

# PEAK OF FLIGHT

N E W S L E T T E R

In This Issue

## *How To Make Your Own Rail Guides*



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## How to Make Your Own Rail Guides

By Barry Friedrichs

We are in a hurry to get rail guides, and we do not want to wait on the mail, and we want to fly this afternoon. What are we going to do?

Being the smart resourceful people that we are, we are going to make my own. These instructions will tell us how.

Here is a list of questions that have to be answered before we start work. They are:

- What is a rail guide?
- What is the size of the rail?
- What will fit in that space?
- What can we get today?
- What pieces and parts do we need?
- How do we put it together to meet our needs?
- Where do we locate them on the rocket?

### What is a rail guide?

A rail guide or rail button is something that slides easily inside of a launch rail, that will not bind up and cause friction that will prevent my rocket from launching. It acts as a heavy duty launch lug. At Apogee Rockets, they sell Rail Buttons. The link for them is: [www.apogeerockets.com/Building\\_Supplies/Launch\\_Lugs\\_Rail\\_Buttons/Rail\\_Butons](http://www.apogeerockets.com/Building_Supplies/Launch_Lugs_Rail_Buttons/Rail_Butons).



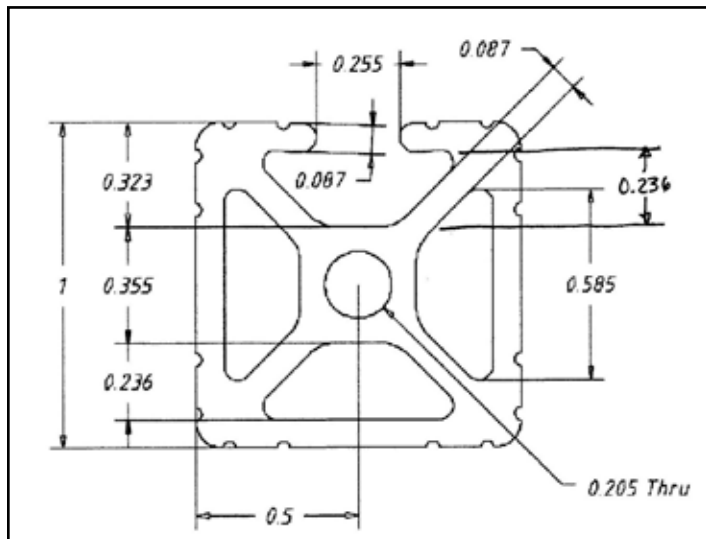
**Figure 1: The traditional rail buttons as sold by Apogee.**

What we are trying to make is a substitute for rail buttons, shown in Figure 1. When we look at this picture from the Apogee catalog, we see a screw that will screw into a blind mounting nut or a "T" nut, which will be inside the body tube of the rocket; and we see two black plastic bushings (maybe delrin or nylon, which can be used as a low-friction devices, to help slide inside the launch rail), which will be on the outside of the rocket. The screw goes through the hole in the bushing and screws through a hole in the body tube allowing us to screw into

the blind mounting nut on the inside of the rocket. We now know what we are making, and what it looks like and how it works.

### What is the size of the rail?

We decided that we wanted to use a rail like what is at the local clubs. The clubs we fly with usually use a launch rail like the Apogee Rockets rail guide. ([http://www.apogeerockets.com/Launch\\_Accessories/Launch\\_Pads/Launch\\_Rail\\_Standard](http://www.apogeerockets.com/Launch_Accessories/Launch_Pads/Launch_Rail_Standard)). This launch rail is also called 1010 rail, and there is a bigger one called a 1515 rail that is frequently used with bigger high power rockets.



**Figure 2: Dimensions of the standard 1-inch rail.**

### What will Fit in that Space?

From looking at the drawing of a 1010 rail, as in Figure 2, we can see that the slot width is .255" wide. Now if we look up the diameter of a 1/4" screw (machine screw is the more proper name) or a 1/4" bolt, we can learn that the bolt is normally .243" to .250" in diameter. (A note here; a very valuable tool to use is a pair of calipers, which are tools for measuring things. They are precise instruments and can be very accurate. You can purchase an inexpensive set at Harbor Freight. You can also get them at MSC, McMaster-Carr, or Grainger, or places that sell machine tools and industrial

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fasteners. If you are not familiar with calipers, then probably the best type would be digital calipers). So a 1/4" bolt is the correct size to fit in the slot.

The next item to be concerned about is the size of the head of the screw. We can see from Figure 2 that the depth of the slot is 0.236". So while the neck of the screw is just under 1/4" wide, the distance from the bottom of the head of the screw to the top of the screw cannot be greater than 0.236", and to be better, should be about 0.200" thick or less.

For us, we usually use a pan head screw. Figure 3 shows dimensions of these heads for your reference.

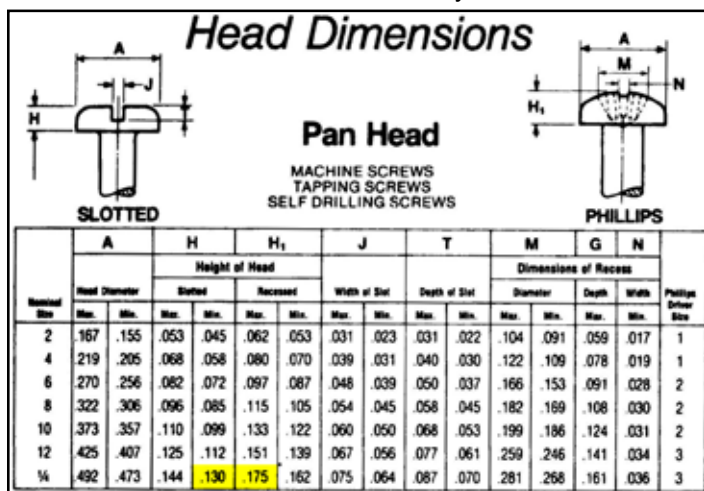


Figure 3: Head Dimensions for Pan Head screws.

Looking at Figure 3, at the bottom row for 1/4 inch screws, we can see that dimensions H or H<sub>1</sub> for Phillips head screws are 0.130" and 0.175". It appears either one of these will perform what we are needing and fit in the slot for the rail.

It looks like a 1/4-20 (The 20 means the number of threads or turns per inch of length. In this case, if you were

to measure 1" of threads, there would be 20 of them). Pan head machine screw will do the job for us. If possible, we should test our screw head on a 1010 rail if we can find one. Testing prevents many mistakes.

If we look at Figure 4, we can see the dimensions of the nuts we can use.

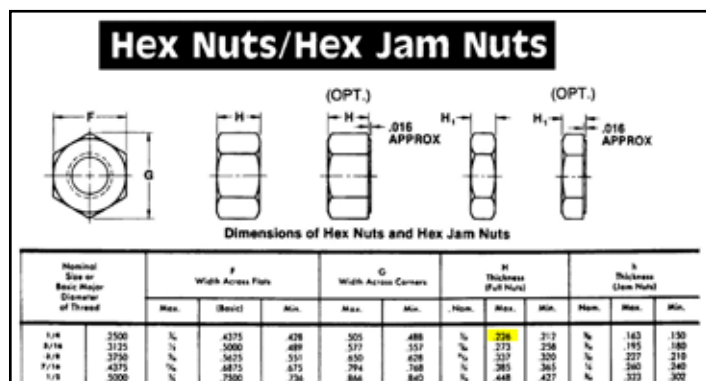


Figure 4: Dimensions of Hex nuts.

The 1/4-20 nuts should be .226 inches thick. If we take one of these nuts and screw it on to the 1/4-20 Pan head machine screw, we would like it to be anywhere from 0.100" to 0.125 (an 1/8") from the bottom of the screw head. This will allow us to fit within the rail and still slide easily. We came to this dimension by looking back at Figure 2. Near the top middle of the diagram is the dimension 0.225 (the width of the slot); below this number we can find another number, 0.087. This is the thickness of the rail where our bolt head will be sliding.

We know that if our distance from our nut to the bottom of the head is 0.087" it will not slide in the rail, so the number and distance needs to be greater. 0.100", might be a little too tight, but in theory it should work. To make it easy for us, we screw the nut down onto our machine screw

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and then take a piece of 1/8" plywood, a 1/8" launch rod, or a drill bit of that size and use it for a spacer. It will go in-between the nut and the head of the screw to give us good spacing distance. After we get the nut in place, we can place a little paint on the threads to lock this nut in place as a thread locker.

With this nut in place, we now have the entire black plastic bushing, like in the picture, duplicated. All we have to do is mount this onto the rocket.

We need to now drill a hole at each location on the rocket where a rail button will be mounted. The hole we will

drill will be big enough in diameter to allow the machine screw to slide through or thread through our hole. To learn this dimension, we are going to go to Figure 5.

If we go down to the third block on the right, we will see the number 1/4, which means 1/4" diameter. We can use a letter "F" drill for a somewhat tight fit, all the way up to a letter "H" drill. If we use an "F", "G", or "H" diameter drill bit, our screw will go through the hole.

We can drill the hole now, but let's do a couple of other things first. We can take the calipers and measure the wall thickness of our body tube, or we can calculate it from the catalog of where we purchased it. If we go to the catalog, we can learn the outside diameter and the inside diameter of our body tube. If we take the outside diameter and subtract the inside diameter, and then divide by 2, we will have our wall thickness.

For example, if we go to the Apogee web site and look under the Catalog menu, and then Building Supplies, and then click on Body Tubes, we can scroll down to a body tube like the 66mm/BT-80 [www.ApogeeRockets.com/Building\\_Supplies/Body\\_Tubes/Tube\\_Assortments/Mid-Power\\_Tube\\_Assortment](http://www.ApogeeRockets.com/Building_Supplies/Body_Tubes/Tube_Assortments/Mid-Power_Tube_Assortment). From this page we can learn that the outside diameter of the 66mm body tube is 2.600" and the inside diameter is 2.558". If we go by the formula above, we can take  $2.600 - 2.558 / 2$  and come to an answer of 0.021". Our wall thickness should be 0.021".

When we assemble this rail button, we already know that we are going to need about .125" of space for the rail

| CLEARANCE DRILLS FOR MACHINE SCREWS |            |                |            |                |
|-------------------------------------|------------|----------------|------------|----------------|
| Close Fit                           |            |                | Free Fit   |                |
| Screw Size                          | Drill Size | Decimal Equiv. | Drill Size | Decimal Equiv. |
| 0                                   | 52         | 0.0635         | 50         | 0.0700         |
| 1                                   | 48         | .0760          | 46         | .0810          |
| 2                                   | 43         | .0890          | 41         | .0960          |
| 3                                   | 37         | .1040          | 35         | .1100          |
| 4                                   | 32         | 0.1160         | 30         | 0.1285         |
| 5                                   | 30         | .1285          | 29         | .1360          |
| 6                                   | 27         | .1440          | 25         | .1495          |
| 8                                   | 18         | .1695          | 16         | .1770          |
| 10                                  | 9          | 0.1960         | 7          | 0.2010         |
| 12                                  | 2          | .2210          | 1          | .2280          |
| 1/4                                 | F          | .2570          | H          | .2660          |
| 5/16                                | P          | .3230          | Q          | .3320          |
| 3/8                                 | W          | 0.3860         | X          | 0.3970         |
| 7/16                                | 29/64      | .4531          | 15/32      | .4687          |
| 1/2                                 | 33/64      | .5156          | 17/32      | .5312          |

Figure 5: This table answers the question of what size drill should you use to fit the screw.

Continued on page 5



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to slide in. We know that our nut that we will screw on is about .226" thick. We know that our body tube is about 0.021" thick, and we are going to want to put a washer on the inside of our body tube and another nut, but this time it will be a lock nut so that the rail button does not get unscrewed by vibrations in flight.

In Figure 6 below, we can see dimensions for washers. These are also called "Flat Washers", because they are flat!

The washers that we want to use are in the 1/4 row, and we can see that they are 1/16" thick. 1/16 equals 0.0625 in decimal form. Save this number, because we are going to add it to the other dimensions in the previous paragraph.

In Figure 7 on the next page, we can see that the thick-

ness of a lock nut with nylon insert is 0.313".

Now we can take these dimensions and learn how long our machine screw needs to be.

We take the .125 (space between bottom of head and the nut), add the thickness of the nut, which we know is 0.226. We add to this the body tube thickness of 0.021, the washer thickness of 0.0625, and the locknut thickness of 0.313 and we should have the following:  $0.125 + 0.226 + 0.021 + 0.0625 + 0.313$  and the sum is 0.7475". Machine screws come in different lengths, measuring from the bottom of the head to the end of the threads. Our calculated thread length is 0.7475" and that is very close to being 3/4" (0.750")

## What Can We Get Today and What Do We Need?

We now know that when we go to a hardware store and go to the bolt bins, we are going to be looking for 1/4-20 pan head screws, 3/4" long, a flat 1/4" washer, a 1/4-20 nut, and a 1/4-20 lock nut. For our rocket we will need two of each one of those to make two rail buttons.

Our rocket in our example is using a 66mm paper tube. This means that our rocket is not very heavy or the paper tube will come apart. Since our rocket is not very heavy, we are going to use nylon screws, washers, and nuts, because they are lighter in weight.

If our rocket was a heavy rocket, and / or a high power rocket, we might use stainless steel screws, washers, and nuts.

## Where are we going to mount these rail buttons?

We were originally going to use launch lugs, but we decide that we needed rail buttons because of the size of this rocket, with the body tube 2-1/2" inch

| U.S.S. Washers     |            |            |              |                    |                        |
|--------------------|------------|------------|--------------|--------------------|------------------------|
| STANDARD WASHERS   |            |            |              |                    |                        |
| Bolt Size (Inches) | I.D. (In.) | O.D. (In.) | Thick. Gauge | Est. Pcs. 100 lbs. | Weight Lbs. Per M Pcs. |
| 3/16               | 1/4        | 5/8        | # 18 (3/64)  | 36,200             | 2.8                    |
| 1/4                | 3/8        | 1          | # 16 (1/16)  | 14,900             | 6.7                    |
| 5/16               | 1/2        | 1 1/8      | # 14 (3/64)  | 9,000              | 11.1                   |
| 3/8                | 5/8        | 1 1/4      | # 14 (3/64)  | 6,700              | 14.9                   |
| 7/16               | 3/4        | 1 3/8      | # 14 (3/64)  | 4,100              | 24.4                   |
| 1/2                | 7/8        | 1 1/2      | # 12 (3/64)  | 2,600              | 38.5                   |
| 9/16               | 1          | 1 5/8      | # 12 (3/64)  | 2,200              | 45.5                   |
| 5/8                | 1 1/8      | 1 3/4      | # 10 (3/64)  | 1,300              | 77                     |
| 3/4                | 1 1/4      | 2          | # 9 (3/32)   | 910                | 110                    |
| 7/8                | 1 3/8      | 2 1/4      | # 8 (1/16)   | 650                | 153                    |
| 1                  | 1 1/2      | 2 1/2      | # 8 (1/16)   | 530                | 188                    |
| 1-1/8              | 1 3/4      | 2 3/4      | # 8 (1/16)   | 450                | 220                    |
| 1-1/4              | 1 7/8      | 3          | # 8 (1/16)   | 380                | 260                    |
| 1-3/8              | 1 1/2      | 3 1/4      | # 7 (3/16)   | 300                | 333                    |
| 1-1/2              | 1 5/8      | 3 1/2      | # 7 (3/16)   | 260                | 385                    |
| 1-5/8              | 1 3/4      | 3 3/4      | # 7 (3/16)   | 230                | 440                    |
| 1-3/4              | 1 7/8      | 4          | # 7 (3/16)   | 200                | 500                    |
| 1-7/8              | 2          | 4 1/4      | # 7 (3/16)   | 176                | 569                    |
| 2                  | 2 1/8      | 4 1/2      | # 7 (3/16)   | 159                | 630                    |
| 2-1/4              | 2 3/8      | 4 3/4      | # 5 (3/32)   | 121                | 826                    |
| 2-1/2              | 2 5/8      | 5          | # 4 (1/8)    | 104                | 961                    |
| 2-3/4              | 2 7/8      | 5 1/4      | # 3 (1/4)    | 91                 | 1100                   |
| 3                  | 3 1/8      | 5 1/2      | # 2 (1/2)    | 77                 | 1300                   |

| S.A.E. WASHERS     |            |            |              |                    |                        |
|--------------------|------------|------------|--------------|--------------------|------------------------|
| Bolt Size (Inches) | I.D. (In.) | O.D. (In.) | Thick. Gauge | Est. Pcs. 100 lbs. | Weight Lbs. Per M Pcs. |
| # 6                | 5/32       | 3/8        | # 18 (3/64)  | 79,000             | 1.26                   |
| # 8                | 3/16       | 1/2        | # 18 (3/64)  | 58,500             | 1.7                    |
| # 10               | 3/32       | 1/2        | # 18 (3/64)  | 43,500             | 2.3                    |
| # 12               | 1/4        | 5/8        | # 18 (3/64)  | 36,200             | 2.8                    |
| 1/4                | 3/32       | 5/8        | # 16 (1/16)  | 22,200             | 4.5                    |
| 5/16               | 11/32      | 11/16      | # 16 (1/16)  | 19,200             | 5.2                    |
| 3/8                | 13/32      | 13/16      | # 16 (1/16)  | 14,000             | 7.2                    |
| 7/16               | 15/32      | 59/64      | # 16 (1/16)  | 10,500             | 9.5                    |
| 1/2                | 17/32      | 11/8       | # 13 (3/32)  | 5,500              | 18.3                   |
| 9/16               | 19/32      | 13/8       | # 13 (3/32)  | 4,300              | 23.4                   |
| 5/8                | 21/32      | 15/8       | # 13 (3/32)  | 3,600              | 27.7                   |
| 3/4                | 13/16      | 1 1/2      | # 10 (3/64)  | 2,100              | 47.4                   |
| 7/8                | 15/16      | 1 3/4      | # 10 (3/64)  | 1,600              | 63                     |
| 1                  | 1 1/16     | 2          | # 10 (3/64)  | 1,200              | 83                     |
| 1-1/8              | 1 1/8      | 2 1/4      | # 10 (3/64)  | 920                | 109                    |
| 1-1/4              | 1 1/4      | 2 3/4      | # 9 (3/32)   | 630                | 160                    |
| 1-3/8              | 1 1/2      | 3          | # 9 (3/32)   | 525                | 190                    |
| 1-1/2              | 1 5/8      | 3 1/4      | # 9 (3/32)   | 425                | 240                    |



Figure 6: Dimensions of washers

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## How To Make Your Own Rail Guides


| Nylon Insert Locknuts   |             |                |                    |               |                                  |                            |                            |
|---|-------------|----------------|--------------------|---------------|----------------------------------|----------------------------|----------------------------|
|  |             |                |                    |               |                                  |                            |                            |
| Size  | A Thickness | B Across Flats | C Across Corners** | Weight Lbs./C | Prevailing Torque In.-Lbs., Max. | 1st Removal In.-Lbs., Min. | 5th Removal In.-Lbs., Min. |
| 2-56, 2-64  | 1.143       | .250           | .275               | .14           | 3.0                              | 1.0                        | 0.5                        |
| 3-48, 3-56  | 1.143       | .250           | .275               | .14           | 3.0                              | 1.0                        | 0.5                        |
| 4-40, 4-48  | 1.143       | .250           | .275               | .14           | 3.0                              | 1.0                        | 0.5                        |
| 5-40, 5-44  | 1.143       | .250           | .275               | .14           | 3.0                              | 1.0                        | 0.5                        |
| 6-32, 6-40  | 1.178       | .312           | .344               | .26           | 6.0                              | 1.5                        | 1.0                        |
| 8-32, 8-36  | 1.229       | .345           | .378               | .42           | 9.0                              | 2.0                        | 1.5                        |
| 10-24, 10-32  | 1.239       | .375           | .413               | .50           | 13.0                             | 2.5                        | 2.0                        |
| 12-24, 12-28  | .313        | .437           | .488               | .92           | 30.0                             | 5.0                        | 3.5                        |
| 1/4-20, 1/4-28  | .313        | .438           | .488               | .90           | 30.0                             | 5.0                        | 3.5                        |
| 1/4-18, 1/4-24  | .344        | .500           | .557               | 1.20          | 60                               | 8                          | 5.5                        |
| 1/4-16, 1/4-24  | .453        | .562           | .628               | 1.80          | 80                               | 12                         | 8.5                        |
| 1/4-14, 1/4-20  | .453        | .625           | .698               | 2.30          | 100                              | 17                         | 12                         |
| 1/4-13, 1/4-20  | .594        | .750           | .840               | 4.30          | 150                              | 22                         | 15                         |
| 1/4-12, 1/4-18  | .641        | .875           | .982               | 7.10          | 200                              | 30                         | 21                         |
| 1/4-11, 1/4-18  | .750        | .938           | 1.051              | 8.30          | 300                              | 39                         | 27                         |
| 1/4-10, 1/4-16  | .875        | 1.062          | 1.191              | 12.0          | 400                              | 58                         | 41                         |
| 1/4-9, 1/4-14   | .984        | 1.250          | 1.403              | 19.0          | 600                              | 88                         | 62                         |
| 1/8-1, 1/8-12, 1/8-14   | 1.047       | 1.438          | 1.615              | 27.0          | 800                              | 120                        | 84                         |
| 1/8-7, 1/8-12   | 1.172       | 1.625          | 1.826              | 41.0          | 900                              | 150                        | 105                        |
| 1/8-6, 1/8-12   | 1.391       | 1.812          | 2.038              | 58.0          | 1000                             | 188                        | 132                        |
| 1/8-5, 1/8-12   | 1.578       | 2.000          | 2.249              | 77.0          | 1200                             | 220                        | 154                        |
| 1/8-4, 1/8-12   | 1.609       | 2.188          | 2.415              | 100.00        | 1350                             | 260                        | 182                        |

Figure 7: Dimension of nylon insert locknuts.

diameter. It was getting too big for a regular launch rod.

If we look at the bottom of our rocket, we have space to mount the rail button and at the top we have room to mount a rail button. So let's figure out how we are going to do it.

We have to mark our body tube. We take a piece of aluminum angle or the Estes Ultimate Tube Marking Guide

([www.ApogeeRockets.com/Build- ing\\_Supplies/Tools/ Ultimate\\_Tube\\_Mark- ing\\_Guide](http://www.ApogeeRockets.com/Build- ing_Supplies/Tools/ Ultimate_Tube_Mark- ing_Guide)), and use it to establish a straight line. We bought our aluminum angle in a hardware store or the hardware department of a big store.

As a straight edge on our rocket for marking a line, the aluminum angle looks like the image in Figure 9.

Now we have the line aligning our rail buttons, but where on the line?

According to Tim Van Milligan's videos on installing rail buttons ([http://www.apogeerockets.com/Advanced\\_Con- struction\\_videos/Rocketry\\_Video\\_103](http://www.apogeerockets.com/Advanced_Con- struction_videos/Rocketry_Video_103)), the buttons should be far enough apart that they support the rocket. Tim says they should be on opposite sides of the Center-of-Gravity if at all possible.

Now that we have these locations, we take a drill with a



Figure 8: Estes' Ultimate tube marking guide is used to draw lines down the sides of tubes.

Continued on page 7

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## How To Make Your Own Rail Guides



**Figure 9:** Draw a straight line along the tube, so both buttons are aligned.

bit of letter "F" size and drill a hole at the two locations.

Now we can take a 1/4-20 pan head screw, 3/4" long, that has a nut screwed on to it, that allows for a space of 1/8" from the bottom of the head to top of the nut. Remember, this space is what will allow it to slide onto the launch rail.

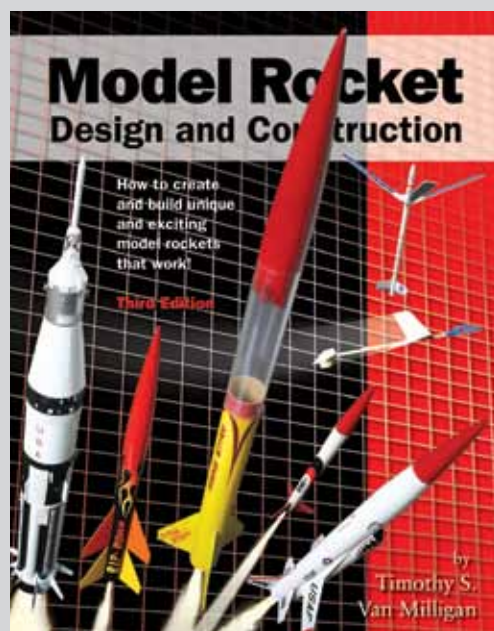
We put a drop of paint on the threads to bind them so they do not easily move. Then we take this assembly and push it through one of the holes we have just drilled, as shown in Figure 10.

On the inside of the tube, we take a flat washer and put it over the end of the screw. Then we take a lock nut and screw it down tight over the end of the screw. This will look

**Figure 10:** The homemade rail buttons as seen on the outside of the rocket.



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## Model Rocket Design and Construction

By Timothy S. Van Milligan

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This massive, 328 page guidebook for serious rocket designers contains the most up-to-date information on creating unique and exciting models that really work. With 566 illustrations and 175 photos, it is the ultimate resource if you want to make rockets that will push the edge of the performance envelope. Because of the number of pictures, it is also a great gift to give to beginners to start them on their rocketry future.

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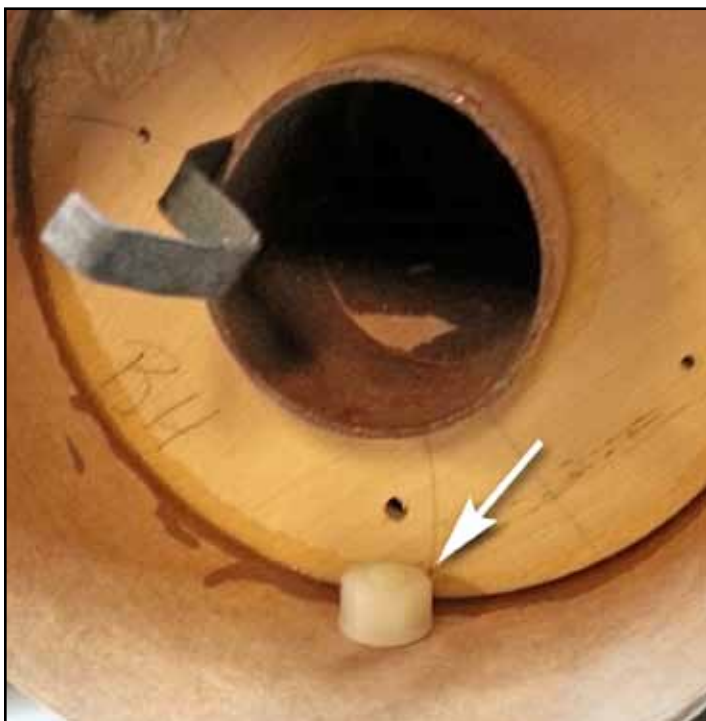
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## How To Make Your Own Rail Guides



**Figure 11:** The washer and lock nut on the inside of the tube.

like what is shown in Figure 11.

You'll also want to test fit the homemade rail guides on a rail to make sure that they slide easily. Figure 12, to the right, shows my rocket being tested in such a manner.

You can use this same technique for making rail guides



**Figure 12:** The finished rail buttons.

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## How To Make Your Own Rail Guides

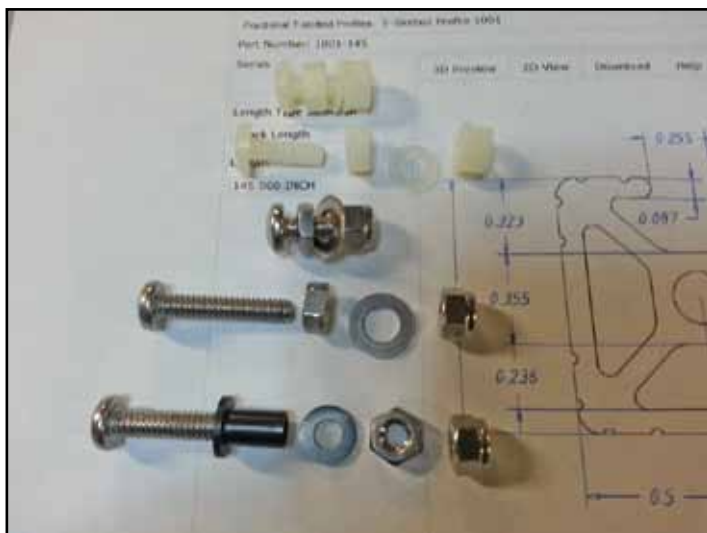


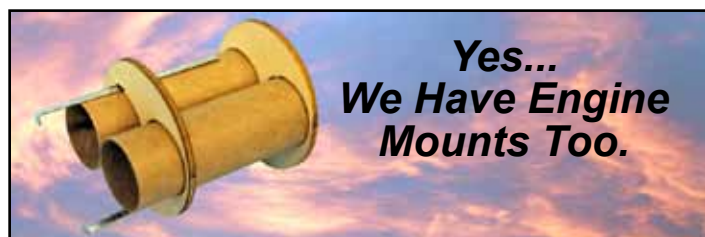
Figure 13: A variety of rail guides can be made using this technique.

for the larger 1-1/2 rail launchers, as well as modifying it for different configuration rockets. For example, you can make stand-offs for rockets that have a larger diameter nose cone than the tube where the rail buttons are located.

### About the Author

Barry Friedrichs is a born again rocketeer who first started flying rockets in 1966 and was part of the team that flew model rockets inside the Astrodome on national TV in 1969. He has worked in many disciplines over the years and was a whitewater river guide for 25 years. When not selling gold and silver IRAs and coins, he builds high power rockets in Colorado for one of his hobbies. He believes one of his most valuable resources is learning how to question everything and is always asking why.

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