

HOW TO MAKE Biomass Briquette Molds

Drawings and Assembly Compendium
Round, Square, Stick, Cube and Chunk



ENGINEERS WITHOUT BORDERS-USA
GREATER CINCINNATI PROFESSIONAL CHAPTER

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Scope of Design

This document is about Choices. Briquetting for any operation requires a biomass mold of one type or another, whether it's a small village, single family, or classroom operation. You have "*choices*" and there are no wrong or right, best or worst, good or bad molds for making biomass briquettes. A variety of molds will work equally well, and one type may be best suited for you depending on the availability of construction materials and tools, cost, skill level, and briquetting requirements. This document provides choices to consider when selecting a biomass mold design.

Choice of Material

We have focused the design effort using USA schedule 40 PVC plastic pipe or dimensioned wood lumber, 1½ inch 38mm thick x 3½ inch 89mm wide. While PVC is a good choice of material to use as a mold, it can be expensive or unavailable in some locations. With that in mind, we present designs using wood as an alternative to PVC. Metal is certainly an option under some circumstances. However, we do not present designs using metal in the document. You may be able to apply some of the designs to metal construction.

We do not recommend using plastic pipe with a wall thickness less than ¼ inch 6mm. Based on a typical biomass pressing requirement of 145 lb/in² (65 kg/in², 1N/mm²) of force, the required pressure on a 3-inch (75mm) briquette with a 1-inch (25mm) hole would be 900 lb (400kg). A 6-inch (150mm) diameter briquette with no hole requires about 4,000 lb (1,800kg) of force. The Easy BioPress Micro Compound Lever Press can easily exceed these force requirements. A wall thickness less than ¼ inch 6mm does not hold up well under this pressure.

The plastic pipe dimensions used in this document refer to 3 inch schedule 40 PVC, ID = 3 inches (75mm), OD = 3½ inches (89mm), maximum working pressure from 130 to 260 p.s.i., and 4 inch schedule 40 PVC, ID = 4 inches (100mm), OD = 4½ inches (114mm), maximum working pressure from 130 to 220 p.s.i.

Plastic pipe sizes and wall thicknesses vary around the world, and you may need to make dimension adjustments to those specified in this document. In addition, make necessary adjustments to accommodate the standard dimensioned lumber found in your local area.

Size & Shape

Often the briquette is round and occasionally square in shape, three to six inches in size, and with or without a center hole. With the introduction of the "Gasifier Stoves" small chunks or cubes of biomass material are desirable to allow for a better performance from the stove. We offer the "Stick & Cube Briquette Mold" as a do-it-yourself solution. The "stick" measures one inch thick (25mm), one 1½ inches wide (38mm) and nine inches long (225mm) and can be segmented for breaking into chunks one inch wide.

Without indentations the 9-inch-long stick can be inserted directly into a rocket stove built for wood, or used as is in a regular stove.

Mold Maintenance

Coating the wood mold with a water repellent substance helps to prevent the wood from becoming waterlogged and helps to reduce the force required to eject the briquette. Good sanding of the gloves prior to applying a protective coating is important to assure easy ejection. Suggested coatings are any synthetic finish like polyurethane, water-based acrylic, linseed oil, new or used motor oil, grease or lard.

After use clean both the wood mold and the PVC mold with water to remove residual biomass.

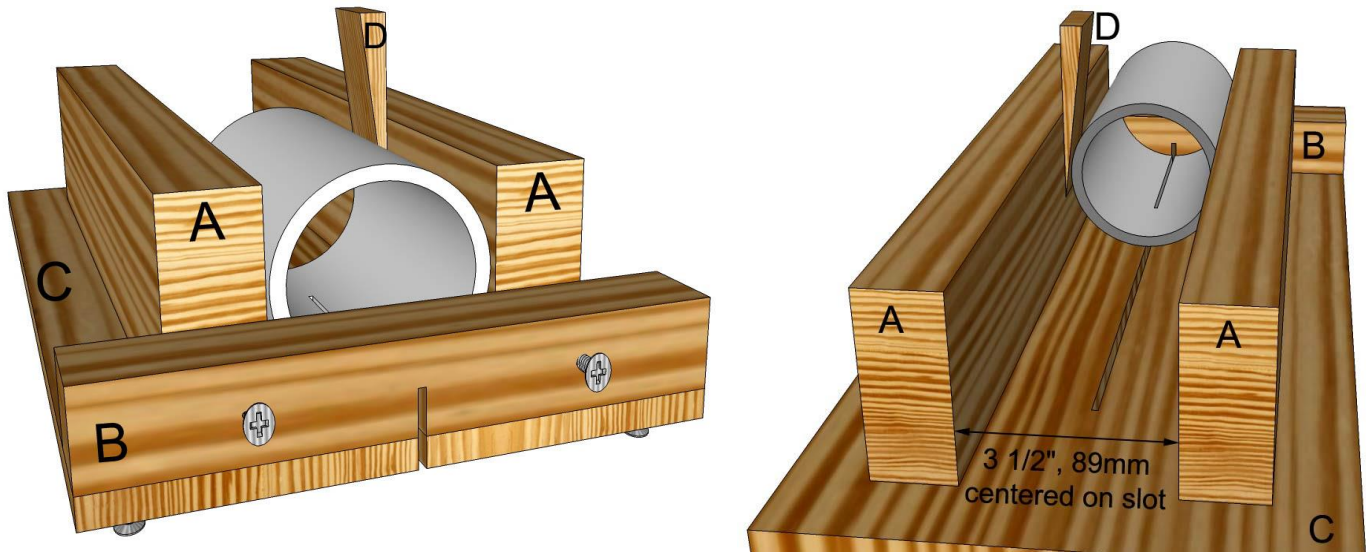
PVC Mold Section
Jigs for PVC Molds

Whether you need a slotted or a drilled PVC mold, safe construction of the mold is an important consideration, and this suggested jig is useful for both types of PVC molds. The jig can be used to support the PVC for drilling, for sawing into two sections, for cutting the vertical slots, and to assist lay-out marks for drilling or sawing.

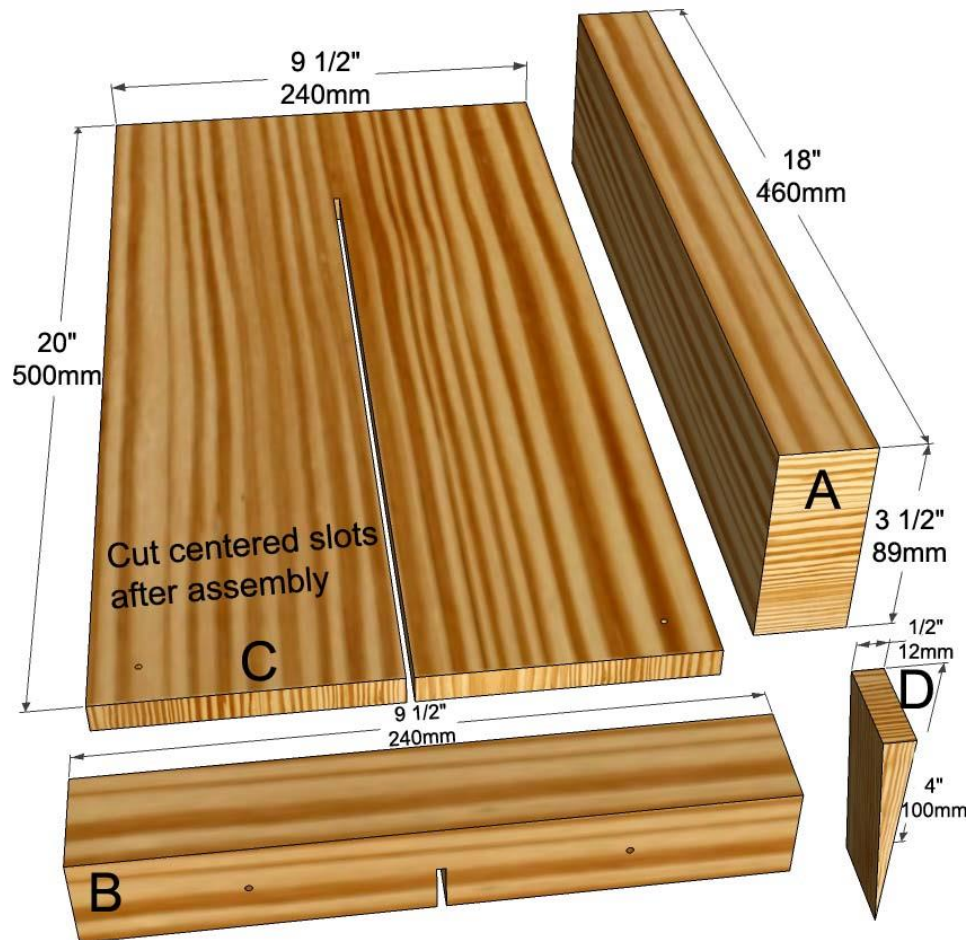
As you can see from the picture below a narrow wedge secures the PVC between two rails supported on a slotted base. The jig support can be used to hold the PVC for both hand tools and power tools such as a table saw, a radial arm saw, or a compound miter saw, aka “chop saw”.

Some typical uses for the jig are pictured below. Dimensions are suggested for use with a 3-inch diameter schedule of 40 PVC. Adjust the length and other dimensions to fit your PVC size.

Part	Name	Size	Length	Description
A	Rails	1 1/2" x 3 1/2" 38mm x 89mm	18" 460mm	Centered to fit PVC
B	End	1 1/2" x 1 1/2" 38mm x 38mm	9 1/2" 240mm	End Stop
C	Base	Any thickness from 1/4" 6mm and up	9 1/2" 240mm x 20" 500mm	Base, NO nails/screws in the center of part B
D	Wedge	1 1/2" 38mm x 1/2" 12mm	4" 100mm	Used to secure PVC



Assemble rails A centered on base C for a slightly snug fit to the PVC. Use wood screws or nails to fasten the parts, but do not fasten near the center of part B, allowing for a safe cutting saw space.



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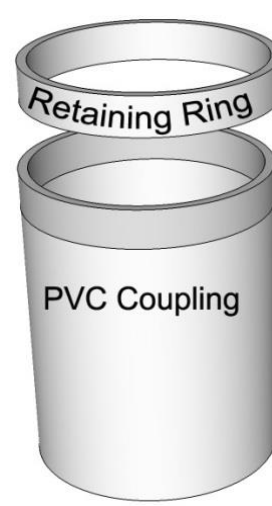
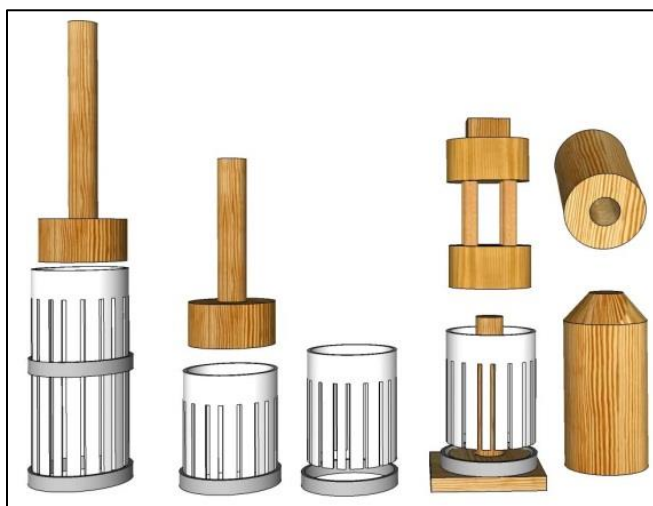
After complete assembly use a table saw or hand saw to cut the centered slot. Do NOT cut part C into two sections. Leave a couple of inches of wood at the far end.

Vertical Slotted PVC Mold



Vertical slot drainage provides less ejection stress on the briquette compared to the traditional PVC mold using drilled holes, requires less ejection force (typically ejected by hand), and is self-cleaning as the briquette ejects. This configuration allows for a faster thru-put because the press is not typically required to eject the briquette, allowing the press to immediately compress the next mold rather than eject the previous briquette.

The slots begin near the top of the mold and continue to the bottom forming a flexible finger. A retaining ring holds the fingers in place during the compression stroke and is removed for ejection. Center to center slot spacing is suggested to be between $\frac{3}{8}$ " and $\frac{5}{8}$ " 10mm to 15mm depending on the length of the mold. We recommend $\frac{3}{8}$ " 10mm center to center spacing for most molds. $\frac{1}{2}$ " 12mm spacing is suggested for the 16" 400mm tall mold. Leave at least 1" 25mm of uncut PVC at the top of the mold.



The retaining ring can be cut from the end of a coupling used to join two sections of 3" PVC. The recommended mold height for use with the micro compound lever press is 4" 100 mm high. Select a plunger rod and piston from the plunger section of this document that best fits your situation.

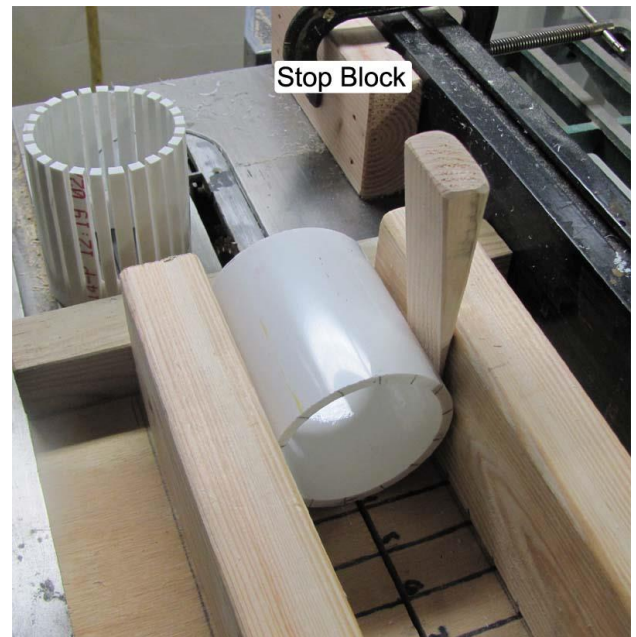
Pictured above are suggested configurations along with a picture of a 16" 400 mm mold used for testing.

Cutting PVC Slots

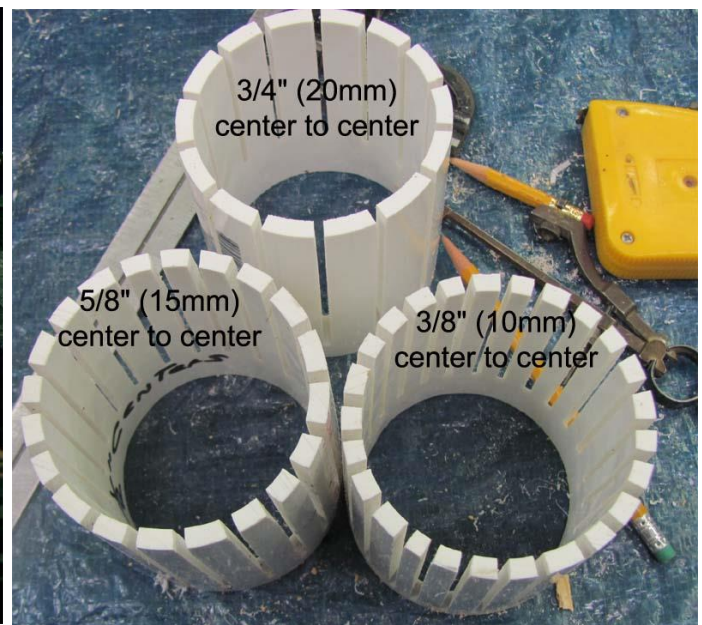
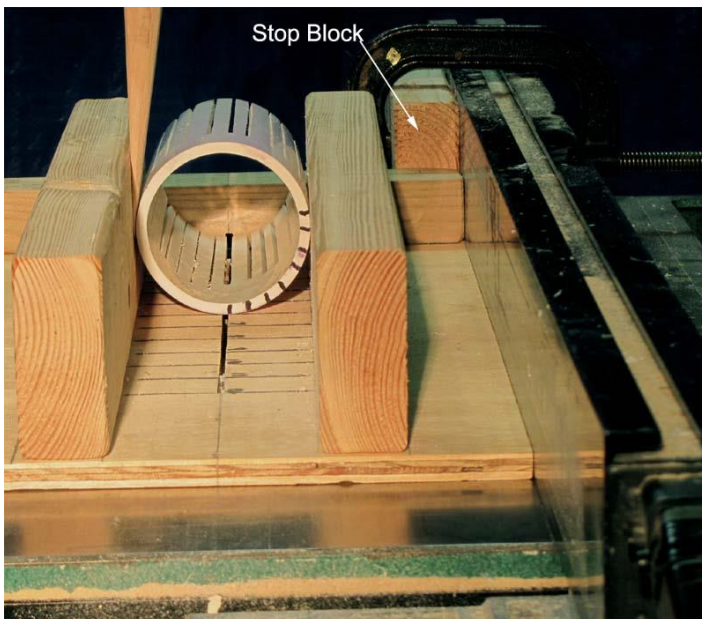
A power saw or hand saw can be used to cut the slots for a vertical slotted mold. Below are a few examples for cutting the slots. Use the PVC jig described earlier. Wear the appropriate safety glasses and hearing protection as suggested by your local authorities.



Mark center to center spacing



Secure in jig using wedge, adjust stop block for proper depth of cut



Hold the jig against the rip *fence* as the cut is made. 3/8", 10mm is an ideal slot spacing for most molds, with 1/2" 12mm used for the 16" 400mm mold.

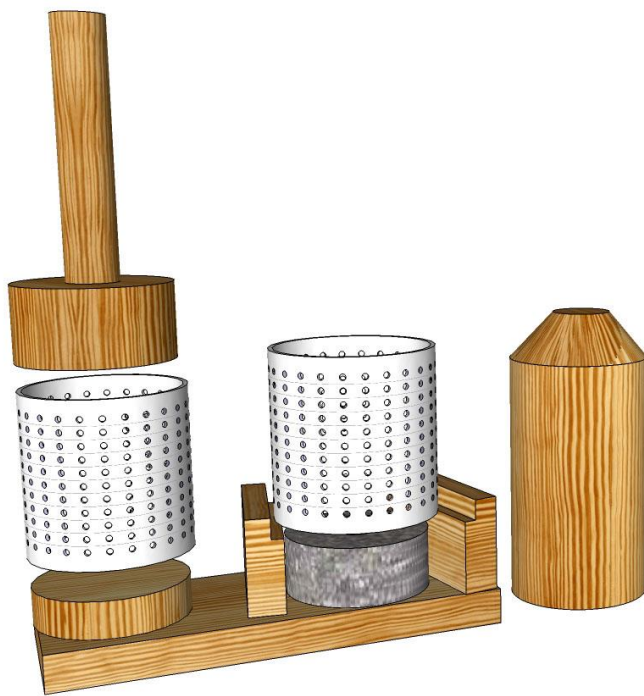


Compound Miter Saw, aka "Chop Saw" Radial Arm Saw Draw a mark around the circumference where the cut is to stop

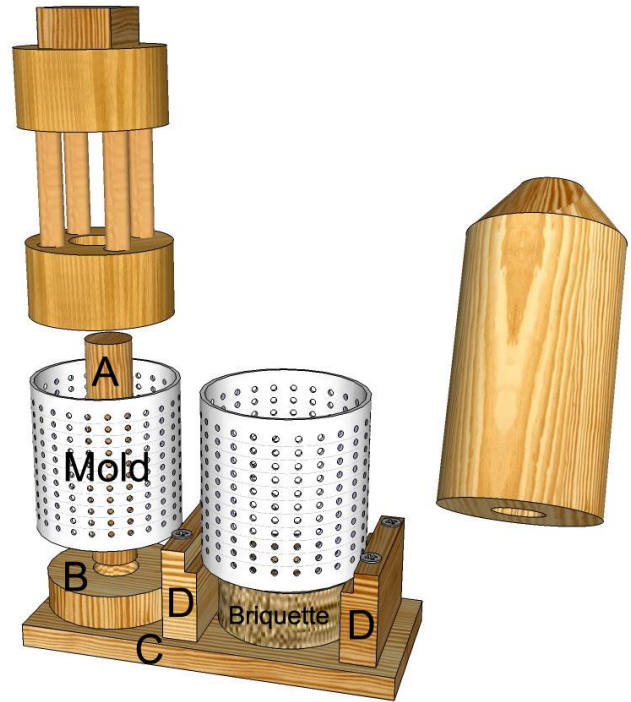


Drilled PVC Mold

Start with schedule 40, 3" 75mm diameter PVC cut to 4" 100mm in length. Lay-out markings to drill 1/8" 3mm to 3/16" 5mm holes spaced from 1/2" 12mm to 3/4" 20mm center-to-center. Deburr and clean both inside and outside of the drilled mold. Sand edges to smooth. If you are making briquettes with a center hole, drill a hole in base B to accommodate the center post or drainage tube. A suggested briquette jig for 3" drilled PVC is shown below. The circular base can be drilled with a center locating hole to position and hold a post or drainage tube used to form a center hole in the briquette.



Jig for solid briquette



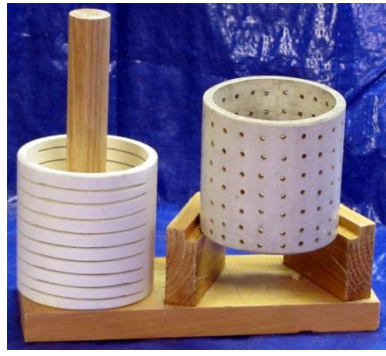
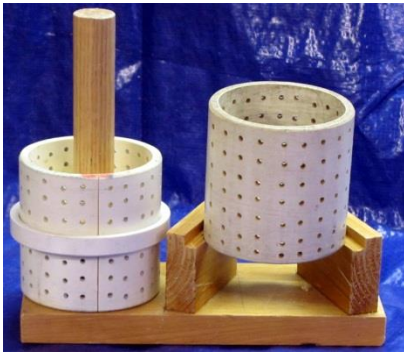
Jig for center hole briquette

A Center Post 1-pcs 5" 125mm long x 1" 25mm diameter or whatever is available.

B Locating Base 1-pcs 1/2" 12mm thick x diameter for a slightly loose fit inside the mold. Center hole 1 1/8" 28mm if using 1" center post.

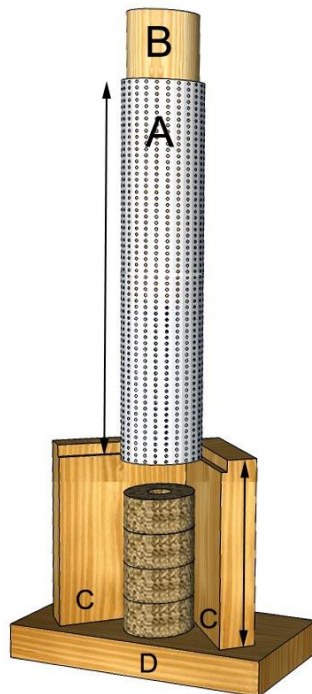
C Base Plate 1-pcs 3 1/2" 89mm wide x 9" 225mm long x from 1/2" to 1 1/2", 12mm to 38mm thick.

D Ejection Rails 2-pcs 3 1/2" 89mm long x 2" 50mm high x thickness from available material. Cut a 1/4" X 1/4", 6mm x 6mm notch at top inside of rail to support the mold. Attach to base C at an angle so the back is narrower than the front making it easy to slip the mold onto the rails from the front.



This can be used for drilled, solid or split mold, or horizontal slot mold.

Large PVC Molds



The large compound lever press shown below will typically use a 16-inch-tall mold as shown and often has a built-in briquette removal rail mounted on the press. There are occasions when a movable ejection rail is useful. The above diagram is an easy solution to that need. The wood stock is from 1 ½" 38mm x 5 ½" 140mm stock. The height of part C is determined by the number and height of briquettes to be ejected from the mold. At the top of part C there is ¼" x ¼", 6mm x 6mm, notch on the front side of part C to rest the edge of the PVC mold during ejection.



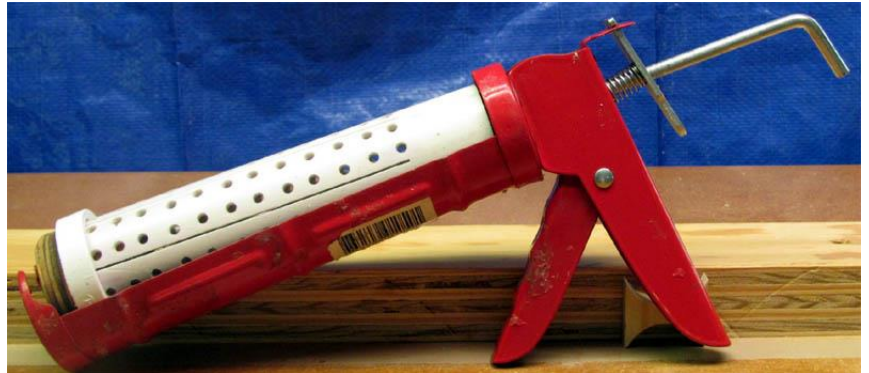
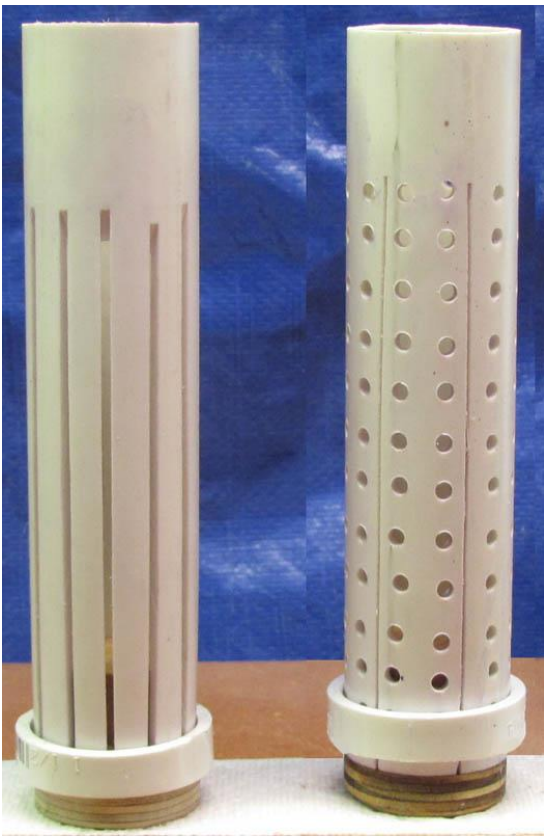
Large Press Briquette Removal Rail Large Compound Lever Briquette Press

Caulking Gun Press & Mold (Open Frame)

The caulking gun press & mold is a quick & easy low-cost approach for making a few briquettes. This design uses the USA standard caulking gun for a 10oz tube. The mold is from PVC sold in the USA as 1½" schedule 40 and measures an OD = 1 15/16" 49 mm, ID = 1 9/16" 40 mm, wall thickness = 5/32" 4mm. This size is a perfect fit compared to the standard 10oz caulking tube. Compressed biomass in a tube this small can be very difficult to eject and ease of ejection is an important consideration.



We solve this problem with the use of slotted molds, both the drilled mold and by use of the vertical slotted mold. Both molds use a retaining ring to hold the slots in place during compression. The rings are ½" 12mm wide cut from the end of a 1½" 38mm coupling or elbow. The open tube is closed at one end with the use of an end cap as shown in the picture below. Typically, two briquettes can be made with a spacer between the two fillings of biomass material. After compression, the end cap and the retaining ring are removed, and the briquettes slide out easily with a push rod.



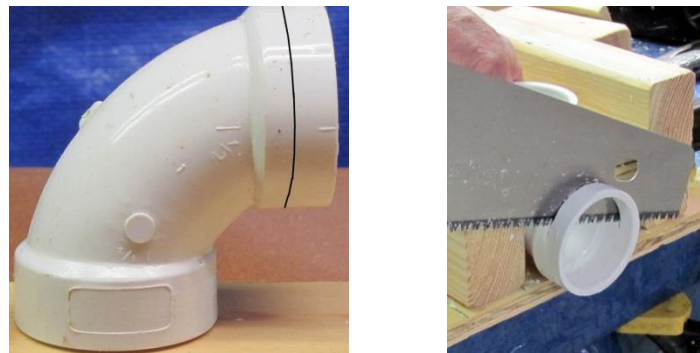
Vertical slotted mold and a four-slot drilled mold with retaining ring and end cap.

Caulking Gun Mold Dimensions (Cut four slots in the mold as shown.)





Use the PVC jig to hold the 1½" PVC for drawing lines and for sawing. A block of wood against the PVC helps the wedge to be more effective as shown in the right hand picture above. Slots can be cut by any of the methods described in the vertical slotted PVC mold section.



The retaining ring is cut from the end of a 1½" coupling or elbow as shown above.



Attach retaining ring and end cap. You may need to hold the end cap in place with one hand while using the other hand to make the first filling. Experiment to determine the correct amount of biomass for each of the two fillings. Insert the spacer and gently compress using the removal push rod. Make the second filling and insert a second spacer as the final step in the filling procedure.

We originally used plastic spacers made from 1/8" 3mm stock but had difficulty with them turning sideways inside the tube during the filling process. Switching to ¾" 19mm thick wood spacers easily solved that problem. Coating with motor oil or other water-resistant coatings is important to prevent them from expanding and lodging inside the tube.

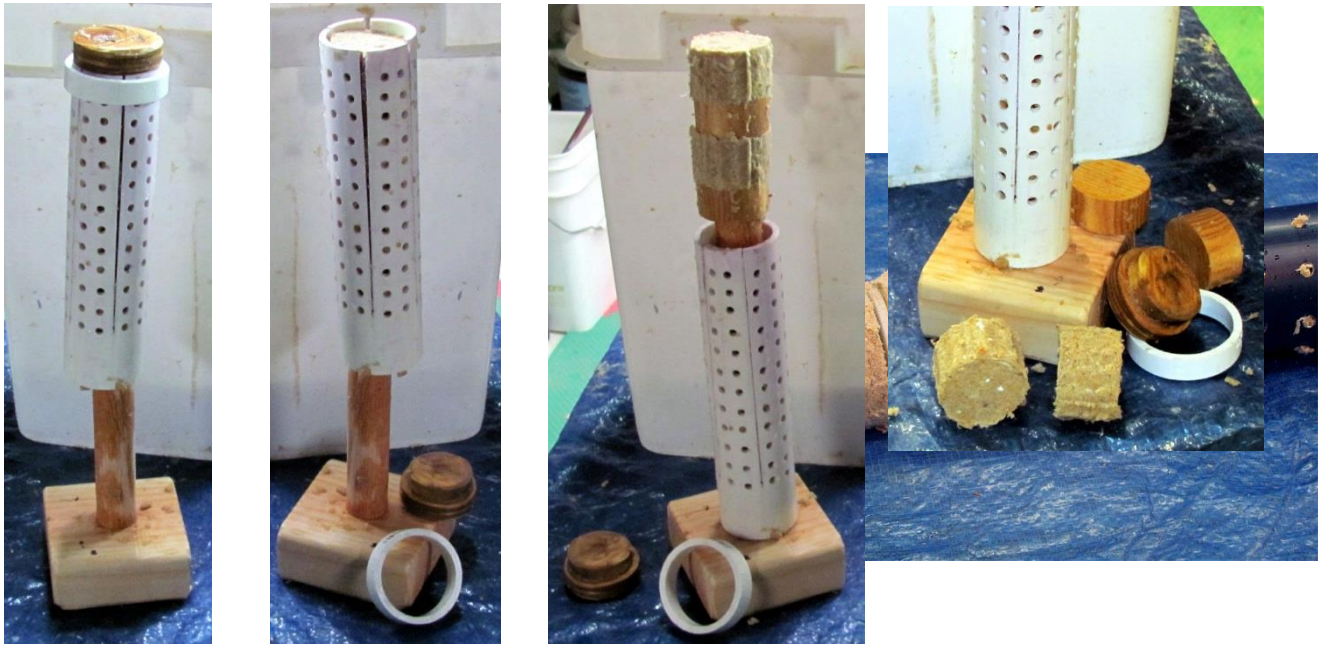


Holding the end cap in place with one hand, use the other hand to guide the tube into and under the lip of the plunger end of the caulking gun. Compress the biomass until adequate pressure has been achieved.



Removal of the mold requires the release of the plunger pressure lever by pushing on the plunger release lever shown in the picture above. This can be quite difficult by hand, and we recommend tapping with a small block of wood or hammer to release it.

Rest on removal rod, remove end cap and retaining ring, and gently push the briquettes from the mold.



Caulking Gun Briquette Press (Bulk Load)

An alternate approach for a caulking gun briquette press is the "bulk loading gun" where the mold is an integral part of the press. The model shown is a COX 51001-2T with a solid 2" 50mm ID barrel, 14" 355mm long with a quick release endcap designed for bulk loading. This model has a 26:1 load magnification. Testing determined that a less expensive model with a ratio of 12:1 (model 51001) was quite adequate.



Half of the barrel was drilled with 3/16" 5mm holes using 3/4" 19mm spacing starting at the removable end-cap end of the barrel as shown to the right. 1/8" 3mm holes are better since they clog less. Spacing can be reduced to 1/2" 12mm and would be more than adequate to accomplish good drainage.



The ID of the barrel is 2" 50mm. Spacers shown to the right measuring slightly under 2" 50mm in diameter were cut from 1/8" 3mm plastic stock for use in separating multiple briquettes in the same load. However, we had the same problem with these spacers we had when using them is the open frame gun above. They had a strong tendency to turn sideways and become buried and lodged vertically in the loose

biomass. For the same reason as before we recommend using spacers cut from $\frac{3}{4}$ " 19mm stock to prevent rotating sideways inside the barrel.

The picture to the right uses $\frac{3}{4}$ " 19mm wood spacers soaked in used motor oil.

Pressing three briquettes measuring 1" 25mm thick was the most this barrel could accept.



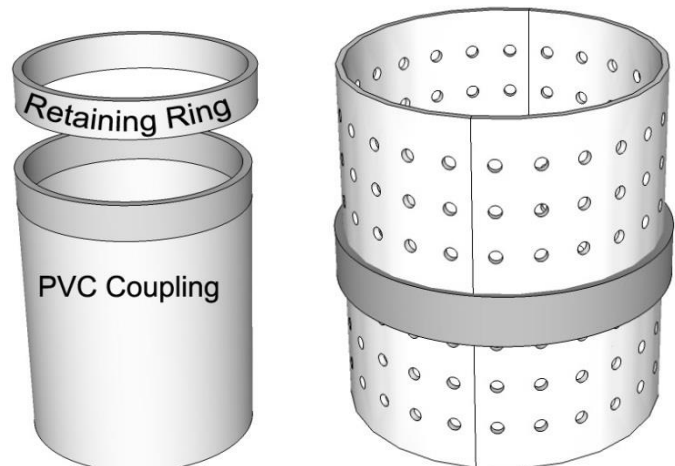
An addition, a drilled disk was used in the quick release endcap and helped with better drainage. A section slightly over 2" 50mm in diameter was cut from the $\frac{1}{8}$ " plastic (could be metal) stock and randomly drilled with $\frac{1}{8}$ " holes.

You may find it helpful to use a pusher rod slightly under 2" 50mm in diameter to assist installing the spacers between loads of biomass.



Recommended changes are to use $\frac{1}{8}$ " 3mm drainage holes in addition to drilling a few randomly located holes in the second half of the barrel (toward the handle end) to prevent water from building up during the loading process.

Split PVC Mold



Use of the split mold is suggested where less ejection stress on the briquette or where ejection away from the press is desired.

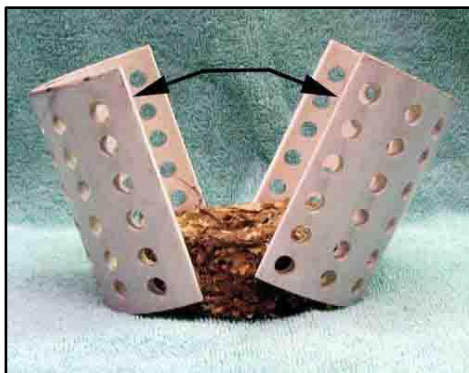
A drilled or horizontal slot mold can be cut in half vertically and held together by a ring $\frac{1}{2}$ " 12mm wide cut from the end of a coupler used to join two sections of PVC together. Typically, the material removed by the saw blade is sufficient to allow the mold to fit

snuggly inside the retaining ring. A retaining ring can also be cut from wood or other available material.

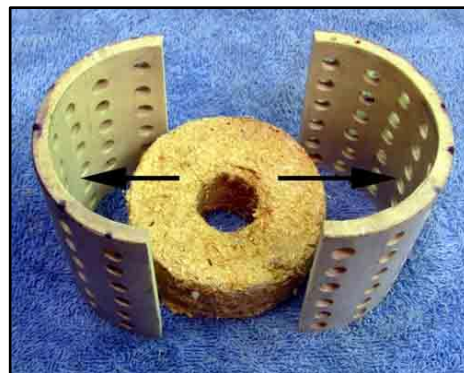
After the biomass has been compressed, remove the ring from either the top or bottom of the mold, whichever is easier, and open using one of the methods shown below.



Book Open



Tilt Open



Slide Open

Slotted Wood Mold Section

Vertical slotted wood as an alternative to drilled PVC molds is suggested for use where PVC is difficult to acquire, expensive, or an alternative construction method is desired.

Vertical slot drainage provides less ejection stress on the briquette compared to the traditional round PVC mold using drilled holes. The molds are designed for quick and easy ejection of the briquette allowing for a faster thru put.

If you change dimensions, it is important to consider maintaining an expansion space after the briquette is ejected from the mold. In general, biomass is elastic in nature and under considerable compression inside the mold. As the briquette ejects from the mold it expands requiring an increased ejection space. The off set from foot "C" allows for that expansion.

Stick & Cube Slotted Wood Mold

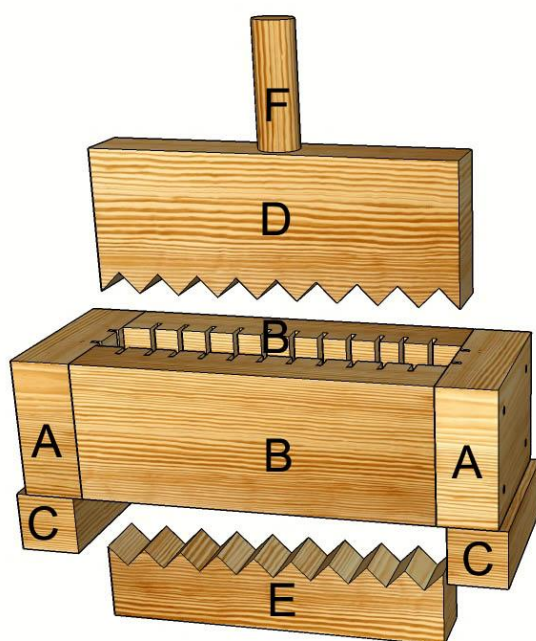


Cubes

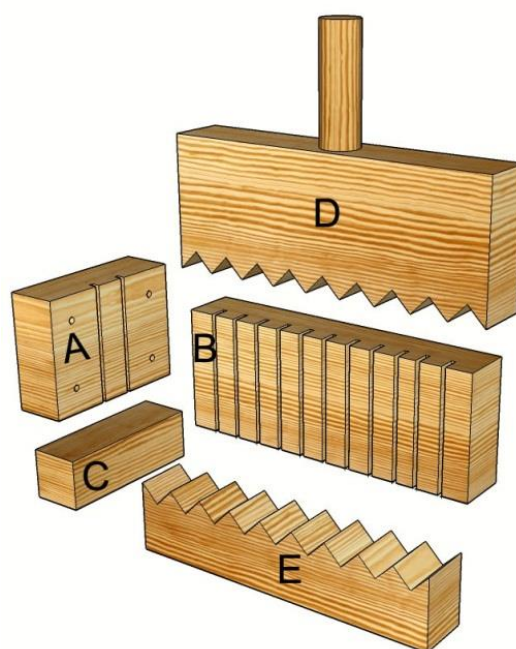


Sticks

The biomass stick measures 9" x 1 1/2" x 1", 225mm x 38mm x 25mm. The dried briquette can be used directly in a "Rocket Stove" or broken into smaller sections for use in a "Gasifier Stove" or other biomass stoves.



Labeled Parts

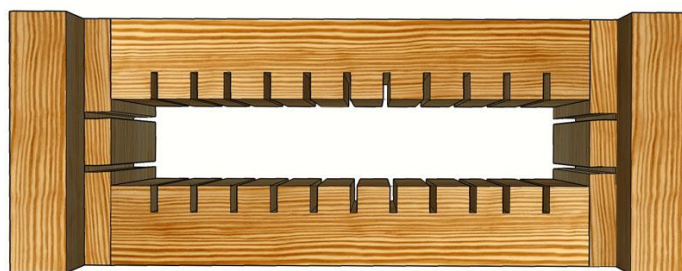


Exploded View

Wood stock is 1 1/2", 38mm thick, slots are the width of the saw blade and not to exceed 1/8", 3mm. It is particularly important to keep the wood grain orientation as indicated by the pictures to maintain structural strength during compression. Parts A & B are fastened together using screws. Base E remains detached and is removed for briquette ejection. It is important to sand the slots well, and to coat the mold with a water-resistant covering like polyurethane, motor oil, wax, grease, lard, etc. to maintain good ejection and long-term operation.



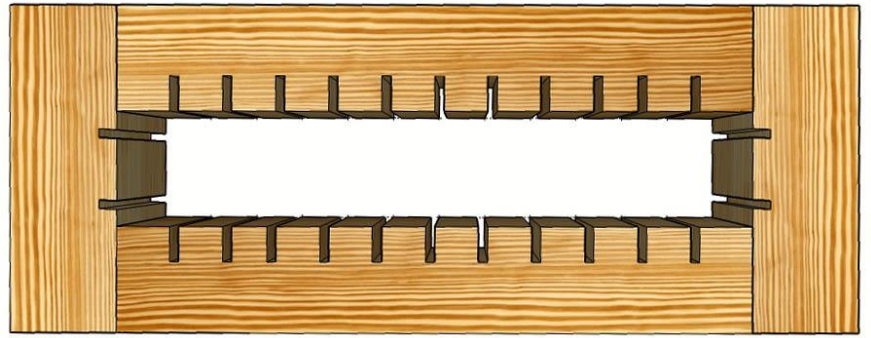
Internal View



Bottom View



Internal View



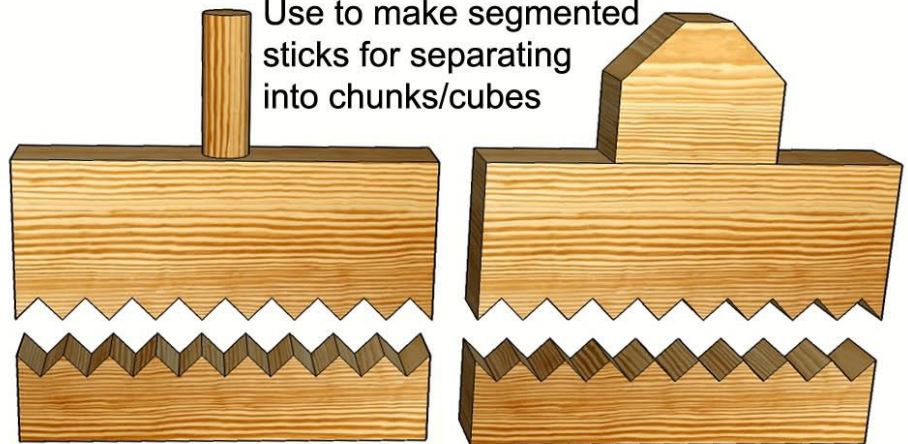
Top View

Stick & Cube Plungers

Use to make
Stick Briquettes

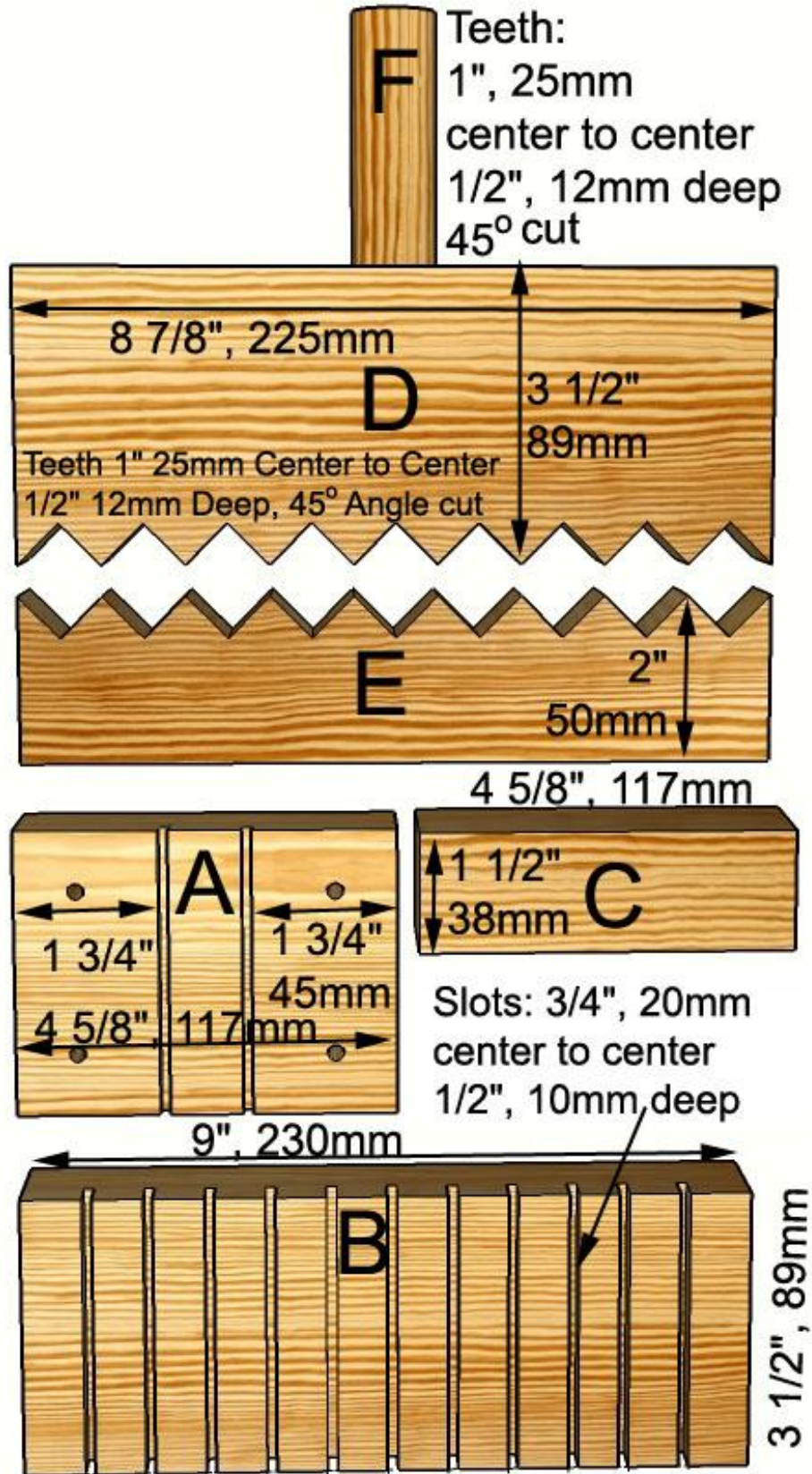


Use to make segmented
sticks for separating
into chunks/cubes



Plunger & Foot

Parts Diagram



Parts List, Stick & Cube Mold

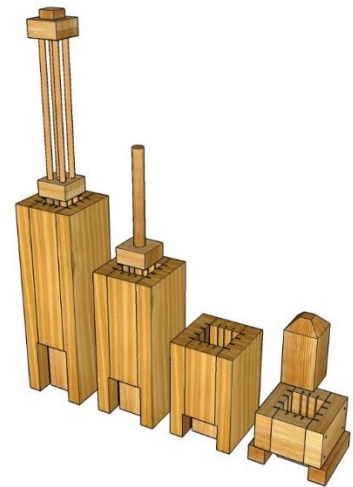
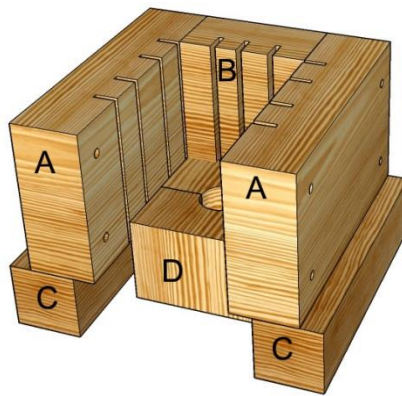
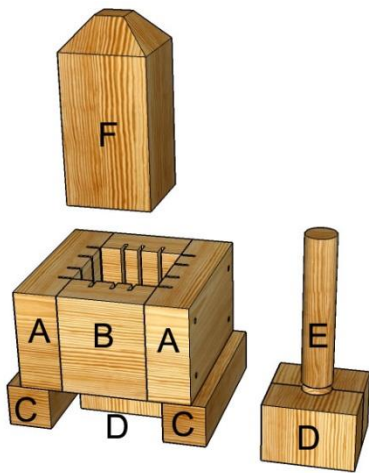
- A End 2-pcs 4 5/8" 117mm wide" x 3 1/2" 89mm tall, 2-slots 1/2" 10mm deep, 1 3/4" 45mm from side. Four screw holes located 1/2" 12mm from the edge per the drawing.
- B Side 2-pcs 9" 230mm x 3 1/2" 89mm, slots on 1/2" 10mm centers, 1/2" 10mm deep.
Make certain the inside distance between sides B & B is about 1 5/8" 41mm to allow ample room for the plunger. It can be useful to insert a thin section of cardboard between the plunger and one side when fastening together parts A & B.
- C Feet 2-pcs 4 5/8" 117mm long from 1 1/2" x 1 1/2", 38mm x 38mm stock.
Attach to part B using nails or screws.
- D Plunger 1-pcs 8 7/8" 225mm x 3 1/2" 89mm from 1 1/2" 38mm stock,
fitted with a 1" 25mm dowel rod.
Make the overall height of the plunger and dowel rod 7" 175mm.
See plunger section for options.
To make cubes or chunks cut teeth spaced 1" 25mm apart.
and 1.2" 12mm deep, 45° angle cut.
- E Base 1-pcs 8 7/8" 225mm x 2" 89mm from 1 1/2" 38mm stock.
On one side cut teeth spaced 1" 25mm apart and 1.2" 12mm deep, 45° angle cut.
Flip to the smooth side to make "Stick" briquettes.

Square Slotted Wood Mold

When PVC is not an option, or you need a square briquette, wood or metal is an option. Below are vertical slotted wood molds useful for making a single briquette and for making 2, 3, or 4 briquettes in one filing of the mold. After compression, remove the base and continue pressing on the plunger will eject the briquettes. Ejection of the briquette after compression is easily accomplished by hand pressure for the single or dual briquette mold.



Parts Labeled



Top View



Bottom View



Open view

Square Slotted Wood Mold Dimensions

A Side 2-pcs 6" 150mm wide" x 3 1/2" 89mm tall, 4-slots 1/2" 10mm deep, 1 1/2" 38mm from side and 2 3/8" 60mm from side. Four screw holes located 1/2" 12mm from the edge per the drawing.

B End 2-pcs 3" 75mm wide x 3 1/2" 89mm tall, 3 slots 1/2" 10mm deep, two slots 3/4" 20mm from side and the third slot centered on stock.

Make certain the inside distance between sides B & B and A & A are about 1 5/8" 41mm or less to allow ample room for the plunger. It can be useful to insert a thin section of cardboard between the plunger and one side when fastening together parts A & B.

C Feet 2-pcs 6" 150mm long from 1 1/2" x 1 1/2", 38mm x 38mm stock.

Attach to part A using nails or screws.

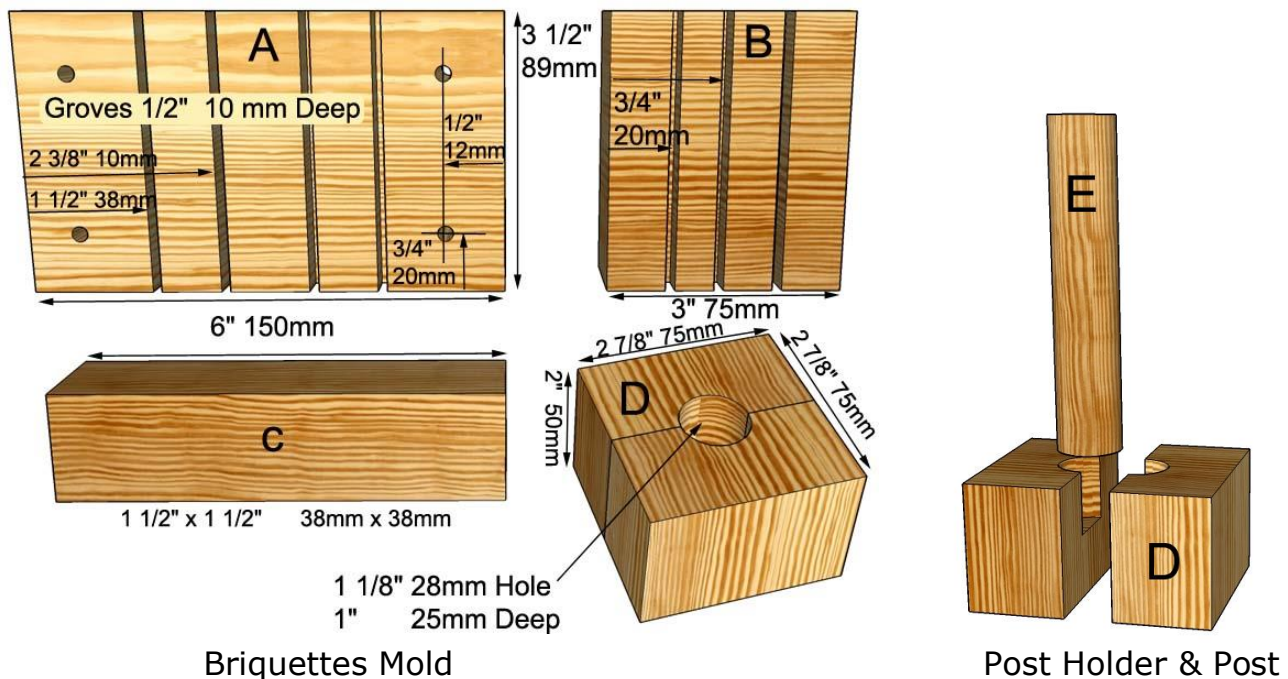
D Plunger Base From two pieces of 1 1/2" stock. Each half 2 7/8" wide x 1 1/2" thick x 2" tall. 70mm x 38mm x 50mm. Position the grain to run vertical.

E Post 1" 25mm diameter, 4" 100mm tall.

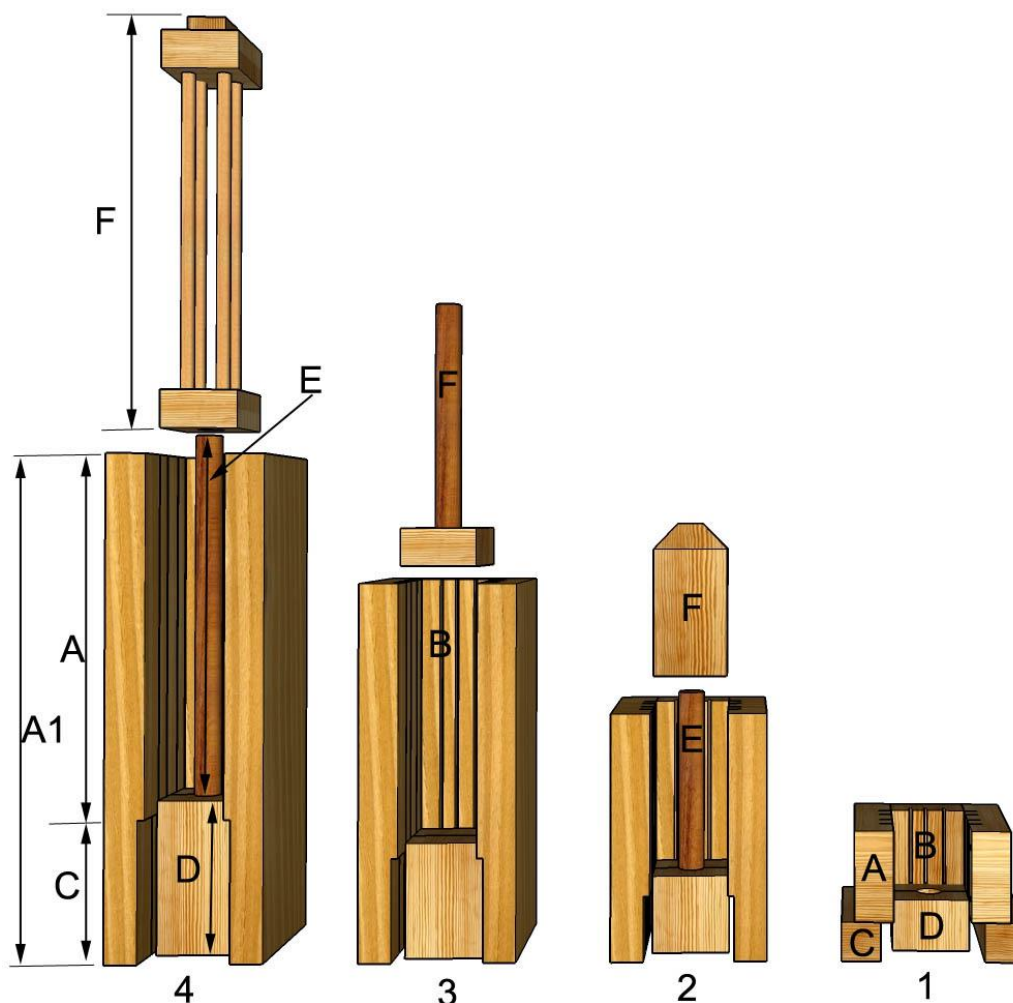
F Plunger 1-pcs 2 7/8" x 2 7/8", 70mm x 70mm, square, x 6" 150mm tall.

Taper top to assist center alignment on the press.

See the plunger section for more options.



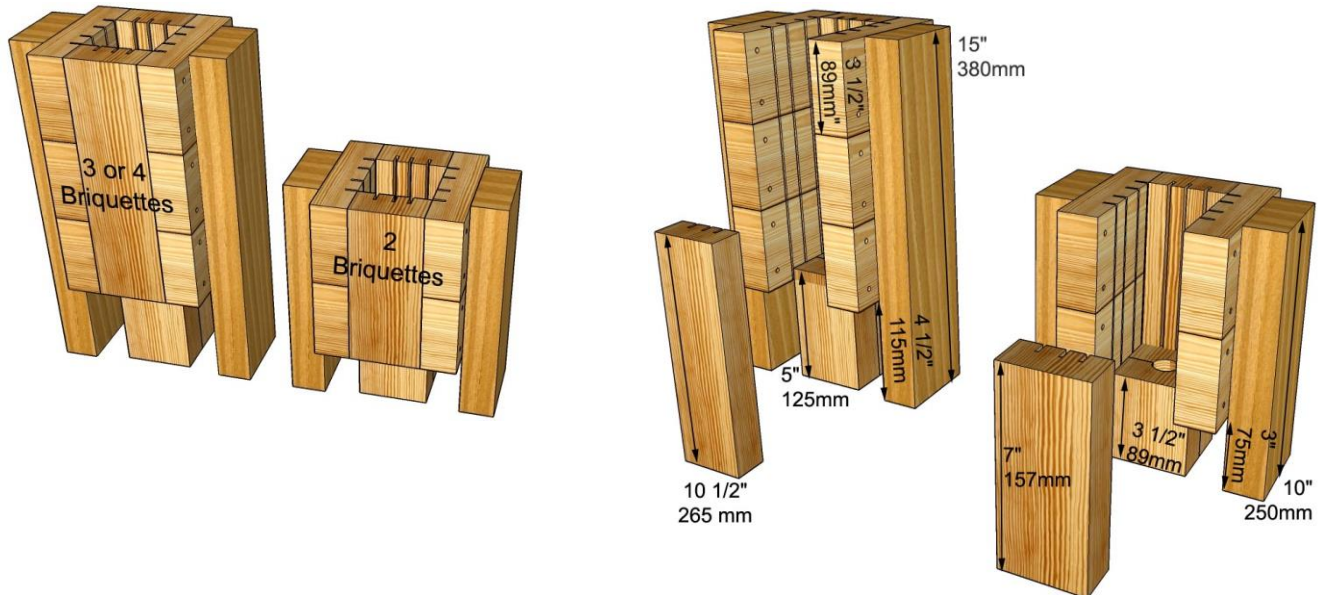
Multiple Briquettes Square Mold Dimensions



Briquettes Per Mold	A 6" 150mm wide	A1	B 3" 75mm wide	C Height	D 2 7/8" x 2 7/8"	E 1" 25mm Post	F Total Height
1	3 1/2" 89mm	5" 125mm Tall	3 1/2" 89mm Tall	1 1/2" 89mm Tall	2" 50mm Tall	4" 100mm	6" 150mm
2	7" 175mm	9 1/2"	7" 175mm	2 1/2"	3" 75mm	7 1/2"	7" 175mm
3	10 1/2"	14 1/2"	10 1/2"	4" 100mm	4 1/2"	11"	10 1/2"
4	14"	19 1/2"	14"	5 1/2"	6"	15	14

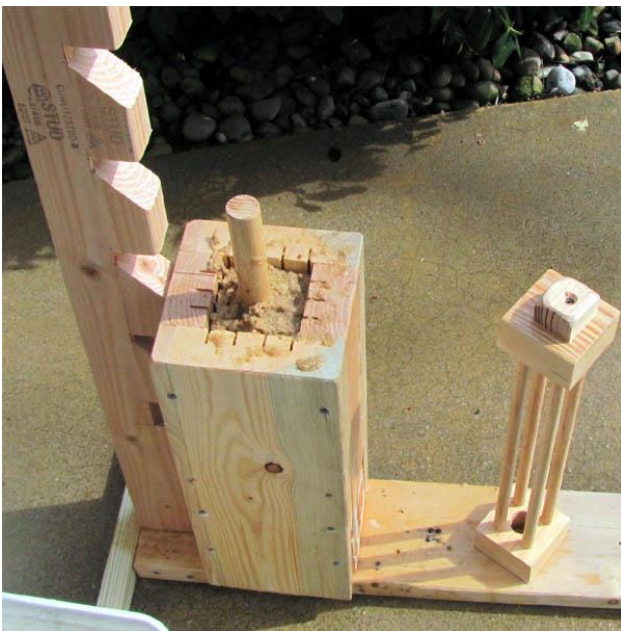
Multiple Briquettes Square Slotted Wood Mold Alternate

If you do not have access to lumber wide enough to make part A (6" 150mm) or cutting the notch in the bottom of part A is not possible, below is an alternate configuration. This approach requires more wood and the other design but may be the best overall choice. Below are the dimensional changes required.



Use spacers to separate each filling.

Making Briquettes using Square Slotted Wood Mold (Four Briquette Version)



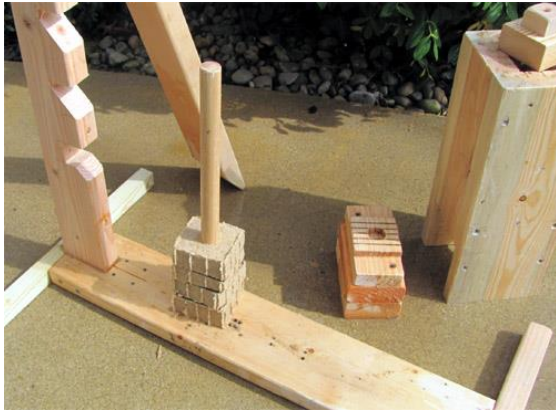
Mold filled using 3 spacers



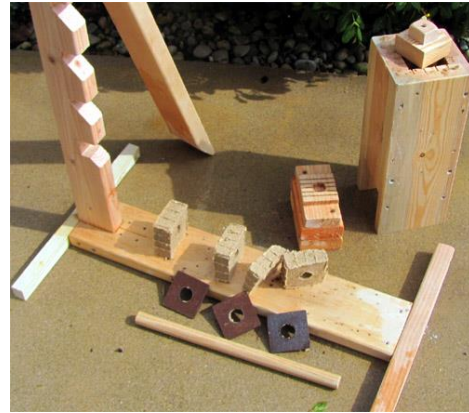
Plunger inserted



After compression.



Briquettes ejected with post

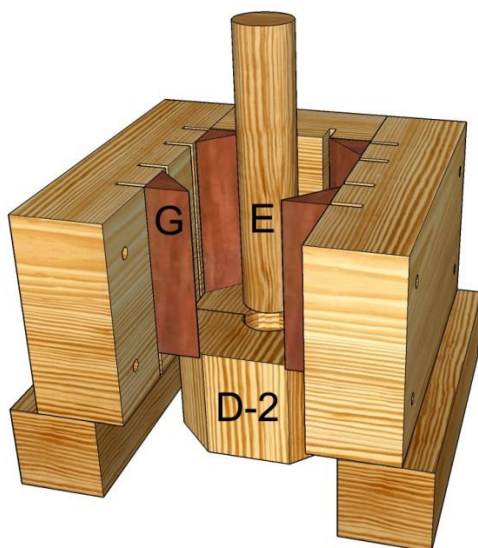
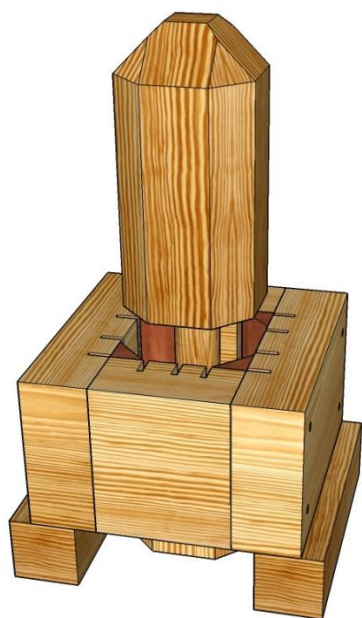
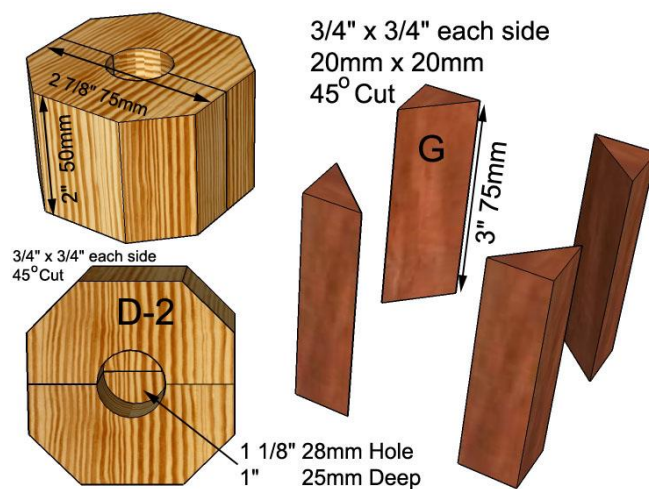


Post, spacers and briquettes.



Sun drying

Quasi Round Slotted Wood Mold



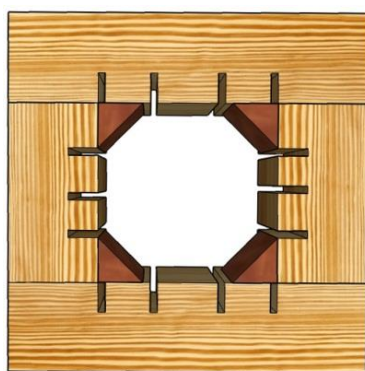
6", 150mm Total Height
3/4", 20mm Stock



Adding parts G and D-2 to the square mold makes a quasi-round mold



Side View



Top View



Bottom View

Plunger Piston & Rod Section

Crafting a plunger piston & rod can be done any number of ways using your local resources and materials. The use of solid wood may or may not be possible in your area. If not, consider making the piston using the split piston method described below.

Split Plunger Pistons

When a briquette with a center hole is required the center post must extend into the plunger piston. Drilling an accurate hole centered in the stock to accommodate that post can be a challenge. Often, an easier method is to use a split piston and manufacture the hole in each half of the piston. Typical examples are shown below.

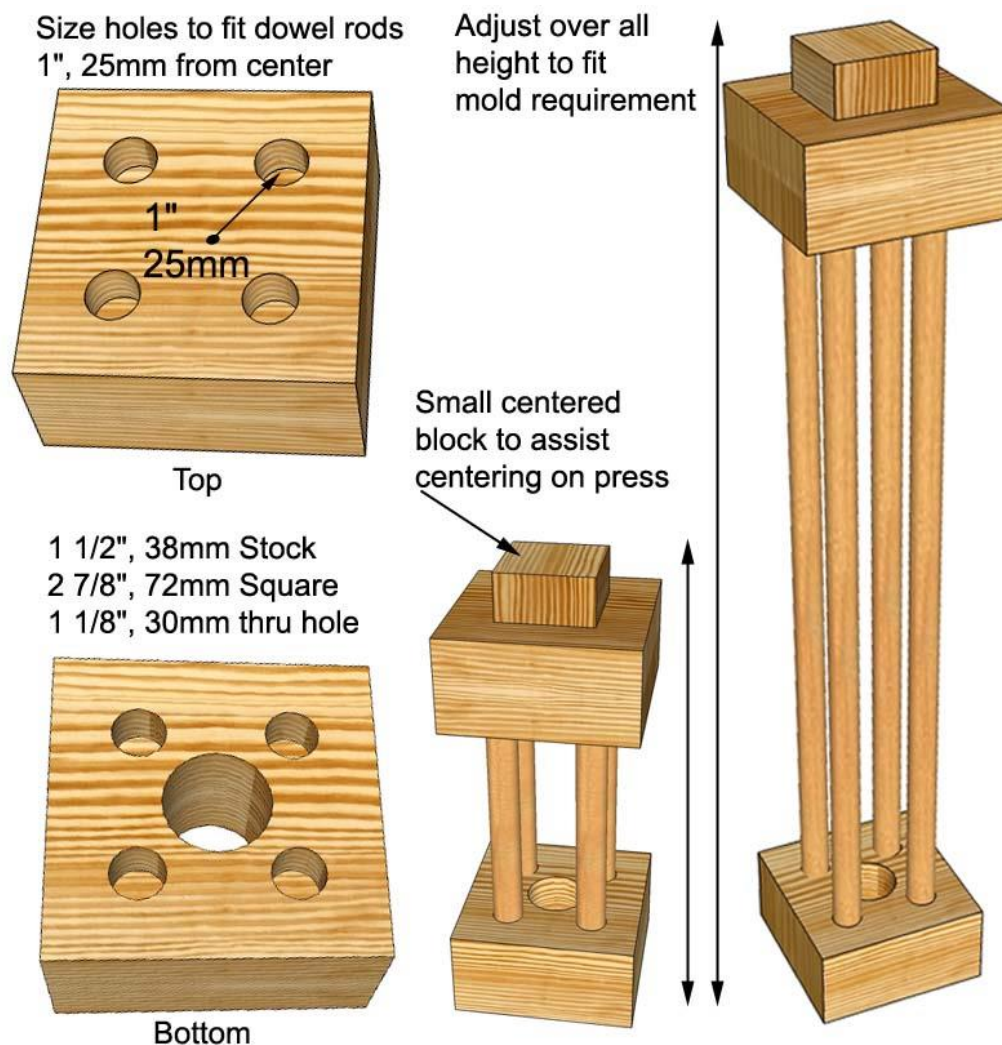
The diamond shaped hole can be cut in each half using a tilted blade on a table saw. The square hole can also be cut using several passes on a table saw using a rip-fence guide. The round hole is when large stock is not available, and two halves must be joined and then drilled to size. Gouges and chisels work well when power tools are not available.

Care is recommended when joining the two halves to position the fasteners, nails, or screws accurately to avoid interfering with further construction after the joining.

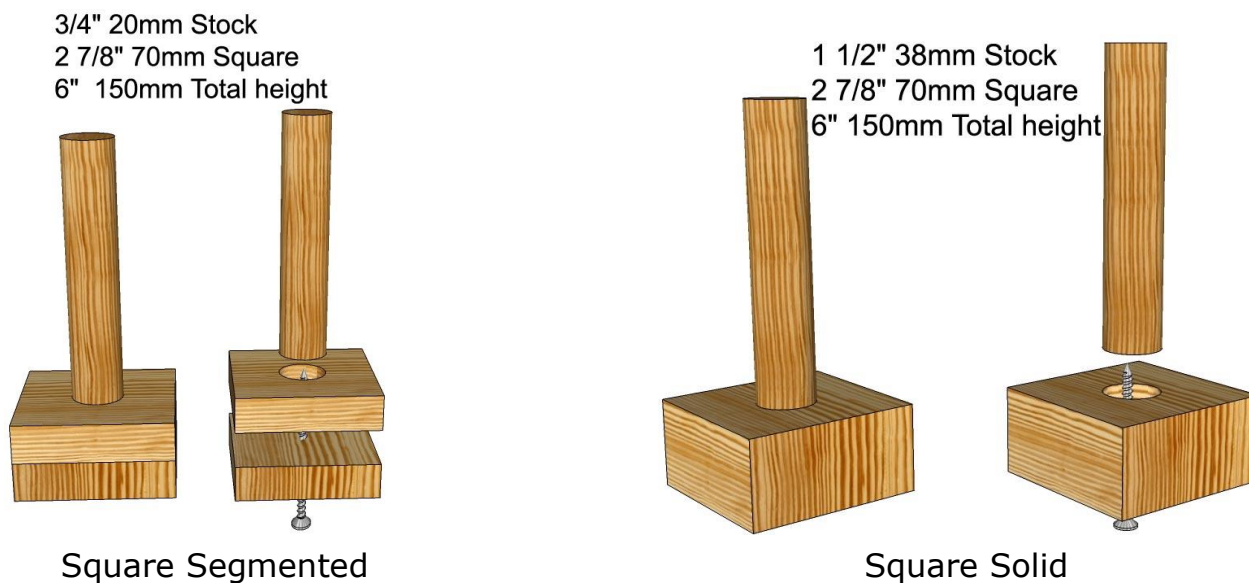


Square Dowel Rod Plunger Piston

Another alternate method is to use dowel rods between the top and bottom base as shown below.



Square Post & Plunger Piston



Round Dowel Rod Plunger Piston

Size holes to fit dowel rods
1", 25mm from center



Top

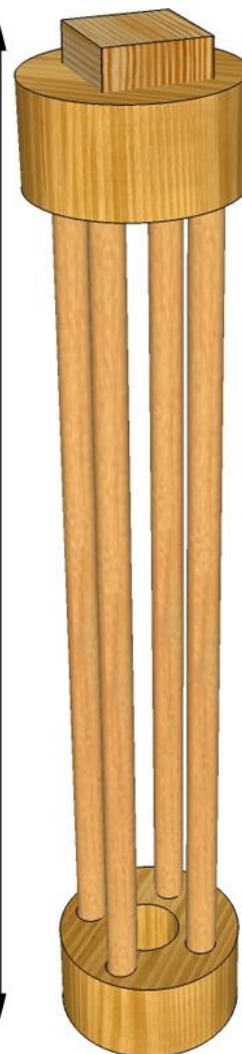
1 1/2", 38mm Stock
2 7/8", 72mm Round
1 1/8", 30mm thru hole



Bottom

Adjust over all
height to fit
mold requirement

Small centered
block to assist
centering on press



Round Post & Plunger Piston

6", 150mm Total Height
2 7/8", 72mm Round
3/4", 20mm Stock



Round Segmented

1 1/2", 40mm Stock
2 7/8", 72mm Round
6", 150mm Total Height



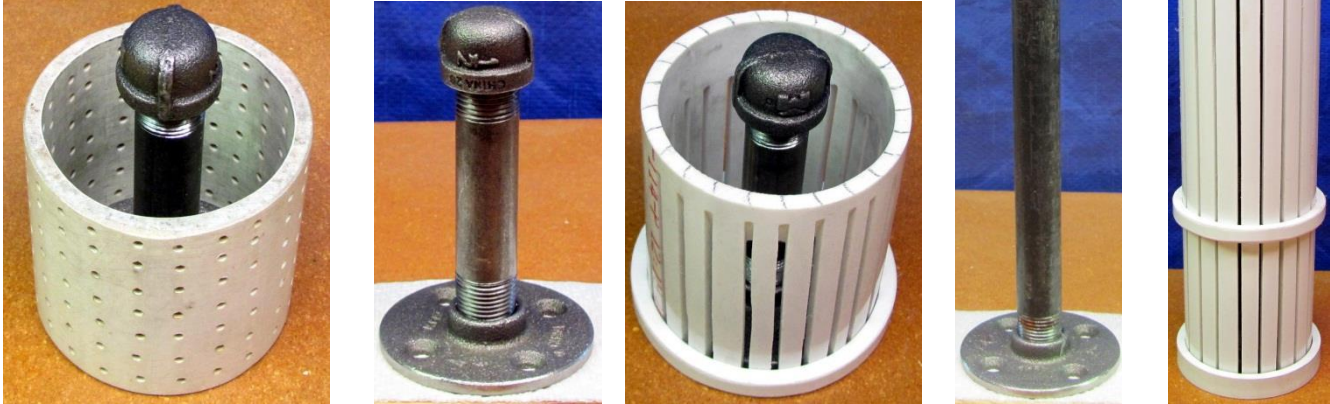
Round Solid

3", 75mm
Metal Washer



Round Metal Washer

Cast Iron Floor Flange Plunger

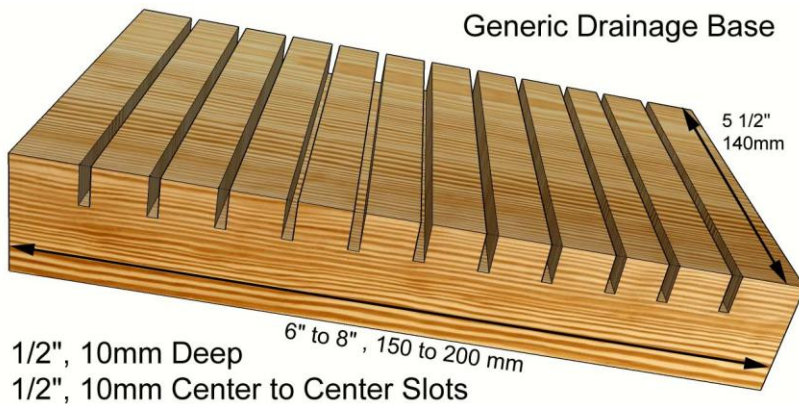


A cast iron floor flange for $\frac{1}{2}$ " black iron pipe fits nicely inside a 3 inch 75mm schedule 40 PVC pipe, and can be used as a plunger for briquettes not requiring a center hole. You may need to slightly grind the circumference of the flange for a clearance fit. An end cap on the end of the $\frac{1}{2}$ " pipe protects the press and your fingers from damage by the sharp edge.

Drainage Bases

Drainage Base Generic

Rather than building a custom drainage base for the various molds that make a solid briquette you can often use a generic slotted base plate to hold the mold. Better drainage from the bottom of the mold makes a briquette with less moisture and allows for a faster drying time. Dimensions are your choice while a typical example is shown below. Good sanding of the slots assures good drainage.



The dark colored drainage base has been coated with used motor oil.

Drainage Base Perforated PVC

There are occasions when extra drainage from the bottom of a PVC mold using a center hole is helpful. One solution is to use a perforated base plate and a perforated drainage tube. Size the smaller disk to fit the inside diameter of the mold and the lower disk to support the PVC. Suggest scattering drilled holes $1/8"$ 3mm holes around the disk area. To use, place on a generic drainage base plate shown below.

