

Totally Trebuchet Construction Guide

An Illustrated Assembly Manual

Organize the Tools and Materials

The trebuchet can be assembled with minimal frustration by taking the time to read through the directions. Prepare the necessary tools and materials before beginning the assembly.

Required Tools

Safety Glasses	5/64, 5/32, 1/8 Allen Wrenches or Hex Keys
#2 Phillips Head Screwdriver	Dial Calipers (Optional)
5/16" Combination Wrench	25' – 100' Tape Measures
3/8" Combination Wrench	12" Rule
Needle nose pliers	1/16" drill bit and drill

Materials

Refer to the end of this text for an illustrated parts catalog.

Structural Metal Components

Qty.	
1	6x9 Flat Plate
4	13 Hole Angles
2	7 Hole Angles
2	11 Hole Flat Bars
2	7 Hole Flat Bars
2	Sine Triangles
4	90 Degree Fish Plates
1	180 Degree Fish Plate

Machined Parts

Qty.	
1	3" Hex Wheel
1	4" x 3/16 Axle
1	1-1/2" x 3/16 Axle
1	7/16" x 3/16" bore Hex Adapter
1	1/2" Shaft Collar
8	3/16" Shaft Collars
1	Mast Holder

Hardware

Qty.	
22	#10-24 x 3/8" PH Machine Screws
3	#10-24 x 1/2" PH Machine Screws
2	#10-24 x 3/4 PH Machine Screws
4	#10-24x 3/4" Coupling nuts (standoffs)
16	#10-24 Hex Nuts
25	#10 Flat Washers
25	#10 Split Ring Lock Washers
4	#10 Fender Washers
4	#10-24 x 5/16" PH Screws (Mast Holder)

Miscellaneous Supplies and Materials

Qty.	
1	9.8 Ounce Steel Ball
2	Wood Balls, 1" Diameter
1	Wood Balls 1-1/4" Diameter
1	Wood Balls 1-1/2" Diameter
10'	Fishing Line
1'	1/16" Welding Rod
2	18"x 5/16" Dowels
2	Zip Ties

Support Frames

Step One: Attach 90 Degree Fish Plates

Necessary Components

Qty. Description

- 1 Rectangular 6 x 9 plate.
- 2 #10-24 x 3/8" PH machine screws, nuts and washer assemblies.
- 2 90 degree fishplates

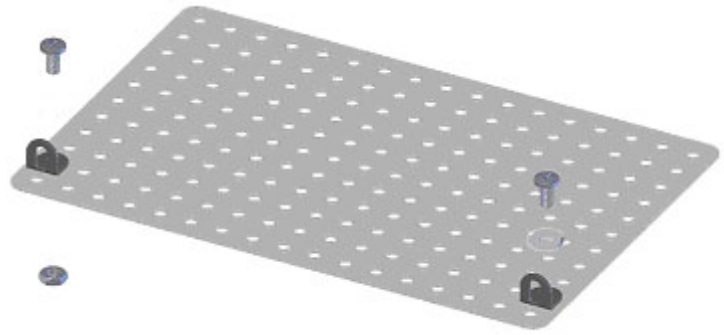


Fig. 1

Performance Tip. Lightly tighten all machine screws and nuts at this time. The fasteners can be fully tightened during final assembly.

Procedure

Use #10-24 x 3/8" Phillip head machine screws to attach the 90 degree fish plates to the end holes on the second row of the 6x9 base plate. Use split ring locking washers (*Not shown*) between all the hex nuts and flat washers. **The fishplate is secured to the end hole in the second row.**

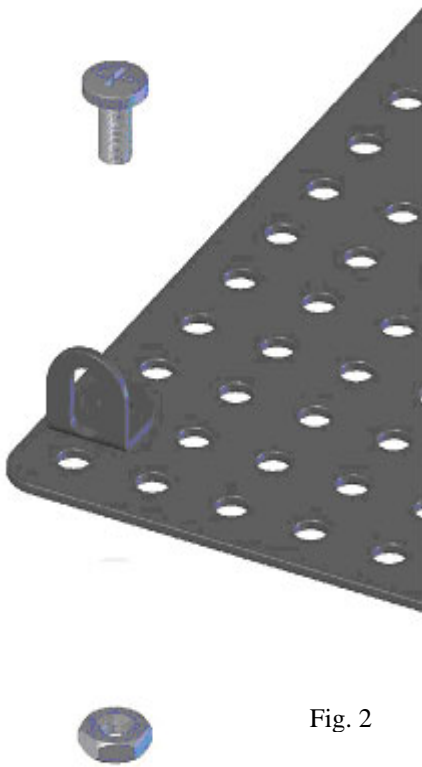


Fig. 2

Note: Be certain to align the orientation of the long hole in the 90 degree fish plate as illustrated in figure 2.

Step Two: Attach the 13 Hole Angles

Necessary Components

Qty. Description

- 2 13 hole angles
- 2 #10-24 x 1/2" Phillip head machine screws, nuts and washer assemblies.

Note: Flat washers are used with screws in order to evenly distribute the clamping force generated when the screw is tightened.

Procedure

Use #10-24 x 1/2"

Phillip head machine screws to attach the 13 hole angles to the fish plates. Use split ring locking washers (*Not Shown*) between all the hex nuts and flat washers.

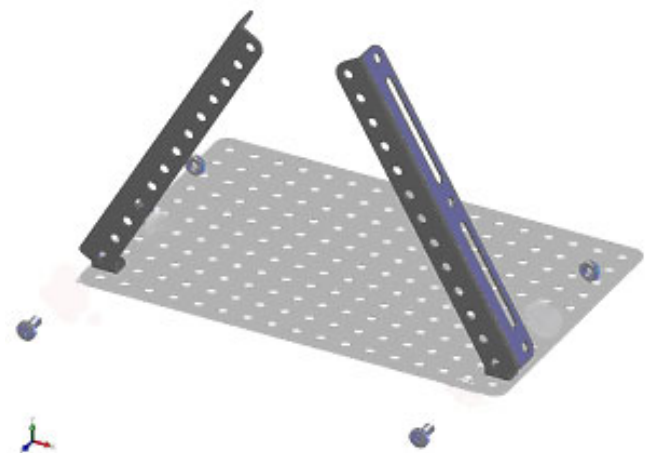


Fig. 3

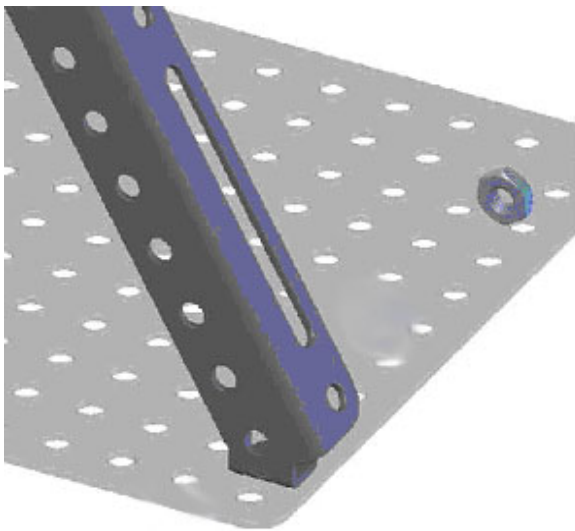


Fig. 4

Note: Be certain to align the orientation of the 13 hole angles as shown in figures 3 and 4. Mount the 13 hole angles outboard of the fish plates as illustrated.

Note: It will be necessary to position the washer and nut in place BEFORE passing the machine screw through the 13 hole angle.

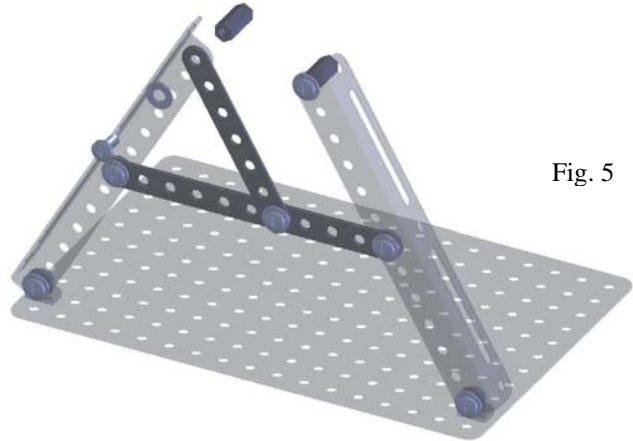


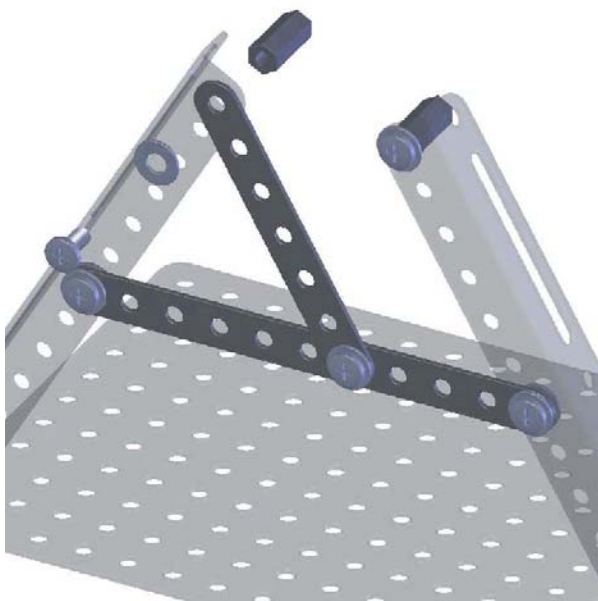
Fig. 5

Step Three: Attach the Cross Bracing

Obtain these components:

Qty. Description

- 1 11 hole flat bar
- 1 7 hole flat bar
- 3 #10-24 x 3/8" PH machine screws, nuts and washer assemblies.
- 2 #10-24 coupling nut
- 2 #10-24 x 3/8" machine screw and washer



Procedure

Use two #10-24 x 3/8" Phillip head machine screws to attach the 11 hole flat bar across the 13 hole angles.

Use one #10-24 x 1/2" Phillip head machine screws to attach the 7 hole flat bar diagonally across the 11 hole flat bar. Use one #10-24 x 3/8" machine screw and flat washer with a #10-24 coupling nut to attach the 7 hole flat bar to the right side 13 hole angle as shown in figure 5.

Fasten an additional #10-24 x 3/8" machine screw and flat washer with a #10-24 coupling nut to the left side 13 hole angle as shown in

Fig. 6

Note: Be careful to align the orientation of the 11 hole flat bar to the 13 hole angles as shown in figures 5 and 6. Mount the 7 hole flat bar diagonally as shown in figure 6. Attach the #10-24 coupling nuts to the end holes of the angles as shown in figure 6.

Step Four: Attach the Sine Triangle

Obtain these components:

Qty. Description

- 1 Sine Triangle
- 2 #10-24 x 3/8" machine screw and washer

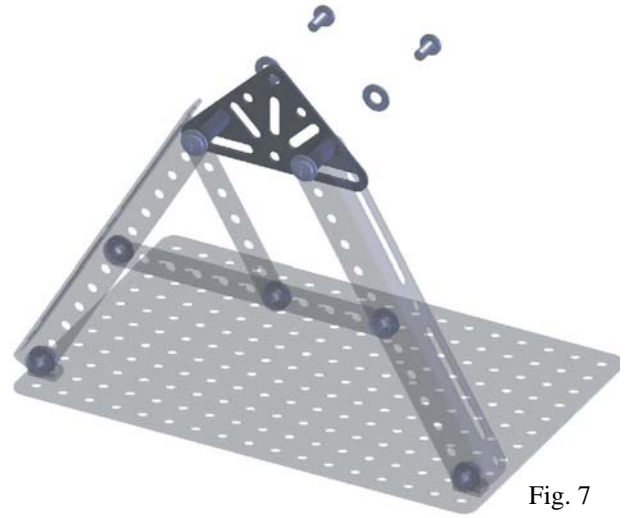
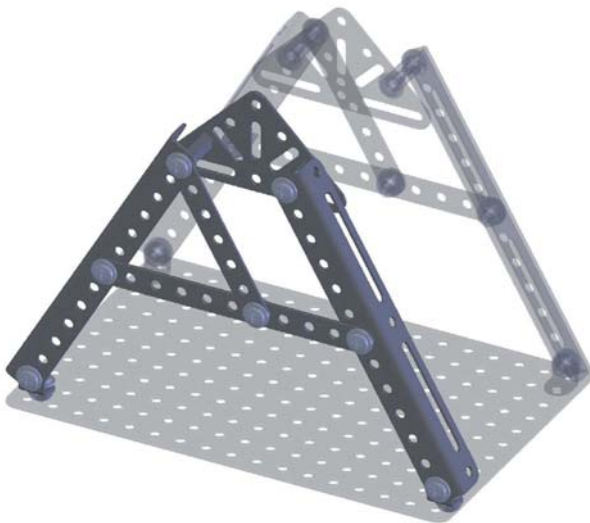


Fig. 7

Procedure

Use two #10-24 x 3/8" Phillip head machine screws and flat washers to attach the sine triangle to the coupling nuts as shown in figure 7.

Step Five: Repeat the Procedure for the Other Side



Throwing Arm Assembly

Step One: Make up the Axle Assembly (*figure 10*)

Necessary Components

Qty. Description

- 1 3/16" diameter x 4" long axle.
- 1 Stainless steel hex adapter.
- 6 3/16" (*bore*) shaft collars.
- 3 3/16" fender washers



Fig. 9

The completed throwing arm assembly

Procedure

Obtain the necessary components to construct the axle assembly illustrated in figure 10. Use only the hex adapter and set the remaining components aside for later use.

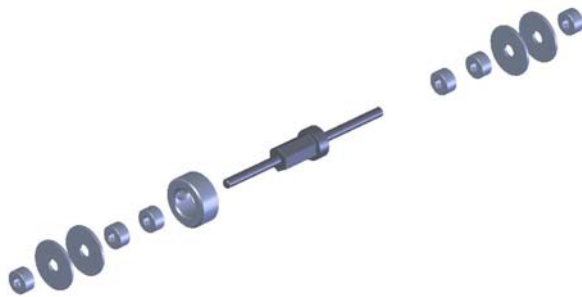


Fig. 10

Step Two: Secure the 3" Wheel and Hex Adapter (*Figure 11*)

Necessary Components

Qty. Description

- 1 Stainless steel hex adapter.
- 1 3" Wheel
- 1 1/2" (*bore*) Shaft Collar



Fig. 11

Procedure

Fasten the 3" wheel to the hex adapter using the 1/2" shaft collar. Secure the shaft collar to the hex adapter using the shaft collar set screw.

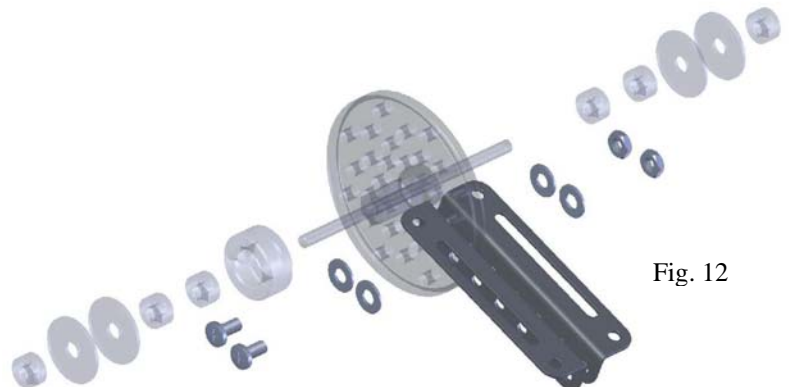


Fig. 12

Throwing Arm Assembly

Step Three: Counter Weight Arm (figure 12)

Necessary Components

Qty. Description

- 2 7 hole angles.
- 2 #10-24 x 3/4" machine screws and washers

Procedure

Obtain the necessary components to construct the counter weight arm assembly illustrated in figure 12. Note: An orthographic (front) view of the counter weight arm assembly is shown in figure 13. Use this view to obtain proper orientation of the throwing arm, 3" wheel and fasteners.

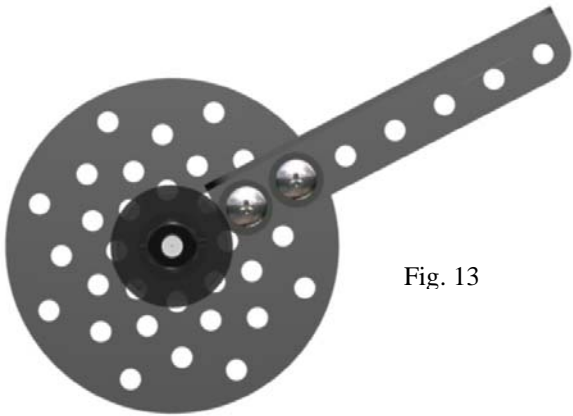


Fig. 13

Step Four: Counter Weight Assembly (figure 14)

Necessary Components

Qty. Description

- 1 3/16" x 1-1/2" axle.
- 2 3/16" (bore) shaft collars
- 1 180 degree fish plate
- 4 3/16" flat washers
- 1 #10-24 x 1/2" Phillip head machine screw and nut
- 1 9.8 ounce steel counter weight

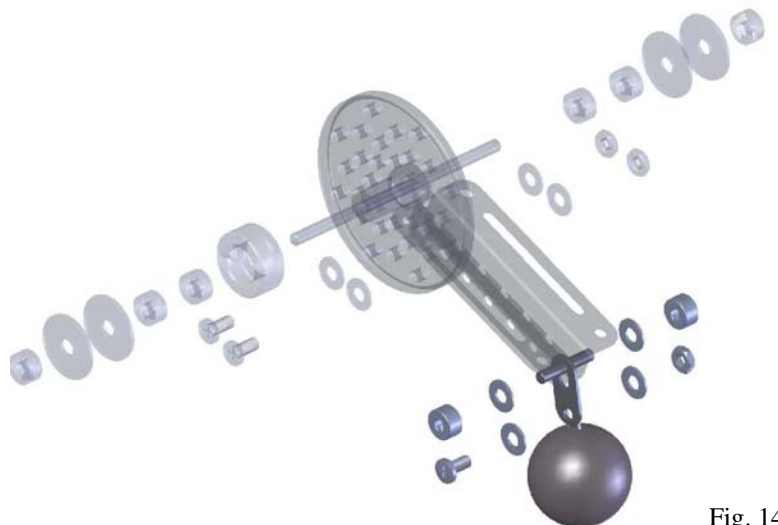


Fig. 14

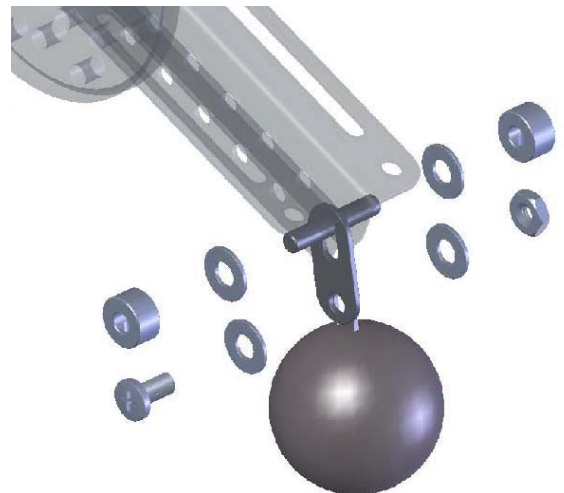


Fig. 15

Procedure

Obtain the necessary components to construct the counter weight assembly illustrated in figure 15. Connect the fishplate to the steel counter weight using the #10-24 x 1/2" screw, washers and nut as shown in the illustrations (*Top and left*).

Attach the fishplate and counter weight assembly to the end of the counter weight arm by passing the 1-1/2" axle through the arm members and fishplate. Capture the fishplate inboard between the two 7-hole angles. The fishplate should hang in between the 7-hole angles in such a way as to swing freely through 270 degrees of revolution or more.

Note: Add #10 washers as needed to adjust for side play between the axle and the fishplate.

The fishplate should be firmly affixed to the counter weight so that it cannot move or swing freely.

Step Five: Throwing Arm Assembly (figure 16)

Necessary Components

Qty. Description

- 1 5/16" x 18" wood dowel.
- 1 Mast holder with #10-24 set screws
- 2 1/8" hex key set screws 1/4-20 x 1/4"
- 2 #10-24 x 1/2" Phillip head machine screws
- 2 #10 flat washers

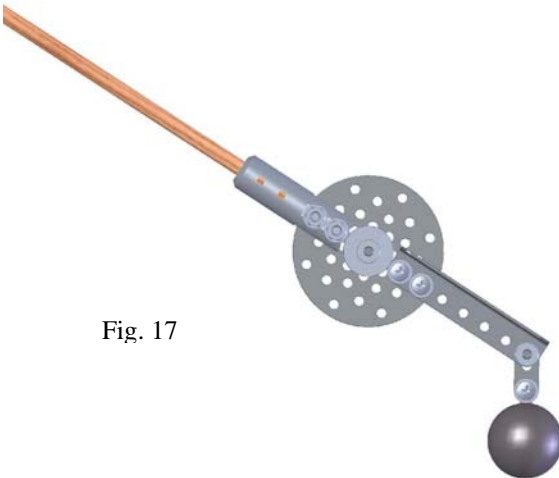


Fig. 17

dowel length is determined experimentally by the user. Start longer and keep testing in order to find the optimum length.

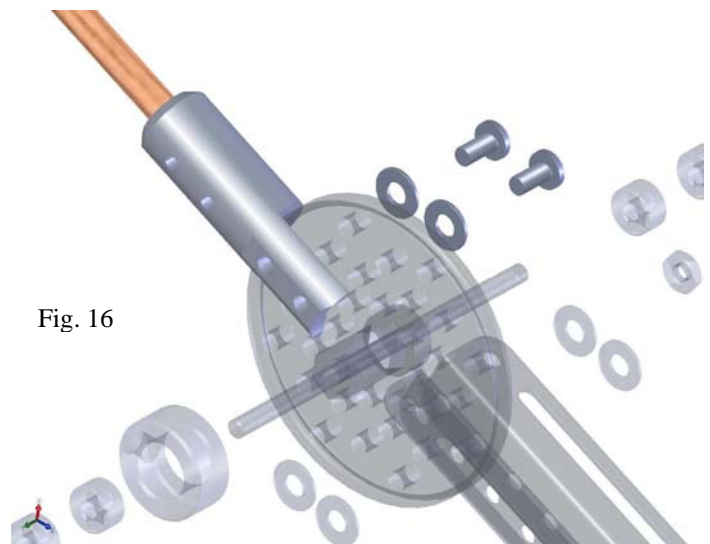


Fig. 16

Procedure

Secure the mast holder to the 3" wheel using 2 #10-24 x 1/2" machine screws and washers as shown in figures 16-17. Hex nuts are not required since the shaft retainer has threaded holes to accept the #10-24 machine screws.

Fasten the 5/16" x 18" wood dowel to the shaft retainer using the #10-24 set screws as shown.

Note: The wood dowel has holes drilled at either end to accommodate the fastening of the release pin. The

Step Six: Throwing Arm Release Pin
(figure 18)

Necessary Components

Qty. Description

- 1 Hose clamp or zip tie
- 1 Paper Clip or 4" length of wire rod



Fig.19

Release Pin



Procedure

Fashion the paper clip or wire rod into the release pin shape pictured in figure 20.

Mount the release pin to the throwing arm by passing the bent wire through the 3/32" hole in the wood dowel. Secure the release pin using the hose clamp (pictured in figure 19) or zip ties provided in the kit.

Note: Trebuchet performance and range can be improved by fastening the release pin to the throwing arm using either duct tape, zip ties or tightly wound elastic bands instead of the hose clamp. Remember that even a small amount of additional weight at the end of the throwing arm will decrease the net torque produced by the counterweight and reduce the speed and thus range of the projectile.

Drawing showing the approximate bend configuration of the release pin.

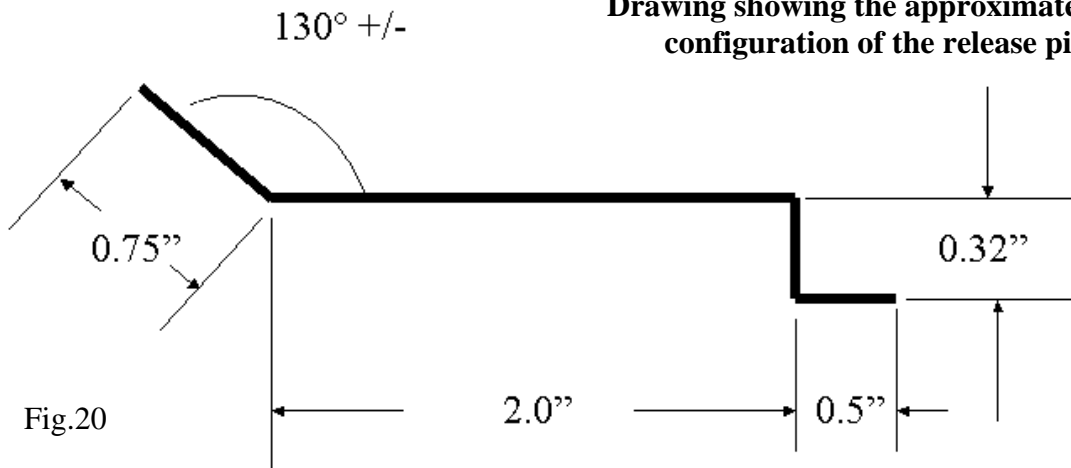


Fig.20

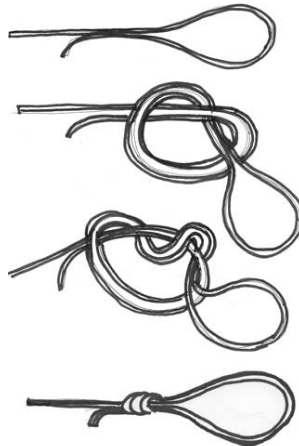
Note: The builder must determine the wood dowel length. There are many ways to optimize the wood dowel length. Trial and error is one method. A better method is using the GEARS-TrebStar™ simulator to make and test iterative designs in an effort to optimize both the dowel length and the projectile length.

The Sling and Projectile Assembly

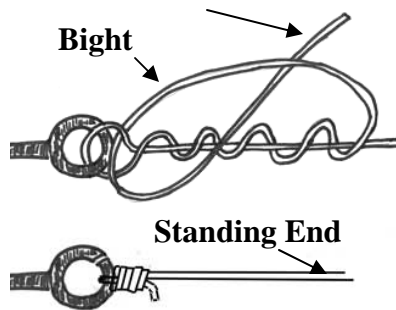
Fashion an eye on the end of the sling using a surgeons loop. (shown below)

Surgeon's Loop

1. Make a large loop at the end of the line.
2. Tie a single knot using the loop end.
3. Repeat the single knot one or two more times.
4. Pull tight.
5. Trim the line end close to the knotted loop.



Working End



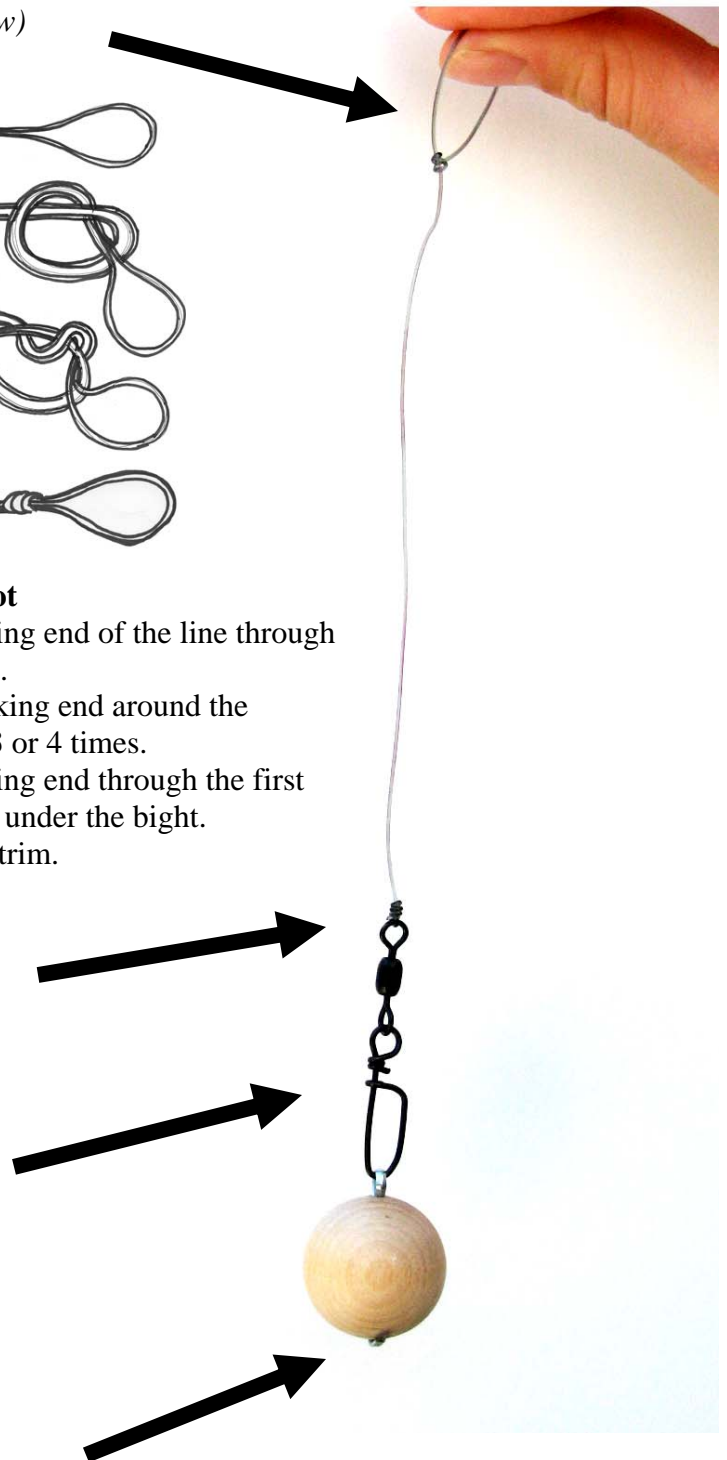
Fisherman's Knot

1. Pass the working end of the line through the swivel eye.
2. Wrap the working end around the standing end 3 or 4 times.
3. Pass the working end through the first loop and back under the bight.
4. Pull tight and trim.

Attach the snap swivel to the sling using a fisherman's knot. (Shown above)

Open the snap swivel hook and pass it through the eye of the cotter pin.

The Cotter pin passes through the hole in the ball and the ends are bent back and flush to the surface.



Integrating the Subassemblies

Attaching the Throwing Arm to the Support frames

Step One: Select the axle assembly components from step one. Attach the throwing arm by passing the axle through the top hole in the sine triangle and sliding the fender washers and shaft collars in the order illustrated in figure 21.

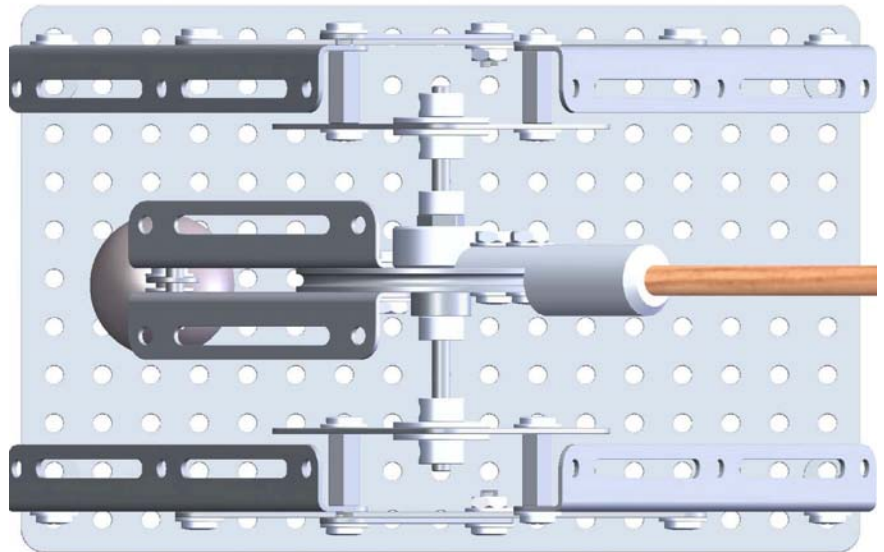


Fig.21 A top view of the axle assembly

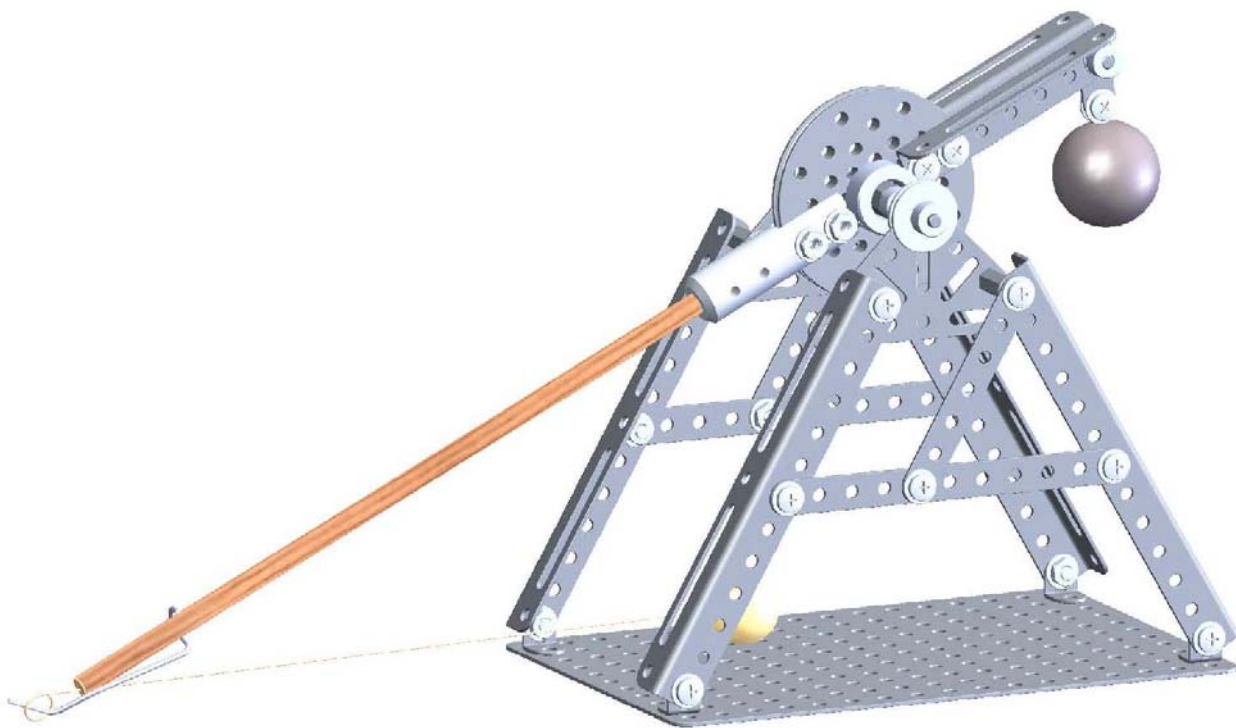


Fig. 22 The completed trebuchet