Everything You've Always Wanted To Know About Spark Plug Heat Range...

But Were Afraid To Ask!

Definition

The term "heat range" refers to a spark plug's thermal characteristics . . . more specifically, to its ability to dissipate combustion heat from its firing end to the cylinder head and cooling system.

For any specific application, it is the range of temperatures from idle to full throttle that determines the heat range of a spark plug. From a design standpoint, this range of operating temperatures is largely determined by the length of the insulator tip at the firing end.

For best service, the range of temperatures a plug must operate within is between 700°F and 1500°F (400°C to 800°C). The Heat Range Scale illustrates the typical temperature readings of three different heat range designs, run in the same engine at all load conditions—idle to full throttle.

A spark plug must run cold enough at wide open throttle to avoid becoming a source of preignition. On the other hand, it must also operate hot enough at idle and slower speeds to burn off conductive deposits that can short circuit the high voltage and result in misfire.

Usually, each size and design of spark plug is manufactured in various heat ranges. As illustrated, they vary from a "colder" type which operates on the lower end of the temperature scale to a "hotter" type which operates on the higher end of the same scale, in the same engine, under identical conditions.

Spark plugs with short insulator firing tips are called "cold" designs because they dissipate heat rapidly. They are generally used where combustion chamber temperatures are relatively high. "Hot" designs, with their longer insulator tips, have a much slower rate of heat transfer and are generally used where combustion chamber temperatures are relatively low.

Turbo-Action design plugs have projected firing tips. The firing tip is positioned deeper into the combustion chamber and benefits from an effect called "charge cooling," at higher engine speeds. Charge cooling is an effect produced by the cool, incoming, fuel/air charges, which lower the temperature of the firing tip.

By providing more protection against overheating at high speed, the plug can be designed to operate at a higher temperature level at low speeds thus broadening the range of operating temperatures the plug will accomodate for each engine application.

It is, however, the temperature range within which the plug will operate in any given engine that determines whether it is a hot or cold type and not necessarily the design alone.

Spark Plug Evaluation

The relative heat range of a spark plug, or to be more exact, its preignition rating is determined by a procedure established by the Society of Automotive Engineers (SAE).

A specially designed single-cylinder engine is used for spark plug rating. It is a supercharged four-cycle design with 17.6 cubic inches displacement and a constant spark advance at full throttle. The spark plug rating is established at the power level just below the point where the plug enters preignition, as determined by special instrumentation.

Champion supplements the single-cylinder engine rating tests by temperature surveys in new production engines. These tests are performed regularly on engine dynamometers and chassis dynamometers to evaluate spark plug heat range and thermal characteristics of each application.

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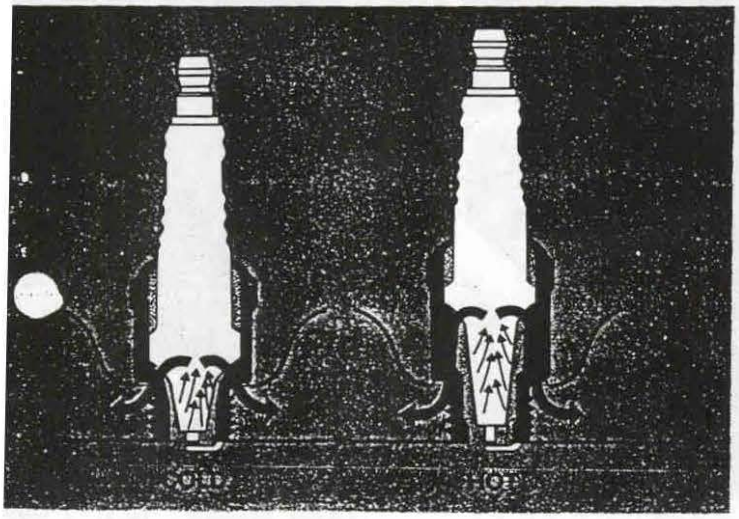
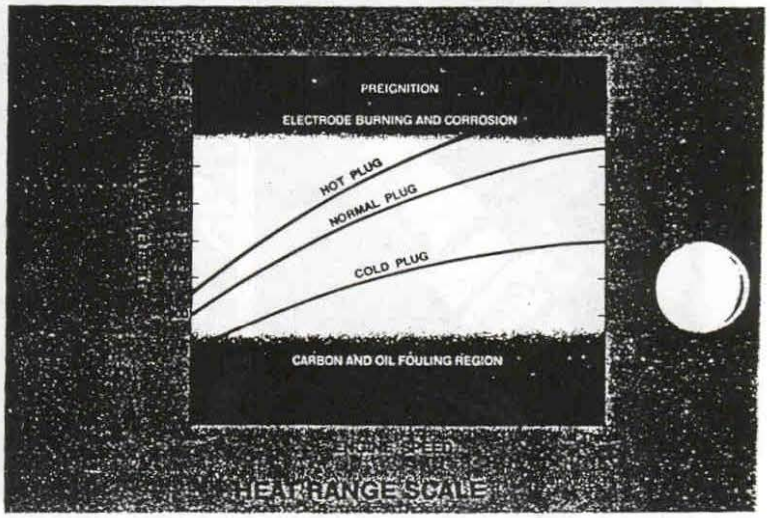




Champion's Thermocouple Spark Plug

During engine operation, the hottest point on a spark plug is at the firing end of the insulator. By precisely measuring the temperature of the insulator tip, the correct spark plug heat range for any engine can be determined. This procedure is accomplished through the use of Champion-designed thermocouple spark plugs.

Thermocouple spark plugs have a minute temperature sensing element, or thermocouple, imbedded in the insulator tip. Special instrumentation, either portable for track tests or permanently mounted in the Champion dynamometer facilities, allows the operator to observe and record plug tip temperatures in all cylinders while operating at various road speeds and load conditions.

Many engine manufacturers and research laboratories now use Champion thermocouple spark plugs in their engine studies. Thermocouple plugs are a proven and invaluable research tool . . . at Champion, we think it is the best way to select spark plugs for every engine.

Factors Affecting Spark Plug Temperatures

It has already been explained that a spark plug's operating temperature will depend, to a great extent, on its individual design. The following list of service conditions also influence spark plug temperatures.

Engine Speed and Load—Increasing engine speed or load will cause spark plug temperatures to rise.

Ignition Timing—Spark timing has one of the greatest effects on spark plug temperatures. To advance timing beyond manufacturers specifications seldom produces impressive gains in power, yet it can increase fuel octane requirements several numbers and raise spark plug temperatures by hundreds of degrees.

Fuel/Air Ratio—Fuel/air ratios, within the normal operating ranges, have a relatively minor effect on spark plug temperatures. The highest temperatures will be found at maximum power settings. It should be noted, however, that the effect on valve temperatures may be considerably different and more pronounced.

Cylinder Head Temperature—Spark plug insulator tip temperature is affected directly with cylinder head or coolant temperature. An increase of 50° in coolant temperature, however, would have a miner effect on final plug temperatures but could totally disrupt engine operation. In cases of localized cooling system stoppage, or clogged fins on air-cooled engines, the spark plug can exhibit severe overheating tendencies.

Spark Plug and Combustion Chamber Deposits—Deposits must be kept to a minimum to reduce the possibilities of fouling. Deposits mask the surface of the insulator tip and will operate at higher temperatures. The surface of the insulator, however, will operate at a lower temperature.

Detonation—Detonation can seriously overheat spark plugs. High frequency shock waves associated with severe detonation may damage the plug either by insulator fracture or by flexing of the ground electrode. Severe hammering pressures and temperatures associated with detonation can be extremely harmful to the pistons, valves, bearings, and other engine components. Detonation occurs when the anti-knock value of the fuel does not meet engine requirements.

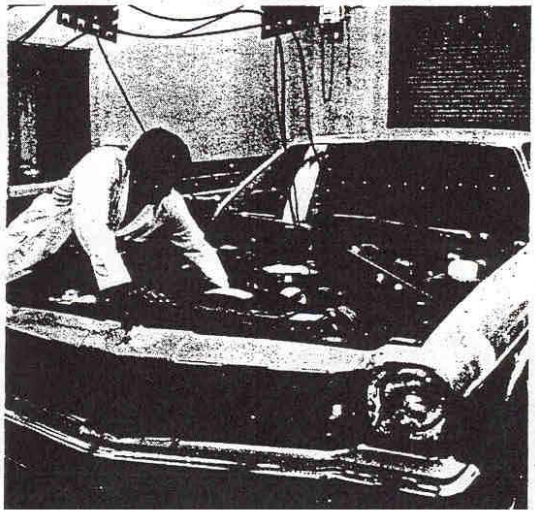
Preignition—Preignition will cause a very rapid and severe temperature rise of the spark plugs and other combustion chamber components. Preignition is just what the term implies—ignition of the fuel charge prior to the timed spark.

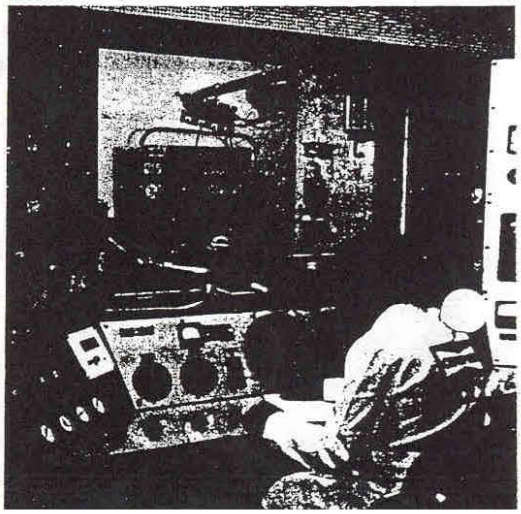
Fuels—When gasoline engines are converted to operate on a different type fuel, spark plug temperatures may be affected. This may require a change from the heat range recommendation for gasoline. Engine manufacturers should be consulted for specific information on engine conversions.

Compression Ratio—Engine modifications which include a change in compression ratio could very well require a different spark plug heat range. When compression ratios are increased, colder running plugs may be required; when decreased, hotter running plugs may be more desirable.

Consult Champion Catalog

Unqualified experimentation with spark plug heat ranges is not recommended. For assurance that both spark plug performance and service life will not be impaired, always consult a Champion catalog for the correct replacement number for any engine.





A WEIGHTY PROBLEM WITH HEI

Electronic ignition systems, as efficient as they may be, still require regular maintenance. While the electronics of the system is designed to deliver maximum voltage over a consistently longer period of time (as compared to conventional systems), the mechanical components are still subject to wear.

A local fleet, operating Chevrolet trucks, recently experienced a wear problem in the distributor of a GM High Energy Ignition (HEI) system. The regular driver of the truck complained of rough and erratic performance, and a general overall lack of power.

A visual check of the interior of the distributor revealed a peculiar situation. The axis holes in the advance weights had worn virtually to a slot, as illustrated in Figure 1 and 2. Removal of the springs and weights revealed that the axis pins were also severely worn, as illustrated in Figure 3. The advance curve was obviously affected, and full advance probably could not be attained . . . thus, the reason for the driver's complaints about performance. These areas are normally void of lubrication with exception of that which is applied during manufacture of the unit. The wear which occurred is a direct result of metal-to-metal contact. Also of concern is the fact that, in this particular case, the wear problem developed in only 20,000 miles. Where motorists complain of poor performance from their HEI equipped GM vehicle, check the advance mechanism.

Ignition system maintenance has been minimized in the HEI; however, the need for distributor service continues to exist . . . A good reason for regularly scheduled tune-up intervals.

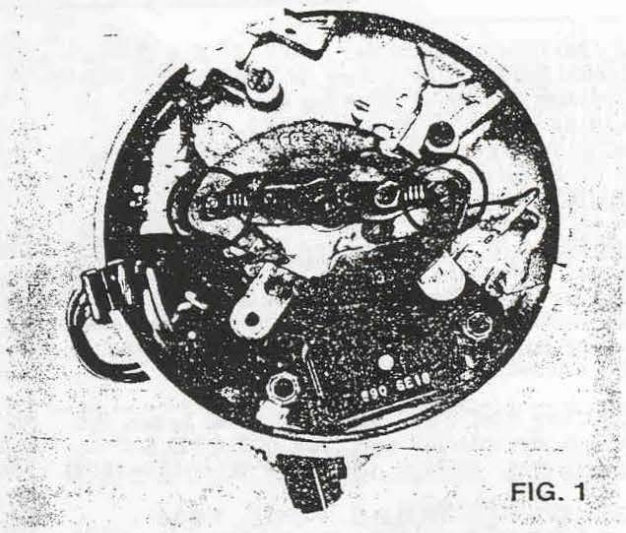


FIG. 1

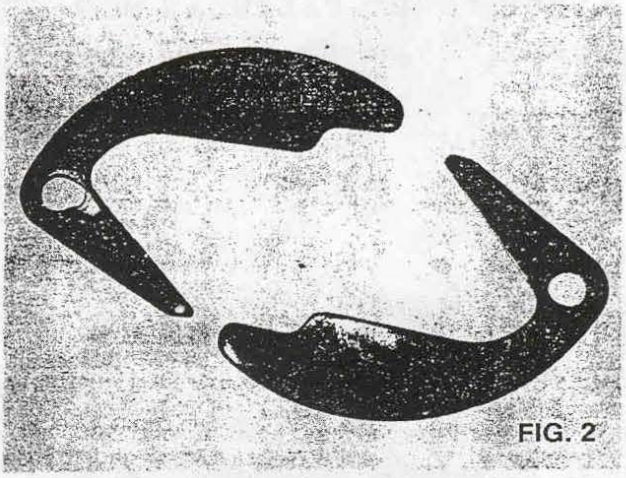


FIG. 2

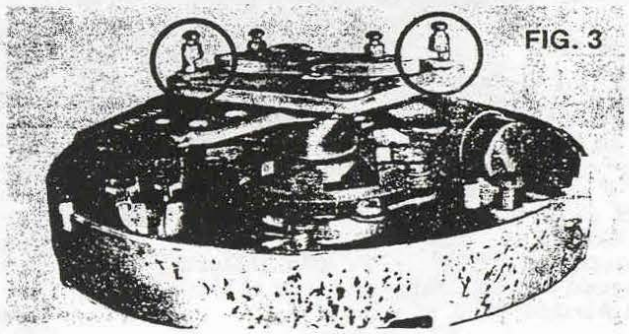


FIG. 3

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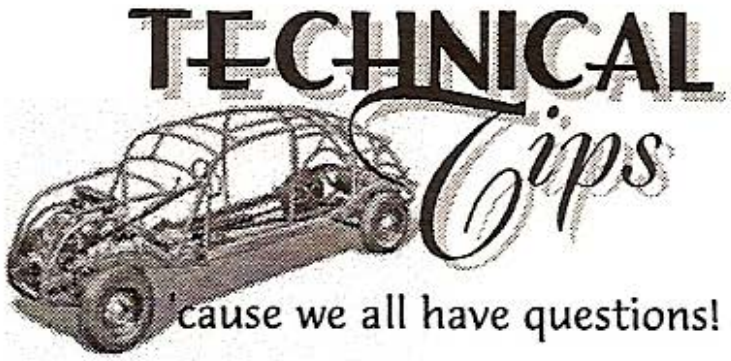
D. E. Shriver.....Editor

Our thanks to Bob Ball for the "Champion" information. While part of it is only applicable to late model GM engines, we felt it was too good to pass up completely. Remember that this does not constitute an endorsement of either Champion or GM but is provided as good to know information regarding any and all ignition systems and spark plugs. Believe most Airflows from 1935 on used Autolite spark plugs and ignition systems with the exception of the C-2 which continued to use Delco-Remy. Naturally all '34 Airflows used Delco-Remy. If I am wrong, somebody correct me! Also noteworthy is the fact that except for minor variations, later model Chrysler straight eight engines used a distributor which can be readily interchanged with the older versions. Don't actually know about the sixes - I am sorry. Maybe someone can fill us in on them. Further, we neither are nor do we claim to be expert on electronic ignition systems., we do understand, however, that one of the biggest reasons for changing to these involves the attempts to meet the Federal standards relative to emissions. Reduced maintenance is a fringe benefit. I guess most of



Proper Spark Plug Color

Help!
Last year at Hershey, an Airflow being judged was downgraded because he didn't have the correct color spark plugs. Since I need to get new plugs, I'm hoping someone can tell me what color, range (#) and place to purchase the plugs for the aluminum head?
Thanks, Jon Clulow, Pasadena, MD

Most likely they took off for an aluminum or cad base on the sparkplugs as all plugs that old were black base. You can just paint them with black engine enamel if you like. Don Mitchell, ACA Chief Judge