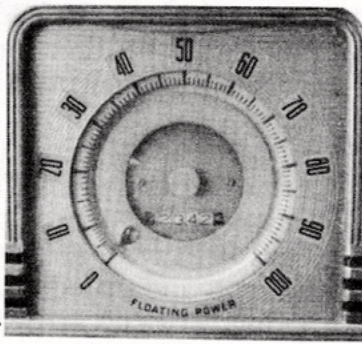


The Operation, Care and Repair of a Speedometer

by SK Staff



How a Speedometer Works

Simply speaking, a speedometer is nothing more than a device that measures the revolutions of a cable and converts that into a number which is read from a dial. That's simply speaking.

The speedometer system consists of a number of parts, working together, so that the speedometer indicates (roughly) how fast the vehicle is moving across the ground. The speedo was designed to work in your vehicle with a certain set of pre-determined criteria. Change that criteria and you alter the accuracy of the speedometer's reading.

For purposes of this article, we are not going to get into the electronic speedometers used in modern cars. We are going to stick with the mechanical device and the parts that make it work – or not work.

Let's start, well, at the beginning. Inside the transmission is a gear that operates along with the output shaft. It is dedicated to the speedometer and is known as a driving gear. It is generally within the tailstock of the transmission. As a rule, it is not a problem. It cannot be easily accessed and needs no adjustment. It is a helical gear designed to convert the rotation of the shaft ninety degrees to engage a

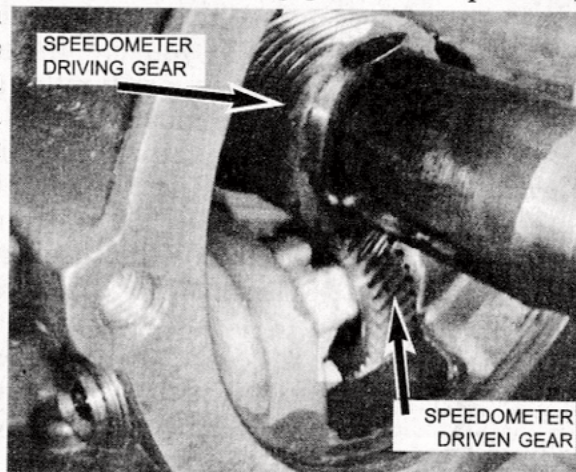
gear which is fitted perpendicular to the shaft. That is the driven gear. The two gears are calibrated (at the factory) to properly engage in a ratio with the rotations of the output shaft. If one gear is changed, the other has to be as well. We will touch on that subject, very briefly, later.

The driven gear is most often nylon. It requires no additional lubrication. Under normal circumstances, neither the driving gear nor the driven gear require any service. Generally the driven gear is held in place in the transmission with a retainer clip. One screw holds it, and with the clip removed, the driven gear is readily removable.

An adapter fits onto the shaft end of the driven gear. It grasps the nylon shaft at one end and is a receptacle for the cable (or chain) end at the other. Although the gear itself normally requires no service, the cable or chain does. The cable or chain (for simplicity, let's call either system a cable) occasionally kinks, twists and breaks. It then has to be replaced. Normally removing a knurled nut at the driven gear is all that has to be done. Why does a cable kink or break? Most of the time it can be blamed on lack of lubrication. Again, let's come back to that subject.

The cable is merely a method of connecting the driven gear to the speedometer meter on the instrument panel. It is able to snake up under the engine and transmission, up through an opening in the firewall and connects (again, normally with a knurled nut) to the speedometer 'clock' or head. If a cable breaks, don't try a repair. Just replace it; they are generally universal and any after-market auto parts store will carry a universal replacement cable kit. It will probably have to be shortened, and a terminal attached, but that is a simple job. A chain can be repaired. See *Skinny Knuckles*, November 2014.

Now we get to the complex part of the speedometer system: the 'clock' or 'head.' In most cases, the meter you see on the instrument panel contains three readings: ground speed of the vehicle, total miles driven since the car



was new, and a trip meter which is re-settable and indicates how far you have driven since re-setting. The last two are called odometers, and they measure not speed but distance.

This is very important: although the accuracy of the speed reading may be incorrect, the odometers operate off a different set of gears and measure rotations of the cable directly, so they are generally pretty accurate. An error in the indication of speed does not mean a comparable error in mileage.

The speedometer is a rather complex device. We strongly recommend against a novice fooling with it or trying to make any adjustments or repairs.

The principle of how the speedometer works is based on magnetic fields, known as 'eddy currents.' The mechanical speedometer on most of our vehicles is known as an eddy current speedometer. Modern electronic speedometers work on a totally different principle.

The clearest explanation for how a speedometer works was found on the Internet site, Wikipedia: "A small permanent magnet affixed to the speedometer cable interacts with a small aluminum cup (called a speedcup) attached to the shaft of the pointer on the analogue speedometer instrument. As the magnet rotates near the cup, the changing magnetic field produces eddy currents in the cup, which themselves produce another magnetic field. The effect is that the magnet exerts a torque on the

cup, 'dragging' it, and thus the speedometer pointer, in the direction of its rotation with no mechanical connection between them.

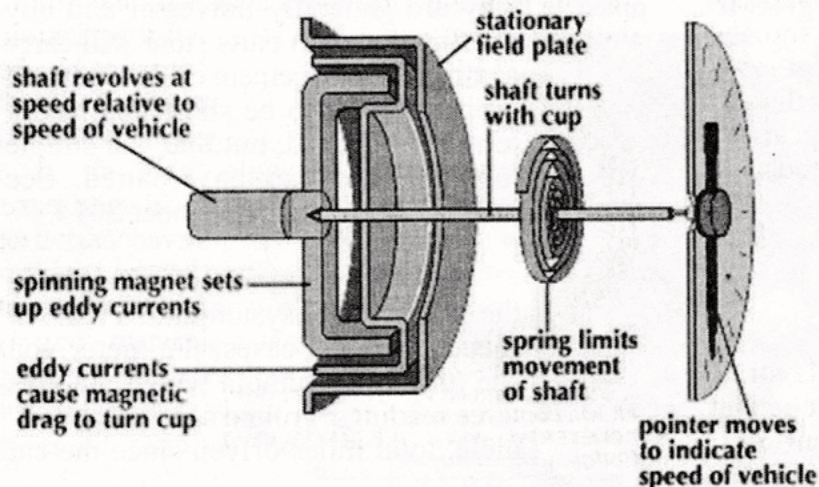
"The pointer shaft is held toward zero by a fine torsion spring. The torque on the cup increases with the speed of rotation of the magnet. Thus an increase in the speed of the car will twist the cup and speedometer pointer against the spring. The cup and pointer will turn until the torque of the eddy currents on the cup is balanced by the opposing torque of the spring, and it will then stop. Given the torque on the cup is proportional to the car's speed, and the spring's deflection is proportional to the torque, the angle of the pointer is also proportional to the speed, so that equally spaced markers on the dial can be used for gaps in speed. At a given speed the pointer will remain motionless and pointing to the appropriate number on the speedometer's dial."

What does that mean to you? It means: Don't touch it! Leave any repairs or adjustments to an expert.

Let's backtrack a little. By using a measured mile, a highway radar speed unit or a GPS (that's one of those modern electronic devices that we don't own or understand how to use) you can determine how long it takes your vehicle to travel a set distance. From that you can determine the error in your speedometer.

For example, if you travel a measured mile in sixty seconds, you are traveling at a mile-a-minute, or 60 miles an hour. If it takes two minutes to travel that one measured mile, you are traveling at 30 miles an hour. Three minutes would be 20 miles per hour. By watching the speed indicated on the speedometer, you can determine the error in speed.

When built, the speedometer was calibrated to read a reasonably accurate speed. For commercial vehicles it is



mandated by the government at plus/minus 5 miles per hour at a speed of 50 miles per hour:

Code of Federal Regulations (annual edition) – Title 49 - Transportation

393.82 Speedometer. Each bus, truck, and truck-tractor must be equipped with a speedometer indicating vehicle speed in miles per hour and/or kilometers per hour. The speedometer must be accurate to within plus or minus 8 km/hr (5 mph) at a speed of 80 km/hr (50 mph). [70 FR 48054, Aug. 15, 2005]

Passenger cars do not carry a similar regulation, but it is generally accepted that the indicated speed would be calibrated at 10% or less, but indicating a speed actually in excess of the actual road speed. That is, if you are traveling at 40 miles per hour, the speedometer will read up to 44 miles per hour, but not less than actual speed.

Okay, if that's true, why does your speedometer read in excess of 10% +/-? First reason is tires. When the vehicle came out of the factory everything was predicated on factory-size tires. A smaller tire will require more revolutions to cover one mile than will a larger tire. Either one will require a difference in the number of shaft rotations of the output shaft of the transmission, so the readings to the speedometer will vary. Change in transmissions or differentials will do the same thing. If you have changed the gearing in your differential to increase low speed performance, or high-end speed, it is going to require a variation in revolutions of the output shaft of the transmission. At this point it can get very complicated. There are formulas which can be used to determine what changes have to be made to the driving gear and the driven gear within the transmission to provide accuracy. We are not going to discuss that. If you've change tire size or differential gearing, run that measured mile at a variety of speeds and make a variation chart for yourself.

How to Repair a Non-Functioning Speedometer

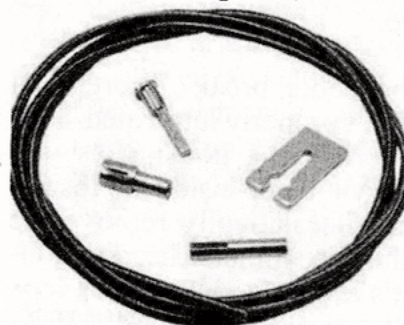
The odds are definitely in your favor, if the speedometer stops working completely, that the cable is broken. It's a common problem. Start

by detaching the knurled nut at the back of the speedometer head (behind the instrument panel). Have a friend hold or watch the cable end as you drive. Have him gently pull on it to assure that if it is broken, the pieces will be separated. If the cable does not rotate within the casing, it's broken. (If it does rotate, either the cable was not securely inserted into the back of the speedo unit, or the unit itself is damaged. The end of the cable is square. It must fit into the square receptacle at the back of the speedometer meter. If you have changed the cable, the new one may be just a little too short. If it is properly engaged and still does not operate, call on an expert. See below.)

To replace the cable is a simple job, but dirty. Spread rags over the floor under the speedometer, and over the seats near it. As you remove the cable, it will flop around like a boated fish, and that cable is going to be covered with a thick, dirty black graphite grease. You don't want that on your upholstery. Grasp the end of the cable with your hand or with a pair of pliers and pull it out. A portion of the cable will come out; the rest has to be removed from the transmission end.

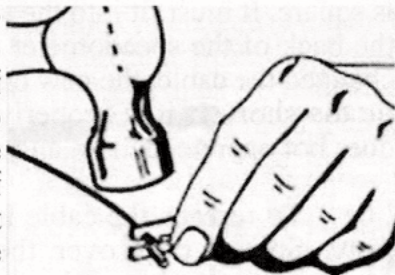
In or near the tailstock of the transmission you will find the speedometer cable housing. It is attached by a knurled nut. Unscrew that nut, and the casing will come free. It may take a little wiggling of the casing, if the grease has hardened and is acting like a glue. Remove the remainder of the cable as you did with the first part. You will need both parts so that you can measure the old cable and fabricate a new one exactly the same length. Too short and it will not engage with the unit in the instrument panel; too long and it will kink.

Measure the two pieces, and buy a universal cable kit at a local auto parts store. Make sure that the replacement cable is at least as long as the old one.

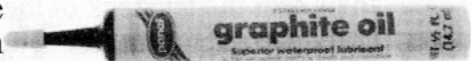


A Universal speedometer replacement kit will contain a length of cable, a variety of ends and a split die crimping tool.

The universal kit will generally contain a length of cable, one end square. DO NOT cut the square end. In the kit there will probably be two or more end fittings. Select the end fitting which matches the old cable. Cut the new cable so that the new cable length, including the fitting, matches the old one exactly. There is generally a fraction of an inch of leeway permitted. Also in the kit should be a split die. It is used to crimp the end fitting onto the new cable. Insert the cut end of the new cable into the fitting, slip the die over the end of the fitting and rest the fitting and the cable and the die on an anvil or other solid support. Strike the die once with a hammer. One solid blow should do it. You only want to crimp the fitting on, not distort it. After you've done it once, it's a simple job, but you don't get a second chance once you've ruined the cable or the fitting, so work carefully.



Lubricate the cable. You can buy speedometer lubricant at the auto parts store. We've made our own (dirty work) from an old formula using Vaseline® and powdered graphite. Insert the cable back into the casing from the transmission end. The cable will only go in one way. Insert the fitting into the adapter at the tranny. Attach the knurled nut. Fit the square end into the back of the speedometer, and attach the knurled nut. Test the car. The speedometer should read accurately as it did before the cable broke.



Why did the cable break? More than likely because it wasn't properly lubricated. That cable is spinning within the housing as you drive. When it gets dry it binds inside the casing, catches and breaks. Occasionally remove the knurled nut from the speedometer head and lubricate the cable. It's a simple job.

There is another possible reason for the speedometer failing, and that's a stripped driven

gear at the transmission. It's not a common problem, but if the cable binds and the driven gear cannot rotate, the nylon teeth can strip. To check the driven gear, remove the knurled nut at the tranny, and remove the retainer clip. The shaft of the driven gear will be visible and easily removed. Check the teeth to be sure that they are not stripped or damaged. If they are, in most cases it's an easily replaceable part. Count the number of teeth, then recount for accuracy. Driven gears look the same. The number of teeth must be the same to engage properly with the driving gear.



If the Speedometer Head is Not Working or If the Speedometer Requires Calibration

Repairing a speedometer head is not a job to be attempted by the novice. It's like taking a clock apart. There are springs, pivots, and magnets to be dealt with. Remove the knurled nut from the back of the speedo, disconnect any wires (for lights) and remove the entire speedometer head. Pack it well – well cushioned and well protected, and send it to Williamson's Instruments. Why Williamson's? They know their stuff. They have the experience, knowledge, expertise and equipment to repair your speedometer.

And if the speedometer head merely requires a calibration? They can do that too. But they don't just do the calibration. The speedometer will come back to you in (mechanically) like new condition. And their work is guaranteed, and the guarantee is transferable, if you sell the vehicle. Why are we touting Williamson's Instruments? They've worked on our gauges and did a great job. And when a further problem occurred, they made the repair quickly and at no charge.

We've discussed speedometer calibration with the company's owner, Ron Beliles. He told us that under normal circumstances – that is, if the tires are the original size, the transmission or differential hasn't been changed or altered – the

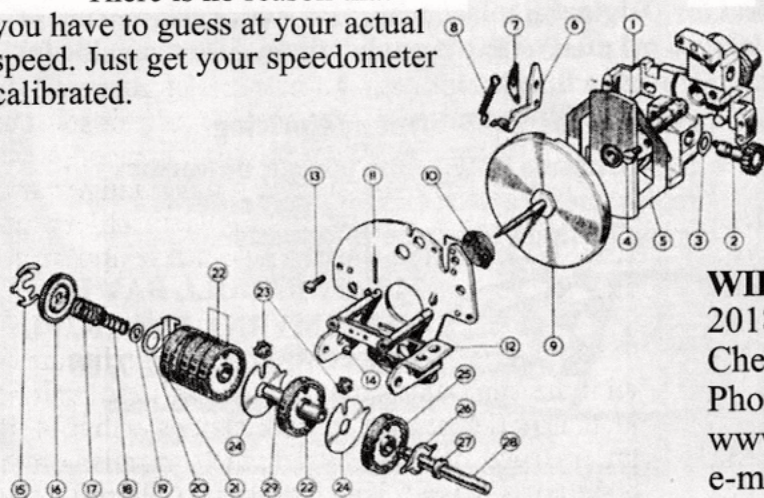
ratio of cable to speedometer gearing is 1:1. That is, one revolution of the cable means one revolution of the speedometer mechanism. He doesn't require percentage of variation, and you don't have to go through the rigmarole of measuring and logging speed to figure how much your speedometer is off - that is, if the tires, differential, etc. are factory spec.

Most speedometer assemblies are made of pot metal. The metal swells and shrinks, and these changes will affect speedometer operations and readings. They disassemble the entire unit. Everything is taken apart and cleaned. The pot metal is reamed to restore free movement. The reaming also removes the hardened grease from the cable, which, as mentioned earlier, can act like a glue, restricting free movement. Then they recharge the magnet on the cable end; they replace the center bushing (for the pointer or needle) and they'll even touch up the pointer at no additional charge.

Then the entire unit is calibrated using specialized machines at ten mile an hour increments, from 10 mph up. Once they are satisfied with the operation, it is returned to you, along with their lifetime guarantee.

And if you have changed the tire size or altered the rear-end gearing? Talk to Ron. He'll make suggestions on how to have the speedometer calibrated taking those factors into consideration.

There is no reason that you have to guess at your actual speed. Just get your speedometer calibrated.

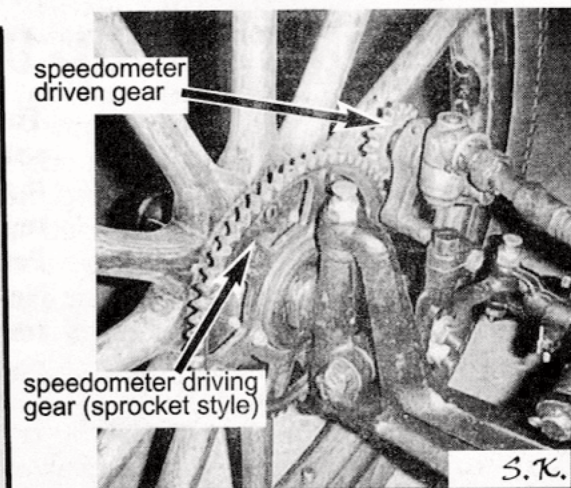


NOW THE EXCEPTIONS

Most vehicles, being rear-wheel drive, utilize a system similar to that described on the previous pages: a driving gear in the transmission operating a gear-and-cable system that operates the speedometer dial on the instrument panel.

Many newer cars, and a few older exceptions, are front-wheel drive and their transmission differs from what we are used to. The speedometer is driven from the front, generally from the transmission with a system similar to the rear-wheel drive cars. A few cars though, and the Volkswagen Beetle is a prime 'modern' example, use a speedometer drive from the front wheels. Another vehicle, and one that we may be more familiar with, is also a front-wheel driven speedometer assembly.

The Ford Model T (on those 'T's that had a speedometer), used a sprocket gear on the front wheel to drive a take-off assembly. A cable transferred the rotations to the speedo's head on the dash.



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