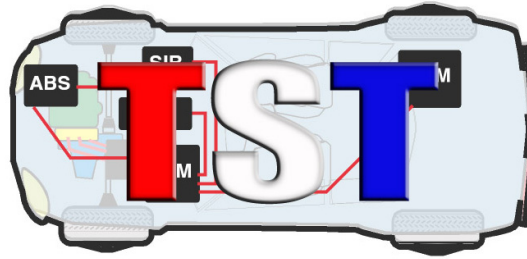


January 2010



Technicians Service Training

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Jerry "G" Truglia

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Engine Knock Sensors

Engine knock limits performance and can cause permanent damage



Under certain conditions, combustion in a spark ignition engine can degrade into an abnormal preignition

process that causes a "knocking" or "pinging" sound. This undesirable combustion process limits the engine's output and specific efficiency levels. It occurs when the fresh air/fuel mixture pre-ignites in spontaneous combustion before being reached by the expanding flame front.

Under normal combustion chamber conditions, the spark at the spark plug starts the burning process. A wall of flame spreads rapidly in all directions from the spark, moving outward through the compressed mixture in the combustion chamber until all of the charge is burned. The speed with which the flame spreads is called the *rate of flame propagation*. During combustion, the pressure in the combustion chamber increases to several hundred pounds per square inch (psi), and may exceed 1,000 psi in a modern high compression engine.

(Con't on page 3)

Technicians Service Training

11 Lupi Plaza

Mahopac, NY 10541

Phone: (845) 628-6928

Fax: (845) 628-9109

Email:

Info@tstseminars.org

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Currently there are **TST chapters in Connecticut, Massachusetts, New Jersey, New York** and membership continues to grow. For more information you can call

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TST is a group of dedicated technicians and instructors committed to the continuing education of our fellow technicians. We provide once a month training seminars to technicians at a reasonable price. TST brings our members nationally known instructors and state of the art training.

Our Goal & Mission Statement

- ***Keep our fellow technicians up to date with the latest technology.***
- ***Provide training seminars for a reasonable price.***
- ***Deliver information that the technician can use now.***
- ***Keep technicians informed of information affecting our industry.***
- ***Increase consumer awareness of what a good technician is.***

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TST membership includes special pricing on once a month week-day night seminars and the occasional full Saturday seminar. With a \$75.00 yearly membership, the monthly seminars are only \$65.00. TST classes are NOT sales or product seminars. The instructors that TST brings in are all “hands-on” industry experts with up to date, cutting edge knowledge that you can use in your shop the next day. That’s 65 dollars for a seminar in which you are able to learn something useful, for fixing those tough jobs that we all see on a regular basis. Our instructors are masters at making the complex understandable. Membership also includes a Monthly Newsletter full of real world technical articles, diagnostic case studies, and solutions to the kinds of problems you see in your bays each week.

The following are some of TST’s regular instructors:

Bernie Thompson of ATS www.ATSnm.com

John Thornton formerly of Team AVI

Wayne Colonna of ATSG www.ATSGmiami.com

Jorge Menchu the “Labscope Guru,” owner of AES

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John Anello Auto Tech On Wheels www.autotechonwheels.com

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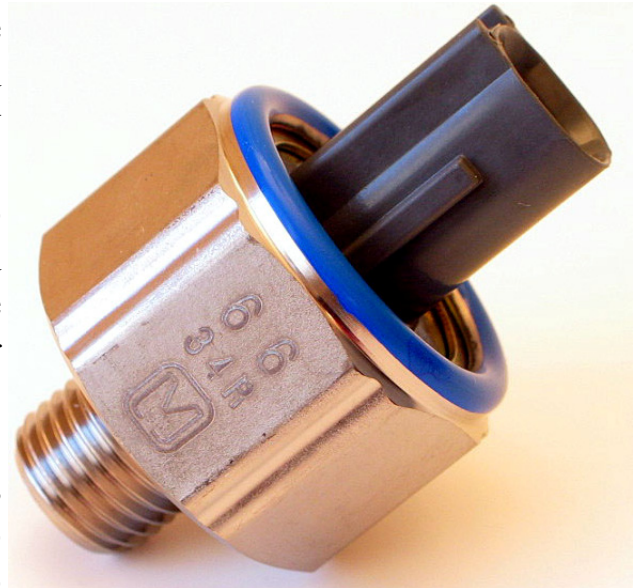
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Jerry “G” Truglia National Instructor & owner of A.T.T.S. Inc.

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Engine Knock Sensors (con't from p. 1)

When the end gas explodes before the flame front reaches it, there will be a sudden and sharp pressure increase, followed by a very rapid oscillation of pressure in the combustion chamber. Shock waves from this explosion progress rapidly through the burned gases in the combustion chamber and strike the exposed surfaces of the piston, cylinder head and cylinder walls. These shock waves, or pressure pulses, bounce off the metal surfaces and pass back and forth at sonic speeds through the gases, creating a series of pressure pulses in the gases which cause the characteristic engine knocking noise.



The repeated shock wave blows can impose severe stress on engine parts. Shock loads are applied to the piston, connecting rod, crankshaft and bearings. Bearings, in particular, are susceptible to rapid failure under severe knocking conditions, although pistons, rods and crankshafts have also failed from this condition. Chronic preignition also causes increased thermal stresses at the cylinder head gasket and in the vicinity of the valves. All of these factors can lead to permanent mechanical damage.

A number of environmental factors can influence an engine's tendency to knock. For example, a hot engine will knock more easily than a cold engine. A 20° F rise in air temperature increases an engine's octane requirement by about three octane numbers. An increase in humidity from 40 to 50 percent at 85° F reduces an engine's octane requirement by one octane number. This follows the common perception that an engine will run better and more quietly in damp weather. Engine deposits increase octane requirements because they increase the compression ratio. Advancing the spark or leaning the air/fuel ratio increase the engine's octane requirement. Last of all, higher altitudes reduce an engine's octane requirement because the air is less dense.

It requires an appreciable time, measured in microseconds (0.000001 second), for the mixture to begin to burn. Increasing the temperature in the combustion chamber reduces this time. So if the temperature in the combustion chamber gets hot enough or is maintained long enough, the end gas will explode prematurely.

(Con't on page 4)

Engine Knock Sensors (con't from p. 3)

Several methods may be used to prevent knock. Increasing the rate of flame propagation allows the flame to reach the end gas in time. Subtracting heat from the end gas reduces the likelihood that it will preignite. And using a fuel that is chemically more stable will allow the engine to tolerate higher temperatures without knocking.



Knock can also be controlled by limiting the amount of spark advance. On engines with a fixed spark advance curve, the advance is normally designed with a safety margin to limit total advance at a point before the knock limit is reached. Because the knock limit depends upon fuel quality, as well as engine and environmental conditions, the spark advance is normally retarded more than necessary to maintain an adequate safety margin. The result is increased fuel consumption and reduced performance.

If allowed to continue, preignition can cause serious internal engine damage, as this damaged spark plug illustrates. Before systems were developed to monitor and control knock, spark advance was limited to avoid the possibility of engine knock and knock damage.



This disadvantage could be avoided if the knock limit were determined continuously during operation. The ignition advance then could be continuously adjusted, in a closed loop operation, just below the point where knock begins. The only problem is, how do we let the control unit know when the engine has begun to knock?

In 1880, Jacques and Pierre Curie made a discovery regarding the characteristics of certain crystalline minerals. The crystals became electrically polarized when subjected to a mechanical force. Tension and compression generated voltages of opposite polarity that were in proportion to the applied force. The converse of this relationship was also confirmed.

(Con't on page 7)

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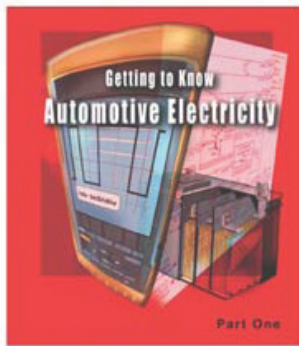
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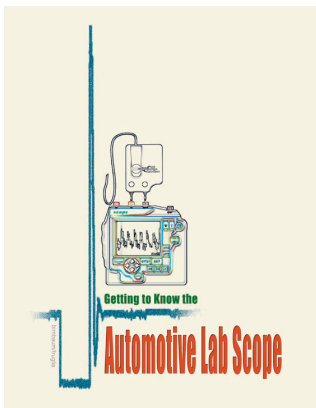
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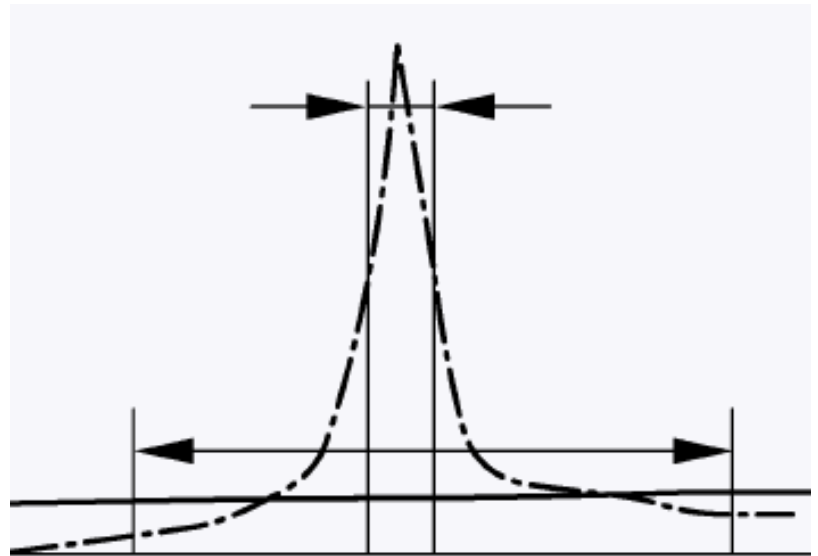
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Engine Knock Sensors (con't from p. 4)

If a voltage generating crystal was exposed to an electric field, it lengthened or shortened according to the polarity of the field, and in proportion to the field strength. These behaviors were



labeled the piezoelectric effect and the inverse piezoelectric effect, respectively. Piezo is taken from the Greek word piezein, meaning to press or squeeze.

A piezoelectric knock sensor is capable of registering engine vibrations within a set frequency range that has been associated with engine preignition and knock. The weak voltage signal generated by the sensor is sent to the PCM for evaluation and corrective action.

The magnitude of piezoelectric voltages, movements or forces are small and often require amplification to make them useful. A typical piezoelectric ceramic disc will increase or decrease in thickness by only a fraction of a millimeter, for example. Despite these limitations, piezoelectric materials have been adapted for use in a wide range of applications, including the subject of our discussion: the knock sensor.

The knock sensor consists of a *piezoceramic ring*, a *seismic mass* and *contact electrodes*. The complete unit is attached to the engine block at an appropriate location. The knock sensor is accelerated due to engine vibrations, causing the seismic mass to generate a force to the piezoceramic ring.

(Con't on p. 9)

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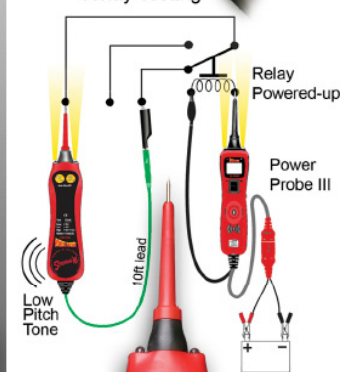
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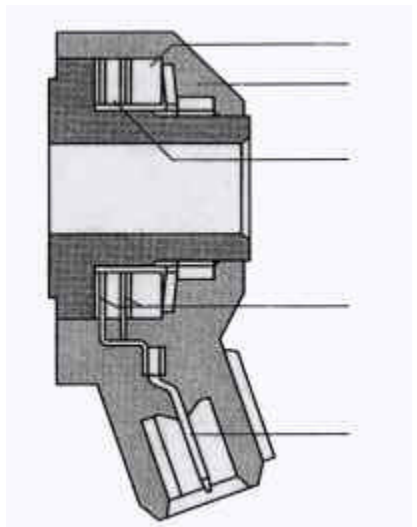
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Engine Knock Sensors (con't from page 7)

In this cutaway view of a flat response-type knock sensor, its seismic mass (1), cast mass (2), piezo-electric cereamic (3), contacts (4), and harness connection (5) are visible.

The piezoceramic ring generates an electrical signal which is proportional to the vibrations in a specific frequency range. If the engine starts to knock due to low octane fuel or other operating condition changes, the knocking signal is detected by the PCM and the ignition timing map is adjusted accordingly.

Two major knock sensor designs are used today: *broadband single wire* and *flat response two wire* knock sensors. Both sensor designs use piezoelectric crystals to produce and send signals to the PCM. The amplitude and frequency of this signal varies, depending upon the vibration levels within the engine. Broadband and flat response knock sensor signals are processed differently by the PCM.



We will dig deeper into knock sensor design and operation in the next *issue*. We also will share some valuable information on engine management system strategies and knock sensor diagnosis.

WELLS

Article Courtesy of Wells Manufacturing Corp.

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Questions:

1. Do you want seminars to continue in your area?

2. Do you find the seminars useful?

Please ask a fellow technician to come and check-out our seminars so we can continue to bring you the best available information each month.

We need your support:

Thank you,
G Truglia

Important TST Notes (con't from page 9)

- Next month we are planning to do Part II to our Hands-On Electrical Diagnostics seminar. Be sure to bring your meter and scope, because the majority of the class will be hands on, focusing on the most common testing methods and electrical problems that we deal with.
 - We encourage you to attend this class so that you can make better use of the tools you already own, bring your diagnostics to the next level, and prepare for the ASE A6 Examination. We will be covering real ASE questions and solving them hands on.
 - Take your shot at TST Hands-On Certification FREE! Throughout the seminar we will be proctoring the hands-on exam. This way, you will be fully prepared for the ASE A6 examination, and more importantly real electrical problems in your shop.



- The Big Event is only in three months! **Bernie Thompson and John Thornton** are presenting in other states but only at TST does it cost as little as \$175. Scott Manna, another nationally renown instructor, is presenting at the Big Event as well. What are you waiting for? Prices go up in February so pencil in the date and sign up today!
- Craig, the call guy, is working full time in automotive repair and will not be able to zealously follow up on all his phone calls like he used to. So, please sign up online or in advance!

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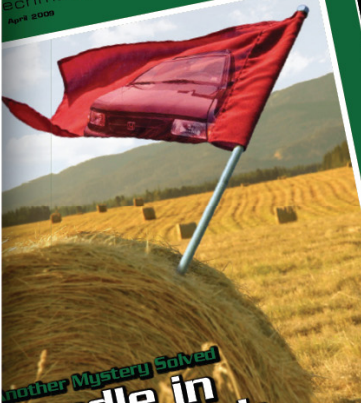


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Another Mystery Solved
Needle in a Haystack

M Business INSIDER

Inside the Insider

Five Ways to Limit Liability
By slipping out into the business world, every shop has exposure. While you cannot stop people from suing you, you can limit your business, personal assets and wallet from more liability if you take some steps to protect yourself.
(Turn to page 1)

Human Potential
The mind is a strange and powerful tool. Psychologists tell us some very interesting things about its function. First, 90% of its activity is subconscious.
(Turn to page 1)

In Times Like These
Small business is the lifeblood of our economy. Businesses like ours.
(Turn to page 3)

Sole Proprietorship
It does not matter whether the individual or a newly started business ventures this question comes up on a regular basis. My answer to this dilemma has always been the same, it depends.
(Turn to page 6)

MT Business Insider Pricing Matrix
Businesses are based on percentages, but customers look at prices. How do you reconcile your business need to make a profit with your customer's need to pay a fair price?
(Turn to page 8)

E Certification: The Competitive Advantage
Of the most powerful influences on a shop's success is the reputation of its technicians. From family and neighbors, business customers and the general public, a business based on reputation is a business that is successful.
(Turn to page 10)

Five Ways to Limit Liability for Business Owners
By stepping out into the business world, every shop has exposure. While you cannot stop people from suing you, you can limit your business, personal assets and wallet from more liability if you take some steps to protect yourself.
First, incorporate or form a limited liability company (LLC). This requires that you file articles of incorporation with the Secretary of State, or whatever government agency in your state. Once you incorporate, you hold your business out to the public as a corporation.
This requires that you file articles of incorporation with the Secretary of State, or whatever government agency in your state. Once you incorporate, you hold your business out to the public as a corporation.
The mind is a strange and powerful tool. Psychologists tell us some very interesting things about its function. First, 90% of its activity is subconscious. Let's define things within or without oneself. 90%! Think about it -- if you are 100% in control during your work, how many times are you capable of achieving it all only 10%?
It's generally agreed that a human's learning ability is physical. Remember that a scrap of brain tissue no larger than a grain of rice contains more information than a computer's brain weighs about three pounds. How many ounces of yours do you actually use?

Crazy New Maintenance Items

Hyundai has been making some very solid, high quality vehicles and because they do not break, we might not pay too much mind to the specifics of their repair. Here's an easy and necessary maintenance job on late model Hyundais you might not be aware of: replacing the Gas Tank Air Filter.



Every 30,000 miles, Hyundai requires for warranty purposes that the Gas Tank Air Filter be replaced. All you need to do is remove the rear left wheel house inner cover by popping out few plastic clips and three screws. Unscrew and unfasten the filter from associated tubing and mounts, and replace it with an eight dollar one from the dealer.

Dealers charge an hour's labor for this procedure. You can remove the wheel to make the procedure easier, but it really is not necessary.



Aside from fulfilling warranty requirements, which lasts 10 years/100,000 miles for Hyundais, this procedure can help your customer avoid future EVAP issues. Here's what a Gas Tank Air Filter looks like in a 2007 Hyundai Elantra after only 28,000 miles. As you can see in the picture to the left, it already is clogged with debris.

Many dealers are so unused to this new technology, they do not even do this procedure. So, keep an eye out for this component in your diagnosis and in the maintaining of your customers' vehicles.

[Article by Craig at TST](#)



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