## Moving Frame Hydraulic Press

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It's alive (finally!). One of my more elaborate (and time consuming) builds has been the construction of a 20-ton hydraulic press. What follows here should be taken as more of a journal rather than build instructions.

The basics of a press are reasonably simple. There is a pump (two-stage) that sucks oil from a reservoir (typically 5 gallons). The pump is powered by an electric motor (3..5 hp, 220v, 3400 rpm). The pump sends the oil through the pressure gauge (optional) to the valve (with up, down, and spring return to center settings). The valve has four ports - input from the pump, out to one end of the cylinder, out to the other end of the cylinder, and a return flow to a filter through which oil finally returns to the reservoir. The line from reservoir to pump and from the filter back to the reservoir are low pressure, everything else is high pressure. You can cheap out using black pipe fittings on the low pressure side but buy quality fittings and hoses from a hydraulic shop for all of the high side stuff. T'ain't worth having it blow up to save a few bucks! The motor, the cylinder size, the pump's capacity, line sizes, etc. all impact the power and speed of the press. There are plans available that go over the details (Batson, 1994) and the Surplus Center (www.surpluscenter.com) can supply the parts.

The presses I have seen in use by knife-makers have fallen into two general classes. There are 'C' presses which are configured like the typical power hammer - an anvil running from ground level to the crush point (~ 36" off the floor) with the cylinder above the anvil hanging from a heavy spine connecting the two. 'H' presses are composed of a heavy rectangular frame with the lower die at the bottom of the frame and the cylinder hanging from the top of the frame. In both cases, as the cylinder extends, the upper die descends until the work is trapped between the dies. Consideration must be given to insure the upper die moves down smoothly and with minimum wobble during the extension. Typically, the pump, reservoir, etc. are attached high on the unit making a top-heavy system and thus requiring a heavy base and/or a bolt system locking the unit to the floor. 'H' presses tend to be smaller (and lighter) and may simply sit on a heavy wooden base since the forces are well contained within the frame itself. Alternative layouts are to move the majority of the hydraulics to the base of the press and use long lines or even flip the system upside down and have the cylinder push up instead of down (though to us old power hammer users, that just ain't natural!).

The one major down side to these designs is the exposure of the hydraulic system to the air space occupied by the user and his trusty gas forge. A leak in the high pressure side can result in an atomized cloud of oil looking for a source of ignition (...remember that gas forge?....). A quick Google search turns up 200,000+ hits on "hydraulic leak+fire+explosion". A Navy study (Hoover et al.,2005) concludes "It was found that a significant fire and explosion potential does exist under conditions typical of normal hydraulic system operations". With some prompting from

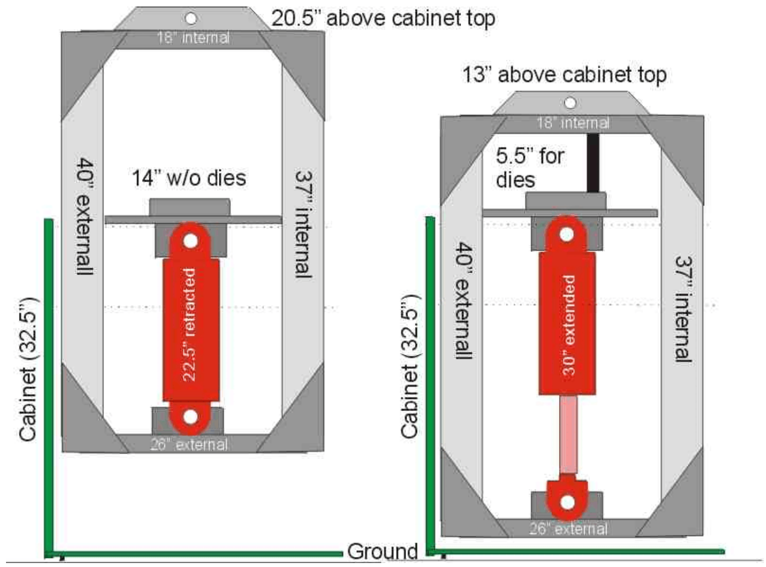


**Figure 1: Diagrammatic representation of movement**

Bruce Freeman, I conceived of an enclosed press in which the frame moves as the cylinder cycles (Fg.1).

The key idea is that there is a strong metal cabinet enclosing all the hydraulic parts. If there is a leak (and or a fire), it will be contained. The upper end of the cylinder is attached to the cabinet top and the lower die sits directly above that point. The other end of the cylinder is attached to the bottom of the frame. When the cylinder is retracted, the frame is pulled up and protrudes above the cabinet's top. When the cylinder extends, the frame sinks into the cabinet until the upper die (attached to the inside center of upper lintel of the frame) makes contact with the lower die. The effort in making the frame is identical to that of an 'H' press and with the castors on the bottom of the cabinet, the

**Figure 2: Completed press**

Figure 3: The frame

whole thing is movable (though like pushing a car!). Figure 2 will give an overview of the unit.

I acquired the parts from a horizontal 20-ton press which included the reservoir, pump, motor, gauge, valve, filter and cylinder (5.5" diameter, 7.5" travel) along with hoses and fittings for $200. By the time I bought new hoses and a number of fittings, the damages rose to $450.

The frame (Fg.3) consisted of two sections of 6" x 4" I-beams (~38" long) with the upper and lower lintels being 6" wide x 1.75" thick x 24" long The lintel ends were positioned over the I-beam webs and heavy angle-iron pieces (5.5" long x 3/8" thick) were welded on both sides where the lintels connected to the webs. Diagonal braces (2" x 3/8") were then welded on the corners to further strengthen the frame. A block was welded on the top to provide a lift point and to prevent the upper lintel from flexing. A pair of 6" long pieces of light angle-iron were welded on the underside of the top lintel to hold the upper die blocks. A heavy block with an appropriate hole for the pin for the lower end of the cylinder was welded to the lower lintel. Figure 4 shows that arrangement as well as the partially constructed cabinet.

Figure 4: Frame & open cabinet

I had scrounged the remains of a car-alignment system consisting of two box supports (36" tall x 24" deep x 30" wide) made of 3/16' plate which were sectioned and "frankensteined" into a single cabinet of the same overall dimensions. Figure 4 show one of those boxes bottom side up. Eventually, its brother contributed the top of the cabinet and the material to fill in the gaps in the lower box. Before too much material had been added to the cabinet skeleton,, a set of four casters were attached to the bottom of the cabinet (drill, tap, etc.) and four screw-leveling units were also attached. After completing the beast, it isn't going to move by itself, so those screw-leveling units will probably never be used.

In the outer "cavities" of the I-beams, I initially bolted a ~24" of square-tubing (~ 2.25" internal measurement). There were two ½" x 13 bolts welded to the tubing which ran through the web of the I-beam. A nut on either side of the web allowed for adjustment of the tubing relative to the web. I fabricated a piece of heavy angle-iron with two 2" square pieces of tubing (think "U" shaped) welded at right-angles to the angle-iron. The smaller tubing 'telescoped' into the larger pieces while the angle iron ran from left to right under the frame. By adjusting the bolts, the frame was able to smoothly slide up and down on the smaller tubes. The frame was then suspended in the cabinet with the angle-iron/tube assembly in place. That assembly was tack welded in the bottom of the cabinet. The frame was removed and the assembly was throughly welded in place. Having an electric hoist hanging from a beam in the shop ceiling made all of this possible without requiring hernia repairs.

The hydraulic layout consisted of the reservoir being centered at the back and bottom of the cabinet. The motor originally was attached to a plate, was suspended internally on the right side of the cabinet and had its shaft pointing up. There was an oil seal surrounding the shaft. The pump was above the motor. Due to the original motor losing the 'magic smoke' (just before my meeting, of course), the pump had to be spun 180 degrees and the replacement motor mounted above the pump and on the outside of the cabinet (see Fg.2). I think this is actually a much better arrangement with regard to oil leaks into the motor and general ventilation. A low-pressure hose connected the inlet of the pump to the reservoir. A high-pressure 'T' runs from the pump towards the frame. One branch of the 'T' is directed upwards and connects to the gauge which protrudes through a hole in the cabinet top. The other branch connects to a right-angle fitting that, in turn, connects to the valve. The valve is located on an internal bracket on the left side of the interior of the cabinet. The valve control rod extends towards the front of the cabinet, passes to the left of the cylinder (but to the right of the left frame upright) and emerges through a slot in the front of the cabinet. A mechanical linkage connects the rod to a foot pedal (the yellow thing near the floor in Fg.2). There are a pair of hoses running from the top of the valve to the cylinder (it's a GOOD idea to figure out which one does what before buttoning everything up - foot petal down ought to cause cylinder extension and frame movement downwards). From the valve, there is a right-angle turn to the filter and finally a hose from the filter back down to the left side of the reservoir. If I were doing this again, I would make an internal frame, hang all the hydraulics, then wrap that frame in light sheet steel as opposed to shoe-horning everything into a pre-existing space. Oh well, it saved me money. One *really*

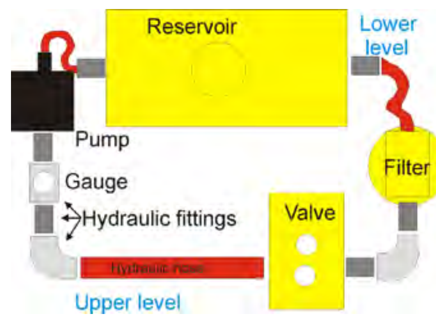


Figure 5: Hydraulic layout

intelligent move is to haul the press to a hydraulic shop when you buy the fittings and hoses. Having it there when the guy discovers he needs to improvise may save you many return trips!

I cut a 7" x 30" slot (½" back from the edge) in the top and also cut a hole for the gauge. The top was slipped over the frame (thanks to that electric hoist again!) and lowered in place. There was also a hole cut above the pump so the motor and its shaft-coupler could mesh with the matching coupler on the pump's shaft. It's a *real* good idea to know which direction (clockwise or counterclockwise) the pump wants to move and then to set up your motor to match (how do I know? Don't ask!). ½" holes were drilled and ½" x 13 nuts welded to the inside of the cabinet. There was also a pair of 3/8" holes (with welded nuts) put in on the front of

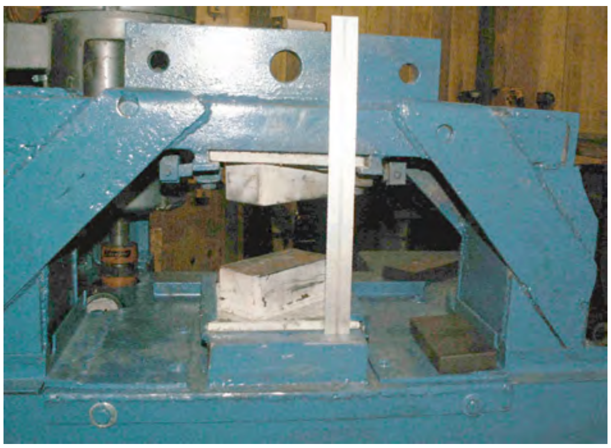

**Figure 6: Closeup of business-end of press**

the cabinet (~ 9" on either side of the center line).

A sheet of 1/4" plate (10" wide) was cut to fit between the uprights on the frame, deep enough to overlap the top and cover the slot, and provided with a front edge that overlaps the front surface of the cabinet top (See Fg.. 6). A large block of steel was welded to the top of the plate to form a base for the lower die blocks and another block was welded on underneath to provide the attachment point for the cylinder. This plate is bolted to the cabinet top using the two 3/8" holes mentioned above and with a pair of additional 3/8" bolts back behind the frame. The heavy block was also provided with light pieces of angle-iron to provide the slides for the lower die blocks. Since the basic idea is to contain any major problems, sheet steel was welded to the insides of the uprights and dust covers were fabricated to close off what remained of the slot between the uprights. In addition, a pair of dust covers were fabricated to cover the openings in the slot to the outside of the frame uprights. Just to be safe, I included a hinged lid on the cabinet top wide enough to allow the business end of a fire extinguisher to get through.

For those who might be following this, you might wonder why the die mount plate was only 10" wide when it could have run from one upright to the other and thus eliminate the need for the internal dust covers. That extra space allows you to get your paws in under the die plate and get the pin into the upper mount of the cylinder. A little help from the hoist, a tapered pin and a brass hammer makes this relatively easy.

Electrical connections consisted of a flexible conduit running from the motor to a outdoor switch box bolted to the side of the cabinet (Fg.2). A 220V switch connects the power cable to the motor lines. Be sure to use heavy enough cable based on you motor. To make getting the top off the cabinet a little less of a hassle, the switch box has a ½" x 13 bolt permanently attached to its back side. The bolt runs through a hole in the cabinet side and is nutted down. If the top comes off, just back off that nut and all the electricals are now free of the cabinet.

The final step(s) were to plug all the holes, cut plate to fit the big openings, fabricate inspection doors, and weld everything in place, slap a coat of paint on it and have a beer. Okay - maybe not yet. Notice the white dies in Fg,6. The dies are blocks of steel welded to 6"x6" x 1/4" plate. They slide into their respective locations and can be rotated as needed. In Fg.6, long work would hit the motor, so just spin the plates 90 degrees.

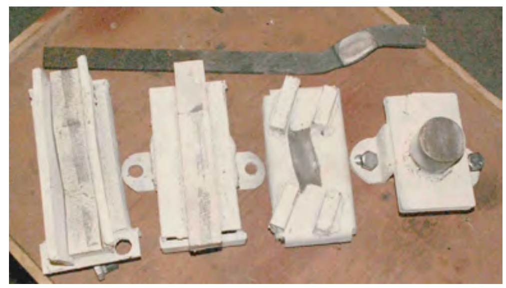

**Figure 7: Tong dies**

Total extension on this system is 7.5" and I've set this pair of dies to allow 4" of clearance. With a 3400 rpm motor, the system cycles from full open to full close in ~ 3 seconds. Weight is maybe ½ ton (and could have been lighter except for the heaviness of the surplus materials). Total build time - probably 40-60 hours (but a lot of that was due to reconfiguring surplus materials!).

As an experiment, I worked up some tong dies (Fg.7). The pair to the left force a bar through the 45 degree bends and the pair to the right positions the tong blank and crushes in the rivet location. The "ears" allow the upper dies to be bolted to the upper die block. Due to good old humid Florida, storage position is frame up (cylinder retracted) with a piece of 2x4 in place (so any slow loss of pressure doesn't result in gravity extending the cylinder and exposing the ram to rust).

Now comes the fun part - figuring out what I'm going to do with it!

**References**

Batson, James. 1994. Build your own hydraulic forging press. Batson Engineering. ~40 pages

Hoover, John B.; Bailey, J L.; Willauer, H D.; Williams, & Handle, F.W. 2005. Evaluation of Submarine Hydraulic System Explosion and Fire Hazards.http://handle.dtic.mil/100.2/ADA441229