)
TSC=Tractor Supply Co. (www.tractorsupplyco.com) Hardware=local hardware or Lowes

Bulk Steel Materials List

Ouantitv	Bulk Dimensions	Use
30' (feet)	3" x 3" x 1/4" square tube main	structural frame members
32" (inches)	2" x 2" x 3/16" square tube	valve pedestal/bucket brace
92"	3" wide x 1/2" thick plate (flat bar)	links/cylinder ears
1	12" x 12" x 1/4" plate	motor mount
1	12" to 18" high seat pedestal	mount seat and swivel
68"	1" x 1" x 3/16" angle iron	front receiver brace/platform
4	3" x 3" x 4" triangles of 1/4" thick plate	brace rear receiver
60"	1" OD cold rolled steel rod	pins
36*	1" ID mechanical tubing	form pin holes
37"	2" wide x 1/8" thick plate	bucket reinforcement
18"	2" x 2" x 3/16" angle iron	valve pedestal
26"	3" x 3" x 1/4" angle iron	bucket link to dipper
62"	2" wide x 3/8" thick plate	links to bucket/ripper teeth
1	26" x 36" sheet of 1/8" sheet metal	form bucket shell
124"	2-1/2" OD schedule 80 pipe or 2-1/2"x2-1/2""x3/16"sauaretube	outriggers/tires
14"	4" x 4" x1/4"angle iron	outrigger feet
1	8" x 30" piece of 3/8" plate	form boom swivel

Misc.

6	1/2" OD x 6" hitch pins	lock outriggers and tires
16	3" cotter pins	lock pins to boom etc.
1	seat	sit on
1	swivel	you know
1	7/8" weld on hitch	towing
2	tires/rims/hubs	locomotion
l pack	wide and long zip ties	secure hoses
6 or more	grease fittings	grease swivel joints
1 quart	oil based primer	prime
1 quart	oil based color	protection and looks
10 gallons	hvdraulic oil	machine function

A Few Notes

PINS AND FITTINGS: The pin-holes throughout the backhoe are 1" diameter and will be fitted with a 1" solid round rod cut to length. The mechanical tubing will act as support for the pins and offer a place to lock the pin into a fixed position. A small hole is drilled through the mechanical tubing and the pin where a cotter pin can be inserted to hold the pin into place. Do not lock an area that needs to swivel. A grease fitting is inserted into the longer sections where the pin will rotate inside the mechanical tubing. Keep it greased well.

CYLINDERS: Four 16" stroke cylinders are used to articulate the backhoe. Any variation in length will cause a variation in movement You may use any 16" stroke cylinders from 2" bore to 3" bore. If you use welded cylinders, you will have to modify the cylinder ears.

VALVES: The 4 spool valve block is one of the most expensive individual components. Feel free to find a cheaper one as long as it is rated for at least 6 GPM, is for double acting cylinders, has open center flow and has spring return to center handles. Be advised that the SAE 8 to 1/2" NPT and SAE 12 to 3/4" NPT fittings are for the specified valve block. If you buy a different valve be prepared to buy different fittings.

PUMP: The pump of choice is a hydraulic gear pump with at least 6 GPM flow rating. The name brand is not significant I chose the Barnes because it has the 4-bolt mount and will couple directly to a pump to motor bracket. If you choose a 2-bolt mount or a vertical shaft motor, you will have to create a bracket or use a pulley to pulley drive.

TANK: The tank should almost match the pump flow rating. The closest I found was a 5 gallon tank. The next size up is 10 gallons and is really too much storage. Keeping the tank and pump close helps keep the hydraulic fluid temp down, which prolongs the life of your system.

HYDRAULIC FILTER: The fluid is filtered on the return side of the valve. This side is low pressure and creates less headaches. Suction strainers from the tank to pump can clog and rob the pump of fluid. This will cause premature failure of the pump. Remember to use clean technique when pouring hydraulic fluid

HOSES: I have included all the necessary hoses and fittings to match to other system components. The hoses are longer to provide loop areas where the backhoe articulates. Be sure to secure the hoses to the frame at various points. I recommend using the zip ties to secure the hoses first. When first using the backhoe, look for any areas that the hose might rub. Correct these immediately to prevent bursting a hose. You may choose to go back and secure hoses with a half round pipe clamp at a later point

COUNTER WEIGHTING: Once constructed the backhoe is in an approximate neutral balance. This means the weight forward of the outriggers is almost equal to the weight rearwards of the outriggers. If you find the backhoe to constantly tip up in the rear you have two choices. You may anchor the rear to a truck/tractor/lawnmower or you may fill the main frame member with lead or iron scraps to add weight.

STEEL: Please do not substitute any thinner material for the links. Articulation joints are the weak areas on any backhoe. You may use 3/16" square tube for the frame, but no thinner. You may feel free to use alternates for the seat pedestal, valve pedestal tank mount or motor mount

DRILLING HOLES: If you do not have a drill press you will have to ensure that the 1" holes are drilled straight through the pieces. On the square tubing I recommend marking and punching the center point on both sides of the tube. Drill through one side, flip the piece over and drill through the other side.

CYLINDER EARS: Remember I said that cylinder ears would have to be modified if you used welded cylinders? The way to do this is to skip the step that requires you to weld to 1/2" thick plates together. Instead, clamp the two plates together, mark and drill the 1" holes so that the holes will be in the same location on each piece. Now the two pieces are welded apart from each other at a distance that your welded cylinders cross tube end will fit between. Most tie-rod cylinders come with 1" pins that are designed to pin the cylinder to a single ear as used in my version of this backhoe. If you use welded cylinders, you will have to cut 1" rods to length for pins and that will increase your bulk stock requirements.

BUCKET: The bucket shell is formed from 1/8" thick sheet metal. You may cut out the pieces as shown in the construction guide so that it can be bent to shape. Here you will have a few seams to weld. You may also do as I did and cut out each individual piece and weld all the seams together. I used sections of angle iron from an old bed frame to clamp the pieces in position before welding. If you accidentally weld the angle iron to the bucket, oh well. It will just add more reinforcement.

MOTOR: The smallest motor recommended is a 8 HP. Anything larger is great You may salvage any vertical shaft motor to save money but it probably will not bolt to the pump bracket and you will have to fabricate a mounting bracket to direct couple or you may even have to use a pulley to pulley set up. If you are going to make your own pump mounts then delete the pump to motor bracket from the materials list. If you are going to use a pulley-to-pulley set up, then delete the pump to motor couplings, flexible insert and pump to motor bracket from the materials list

WELDING: This is probably the most critical area in the entire construction. I recommend using an arc welder and 6011 sticks. Whatever you use, it must have good penetration to form a strong bond Be sure to clean all surfaces of rust, paint and oil before welding. I can tell you from experience, if you do not make every weld sound, the machine will show you your error. The forces generated by this backhoe can and will bust weak welds.

BUSHINGS: The ideal bushing is mechanical tubing 1" ID x 1.5" OD. You will find that this is an expensive piece of metal. My local dealer priced a 5' section at $150! While this is the best and recommended metal for bushings, there is an alternative. Check out Baum Bearing for better prices.

PRIMING: The cylinders will need to be primed before final use. This is similar to bleeding the brakes on your car. Have someone operate the valve handles one at a time while you loosen the fitting at the cylinder. You will find that initially bubbly fluid comes out. Within a second or two a steady stream of hydraulic fluid will come out. Now you quickly tighten up the fitting. Do this for each port on each cylinder. Keep an eye on the fluid in the tank. You will lose some fluid while priming and you need to make sure the fluid level in the tank doesn't drop. If it gets to low, air will be sucked into the system and this will defeat your priming efforts.

Constructing the Backhoe

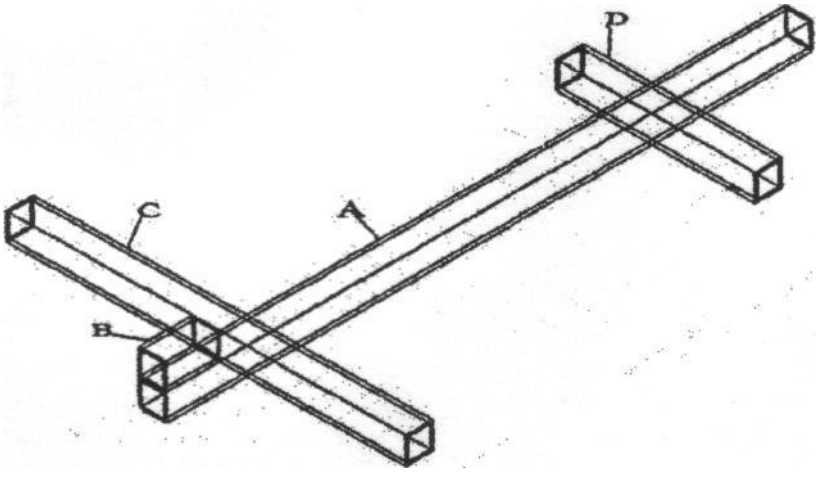
The following pages are designed to aid you in the actual construction of the backhoe. You will find that some pictures do not have labeled dimensions. The dimensions are included in the text and 2D dimensioned views can be referenced in the index section. Read through the entire book at least once before starting. It helps to know the steps ahead and the final outcome before you start constructioa

Begin by cutting the following from 3" x 3" x 1/4" square tube.
A-72"long
B-6"long
C-44" long
D-22" long

Refer to diagram and weld the B to the top of A ensuring that the ends are flush. From this point out, this end will be the front and the opposite end will be the back or rear. Also, part C will be called the front receiver and part D will be called the rear receiver. Do not weld the seam where C will lay, as it will interfere with correct alignment of C.

Weld C in place so that it is butted up to B, lays at a right angle to A and B, and the center of 22" is laying on the center of A.

Weld D in place so that it is on the underside of A, at a right angle to A and the rear edge is 12" from the rear of the frame.

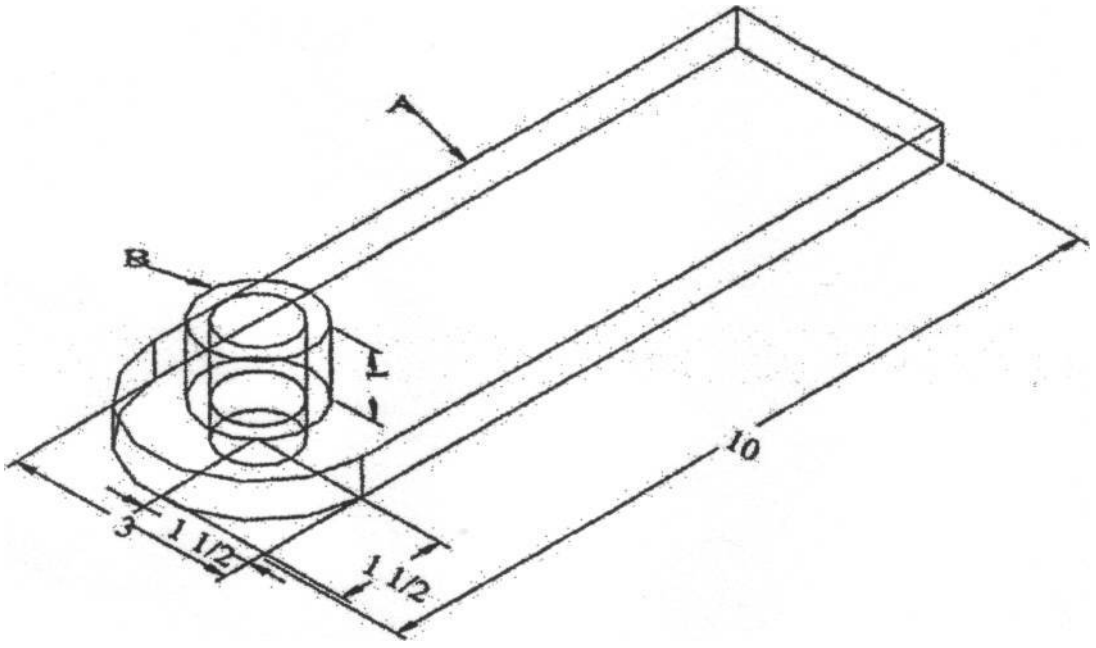


Cut the following:

2 sections of 3" x 10" x 1/2" plate
2 pieces of 1" ID mechanical tubing, 1" long

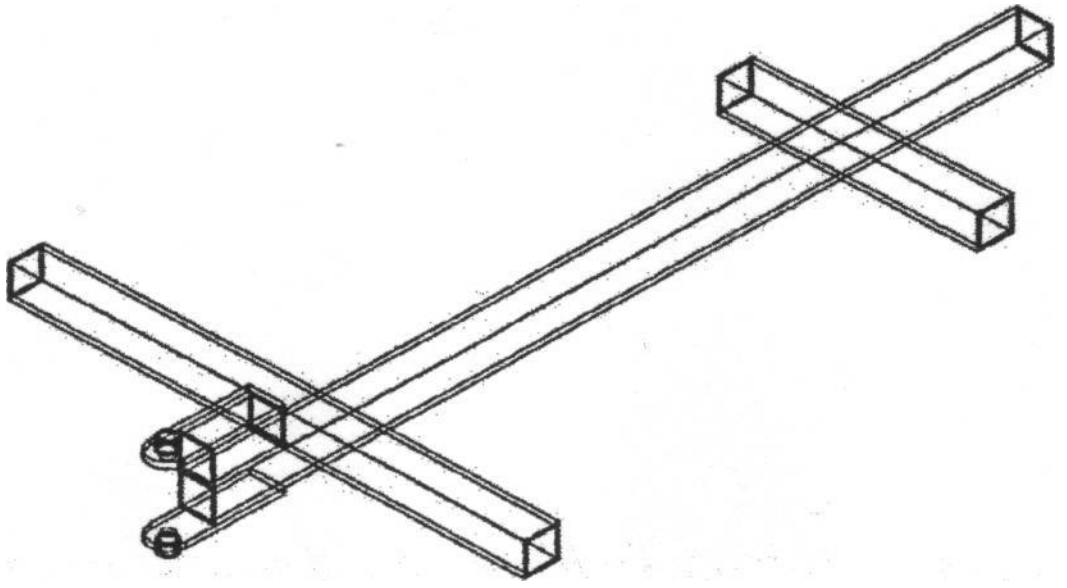
On each 10" long section of 1/2" plate pick any end and punch a center point that is 1-1/2" from the end and 1-1/2" from the side (center of the plate). Using this point, scribe an arc across the end with a compass that has a radius of 1-1/2". This is your cut line to round the end off. You may cut with a torch or cut off section with a saw and grind to the final line.
Using the same center point, drill a 1" diameter hole through each plate.
Note: This process will be repeated many times during the construction.

Lay one plate flat and insert a 2" or 3" section of 1" rod into the hole. Slide one piece of 1" long mechanical tubing over the rod and push it down flush with the plate. Weld tubing in place. Repeat for the other plate.



The plates are welded to the front of the frame. Weld the top one on first so that the rear of the plate is flush with the rear of the short piece of square tubing and the plate's mechanical tubing is pointing upward. *See next diagram.*

Clamp the bottom plate in rough position so that it is 6" back from the front edge and the mechanical tubing is pointing downward. Insert an 8" or longer piece of 1" solid rod through both plates mechanical tubing. Use a square to make sure the rod is at right angles to the plates and it is sitting on the center vertical line of the square tubing. Weld the bottom plate in place.



Cut the following:

A-2 pieces of 2" x 2" x 3/16" angle iron, 9" long

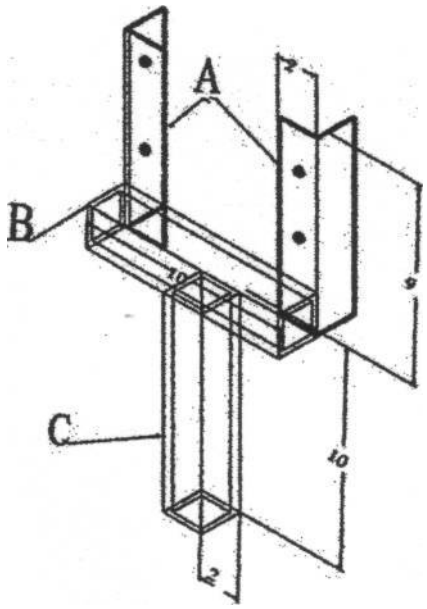
B & C-2 pieces of 2" x 2" x 3/16" square tubing, 10" long

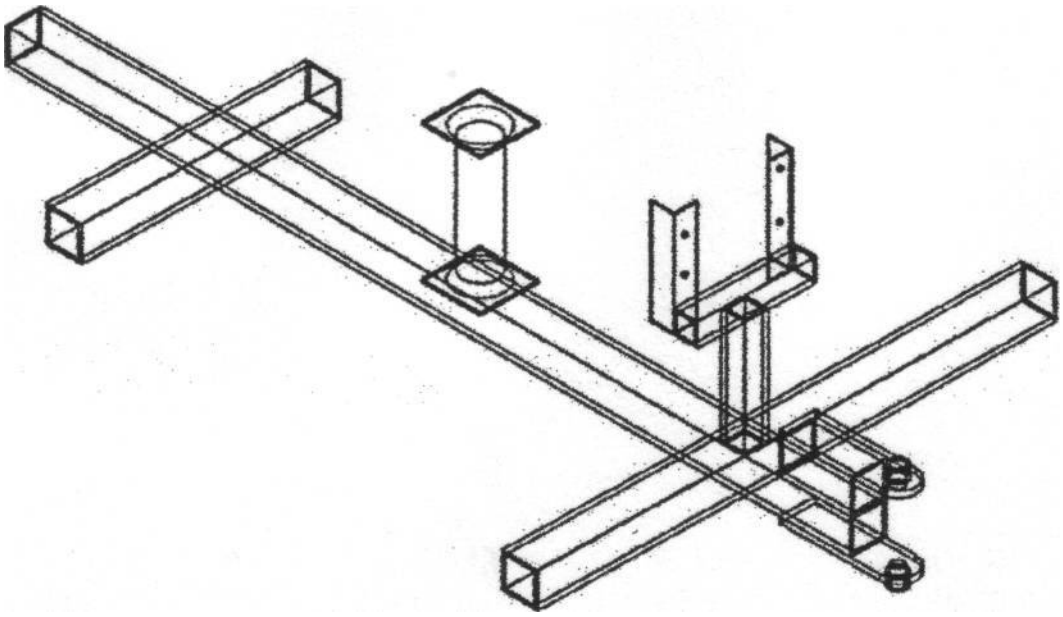
Weld B and C together so that they form a T-shape and the center 5" mark of B sits on the center 1" mark of C.

Weld pieces A onto the outer ends of B. Keep them at right angles to B.
This is designed for the valves to rest on B and holes matching your valve block will be drilled through pieces A to fit. If you purchase valves that the body is designed to lay horizontal, you will need to reposition pieces A.

The entire assembly is welded onto the frame behind the front cross section. It is butted up tightly to the cross section and sitting center-line to center-line on the frame.

Note: The seat pedestal shown is a 12" high pedestal purchased at Walmart. This is designed for use in boats and readily takes a swivel and seat It is welded at approximately 24 "from the valve pedestal previously mentioned You may position it closer if your legs are shorter but I would not push it farther back as it will interfere with the tank and motor mounting.


A
B
C
10
10
2
2
9

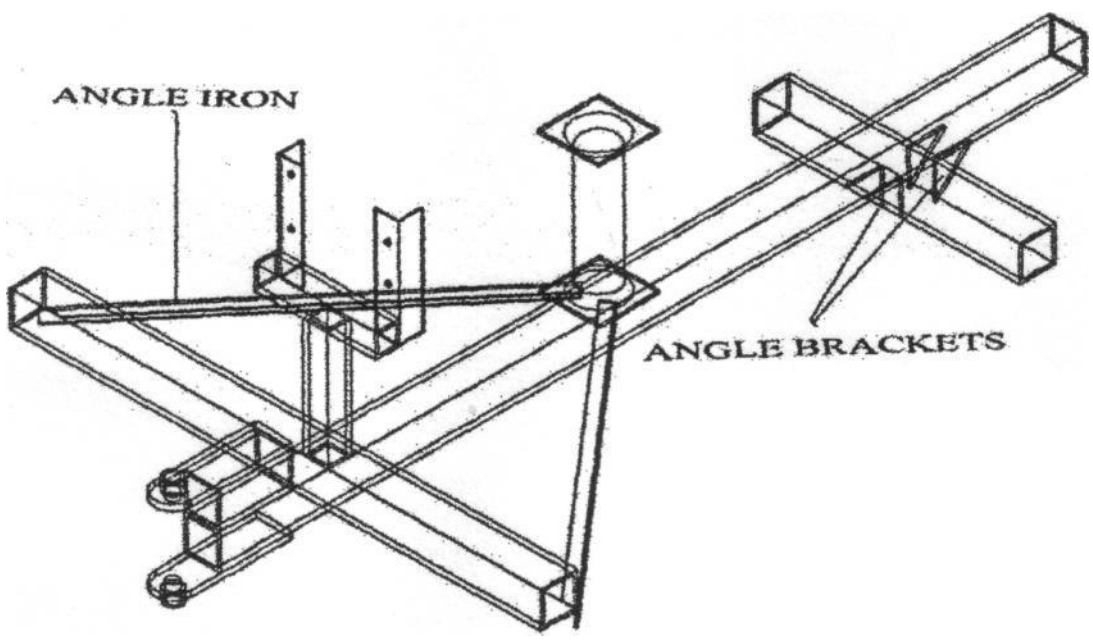


Cut the following:

2 pieces of 1" x 1" x 3/16" angle iron, 34" long
4 triangles from 1/4" plate with 3" x 3" x 4" sides

The angle iron is welded from the outer ends of the front cross section to the main frame member at an angle. The exact placement is not critical as long as the pieces are level and flush to the top of the main frame member. You may point the angle iron up or down. This triangular area created will hold a piece of 3/4" PT plywood for foot support. Which will be cut and attached after the swivel cylinder is mounted to the frame.

The triangles are welded to the underside of the main frame member and the rear cross section to add support and prevent twisting. Weld two on each side, where each piece is at the outer edge of the main frame member.



Cut the following:

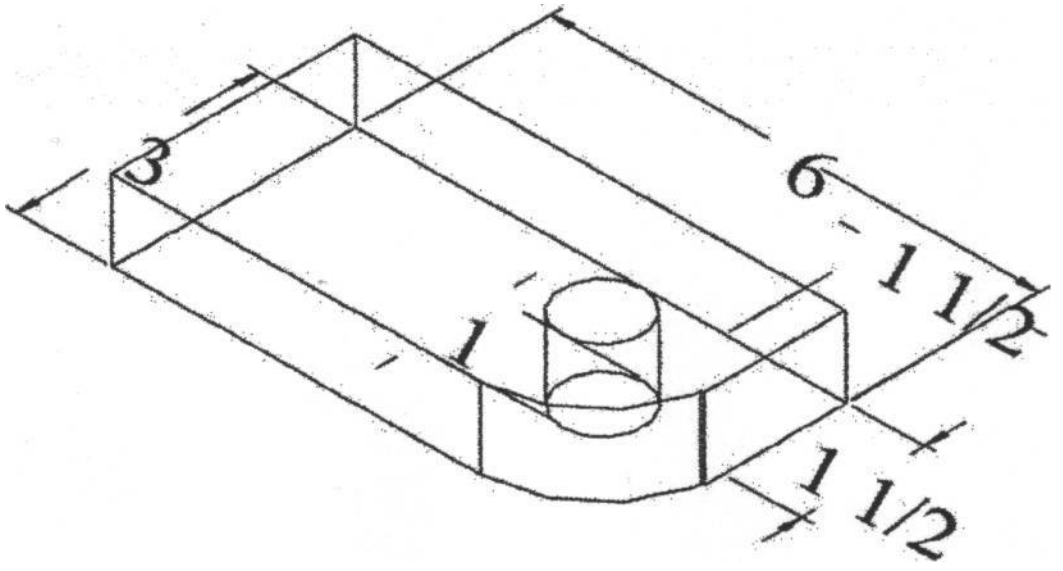
Two 3" x 6" x 1/2" plate

The plates are welded together to form a 1" thick piece.

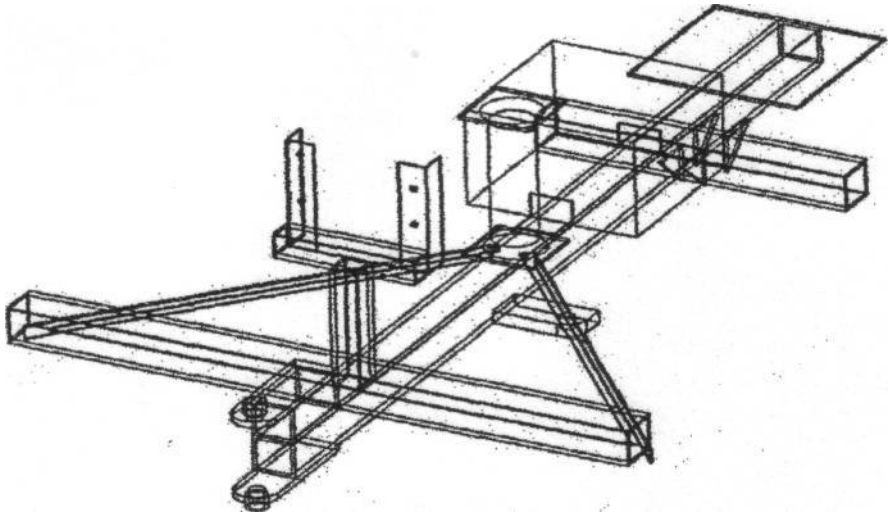
Punch a center point that is 1-1/2" back from one end and on the center 1-1/2" line. Use a compass to scribe a 1-1/2" arc using the center point. Round off one corner only.

Drill 1" hole through the center point.

This will hold the swivel cylinder and is welded in position so that the front edge is26-1/2"back from the front, the rounded corner faces the front and the plate is on the side in a horizontal position.



Note: The picture below also reflects the hydraulic tank and motor mount to be discussed later.



Cut the following:

A-2 sections of 2-1/2" OD Schedule 80 pipe, 22" long
B-2 sections of 3" x 3" x 1/4" square tube, 30" long
C-2 sections of 4" x 4" x 1/4"" angle iron, 7" long

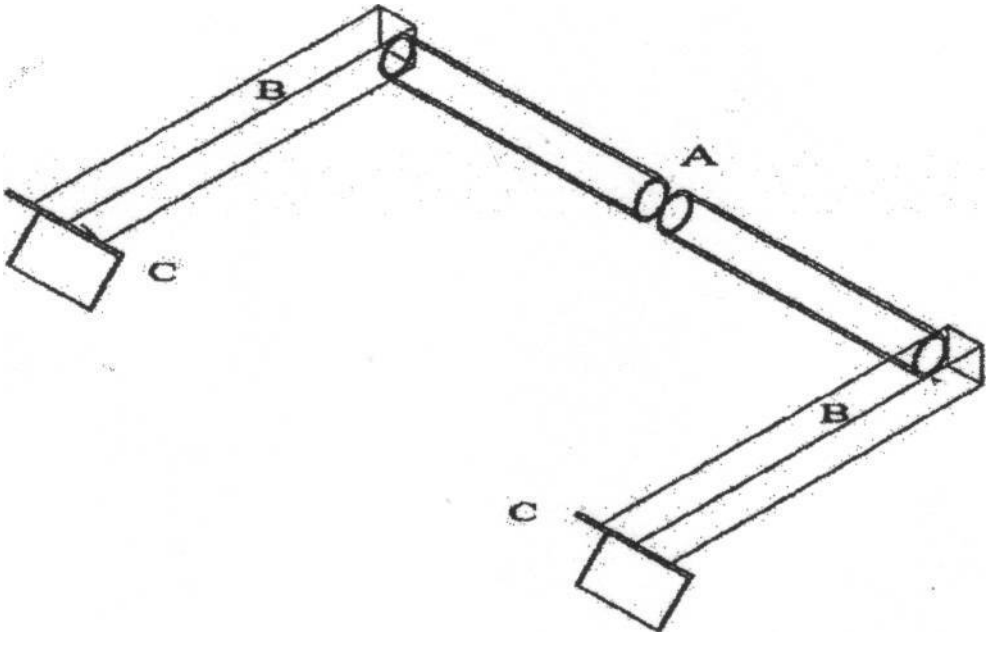
Note: You are creating the outrigger arms. They must be made as mirror images of each other.

At the end of B, where C is shown attaching, cut an angle back that is 60 degrees. Do this for both pieces.

Weld the 2-1/2" OD pipe in place, so that it is flush with the top edge and approximately centered

Weld the angle iron in place, centering it on the square tubing. You want the protruding part to be at the bottom as showa

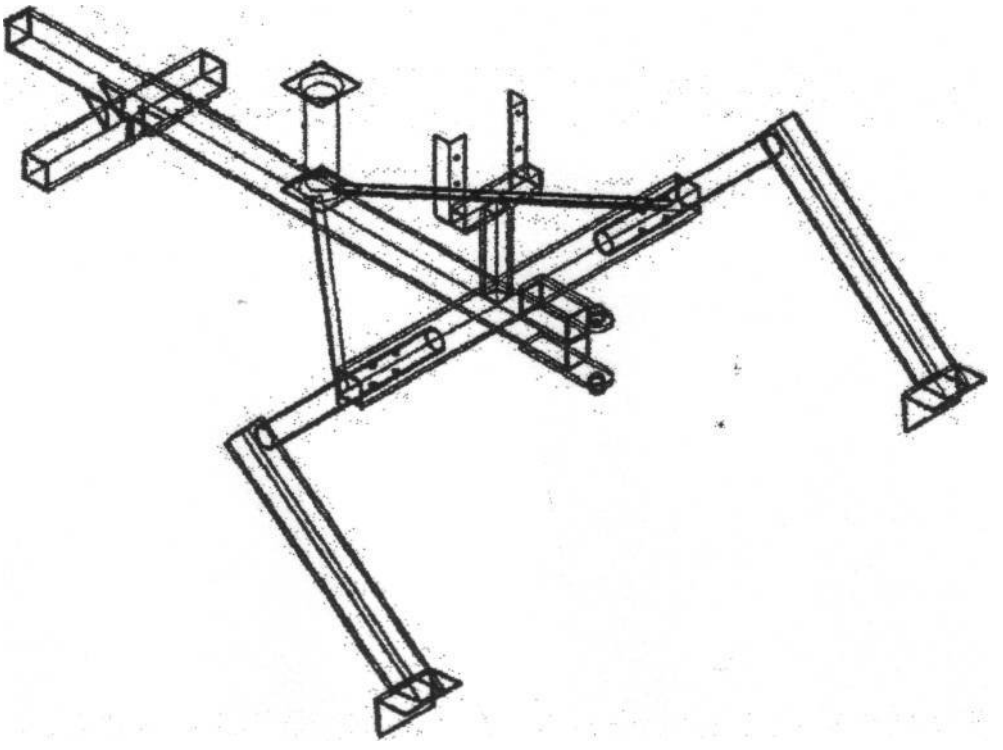
Make the other side as a MIRROR IMAGE.



Insert the arms into the front receiver ends so that 11" of the tube is inside the receiver and 11" of the tube is outside. Support the frame on each end so that it is plumb and level. Adjust the height until the outriggers are positioned forward at an approximate 60 degree angle from the frame.

Drill two 1/2" holes from the top, on each side, so that they fall on the center line of the cross section and are placed at 3" and 6" from the outer ends of the cross section. These holes are to go through the cross section and the tubing all at once. You will use two 1/2"x 6" pins on each side to lock the outriggers into working position.

Note: You may substitute 2-1/2 " x 2-1/2 " square tubing for the 2-1/2" OD pipe. Just remember that now the pieces will have to be welded together at the 60 degrees angle and cannot be adjusted

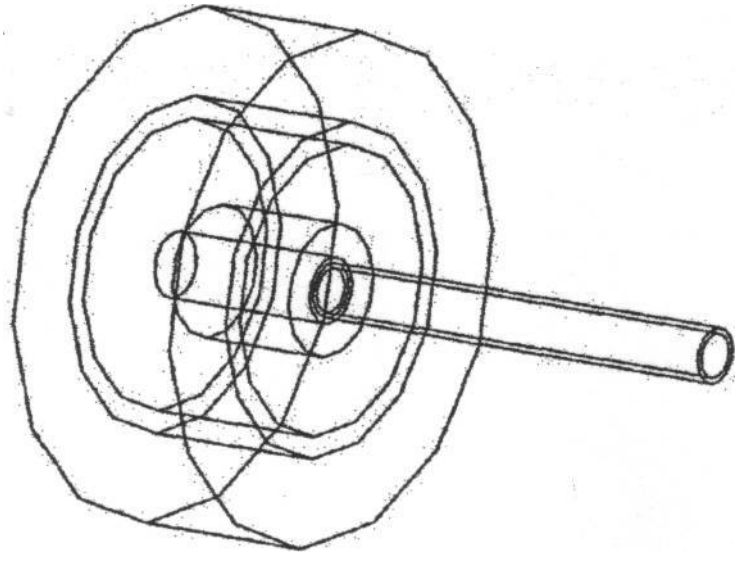


Cut the following:

2 pieces of 2-1/2" OD schedule 80 pipe, 22" long OR
2 pieces of 2-1/2" x 2-1/2" x 1/4" square tube, 22" long

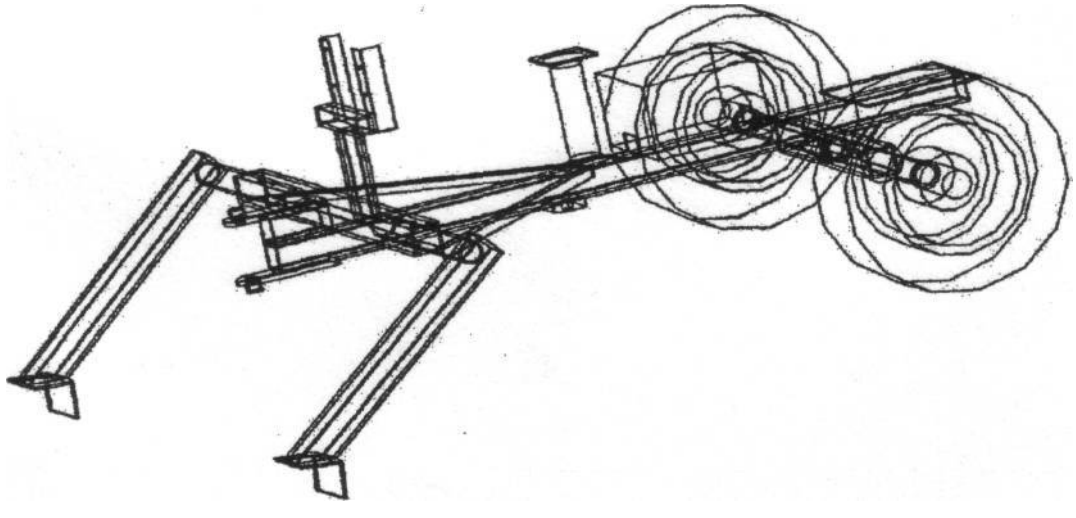
Here is one area where I cannot walk you through step-by-step.
You need 14" or 15" rims with associated tires and hubs. What you want is to weld the pipe OR square tube to the rear of a wheel hub. You want this to be centered so that the backhoe will run smoothly when being towed behind your vehicle. Look around the junkyard and you may find this with a 2 *W* pipe already attached.

See picture on next page.



To finish, insert the pipe OR square tube 11" into each end of the rear cross receiver and drill a 1/2" hole completely through the receiver and pipe OR square tube at a centerline point that is 3" back from each end. Insert a 1/2 x 6" hitch-pin to lock tires into place.

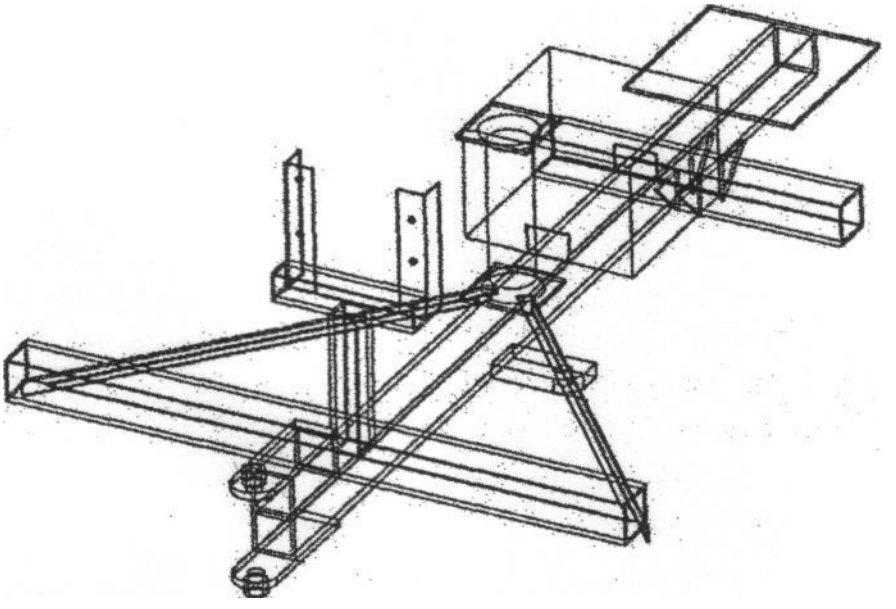
N o t e : You can always consider using a small trailer to transport the backhoe. This will save money by not having to register the backhoe as a trailer and provide lights and tag.



The final step to complete the frame is to weld on the tank and motor mount

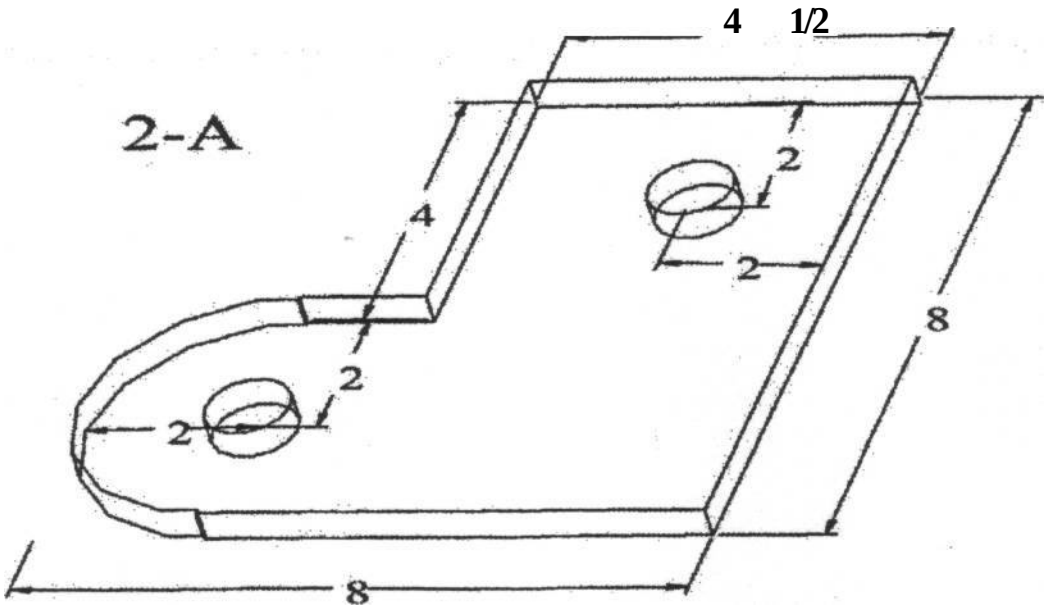
The motor mount, a 12" x 12" x 1/4" plate, is welded on to the rear of the frame and is flush with the rear edge.

The tank is mounted as close to the seat pedestal as possible to give room for the pump and hoses to run. Your tank will have
a large 1-1/2" opening on one side and a smaller 3/4" opening on another side. The smaller opening is the return flow and this is where you will mount a return flow filter. Keep that in mind and do not weld that hole to close to another object and do not place in so that it is over the top of the main frame member.

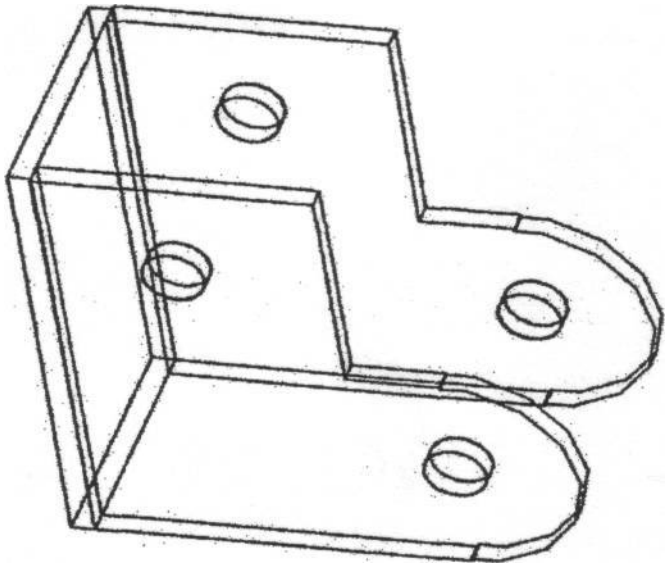


If you are going to tow this backhoe, weld a weld-on 7/8" trailer hitch onto a 36" length of 2-1/2" OD pipe or 2-1/2" x 2-1/2" x 3/16" square tube and insert 12" into the rear of the frame. Drill a 1/2" hole through the frame and pipe or square tube. Insert a 1/2" x 6" pin to lock it into place.

On to the Boom Swivel:
Cut two of the following from 3/8" plate. Clamp the two pieces together so that all edges are flush and drill the 1" holes through both pieces as shown.



The two pieces are welded to a piece of 3/8" plate that is 8" x 4-1/2". Keep the two pieces parallel to each other. It may help to use two sections of 1" rod (you will need two, 6-1/2" long for this later) placed through both holes to keep them parallel.



It should look like this.

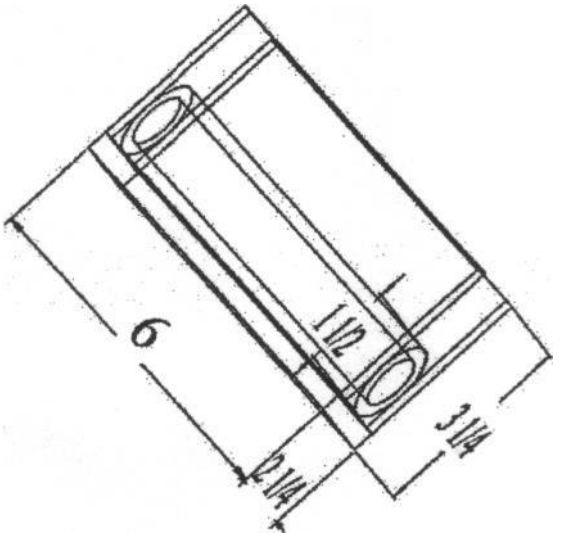
Cut the following:

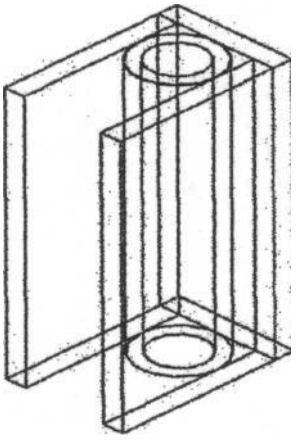
1 piece of 1" ID mechanical tubing 6" long
2 pieces of 3/8" plate, 3-1/4" *x* 6"
1 piece of 3/8" plate, 2-1/4" *x* 6"

Look at the following diagrams.

A box is made with the two 3-1/4" x 6" plates and the 21/2" x 6" plate and the mechanical tubing is sandwiched between the two sides and buts up to the back plate.

What is not shown is the grease fitting. On the back of the 21-1/4" *x* 6" plate, drill a hole through the plate and the mechanical tubing and tap the hole for a long thread grease fitting. The exact size of the hole is determined by the grease fitting you purchase.





This view should help clarify the assembly.

The assembly with the mechanical tubing is now welded to the back of the prior assembly as shown. It is centered on the back and the bottom edges are flush.