Smith Speedo dissection

General disclaimer

First, I don't know have any experience working for Smith or doing this commercially. I have done several of my own instruments, with success. They are much like lobsters, hard to open and full of mysterious stuff.

I started this adventure before reading the excellent post from Mike Taglieri [see below] from the Brit-Iron. mailing list. Read it first. There are also some very good comments from Ron Thompson [see below] from the same list, and some correspondence with Ian Bardsley [see below] of the BMOC in Vancouver.

This site is very much a work in progress. Please contribute - tell me what worked and didn't work and we'll add it in...

If you have any more knowledge or experience to add, please email me at ***randell@shaw.ca***

updated: June 21, 2000

and again on March 10, 2002 and August 22, 2002 and March 15, 2004

There is a good site on Smith car instruments, they are more lightly built, but have the same principles
http://ourworld.compuserve.com/homepages/arhodes/Speedo.html

There are many excellent rebuilders of Smith instruments out there. I would strongly suggest that you send your instrument to one of them.

In Atlanta Georgia - http://www.joellevinecompany.com/index.html

A Gagg & Sons - Specialists in repair and renovation of Smiths speedometers

Foreign Speedo in Palo Alto

Nisonger's

APT instruments http://www.gaugeguys.com/

Gower Oaks (who will also sell you a new one)

In addition, most Brit part suppliers will sell you a rebuilt speedo, with or without a core charge.

End of Disclaimers- You're on your own now.

This page is intended only for members of the Pete the Cheap society. With the Atlas speedo, I got lucky and found a loose screw that was easily removed. In the process, I cleaned and lubed the instrument and cleaned the glass (badly needed). If you need to replace the glass on an instrument, it will probably be dirty inside. Go ahead and take the rest of it apart. These are not complicated. Odds are a careful cleaning and lube (use sewing machine or other light oil sparingly) will give you a working instrument, and you can spend your $200 on more fun stuff, like a Drouin blower..

Incidentally, the original glass is an odd thickness, window glass will either be too thick or too thin. Take an old piece of the glass with you. A new glass will cost you about $5 at any glass shop.

How it works

Smith magnetic speedos and tachs are essentially the same instrument. A reducing gearbox is driven by the engine or rear wheel. It spins a cable composed of a spring wound wire turning inside a lubricated sheath. At the instrument end the cable spins a rotor with embedded permanent magnets. The rotor supports a needle like axle on which is mounted the indicator needle. On the axle is mounted an aluminum disc and a very light spiral wound spring. Although aluminum is not a magnetic metal, it is conductive. The rotating magnetic field induces an eddy current in the disc, and this current interacts with the rotating magnetic field to exert a small torque to the axle. This force is resisted by the spring *et voila* - a measurement of the rotation speed of the magnet. A steel adjustment plate above the disc can be moved up or down, varying the strength of the magnetic field and thus the measured force.

How it doesn't work

The clearance between the magnet and disk is critical, and not very much, just a few thousandths of an inch. For more detail, see Ian Bardsley and Ron Thompson's emails below. If something (like a bug, they just love to crawl in there and die) gets in there, it can cause the disc and thus the needle to attempt rotating at magnet speed, becoming very broken in the process. If the inner cable is too long, it will push on the magnet, causing it to wear away the pot metal retaining surface and make contact with the disc, also not a good thing. The force generated to turn the needle is very small, so a bug, cocoon or just plain dirt can easily

hold the needle from rotating. If the lubricant dries out after only 30 years or so, the needle axle to disc bearing surface can get twitchy- although twitchiness it probably a cable problem. This quote is from a former Smith's technician, courtesy of Chris Ghent on INOAList; (the original post is below)

"Cables," he said, "should never be coiled tightly, but left hanging. The inners take a set and this causes a flick in the cable operation leading to wobbly needles."

" When people say, it can't be the cable, I've just replaced it, " he says, "Yes it can," and shows them the flick test. This is a Smiths test and is laid out in a pamphlet he gave me a copy of. What he referred to as "flick", they called "snatch". It goes like this... pull the inner out of the cable and hold it in a loop, one end in each hand, pointing up and held like you would hold a straw. Gently roll one end between thumb and forefinger and feel with the other hand whether it starts to turn immediately. If it does it is OK. When they are not OK they don't turn for a split second and then flick around, as if something is bent.

On the subject of cable length- "The inner should protrude no more than 7/16ths out of the top of the outer when the crimp is pushed back inside the outer as far as it can go. At this point the inner should stick out the bottom of the outer by 5/8. "

He made the point that the 5/8 sticking out all needs to be square, if some of it is still round then it will push the inner up into the speedo/tach. The consequences of the inner protruding too far into the speedo/tach is that it destroys the mechanism.

Getting in to it

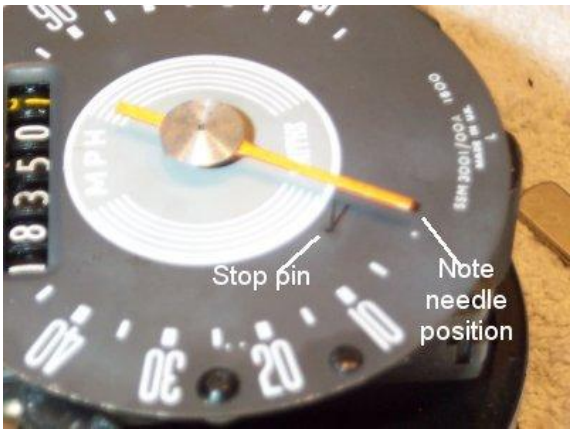
The toughest part is getting the bezel off and back on. The truly cheap can re-use the bezel two or three times. I find universal linear gasket material (electrical tape) will cover these sins up, particularly for Commando instruments, since the bottom of the bezel is covered by the cup. This is the simple and basic method of getting the bezel off with an old screwdriver - go around 4 or 5 times with *small* bites. If you are slow and careful, you will be able to get it back it on fairly neatly.

Be aware that the 'new' crimp on bezels are straight up and down on the bottom lip - without a special tool it is hard to get a clean result. A lathe is recommended, yr friendly local machinist may do it for a sack of beer. If you are careful getting your virgin bezel off, it may go back on more neatly than a new one.

This is a 'grey face' speedo from a 67 Atlas. The tach is essentially the same instrument, without the odometer spur gear, axle and odometer. Note the provision for a trip odometer below the magnet rotor.

These are all the parts. As you can see, there's not much inside the case. Generally, I was impressed with the design and robustness of these much maligned instruments. There really isn't very much to break down, wear out or gum up. I can see that the most common problem would be the pressure put on the magnet rotor retainer by an over long cable. The gap between this rotor and the aluminum disc is critical, and if it fails, much can go wrong quickly.

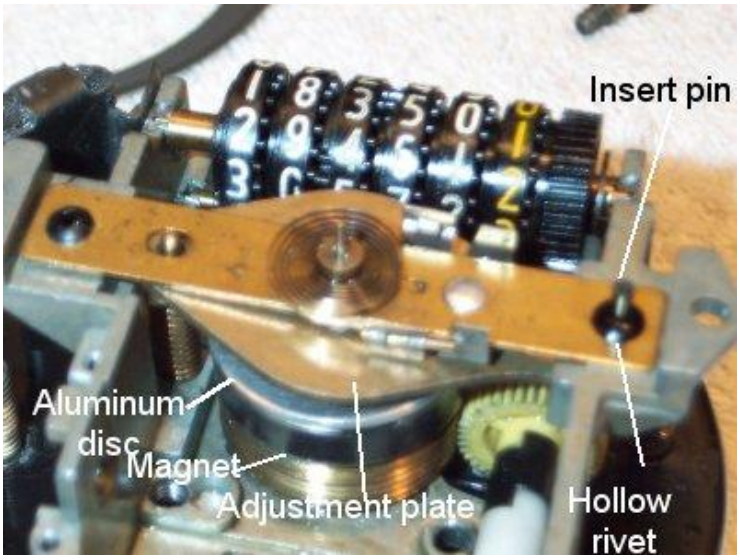
This was improved for the next generation, the 'green dot' instruments found on commandos. See the next page for a few photos from a tach. Green_dot below.



The face is held on by the two hollow plastic rivets, which are expanded with an insert pin (see photo below). Before removing the face, push the stop pin down - it's spring loaded - and allow the needle to reach its rest position. Note this for assembly. The needle is a friction fit and can be gently levered off - I used a tack puller. The friction fit will be impaired by what you just did, so when you reassemble, pay attention to it and be certain it is snug.

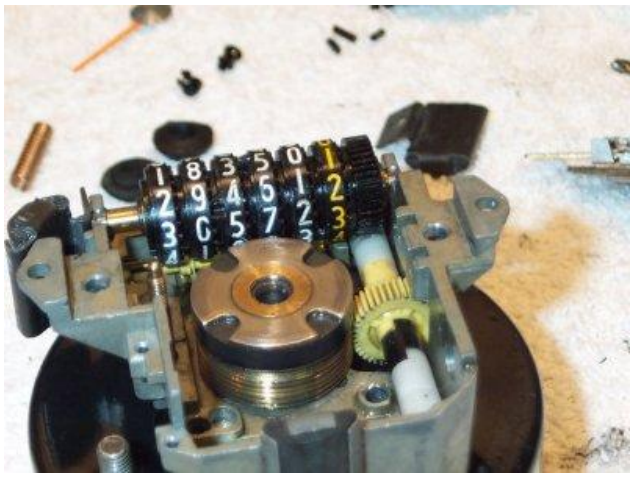
This is what's under the face.

The drive cable turns the magnet rotor, which creates a rotating field between the magnet and the adjustment plate. This causes an eddy current and electric field in the aluminum disc. This field interacts with the magnet, and tries to rotate with the magnet rotor. This is resisted by the hairspring. The needle measures the force created. The steel adjustment plate is pivoted in slots on the right side, and fixed on the left with the adjustment screw and spring. Turning the adjustment screw varies the strength of magnetic coupling between the spinning rotor and the plate, which changes the strength of the eddy current acting on the aluminum disk, which changes the force thus adjusting the measurement.

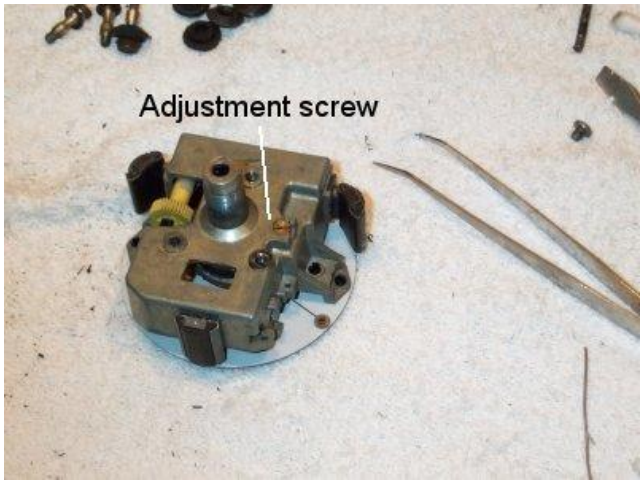


The brass plate carrying the spindle and hairspring mechanism is held in by two more plastic rivets. Push the pins through and remove the rivets. Note the height of the adjustment screw for reassembly. You will have to adjust the reading if you disassemble this plate. The spindle plate and adjustment plate will lift off together.

This is the stray screw (from one of the bumpers) that was stuck to the magnet and rattling around against the adjustment mechanism. The large disc is the magnet rotor. The drive cable attaches to the lower end of this. I did not need to get this out, so if you need to, let me know how it's held in.



This is the odometer drive. The axles for this lie in a slot and are retained with punch marks. See Mike Taglieri's Brit-Iron post below for details on disassembly.



The adjustment screw has a serrated edge, and should be held in place with a punch mark just to the right of the white line in this photo. You will need to do the same, after adjustment.

This is the highly technical test bench and stand at my modern facility. I used a good speedo hooked up to a spare drive cable to calibrate my electric drill (conveniently, flat out it does 45 mph). I then hooked up the rebuilt and adjusted it to read 45. One turn of the adjustment screw is about 4 or 5 mph, so this is not rocket science.

The only other possible adjustment is needle position. If your speedo is out by the same amount (say 5 mph) everywhere on the dial, you need to reposition the needle appropriately.

Reassemble the bumpers on to the guts - I used loctite, since this was the cause of my grief.

Insert into case - it should be tight, so make sure that the internal screw rubbers are in place, and the foam gasket for the drive, and that the alignment is correct, it only goes in one way. Replace external screw rubbers and install pillar screws. Replace reflector ring, gasket, glass, gasket and bezel.

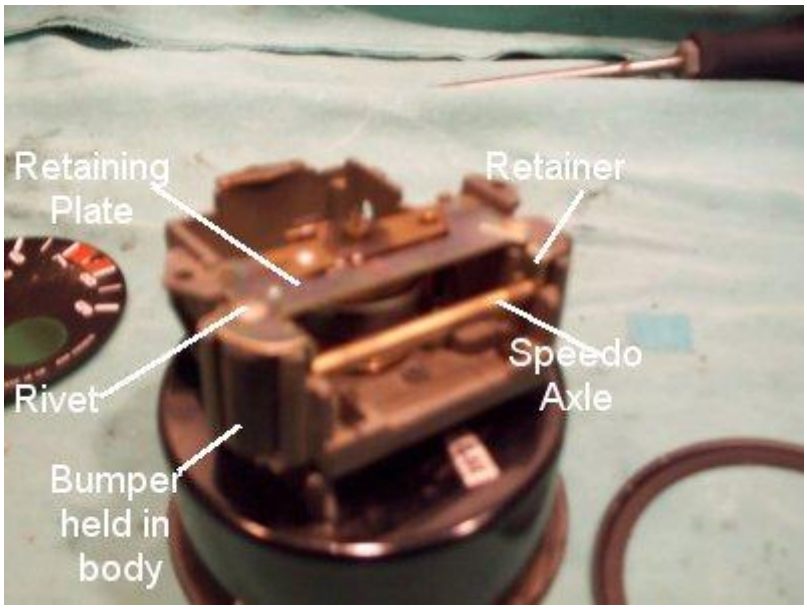
Whether you crimp the bezel back on is a measure of your confidence. Tape works good.

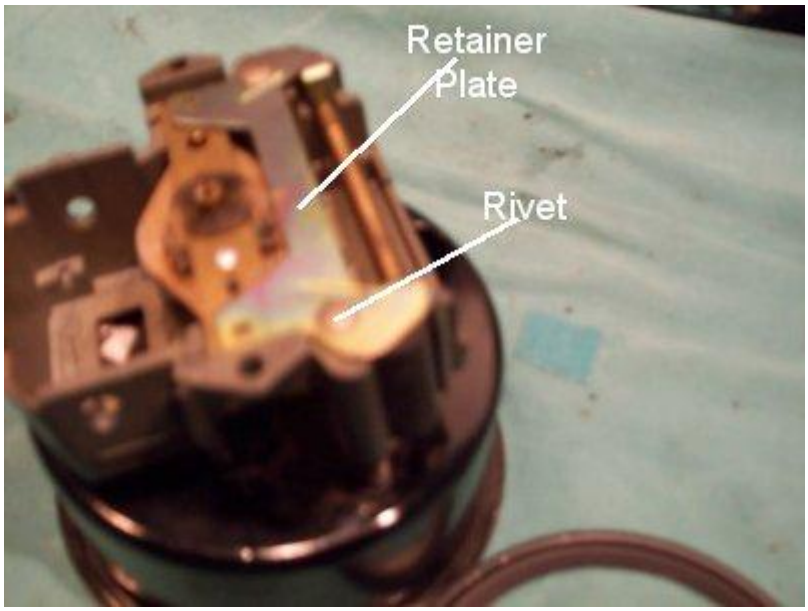
Green Dot

These are the 'green dot' Smith magnetics as supplied on Commandos. This one is from 74. I apologise for the quality of the photos - down to the last few frames, and I'm not opening it up again.

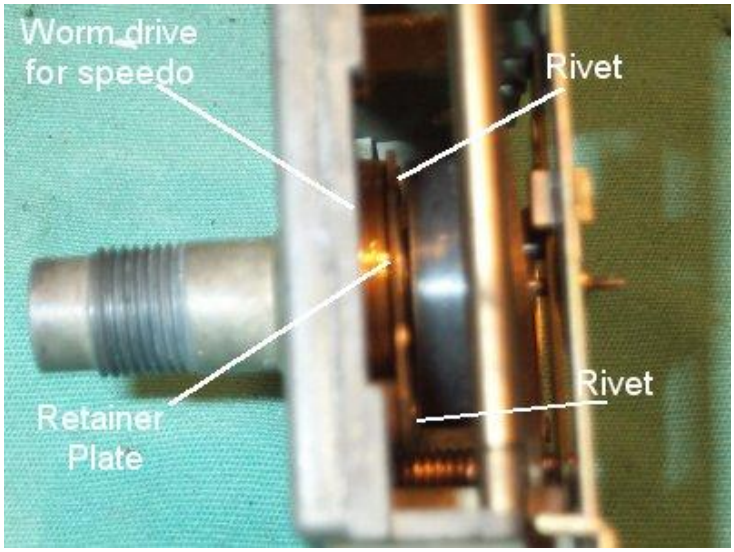
This is a tach, which I had to replace the glass on. Note that the tach and the speedo are essentially the same instrument, with the addition of the odometer worm drive and mechanism. I took the time to strip, clean and lube before replacing the bezel. I am going to try a few different ways of attaching the bezel with this, to avoid the beat up look from prying them off and hammering them back on.

General: This is generally better built than the earlier model. The castings are better, and the instrument is much cleaner, probably because the Commando mounts include dust boots to keep all that crap out. There are some improvements, the spindle plate and odometer axle are held in with a fairly hefty retainer, replacing the expanding plastic rivets. This should make the instrument smoother, as vibration here would cause a fluttering of the needle when the distance between the aluminum disc and the magnet rotor varies. There is also a plate added to retain the rotor. Since failures seem to be caused by the cable pushing the rotor against its stop, until the stop fails and the rotor pushes into the disc - this would be a significant improvement. The whole casting is new, with integral slots for the bumpers, rather than the screw or riveted on steel frame of the previous model. Note that the worm gear for the odometer drive is present on this tach rotor, probably to simplify the parts list. This is a second just as out of focus shot of the top retainer plate and rivets.

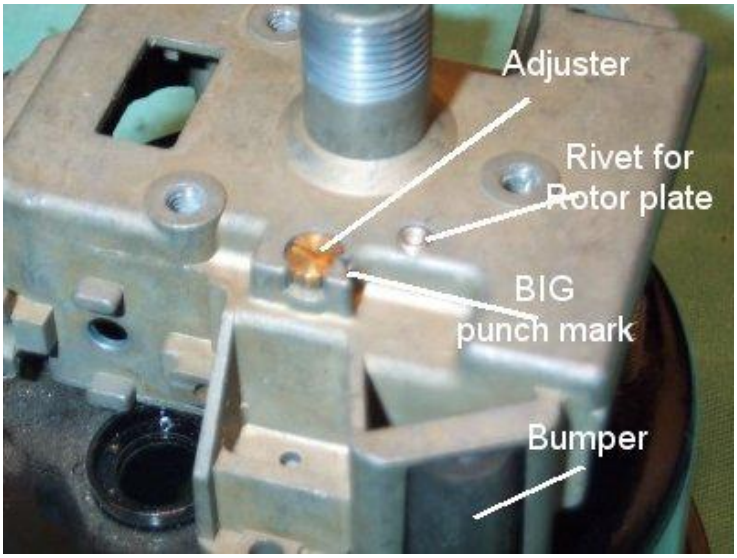




These rivets will have to be drilled out for disassembly, and replace with new.
The hairspring mounting is also different, retained here with a blob of adhesive rather that the clip arrangement used previously.



This is the rotor retainer plate. A much more robust arrangement than the previous. What you can't see in this is that the retainer plate comes in from one side, with a cutout around a slot between the odometer worm drive and the magnet rotor. The rivets are swaged from the bottom as in the next shot-



Note the size of the punch mark retaining the knurled adjustment screw. I think they gave Gertie in the factory a big hammer and told her to make sure it doesn't come loose- or maybe Bert was giving her a bad time that day.....

The last case I assembled, I drilled a hole in the bottom in line with the adjuster. Although I can set them pretty close with the drill set up, you never know, and I would hate to take the bezel off just to tweak it a little.

From: MikeTnyc@aol.com (*ed note .. not the current email)*
Date: Tue, 8 Aug 1995 01:23:46 -0400
To: BRIT-IRON@indiana.edu
Subject: Working on a Speedo (Part I)

Several times I've taken apart magnetic-type speedos to clean, lube and adjust. Some people might want to try this themselves, so I'll discuss it here. I apologize in advance to some of you, because this is going to be very elementary for the sake of those who may need it. What I did recently on Raul's speedo was open the unit, blow out the considerable dirt, etc., since the last time I worked on it (mid 80's), clean & lube the geartrain to the odometer, add 600 miles to the total, which elapsed when my speedo drive was broken in July, and reset the needle slightly because the unit was reading a little high at highway speeds. No major repairs, which might better be left to a pro, but these little repairs may interest some of you.

Here's a summary of how to do them:

<<<WARNING: I used to be a professional camera repairman, and have also done watches. I am very comfortable working on tiny, mechanisms and, as a friend once remarked, my tool collection contains "some of the weirdest shit imaginable." Therefore, telling you how to do this does not mean that I recommend that everyone on this list SHOULD do it, particularly since individual parts accidentally broken might be hard to find. Use your judgment. On the other hand, a speedo is much larger and beefier than a camera or a watch, and not THAT hard to work on. Someone who can, say, clean and adjust an ammeter or a spring-wound clock will probably do OK -- indeed, the hardest job is getting the needle off, which is not unlike removing the hands of a clock. If you've never touched anything smaller than a gearbox, however, maybe you should practice on something else.>>>

Do this work on a clean desk rather than a workbench. A magazine, pad of paper, blotter, etc., will provide a resilient work surface. You also need a pad to make notes on, unless you're working on one so large you can write & draw on that. Ideally, the desk should have a drawer, which should be held open 4" or so with a clamp, block of wood, etc. That way if the unimaginable happens, it'll land in the drawer rather than on the floor.

TOOLS & MATERIALS
-- set of jeweler's screwdrivers, mostly to use as probes. When I say "large" or "small" screwdriver, I mean of these.
-- Q-Tip. Get the genuine article, with the rolled-paper stems rather than the wood or plastic. (generics have shorter fibers, which can come off, etc.)
-- WD-40, Liquid Wrench or similar; white grease.
-- single-edge razor blade.
-- machine oil (sewing machine oil or gun oil is good. Not engine oil, or "smelly" oils like 3-in-1).
-- clear or black silicone; glue (contact cement or airplane glue); nail polish or other lacquer; talcum powder.
-- black enamel paint, if needed.
-- egg carton (w/o eggs).
-- 2" to 3" plastic or metal cap (from large aerosol can is good).
-- tweezers ("MM" style watchmaker or hobbyist tweezers preferred [i.e., 5" long tapering to a point]. Hemostat or VERY fine needle-nose pliers could also be used. Medicine-cabinet tweezers are not satisfactory).
-- one or more soft, wooden probes. Chopsticks are ideal.

STEPS (assuming speedo out of bike and on desk).

1. Get the bezel loose. When I first worked on my speedo, I pried it off all the way around the back, and scarred it quite a bit. Someday I may get a new one, but haven't yet. Others on this list have suggested more sophisticated ways than I know.

2. Take off the bezel, glass, various rubber seals, etc. Pull gently, because they may be stuck from age. Lay them out in order, making notes as to direction, etc, if you plan to reuse them. There is a black metal disk on the case above the dial, which may be glued on. Pry off gently & evenly all around the edge with a small screwdriver.

3. Removing speedo mechanism [hereafter, "guts"] from speedo case: there are 3 screws in the back. Loosen them part-way, then use them, and the central threaded hub [hereafter, "hub"], to push the guts up evenly. The screws go through rubber washers [hereafter, "rubbers"], and there are also three rubber bumpers around the outside of the guts. These may be stuck to the case from age. Push the screws alternately to rock the guts back and forth, and eventually it'll unstick. (Finger pressure should be enough -- put that hammer down!) The screws and rubbers should go in the first compartment of the egg carton, to keep them orderly. Take notes on which side of rubbers faces in, etc.

4. Slowly move the guts up out of the case. Eventually, you'll have to remove the screws and push only on the hub. Be ready to catch the guts when it comes loose, but hold it by its main casting or the edges of the dial, lest the needle catch on something. From now on, you can hold the guts upright by sitting it in the aerosol cap. It won't sit flat on the desk, because various things stick out of the back. Do not put it face-down.

REMOVING THE NEEDLE

5. Taking the needle off is the trickiest job, a bit like taking the hands off a watch or clock. To make it easier, put some WD-40 into the depression at the center of the needle hub and let it sit awhile.

NOTE: From now on, "putting" oil, grease, glue, etc. means to put some onto a saucer, scrap of paper, etc., then use one of the smaller screwdrivers to transfer small amounts. Under NO circumstances should you spray WD-40, etc. onto the speedo. Also, do not use undue force on any of the following procedures.

6. Before removing the needle, you must figure out where it points at when put back on, so you can return it to the same place. Notice the needle stop, which is a piece of wire. It's spring loaded, so you can push it in down into the dial. Move the needle forward from the stop a bit, then push the stop in far enough in with the tweezers so the needle can move backwards OVER the stop; i.e., you will move the needle below 10 mph toward the area that says "MADE IN U.K." (NOTE: From now on, when I discuss the needle, "forward" means clockwise, "backward" means counter-clockwise. "Up" and "down" mean toward or away from the guts).

8. Now, the needle is not held by a stop, and will move to the position where the spring no longer exerts a force on it. Tap the hub gently on the work surface to help overcome friction, and ensure the needle moves completely, then note where the needle winds up. Try this several times, moving it 1/4" or so one way or the other to see if it moves to a repeatable spot on the dial when the hub is tapped. Carefully make notes about that spot , because this is where you'll aim the needle when you put it back on, unless your speedo has been reading consistently low or high, in which case you'll compensate.

7. Move the needle forward over the stop, then look inside the guts which you wiggle it forward and backwards. You will see an aluminum disk that turns with the needle. If you like, spin the inside of the hub with the chopstick. You'll see that there's a fat disk connected directly with the chopstick or cable, right below the thin, aluminum disk that connects to the shaft on which the needle turns.

8. To remove the needle, turn it up to 30 mph or so, so it won't hit the stop. Then immobilize the shaft by touching the edge of the aluminum disk with a screwdriver, and gently turn the needle back-and-forth until it comes loose from the shaft. Use a fairly large screwdriver on the disk, so you can hold the blade crosswise to the edge of the disk and it won't slip off. NOT MUCH FORCE IS NEEDED. Hold the needle on both sides of its hub and as close to the center as possible so you won't bend it.

9. Ultimately, the needle should get loose on the shaft, and can be pulled off. If you think you need to use too much force, try more WD-40 or Liquid Wrench. There are more drastic ways to get the needles off, which I'm not mentioning here. E-mail me if this way doesn't work.

10. When the needle is off, put it in the egg carton. You can cut a thin wedge of paper, twist it to a point, and use it to clean the WD-40 from inside the hole, then put the needle into the egg carton.

REMOVING THE DIAL

11. The dial is held by two odd little fasteners at 3:00 and 9:00. These are vaguely like the little metal fingers that hold the light sockets on the speedo's bottom, but have solid plastic shafts pressed inside to keep these prongs from vibrating loose. If you look on the back of the dial, you will see how the shaft holds the prongs apart. The shaft is probably stuck tight. Use a probe to push it toward the front of the dial -- a chopstick works well, but may have to be whittled down (WD 40 may be needed). Once the shaft breaks loose, you can push it out either from the front or the back.

The front is far more accessible, but be careful not to slip and scar the dial.

12. Once the shafts are out, the dial pops off easily. It can be cleaned carefully with mild soap and water, if needed, but nothing harsh. (I used shampoo and my fingers, blotted the bulk of the water off, then let it dry under a desk lamp. VERY LITTLE HEAT or you could melt the fasteners). You can repair flaws in the dial with black model airplane enamel, etc. I find the shaft of a Q-tip, cut at an angle with a razor blade, makes an excellent micro paint brush for this purpose.

INSIDE

13. With the dial off, you can see how all the little wheels work (unless you're opening the speedo because they don't). Turning the center of the hub with the chopstick turns the fat disk, which is a magnet. This sets up eddy currents in the aluminum disk that drags it along, but that disk is connected to the coil spring that wants to push it back, leading to an equilibrium at a given speed, depending on how fast the hub turns. Down under the disks is a brass ring gear that turns a nylon geartrain for the odometer. If you have a basic speedo, you'll see another nylon gear down near 6:00 on the guts. This is for the trip odometer (which some makers who weren't as cheap as Norton fitted in their speedos). I hope your speedo needs no work, but at least blow out dust gently with a rubber ear syringe, and gently pick off hairs, etc. The end of the hairspring that does not move is held with glue, and you may want to put a bit more airplane glue on there, with extraordinary caution not to get it on the rest of the spring. [See at end if you do need work here].

14. My odometer works fine, so I merely cleaned visible grime off the teeth of the big nylon gear, which is turned by the big brass gear and in turn moves the others. Then I lightly applied white grease to the nylon gear's teeth, again using a Q-tip shaft cut on the diagonal. ["lightly" means that if you can see the grease easily when you're done, it wasn't lightly enough].

Some people would not use grease at all on these gears, and I don't use it on the others, but the big nylon one slides against the brass gear to a considerable degree.

15. At this stage it's a quickie to change the odometer reading to correct errors, etc. I like a visible reminder of the miles Raul and I have spent together, so I added 650 miles to my speedo to correct for the period in July when my speedo drive was kaput. I suppose this could also be used for less than honest purposes, so if you see bikes being sold with suspiciously low mileage (or bikes at rallies getting trophies for suspiciously HIGH mileage), now you know why.

16. To adjust the numbers, you remove the e-ring from the left side of the shaft on which they turn [this is also the side where there's quite a bit of room. The e-ring on the other side is so tight against the casting that it would be very difficult to reach.]

17. If you've never heard of an "e-ring," take a look at it: a dark metal ring that snaps into a groove on the shaft. You can either pry the side opposite the opening away from the shaft with a tiny screwdriver, or press on the open side with a larger one. (One could also grab the thing with small pliers to pull it off -- tweezers are not strong enough). When an e-ring comes off, it usually flies across the room, a good reason to wear eye protection. In this case, however, the e-ring should fly no further than the big magnet 1/2" away. Turn the hub center if you can't find it. (If you inspect it when it's off the shaft, you'll see why it's called an e-ring).

18. With the e-ring off, the disks with the numbers on them can be slid to the left, turned, then slid back. The left digits are the more readily moved, which is convenient, since few people would want to correct an error on the low digits. Once the numbers are right, push the disks back and get the e-ring back in, starting it in the slot with the tweezers. which can be a royal bitch of a job. There's a small washer that will block the groove unless you get it evenly on the shaft. Also note that the e-ring has one smooth side and one side with an uneven, burred edge. I would face that edge away from the numbers to make it easier to get it in the groove.

Obviously, if you hold the shaft vertically, gravity will help keep the disks and washer in place while you struggle with the e-ring. (Note: if your washer is steel, it may be attracted to the tweezers and continually jump up out of its groove. Tweezers and other small objects can be demagnetized by quickly passing them into and out of the loop formed by the copper-wire tip of a soldering gun. Do not shut off the gun with the object inside, which may remagnetize it).

PUTTING IT BACK TOGETHER

19. First, push the dial back on, then slide the plastic shafts into its fasteners with the chopstick. You can install the needle either before or after the guts are back in the case: Tap the hub until the spring-loaded disk has settled to its rest position, push the needle firmly on the shaft in the location you previously noted, then move it clockwise over the spring-loaded stop.

20. To install the guts in the case, get the internal rubbers in place the right way [you took notes, remember?]. Brushing all rubber parts with A LITTLE talcum powder on a Q-tip helps them not to stick (don't forget the 3 rubber bumper strips on the outside of the guts). Check that the foam seal on the back of the guts was not disturbed, then gently wriggle the guts back into the case. Note that the 3 holes are NOT symmetrical -- the guts fits only one way. Once it's on, you can install the outer rubbers and the screws, then glue on the black metal surround with airplane glue, contact cement, etc.

21. I do not reassembled the bezel and glass the "proper" way [crimping, etc.], and I do not reuse the rubber seals. I just carefully glue the glass inside the bezel with clear silicone, then use more silicone to hold the bezel onto the speedo case. (Let the glass harden first, so you can scrape off any smeared silicone with the razor blade). Someone else on this list can tell you how to do it "right," but a leakproof joint is more important to me than historical accuracy no one sees, and the "right" way will not be more leakproof than silicone.

TIPS ON ADVANCED STUFF

I haven't had to do serious surgery on a Smiths, so I can't get too specific [unless someone gives me a dead one to dissect]. The general approach is as follows: The shaft that holds the gears is held with rivets, which can be drilled out -- best done with a Dremel tool. The hairspring system, however, is SO delicate that if you bent or derange it, you may never get it right again. Therefore, if you drill or otherwise do serious work on the odometer, cover the spring mechanism with a small bottle cap, etc., then wrap all of it with masking tape or similar -- stuffing tissue in large cavities first, if it seems appropriate -- so shavings and crud will not get in. [This works very well: I have on occasion actually sawed body castings of cameras without removing far more delicate than this by protecting them with masking tape. If I had to disassemble the hairspring and had never done it, I'd practice on a wind-up clock -- very similar.

Odometer parts seldom break, though I once had a plastic gearwheel in a VW speedo that sheared off its shaft, and I was able to epoxy it in place. Take very careful notes with drawings, etc. for any major surgery, and have many, many egg cartons).

Best of luck, and keep the speedo side up.

Mike Taglieri
Raul -- '72 Commando Interstate

Date: Sat, 9 Mar 2002 15:36:59 -0500
From: Ron Thompson <rtetetet1@FUSE.NET>
Subject: Re: Speedo Repair

Ian don't be afraid of those Smith's gauges. They are easy to fix really. The link you posted goes no where for me but this one I attached will give you a brief overview. **http://members.shaw.ca/randell/Smith/Speedo.html**

I have used the screw driver method to get the bezel open but it is slow and usually trashes the bezel. I am working on a tool for my lathe to do this. I find the biggest problem to be dirt, dried grease and occasionally a nick in the aluminum disc that causes erratic slow speed readings. I recently repaired a speedo that the odometer had vibrated the axels out and chewed the case to the point that it could not be captured any more. I mare delrin bearing blocks that were held in by the rubber shock mounts.

The calibrating adjustment is easy to do, just make sure you lock the adjusting screw down after you are finished. But take the unit as far apart as you dare and clean it out of all old dirt and grease first.

NOTE: for those of you who have gauges that just seem stuck, before you break them open, try using a small wire to flick the disc or needle through the light hole first. I've opened a bunch that were just fine except that some grease had stuck the needle. Had to do the whole glass and bezel process just to unstick the needle. Yes I did the whole clean up thing too while there.

The trick to calibrating is to have a rotating source that you can use that you know the RPM. If you have other gauges that you can compare to, a drill works fine with an old stub of cable in it. If you can't find a source with given RPM that you need, if you know the amount you instruments are off, you can use a drill at high to see where it reads before you adjust it, then back it off to where you need to be.

If you are looking to get dead on, it will take some math. The speedo math is like this. But first you need these.
Rotations of the rear wheel per mile. (R)
You'll have to find the actual circumference of your rear wheel. Divide 5280' by the circumference.
How many rotations of the wheel to rotate the speedo drive on rotation. (V)
The speedo reduction ratio. i.e. 3:1 or 4:1

R / V = how many rotations the cable makes per mile (SD)

So SD / speedo ratio (3 if 3 to 1 or 4 if 4 to 1) will equal the RPM per mile per hour the speedo needs to turn to give you the proper speed reading.

So if your rear wheel has to turn 769.7 times per mile. (19" wheel with 3.5" tire) and you have 10:1 ratio speedo drive it would look like this; 789.7/10 = 76.97 so your cable spins 79.67 times per mile.

If you have a 4:1 ratio speedo, 79.67 / 4 = 19.242 RPM per mile per hour.

So if you drill turns 1000 RPM / 19.242 = 51.96 MPH indicated speed on gauge.

Now for the bezels. I buy new ones from one of my favorite Brit dealers, last ones came from Art X. I chuck the gauge case in my lathe, stack the shade ring, gasket, glass and bezel on the case and use a wood circle to hold it in place with the tail stock center. With an old bearing tipped router bit in the tool post, I roll crimp the bezel around the lip of the case. By gradually rolling the lip with the bearing it goes down nicely.

If you have to do yours by hand, wood block and hammer, go slow. You are forming metal and it don't like major shape changes without deforming.

CAUTIONS:

Don't use solvent based cleaners in the speedo or they eat the paint on the ODO and the plastic parts too. Silicone spray lube, the stuff that dries works well. I use silicone grease on the internals. (*Super Lube*) Don't use Alcohol on Chronometric units, the ODO is a decal.

Be extra careful of the face of the gauge. It is flat paint and will scratch or take oil stains easily. If you have to pry the needle off with a tool, you must put something under to tool on the face plate to keep from marring the surface.

Paint the inside of the gauge white before you re-assemble, helps the gauge light better. You can also buy fluorescent orange paint at art supply stores to perk up the color of the needle. I have been playing with putting a plexi ring under the shade ring to light the face better. Especially that neon clear stuff. LEDs too.

Do this on a clean table with plenty of light.

Have fun, move slow

Ron

----- Original Message -----
From: "Ian Bardsley" <Ian_Bardsley@TELUS.NET>
To: <BRIT-IRON-L@LISTSERV.INDIANA.EDU>
Sent: Saturday, March 09, 2002 11:29 AM
Subject: Speedo Repair
Having exhausted this years Commando repair budget on an unplannedfront-end re-build, I am now contemplating taking a run at fixing the speedo and tach myself. (..... I can hear you doubters snickering). Both instruments demonstrate the same fault - they read high, which I think could be due to cable lube getting onto the magnet/drum mechanism.

Anyway, I dug out Mike Taglieri's 2 part epistle on speedo repair as a reference. I also trolled the web and came across this interesting speedo repair manual: **http://ourworld.compuserve.com/homepages/arhodes/Speedo.html** It covers Smiths and Jaeger magnetic instruments in a generic way. There are numerous full colour pictures and detailed instructions. There a couple of useful post in the archive on bezel replacement. Does anyone have any other useful information before I dig-in.
Ian 75 MK III

Original post by Chris Ghent on INOAList;

I consulted out local Smiths man today. He was trained by Smiths, bought all their gear when they left Australia, and is in the throes of retiring. He said... The inner should protrude no more than 7/16ths out of the top of the outer when the crimp is pushed back inside the outer as far as it can go. At this point the inner should stick out the bottom of the outer by 5/8. He made the point that the 5/8 sticking out all needs to be square, if some of it is still round then it will push the inner up into the speedo/tach. The consequences of the inner protruding too far into the speedo/tach is that it destroys the mechanism.

So those are the measurements all new cables should be checked against. He says many new cables are wrong, and despite his broadcasting the needed measurements locally, the over long cables that turned up in the post Smiths era supported him very well for years by causing a lot of broken instruments.

He also mentioned the flick test for new cables. Cables, he said, should never be coiled tightly, but left hanging. the inners take a set and this causes a flick in the cable operation leading to wobbly needles. When people say, it can't be the cable, I've just replaced it, he says, yes it can, and shows them the flick test. This is a Smiths test and is laid out in a pamphlet he gave me a copy of. What he referred to as "flick", they called "snatch".

It goes like this... pull the inner out of the cable and hold it in a loop, one end in each hand, pointing up and held like you would hold a straw. Gently roll one end between thumb & forefinger and feel with the other hand whether it starts to turn immediately. If it does it is OK. When they are not OK they don't turn for a split second and then flick around, as if something is bent.

He showed me brand new cables that did it. So there is the inner outer length thing laid out... I would never fit a speedo cable without checking the inner length because I have done it, and it hurts.

regs --Chris

Ian Bardsley and Ron Thompson's emails

Hi Mike,

Well, I opened up my tachometer to see what was causing it to read high and I found that the disk was rubbing against the top of the magnet. The questions of the moments are why and what can be done? Since you're one of the few that have ventured inside the magic boxes, I thought I'd share what I've found and pick your brains.

I have removed the disk/spring carrier assembly and find evidence of the contact with the magnet on the lower outer side of one part of the disk. I assumed this was due to the magnet riding too high and I went on to remove the magnet/worm/cable spindle assembly. It is a pressed-up assembly and the worm is held against the retaining bar by a very thin wave-spring washer. There's no real evidence of wear.

In your web page, you say that the adjuster moves the disk higher, but I can't see how. The adjuster plate moves up/down with the screw, but it's not fastened to the disk at all. As far as I can see, it varies the magnetic field return path which flows through the disk and returns via the adjuster bar. Shortening the path would increase the overall field strength, increasing the coupling etc. The disk spindle seems to sit in a bearing at the centre of the magnet and thus the distance between the disk and magnet

should be controlled by the bearing & spindle - being brass, perhaps its worn down.

Assuming I am correct - and I hope I'm not, it seems that the magnet could be riding too high because of wear in the worm-retaining bar interface & disk spindle/bearing - probably due to lack of lubricant (it was quite dry in there), or upwards pressure from the cable. Being unable to separate the worm/magnet & retaining bar, the only remedy I can think of is to shave a few thou of the top of the magnet - it has what I looks like an aluminium slotted face of similar thickness to the disk. This would restore some magnet to disk clearance, but I am less than enthusiastic.

The metal on top of the disk could also be mumetal - a magnetic shield. This would channel the magnetic field through the slots making a more defined field pattern and aiding with the eddy current flow.

Anyway, enough rambling. Any thoughts you have will be appreciated.

Regards, --Ian Bardsley

Miker Wrote:

Don't have a whle lot of experience, but will share what I have.

Is this an early i.e. grey face pre 69, or the later Commando type? There were quite a few improvements made some time between 68 and 73, notably the way the rotor is retained.

Sounds to me, though, that the aluminum rotor/spindle assembly has lost whatever retains it to the moving adjuster plate. It should have very little float on the adjuster plate- IIRC, there's a kind of ball/socket affair where the spindle passes through the adjuster plate, but I don't recall what holds it in place. It moves quit directly with the adjuster. I'm attaching a few full size closeups of the grey face atlas speedo- you can zoom in pretty close, and maybe notice any differences. This was/is a working instrument, other than stray parts bouncing around. What I do notice is how very little clearance there is between the alum and rotor- and this is adjusted correctly.

Tsawassen is coming up- there will probably be a few dead Smith clocks on offer, good parts donors. The good lord and SWMBO willing, I might be there.

-- Miker

Ian Bardsley wrote:

I made a couple of observations today that I thought you might find interesting. Drilling out the rivets naturally generated some swarf that attached itself to the magnet. Couldn't get it off with my fingers or the vacuum cleaner, so I resorted to using my magnetic pick. The bits congregated in the magnet slots and they have an affinity for the pointed tip of my pick – probably due to focussing of the pick field at that point. Worked quite well.

Because the other end of the pick has an embedded magnet, I used it to sense the polarity of the speedo magnet. The slots in the magnet top cover are poles and they are arranged N - S - N - S. So I think my theory on the top cover being to focus the field may be correct.

The contact area is between two of the slots and I noticed that the interface between the slotted top cover and the magnet itself was just a shade wider where the contact had been. So I measured the combined thickness of the magnet & cover between each slot. This showed that the cover was slightly bowed to about 0.005", with the widest part where the contact has been made (and opposite, where no contact has been made). Putting it face down on the cover allows me to rock it slightly.

I put the bits back into the casing without fasteners and I find that the magnet pulls itself upwards to the adjusting bar. If I hold the magnet retaining bar down against the casing, the magnet "levitates" towards the retaining bar and there is clearance between the magnet & disk. Hopefully this continues to be true if I ever find the right sized rivets to put it back together again. I may flatten the magnet top cover just to be sure.

--Ian

Interesting stuff. It looks like I won't make it to Tsawassen, as the weather forecast has improved greatly for the weekend, and I have farm stuff that I have to get at. I asked Ken Jacobsen to pick up any cheap non functioning Smiths for me, and intend to do more surgery on them- partly to accumulate some spares for the internals (I think most parts are common. The rotor for the tach has a worm machined on- and it doesn't drive anything). I am making up a jig to roll bezels back on with a lathe, which I now have access to. Will take some photos and post them.
-- Miker

Hi Mike, Too bad you can't make Tsawwassen. Here's the latest - sorry about the length, but I need to share it with someone who is interested:

I trial assembled the magnet & disks assemblies using screws & nuts (#2 & #3 respectively), less than ideal, but no rivets to be found. The disk still bottomed on the top of the magnet. So, I got aggressive and carefully took 2 -3 thou off the top of the magnet cover using wet & dry on my glass plate. Getting the swarf off the magnet was quite the chore (I carefully plugged the bores). This restored the air gap and it then seemed to run cleanly. I have since lubed & assembled the body and replaced the dial & needle.

This am, I trial calibrated using my drill and a green spot speedo I borrowed from a club member. My theory is that the speedo and tach use the same drive mechanism, so the calibration marks - those little white dots at 30, 72 and 123 (or so) mph should line up with the corresponding marks on the tach at 2, 4.8 and 8 x 1,000 RPM. Using my drill, the speedo gives about 123 MPH, so I adjusted the tach to correspond. BTW: my tach is marked 4:1 and my drill say's 2500 rpm, so the 8,000 RPM this indicates is in the ball park (the drill's getting a bit tired).

The good news is that the tach now runs smoothly throughout the range. When I first revved it up, it read way up at the top of the scale, but I had the adjuster plate cranked down. It took almost all the adjustment (i.e unscrewing the adjuster) to get it calibrated (should've took more off the magnet). Hopefully, it will stay set. I plan to check my calibration against a tach - if I can find someone locally with one hanging loose.

FYI: after running the disk/spring/adjuster assembly though my fingers quite a bit, I am now convinced that there is no connection between the adjuster plate and the disk - it works through varying the magnetic coupling. The disk - magnet clearance is set by the disk spindle - magnet bearing. On close examination, the bottom of the spindle has a conical hub (several times larger in diameter than the shaft), and the magnet bore has a corresponding brass bush - probably in the top of the worm gear. So the spindle rides on top of the magnet. As the magnet rises, it lifts the disk. If this bearing wears, the air gap disappears - and the instrument reads high, firstly due to increased magnetic coupling, then due to drag (recall that my disk & magnet had wear marks). Also, I'm convinced that the wormwheel is intended to ride against the magnet retaining bar - since it had a spring to keep it there. This isolates the magnet/disk bearing from cable end thrust.

So what do I take from all this: my problem was due to loosing the air gap, probably due to wear in the spindle/magnet bearing, again probably due to lack of lubrication. Unfortunately, this looks likely to happen again - you can only put a little lube in this bearing. I should probably have taken more off the magnet (at least .005"). I measured the penetration of the cable stub into the magnet spindle, and there seems to be 75 - 100 though end clearance - so I doubt cable thrust is the problem (no brass from the worm gear in evidence).

Anyway, now for the bit I dreaded from the beginning, replacing the bezel. FYI, my old one was quite rusted and bits fell off as I un-crimped it. Need to figure a technique to roll down the edge on the new one. I'm not declaring victory yet, but I'm reasonably sure it'll work for a while. I found your web page and Mike Taglieri's epistle invaluable. If you're interested and this works, I'd be pleased to write it up so's you can add it to your web page.

See you at Positive Earth. Cheers, --Ian

Ron Thompson wrote:
I trial assembled the magnet & disks assemblies using screws & nuts (#2 & #3 respectively), less than ideal, but no rivets to be found. The disk still bottomed on the top of the magnet. So, I got aggressive and carefully took 2 -3 thou off the top of the magnet cover using wet & dry on my glass plate.

Getting the swarf off the magnet was quite the chore (I carefully plugged the bores). This restored the air gap and it then seemed to run cleanly. I have since lubed & assembled the body and replaced the dial & needle.

I'd be surprised if you actually took .001 off with sand paper. It takes plenty to do that. It almost sounds like you have a lot of slop ply in the bearing on the worm gear side. Or you have a lot of vibration wear on the alloy case where the adjusting bar sits as a fulcrum.

This am, I trial calibrated using my drill and a green spot speedo I borrowed from a club member. My theory is that the speedo and tach use the same drive mechanism, so the calibration marks - those little white dotsat 30, 72 and 123 (or so) mph should line up with the corresponding marks on the tach at 2, 4.8 and 8 x 1,000 RPM. Using my drill, the speedo gives about 123 MPH, so I adjusted the tach to correspond. BTW: my tach is marked 4:1 and my drill say's 2500 rpm, so the 8,000 RPM this indicates is in the ball park (the drill's getting a bit tired).

They are similar but not the same. Of course I use a slower drive sourse, 1200 RPM. My Triumph black face OIF tach, 4:1, registers 5500 indicated at 1200 RPM cable speed. Also you are assuming that your tach drive from the engine is a 1:1 output.

FYI: after running the disk/spring/adjuster assembly though my fingers quite a bit, I am now convinced that there is no connection between the adjuster plate and the disk - it works through varying the magnetic coupling. The disk - magnet clearance is set by the disk spindle - magnet bearing. On close examination, the bottom of the spindle has a conical hub (several times larger in diameter than the shaft), and the magnet bore has a corresponding brass bush - probably in the top of the worm gear. So the spindle rides on top of the magnet. As the magnet rises, it lifts the disk. If this bearing wears, the air gap disappears - and the instrument reads high, firstly due to increased magnetic coupling, then due to drag (recall that my disk & magnet had wear marks).

Yes this is the premise that the disc and magnet operate by.

Also, I'm convinced that the wormwheel is intended to ride against the magnet retaining bar - since it had a spring to keep it there. This isolates the magnet/disk bearing from cable end thrust.

You lost me here. I have a RSM 3003/C0A in my hand and have no "magnet retaining bar." The worm gear / magnet is held by the alloy case in a bearing.

So what do I take from all this: my problem was due to loosing the air gap, probably due to wear in the spindle/magnet bearing, again probably due to lack of lubrication. Unfortunately, this looks likely to happen again -you can only put a little lube in this bearing. I should probably have taken more off the magnet (at least .005"). I measured the penetration of the cable stub into the magnet spindle, and there seems to be 75 - 100 though end clearance - so I doubt cable thrust is the problem (no brass from the worm gear in evidence).

This is quite likely. The spindle on the needle is steel and the bearing "cup" is brass. Either wear or pounding. The abration on the magnet wheel and aluminum disk are your worse enemy. They increase the turbulence effect and make the needle read high and erratic. You can lube this bearing area but take care that you don't fill it and that what you use is not so thick as to induce more movement on the spindle.

Anyway, now for the bit I dreaded from the beginning, replacing the bezel. FYI, my old one was quite rusted and bits fell off as I un-crimped it. Need to figure a technique to roll down the edge on the new one.

I would check your tach drive ratio first to make sure you have the calibration correct. unless you want to drill an extra hole in the back to make adjustments without tear down.

The best way to re-crimp is to "roll" crimp the lip back down. I do this on a lathe. Chuck the body of the case near the base where the cable comes out. I made a wood disc that fits over the bezel and I run the tailstock into it to clamp the bezel to the case. I run the lathe slowly and with an old router bit with a bearing on the end clamped in the tool post, I run the bearing in and slowly roll the edge down. You may be able to figure another way to do this without a lathe. Banging it down with wood block gives you a lumpy crimp job, and you take the chance of cracking the glass.