


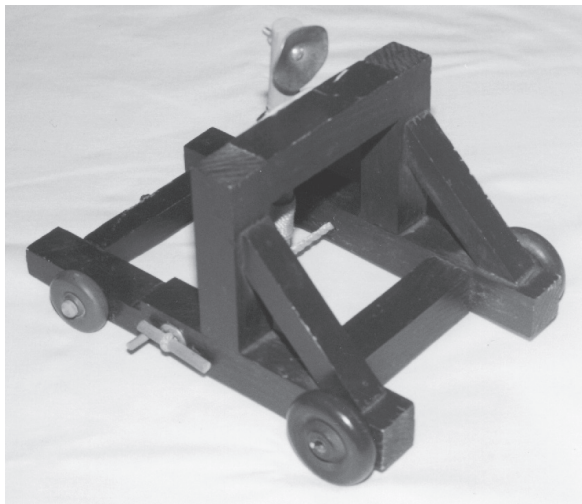

Wild Donkey: An Onager Catapult

Adult supervision required

Use protective eyewear

-  Swinging arm alert: watch out for moving arms or levers
-  Sharp and/or heavy tool advisory: Project requires use of saw or hammer
-  Flying object alert: Use care when aiming and firing

The onager-style catapult was among the most successful catapult designs ever created. Powerful, easy to make, and accurate, it had many advantages. The Roman historian Ammianus Marcellius, who lived around the year 350 BCE, wrote much about Roman army life as he personally experienced it when he was a Roman soldier. Here is his description of the type of catapult that the Romans called the Wild Donkey, or onager.



10.6

A[n] Onager's framework is made out of two oak beams, straight except for a hump in the middle. There are large holes in the middle of each beam, through which strong ropes made from cattle sinews are stretched and twisted. A long arm is inserted between the bundles of rope. At the end of the arm is [a] pouch for holding the projectile and a pin. When the pin is released, the arm rotates until it strikes a crossarm covered with a sack stuffed with fine chaff and secured by tight binding.

During combat, a round stone is placed in the pouch and the arm is winched down. Then, the master artillery-man strikes the pin with a hammer, and with a big blow, the stone is launched towards the target.

It was not only the ancient Greeks and Romans who built and used the onager. This weapon was popular with the armies of a large number of tribes and nations. Records are sketchy, but it was probably used for a very long time. The onager was a simple yet effective weapon and was used long after the more complex types of ballistae designed by the Greeks were forgotten. It is possible that catapults of this sort, with a single horizontally mounted rope spring and cloth sling, were used well into the Middle Ages.

MATERIALS

- Saw
- Drill
- ½-inch drill bit
- ⅛-inch drill bit
- ⅜-inch drill bit
- Ball peen hammer
- 1-inch-long nails
- Glue
- Small hook and eye
- Sandpaper

THE CATAPULT FRAME

- (2) 1-inch by 1-inch by 10-inch pieces of pine (Frame) You can find the wood pieces in the dowel section of most hardware and home stores
- (2) 1-inch by 1-inch by 4-inch pieces of pine (Uprights)
- (3) 1-inch by 1-inch by 4-inch pieces of pine (Cross Members)
- (2) $\frac{3}{4}$ -inch by $\frac{3}{4}$ -inch by 4-inch pieces of pine (Upright Supports)
- (4) 1-inch by 1-inch by 2-inch pieces of pine (Footers)
- (4) 2-inch-diameter wheels
- (4) $1\frac{1}{2}$ -inch axles to fit wheels

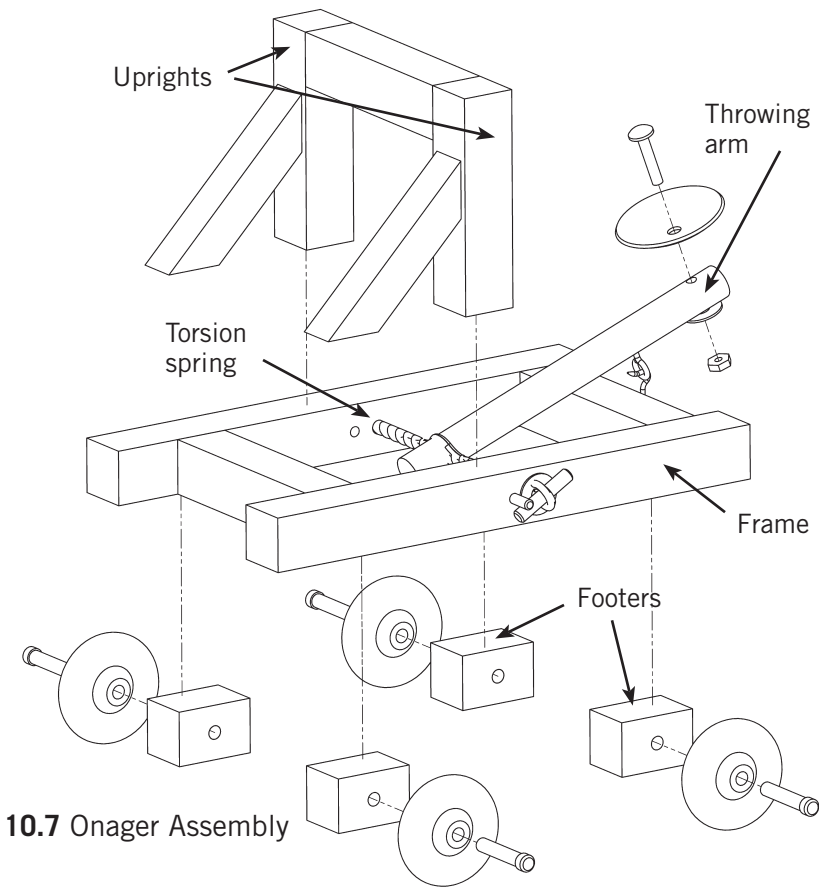
THE TORSION SPRING AND THROWING ARM ASSEMBLY

- (1) $\frac{5}{8}$ -inch wooden dowel, $8\frac{1}{2}$ inches long (Throwing Arm)
- (1) 18-inch length of $\frac{1}{8}$ -inch nylon cord
- (2) $\frac{1}{2}$ -inch-diameter washers
- (4) $\frac{3}{16}$ -inch-diameter dowels, $1\frac{1}{2}$ inches long
- (1) #10 machine screw, $\frac{1}{2}$ inch long, with corresponding nut and lock washer
- (1) 2-inch-diameter fender washer, with a small diameter inside hole

DIRECTIONS

General Notes

1. It is important to cut all of the wooden pieces to the sizes shown as accurately and as squarely as possible. Sand each piece after cutting to smooth it and remove splinters.
2. Wooden pieces may be attached to one another by using nails, glue, wooden dowels, or any combination thereof. If you want a sturdier model catapult, then use wooden dowels instead of nails to connect the parts.



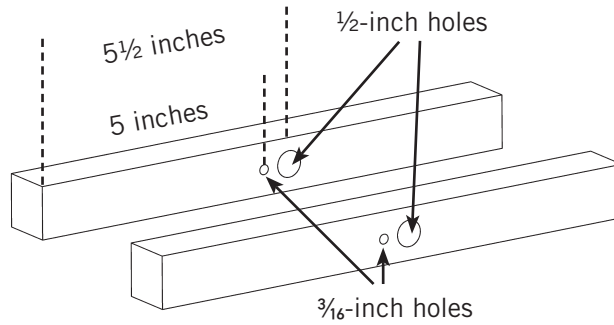
10.7 Onager Assembly

3. A picture is worth a thousand words, so refer to the assembly diagrams throughout to understand how all the subassemblies are made. The exploded **diagram 10.7** shows how all the parts will eventually fit together in the completed project.

Building the Onager Frame, Uprights, and Footings

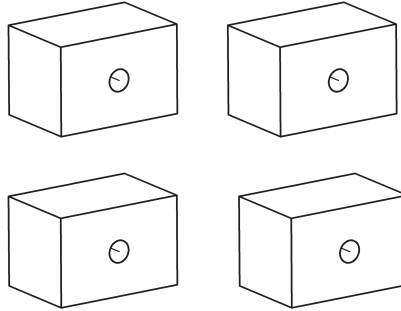
1. Drill a $\frac{3}{16}$ -inch-diameter hole in the two Frame pieces at a point 5 inches from one end.
2. Drill a $\frac{1}{2}$ -inch-diameter hole in the Frame pieces at a point $\frac{1}{2}$ inch from the same end.

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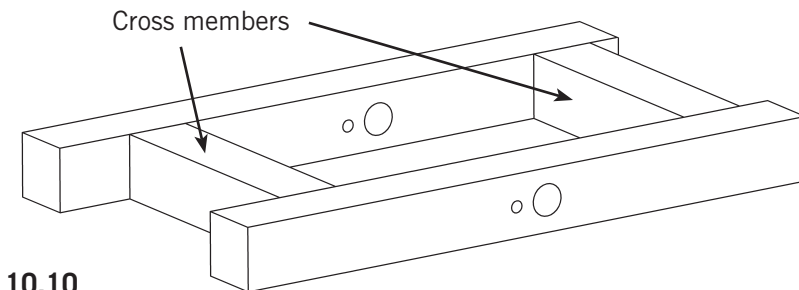


3. Drill a hole the same size as the wheel axles you have (often, but not always $\frac{5}{16}$ -inch diameter) in the center of each of the four Footers.

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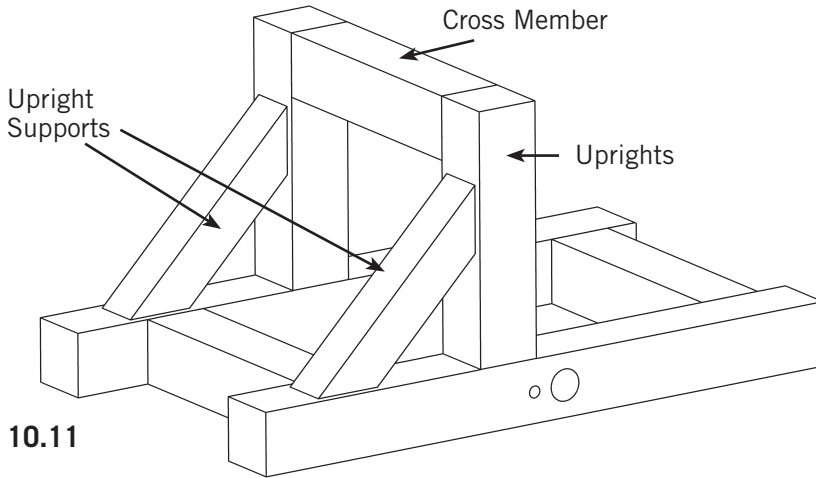
4. Attach the two Cross Members to the Frame pieces as shown in **diagram 10.10**, using glue and/or nails, or dowels.



10.10

5. Attach the two Uprights to the Frame, using glue and/or nails, or dowels. Connect the top ends of the Uprights with the third Cross Member.
6. Cut 45-degree angles on the ends of the Upright Support pieces so they form trapezoidal shaped pieces as in **diagram 10.11**.

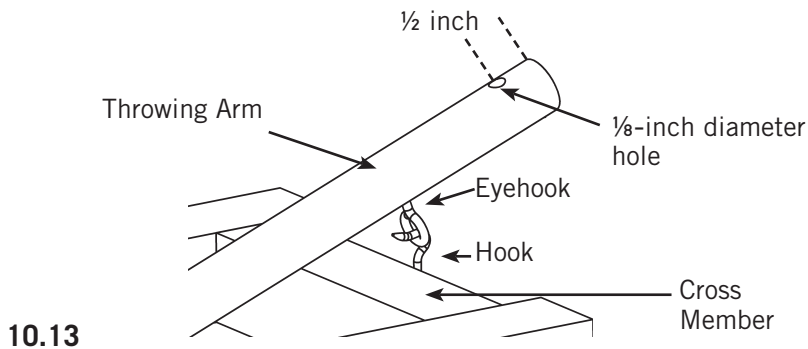
Attach the two Upright Supports to the framework, one end to the Frame piece and the other to the Uprights. The Upright Supports brace the upper Cross Member so it can withstand the impact of the Throwing Arm.



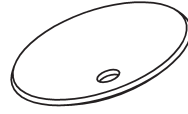
7. Attach all the Footers to the framework as shown in **diagram 10.7** using glue and/or nails.
8. Insert the Wheels and Axles.

BUILDING THE THROWING ARM

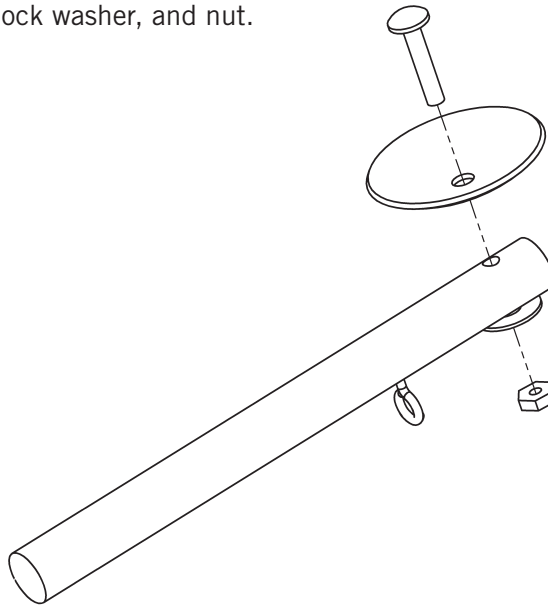
1. Attach the eyehook to the Throwing Arm, and the hook to the rear Cross Member. They must align so that the hook mates with the eyehook when the arm is retracted.



2. Drill a $\frac{1}{8}$ -inch-diameter hole in the Throwing Arm, $\frac{1}{2}$ inch from the end, as shown in **diagram 10.12**.
3. With the round end of a ball peen hammer, shape the fender washer into a cup.



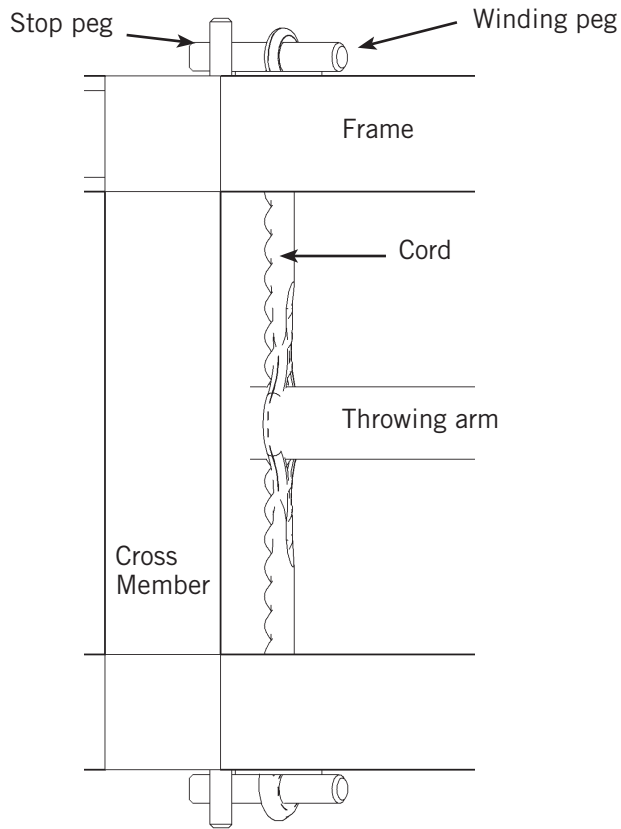
4. Attach the washer, cup side out, to the Throwing Arm with the bolt, lock washer, and nut.



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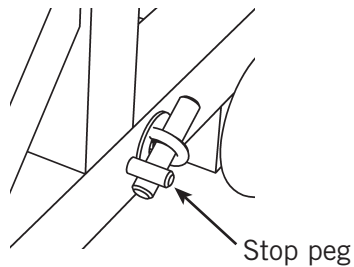
ASSEMBLING THE TORSION SPRING

1. Tie the cord ends together securely.
2. Insert the looped ends through each $\frac{1}{2}$ -inch hole in the Frame. Insert the $\frac{3}{16}$ -inch dowel in each end of the cord on the outboard side of the Frame. **Diagram 10.15** shows a view looking down from above.



10.15

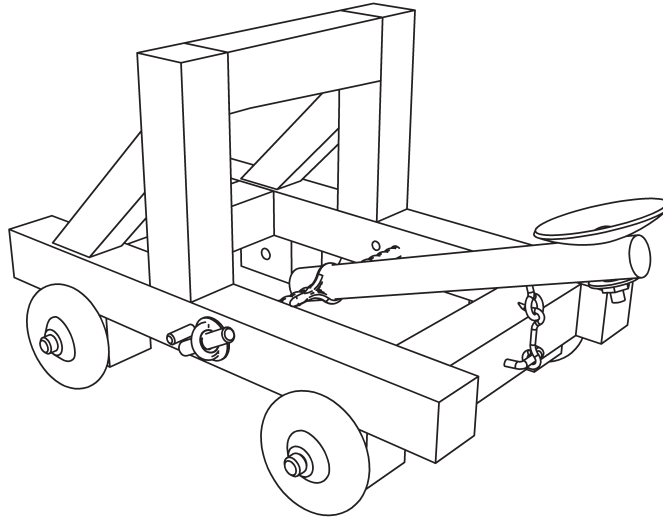
3. Insert the Throwing Arm through the cord and twist the cord in the direction of the upper Cross Member. (When the cord is twisted, the Throwing Arm will want to pop up, toward the Cross Member.) Tighten the rope spring by turning the pegs a few twists at a time, alternating sides. Continue to twist the cord until it is very tight.
4. When tight, maintain tension in the cord by inserting the stop pegs in the $\frac{3}{16}$ -inch diameter holes on the Frame pieces.



10.16

OPERATING THE ONAGER

1. Carefully pull the Throwing Arm back. Latch with the hook and eye.
2. Place a projectile (such as a walnut) in the cup-shaped washer.
3. Attach a string to the hook. Grab the string and jerk the hook from the eyehook to fire the catapult. The more tension you put in the torsion bundle (the twisted cord), the farther the catapult will shoot.



10.17

