



Elevator Trim Rigging and Adjustments

Except where noted otherwise, photos and article by Steve Mestler

Caution: These procedures are to be used at your own risk. Republic had no instructions on how to adjust or replace the trim system in the Republic Seabee, so use caution and if you have any doubt about your abilities, please get the advice of an FAA Approved Mechanic. He or she will have to check your work and make a logbook entry after the procedure is complete. Any photographs or illustrations listed below are for clarification purposes only. Your installation and procedures may vary. Read through this article completely first.

Note: When the term "Bowden Cable" is used in this article, it includes the 1/16" stranded cable that is the inner moving cable inside the sheath. The term is used to include the sheath and cable assembly as a whole.

In my opinion, the elevator trim system in the Seabee is the weakest system in the Seabee. There are chains, cables, sprockets, torque tubes and threaded rods that have to push, pull and turn from the crank on the overhead panel above the pilot all the way back to each individual elevator trim tab. A lot can go wrong between here and there. It is, however (with proper maintenance), a tried and true system and other than installing an electric system (available as an STC), there isn't much of a change that can be made to it. I will admit that there is an advantage to our mechanical system; if the trim crank turns freely chances are very good that the trim tabs will be moving hopefully in the right direction. Proper lubrication and a critical eye to telltale signs of potential failure is the key to a reliable trim system on the Seabee. The Seabee trim system is critical for safe flight! It must work flawlessly.

Former Seabee club members report trim tab failures in various newsletters from the past by Dick Sanders and it doesn't sound like fun when it happens. They say the Seabee pitches up and down with no way of controlling the fluctuations. They mention that a slower speed helped along with a LONG runway or lake for landing. The best way to avoid this situation is avoidance; keep your trim system well maintained. Hopefully this article will help you.

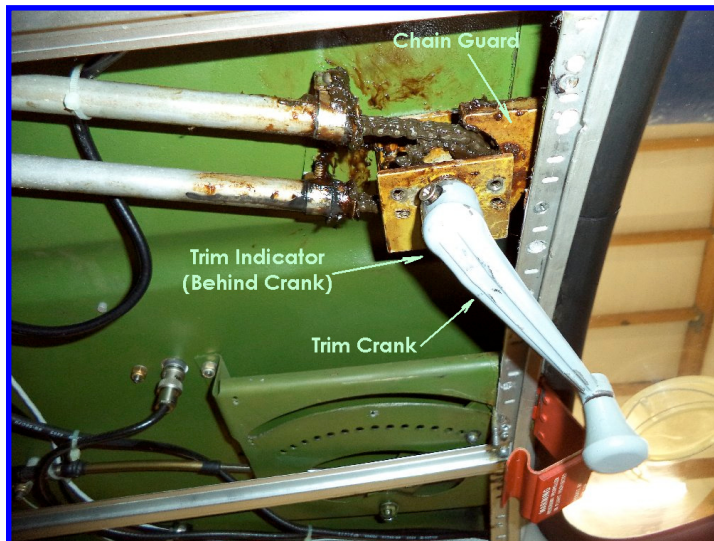
Note: Take lots of pictures as you disassemble the trim system so you will know where and how things go back together. These will be invaluable later.

System description:

The trim crank overhead is directly connected to a horizontal sprocket that is encased in a box that houses the sprocket, chain, chain guard and trim indicator. The trim indicator next to the trim crank shows the relative position of the trim tabs if everything is rigged correctly. The indicator will move aft for nose up trim and forward for nose down trim. From the full nose down position the crank should turn about 8 full turns to the full nose up position. The mid position of the indicator overhead should approximate the trim tab neutral point (see photo below).



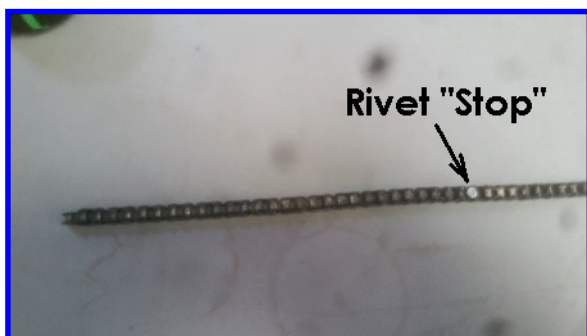
Trim Handle with trim indicator.
Indicator shows slight nose up trim.



*Trim Crank and Trim Sprocket
(Notice aluminum tubes for chain guidance)*

Around the forward sprocket is a chain with a .25" pitch (distance from link to link in the chain). The chain is protected from jumping a tooth in the sprocket by a solid, circular aluminum guard (see photo above) that guides the chain around the sprocket. Both ends of the chain then go aft through flared-end aluminum tubes in the ceiling which act as vibration dampers and chain guidance.

There are two rivet "stops" driven through the forward chain at strategic locations to prevent turning the trim crank too far (see below). These "stops" go up against the sprocket and stop the trim crank travel. The chain should be installed with these rivet "stops" next to each other after the chain is threaded through the crank sprocket. This will give equal amount of turns to the trim system ensuring the 25-degree up and down movement of the trim tabs as required by the Type Certificate (see photos below). One rivet stop is located approximately 10 links from the end and the other is approximately 23 links from the end of the chain (check your chain to see how many links are required). The 10-link stop is on the right side of the sprocket and the 23-link stop is on the left.



*Photo of rivet "stops" on forward chain. Same chain; two rivets.
(Photos by member Jaren Lynn)*

On the ends of the forward chain are fittings that are connected with a master link to the last chain link. These fittings are swaged onto a 1/16" inner cable that runs through a Bowden cable that runs from the aft cabin bulkhead all the way back to the bulkhead just above the tail wheel. The cable then exits the Bowden cable up to another sprocket located on a bracket at and above the trailing edge of the horizontal stabilizer. There is only one adjustment possible for the trim system: a turnbuckle inline with the lower cable forward of the aft sprocket. The aft sprocket is attached to a torque tube (about 3/8" diameter) that goes out both sides to the left and right. These torque tubes are attached to heavy flexible cables (similar to speedometer cable) that go out to each trim tab gearbox in the left and right horizontal stabilizers (see photo below).



Flexible cable attached to each trim gearbox from the rear sprocket

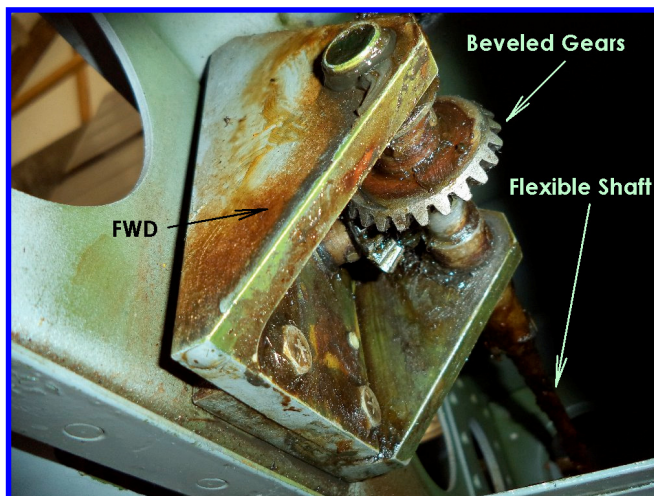


Flexible Cable Sprocket End

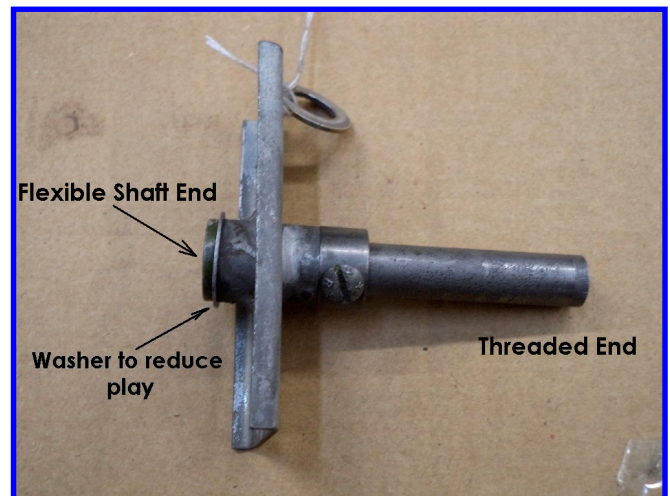


Flexible Cable Trim Gearbox End

The trim gearboxes have 45-degree beveled gears that transfer the lateral rotation of the torque tubes into a rotary motion that pushes or pulls a threaded pushrod via a drive unit in the leading edge of the respective elevator. These drive units are different on each side. There is a left unit and a right unit.

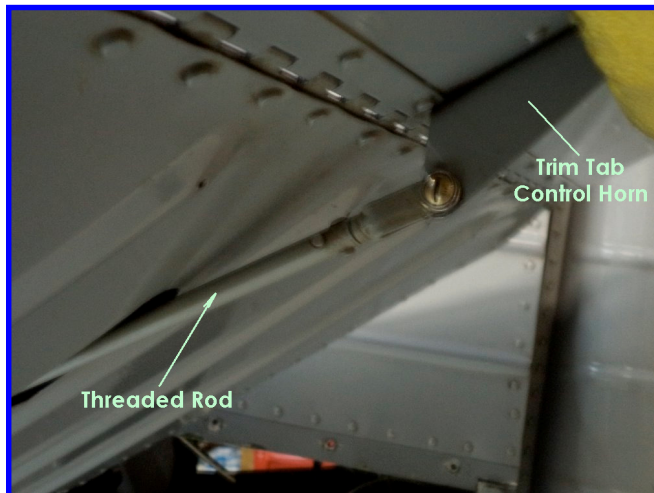


Right-Hand Trim Gearbox



*Drive Unit
Fork fits into flexible shaft end*

There is another shorter flexible shaft (not shown) that comes out the rear of the trim gearbox, through the rear horizontal stabilizer spar (with a grommet) and has a fork end that fits into the drive unit in the elevator. The pushrod is then attached to the trim tab control horn and moves the tabs up or down depending on the rotation of the trim crank up front.



As you can see there are quite a few components comprising this system. The failure of any one of them could cause partial or total trim failure. As you probably know there is an Airworthiness Directive (48-01-03) that addresses the trim system and requires a periodic 25-hour inspection of the trim "play" OR install a steel bushing in the control horn to prevent more than 1/8" of total movement in the trim trailing edge itself. (See Republic Seabee Service Bulletin #20 and Republic Distributor Bulletin #12.)

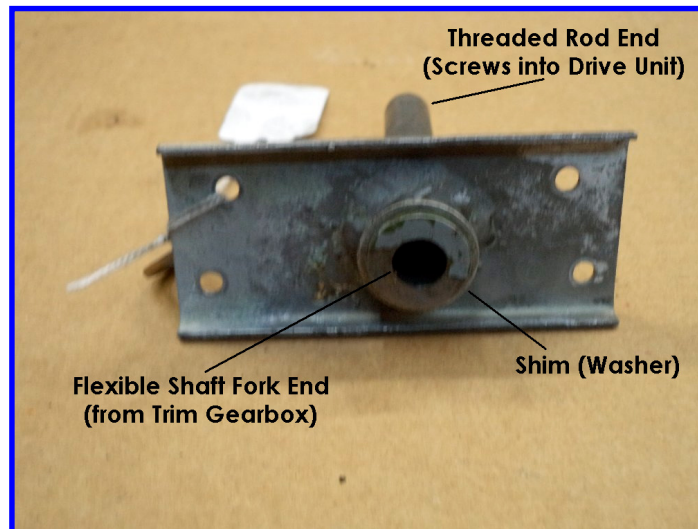
I have found three more reasons for excessive play in the system:

- 1- Trim tab hinges are worn. Hinge replacement will cure this problem. Extruded hinges are best. They are a little more money but worth it.

WARNING: When replacing the hinges, make sure the ends of the hinge pins are secured! Some Seabee owners install small cotter pins at the very ends of the hinge to hold the hinge pin in place. The original hinges from Republic were simply crimped. This will fail over time.

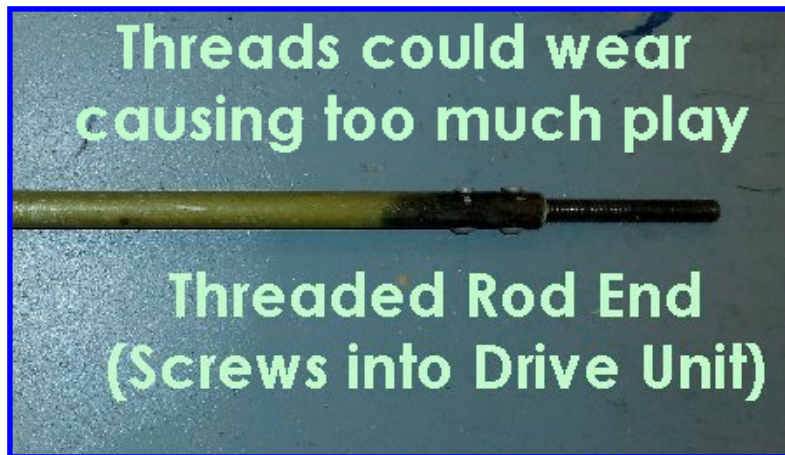
(Quick story: I was flying back from New York to a friends place in North Carolina and upon starting my descent I noticed a vibration so bad I could feel it in my shorts. As I slowed down it seemed to disappear. When I landed I looked the Seabee over and noticed nothing until I raised the elevators and looked underneath. The hinge pin on the right side had come halfway out! The hinges had been crimped and the hinge pin still worked its way out. Scared me to death. I installed cotter pins the next day.)

- 2- The drive unit that the threaded trim tab pushrod screws into has excessive play. A shim MAY solve this problem (see drive unit photo below). Otherwise a drive unit replacement will be necessary.



*Trim Drive Unit mounted inside each Elevator
(Right Drive Unit Shown)*

- 3- Threads on the trim tab rods or inside the drive units are worn. Threaded rod or drive unit replacement might be necessary. The thread should be a standard 1/4-20 thread.



I have had all three problems listed above and each one can cause excessive trim tab play and cause in-flight vibration. Even though the AD addresses only the trim tab control horn issue, a critical look at the other components could be the cause of trim tab vibration. The bushing in the control horn solves only one of the symptoms.

Trim cables are still available and are standard 1/16" (inner stranded cable) Bowden cables. They are very long; about 15 feet for the outer sheath with a few more feet of 1/16" stranded cable extending to the rear! This does not include the chain. So there is at least 20 feet of cable/chain all told.

I know that there are cables available that have a Teflon lined sheath that eliminates cable wear and makes the trim crank run very smoothly. Nice! The fittings at the ends of the cables may be a bit difficult to come by. I haven't checked on the availability of them yet. The Teflon cables come with fittings already swaged in place.

The chains are still available through MSC Industrial Supply Co. (www.mscdirect.com/). These chains have a .25" pitch (ANSI 25) with master links on both ends of the forward chain and one master link and one threaded fitting for the turnbuckle on the rear chain. Part number MSC#: 35403757 or 58636853, Mfr Part #: RC025R1A. These chains are also available at McMaster-Carr (www.mcmaster.com) P/N: 6261K171.



Forward Chain with rivet "stops"



Rear Chain with One Turnbuckle

Note: Make sure you check your chain dimensions before ordering. It is a standard chain but do this to make sure you get the right one. The chain specifications are shown on the MSC and McMaster website. At last check a ten-foot chain, which is plenty to do both chains, was about \$50. The master links were about \$1.00 each (you will need four). Also remember to reinstall new rivet "stops" (#4 short rivet) in the same locations as the old chains.

**Lubrication:**

I was told years ago by an old-timer to spray the outside of the Bowden cable with your favorite lubricant; LPS-2, WD-40, etc. (something thin). The lubricant will then seep into the Bowden cable and eventually reach the inner stranded cable. You must start from one end of the cable and work your way toward the other end. I normally use a rag saturated with LPS-2 and run the rag the full length of the cable adding LPS-2 to the rag along the way. It is a tedious job but well worth the trouble. It has worked for me for the last 15 years and I show no signs of wear or jamming. Do this during every annual or 100-hour inspection.

Some Seabee owners have used grease (myself included) for the trim tab gearbox and forward trim sprocket but this can be problematic in colder temperatures. The trim system will freeze up and be nearly impossible to operate until it "thaws out". The official Republic Lubrication Chart says to use "AIO" (Aircraft Instrument Oil). This oil is very thin and does provide protection against corrosion and the parts will move freely but I use plain old 30-weight oil now. It hasn't frozen yet and is cheaper than AIO. Regular engine oil will work as well. The point is don't use grease.

If you notice a slight resistance or jerkiness in certain spots during trim movement, even after lubrication; you may have a frayed cable or a jammed sprocket. Check the sprockets after the chains are removed for freedom of movement. A cable replacement will be required for it will be just a matter of time before the trim system (the stranded cable) fails completely. Murphy's Law will prevail however, as it will fail at the most inopportune time during flight! Like I said, it must work flawlessly. Check the inner stranded cable for frayed strands or flat spots. You should do this at both ends of each cable. Get a friend to operate the trim system SLOWLY as you watch the cable at both ends. It is impossible to check the inside of most of the cable as the fittings at the cable ends prevent it from being exposed. Check what you can.

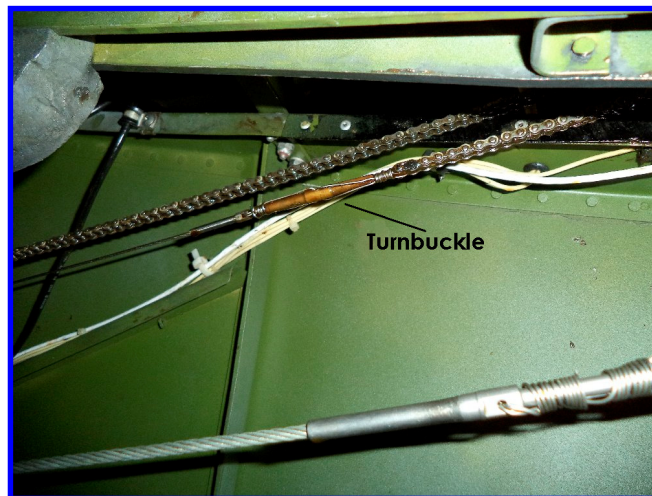
Cable Adjustment:

You will notice that with the trim handle turned full nose up that the end of the left chain is visible at the aft end of the left aluminum tube. The master link should also be visible. This is not the case for the right side of the forward chain. You can't see any part of the right end of the chain! So, how do we find out how to get the rivet stops next to each other (side-by-side)?

You can do this with the trim system as it sits right now by turning the trim handle and counting the links from one rivet stop to the other rivet stop and dividing that number by two to get the alignment of the rivet stops correct. Now turn the trim handle slowly the other way as you count the "half" number you

came up with. This will put the rivet stops side-by-side inside the aluminum tubes. After lining up the rivet stops, DON'T MOVE THE TRIM HANDLE. You can temporarily clamp them (gently) forward of the aluminum tubes to prevent any movement. Now go to the rear and check the trim tab position. It should be approximately neutral.

Open the left-hand-side hand-hole under the horizontal stabilizer and check the chain "slop". You don't want the chain too tight, as this will cause binding and will wear the chain and sprockets needlessly. Hold the top chain up until a slight tension is felt. The total vertical movement shouldn't be more than an inch or so. The chain guard by the hand crank in front and the one in the rear sprocket support will prevent slipping a tooth on the sprocket under most circumstances. If the cable needs adjustment, remove the safety wire around the turnbuckle and turn the turnbuckle until the cable is at the correct tension. There is only one turnbuckle so adjustment is fairly simple. If you find that the chain is too long or the turnbuckle bottoms out, you may have to remove a link to make it shorter or change the chain as it may have stretched for some reason. Check the full length of both chains for damage. Also check the mounting bracket in the rear and the trim handle support up front for security.



*Turnbuckle on the rear chain
(Viewed through the left-hand round access panel under the stabilizer)*

After the trim handle is set and locked at the correct position (above), check the trim tabs for the neutral position. If they are not the same or are not neutral, remove the cotter pin at the trim tab fork (or trim tab control horn attachment) and remove the trim rod from the control horn. Rotate the rod to get a neutral setting on the trim tab. Do the same thing on the other side if necessary. Remember to reinstall the cotter pin in the pushrod fork bolt (or other safety item).

Temporarily safety the turnbuckle to prevent it from turning and check the trim system from the cockpit. Check full travel to the rivet stops in both directions

and that there is no binding or funny noises coming from the cables. You might need a friend again to turn the handle as you check along the length of the cables.

The official FAA Type Certificate (A-769) says the trim tabs should go up and down 25 degrees in both directions. You can do this by making a cardboard triangle with a 25-degree angle on it and putting it on the trim tab to check for the correct angle. The best way to check this is to invest in an electronic protractor. These protractors can be "zeroed out" when the elevator is at rest (i.e. down) and the trim tab is at neutral. Then when you crank the trim tab to its full up or down position, the angle can be measured on the protractor. Either way will work fine. When you are satisfied the trim is set correctly, safety the turnbuckle according to FAA AC43.13.



Electronic Protractor
(about \$80)

The threaded trim tab rods should be turned into the gear boxes about 15 turns (plus or minus a few turns). You did count the turns when you took them out right? This will give enough threads in either direction and still have a safe amount of thread inside the drive unit located in the elevator. You may have to tweak it during the "adjustment" phase.

Chain removal (both chains):

In order to remove the old chains and replace them, you must remove the trim actuating rods from the trim tabs and remove them from the drive unit. Count the turns required to remove them and write it down. This will help with the installation later. From the cabin, turn the trim handle full nose up. This will expose the master link on the left cable overhead that will be removed shortly.

If you have the chains out of the Seabee the lengths should be:

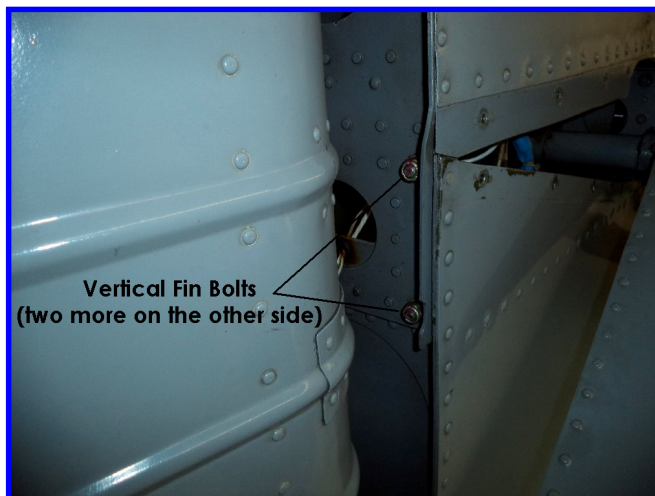
Forward – 48-1/4" (this chain has the rivet "stops")

Aft – 45-1/4" (this chain DOES NOT have rivet "stops")

Note: Believe it or not, it will MUCH easier to change the chains and the cables when you take the vertical stabilizer (fin) off. It's easy to do but it is usually a two-person job. This will expose the rear sprocket fixture and chain quite well.

Take the side access panels at the base of the vertical fin off. Disconnect any wires going to the rudder i.e., Tail Light. The rudder must come off first by removing the four hinge bolts; two on the bottom hinge and one on each hinge above that. Pull the rudder straight back to remove it.

Disconnect any wires and cables going up through the vertical fin; i.e., Antenna cables, beacon wires, etc. Then remove the center spar bolt in the fin (tough to reach through the left-hand inspection hole) and remove the four bolts on the trailing edge of the fin. Lift the fin straight up until clear of the airframe and, with padding on the left horizontal stabilizer, rotate the fin and lay it down on the horizontal stabilizer or remove it completely if there are no wires attached to it. This will give you the best access to the trim system in the tail.



Vertical fin retaining bolts. Two are located on the other side of the fin in the same relative location. There is one other bolt inside attached to the vertical fin center spar. This bolt is tricky to get to. You will need a ratchet with a long extension and a good flashlight to get to it.

Remove the safety wire from the turnbuckle on the lower trim cable and remove the turnbuckle. Disconnect the rear upper chain from the cable at the master link connected to the fitting on the end of the 1/16" cable. Disconnect the turnbuckle threaded fitting by removing the master link going through it. Save the fitting for the new chain. Pull the bottom chain through the rear sprocket slowly until it comes free. This will now allow some slack up front for the forward chain removal. Don't worry about pulling the inner cables through the Bowden sheath as the fittings on the ends of the inner cable will prevent this.

If you are installing a new rear chain, you can do it now but don't install the turnbuckle just yet. Slack will be needed up front to remove the forward chain. Connect the upper chain master link and clip to the fitting on the cable end. Now go to the cabin.

Pull the inner stranded cable, on the cabin end, forward to loosen the forward chains. The master link on the left cable should be in view. Disconnect the master link clip and master link from the aft end of the left chain.

Note: You need to cut two pieces of string about 48" long (.020" safety wire would work as well). These strings will make installing the new chains much easier.

Tie one string to the left-hand cable end through one of the chain links. Now with you (or your friend) turning the crank slowly full nose down, pull the right chain slowly out the rear of the aluminum tube. The right master link should expose itself after about 10 turns. Use caution threading the chain through the crank handle sprocket so it doesn't jam against anything. The first string will be threaded through the left aluminum tube and should hang down out the front end. Disconnect the string from the chain. As the chain comes free of the sprocket, tie the other string to the chain end and as the chain is removed from the aluminum tube the second string will hang down the back end of the tube. You now have a string going through each tube with the ends of the string hanging down each end.

As you take the chain out slowly, remember the position and orientation of the rivet "stops". The 23-link rivet stop should be on the left side and the 10-link rivet stop should be on the right. Thread the 23-link rivet stop through the right tube first then thread it through the sprocket and down the left tube using the two strings mentioned above.

Important: The rivet head, used for the rivet stops, should face inward so that it is the stopping surface. That is, the sprocket should touch the rivet head NOT the shop end.

Reinstall the master links on both ends of the forward cable. As long as you have the "rivet stops" lined up at the forward ends of the cables and you have the correct lengths of chain installed, the trim chains will line up in the rear. See the Adjustment Section above. Now go to the back and connect the rear chain.

Thread the rear chain through the top of the rear sprocket and forward toward the turnbuckle. Be sure the turnbuckle is on the lower cable and install the master links for both ends of the cable. You should now have the upper cable and chain going up over the top of the rear sprocket. The lower chain/cable has the turnbuckle attachment. Safety the turnbuckle after adjustment above.

Note: When reinstalling the vertical fin, use NEW AN5 nuts and bolts! They are all standard sizes. The spar nut plate should be checked for its locking ability. Replace the nut plate if you can thread the bolt through it by hand.

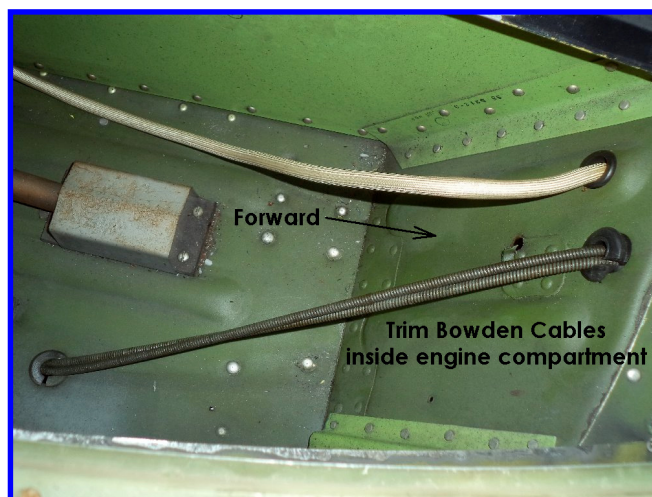
Cable Removal and Installation:

Again, take lots of pictures before you start disconnecting everything. The most difficult part of this whole operation is getting the old Bowden cables out. Unlike the chain replacement, the vertical fin does not need to come off. Along the entire length of the fuselage there are clamps holding the cables in place. These must be removed and replaced if any clamps show signs of excessive wear. If you are just replacing the Bowden cable, disconnect the master links at each end of the cables front and back. Use caution, as these master link clips are VERY small and a bit difficult to remove. A small jewelers screwdriver works well to get the clip off the master link. The chains may be left in place if they are not to be replaced.



Master Link and fitting on chain ends

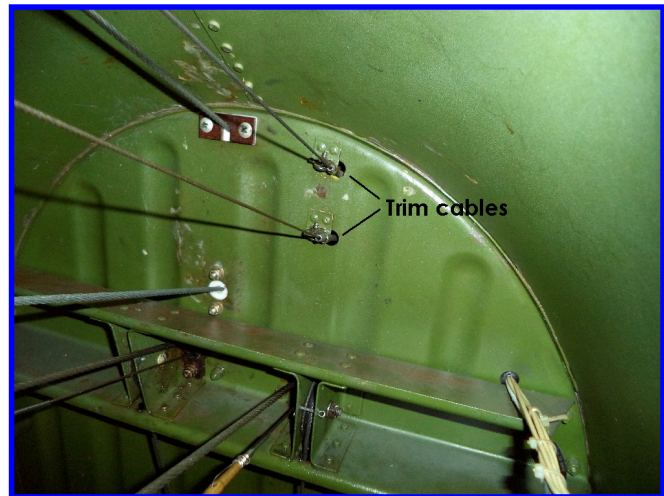
In most cases I've seen, the Bowden cable runs from the cabin bulkhead down through the engine compartment in two places then through the baggage compartment again and running back along the fuselage to the aft bulkhead by the tail wheel. I would start from the front and work back toward the tail. Usually there are two grommets around both cables (see photo below) in the engine compartment. These should be installed BEFORE the cables are threaded through the firewall and cabin bulkhead. Work the cable out of each bulkhead and when all the cable is through, pull it out through one of the round hand-holes.



Engine compartment showing Bowden Cables

It may be a good idea to mark the end of the new cables before installing them so the new cables can be replaced in the same location. Make sure the cables are not twisted as you install them. Remember that the cables are side-by-side up front and on top of each other in the rear bulkhead. The bottom cable in the rear is the “nose down” cable; that is, when the bottom cable is pulled forward the trim tab will go up hence the “nose down” trim. Consequently the cable on the left up front is the same “nose down” cable. When it is pulled (crank counterclockwise), the trim tab is moved up for a nose down effect. Get your mechanic to check the trim movement before you finalize the installation. It is most critical to keep the same cable orientation as the original installation.

Trim cables at aft bulkhead looking forward. When lower cable is pulled forward, trim tab moves up for nose down trim.



Note: If you are replacing the Bowden cables and they are the original style (not Teflon) soak both new cables in LPS-2 or WD-40 BEFORE installing them. This will ensure that lubrication is in every nook and cranny of the cable prior to installing them.

Starting from the cabin side, run the cables down the same route they had originally. Cable routing is through the baggage compartment then the engine compartment then back to the baggage compartment and through the fuselage. Whew!

You can now reattach the cable end fittings to the chains with the master links and clips. When the cables are installed in the original position, install the clamps around the cables as they were before removal. Attach the cable end fittings to the chain end-link. Make sure the master link clip is installed and snaps in place. If you bend a master link clip you must replace it.

Before safetying the turnbuckle, test the trim system for correct operation. Looking up at the crank; turning it clockwise should be "nose up" (trim tab down) and turning it counterclockwise should be "nose down" (trim tab up). Turn the crank until the "rivet stops" hit the sprocket to insure the cable isn't binding anywhere. When you are satisfied that the cables are working correctly and not interfering with any structure, safety the turnbuckle when the tension on the cable is correct (NOT TIGHT, just enough to take the slack out).

After any of the above procedures, operate the trim system numerous times to insure the trim works correctly. This will also spread the lubrication around evenly. Have your favorite mechanic check your work and sign the logbook. You're done!

If you have done this before, perhaps a different way, I'm all ears! Let me know what and how you did it and I will post it (with your permission) on the Seabee Club website. My thanks to Seabee Club member Jaren Lynn for his photos and his inspiration to write this article.

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P.S. Another trim situation has reared its ugly head! If the trim cable/chain is too loose, the chain can bunch up between the aluminum guide tube and the forward trim sprocket (next to the trim handle) causing an immovable crank. This has happened and is quite disconcerting in the air. In this case we had to remove two links in the rear chain and reattach the aft links to get the correct cable tension. This was noticed during an annual inspection as the turnbuckle was bottomed out and the cable could not be tightened any more. If this happens, use a Dremel tool with a cutoff wheel to remove a link or two. Go slow and be precise! This may be an indication that the chain has stretched or is damaged (worn links). Chain replacement will be necessary in this case.