

BEN Namibia Bicycle Ambulance
Fabrication Instructions
September 7, 2007

Introduction:

This design is based on bent steel tube frame technology. Most tolerances are low, 2 mm or so, but a few are .5mm. The dropouts, dropout placement, and hitch must have the most accuracy, including matching the stretcher width, fender spacing, and handle spacing to have 2mm clearance.

Bending: all bends are done from the center of the tube, and specified for a Hossfeld-style bender that has a 1" round tube die set with a nominal bending radius of 3". In actual use, this is 81mm radius, and takes 127mm of tube for a 90 degree bend. All bends are 90 degrees. To follow the diagrams, Cut the tube to the overall length, mark the center, then mark the "First Bend Distance" on each side of the center line. In the case of the outside frame, where there is a second set of bends, it's still measured from the center line.



See the Bicycle Ambulance Fabrication Video Manual to augment this fabrication manual.

Trailer Frame:

1. For all frame tubes use 25.4mm X 1.6mm mild steel round tubing. Cut the "Outside Frame" tube to 2818mm and mark the center at 1406mm. Measuring from the center, mark the bend lines on each side at 356mm and 1193mm. There will be progressive bends from the center, in each direction, to minimize fluctuation in bending.
2. Bend the "Outside Frame", bending away from each mark (towards the end of the tube). Place the part on a flat surface and manually adjust angles and accuracy to one plane. All bends for the ambulance are right angle bends.
3. Bend the "Inside Frame" in the same manner, first cutting the tube at 3188mm and marking the center at 1594mm, then marking the bends from the center in each direction at 205mm. Bend from the center out for each side, and adjust the part to make sure it's in one plane and with right angle bends.
4. Measure the "Inside Frame" from center to center, just past the bends, and add 25mm to get the outside dimension. This should be 572mm on center, and 597mm outside.
5. Cut off the ends of the "Outside Frame" tube, so that when mitered they will fit against the "Inside Frame." Practice mitering with a hacksaw or half round file so that you use 6 mm of material (A full miter would use 12.7mm—the radius of the tube. Thus, use the Outside dimension of the "Inside Frame" (597mm) as the distance of the gap that should exist between the ends of the Outside Frame, BEFORE mitering. After mitering, the gap should be 12mm wider at the widest point of the miter.)
6. Tack weld the "Inside Frame" and "Outside Frame" together for now.
7. Bend the "Handle", as you bent the "Inside Frame", again finding the center, then bending each side way from the center.
8. Prepare a handle welding jig to hold the center of the handle at 530mm above the ground. Once you add the radius of a 26" wheel, with the dropout, the handle will rest at 815mm above the ground, a good hitch height for most bicycles. Lay the trailer frame on the ground, with the handle in the welding jig and in place on the frame, just back from the bend on the "Inside Frame". Mark the angle on the handle, then cut and miter the handle to fit the frame. Tack weld (securely) in place. Ensure that the stretcher fits through the gap made by the handle before finishing the weld.
<<<<There is a fixture for this step>>>>
9. Cut the "Pulling Tube" to 300mm, miter one end, and weld it onto the handle, parallel with the trailer frame, and in the center of the handle.
10. Prepare dropouts by cutting a 10mm wide slot, 15mm deep, in 30 X 30 X 3mm angle iron. <<<<There is a fixture for this step>>>>



11. Make a dropout jig with a 1 meter length of M10 threaded rod and 8 nuts. Use the jig to hold the dropouts in place, with each pair centered on the wheel wells on the underside of the trailer, and 100.5 mm apart (standard hub spacing is 100mm for a front hub, for the 26" mountain bike wheels that you'll use.) <<<<There is a fixture for this step>>>>
12. Weld on the dropouts, using a 40mm long piece of 10mm rod to reinforce each on the inside of the wheel well. The wheel well is so wide to accommodate double-wide tyres for sandy conditions. <<<<There is a fixture for this step>>>>
13. Finish welding the trailer frame together.

Stretcher Frame and Canopy:

1. Bend the two "Stretcher Frame" parts in the same manner, first cutting the tube at 2516mm and marking the center at 1258mm, then marking the bends from the center in each direction at 175mm. Cut two 21.4mm tubes to 1200mm, and sleeve them on center inside the stretcher frames. Weld together.
2. Cut the "Feet" and weld them onto stretcher frame rails, 150mm on center with the head and foot ends of the stretcher frame. <<<<There is a fixture for this step>>>>
3. Cut the Outside Pivot tubes, Backrest rails, and Backrest end piece. Miter the Backrest rails to fit onto the Outside Pivot Tubes and the Backrest End tube. Weld them all together in place to ensure good geometry. <<<<There is a fixture for this step>>>>
4. Inside Pivot Tubes: Miter ends of a 21.4mm tube, then cut off the ends to be 35mm long. Using the Outside pivot tubes on the backrest as a jig, weld these to the stretcher, concentrically (accuracy very important here), 900mm back from one end of the stretcher, which will become the Head End.
5. Bend, cut, and miter, the "Stretcher Stiffener Tube". Weld it to bottom of the stretcher, just to the foot end of the pivot tubes by 30mm. <<<<There is a fixture for this step>>>>
6. Weld the 5mm chain to the foot end of the left stretcher rail (looking from the head end), and to the matching Backrest rail, keeping it just tight when the backrest is fully down. Slide a length of bicycle tube around the chain before welding to protect the stretcher and patient. Weld the half-link of 8mm chain as a hook to the side of the middle of the last link of chain, on the backrest rail. Make sure the 5th link from the end can hook over this half-link to hold the backrest up.
7. Create two ends for the canopy frame by bending a 800mm long length of 12mm X 1.6mm square at 200mm from the center, on each side. The ends of this part should be narrow enough to fit between the fenders (approx 550mm). Repeat. Cut two lengths of the same material, 1300mm long. Weld nuts onto the ends of on of the bent canopy parts, and weld the ends of the other part into bicycle stems, cut off just past the joint. <<<<There is a template for this step>>>>
8. Cut and sew fabric for the canopy. Sew in webbing in four places on each end—the corners, and 200mm in from the end, on both sides. Attach this after the ambulance frame is completed and painted.

Stretcher fabric:

1. Cut the stretcher material to 2000mm by 500mm
2. Hem the edges folded over 50mm.
3. Mark one end "Head". measure and mark the following lengths from the Head end (units in cm): 2, 17, 32, 46, 60, 72, 84, 94, 106, 119, 133, 147, 161, 174, 188. The overall length is 190cm, and overall width 40cm. <<<<Create a fixture for this step>>>>
4. Sew in 1350mm lengths of webbing into the first 6 marks from the head end, and sew in 1500mm lengths of webbing at the 9 marks at the foot end.
5. Tie loops in the stretcher webbing using the loop tying jig (50mm opening) to the ends of the webbing at a length that leaves a 100mm gap between the opposite loops, when wrapped around the appropriate frames. The short setting is for the 6 loops at the head end, and the longer setting is for the 9 remaining loops <<<<There is a fixture for this step>>>>
6. As with the canopy fabric, attach this after the stretcher frame is complete and painted. You will use two lengths of bicycle tube, threaded through each loop and tightened, to provide a bit of suspension.



Hitch:

1. Cut the hitch clamp angle pieces, weld on bolt/nut assemblies in the middle of the angle stock pieces to act as the clamp. Cut the rectangular tube, and weld it on as well.
2. Weld the heads of two 30mm long M16 bolts together at right angles, and weld two M12 nuts together. Drill these nuts out with a 12mm bit. Thread on an assembly of two threaded nuts sandwiching this drilled double-nut plus a 1mm spacer, to a M12 bolt, and align this simple jig on the rectangular tube of the hitch, vertically. Weld the end nuts securely, and then remove the center nuts. Drill out the outer nuts to 12mm. Weld these double-M12 nuts to an M16 nut at right angles.
3. Weld the remaining M16 nut on the end of the pulling tube on the trailer. Assemble the hitch.
4. Weld a M10 nut vertically onto the end of the hitch pin, and tie string around the hitch, and through this hole. The hitch pin slides through all the M12 nuts to connect and disconnect the ambulance without taking off the hitch from the bicycle.

Fenders:

1. Bend the fender tubes--this can be done by making a bending jig from a piece of bicycle rim, cut and opened up, and welded to a frame. Bend a 6 meter 19 X 1.6mm round tube around in two complete circles, to get two and a half ambulances worth of fender tubes. <<<<There is a fixture for this step>>>>
2. Lay the fender tubes on a piece of sheet metal, 0.6mm thick galvanized, and trace the outline. Add 25mm to the bottom, past the end of the fender tube. <<<<There is a fixture for this step>>>>
3. Weld the fender tubes to the inside frame on the ambulance, using the stretcher as a guide—leave 1mm between the stretcher rail and the fender tube on each side. <<<<There is a fixture for this step>>>>
4. Weld the Top Fender Support Tubes to the top of the fender tubes.
5. NB: Complete the rest of the fender assembly after the frame is painted.
6. Cut out these two pieces of sheet metal, bend the bottom up 10mm. Drill holes and use self-tapping screws to attach this fender to the ambulance frame. This sheet will be positioned on the outside/wheel side of the fender tube. <<<<There is a fixture for this step>>>>
7. Cut two more sheet metal pieces to be the top fenders. Bend each side in 10mm, and bend one of the long sides another two times for stiffness.
8. Bend this fender over the fender tube, and drill then screw it into place. The bends should be on the underside.

Finishing:

1. Place the Stretcher onto the Trailer Frame, with the head end close to the pulling bicycle. Position the pivot tubes 130mm in front of the dropouts/wheel axles, on center.
2. Cut two 40mm long pieces of 12mm square tube, and weld one to the right side of the stretcher, extending horizontally, in front of the fender tube, and the other to the left side of the stretcher, behind the fender tube. These pieces will align the stretcher on the ambulance frame. There should be 1mm of clearance for each, but not more.
3. Sand, clean, and paint the stretcher and trailer.
4. Ensure proper hub adjustment on the wheels.
5. Tape the rim with insulation tape, once around. Poke out a hole for valve.
6. Fit wheels with tubes and tyres (26 X 2.1" preferred), inflate with air to 200 kPa. Check the bead seating for bulges, and fix if necessary.
7. Attach the wheels to the dropouts, using washers if necessary to space the hub out to the dropouts. Wheels should be



parallel, vertical, and in line with the trailer frame. Visually check from behind the ambulance, from a distance.

14. Attach a piece of string, 35cm long, to the hitch pin and the end of the pulling tube (around the threads of the first bolt). Tie knots and singe ends to prevent fraying.
15. Attach string/webbing between the head end of the backrest and the stretcher frame, while the backrest is hooked on the 5th chain loop. The string should allow the backrest to move freely up to this point, but not far beyond.
16. Attach the Stretcher fabric to the stretcher frame, starting from the head end. Lace the loops in the webbing using road bicycle tubes. Tie a knot in the tube at the pivot, and halfway down the foot end of the stretcher, as you go.
17. Attach the canopy fabric to the canopy frame with short pieces of elastic cord, tied tight. The canopy should be tight.
18. Cut and burn off all loose threads and frayed ends of strings and webbing.
19. Confirm proper functionality and specifications for the bicycles for the ambulances. (Good brakes, shifting and good gear ratios, small mountain bike frame, preferably women's frame, wide and knobby tyres.)
20. Apply grease to the hitch threads.
21. Attach the hitch to a bicycle seatpost.
22. Attach reflectors to the mud guards and canopy.
23. Test ride, first without, then with, a passenger.



