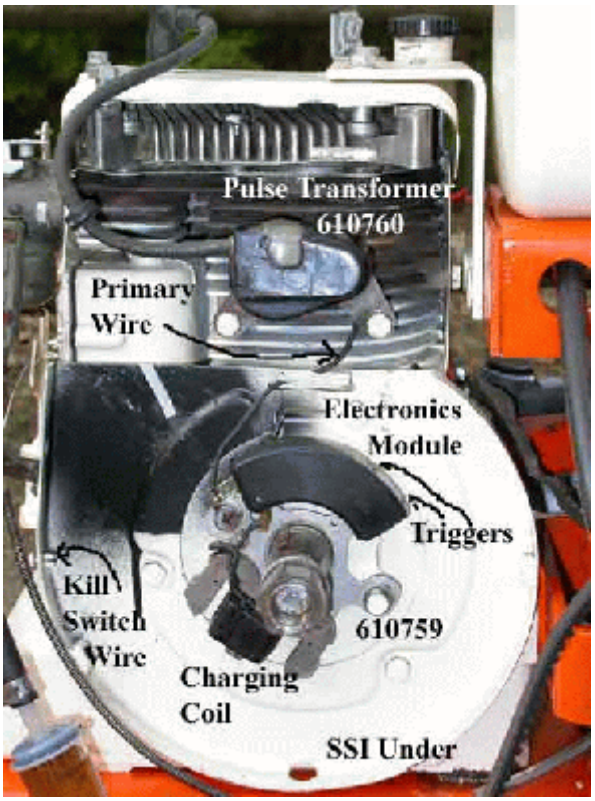
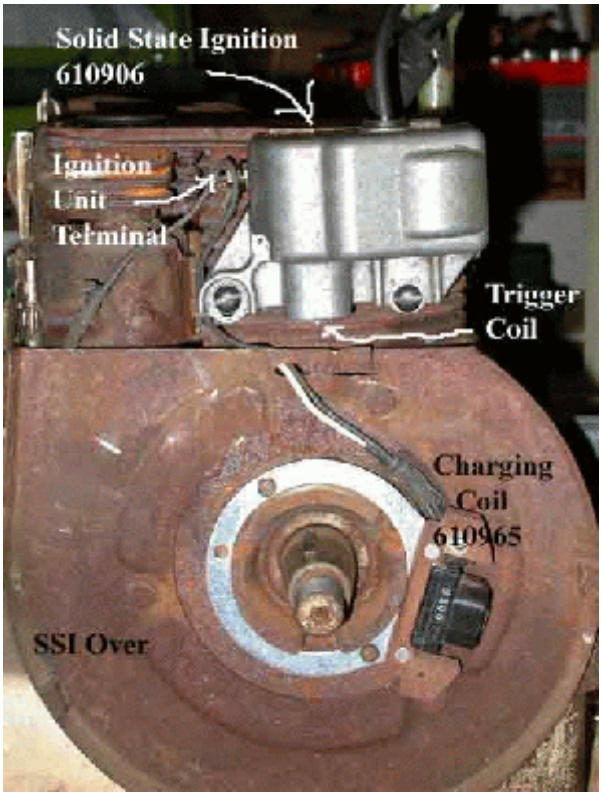
Solid State Ignition Replacement

May 15, 2005

Introduction:
There are two Tecumseh Solid State Ignitions (SSI) configurations we are concerned with here:





The one on the left I call “SSI Under” for short because it is under the flywheel.
The parts are:

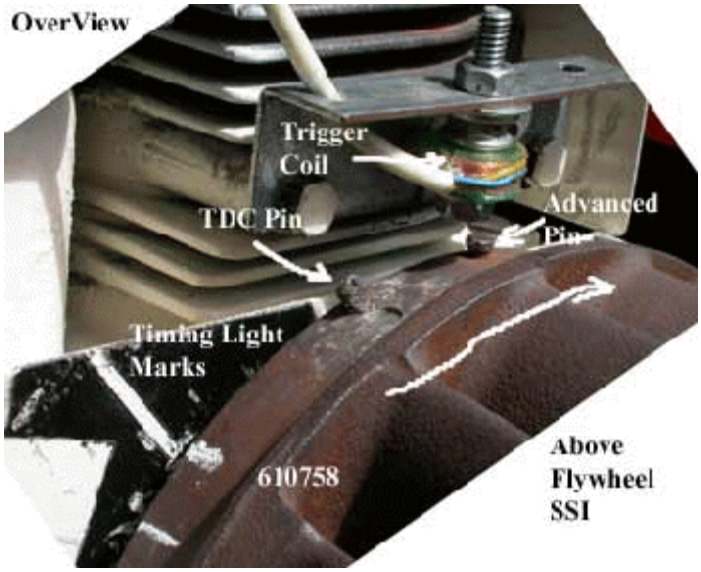
Flywheel P/N.....610758
SSI P/N.....610759
Pulse Transformer.....610760

The one on the right I call “SSI Above” for short because it is above the flywheel.

Flywheel P/N.....611000
SSI P/N.....610906
Charging Coil.....610965

The replacement scheme here applies to both configurations. The SSI Above uses two trigger pins to automatically advance the spark timing from near Top Dead

Center (TDC) for engine start up to the spark advance for a running engine. The Trigger Pins are on the outer circumference of the flywheel. The second step in replacing the SSI Under is to add the two trigger pins to the flywheel. For the SSI Above configuration, we can skip this step because the Trigger Pins are already in place.



For an overview of the modification, an SSI Above flywheel,610758, with it's trigger Pins is shown at the left. Above the advance (short) trigger pin is the trigger coil. This is a sewing machine bobbin with fine wire wound on it and mounted on a 1/4 inch machine screw with the head facing down. A rear earth magnet is mounted on the head of the screw. When the flywheel rotates, a voltage is generated in the coil when the trigger pin goes by. This voltage is routed to the control module of a Chrysler ignition system and initiates the spark.

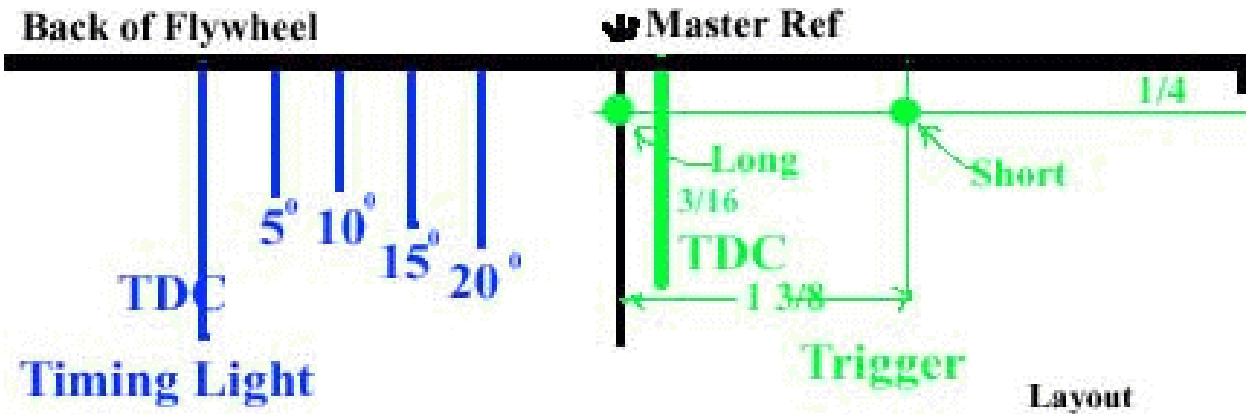
The original Tecumseh engineering using two trigger pins of different heights is very ingenuous in that it allows the use of one trigger coil but automatically advances the spark with engine RPM.. When the trigger pins go by the trigger coil, it is the change in magnetic flux that produces the voltage. As RPM increases, this rate of change of magnetic flux increases and the voltage increases. At cranking speed, low RPM, the short trigger pin has too large of an air gap to generate a sufficient voltage to trigger a spark, however the tall, start pin has a closer gap and readily triggers a spark. As RPM increases, the shorter, advanced pin produces a higher voltage and triggers the spark before the tall start pin. This is important because one task in the modification is to adjust the distance of the trigger coil to have a just after TDC spark for starting the engine but also have it advance when the engine is running. These adjustments are made with a timing light and timing marks that we will be adding.

The sequence of the modification consists of:

Task 1. Preparation,
Task 2. Adding the Trigger Pins,
Task 3. Adding the Trigger Coil,
Task 4. Installing Automotive Parts
Task 5. Adjustment / Test
Appendix 1 Making the Trigger Coil

Task 1. Preparation

Remove the flywheel. If we first paint the outer circumference of the flywheel white, our pencil marks locating the trigger pins and timing marks will be easier. Then



before painting the flywheel black, the use of narrow strips of masking tape at the timing marks will make them show up easily. After the white paint is dry, lay the flywheel fin side down. We can use the key way for the woodruff key to locate a master reference line by installing a 3/16 piece of square key stock , at least 2 inches long, into the key way. Using a straight edge and clamp, mark both sides of the key way at the outer part of the flywheel as shown. Locate the center of the two marks and carry it around the edge to the outer circumference of the flywheel. This is the master reference line for locating the trigger pins and timing marks.

A little about the ignition timing. The long trigger pin is about 3 Degrees After TDC and the short trigger pin is about 17 degrees Before TDC. With a circumference of 24 or 24.5 inches, one inch on the circumference is 15 degrees. Also, on my HH-120, there is a convenient window to shine a timing light to observe the actual spark timing when the engine is running if one puts the timing marks there. This window is under the badge (which has the model and s/n).

The layout of the timing marks is shown in blue above. Starting at the master reference line, measure 2 inches to the left for the TDC mark and 1 inch to the left

for the 15 degree mark. Divide the inch between them into thirds for the 5 and 10 degree marks and use the same increment for the 20 degree mark. This position should put the timing marks in the window for the timing light. Also, only for the flywheel that already has the trigger pins, measure a line 3/16 to the right of the long trigger pin for a line that represents TDC with respect to the trigger coil which is to be added. Put thin strips of masking tape on the timing lines and paint the flywheel black.

Task 2. Adding Trigger Pins

For the configuration with the SSI Above the flywheel, the trigger pins should already be in place and this task can be skipped. Note: The flywheel from my HH120 SSI Above, p/n 611000, seems to fit the HH1120 which has the SSI Under flywheel p/n 610758, but both have external motor / generators. Given the option, I would change flywheels rather that add the trigger pins. The original ignition components, except for the magnet on the flywheel, should be removed as they would no longer be used. If there was a stator under the flywheel for charging the battery, the flywheels may not be able to be switched.

For the configuration with the SSI Under the flywheel, the task here is to install the trigger pins. Set the flywheel on a very flat surface and using something 1/4 inch thick, scribe a mark 1/4 from the back side of the flywheel. It is important that the long and short trigger pins be the same distance from the back of the flywheel so the center of both trigger pins track the center of the trigger coil or one might have trouble making the final adjustments. The long trigger pin goes on the intersection of this line and the master reference line. Measure 1 3/8 inches to the right of the master reference line to similarly locate the short trigger pin. I found a measuring tape for sewing flexible to fit the curve of the flywheel but checked if for accuracy with a steel tape.

Also, if one compares the locations of the trigger pins from the SSI Under with those of the SSI Above, you will note that there is a difference in trigger pin locations. This is because there is a bolt which holds the magnet which is too close to where the short pin would go if they were the same. The trigger pins to be installed and the trigger coil are offset to the left to avoid this problem. Caution, the flywheel is balanced by drilling holes in the back to remove some weight. Check to see if one of these holes is too close to the trigger pin location.

Center punch the trigger pin locations, put thin strips of masking tape on the timing lines and paint the flywheel black. The next step is to drill the holes for the trigger pins located above. I drilled some test holes in scrap metal and found that a number 12 (.189 inches) drill bit was a good size to start with. With one pin, it was

too small and I should have re-drilled it with a # 11 (.191), the size of the pin. With the other pin, the hole was too big and I had to use a dab of JB Weld. Drill the holes 5/8 inch deep. The trigger pins come in a kit with one short one and one long one, TECUMSEH p/n 730201. I found instructions for installing in one of the kits,

but not in the other two kits so they are shown below.
Now the hard part is done.

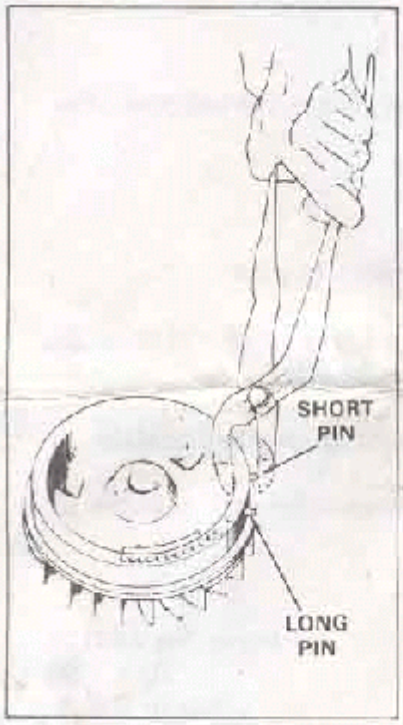


Figure A

INSTRUCTION SHEET TO INSTALL FLYWHEEL TRIGGER PINS, PART NO. 730201

Removal of Damaged Pins

CAUTION: Pins must not be reused. Use care not to damage flywheel. Never hammer on a flywheel as permanent damage to the magnets could result.

Use vise-grip pliers to remove pins. If pins are very tight, hammer lightly on the pliers at the same time pulling on the pins. Do not twist. If a vise is used to secure the flywheel, use care not to damage.

INSTALLATION OF NEW TRIGGER PINS

1. Position the flywheel with the fins on a flat surface. Holes toward you - See Figure A.
2. Coat shaft of pins with Locktite.

CAUTION: Do not use a hammer to drive in pins

3. Use masking tape to cover wide-mouth pliers (channel lock type) and press fit the short pin into hole on right. Fit the long pin on the left.
4. Pins must be pressed up to pin shoulder. Wipe away any excess Locktite.
5. The magneto air gap must now be adjusted to correct for any changes in trigger pin height.

TECUMSEH

Form No. 694120
Rev. 3/88
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Task 3. Installing the Trigger Coil

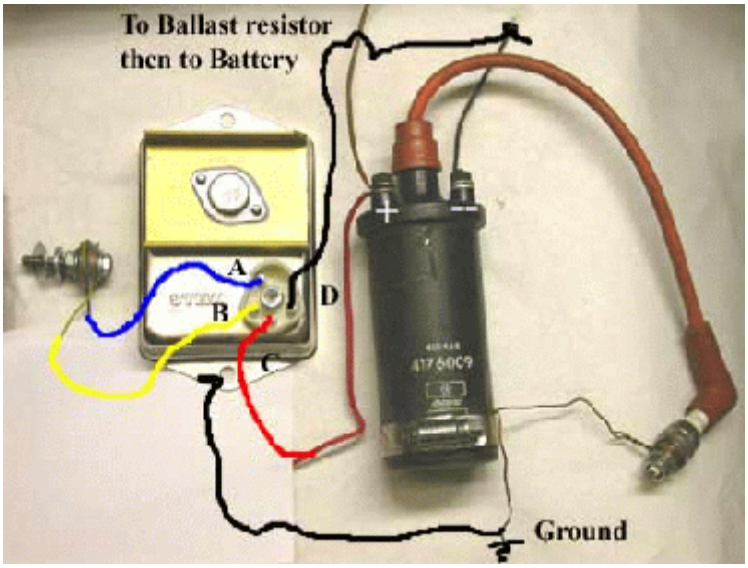
The trigger coil mounting bracket is fastened on the two bosses shown in the introduction using two 1/4 NC screws, ½ inch long with lock washers. If needed, the holes can be adjusted using a 1/4 round file. If the flywheel has factory installed trigger pins, use the hole centered between the bosses for the trigger coil. If you installed the trigger pins as above, use the hole offset to the left for the trigger coil. Set the trigger coil close to the trigger pins and adjust as necessary to have the center of the trigger coil track the center of both trigger pins when you rotate the flywheel. Again, adjustment of the hole with a 1/4 round file as necessary. Set the gap between the tall trigger pin and the trigger coil to 11/64 inch for an initial setting by adding thick and thin 1/4 inch washers between the trigger coil and the mounting bracket. Feed the trigger coil wires thru the unused hole to keep them from rubbing on the flywheel. The final trigger coil adjustments will be made in Task 5 by shimming, changing the washers.

Task 4. Installing Automotive Parts

The main objective of this whole effort is to be able to replace failed SSI units with an ignition system that is available, affordable and simple enough for almost any one to install. The mid 1980 Chrysler ignition system seems to satisfy this objective best of all. It basically is an ignition coil like that used in battery powered point / condenser systems with a transistor switch that replaces the points. The transistor switch and associated electronics is in a box called a control module. A trigger coil connects to the control module to initiate the spark. The web site, http://members.aol.com/pullingtractor/ignition.htm has a wealth of information; the main difference here is the trigger coil specifically designed for the Tecumseh engines.

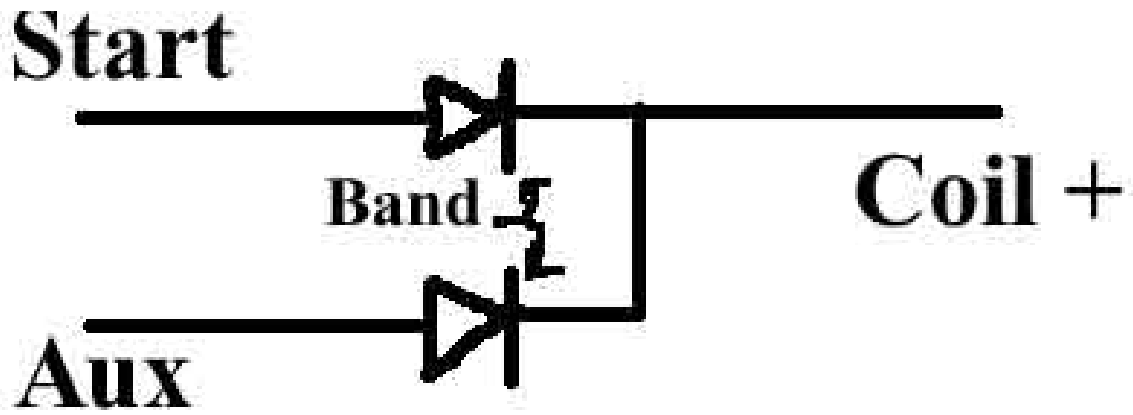
I used an ignition coil from a junked Carvan that requires an external resistor to limit the current draw. The Tecumseh 32080 or Kohler 231281 or Stens 460-048 coils ($30) already have the resister built in and should work fine. The control module I chose was a Wells CR109 because of the lowest cost, $16.

The trigger coil leads(yellow and Blue) are connected to pins A and B of the Control Module. At this point, it does not matter which is which. The - of the ignition coil (black) is connected to pin D of the Control Module. The + (red) of the ignition coil is connected to both pin C of the control module and the + 12 volt battery thru a switch. For my coil, I needed a ballast resistor also.



I found some crimp connectors MOTOMITE 85456 which with a slight crimp fit the pins of the control module. The Control Module can be mounted in any cool place. And the ignition coil where convenient. The Control Module, coil and spark plug must be grounded.

The 12 Volt power source will vary from tractor to tractor, but must be present for both engine start and engine run. If there is a fuse coming off the plus side of the battery , it could be connected to a switch , ballast resistor if needed and the plus terminal of the ignition coil. If the engine has an external DELCO motor / generator and regulator, the regulator probably has a L or Load terminal used for lights and a starter solenoid. This would be a good source for the 12 Volt power. If a more modern key switch is used with positions for a start solenoid and Aux, it could be used with a pair of diodes, 20 Volts or higher and about 4 amps or greater, 1N5406.



Never connect to the “M” of a key switch because this only connects to ground in the off position and has no connection in the on position.

Task 5 Adjust and Test

We do a functional test and adjustment here <u>before</u> installing the blower housing, using the starter motor and fully charged battery to turn the engine. We want to do the adjustment at a high cranking RPM so the spark plug is removed, threads connected to a bare wire which is grounded and the a new spark plug connected to the ignition coil. The picture below shows a modified SSI Under flywheel with the

trigger installed in the left hole but the procedures also apply to a SSI Above flywheel with factory installed trigger pins and the trigger coil installed in the hole centered with the mounting bracket holes. We painted timing marks on the flywheel for the timing light but now need an associated TDC line on the Blower Housing Baffle. If the flywheel is turned to line up the trigger coil with the trigger coil timing mark, this should be TDC. It is best to have the cylinder head off and zero the travel of the piston with a dial indicator. If needed, the trigger mounting hole can be adjusted with a 1/4 round file. The initial air gap between the trigger coil and the tall trigger pin can be set to 11/64 inch by changing the washer stack.

Power up the ignition, crank the engine and observe the spark plug. If a spark is not present, check the new ignition wiring and /or remove a washer from the stack. When you get a spark, set up an inductive timing light aimed at the trigger coil and see where the timing is. If the spark occurs as the tall trigger pin passes the trigger coil, the adjustment is good. If the spark occurs when the short trigger pin passes the trigger coil then the trigger coil is too close (the engine may try to start with 17 of spark advance) and a thin washer needs to be added to the stack.

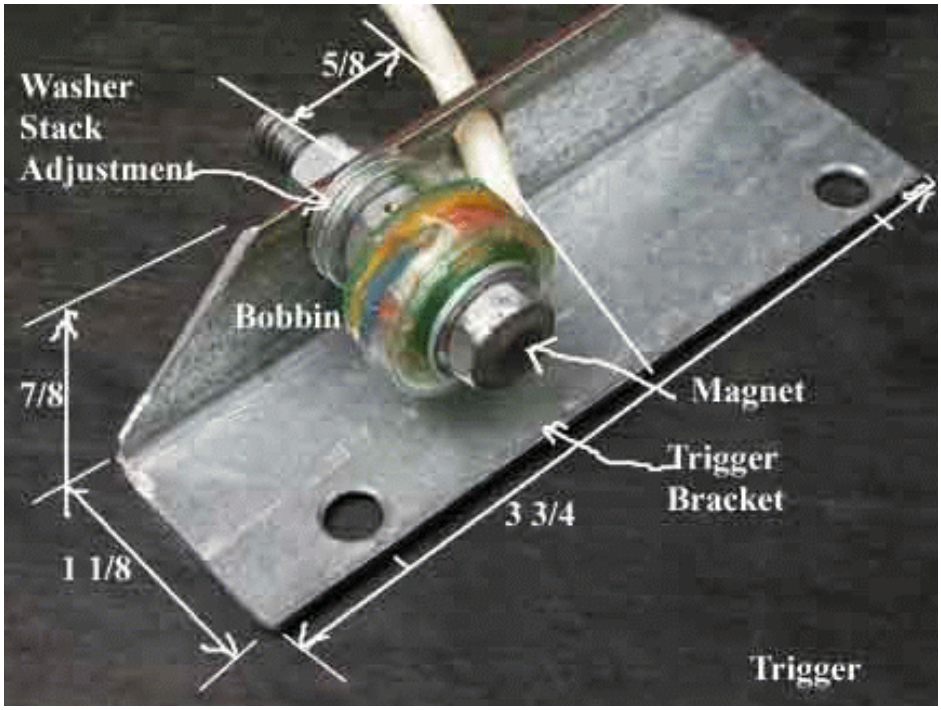
IF you are not able to find a good adjustment doing the above, try reversing the trigger coil leads that are connected to the control module. The ignition will work either way, but I have observed a difference in timing (about 5 degrees of retard).

The above adjustment is very conservative. If you are not able to find a good adjustment doing the above, try cranking the engine at a lower speed by installing a spark plug to add compression. It is important that the spark fire off the tall trigger pin when starting and transition to the short trigger pin as the RPM increases.

When the trigger coil is adjusted, all bolts tightened and wires secured, install the blower housing, run the engine and check to timing. It should be advanced 17 deg when the engine is running. Lastly, reinstall the badge over the timing light window .

Note: There is a short 5/16 NF bolt that holds the blower housing on the right side. If a long bolt is put in its place, the bolt will hit the trigger pin. It would be a good idea to check this before installing the blower housing.

Appendix 1 Making the Trigger Coil:



I have templates, patterns and special tools to make the trigger, but am trying to provide enough information here for someone to make there own. The trigger bracket is made of folded galvanized sheet metal about 1 /16 thick. Since it is part of the magnetic path, it needs to be made of iron. The part that is vertical when installed has two 1/4 holes about 2 3/4 inches apart for mounting to the block and centered about 3/16 from the edge. Locate the midpoint between these holes and carry it up to the part that is horizontal when mounted. The hole for the trigger coil when one is using factory installed trigger pins is centered on this line about 3/16 from the edge. Locate one more hole 5/8 inch to the left for the trigger coil when the trigger pins are installed as above.

The mounting bolt is 1/4 NC 1 ½ inches long. With a Radio Shack Rear Earth magnet (64-1895) fastened to the top with JB Weld. The bobbin is spooled nearly full with fine, 32 gage, wire. The winding is protected and wires fastened with E-6000 Adhesive.

I have some materials and supplies and can provide a Trigger Coil Kit $25. Contact me, Ed Stoller at edstoller@earthlink.net.

Appendix 2 Tractor Pulling Ideas:

The original design of these engines had fixed spark advance, not with standing the switch between the two fixed spark timings. Ideally, the optimum spark advance depends on RPM (and engine load). I would guess that the 17 degrees of spark advance is targeted to a nominally high RPM like 2800. There are some that abuse these engines by running them above the rated 3600 RPM, like 4000 RPM. It stands to reason then, that one might want to optimize the spark timing at the highest RPM to get maximum power out of the engine. The ignition replacement above has a lot of latitude to adjust the timing.

One idea is to add a second trigger coil ahead of the one above and to have a user operated switch to kick in the added spark advance when it was wanted. The smallest increment of added advance would be limited by the physical size of the trigger coils. I have observed that the trigger coils I made (or my late wife actually made on her sewing machine) are more sensitive than need be. This is evidenced by the fairly large air gap. I did remove some of the wire so the bobbin was only about 7/8 full. So there is some latitude in reducing the diameter of the bobbin at least where they would touch. Also, the placement of the lead wires could be tailored allow the coils to be closer together.

A second idea is to make the mounting bracket, that the trigger is mounted on, slotted so it could be dithered. I remember my uncle Fred had a Model T, or was it an A, that had a lever behind the steering wheel for this. I would want it to be spring loaded to the engine start position. A throttle / choke cable or such could be used to pull it to a advanced position.

Thirdly, the Control Module seemed to add about 5 degrees of retard on occasion. I think the trigger coil has a positive going pulse follower by a negative going pulse or a negative pulse followed by the positive depending on the way the trigger wires are connected. This could effect the advance characteristics of the module. Also, as RPM increases the trigger voltage would increase which might act like a built in tac. I only ran the replacement ignition for about an hour on an engine with known warn piston and intake valve guide. The engine ran OK but was a little rough. I don’t know weather this was mechanical or ignition induced. I need to get the variable speed electric motor powered engine simulator on line so I can investigate these issues further. If anyone has the performance characteristics of the control module , I would appreciate some input.

Lastly, if one wanted to play with the timing for the replacement ignition above, you could use all thin washers on the trigger coil and adjust the air gap to the trigger pins while still keeping the starting spark slightly retarded.