Foundations!

A Resource for Beginners.
by Bud Oggier
the Anvil's Ring/ Spring 1988 Part 9

Bud Oggier Passed away about 4 PM in the afternoon on Oct 25th. He died peacefully in his sleep at Penobscot Bay Medical Center. Many thanks for his permission to print this series. Heaven gets another fine smith. LB

"Hi, Jean, good to see you again! Ready to make a hammer? Good! What kind of hammer do you think you'd like? I get quite a bit of use out of this 2 1/4 lb. crosspeen, particularly for finishing up or working in a tight place. It's too light to move much metal, but it does fine for smoothing up. If you think you'd like one, let's make it.

We can use the same truck axle we made your hardie out of. First thing we need to do is forge it square. The hammer is 1 1/2" square, so let's go. When the piece is hot enough, I'll bring it out and you be the striker. Remember, hit where I hit, and with the same relative force.

OK, the bar is ready. I'm ready, how about you? OK! Hit — again — go stop. Jean, I know I taught you early on that when forging a square section to hit it, turn it a quarter-turn and hit again. Hit, turn — hit, turn. This bar is almost 2" in diameter and quite heavy. We'll need about 4" of 1 1/2" square, so I forged up the bar for about 4", then turned it, and we forged the other side. The bar is too heavy to turn for each and every hit you couldn't control it well and it would be quite tiring.

The piece is almost ready; we should be able to finish the square on this heat. Here we go — hit. Stop and let's check the size. Looks like we need to forge a little more — let's go. OK, stop. I'll check the size again. Looks fine, just a little over 1 1/2" square. Remember, Jean, when measuring a hot piece it will shrink about 1/64" for each inch of section when it cools, so it needs to be just a little over 1 1/2" while hot.

Jean, the end of this bar is going to be the hammer face, so we need to be sure that it is square with the body. It's better to do this now before we cut it off, so let's check. See, it's a little out, so we'll heat it up a bit and you forge the face down square. Remember, when you hit the end you will be upsetting, so you'll have to forge the side where it swell is.

While the piece is heating, take a look at the rule I used to measure with. I made this out of a piece of 1/4" X 3/4" stainless. The end was bent 90° on edge, and the corner forged up square. The short bent leg (about 1 ") was forged and filed so it was 1/4" X 1/2". The long leg is marked with a chisel every 1/4"; one side is measured from the outside of the leg, the other from the inside. The leg acts as a hook to catch the end of the piece. If I need to measure the inside of a piece, the other side of the hook butts into the far side of the hole or shoulder, and I read the scale on the other side. Because it's stainless, it won't rust and the heat won't affect it. I know that 1/4" marking is coarse, but it lets you make a real good estimate of a dimension.

OK, your piece should be ready so go ahead and square it up. Good — now let's check it again; that looks fine. We'll file the piece after it is finished, but not hardened, and you have it close enough for now.

The next step is to cut it off. How do we know when to cut in order to wind up with enough stock to get a 2 1/2 lb. head? Almost every steel supplier has a small catalog that has in it a table of weights and areas for all standard stock sizes. Let's look at mine. Here, see the table says that 1 1/2" square weighs .6380 pounds per inch. So 3 5/8" will weigh 2.312 pounds by the time we punch the eye and dress it up. Also taking into consideration the amount we lose to scale, we ought to be just about right. Let's mark the piece with a chisel, then cut it off.

Ready to strike? OK, go, hit, again — stop. I turn the piece 90°, line up my hot cut and go again, hit, again stop. Turn again and go, hit stop. Turn again and go, hit, turn again. OK — careful now, we're almost through, easy does it — good.

Now we're ready to punch the eye, but where should it go? When we forge the peen it will grow about 1/2 the length of the peen. In this piece that means about 3/4", so the hammer will be about 4 3/8" long. like my hammers to be a little face heavy,

that is, the face wants to hang down. If we put the middle of the eye 2 1/4" from the face, it should be about right. I'll put a good heavy center punch mark in so we can find where to punch the hole. Let's heat it up and punch.

Here's the punch I use for this size eye it is 7/8" X 7/16" at the end and oval shaped. The punch is tapered so that the deeper it goes the larger the eye gets. I'll start the punch and you strike. It's important that the punch is over the punch mark and lined up with the sides. Here we go~ The punch is lined up — go, hit, again, again. OK, stop. Cool the punch and go on, hit again, go stop. Cool the punch; we're about halfway through so I'll mark the hole on the other side and you punch it through. OK. This piece needs more heat. When the piece is heated, be sure to put it on the anvil with the hole down and be careful about lining up the punch. As soon as the punch breaks through, have me stop.

Here we go sure you are right with the punch? OK, stop and let's take a look. It looks good; we matched up the punched holes pretty well. Now drive this drift in about 1/3 of the way and forge down the bulge we got on the sides. OK, now drive the drift all the way through. Good.

Now we have to forge the peen. To hold on to the piece we'll use a pair of hammer-eye tongs. They look like a conventional pair of flat jaw tongs except there is a projection on the end of the jaw that fits down in the eye. Because of these projections you can really hold on to the piece and don't have to put up with it moving in the jaws.

When the piece is hot, I'll bring it out, hold it up at an angle and forge out the peen. Because it will be at an awkward angle, you'll be better off to stand to the side and tilt the sledge at the right angle.

Ready? Here we go! Easy now, we're close to done — there, that should do it. To finish off the radius on the peen, we'll use a 3/8" swage. Before swaging, let's be sure that we won't get an inclusion on the end. See how there is a hollow in the middle of the peen where the outside stretched more than the middle? If we don't get rid of that there's a good chance it will fold over in the swage and leave us with an inclusion that could break out in use. Just put the hammer in the vise and trim them off with a hot chisel. OK, that looks much better; now we can swage it. This time when we heat I'll be heating only the peen. Ready? OK, hit, again, again, stop — that looks pretty good'

I think it is good to chamfer the four sides of the face; it reduces the chances of chipping off the corners and besides, I think it looks better. After you chamfer the corners, we'll take a general heat, finish it all over with a flatter, and re-drift the eye.

While the piece is heating, take a look at this flatter. Notice two opposite sides have about a 1/8 radius; these prevent putting marks on the piece with the edge of the flatter. The other two sides are quite sharp, with just a small radius, so you can work right up to a shoulder.

Jean, first I'll put the peen in a bottom swage and flatten the face, then on the anvil to get all four sides and lastly the peen. The piece just has to be a good red, and the hits on the flatter not too hard. It is important to wire brush the piece free of scale before flatting, or else you'll get heavy pits from scale.

OK, here we go, in the swage — hit, again, once more, harder — stop. Now the sides — hit, again, again — enough. Quickly now, drive the drift through; good. Let's bring it back up to a good orange, put it in the wood ashes to normalize it, then finish and heat treat it tomorrow.

Good morning, Jean. Ready to finish up your hammer? If you feel the piece you'll see that it's still a little warm. It should be a uniform softness and free of any stress. First you should clean this off on the wire wheel and file it all over — make it a nice finished piece.

How are you getting along with that file, Jean? You know, wire brushing this piece with the wire wheel before filing not only cleaned it up, but it removed any scale we got in the annealing process. This scale is harder than the steel and can eat up files pretty quickly. When you file the face, put a little crown in it and a good heavy chamfer all the way around, to again prevent chipping. Be sure to break the edges all the way around the piece, including the eye; I hate a tool with sharp edges.

Well, let's look it over now and see if there is any-

thing left to do. Looks pretty good to me, Jean, what do you think?

There's still one thing to do before we harden. Everything I make gets my stamp on it before it goes out the door. If it's not good enough for me to sign, it's on the way to the dump. Why don't you sign this with your initials and the year. I also put the weight on the heads.

Say, that looks very professional, Jean. Once this is hardened and handled, you can use it with pride; you'll know every lick that went into it.

Take a look at the eye. It is hourglass shaped, with a straight section and a taper on each end. That's because the drift is purposely smaller than the large end of the punch. These tapers lock the handle in when you drive in the wedge.

We're ready to heat treat this, so let's get at it. Into the fire with the peen, but not in quite as far because since it is thinner, it will heat faster. Not too much blower either; we want to heat this slowly so that the heat soaks all the way through the piece. Jean, this hammer is a little long in relation to its thickness — this was done purposely to provide a little more hang so you can hit beyond an obstruction more easily. I had you put the extra crown on the face because it will be used mostly for finishing and this helps reduce hammer marks. Many people think hand forged work always shows a lot of hammer marks, but if you look at the work of the most historically well-known smiths, you'll see that they spent a good bit of time finishing the piece to remove them. The only time they left hammer marks was to produce a textured surface for effect.

How's that piece doing? Almost ready? Remember that when we made the hardie we established this as an oil hardening steel, so open up the tank and set the fusible link. We're just about ready.

Here we go — put the piece into the oil and move it back and forth. See how the oil bubbles more than it did with the hardie? That's because the heated steel mass is greater and it takes longer to cool, a few more puffs of smoke, but still not much. There, the noise from the bubbling has stopped, so it won't be long now. Jean, there is a lump of cast iron about 1" thick and 3" X 5" lying on the floor next to the vise. Put that in the fire to heat while this finishes quenching. Now we're ready to clean this up and polish it a little so we can temper it. There, that looks pretty nice. Is that cast iron hot yet? OK, now set the hammer on top of the hot iron piece and let it heat up — keep turning it so that the heat gets evened out, and watch carefully for the colors to appear.

Do you see this stock formed into a square ring? I use this to get a little extra tempering around the face edges. I'll stick it under the cast iron plate to heat it while we finish tempering the heat. Once we've reached the proper blue color, we'll drive the hot ring over the head. This will heat the edges more and help reduce the chance of chipping in the future. That hammer now looks about the right color of blue, so hold it face-up on the anvil. I'll polish the face now and put on the ring; see the blue get darker? Just a little more — O.K. — knock off the ring and re-quench the head.

Well, let's look at what we've got. That looks pretty good; let me try a file on it. Good, the file almost sticks on the hammer face, but takes a good hold on the edges. Now, once we use the torch on the two ends of the peen to soften them a little more, we'll be finished. Set that head over here with the peen up and I'll give the corners an extra draw. In heating this we have to be careful not to get the edge overheated, so we'll take it a little slow. Watch now, the color is beginning to show; a little more deep blue, almost gray. There, that should do it.

Well, Jean, there is your hammer. It looks like a good one to me. I hope you get to wear out many of them. Now that you know the steps used to make one, you can produce any size or shape you want. Jean, the process we used to make this hammer is basically the same for all handled tools. You may have to modify it some to suit the shapes, but it is mostly the same.

See you next time!"

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The Weightless Hammer

Description

The Weightless Hammer is a ~16-lb sledge-hammer, with a short handle for one-handed use, suspended from a dynamic tool-balancer that is an integral part of a light-weight jib crane. A specially designed bale allows the hammer to strike in virtually any direction except straight up. Being weight-less, the hammer can be lifted repeatedly with little effort for multiple blows. The user must accelerate the hammer for the blow, but this requires no unusual strength. If con-structed with a straight-pein sledge, the user may alternate between flat and pien faces between subsequent blows.

This machine is designed to be easily con-structed at moderate cost from commonly available hardware using a minimum of hand power tools. The machine is not free-standing, but is designed to pivot on the floor and at a rafter or joist. The machine is trans-portable, weighing only 60 lbs, including the 16-lb sledge, and may be easily carried on a car roof rack.

General Considerations

Relieve all corners and edges after cutting or drilling. The approximate scale, e.g., "(1/4)", is given for all drawings. Major hardware is illustrated. Much small hardware is not illus-trated and is left to the judgment of the builder. Most bolts should be held in place with a nut and split washer. Flat washers are used as needed, and fender washers are used against wood or sheet-metal parts. Where tightening a nut would interfere with function, jam nuts or a lock nut may be used.

Recommended Tools

4 1/2" angle grinder with cut-off wheel; vari-able speed reversible 3/8" drill; drill bits; files; cold chisel; cross-cut saw; pop-riveter; screwdrivers; wrenches; hammer; anvil (or metal block); C-clamps; vise; 3/4" tubing bender; 3/8" mandrel; needle-nosed pliers; propane torch (or a forge); 5/16" transfer punch; center punch; tape measure; plumb bob; spirit level; square; marking pen; com-pass; protractor.

Major Parts

1 sledgehammer head, ~16-lb, preferably straight-pein, in good condition.
2 hammer handle, ~ 14" to 16"
3 2 ea. 8 ft 2x4 sheet-metal studs,
4 1 ea 4-wheeled in-line skate
5 bicycle parts, preferably: boy's-style steel bike frame, lightweight (aluminum) rear wheel with 5-sprocket cluster, bike chain, underslung "gooseneck" (handlebar stem).
6 8 ft x 2 3/8" pipe (chain-link fence post)
7 2 caps for 2 3/8" pipe
8 garage-door spring, ~160-lb, with safety cable
9 ~20 ft of 1/4" braided nylon rope

I. Materials and Hardware

1 4 ft of 1/8" wire rope with 4 cable clamps
2 quick links: 1 ea 1/8", 2 ea, 5/16" or 3/8"
3 turnbuckle with ~4" travel
4 8 ft of 3/4" electrical conduit
5 2 ea. 4" ball-bearing garage-door pulleys, with bales
6 bungee cords, 2-ft and (optional) 1-ft
7 small spring link (optional)
8 small pulley block with ~3/4" pulley for 1/4" rope
9 light chain, ~36", with two S-hooks
10 round stock, ~18" of 3/8", ~36" of 1/4"
11 ~14" of 1 1/2" x 1 1/2" 16-ga angle iron
12 hex bolts: 2 ea 4 1/2" x 5/16", 2 ea 5"x3/8"
13 carriage bolts: 2 1/2" x 1/4", ~1 1/2" x 3/8"
14 pop rivets, steel, short
15 pan-head sheet-metal screws, 1" #8
16 3"x3/8" threaded rod
17 eyebolts: 4"x1/4", 6"x1/4", 4"x3/8", 6"x3/8"
18 3"x3/8" lag bolt
19 eyelets, wire coat hanger, 2x4 lumber scrap, and misc. other scroungeable sup-plies

II. Definitions

"Vertical", "high", "above", "below", and simi-lar terms, are used with reference to the final installation of the machine, without regard to the position of the machine during fabrica-tion. "Upper" and "lower" are used with re-spect to the arm to mean closer to and far-ther from the bike frame, respectively. "Front" (and "forward") and "back" are de-fined with the jib pointing toward the viewer.

A. The Jib

1. Cut two 2x4 25-ga sheet-metal wall studs to ~7 feet long. (Keep the scrap.) Fold in the small flanges, top and bottom, at the end of one of the two studs for a length of two feet. (Figure 1).

2. Clamp the studs together back-to-back and drill 1/8" holes through the backs of the two studs, near the top and bottom edges, at approximately one-foot intervals. Pop-rivet the two studs together.

3. Drill a 3/8" hole perpendicularly through in the center of the broad side of a two-foot piece of 2x4 lumber. Mount this board in the end of the stud, where the flange was folded over, using round- or pan-headed screws inserted from back, top and bottom. (Punch holes through the steel with a nail).

4. Extend (i.e., drill) the 3/8" hole in the wooden 2x4 through the sheet-metal 2 x 4's as well. Also drill a 1/4" hole, through wood and steel, two inches from end of the jib and centered vertically.

5. Drill a 3/8" hole about 1" from the other end of the jib, centered vertically. Cut a 3" piece of 3/8" threaded rod, and center it in this hole with a nut and fender washer on one side, and a fender washer, split washer and nut on the other. Do not tighten yet.

6. Make a loop on the end of a 4-foot piece of 1/8" wire rope using two cable clamps. At the level of the 1/4" hole in the wood, spread the two metal studs enough to insert the loop of the wire rope between them. Secure the wire rope to the jib using a 2 1/2" x 1/4" car-riage bolt. Attach a turnbuckle to the other end of the cable with two clamps. Attach a quick-link to the turnbuckle. (Figure 21)

B. The Truck

1. Enlarge the center hole of a 4x4 deck post tie (Figure 2) to 5/16".

2. Cut two pieces of light-weight (~16-ga) angle iron to about 7" long. Drill a 5/16" hole at the center of one face of each angle iron to mount the deck post tie. Drill 5/16" holes about 1" from each end of the other face of each angle iron for mounting the skate wheels.

3. Drill a 5/16" hole in the center of the arc of the pulley bale.
4. **4.** Dismount the four wheels from a roller blade, retaining all hardware.

5. Assemble the truck as shown in Figure 2 using 5/16" washers or 3/8" nuts as spacers between the wheels and the angle irons.

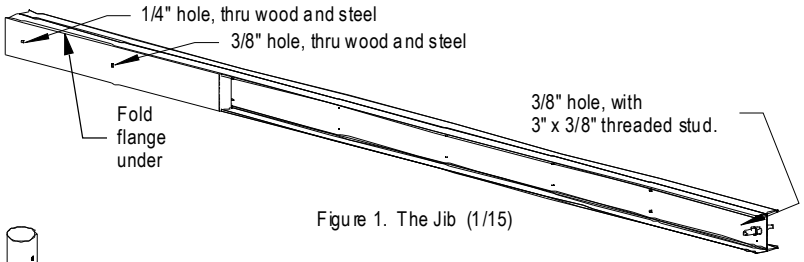

Figure 1. The Jib (1/15)

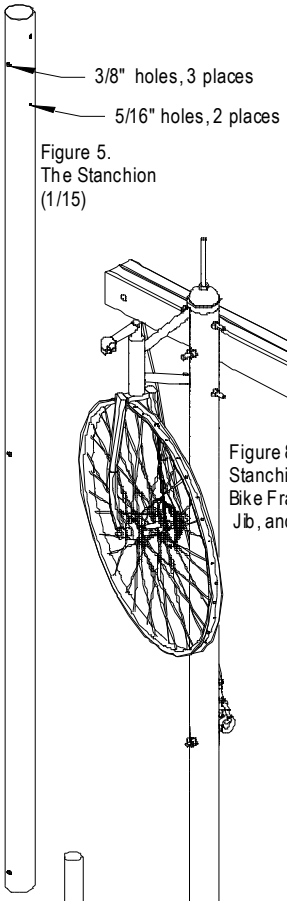

Figure 5.
The Stanchion
(1/15)

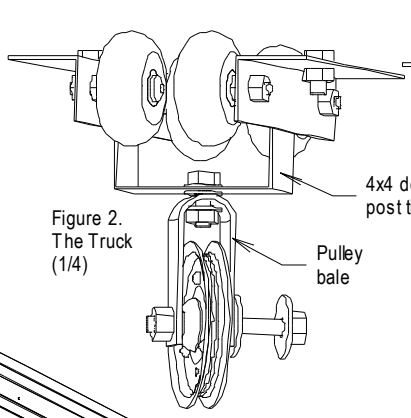

Figure 2.
The Truck
(1/4)

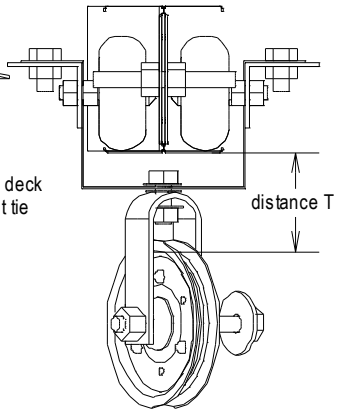

Figure 3.
The Truck on the Jib
(1/4)

Figure 8 (1/15)
Stanchion with Caps,
Bike Frame, Eyebolts,
Jib, and Truck.

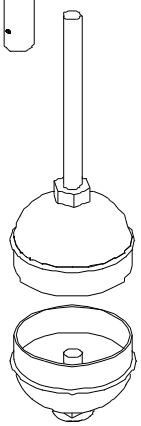

Figure 7. (1/4)
Stanchion Caps
with Pivot Bolts

Figure 4. (1/8)
Bike Frame and Stanchion

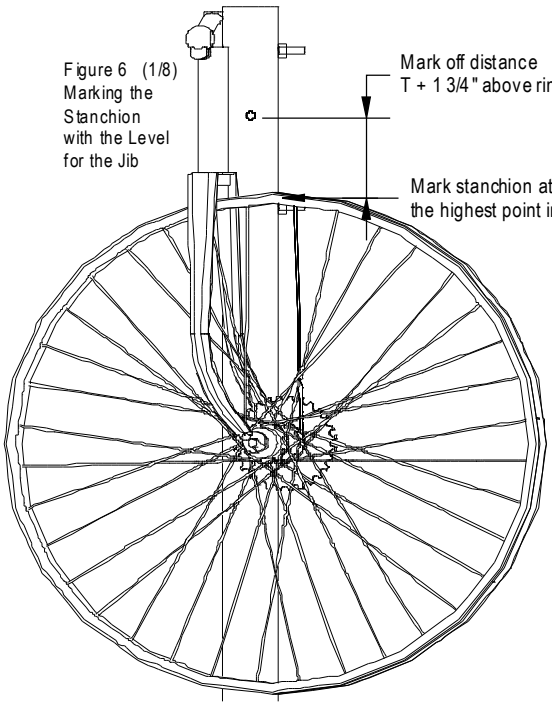

Figure 6 (1/8)
Marking the
Stanchion
with the Level
for the Jib

6. Check that the truck properly fits the jib, and measure the distance T on the truck between the top of the pulley and the bottom of the wheels, Figure 3, for use in step IV.3.

C. The Bicycle Frame

1. Cut the bike chain at one of the narrower (side-to-side) links. Service and lubricate the chain, if necessary, so that it is fully flexible.

2. Remove the wheels from the bike, retaining the mounting nuts. Remove tire, tube and rim strip from the rear wheel.

3. Cut the bicycle frame tubes just in front of the seat and in front of the pedals.

4. From the front frame remove the handlebars and all hardware except the headset (fork, fork bearings and gooseneck). Service the bearings if necessary. Lower the gooseneck as far as possible and turn it 90° to the right. Spread the front fork to accommodate the rear wheel. (A 3/8" threaded rod with two nuts and washers works well as a tool.)

Along one side of the head tube (between gooseneck and fork) mark a line parallel to the axis of this tube. Lay a square along this axis line and mark the point on each frame tube six inches (*minimum*) perpendicular from this axis line. At these marks drill 5/16" holes through each tube, perpendicular to the plane of the bicycle frame. Cut each bike frame tube off **1.** square 1 3/16" (i.e., half the diameter of the stanchion pipe) beyond the center of these holes. (Figure 4)

D. The Stanchion

An eight-foot stanchion pipe will result in a machine ~8′ 8″ tall, and will require ~8′ 2″ under the joists to clear the gooseneck. If less clearance or ceiling height is available, mount the bike frame lower on the stanchion pipe, or shorten the stanchion pipe.

1. Lay the bicycle frame across the 2 3/8" stanchion pipe with the two holes drilled in step 5 along the axis of the pipe and as high up the pipe as possible without the gooseneck exceeding the height of the pipe. (Figure 4) Transfer-punch the position of these holes onto the pipe. Drill 5/16" holes at each of these marks, through both sides of the pipe and perpendicular to it. (Figure 5) Test-mount the bike frame to the stanchion pipe with 4.5" bolts.

2. Mount the rear wheel backwards (i.e., with the cluster on the left) in the front fork. (Figure 4) With the aid of a square, mark the stanchion at the highest point on the rim. (Figure 6) Dismount the bike frame from the stanchion pipe.

3. On the stanchion, mark off distance {T+1 3/4"} *above* the mark from step 2. (See step II.6, Figures 3 and 6.) At this mark drill a 3/8" hole through the stanchion pipe, perpendicular to the holes for mounting the bike frame to the stanchion pipe. Drill two more 3/8" holes directly below this, one at the middle of the pipe, the other 2" from the bottom. (Figure 5)

4. Drill 3/8" holes through the centers of two hemispherical caps for 2 3/8" pipe. In the "bottom" cap, mount a short carriage bolt from the outside. In the "top" cap securely mount a 5" hex bolt from the outside, then cut off the head of the bolt so there is a rod projecting up from this cap. (Figure 7) Mount the end caps on the stanchion pipe. (Figure 8)

III. Preliminary Assembly

1. Remount the bike frame to the stanchion pipe as before. (Figure 4)

2. Mount a 4"x3/8" eyebolt in the bottom 3/8" hole from step IV.3, with the eye under the bike wheel. (Figure 8)

3. Place a nut on a 6"x3/8" eyebolt, and insert the eyebolt into the middle 3/8" hole from step IV.3, with the eye on the opposite side from that in step 2, and the center of the eye held 1.5" from the stanchion. (Figures 9 and 21)

4. Mount the jib on the stanchion using a 5"x3/8" bolt. Connect the quick link on the turnbuckle to the eyebolt in the middle of the stanchion, and adjust the turnbuckle until the jib is perpendicular to the stanchion.

5. Remove the 3" threaded rod from the end of the jib, mount the truck on the jib. Measure the vertical distance V from the center of the truck pulley to the center of the handlebar-mounting hole in the gooseneck. (Figure 9)

6. Remove the truck from the jib and replace the threaded rod. Disconnect the quick link from the eyebolt and bring the jib down to the stanchion.

IV. Arm

1. From an 8- or 10-foot length of 3/4" electrical conduit, cut a 45" piece for use as the lower arm. Drill 3/8" holes 2" from the upper end and 3" from the "lower" end, *offsetting the two holes exactly 90° from each other.* (Figure 10)

2. The remaining piece of conduit is used to make the upper arm. Put an S-bend into this piece (not centered but nearer one end) so that the two ends of the conduit are parallel and the center-to-center offset is *2″ less* than the distance V from step IV.5. The overall length of the S-bent portion should be about 18". Cut off the shorter end of the upper about 6" from the S-bend, such that the overall length is at least 42". (Note: The actual measurement should be about 36", but the upper arm should not be cut to size until the action of the fork is checked, in step IX.3.) Drill a 3/8" hole through the shorter end of this conduit in the plane of the bend, 2" from the end. (Figure 11)

3. Drill two 3/32" holes through the conduit for mounting *each* rope guide *at 90° to the nearest 3/8″ hole.* Drill these holes 4" and 5" from the lower end of the upper arm, 4" and 5" from the upper end of the lower arm, and 5" and 6" from the lower end of the lower arm. (Figures 10 and 11)

4. Drill a 1/4" hole through the lower arm, 1" from the lower end, and at an angle of 25° from the vertical. (Figure 10) Make the terminal rope guide by bending the eye of a 4"x1/4" eyebolt 115° from the shaft. Mount a nut on this eyebolt about 2" from the eye, and install it on the lower arm as shown in Figure 14 with a lock washer and nut.

5. Assemble the arm as shown in Figures 12 to 14. Mount a 4" pulley between (or optionally atop) the lower end of the upper arm and the upper end of the lower arm using a 4"x3/8" bolt. (Do not yet mount the lower arm on the pulley bolt on the truck.)

6. Fabricate rope guides, two at a time, by wrapping the middle of a ~16" piece of ~3/32" dia. (hanger) wire 3 times around a 3/8" mandrel, spacing the wraps at least 1/4" apart, then cutting the coil in the center to make two pigtails of 1.5 rotations. (Only three of these will be used). (See Figures 13 and 14.)

7. To mount each rope guide, insert the straight end into the 3/32" hole nearer the respective pulley, making sure the pigtail is on the correct side of the conduit. With the pigtail end extending about 2.5" from the conduit, bend the straight end on the opposite side of the conduit sharply 90° toward the other nearby hole, against the conduit. Using a needle-nose pliers, bend a small eye loop (~3/16" I. D.) in this end of the wire, centering

the loop over the hole, then cut off any excess wire. Insert a self-drilling screw through the eye and into the hole, and tighten it down to lock the rope guide in place. (Figures 13 and 14)

8. Adjust each pigtail rope guide by inserting a 3/8" mandrel in the pigtail and bending the wire until the pigtail is as close as possible to the pulley and the mandrel feeds directly onto the pulley. Similarly align the eyebolt rope guide (from step 4).

V. The Hammer and Bale

1. Determine the center of mass of the hammer head and mark this point on the side of the hammer head. Measure the distance, R, from the center of mass to the farthest point on any face or corner of the hammer head. Also measure the distance, H, from the center of mass to the top of the hammer. (Figure 15)

2. Measure the distance, P, from the top of the pulley to the bottom of the pulley block. (Figure 16)

3. On a suitable surface, draw a semicircle of radius {R+P+1/8"}. Draw a line through the center and both ends of the semicircle, and sketch the shape of the bale, as in Figure 17.

4. Heat the end of a roughly 3-foot length of 1/4" round stock to a red heat and bend it around a 3/8" mandrel to form an eye, then allow it to air cool (normalize). Make the bale by cold-bending this rod as shown in Figure 17. Make the loop (on the end opposite the eye) to fit the handle 3/4" back from the head. Check that the center of the loop is in line with the center of the eye.

5. Saw-cut the end of the hammer handle to receive a wooden wedge. Drive the handle into the head and drive a *wooden* wedge into the handle slot. Drill a ~5/16" hole, about 3" deep, straight down the handle directly toward the center of mass of the head..

6. Slide the pulley onto the bale, and slide the loop of the bale onto the hammer handle. Use a 2 1/2" x 3/8" lag bolt and a flat washer to mount the eye of the bale to the hole in the handle. The bale should move freely around the hammer, (Figure 18)

VI. Setting up the Machine

Choose an area of the shop for mounting the machine to a joist or rafter, where the rotating machine (jib and arm especially) will not hit light fixtures etc. The upper bearing is an eyebolt installed in a joist or rafter. If there is no joist or rafter at the right position, install a 2x4 where needed and work from that. (Virtually any 1/2" dia. hole, whether in wood or metal, is suitable as the upper pivot, so modify these instructions to suit the location.) This pivot point must be stable, however, not subject to motion.

1. Measure the height of the stanchion from the bottom of the lower cap up to but not including the top pivot bolt. Install a screw eye with a 1/2" hole at a height about 2" higher than this measurement.

2. Use a plumb bob to locate the point on the floor directly beneath the upper pivot hole, and mark this point with an X. If a lower bearing is to be used, affix it to this point. If the floor is solid and would not be damaged by the rotation of the stanchion against it, then there is no need for a lower bearing. However, the machine will eventually wear a dimple into even a concrete floor, so if that would be unacceptable, then install a brick, board, or dimpled metal plate of some sort to act as the lower bearing.

3. Set the stanchion vertical, with the upper bolt inserted into the eyebolt (i.e., the upper pivot bearing) and center the bottom of the stanchion on the X..

VII. Final Assembly of the Jib Crane

1. Lift the jib horizontal and reconnect the quick link on the turnbuckle to the eyebolt. If the jib swivels of its own accord, the stanchion is not vertical. Use a plumb bob or spirit level to aid adjusting it to vertical.

2. Reinstall the truck on the jib and tighten down the nuts on the retaining stud. If the truck runs along the jib of its own accord, the jib is not level. Use a spirit level and adjust the turnbuckle to level the jib.

3. Install the lower arm on the truck and the upper arm into the gooseneck (in which it will fit loosely). Run the truck forward and back along the jib and observe the motion while adjusting the position of the upper arm in the gooseneck. When properly adjusted: (a) the gooseneck should rotate continuously clockwise as the truck moves back, and not reverse direction; (b) the bike wheel should not touch the stanchion when the truck is all the way back; and (c) the arm should remain bent at the "elbow" when the truck is all the way forward. Move the upper arm in the gooseneck until the arm motion is proper, then mark the upper arm at the gooseneck. Cut off the excess length of the upper arm an inch or two beyond the gooseneck. (Figure 21)

4. Two ~25-ga shims will be needed to make the upper arm snugly fit the gooseneck. (Figure 12) Cut a roughly 8"x1.5" strip from the scrap (25-ga) steel from the sheet metal studs. Flatten the strip, then bend it around a 3/4" mandrel and cut it off so it wraps most of the way around the conduit. Insert the shims, one at a time, into the gooseneck, then insert the conduit within the shims.

5. Fabricate a brake to prevent rotary oscillation of the jib while hammer ing. Any device that applies adequate drag to the stanchion will do. A simple such brake is a "garrote" rope around the top of the stanchion pipe, just below the upper cap. This garrot may be tensioned with a strong spring or, as illustrated in Figure 19, by means of a lever mechanism and a bungee cord or light extension spring. Position the brake mechanism (especially the lever) such that it is clear of the bike frame and the gooseneck, throughout the rotation of the machine. (Note: Figure 19 may be interpreted either to be a joist or a 2' length of 2x6 lumber which is mounted to a joist or rafter, whichever is more suitable for the installation.)

III. Installing the Hammer

1. Tie a 1/4" dia. nylon rope (~20 feet long) to the eye of the pulley on the hammer bale. (A small spring link may be used if desired to facilitate installation and removal of the hammer,) Run the rope through the rope guides and over the pulleys, then through the tube-stem hole in the rim. Tie the end of the rope over a 3/8" flat washer to keep it from pulling back through the tube-stem hole. Crank the bike wheel to take up the slack in the rope. Recheck that the rope guides are in line with the pulleys. Adjust the angle between the wheel and the upper arm such that the rope feeds straight from the middle pulley to the wheel rim, then tighten the gooseneck bolt. (Figure 23)

2. Run an ~8' safety cable through the garage-door spring. Using a quick link, mount the spring and cable to the eyebolt at the base of the stanchion. (Figure 21)

3. Using a pliers, force a 1/8" quick link through the end link of the bicycle chain. Lay the bicycle chain over the largest sprocket of the wheel, with the quick-link at the rear of the

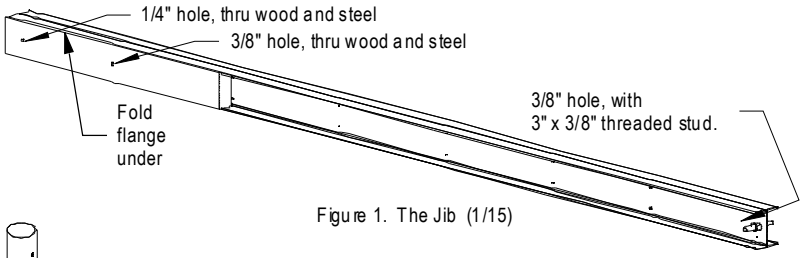

Figure 1. The Jib (1/15)

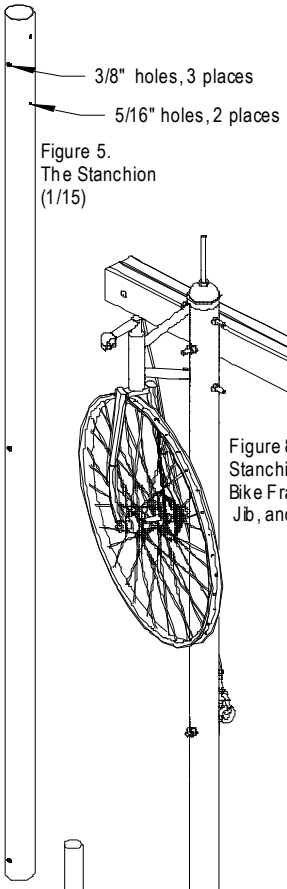

Figure 5.
The Stanchion
(1/15)

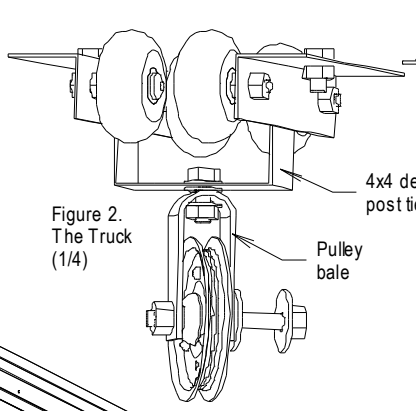

Figure 2.
The Truck
(1/4)

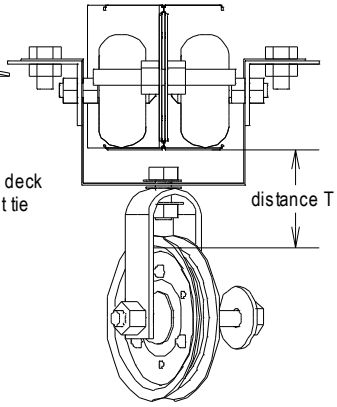

Figure 3.
The Truck on the Jib
(1/4)

Figure 8 (1/15)
Stanchion with Caps,
Bike Frame, Eyebolts,
Jib, and Truck.

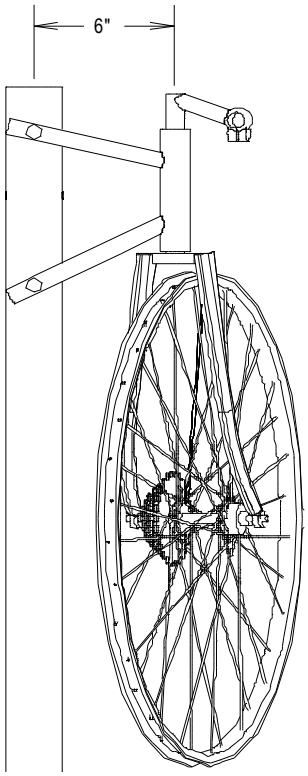

Figure 4. (1/8)
Bike Frame and Stanchion

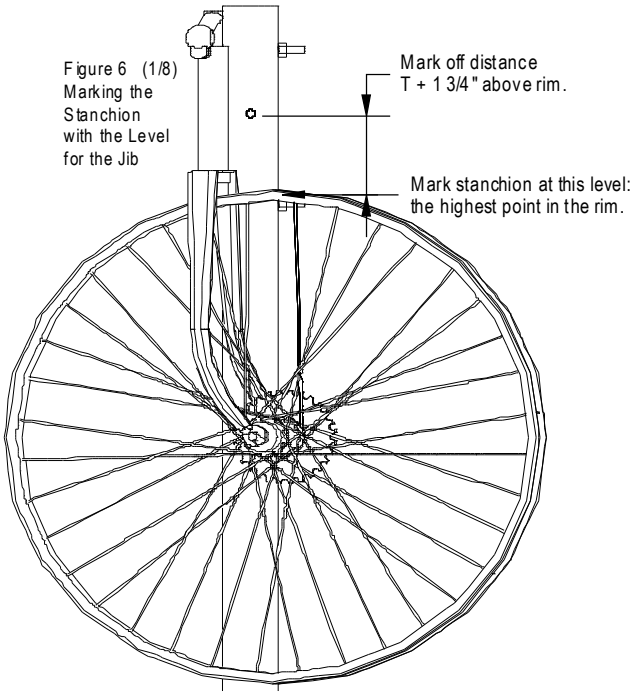

Figure 6 (1/8)
Marking the
Stanchion
with the Level
for the Jib

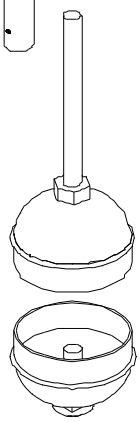

Figure 7. (1/4)
Stanchion Caps
with Pivot Bolts

Figure 22 (1/15)
The Finished Machine

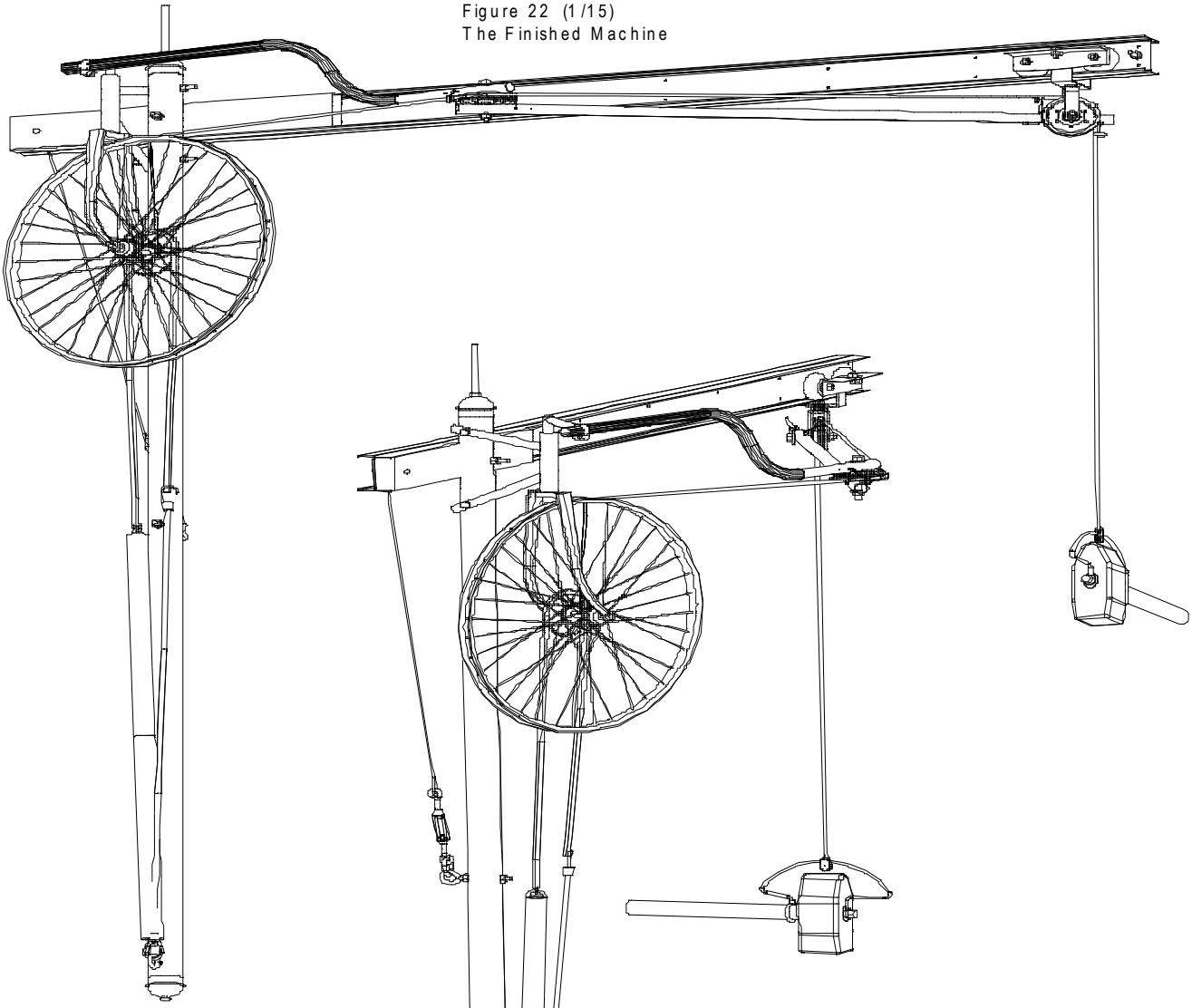

Figure 21 (1/15)
Rear View of
Finished Machine

machine. Insert the terminal loop of the spring into the quick link and close the quick link. Hook one end of a ~2-foot bungee cord onto the opposite end of the bicycle chain. Hook the other end to the bottom eyebolt on the stanchion.

4. Run the free end of the safety cable over the bike frame near the pivot tube, wrap it around the bike frame tubes a couple time to take up slack, and secure the end loop to one of the 5/16" bolts mounting the bike frame to the stanchion. There should be enough slack in the cable that the fork can rotate unhindered, but no more. (Figure 21)

IV. Adjusting the Hammer Motion

1. Crank the bike wheel to lift the hammer up to the truck, then crank it the other way to let the hammer back down to the floor. The spring will stretch.

2. Use a light 3-foot chain with S-hooks on each end to secure the top end of the spring to one of the bolts through the stanchion. Crank the bike wheel to lift the hammer again, all the way up to the truck or some lesser distance. Then crank it the other way to let the hammer back down. Re-secure the spring and repeat this step until the hammer "floats" at the desired level and the "feel" of the hammer is as desired.

3. A J-shaped tool is needed to safely release spring tension in small amounts. (Figure 20) This tool may be fabricated from about 18" of 3/8" round stock. Bend the round stock into a U, with a bend diameter of 5" to 6". Clamp the U in the vise and bend the left branch down and back by hammering. Cut off the bent end 3/4" long to make a stub end.

4. To use the J-tool, hold it upside-down. Lower the hammer to the floor, then insert the stub end into the sprocket near the bungee cord. Rotate the wheel, such that the J-tool lifts a few links of the chain off the sprocket. When the stub reaches the other side of the axle, the spring will suddenly take up the slack, so perform this adjustment cautiously, as it poses some danger to the unwary. Repeat as necessary to release spring tension.

5. When the swing of the hammer is not directly under the jib, the jib will follow the hammer motion. If the jib follows too slowly or drags on the hammer, the brake is too tight. If the jib overshoots and oscillates excessively during hammering, the brake is too loose. Adjust or modify the brake appropriately.

V. Breaking down the Machine

1. Lower the hammer to the floor and chain up the spring (step XI.2). Detach the hammer (with bale and pulley) from the rope. Unwind the rope from the rope guides and remove it from the pulleys.

2. Crank the wheel to slack the chain securing the spring; remove the chain while holding the wheel, then revolve the wheel, hand over hand to release the tension on the spring. Remove and bundle the bungee cord, chain, spring and safety cable.

3. Loosen the clamp on the gooseneck and remove the arm. Tape the shims to the upper arm. Remove the threaded rod from the end of the jib and remove the truck. Remount the threaded rod. Fold up the arm and truck assembly.

4. Release the quick link on the jib cable from the eyebolt on the stanchion and lower the jib to the stanchion. Remove the stanchion assembly from its mounting.

5. If permanently moving the machine, dismount the upper bearing and brake assembly from the joist, and any lower bearing block from the floor.

Tips on Constructing the Weightless Hammer

The first tool on the list is the angle grinder with cut-off wheel. A cheap Chinese version does fine and cuts anything: bolts, sheet metal, steel cables, bicycles, you name it!

Although I recommend a 16# hammer, you may want something else. Just remember, the heavier it is, the slower it will accelerate.

If you don't have a perfect sledgehammer head, go with what you've got. It's easy to change out the hammer later, and the machine will work with any hammer you attach.

You want a boy's bike because the top tube and the down tube spread at a much greater angle than in a girl's bike. This gives you more strength in the attachment of bike to stanchion.

The wheel should be as light as possible. A narrow aluminum rim is best. Heavy is bad.

An underslung handlebar stem is best for reasons of clearance. Although I specify metal tubing for the stanchion and arm, you could use lumber, if you really want to.

You could even use a 2x3 stud for the jib, but you'd have to redesign the truck. (Hint: Use plastic roller skate wheel, instead of roller-blade wheels.) This whole design could be redone many different ways and still work fine. "Quick links" and "spring links" may be brand names. They're chain links that can be opened and reclosed. Anything that will do that will serve. Bungee cords are rubber shock cords, very stretchy. Long, lightweight springs will do. Specified bolt diameters are often more a matter of convenience than an absolute necessity. Use your judgment. You can get a little more work area for the hammer by using an 18", rather than a 24", 2x4 in the jib.

Look at the picture of the truck and construct the upper portion to do the job, from whatever you have handy. The parts specified are available at Home Depot, and have nothing else to recommend them. The top and down tubes of the bike are drilled 6" minimum from the head tube. For a 26" wheel, you might want to make that 7". This may keep the wheel from interfering with the jib cable, but if that should happen, just reposition the jib cable. It's pretty important to drill the 3/8" holes in the lower arm at exactly 90° from each other. That may be the only angle on the whole machine that does matter.

The lightweight wire pigtails work well for 2 of three rope guides. The last rope guide has to be stronger, though, because it pulls the whole machine around as you swing the hammer. If the rope jumps off the 4" pulleys, the rope guides are misaligned. In sketching the bale, the center of the circle is the center of mass of the hammer. Then, as long as you have clearance for the pulley to pass the hammer face and corners, anything goes. The longer the arc of the bale, the more natural the hammer will swing.

Pictured is what I consider to be the practical limit for a useful hammer. This may not be the last word in bale design. I haven't exhausted my ideas. Stay tuned.

If your sledgehammer head is already mounted on a handle, you can live with it, but you'll probably have to drill into a metal wedge and sink a bolt into that. Get the bale eye pivoting correctly, and all else will be forgiven.

__NJBA__ would like to thank Bruce for debuting these plans in our newsletter. Bruce is also the designer of the "Grasshopper Treadle Hammer". Larry Brown, Editor

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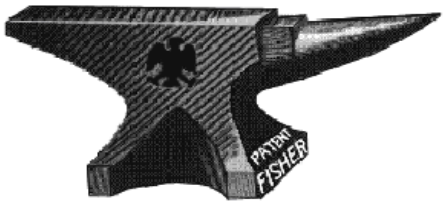

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