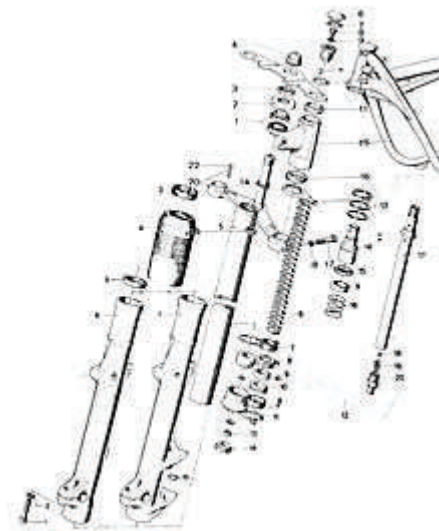


BMW Motorcycle Fork Alignment Procedure

version 1.0

by Randy Glass - ©2002
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Being for the most part a chronologically arranged step-by-step narrative documenting how I came to diagnose the problems I was having with my motorcycle's forks and the steps I took to remedy the problems I found, including the use of special tools and specific procedures used, with many colour pictures



1 - DISCLAIMER and SAFETY WARNING

Doing any work or making any adjustments with the steering, suspension, or brakes of a motorcycle is dangerous. Something as simple as leaving a single wire cable unsecured can cause it to become caught resulting in loss of steering. Even if you do all the things described in this article exactly as described and follow all these instructions to the letter, the processes described in this article can still be very dangerous. Bending of parts can lead to metal fatigue and possible structural failure which can cause expensive damage to parts. Improperly adjusted assemblies, poorly torqued hardware, overstressed parts, or any number of other factors can result in poor operation, loss of control of the motorcycle and possibly even an accident which can result in personal injury or death. In this document I am merely reporting what I learned as I went through this process on my 1979 R100RT. There may or may not be major differences between my bike and yours which could make some of the procedures outlined here dangerous for you to perform as described herein. There are also procedures mentioned but not fully described, such as replacement of fork seals, adjustment of steering bearings, and more. If you are not familiar with the proper procedures for any of the adjustments or processes contained in this article then you should not attempt them. If you decide to work on a motorcycle yourself, after the work is done you should have the motorcycle checked by a trained and certified motorcycle mechanic to be sure that it is in safe operating condition before it is ridden. By continuing to read this information you agree that the author is free from any liability whatsoever. If you do not take 100% responsibility for the results of reading and possibly applying what you read here, you may not read further. Reading this article and/or making use of any of the procedures in this article signifies your release of the author from liability.

What the Fork is Going On Here?

I am not suggesting that you should attempt the procedures outlined herein, but if you choose to, before beginning, make sure that you read this article from start to finish and be sure that you understand all of it. I suggest printing out every page and having them on hand. Be sure that you have all tools on hand before beginning and that the bike can be left for an extended period of time where it is sitting once the process has begun. You should also have (or be able to create) about five or six feet of clearance on each side of the bike. It might take quite a few days or even a week or two to do all of this, so plan ahead! Do not begin until you understand the procedure. Get help ahead of time if you need it.

There are a number of procedures not outlined here such as how to change the fork fluid and how to adjust the brakes and the steering head bearings. You should be familiar with these related tasks and others similar to these before proceeding with the series of adjustments outlined here. Also check your shop manual for proper torque specifications, fluid volumes and specific procedures for your bike that may vary from those discussed here.

Also be aware that this article and the procedures contained herein apply to the '79 model year of the BMW R100RT unless specifically stated otherwise, and may or may not directly apply to your model. There are some major differences between this bike and the earlier models as well as procedures that differ. If you have a /5 or /6 I suggest that you take a look at [Duane Aushman's website](#) for more specific information on these models. Even so, the basics of fork tube alignment on airheads with telescopic forks are contained herein, and the owners of virtually all /5, /6, and /7 bikes will find lots of useful information.



10 - The X-Plane

Adjusting the X-plane assures that the forks are parallel from top to bottom- that is, if you measure the space between the fork tubes, their distance apart is the same under the yoke as it is at the bottom ends as well as all along their lengths, as diagrammed in this photo:



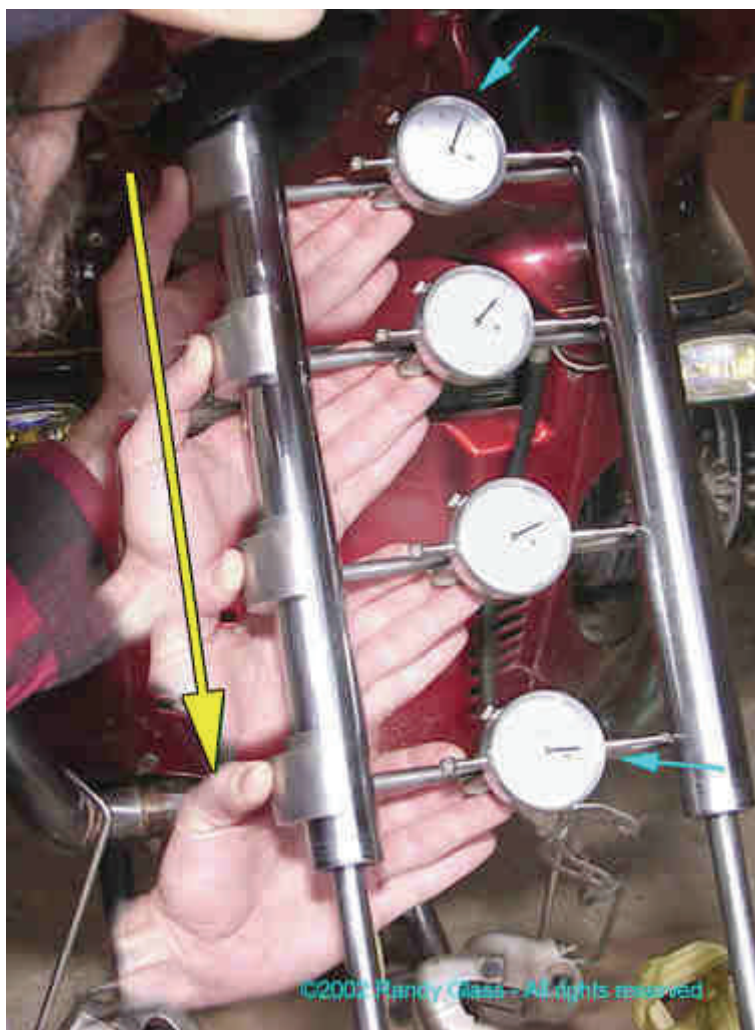
Clymer recommends using a caliper to do this job, but it is an inaccurate method at best, good only for showing that a fork was badly damaged in accident or so out of alignment that the forks would most likely be approaching a nonfunctional state or working so poorly that the measurement would be unnecessary. To most accurately check the X-plane alignment you need the special tool that should have accompanied this document. Before using it, please cleanse your hands of oil and clean the tool as well so that the possibility of it slipping from your hands is minimized. Also, place a folded towel or old bedspread on the floor under the bike so that if the tool is dropped it may be saved from a hard impact with the floor. The tool is seen in position in this next image:



Apply the tool to the fork tubes so as you move the aluminum guide towards proper contact with the

fork leg, the operating shaft of the dial indicator is being compressed into the gauge (it works right handed or left handed). When the guide rod comes into contact with the fork leg, the indicator's shaft should be touching the center (widest part) of the fork leg. If not, loosen the 1/4"x20 nut and then the bolt and adjust the angle of the gauge to the tool for proper contact. Loosening the little silver locking knob visible at the 10 o'clock position in the picture allows the face to be turned so that the needle will align with 0 which will make re-cording of the amount of error a bit easier. Move the tool to the top of the tube and set it to zero.

As you can see, the tool can be easily operated with one hand (although please have a hand under the tool for security!). My thumb is gently holding the tool with just enough pressure to keep it in full contact with the fork leg and my fingers are holding the guide rod gently against the opposite tube. The tool can then be slowly slid down the tubes. It really is not important to know what the measurement is along the entire fork, but it is important to know that you are applying only the minimum amount of pressure to make the measurement and to know the difference in the measurement between the top and bottom of the legs below the fork yoke (lower triple tree).



As you can see in the digital multiple exposure to the left, I am sliding the tool downward along the fork tubes. It will take a bit of practice to do this because you can actually press the tool inward hard enough just using your thumb to deflect the fork tube five thousandths of an inch or more depending on how close you are to the end of the tube at the time. You can demonstrate this by holding the tool at the bottom of the tube and lightly pressing against the damper rod protruding from the fork tube. Even a light pressure down here will deflect the tube and cause the needle to move.

Notice how I am holding the gauge? That is wrong. I held it that because I was snapping the photos with the other. If using the tool as shown in the photo, wrap your fingers around the tool where it meets the tube on the left of the photo (the right fork tube) and lightly hold the tool against the fork by using your right hand behind

the tool.

If you are getting a measurement that is grossly far from parallel it is not important to be totally accurate, but when making the final measurements after adjustments have been made and the fork is close to .000" out, the smallest of sideways pressure will make the reading inaccurate. In the X-Plane you are going to see that there is a lot of flex in the fork tube itself. Up near the yoke it is very easy to get an accurate measurement with this tool, but down towards the end of the fork tubes it is very easy to apply enough lateral force to deflect the tubes .003 and more without realizing that you are doing it. Practice with the tool for some time so that when you approach parallelicity you will have a good feel for the tool. It takes practice.

A method I came up with was a combination of factors. With the tool located near the end of the tube, protect the tool from dropping with your free hand, and then loosen your grip on the tool. While loosening your grip, move your hand (the one holding the tool on the tube) slightly, almost imperceptibly, wiggle your supporting hand left and right. It is sort of a slow vibration of your hand to relieve any lateral tension in your wrist.

There is no mistaking that this will take practice. The tool can be easy to use when measuring deviations of .010 and more, but when you get much below that the deviation of the tube that can be caused by manual pressure against the tube can be sufficient to make accurate measurement very difficult. How easily are the tubes deflected in the X-plane? The pressure of the spring in the measuring tool itself can cause a slight amount of deflection in the tubes!

Try this to quantify how well you are using the parallelness tool: Make marks with a small marker on the inside of the tubes every six inches. Zero out the tool while holding it at the top of the tubes, right under the yoke. Now, move the tool down to the first 6" mark. Check the error. Let's say that it is .002". Now move to the second 6" mark. The error should be double the first, or in this case it should read .004". Now move to the third 6" mark, or 12 inches below the starting point. The error should now read .006", etc. There are other factors at work here, but this should give you a good idea as to whether or not you are working accurately and not deflecting the tubes with hand pressure.

If you find that the tool does not slide down the fork tube smoothly, try a light coat of WD-40 or a little fork oil on the fork tube to make it slick. Repeat this measuring process from top to bottom a few times until the readings you receive are consistent.

BMW specs call for .1mm or .004" as maximum, but Duane Ausherman found that .004"-.006" could cause a severe wobble with his /5 s.*1 If you have the time and patience, you should attempt to get your tubes within about .001" or less out of parallel from top to bottom.

When I first measured mine as shown in the multiple exposure image they were out of parallel about .017" (about four times worse than are called for in the BMW specs) when measured from just under the fairing to the bottom of the legs (being closer at the bottom than at the top). At this point it became clear to me that there was quite a bit of room for improvement.

*1 See Appendix 1 - Page 22

11 - Adjusting the X-Plane



Before we begin with the X-Plane adjustment you need to understand the relationship of forces applied to the tubes and how that affects the alignment of the forks. In this diagram, the cross piece represents the yoke and the two vertical tubes represent the fork tubes. If a spreading force is applied between the tubes as shown at A, the tubes will move apart at that location. The yoke is the fulcrum and the tubes will move together at location B. This can also be reversed. If a clamping force is applied at point A, pulling the legs together at that point, then the fork tubes will be spread apart at point B. The forces applied are being used to align the yoke by applying opposing bending forces to the yoke through the force applied to the tubes.

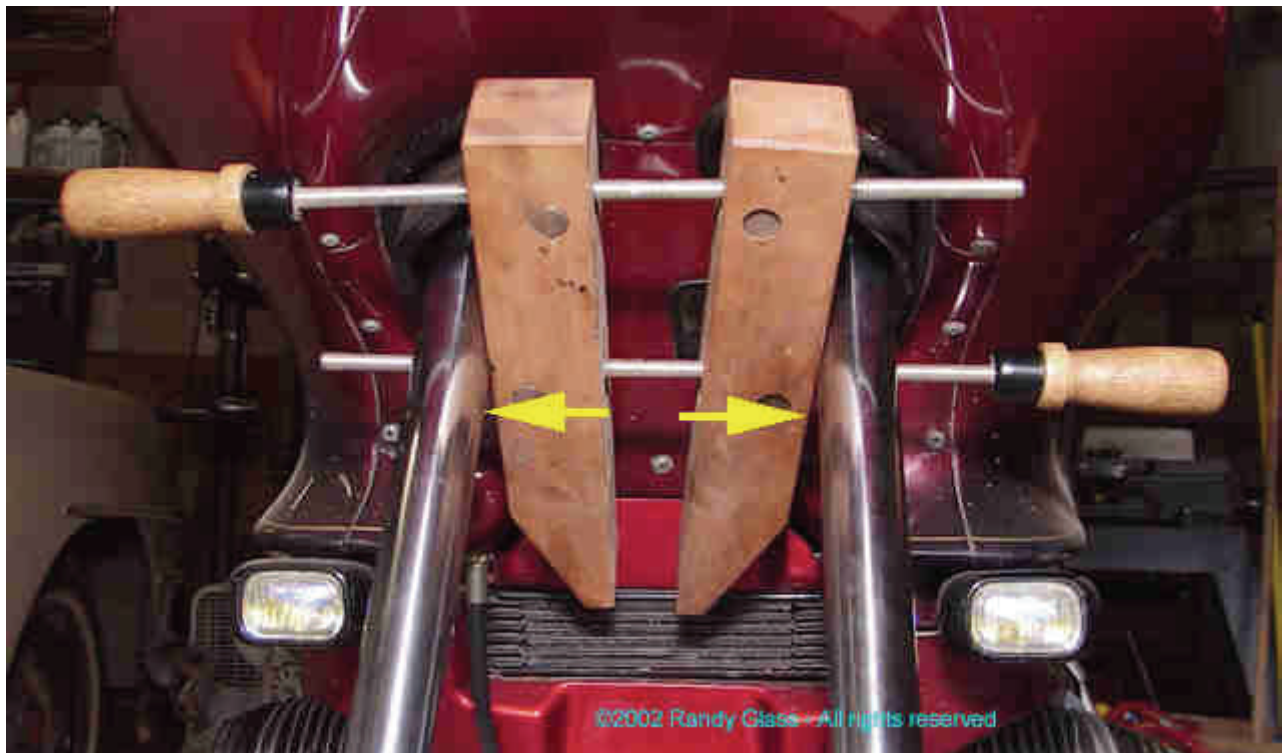
I needed to move the bottom of the tubes apart by .017 or so. I did that by using a clamp as shown in the picture below this paragraph (these types of clamps can apply a spreading force). The benefit of placing the clamp below the yoke is that there is no interference from the yoke, particularly with faired bikes. One person can even apply the clamping force while the gauge at the same time. Below the yoke. Unless you get insane about it there is no real danger of over-clamping if you place the clamp too low much of the clamping energy will be absorbed by the frame instead of actually aligning the yoke. Remember that we are not bending the softer yoke to hold the tubes parallel.



If you don't have such a clamp as pictured here try a large "C" clamp. You can try using two large

blocks of wood (chunks of 4x4's would work) with holes bored in them to slip over the fork legs so that there is a flat surface for the C clamp to push against as well as to protect the tubes. If not, try two lengths of PVC pipe slid over the tubes. It will be difficult to get the clamp to hold tight without slipping, but you want to protect those tubes!

I started my adjustment by clamping the tubes so that they moved about twice as far in the opposite direction. Since they were about .017" too close at the bottom, I clamped them to be about .040 too far apart at the bottom, and I left them that way for a day. I found that this was not enough pressure to get them to .000" so I left them for another day, this time clamped about .150 further than .000" which took a good amount of force from the clamp. After that I was getting very close, with the legs only out about .002 after about 24 more hours of clamping pressure. I once again applied the clamp and waited another 24 hours. The last .001 or .002 or so took about two days to set.



You can also place the clamp above the yoke to do the same job. Here you see a clamp being used to move the upper end of the fork tubes towards each other. This would have the effect of moving the lower ends of the fork tubes away from each other.

If the headlight ears were left on the tubes then using a clamp up here isn't a good idea.

If your tubes are out by .015 or more then you might consider using clamps above and below the fork yoke at the same time- one on the outside of the tubes clamping inward and one pushing outward from between the tubes. Their pressure would have to be balanced but it might help speed the alignment process a bit.

Be patient. It may actually take quite a few days for the yoke to take a set and hold the adjustment that you have forced upon it. After you seem to have the forks properly adjusted, leave them un-clamped for a day or two and see if they are staying in the proper set. After all this work you don't want to bolt everything up to find that you are back where you started! Worse yet would be to get them together, have them work poorly, and wonder if you actually set a correct adjustment or not. I can say that it takes more force and more time to adjust the yoke in the tubes X-plane than in the Y-Plane.

After completing the X adjustment, check the Y-plane once again. It may be necessary to repeat the adjustments, one and then the other, a couple of times before everything is perfect. Remember, patience is definitely a virtue here. This is a process that takes time and rushing it will only be a waste of your energy and of your

time and money. It can easily take a week (or maybe even two) before you get all the adjustments right. And after all, if you are taking the time and effort to do all this, you might as well get it as close as possible.

12 - Assembly

Once the tubes are in alignment it is time to start putting things back together. The first step is to reassemble the top plate. This is critical. It is important that this fits nearly perfectly. With the fork springs removed it is important that, with the upper spring retainers removed, and with the steering bearings correctly adjusted and the top retaining nut tightened, that there be something close to zero clearance and zero interference between the upper fork bracket and the tops of the fork tubes, within reason, regardless of the 160mm (6.3") amount of fork tube that the factory states should protrude above the yoke boss. This to keep the upper fork bracket from being too badly deformed and from stressing the fork tubes when the two spring retaining nuts are torqued. You should be able to replace the top plate, hand tighten the steering bearing lock nut, then hand tighten the two spring retainer bolts all the way leaving zero clearance between the tops of the fork tubes and the bottom of the upper fork bracket. The exception to this is that the interference fit between the upper fork bracket and the upper spring retainers is close and may require a light force with a tool to fully seat them. This is particularly true if you paint the upper fork bracket. If this assembly does not fit properly, torquing the three nuts down will put pressure against the fork tubes and will ruin all your hard work.

I had some apprehensions about how well the legs would go together and work, mainly due to the factory fork brace (which on the /7 s is a one-piece, stamped stainless steel part that also doubles as a fender mount). From what I have seen, these were made to fairly low tolerances. I started the assembly of the legs this way (blue numbers below refer to the image):



After I installed the new fork seals and after the three large nuts were tightened on the upper fork bracket, I (1) slid the two fork legs onto the fork tubes and installed the two nuts on the bottom of the dampers to hold the legs in place. I left off the sealing washers for this part.

(2) I then slid the axle through the fork legs and after pushing the assembly up the fork tubes as far as was possible...

(3) I slowly tightened the pinch bolts. While I was tightening the pinch bolts I was also twisting the axle slightly so that I could get both pinch bolts tight at the same time, thus allowing the legs to self-align during this part of the process. This also shows that the axle is not bent. I pushed the axle just a little further then normal out of the nut end (4) so as to be sure that the pinch area was getting a good grip.

(5) When the pinch bolts were tight I held the axle with one hand and slid the fork leg assembly up and down the tubes to assure myself that they were moving freely. They were sliding beautifully at this point. Better than they had in a very long time.

(6) I have a Telefix fork brace. With the axle now tightened and the legs all the way up on the tubes (the

fork springs were still on the work bench) I installed the Telefix. I took pains to be sure that the brace would hold the tops of the tubes in their present position without any inward or outwards pressure. When the brace was tightened I slid the entire fork leg assembly up and down the tubes to assure myself that the installation of the Telefix had not changed the previous adjustments. What I had created at this point with the fork legs was a relatively rigid assembly. I was assured that the two legs were parallel because they were sliding on the fork tubes that I had adjusted to parallel.

Now I inserted the fender and its brace between the legs. Even though I had adjusted the brace years ago, I could see that, without the Telefix fork brace in place, the stock fender mount would indeed put a bit of outward pressure on the fork legs in the front and there was a slight gap at the rear. If I used only the stock fork brace it would put stress on the upper end of the fork legs causing a mis-alignment. So what I was doing here was using the Telefix brace as a jig to hold the legs in place, and I then used the legs as a width gauge to check the fit of the factory fender brace. With my set-up, once the assembly was complete, most of the stress would be on the fender brace itself and not on the fork legs because the Telefix would hold things in place against the forces created by the fender brace.

If you do not have the Telefix I suggest that you remove the fender from the factory brace and test fit the brace between the fork legs on its own. It should slide between the fork legs with no outward pressure against them once installed (with the same sort of feel you get with a feeler gauge when you adjust your valves- think of the brace as the feeler gauge and the fork legs as the valve stem and the rocker). You are looking for a loose .000 fit.

If the stock brace is too wide you can try to use a really large vise to move the mounting ears together a bit. Try to clamp at the bend and not out at the ends of the mounting ears. PLEASE BE CAREFUL! The brace acts like a big spring and if it slips when it is compressed in the vise it can go flying! A length of rope or cable through one of the mounting holes and tied to the vise as a safety device would be wise here. Shim washers can be used to deal with a brace that is too narrow. The closer the fit to .000 clearance and zero outwards force the better here.

When you think you have it adjusted properly, mount it back to the forlegs with the proper hardware. Check your work by manually sliding the entire assembly up and down on the fork tubes again to assure yourself that you have indeed accomplished something here! It should feel good. Really good! About all I could feel here was the friction of the fork seals against the tubes.

Once you have all of this assembled, slide the fork leg assembly off the tubes and place it off to the side where it won't get knocked over and tweaked out of alignment.

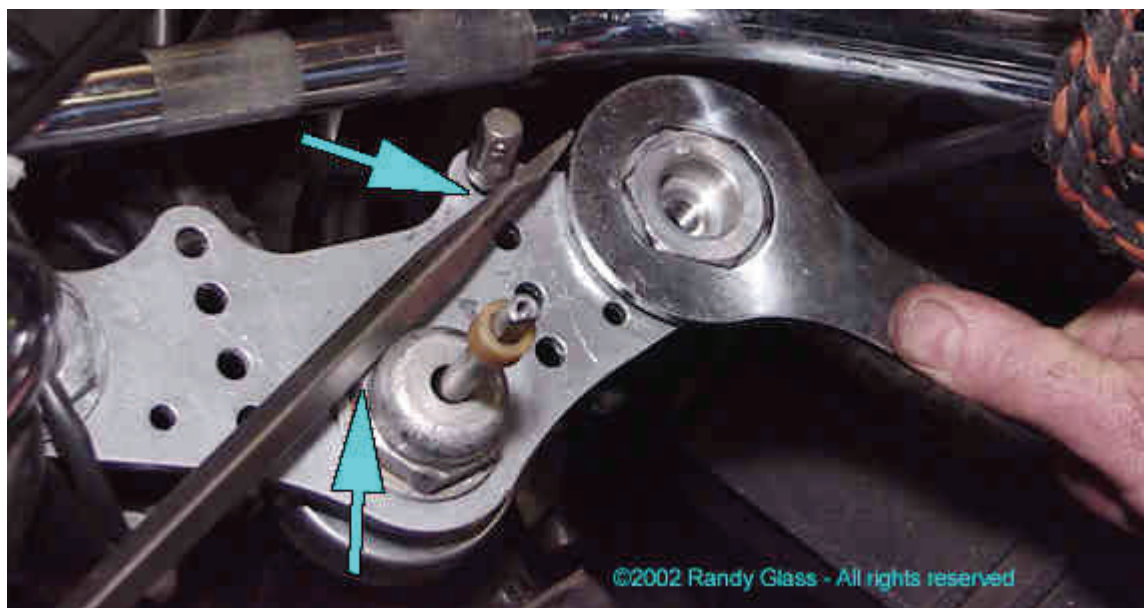


13 - Torquing the Top

Now that the lowers are sliding properly and you have verified that everything is in alignment down there, it is time to start buttoning things up. The following section contains some of the most important information in this entire article, so please read carefully!

Begin final assembly by removing the upper spring retainers and installing the fork springs (and their spacers if so equipped).

Replace and torque the two upper spring retainers. When torquing them into place it is **ABSOLUTELY CRITICAL** to USE A TORQUE RELIEF BAR against the center bolt and somewhere else. If you learn anything from this article this is the keystone principle you need to take with you, whether your forks need alignment or not. This technique has to be followed every time a wrench is used on the upper fork retainers.



As you can see here, a large screwdriver is being held against the top retainer nut and a tool adaptor that I have inserted into one of the spare holes in the upper fork bracket. The places where the screwdriver is resting are indicated by the arrows. My left hand is holding the screwdriver while my right hand is tightening the upper spring retainer.

Clymer states that the correct torque is 87ft/lbs which is quite a bit. Be sure that the anti-torque bar will not slip during the torquing process! Further, it is **CRITICAL** here that the fork yoke not be allowed to come into contact with the steering stop during the torquing process. Notice that in the above picture that the forks are in their center position. If the forks are forced onto the stop during this process then you just about guarantee that you will twist the forks in the yoke and ruin all your hard work and you will have to start the adjustment process all over again.

This is not quite as easy as it may sound. It is difficult to hold the anti-torque bar and have enough leverage to tighten the nut at the same time. One user recommends using a long piece of heavy angle iron that can be held in place on the upper fork bracket with a C-clamp or two. With all the extra holes on the plate of the /7 it wouldn't be too difficult to fabricate some type of adaptor plate with a 1/2" or 3/4" square hole in the top of it to locate a breaker bar or such. The main thing, once again, is to hold the top plate still while tightening the nut so that the forks are not forced against the steering stop.

When the three big nuts are torqued to specs on the upper fork bracket you **MUST** recheck the X-plane and the Y-plane alignment again with the plate of glass and the special tool. This is critical because the torquing of the two upper spring retainers may cause them to "walk" on the upper fork bracket allowing them to throw things out of alignment. This is particularly true with /5's. The tubes will probably still be in alignment, but it is very important to check to be sure. If there is any discrepancy after torquing, repeat the alignment procedures. Once this is done and the tubes are adjusted properly, return the parallelness gauge and glass plate to a safe place.

14 - Button it Up

At this point we are almost done. Install the new felts into the fork boots if so equipped and oil them, then slide the boots or fork gaiters onto the fork tubes. Install the two crush washers at the ends of the damper rods. Use a bit of grease to hold them in place so they don't end up loose inside the dampers. Now reinstall the leg assembly and torque the retaining nut into place while holding the damper rod from turning with a hex wrench, install the fender and its brace along with its related brake parts including the calipers. I left the axle and my Telefix fork brace in place during all this to help maintain alignment.

You can now replace the fender and then the front wheel. Insert the wheel between the fork legs along with its spacer and slide the axle through. It should move through fairly easily, particularly once it is aligned in the left fork leg's axle pinch opening. You should be able to easily move the axle left and right with all this assembled, only hampered by the friction caused by the weight of the wheel itself. Hand tighten the axle nut and then snug down, but do not tighten the pinch bolts. Holding the axle from turning by placing a screwdriver through the large hole in the right end and tighten the axle nut against left fork leg. Now torque the pinch bolts.

Reinstall the instruments and the bars, refill the forks if you haven't already done so, and you are just about ready to ride. Note that the tool you see me using above to tighten the top spring retainer is actually a bicycle bottom bracket fixed cup tool. I had two of them with my bicycle tools for fifteen years (I am an amateur bicycle mechanic as well), not knowing that it fits the upper spring retainer and steering bearing nuts. It works great with the bars off, anyway. Of course, it does not allow you to apply a torque wrench, but can still do the job quite well.

Once done, double (and maybe triple) check every piece of hardware. Brakes, steering, and suspension are no laughing matter! Be sure all cables and wires have gone into their proper place and nothing is interfering with the steering by checking it a few times all the way to both stops- right and left. Be sure that the bars are tightened and correctly aligned for you and that the controls are in their correct positions for your hands. Recheck the brake adjustment and front tire pressure and re-synch the carbs if necessary.

Once you have the bike back on the ground, lock the front wheel using the front brake and bounce the front suspension as violently as you can. It should certainly feel far more compliant than it used to. Now try the compress/rebound and extend/rebound test you did in the beginning. You should now find that the forks settle much closer to their original at-rest position each time.

Beyond that, you are doing the bounce test to check for odd sounds, clanks, binding, leaks, and anything else that might indicate a problem. In the garage is the best place to find those things- not out on the road!

The forks should feel almost like new. Mine felt so good I had to call my wife out into the garage to watch the forks bounce. I felt like a Faith healer- I had laid my hands upon the stricken, and the crippled did walk the earth upon their own feet once more... HALLELUJAH..! Can I have a Amen? O.K. So I get carried away sometimes... So what? It was exciting to have working forks again. I actually did the Happy Fork dance- sorry, no video available.

Down the line, if you want to be sure that most everything is still in alignment, you can remove the front wheel and replace the axle. The axle should slide very easily through its respective openings in the fork legs- as easily as it did in preliminary testing. I did this as a demonstration for my wife earlier in the process- I hit the end of the axle with the palm of my hand and the axle went flying out of the forks and across the garage floor! Wow.. It's never did THAT before!



15 - Postscript

I was able to take a short test ride on the day I finished my work. I can tell you that after dealing with poorly operating, non-compliant forks for so many years it was a real pleasure to have a properly working front suspension on my motorcycle. Even with the BMW heavy-duty springs in there, after the alignment the ride had become far more compliant, even one-up with the stiff springs the ride was softer and smoother. It felt like the highway had been repaved and most of the bumps and ripples had been smoothed out.

The feeling I got as I went down the highway was much the same as when you put new shock absorbers on your car. You didn't realize how bad the old ones were until there was something against which you could compare. I knew the old set up was poor, but didn't realize just how easily they could be improved and how much better they could feel. How good did it feel? It was only a dying battery (that caused me to turn around and return to home after only about twelve miles) that kept me from ending up on the coast, or who-knows-where! T

The ride was sweet to say the least. A subsequent ride also proved to demonstrate that it was far less fatiguing to ride the RT now.

That brings up a good point. Although I get wordy at times, and this article seems quite long, aligning your forks it is not that difficult of a job. Care must be taken for safety's sake, and you have to be detailed oriented and patient, but if you have replaced steering bearings or have had the forks apart before, then this job is most likely within your capabilities. I wrote about as much detail as I could so that if you get stuck or run into some sort of difficulty, you may have hope of finding the answer in here somewhere.

I hope that you have learned a bit about fork adjustment and alignment and I certainly hope that your forks are now working better than you imagined could have been possible. The only bad thing about this is that you won't get to ride your bike. When you are done with all this you are going to be raving about how well your forks now work and everyone will want to ride your bike to see for themselves!

Finally, I would like to personally, and publicly thank Duane Ausherman for his inspiration and the sharing of his knowledge. He brought his fork parallelness gauge to my "Airhead Tech Day" in October of 2001, and his showing me how it worked and how far my forks were out of alignment was an epiphany. I finally could quantify the error and also learned what to do about it. His simple gesture of bringing his tool along has made my motorcycling experience so much more pleasant that words do not express it thoroughly enough. I will think about him on every ride I take from now on- THANKS, DUANE!

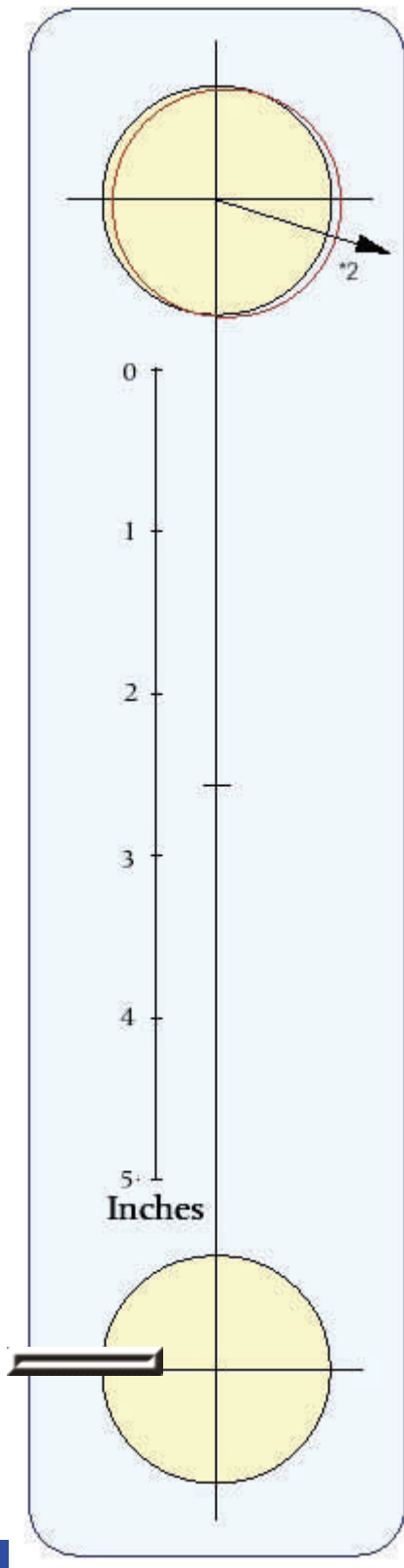
See ya all on the road!

Moto Longa - Vita Brevis
(Ride long - Life is Short)



16 - Appendix 1

How Much Error Is Too Much Error?



There has been discussion over the years as to how accurately BMW forks need to be aligned for proper operation. This drawing is a roughly accurate approximation of the alignment of my fork tubes, as seen looking up at the lower ends of the fork tubes. You get the best view if you view the page at actual size because it was drawn on a scale of 1:1 (Change the magnification of the image until the ruler at the left is approximately accurate when viewed next to an actual ruler held up to the screen).

The two yellow-filled circles indicate the perfect alignment of the tubes (.000 error) in the X and Y planes. The open red circle above shows the amount of error I measured in those planes before I started the alignment procedure, being approximately .017 off in parallel, and one leg being about .070 or .080 or so off (estimated- it might have been a bit more than that) in the Y plane.

It doesn't look like much here, and in real life the directional error *1 was only about .072 inches (less than one tenth of an inch!). The approximate azimuth of the error being shown in the diagram by the direction of the arrow*2, but that was enough to make my forks lose about 50-75% of their perceived compliance, and only regular application of silicone spray on the for- boot felt wipers got them to work very well at all. Also consider the fact that in the middle of the fork tubes where the sliders spend most of their lives, the error was only about half that, or .036 out of alignment.

The amount of adjustment shown here (the difference between the before and after alignments) got the fork assembly to go from teeth-jarring, wrist-wrenching stiff to pavement-absorbing smooth.

I am sharing this with you (and I wrote this document) because so many of the procedures in various manuals and journals simply do not address the small amount of error that can cause the forks to work poorly and I have not seen any of them effectively address how to correct those errors.

I don't know the answer to the question posed at the top of this page but I can say, from my limited personal experience, that the amount of error pictured here was way too much, and correcting it made a huge difference.

2 - Can You Pass the Fork, Please

A motorcycle's fork assembly seems like a fairly simple mechanism. Basically, it is two shock absorbers in parallel. Unfortunately for those of us with forks which are not correctly working, they are much more complicated than that. Not only do they act as the front suspension of the motorcycle they also steer the bike as well. They are subjected to working loads in numerous planes, and while sliding up and down need to be able to be rotated around an axis for steering. They need to be compliant in the vertical plane to absorb road imperfections yet be totally stiff laterally to maintain steering control. Because of all of the that, if there is any problem in the way they function the sticktion that can cause will be readily apparent to the operator. If you hit a bump in the middle of a corner with sticky forks, it is unpleasant at best and can actually be dangerous, affecting your ability to control the vehicle. There are a number of reasons why forks may not move freely including:

DAMAGE- If the bike has been in an accident or struck by some outside force (like a car backing into the forks in a parking lot) the fork tubes, yoke, or other parts can be can be damaged. The two upper, fixed chrome tubes need to be about as perfectly straight as possible for correct operation, not to mention safety.

WEAR- As parts become worn they might work improperly. Worn dampers might not dampen the movement correctly and allow pogo-ing or if the seals or chrome plating on the tubes are not in good condition it can cause fluid leaks.

IMPROPER ASSEMBLY - If things are not put together properly all sorts of things can happen. In this case, when I took my forks apart, I found a copper crush washer which is supposed to be at the bottom of the damper, smashed nearly beyond recognition, inside the bottom of the damper tube and interfering with the spring-and- ball check valve. I also found that the holes in the legs were pointing towards the rear instead of inwards.

BAD or IMPROPER PARTS- I have heard that BMW had a run of top plates on the /5's that were incorrectly machined causing the fork tubes to be thrown out of alignment when assembled at the factory. I personally have experience with an out-of-spec fender support/fork brace on my /7.

DESIGN and MANUFACTURING - In an article on making the BMW forks work better by Joe Minton in Rider Magazine back around 1985 he stated something like, If you think that's a lot of work, you should see what is needed to get Triumph forks to work properly, so it can always be worse.

ALIGNMENT- If parts do not align properly it is very difficult or impossible to get the forks to operate properly. This is mainly what this article is all about- getting the forks and their related parts in proper alignment.

Your forks may be working poorly and you may not even realize it! Try this simple test. Bounce your bike into the compressed position and let it rebound and settle on its own (don't drop it!). Note the position of the fork legs to the fork tube (what height the bike stopped at). Now pull the bike upwards so the forks are fully extended and release it, allowing it to settle down to where it wishes to stop. In a perfect world the two positions (rested after compression and resting after extension) should be in about the same place on the fork tube. If not, then you have sticktion! Something is removing the fork's compliance and causing the bike to ride rougher or stiffer than it should. Before proceeding with the checking and adjustment of the fork alignment be sure to eliminate the other possible sources of problems as outlined above. With the forks apart it might be a good time to rebuild the dampers, install new fork springs, clean and lube steering bearings, clean, lube and adjust the wheel bearings if necessary, replace seals, and do other maintenance as well.



3 - Your Forks Live Here

The fork tubes live in three planes:



Plane-Z is adjusted by being sure that both fork legs extend up through the lower triple clamp the correct distance and that both fork legs are the same length (the correct part numbers). Planes X and Y can be adjusted by the user using the methods and procedures as will be discussed herein.

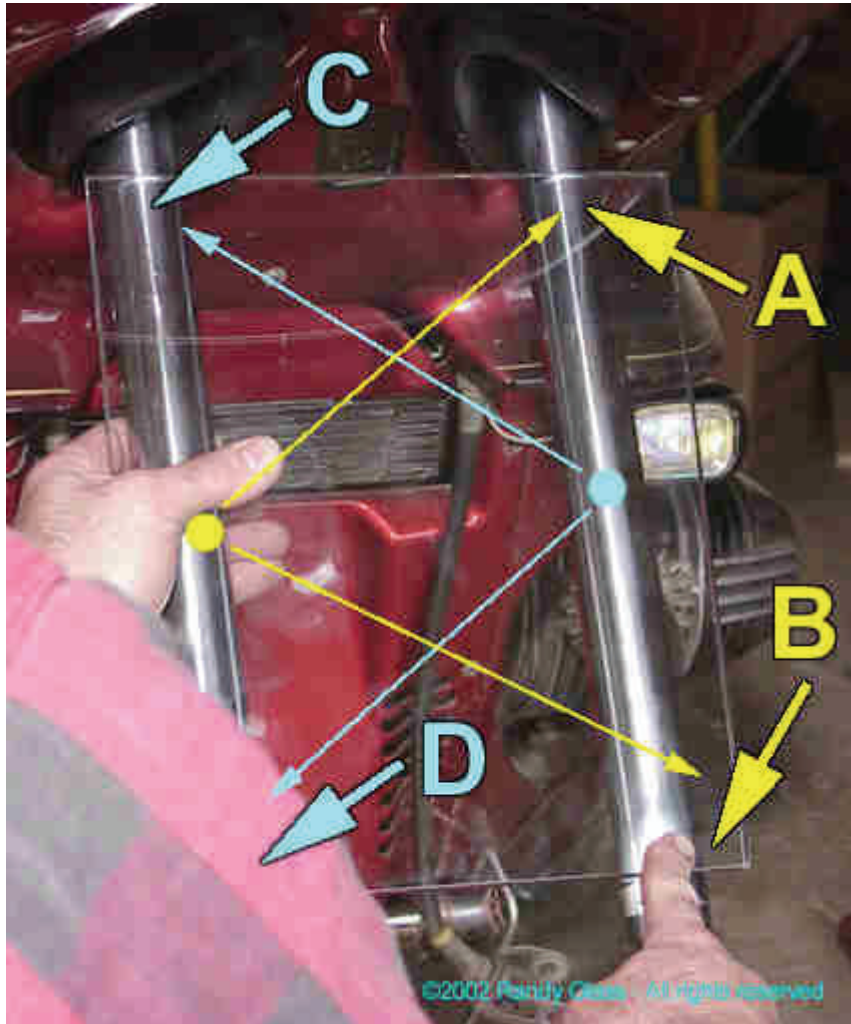
4 - Tools and materials

Here is a list of most of the tools and materials most of you will need:

- The Fork Parallelness gauge
- A piece of 1/4" plate glass approximately 10" x 12"
- Various hand tools needed to remove the fork legs, top plate, front wheel, front brake and related parts- tools such as sockets, wrenches, screwdrivers, a rubber mallet, etc.
- A +/- 6' 2x4" or equivalent
- Ratchet straps and/or some rope
- A large clamp or two
- A metal bar of some sort for holding the forks when tightening the upper spring retainer nuts
- Fork Oil
- New copper crush washers for the ends of the dampers
- New fork seals
- Cleaning solvent
- Lint-free rags
- An old bedspread or blanket
- A few containers of some sort to place removed parts

There are other tools that might be necessary, but these are mentioned in the text.

7 - Interpret The Y-Plane Findings



If you find that the glass clicks at A it should do the same at D when you reverse hands. Conversely, if it clicks at B it should also click at C. If that's the case you have learned two things: you are holding the glass properly and the fork needs to be adjusted in the Y-plane. If you don't get any clicking try putting your thumbs at A and D and pushing them alternately, then repeat the procedure with your thumbs at B and C, in each case without holding the glass against the fork tubes other than where you are pushing with your thumbs. It may be that the tubes are so far out of alignment that the slight flexing of the glass by holding one side and pushing at opposite corners will not cause the clicking. If there are no clicking sounds at all and the glass is visually against the fork tubes along its entire length on both tubes, then the tubes are aligned in the Y-plane. Lucky You!

8 - Adjusting To Tolerance

If the glass rocks at all it means that the forks are not aligned in the Y-plane. If that's the case, it's time to get out some heavy equipment. Using a length of 2x4, place it between the fork legs so that the short end is behind the leg that needs to come forward near the bottom (the long end is in front of the leg that needs to be pushed back at its lower extreme).



For example: in my case, when I used the glass on my tubes, the glass had a gap and clicked at A and D. That meant that, when examining the lower end of the fork tubes, the right tube is behind the left tube (from the rider's viewpoint). So I put the 2x4 behind the right tube and in front of the left tube as is being shown here. The tube with the green arrow is being moved forward in relation to the tube with the blue arrow, which relatively speaking, is being moved backward. Does it matter which moves forward and which moves backward? No, not at all. We really don't have too much concern with the tube's relationship with the bottom of the fork yoke- only that the tubes are lined up in the "Y" plane.

I tied the long, protruding end of the 2x4 to the rear frame and using a length of rope (or alternatively, you can use a ratchet strap), I put tension on the fork legs to bend them into alignment. When you get that set up, leave the bike that way for a while. Here's what the setup looked like:



The rope method is sort of large-scale variation of a traction device they teach in the Boy Scouts (or at least they use to when I was in Scouts). It is referred to as a "Spanish Windlass". The rope goes around the frame and the 2x4 twice, then it is knotted off at the end. Place the handle of the mallet in between the four courses of rope and twist it around a few times until there is sufficient tension on the 2x4, then the handle of the mallet is rested on the valve cover. Don't get too carried away here. It doesn't take a whole lot of force to move the tubes in this plane. Just be sure to attach the rope to the frame of the motorcycle and not a car or the wall because you will end up moving the bike about the garage. This method can create a lot of force, so be sure to use a structurally sound piece of lumber here.

You can drill a large hole in the end of the 2x4 to slide onto the fork leg or make "V" cuts to help it grab the tubes to make it a bit more stable when setting up the process. You could also use a chain link fence post wrapped with rags that can be taped in place instead of the 2x4. Don't be afraid to ask for assistance from someone who can hold the 2x4 in place while you tighten the rope or strap. After about three or four hours, remove the bending assembly and let the forks sit for a few hours. Then, using the glass plate once again, re-check the alignment. Repeat as necessary until you get the tubes into the alignment in the Y-plane. I checked mine after about two hours and found that they had become aligned, and after 24 hours of resting they held their adjustment! Because they were out about .070" to .100 or less (I didn't measure it), I thought they would take a lot longer to get into alignment. Your results may vary.

In the Clymer manual it shows another procedure to check for alignment in the "Y" plane using two straight edges and then sighting across them by eye. I personally consider that method wholly inappropriate as it will not give the accuracy that the piece of plate glass can. It also involves completely removing the fork assembly, an unpleasant task with an RT.



9 - In The Meantime

While you have everything apart and are waiting for the adjustment in the previous section to take it's good time to get some of the other work done. Now is the time to replace the fork seals and possibly to even think about getting the dampers rebuilt if it is necessary.

Now is the time to examine the "Upper Fork Bracket" (the top triple tree). This is relatively soft and it is possible that over the years it has become warped or bent from improper adjustment procedures and other forms of abuse. Use a straightedge and check it on the top face and bottom face on its long axis for flatness. The stock plate is easily bent back to flat using a bench vise- but **BE CAREFUL!** It is a lot softer and more easily bent than you may think. If you have one end of it locked in a vise, one good pull will be all it will take to create an angle bracket good for mounting shelves to the wall and not much more than that.



Another thing to check at this time is the fit of the axle to the fork legs. It is important that the axle move freely through the openings where it gets clamped in the axle, otherwise when you tighten the axle it will put lateral forces on the fork legs, pulling them towards each other, and this throw them out of alignment.

First, check the axle itself. Clean it up, removing any burrs as well as the raised edges of any dings that might interfere with it's surface flatness and slowly roll it on the glass plate to be sure it isn't bent. Being so short it is difficult to see if it is bent or not, so try using a .001" or .002" feeler gauge at various points under the axle as it is rolled on the glass plate. Any deviance should prompt further examination or replacement. A bent axle can cause all sorts of alignment problems.

Now examine the "removal opening" in the axle shown as point "B" in this photo. Remove any burrs there so that pulling the axle through the fork leg won't scar the softer alloy. Once that area is cleaned up, and with the pinch bolts loose as shown here, the large end of the axle should be easily pulled through the right leg's opening. Now, try to push the smaller end of the axle through its opening on the left fork leg. I found that the end of the opening in the leg at point "A" above (the outboard side of the hole) had been made smaller by the years of tightening of the nut and pressure from the washer. It had mushroomed the alloy just enough to not allow the axle to slide through. I used a round file to slowly and carefully chamfer the edge to make that edge opening the same size as the rest of the hole. **WORK CAREFULLY!** Don't muck up the rest of the surface and do not remove any more material than absolutely necessary! Remove a small amount of material and then check the fit, then repeat the filing only if necessary. You can always take a bit more off, but you can't put it back! Once done, with the axle inserted into both legs, it should be able to slide all the way through from one side to the other, only being stopped by the large end of the axle hitting the smaller opening of the opposite leg. In actual usage (i.e. riding) this is not as important as it will be to test the alignment as we go along and in the future to verify that things are still lined up.

Also take a look at the damper rods. If someone has been in there previously, they may have clamped the damper rods in a vise without using some protection. Look for burrs or gouges on the rods. If necessary, clean them up with a fine sharpening stone or other suitable abrasive system. When done, be sure to use some solvent on a rag to remove any metal filings or stray bits of abrasive. It is critical to be sanitary when working on forks.