



REPLACING THE FORWARD RUDDER PULLEYS

Note: You must have the assistance of a qualified Aircraft Mechanic to perform this procedure. A field approval (FAA Form 337) is NOT required for this procedure. It is simply an A&P sign off with a logbook entry with the mechanics signature.

Description:

The forward rudder pulleys are located under the angular panel forward of the hydraulic pump handle. These are 2" pulleys that are really too small for the 5/32" rudder cable that Republic uses for rudder control; especially on steerable tail wheels. AC 43.13 has a chart that indicates minimum pulley diameter for various cable diameters. See chart below:

Minimum Tread Diameter for Pulleys or Sheaves						
RATIO OF CABLE DIAMETER TO PULLEY DIAMETER						
	Desirable Minimum			Critical Minimum		
	42:1	24:1	12:1	28:1	18:1	10:1
Cable Diameter	6x7	6x19	6x31	6x7	6x19	6x31
in Inches	or 7x7	or 7x19	7x31 6x37	or 7x7	or 7x19	7x31 6x37
1/16	2-5/8	----	----	1-3/4	----	----
3/32	2-15/16	2-1/4	----	2-5/8	1-11/16	----
1/8	5-1/4	3	----	3-1/2	2-1/4	----
Our Rudder Cable Size 5/32	6-9/16	3-3/4	----	4-3/8	2-7/8	----
3/16	7-7/8	4-1/2	----	5-1/4	3-3/8	----
7/32	9-13/16	5-1/4	----	6-1/8	4	----
1/4	10-1/2	6	3	7	4-1/2	2-1/2
5/16	13-1/8	7-1/2	3-3/4	8-3/4	5-5/8	3-1/8
3/8	15-3/4	9	4-1/2	10-1/2	6-3/4	3-3/4
7/16	18-3/8	10-1/2	5-1/4	12-1/4	7-7/8	4-3/8
1/2	21	12	6	14	9	5

As you can see, the "Desirable" pulley diameter is listed as 3-3/4" and the "Critical" minimum is 2-7/8". Why Republic used 2" pulleys is anyone's guess. The small 2" pulleys put a tremendous strain on the cables as they go up about 25° to the rudder control arms attached to the rudder pedal bars. There have been cases of the cables fraying just under these 2" pulleys. I have changed the forward Rudder Cables three times in the past fifteen years and that is not a long service life for a 5/32" cable so I, along with other members, researched a cure: 3" pulleys. This pulley size is a good compromise between the "Desirable" and "Critical" pulley diameters.

This procedure requires modifying the forward pulley cover with a "bump" that covers the 3" pulleys and the installation of new, larger pulley brackets. The fare leads next to the pulley brackets will need to be modified slightly as well. All other hardware remains the

same except that some of the Seabees I have seen have the fare leads riveted in place. These must be drilled out and replaced with bolts. Also, you might have to increase the Forward Rudder cable length slightly by $\frac{1}{4}$ " – $\frac{1}{2}$ " or so as well depending on your cable length. This should not be required unless your cables are short to begin with.

If you have found cable fraying underneath the 2" pulleys and are tired of changing the cables every 5 years, this procedure should help.

Procedure:

Step 1: Take the forward center section of the cable covers off. That's the one with the sloped top.

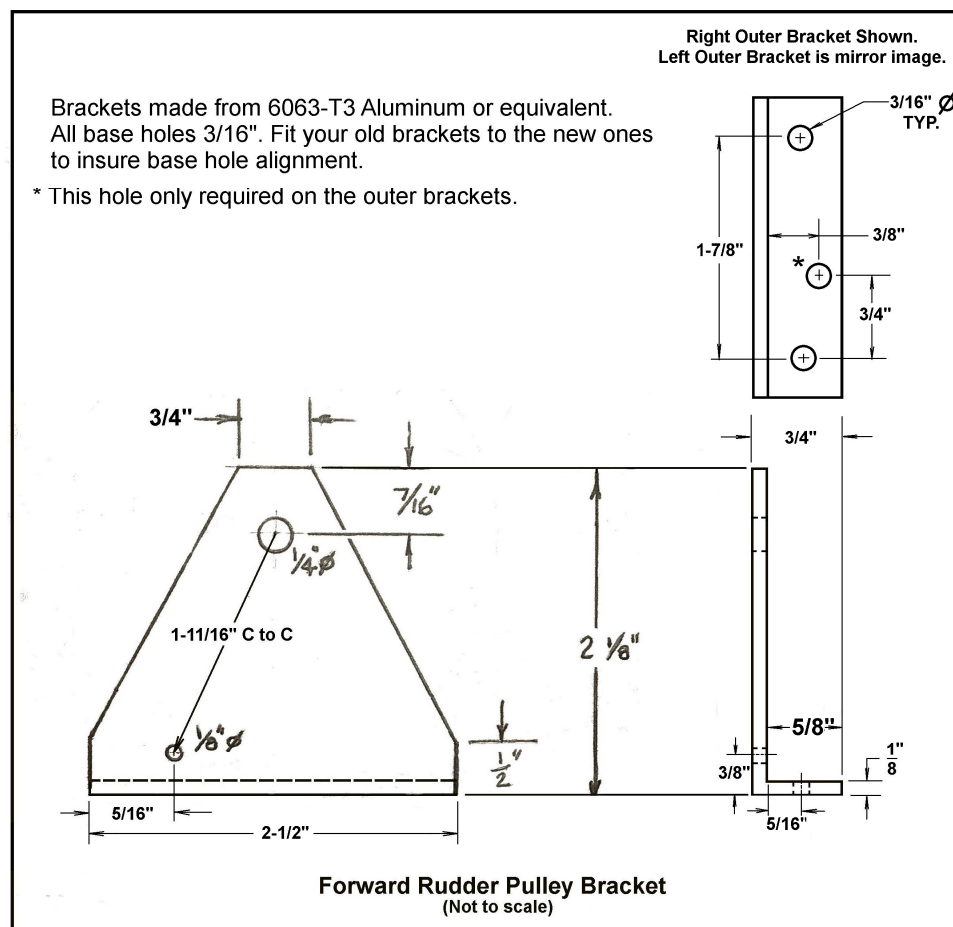
Step 2: Disconnect the rudder cables at the rudder pedal control arms.

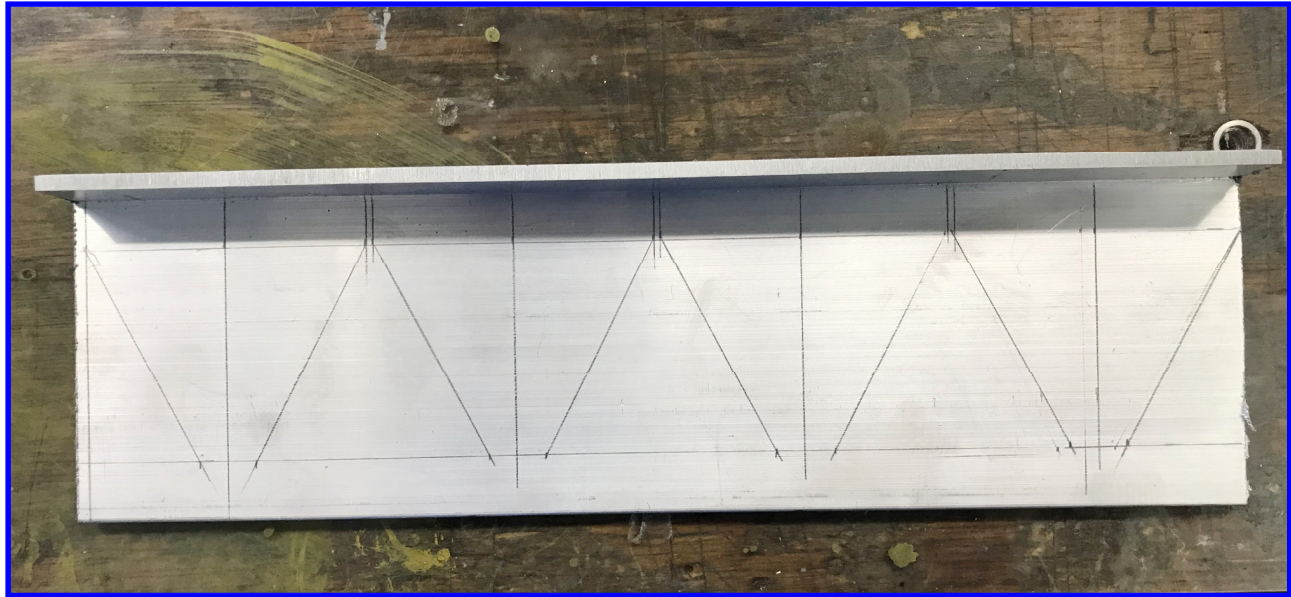
Step 3: Remove the 2" forward rudder pulleys.

Step 4: If the phenolic fare leads next to the pulley brackets are riveted in place, drill them out carefully. They are very long rivets.

Step 5: Open all forward floor access panels (anchor compartment and small access panel left of hydraulic pump) and remove the left and right 2" pulley brackets.

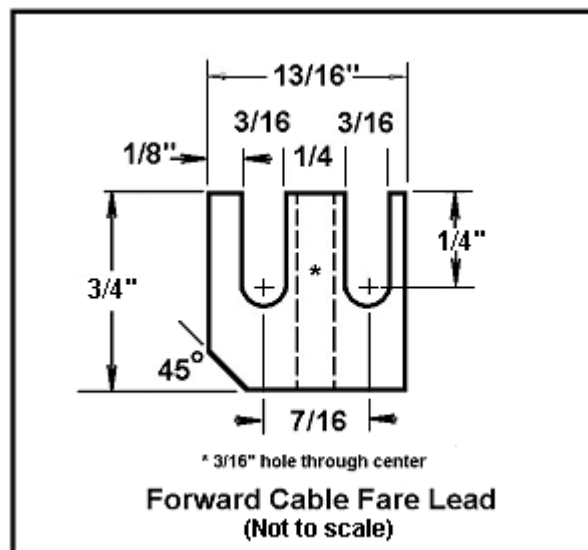
Now, you must make the new pulley brackets. I used a 2" x 2" x $\frac{1}{8}$ " piece of 6063-T3 aluminum angle cut to the dimensions below:





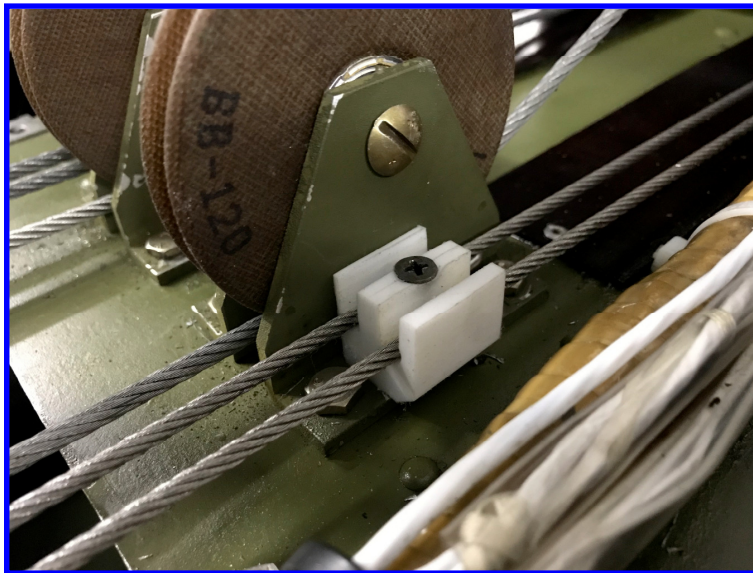
New Bracket Layout

If your fare leads are in good shape a slight modification is required. Due to the thickness of the new brackets, the inner side of the fare leads needs to be shaved down $\frac{1}{16}$ ". This will provide a tight fit against the bracket. If you are so inclined, you can make new ones out of Teflon that will last forever and are very strong and VERY slippery. A well respected A&P at my airport said, "When phenolic meets steel cable, phenolic will win." That means that eventually the cable will wear at the contact point of the phenolic block regardless of location. Teflon is much more forgiving and remember, Republic didn't have Teflon back in 1946 otherwise I'm sure they would have used it.



Forward Fare lead Dimensions

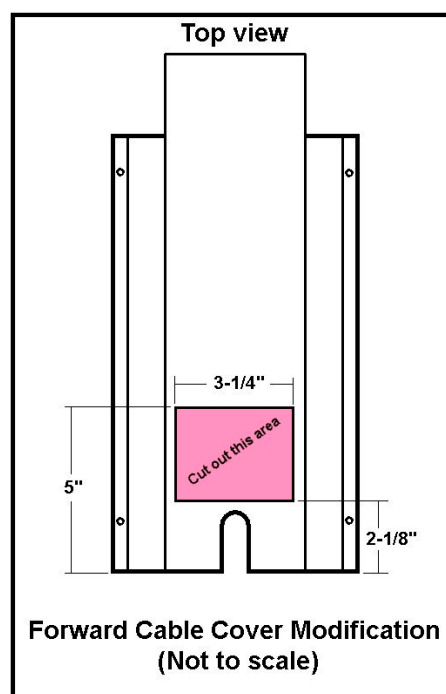
If you have access to a vertical belt sander use it to sand down the phenolic fare leads $\frac{1}{16}$ ". Notice the drawing above; the right side is $\frac{1}{16}$ " thick and fits against the new brackets and the left side is $\frac{1}{8}$ " thick.



Teflon Fare Leads for Aileron and Elevator Cables with 3" rudder pulleys

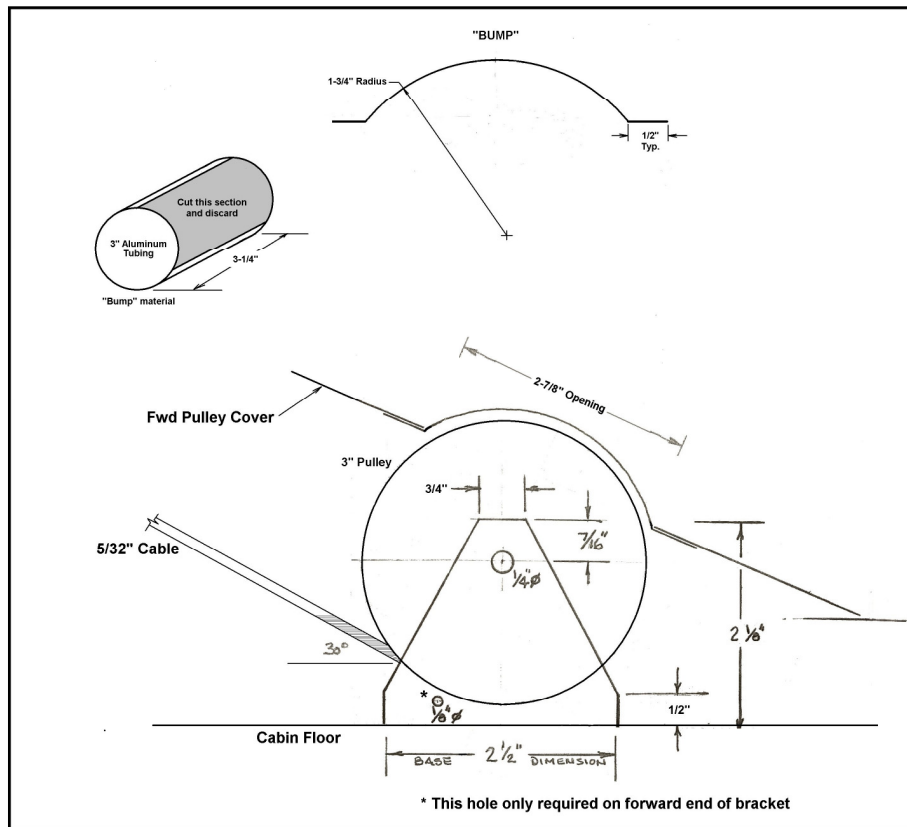
Cable Cover Modification:

The forward cable cover (the sloped one) needs to be modified with a "bump" to accommodate the larger pulleys. Masking tape should be applied to the cover where the "bump" hole will be. Mark the hole required with a fine tipped Sharpie on the masking tape. Using a cutoff wheel carefully cut the opening to the dimensions shown below. I had the luxury of a spare cover to experiment with and if your cover is an original cover, the drawing below will work fine. If you have a different cover you will have to do the "math" to figure out where your hole should be. Start with a smaller opening and gradually enlarge it to fit your pulley situation.



Forward Cable Cover Cutout

I found that the cover was slightly (1/16") off-center to the right of the pulleys so the opening is shifted slightly to allow pulley clearance. See sketch below:



“Bump” fabrication

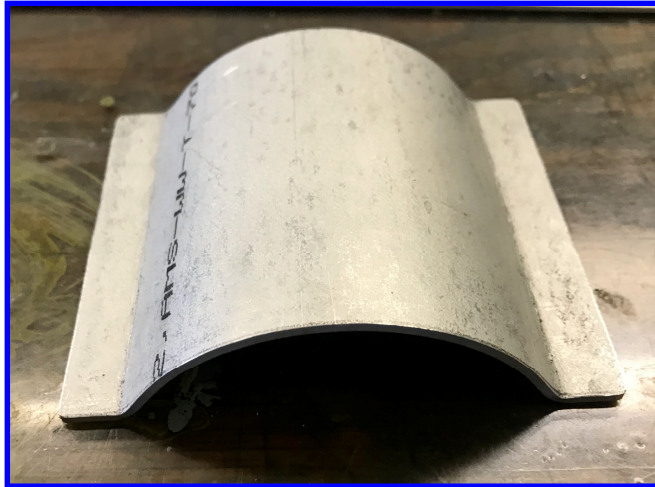
The small hole on the lower edge of the bracket above is for cable guard pins. (Your old ones won't fit). I made some out of 1/8" aluminum welding rod with small holes drilled in the end for the cotter pin. They are 11/16" long with one end bent 90° and a 1/16" hole drilled in the end for the cotter pin. A 1/8" aluminum nail would work as well. Make sure they are safetied with the cotter pin. The AN24 pivot bolts will have to be longer because the brackets are thicker. Be sure to use castle nuts and cotter pins to safety.



Cable guard pins with washer and cotter pin

The "Bump":

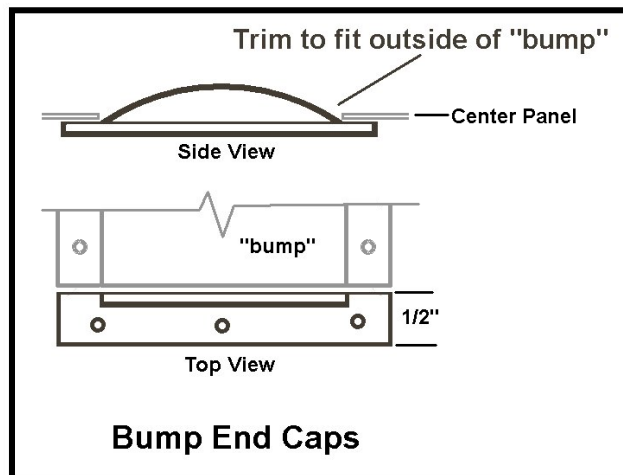
If you happen to have a 3" O.D. piece of aluminum tubing, you are in luck. Just a slight modification to this tubing will give a perfect "bump" to the center section. Cut a 3-1/4" long piece of this tubing then cut a section off lengthwise that will give a total length around of 4-1/2". A 3-1/2" O.D. steel pipe is used to form the "bump". An old Seabee lower landing gear strut was used in my case and it worked perfectly. Otherwise use a steel pipe. You may have to tap it with a hammer to get the 3-1/2" curve to the "bump".



The "Bump"

Lay the cut out section of the aluminum tubing onto the steel pipe and tap it down to form the 3-1/2" diameter (1-3/4" radius) required to clear the pulleys. The ends of the "bump" are then bent over flat 1/2" to provide a riveting flange. Test fit the "bump" as you go. It will probably take a few times to the pipe to get it right. The "bump" is inserted from the bottom of the forward cable cover and some filing and trimming will be required to get it to fit correctly.

There are two end caps for the "bump" made from 1/2" x 1/2" x 1/16" aluminum angle. These are riveted to the center panel along each side of the "bump" and fit on the outside of the "bump" to prevent anything from jamming the pulleys.



"Bump" End Caps

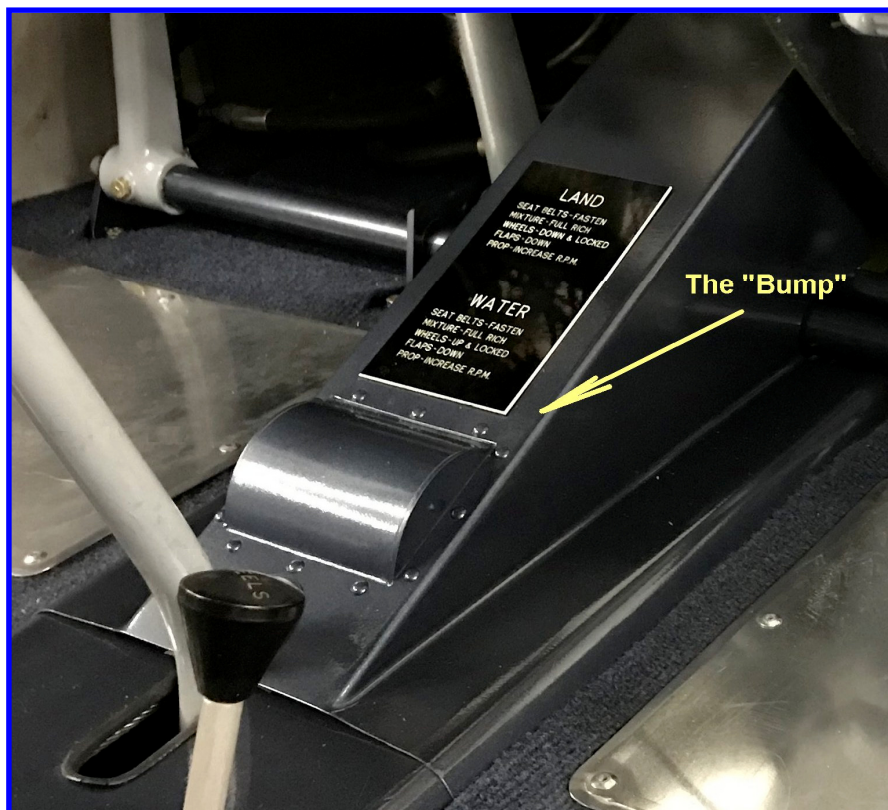
The opening in the center panel must be trimmed to accept the “bump” and the end caps. Both the “bump” and the end caps must fit from underneath the center panel. You may need to trim the end cap rivet flange to fit inside the center panel.

Use masking tape to hold the “bump” and end caps in place and fit the center panel in position over the forward rudder pulleys. Trim and file the opening as necessary to clear the pulleys. Make sure you screw the center panel in place when checking for clearance as some shifting may occur when the screws are tightened. You can use a mirror and a flashlight to look from the forward end of the center panel down to the pulleys to make sure the fit is correct with no interference.

When all is well, mark the rivet locations on the “bump” and the end caps. Use AN470AD-4-4 rivets in 12 places; three on each side of the “bump”. Smooth out the top edges of the “bump” and end caps with a file or Emery cloth. Prime it and paint it.

While you are waiting for the paint to dry, loosen the rudder cable turnbuckles just forward of the tail wheel bulkhead. Attach the cables to the rudder control arms with clevis bolts and castle nuts. Insert the pulleys into the new brackets and safety the clevis bolts. Install the cable guide pins and safety. Tighten the turnbuckles to specs (20# ± 5#) (Make sure the rudder is in alignment with the rudder pedals) There should be no more than three threads showing on each end of the rudder turnbuckles. If there is you should increase the cable length 1/4" – 1/2" depending on how many threads are showing. Safety the turnbuckles.

Below is the finished “bump” and with this modification, especially with steerable tail wheels, I don’t think you will have to replace your forward rudder cables quite so often. I may be imagining things but I think the rudder control is smoother too!



**List of materials**

Qty	Description
2	3" pulleys; P/N BB-120
3-1/2"	3" Aluminum tubing; P/N 6061-T3 (or equivalent)
2	Clevis Bolts with castle nuts, washers and cotter pins; P/N AN24-14 (pulley pivots)
12"	6063-T3 2" x 2" x 1/8" aluminum angle or equivalent
8"	1/2" x 1/2" x 1/16" Aluminum angle
12	AN470AD-4-4 rivets
8	AN3-6A Bolts, washers and lock nuts (Bracket bolts to floor)
2	3/16 x 1-1/4" flat head machine screws, washers & lock nuts (phenolic block screws, if required)
2"	1" x 1" Teflon for fare leads (if replacing phenolic blocks)
2	1/8" x 11/16" cable guide pins for pulley brackets
2	1/8" ID washers for cable guide pins
2	1/2" Cotter pins for above cable guide pins. P/N 380-2-2