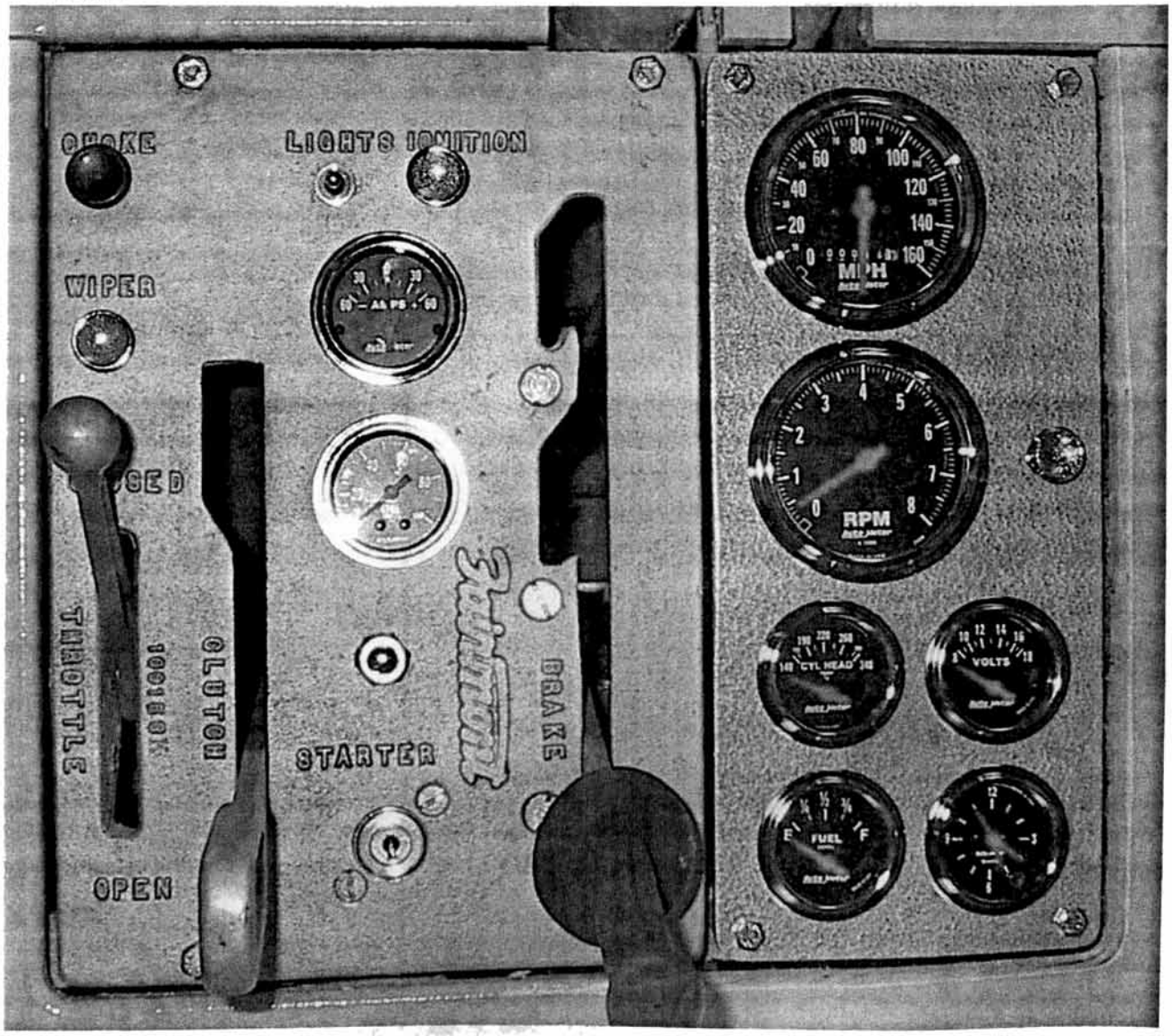
# Instrumentation for Onan CCKB Engine Installed in Fairmont MT-14L

By Dave Sigafoose

INTRODUCTION:

During the first six months I owned my Fairmont speeder, I was constantly concerned about the operation of the Onan engine and my lack of visibility into the engine, having only an ammeter and an oil pressure gauge. What I really wanted was just the basic gauges that one gets in any automobile—speedometer, tachometer, gas gauge, engine temperature gauge. Thus began my quest to add these gauges to my speeder. I went to the local auto parts store here in New Jersey, *Karparts,* and discovered a company called *Auto Meter*. This company manufacturers gauges for automobiles and would be a logical choice

*View of Fairmont Control Panel and Instrumentation Panel*



for gauges to install in my speeder. All were "off the shelf" except for the tachometer, which I had to order directly from *Auto Meter,* and the sender for the speedometer, which I invented (more about that later).

I decided to replace the existing ammeter and oil pressure meter and add a speedometer, tachometer, cylinder head temperature gauge, gas gauge, volt meter, and a clock. The only other gauge that I considered was a gas line pressure gauge, but this required cutting into the gas line to install a sender, and I decided against it, and I believe that vacuum gauges, oil temperature, transmission temperature, are of little value.

I used *Auto Meter* components. Their Web address is www.aautomete.com. You can access their web site to order a catalog or call them directly in Sycamore, Illinois, tel. (815) 895-8141. They sell about 20 different styles of gauges. I chose one called "Traditional Chrome" which closely matches the original Fairmont gauges. Following is a table of the *Auto Meter* parts that I used, along with their prices:

| Item # | Description | Price |
|---|---|---|
| 2489 | Speedometer 160 mph | $216 |
| 2499 | Tachometer 8000 rpm | 121 |
| 2421 | Oil Pressure 0-100 psi | 41 |
| 2516 | Fuel Level 240 ohm-33 ohm | 37 |
| 2536 | Cylinder Head Temp 140-340 degrees | 39 |
| 2586 | Ammeter 60-0-60 Amp | 36 |
| 2592 | Voltmeter 8-18 Volts | 36 |
| 2585 | Quartz Movement Clock | 62 |
| 3262 | Fuel Level Sender | 27 |

Some people might not be interested in installing all of the gauges that I did and would not be interested in making a console plate. This would be no problem at all. The *Auto Meter* catalog is over 90 pages long. The gauges that I purchased were meant to be mounted in a console. They have many other optional ways to mount the gauges. They have mounting plates that have space for three 2 1/6" gauges, flat plates, and others to numerous to mention. Also, there are many other tachometers and speedometers that are bolt–on and include a mounting cup, or the mounting cup can be ordered separately for any gauge. If you decide to go with this mounting option, just skip the next section which describes how I made the console plate.

The following describes in detail the installation and connection of the gauges in the speeder:

PREPARATION:

The first thing that had to be done was to find a place for the gauges. This was obtained by removing the internal tool box from the speeder and relocating it to the exterior front of the speeder. Next was to cut a hole in the 1/2" plywood tunnel cover. I cut a hole 6 1/2" by 14 1/4". I then used a 1/4" round over router bit to finish the edges. With a little bit of yellow paint, it appeared as if the new hole was original.

**Suppliers**

*Adel*

*Auto Meter*
*Sycamore, IL*
*(815) 895-8141*
*www.aautomete.com*

*Bearing Depot*
*Middlesex, NJ*
*(732) 563-2225*

*Greenlee*

*Herbach & Rademan*
*Moorestown, NJ*
*(856) 802-0422*

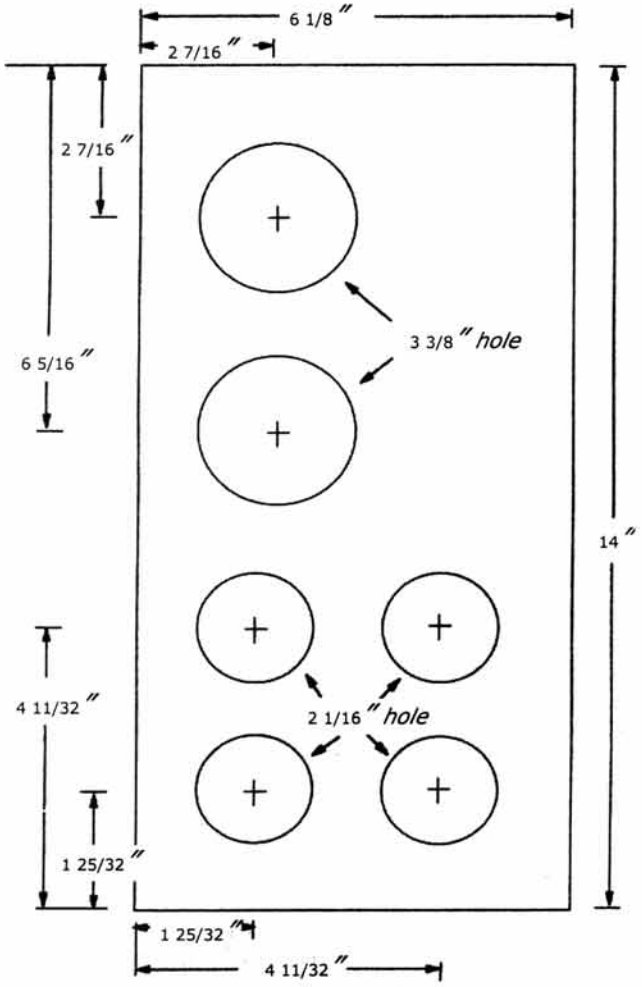
*Home Depot*

*Karparts*

*Omron Corporation*

*Radio Shack*

*Rustoleum*




all measurements in inches

do not scale

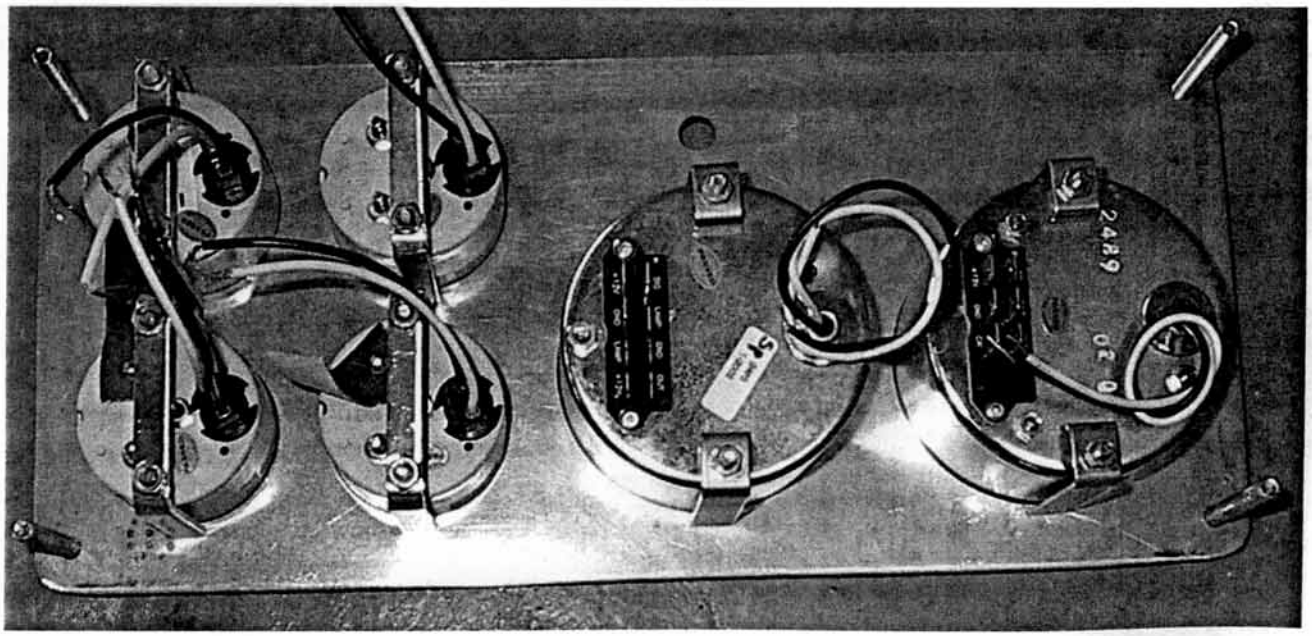
*Figure 1*
*Machine Drawing of Plate*

I then purchased a piece of 3/16″ aluminum and cut it to size, 6 1/8″ by 14″ inches. I rounded the corners with my belt sander and drilled four 1/4″ holes at the top and bottom edges for the bolts that support the plate. The hole size required was 2 1/16″ for the four smaller gauges and 3 5/8″ for the larger gauges. A friend of mine with the proper machine tools cut these six holes. (Cutting of these holes was the only thing I did not do myself for the whole installation. The gauges require precise hole sizes in order to be mounted correctly.) (Fig. 1)

After having the holes cut, I sanded the surface with very fine steel wool to remove the natural oxidation that exists on aluminum. I then sprayed the plate with a coat of *Rustoleum* automotive primer. *Rustoleum* has a nice paint, called "Hammered Gray" (available at *Home Depot* ), which produces a nice uniform finish, which is rather hard to describe but looks significantly better that just flat paint. Only one coat is required, and be sure to apply it as soon as the primer is dry to the touch (about 5-10 minutes), or the primer may lift.

To mount of the plate, I laid it next to the existing control panel and marked the location for the four

*View of gauges from the rear of the panel before any wires are connected*



holes, and drilled them in the same cross members that support the original control panel. I was not able to find spacers the correct length, so I bought 1/2" aluminum rod and cut four pieces 1 9/16" long. After drilling a 1/4" hole in the middle, I had the four spacers for the plate. I would recommend using a drill press to make sure the holes are in the middle of the rod sections.

Also, the top speedometer gauge is too deep and hits the speeder cross member that supports the front of the panels. I used a small rat tail file and removed about 1/8" of metal from the edge of the support in order for the speedometer to drop into place.

The mounting holes are 3/8" from the front/ back edges and 1/2" from the side edges. I also drilled an additional 1/2" hole 1 1/8" to the right of the tachometer for a switch to provide power to all of the gauges for back lighting. It is really impressive is to run at night with all of the gauges lit.

Once the plate was prepared, the gauges were mounted on the plate. The gauges are secured to the plate by a bracket that fits over the back of each of the six gauges and is secured with either a 8/32" or 10/32" nut, depending on the gauge. All of the mounting hardware is included with the gauges, but I didn't like using knurled nuts so substituted the machine nuts.

Notice all of the black and white wires. These are the wires that connect to the light bulbs that provide back light to each of the gauges. There are eight pairs of light wires that need to be connected together, including the ammeter and oil pressure meter wires. Also visible are the brackets and nuts that secure the gauges to the plate.

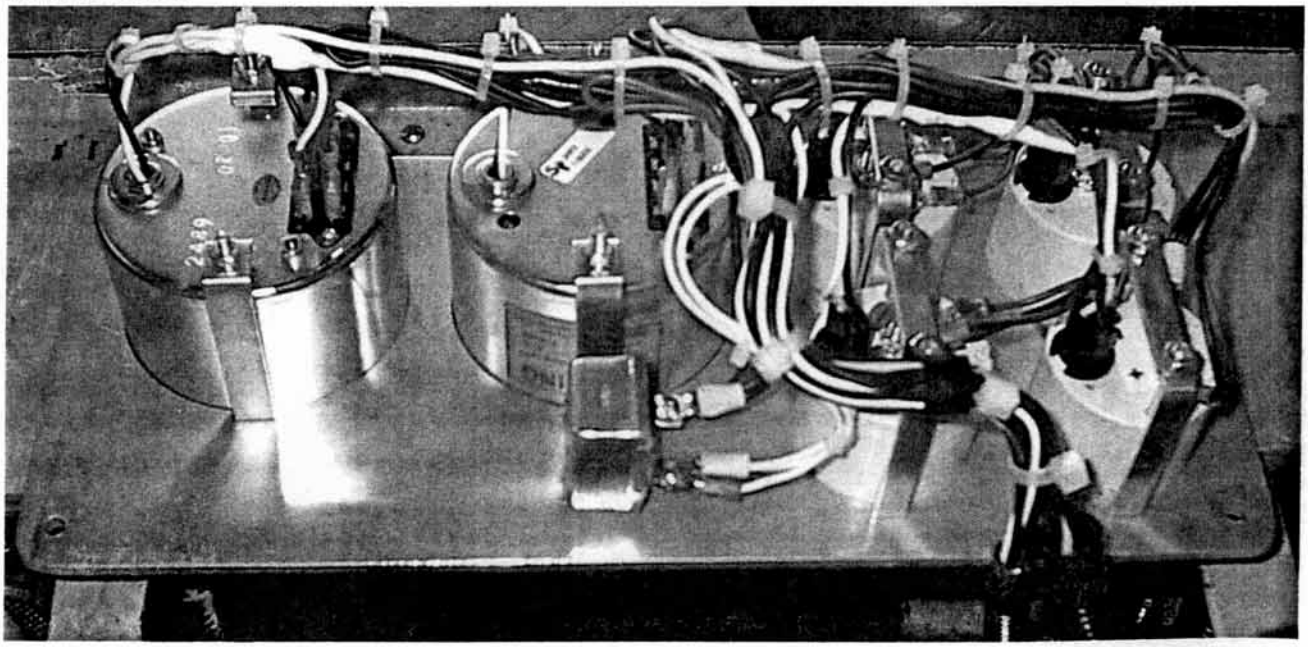
WIRING NOTES:

A number of general things need to be noted:

- Before any wiring is done, it is imperative that the +12 wire be disconnected from the battery.
- All of the connection wire used was #18 stranded—black for ground and white for +12 volts.
- All wiring that left the gauges was encased in black cable protectors, available at any auto store. Three sizes were used—1/4", 3/8", and 1/2", depending on the number of wires that were running together.
- Wires were secured with tie wraps on the back of gauge plate.
- There were too many ground, +12 volt, and +12 volts for back light connections to daisy chain them together. I chose to run three long wires the length of the panel, remove insulation, and solder short wires to each gauge for the above three connections. After soldering, each connection was taped with electrical tape. (The picture makes it somewhat clearer.)
- Back lights for the oil pressure and ammeter were connected to the back of the panel. The gas tank sender needed a good ground, and the speedometer sender required +12 volts and ground.
- I had previously replaced my Fairmont starter button with a universal keyed ignition switch with "accessory," "off," "ignition," and "start" positions. I connected the gauge power to the ignition position, such that none of the gauges (except the clock) will operate or light up unless the ignition is on. The clock has a separate power connection to the input of the ignition switch which provides power to the clock at all times.
- The red tags in the picture are placed by *Auto Meter* on the terminal to which the individual sender connects. If +12 volts is connected by mistake to any of those terminals, the gauge will be destroyed, so I was very careful when connecting wires to the back of the gauges.
- Some of the wires connections to the gauges were directly below the mounting bracket that secured the gauge to the panel. In order to properly tighten the electrical connection, I found it necessary to remove the mounting bracket temporarily.
- All wires were terminated in crimp–on connectors for connection to the various gauges. The tachometer and speedometer uses spade connectors and all of the other gauges just use regular crimp connectors.
- The cable harness was secured to the back of the volt meter with a black plastic cable strap. Extra wire was provided in order to be able to remove the panel and place it upside down on a small piece of plywood, gaining access the back of the panel for maintenance. Care should be taken not to make the wires too long, as the panel lies directly above the drive chain.
- There are 16 wires that leave the panel and connect to various points on the speeder. Following is a table of these wires and their purpose:

| Wire description | Connection |
|---|---|
| Speedometer sender | To sender output |
| Sender +12 | To sender +12 volt power |
| Sender ground | To sender ground |
| Calibrate + | To calibration button |
| Calibrate – | To calibration button |
| Frame ground | Connects to frame of speeder |
| +12 volts | Connects to Ignition output on ignition switch |
| +12 volts clock | Connects to Ignition switch input,always on |
| Tachometer sender | To ignition coil |
| Cylinder head temperature | To temperature sender |
| Fuel level | To Fuel sender |
| Fuel level ground | To Fuel tank ground screw |
| Light power | Connects to ammeter light |
| Light power | Connects to oil pressure gauge light |
| Light ground | Connects to ammeter light |
| Light ground | Connects to oil pressure gauge light |

*Rear view of panel with gauges wired.*



INDIVIDUAL GAUGE INSTALLATION:

Installation of each of the eight gauges required something a little different and unique. The following sections describe the installation of each gauge in detail and any problems that I encountered.

Replacement Ammeter

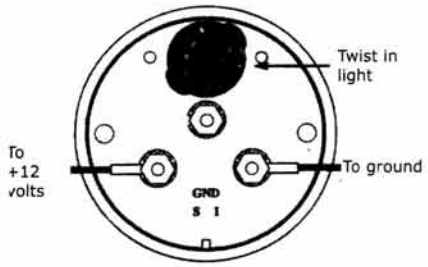
The ammeter is not difficult to replace. As was mentioned before, remove the power wire from the battery. The original Fairmont meter is secured in a similar manner to the *Auto Meter* meters, so just remove the two power wires, nuts, retaining bracket and lift out the old meter. Extend the black and white light power wires on top of the meter by adding an additional three feet of wire to both wires. I used crimp connectors, but one could also solder and tape. Place the ammeter back in the Fairmont console and attach the two power wires in reverse order. The + and – are reversed between Fairmont and the *Auto Meter* gauge, so that if you don't reverse the wires, the ammeter will read charging when it is discharging, and visa versa. Route the two light power wires over to the new panel. Install the two nuts and bracket and tighten and the new ammeter is installed.

Replacement Oil Pressure Gauge

The original Fairmont meter is secured in a similar manner to the *Auto Meter* meters, so just remove the two nuts and retaining bracket and lift out the old meter with the hose still attached. Remove the oil hose from the old meter using a couple of small open end wrenches. The next part becomes slightly difficult. You must remove the small brass adapter from the back of the original meter and install it on the new *Auto Meter* oil pressure gauge. This adapter converts from 1/8" npt to a flare connection for the oil hose. It will be on very tight, and you must be careful when trying to remove it so as not to damage either the adapter or the old meter. Extend the black and white light power wires on top of the meter by adding an additional three feet of wire to both wires. Route the two light power wires over to the new panel. Install the two nuts and bracket and tighten, and the new oil pressure gauge is installed.

*Auto Meter* makes an electronic oil pressure gauge that requires installation of a sender at the engine. As it is not easy to access that part of the CCKB engine, I chose to just replace like for like. If you want, put in an *Auto Meter* #2522 oil pressure gauge with an electronic sender.

*Figure 2*
*Quartz Clock wiring*




Quartz Movement Clock

There is nothing special about connecting the clock, except that you must insure that power is provided to the clock at all times, and note that the +12 and GND connections for the clock are different than any of the other gauges. Just connect the power wire and ground wire to the back of the clock per Figure 2.

Voltmeter

There is also nothing special about connecting the voltmeter. Just connect the power wire and ground wire to the back of the voltmeter per Figure 3.

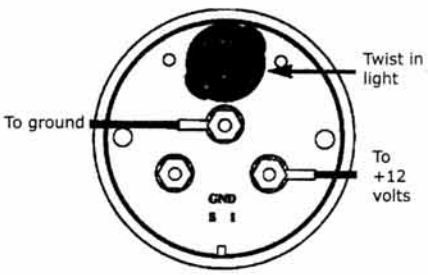



*Figure 3*
*Voltmeter wiring*

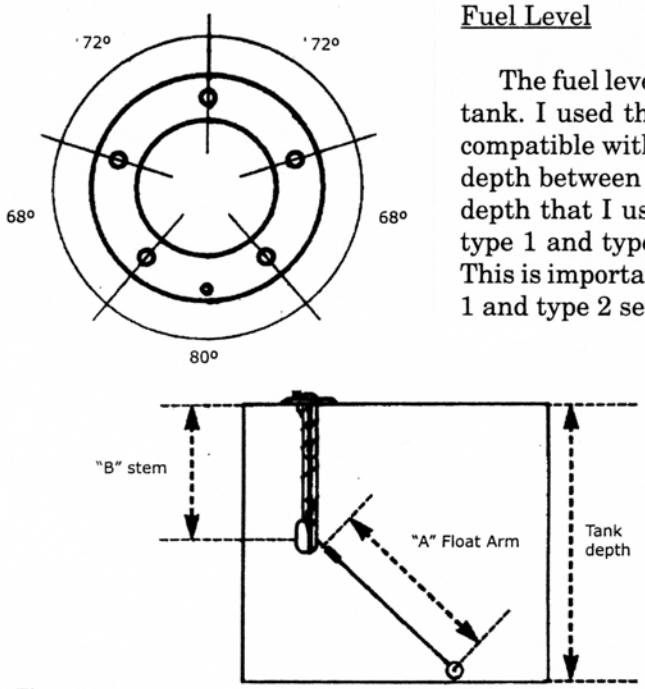



*Figure4*
*Fuel Tank Sender*
*Top and side views of tank*

Fuel Level

The fuel level gauge requires the installation of a sender in the fuel tank. I used the universal sender that is sold by *Auto Meter* and is compatible with their gauge. The sender will work in any tank with a depth between 5″ and 24″. As I have the original Fairmont tank, the depth that I used was 8″. *Auto Meter* makes two kinds of senders—type 1 and type 2. The #3262 sender that I purchased was a type 1. This is important as there are two different adjustment tables for type 1 and type 2 senders and the proper table must be used.

The adjustment process involves adjusting the stem length "B" and cutting the float arm to length "A." The stem is in three sections. For my tank, the middle section was removed and discarded. The wire was too long, so I just wrapped it around the stem a few more times. I would not recommend that the wire be cut and shortened. So, for my tank with a depth of 8″, A=3 3/4″ and B=4 1/16″. These values are provided from a table that is included with the gauge. Once the stem length is adjusted and the float arm cut and attached with a set screw, the float is ready to be installed. (Fig. 4)

The next problem is cutting a hole in the top of the gas tank through which the sender is to be installed. First the gas tank must be removed. Drain the gas from the tank, and remove the four long bolts that hold the two straps that support the gas tank. Also remove the band at the top of the tank from where gas is poured into the tank. After detaching the fuel line, the tank can be removed. (It is also a good time to remove the sediment bowl and clean the bowl and the screen. Mine was full of "junk.")

I washed out the gas tank with water. I also removed three small stones and three pieces of straw from the gas tank. My gas tank now has a lock on it to prevent anyone from throwing "junk" in my tank in the future.

Anyway, the problem is how to cut a 1 1/2″ hole in the top of the tank. The hole should be located 7″ from the front of the gas tank so that it does not interfere with the two wooden cross support brackets. I was also very concerned about a possible explosion when I cut into the top of the gas tank. The easiest way to prevent gas fumes in the tank is to fill it with water. With the tank full of water, I drilled a 1/4″ hole in the top. I also have an *Adel* nibbling tool (which I know is still available) which I used to nibble out enough sheet metal to make the proper sized hole.

I tried to locate a *Greenlee* punch for 1 1/2″ inches, but I couldn't find one. The problem appeared to be with inside versus outside diameters. The *Greenlee* 1 1/2″ punch was too big; the 1 1/4″ punch was too small.

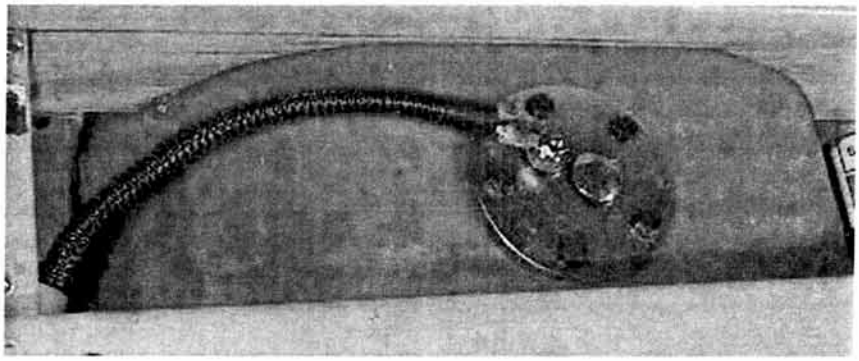
There are five small holes that must be drilled to secure the sender to the top of the tank. The holes are spaced in a unique manor so that it is impossible to install the sender incorrectly. Just lay the gasket on top of the tank hole and use it as a template to mark where the holes should be drilled.

I then emptied water from the tank and washed the tank out with brake cleaner and a final wash of engine starting fluid to get all of the water out. These sprays are quite potent and should only be used in a well ventilated area.

Mount the sender in the gas tank, reinstall the gas tank, connect the gas line and everything is back to normal. The sender must have a

very good ground to work, so I ran two wires from the panel to the sender—one for the sender output, and one for grounding one of the five screws that hold the sender in place.

The following picture shows the sender installed in the gas tank and connected to the wiring harness.



The two wires are run to the panel, with the ground wire being grounded, and the sender wire connected to the proper terminal on the back of the fuel gauge per Figure 5. That is all there is to installing the fuel gauge.

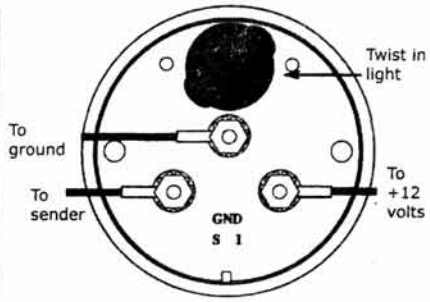
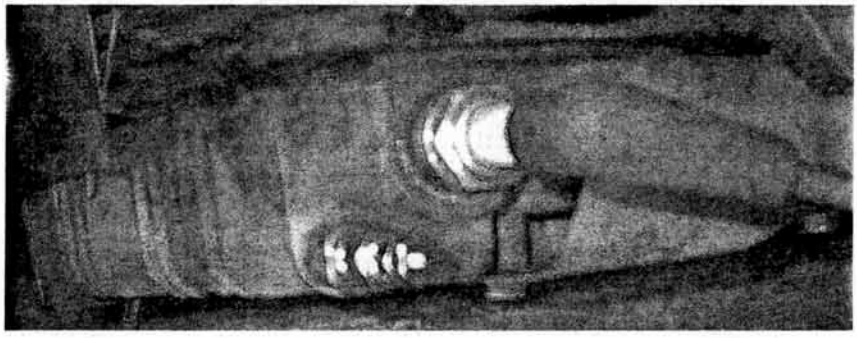



*Figure 5*
*Fuel tank sender wiring*

Cylinder Head Temperature

The unique problem that had to be solved with this gauge was the installation of a temperature sensor in the cylinder head. The sensor has a 1/4″ npt thread, and I had no desire to weld anything to the engine. *Auto Meter* sells a #2261 weld–in adapter if you desire to take that route.

I just bought a 1/4″ brass cap at the local hardware store and drilled a 1/8″ hole in the end. I then drilled the same size hole in the top fin of the right cylinder and attached the cap with a small machine screw. Then it was just a matter of screwing the sender into the cap and the sender was attached to the cylinder. Look at the following, somewhat out of focus, picture and also the picture in the speedometer section.



A wire is run to the panel and connected to the proper terminal on the back of the fuel gauge per Figure 6.

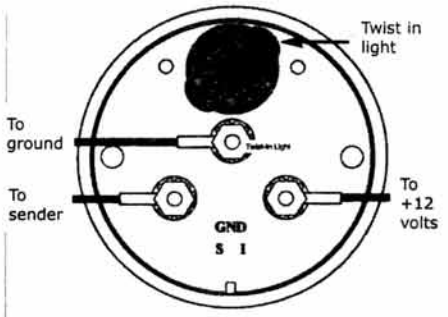



*Figure 6*
*Cylinder Head Temperature Gauge Wiring*

Tachometer

The tachometer presented only one major problem. The stock tachometers that *Auto Meter* sells come equipped with "dip" switches on the back which can be set for four–, six–, or eight–cylinder engines. The problem was that the Onan engine is has two cylinders, and the points only generate one pulse per revolution as opposed to two pulses per revolution for a 4–cylinder engine.

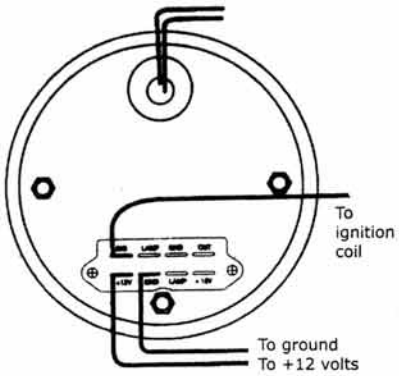



*Figure 7*
*Tachometer Wiring*

I called *Auto Meter* and asked for their service department. I was advised that what I required was a "custom calibration" which was available for an additional charge of $25. (The $121 price that I listed previously included the $25 charge.) It took about two weeks from the time of ordering until I received the tachometer.

All that has to be done is to connect the gauge to the engine. The "SIG" terminal on the back of the tachometer is connected to the "–" negative side of the ignition coil. I ran a wire from the panel along the left side of the speeder and followed the power wire that connects to one of the two low voltage connections to the ignition coil. A couple of tie wraps hold the two wires together. You want to connect the tachometer to the ignition coil terminal that connects to the points. Follow the short wire from the points to the ignition coil to locate where the wire should be attached. (Fig. 7)

Speedometer

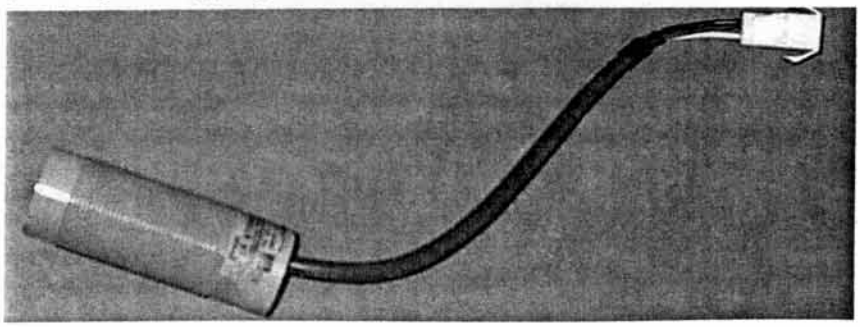
The most interesting and most difficult installation was the speedometer. The unit itself was purchased retail directly from *KarParts,* and is a standard *Auto Meter* speedometer. The speedometer required a sender that provided a square wave signal to the speedometer with the number of pulses per second proportional to the speed of the speeder. The standard sender that *Auto Meter* sells is meant to plug into the side of the transmission where one normally installs the speedometer cable, called the "transmission take-off" which we don't have on a Fairmont transmission.

I called *Auto Meter* service and was told that any kind of speed sender or electronic module that provides between 500 and 400,000 pulses per mile, has an output voltage of 4 to 16 volts peak, and generates pulses proportional to the vehicle speed would work just fine.

Rather than describe all of the things that I tried that didn't work, let me just describe the sender that I built which works very well.

I chose to purchase a "proximity sensor" made by *Omron Corporation.* These are used in many industrial applications. Basically, anything that is placed near the end of the sensor causes the output signal wire to change from +12 volts to 0 volts and lights an LED on the back of the sensor. It will detect most anything—glass, wood, plastic—but the greatest detecting distance is provided by grounded mild steel, per information provided by *Omron.* The sensor also has "hysteresis"—the sensor won't turn on until an object is within 1/4″ of the tip and won't turn off until the object is more that 1/2″ from the tip. Also, the maximum switching rate is 70hz., so I should not expect more than 70 pulses per second from the sensor. The sensor has a NPN–NO open collector with pull–up, with a maximum load of 200ma.

I purchased the sensor from *Herbach & Rademan Co.,* Moorestown, New Jersey, tel. (856) 802-0422. Their part was #TM95SNR275 for $39.50 plus shipping/tax. It comes with only one 1 1/4″ plastic nut,

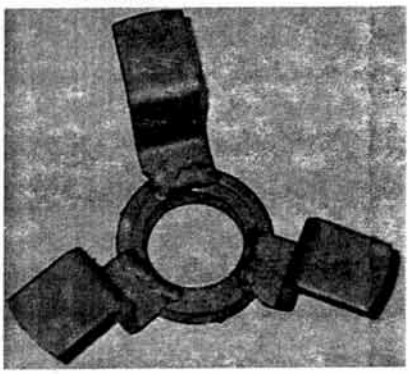


*Proximity Sensor*

and I needed two to mount the sensor and was unable to locate any locally. The *Omron* part is #E2K–X15ME1—capacitive proximity switch. *Omron* also has a web page where you can view/download specifications on all of their sensors. The picture shows the sensor as I received it. I subsequently cut off the connector and replaced it with a *Molex* connector that I bought at *Radio Shack*. This will allow me to easily change the sensor.

The next problem that I needed to solve was to create something that passed near the sensor as the axle rotated. What I did was to purchase a "double split ring" from my local *Bearing Depot,* Middlesex, New Jersey, tel. (732) 563-2225. They carry them as a stock item, and the cost was only $2.85.

*Proximity Sensor Sender*



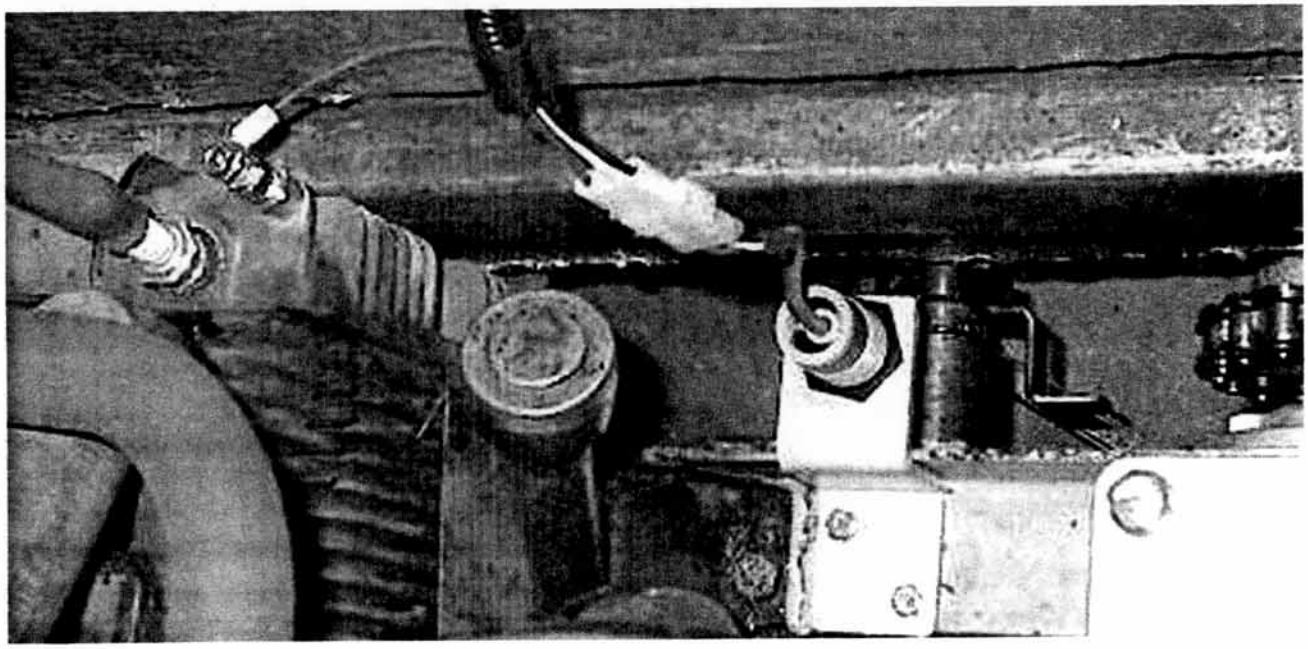
The front axle of the speeder is split, and I needed to attach to the right part that connects to the right wheel. The sensor needed to be as far away from any adjacent metal as possible in order to prevent false pulses. In order to make this possible, I had to make three pieces of steel with an offset. I then welded on three pieces at 120–degree angles, in order to provide three pulses per revolution. If you do the math with 16″ wheels, this works out to about 60 pulses per second at 60 miles/hour, so it is well within the range of the specifications of the sender. The brackets were made out of 1″ wide, 1/8″ thick mild steel, and the bracket length is 1/2″, 1 1/2″, and 3/4″ for the three sections, starting at the ring.

I also rounded the outside edge so I could achieve a clearance of 1/8″ between the sender and rotating bracket. After I welded on the three pieces, I bent them in order to guarantee that they were all in the same plane and were all the same distance from the sensor as they pass near.

I also like the split ring, as I did not have to weld anything onto the axle or remove any part of the axle, and it was very easy to position the ring on the axle in order to line up with the sensor.

There is one final bracket to make, which I made out of 1/8″ aluminum, bent at an angle, painted yellow, and attached to the body of the speeder with two 1/4″ hex nuts. The following picture shows the sensor, sensor bracket, split ring and wiring all installed. It is mounted on the right side, directly above the front axle. (Also visible is the sender for the cylinder head temperature.)

*View of Temperature and Speedometer Sender*



All that remained was to wire the sensor. There are three wires that connect to the sensor as listed in the following table.

| Wire description | Connection |
|---|---|
| White | Sensor output |
| Red | Sensor +12 volt power |
| Black | Sensor ground |

All that remains is to make all of the electrical connections to the back of the speedometer and calibrate the speedometer. Fig. 8 is a diagram of the back of the speedometer.

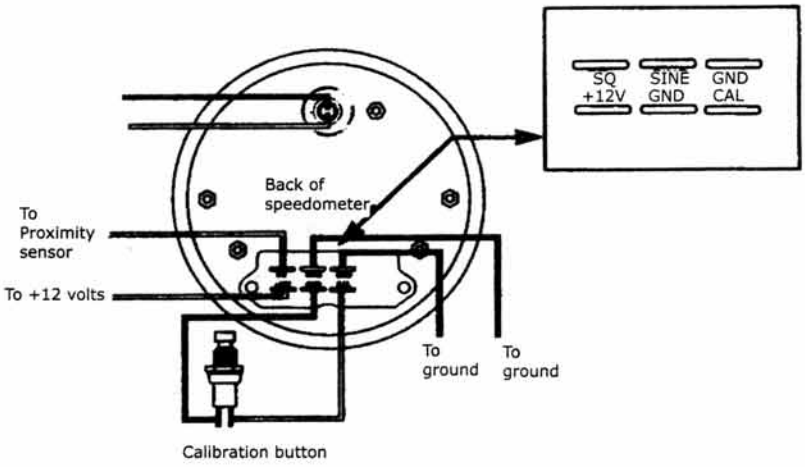



*Fig. 8 – Speedometer Wiring*

Just connect the proximity sensor wire, and the proper +12 volt and ground connections. The sine wave input must be grounded since it is not being used. As a test, if you elevate the speeder and manually rotate the right front wheel, the red LED on the sensor should flash on and off as the axle turns. The calibration button is included with the speedometer. I drilled a small hole and mounted the button on the support member that carries the rear of both console panels. The button is rarely used and should not be easily accessible.

Calibration needs to be done on an actual speeder run and is described as follows. Pull up to a mile marker, stop, and turn off your engine. (Be sure to advise anyone behind you of your strange actions.) Press and hold the calibrate button as you turn on power to the speedometer. The gauge will now read 160 mph. Start the speeder and depress and release the calibrate button. The gauge will now read 80 mph. The speedometer is now counting pulses. Go exactly two miles to the second mile marker and stop. Press and release the calibrate button. The calibration mode will be exited, and the pointer will return to zero. *Auto Meter* recommends that you recalibrate if you install new wheels. After calibration, installation is compete.

## CONCLUSION – THINGS THAT I HAVE LEARNED

First I learned that I was running the engine choked much too long when the engine was cold. It only takes about five minutes for the cylinder temperature gauge to reach 190 degrees.

I also learned that the temperature on the fin that the sensor measures is very accurate but is about 40 degrees cooler than the spark plug, although it is only about 1 1/2″ away. I have to add 40 degrees if I want to have a more accurate reading, and I am sure that the interior is somewhat hotter, as the exhaust pipe measures at close to 600 degrees. On cool days (60 degrees F.) the gauge temperature remains at 190 degrees, but will read 220 degrees on warm days (80 degrees F.). Also, the engine temperature will rise about 45 degrees when the engine is turned off—but all of the above are only approximates.

Second, I have a much better feeling knowing at any moment how much gas is in the tank. I am getting about 30 miles per gallon, so the five–gallon tank is more than sufficient for my needs.

Third, my idle engine speed was set to 1,500 rpm, which is too high, and I plan to lower it. Also, the time to shift from first to second gear is between 3,000 and 4,000 rpm, and I find it much easier to downshift now as one must shift the transmission into neutral and "rev" the engine above 3,000 rpm before trying to put the transmission in low gear. The fastest way to stop the speed when in high gear is to rev the engine, shift into low gear and then back off the throttle. The speeder will slow down very quickly, saving on brake shoe and wheel wear.

And finally, even without GPS, I am able to know how fast I am going and how far I have gone, which is rather pleasant. The maximum speed that I have experienced was 40 mph, but this was on relatively new, welded straight track; I had also just put four new wheels on the speeder. I have only experienced one minor problem with the speedometer proximity sensor: I had it out in the rain, muck, and mud, and oil with no problem. Everything worked perfectly. The next day I lubricated my drive chain with chain lube with "moly" (molybdenum disulphide). The moly was thrown off the chain and onto the sensor. There was enough of it to fool the sensor, the LED remained red and the speedometer stopped working. Just wiping the sensor with a paper towel solved the problem. Until I put on some kind of shield for the drive chain, I occasionally wipe the sensor to remove any moly.

Any suggestions, comments, corrections, questions, please feel free to contact me at davesigafoos@yahoo.com.