

From the Horse's Mouth....

The Champion Spark Plug Company was founded in 1910, and they continue in business today, over 100 years later. Who better to discuss spark plugs - the types of spark plugs, the heat ranges, the types of engines in which they are used, construction of spark plugs and troubleshooting sparkplugs - than the company that makes them.

Following is a reprint (of most) of a Service Manual issued in 1954 for Champion Sparkplug Salesmen. It was intended to make 'experts' of the salesmen; it can do the same for you, too.

For servicing plugs, Champion recommends the following procedures:

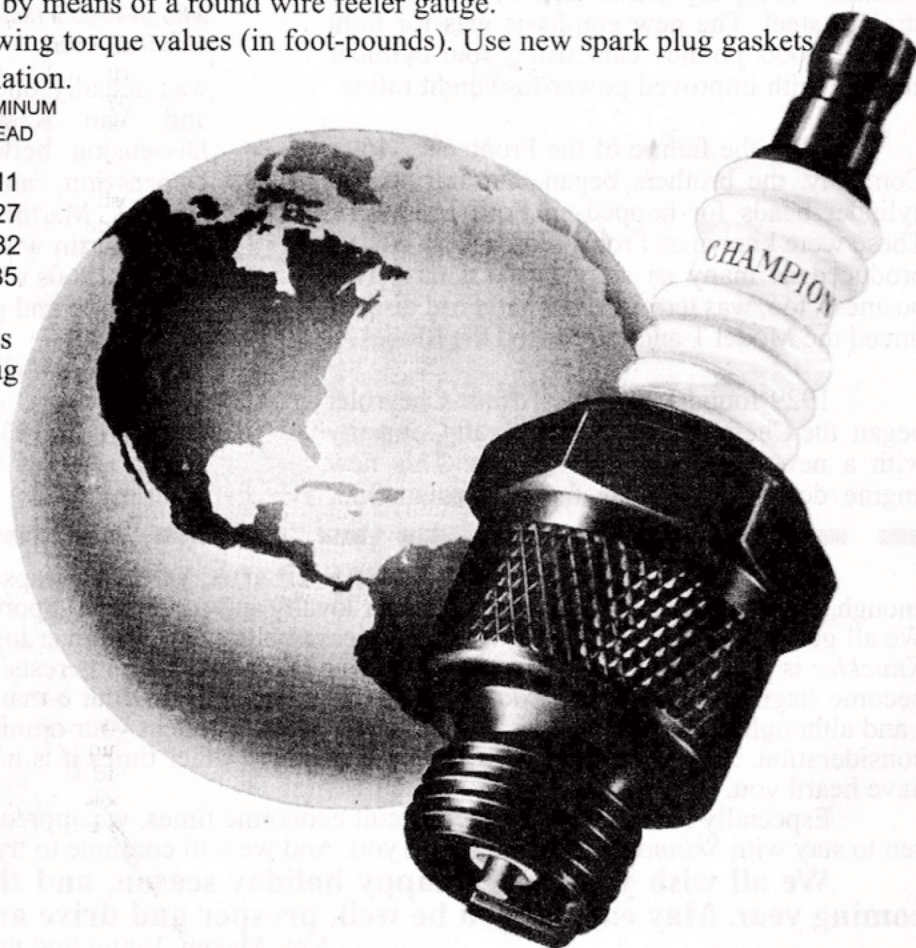
1. Loosen spark plug about two turns.
2. Air blast dirt away from spark plug ports.
3. Remove oily deposits from plugs with petroleum solvent (*We do not recommend using gasoline. Aerosol brake cleaner or even paint thinner is a much better and safer choice.*)
4. Abrasive blast spark plugs for three to six seconds. (*We do not recommend abrasive blasting either. It can break down the glaze on the porcelain.*)
5. Clean the spark plug threads with a fine wire rotary or hand brush.
6. File electrode sparking areas vigorously to obtain bright, flat, parallel surfaces.
7. Reset spark plug gap to specifications by bending only the side electrode.
8. Check the spark plug gap by means of a round wire feeler gauge.
9. Tighten plugs to the following torque values (in foot-pounds). Use new spark plug gaskets

for every installation.

THREAD SIZE	CAST IRON HEAD	ALUMINUM HEAD
10MM	14	11
14MM	30	27
18MM	34	32
7/8"-18	37	35

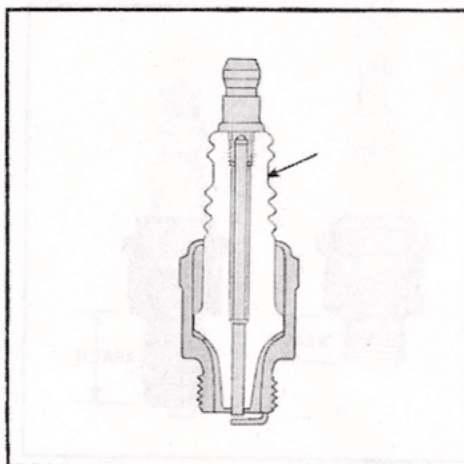
If a torque-indicating wrench is not available, seat the spark plug on a new gasket finger-tight, then tighten as follows:

THREAD SIZE	NUMBER OF TURNS
10MM	$\frac{3}{4}$ - 1
14MM	$\frac{3}{4}$
18MM	$\frac{1}{2}$ - $\frac{3}{4}$
7/8"-18	$\frac{1}{2}$ - $\frac{3}{4}$

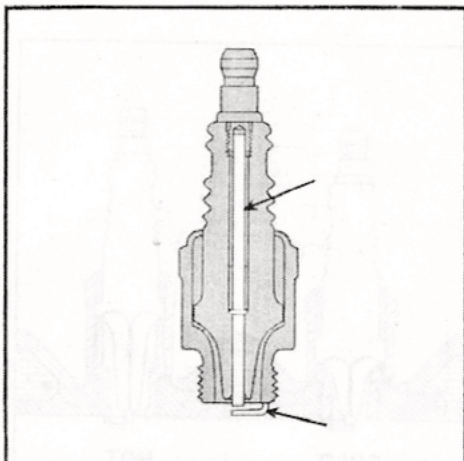


SPARK PLUG CONSTRUCTION

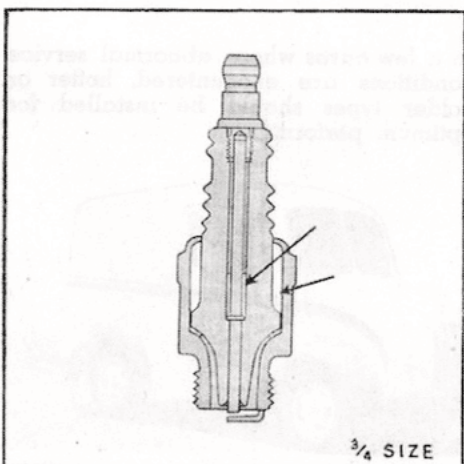
All spark plugs have certain parts in common, but Champions have a number of exclusive features which assure superior performance under all operating conditions. Knowledge of these design superiorities is helpful in selling and servicing Champion Spark Plugs.



CHAMPION-CERAMIC INSULATOR



SPECIAL ALLOY ELECTRODES



SILLMENT SEAL

The Champion-Ceramic Insulator is a product of the world's finest ceramic research laboratory. A composition of rare mineral oxides, the insulator blanks are formed under extreme hydraulic pressure in multiple-place automatic presses. This unique molding process, followed by carefully controlled high temperature kiln firing, assures a high density, homogeneous insulator, completely concentric and free of internal stresses. The end result is that Champion insulators have greater mechanical strength in service, higher resistance to sudden heat shocks, and a uniformly high rate of heat transfer. All of these characteristics are essential to a perfectly balanced spark plug insulator.

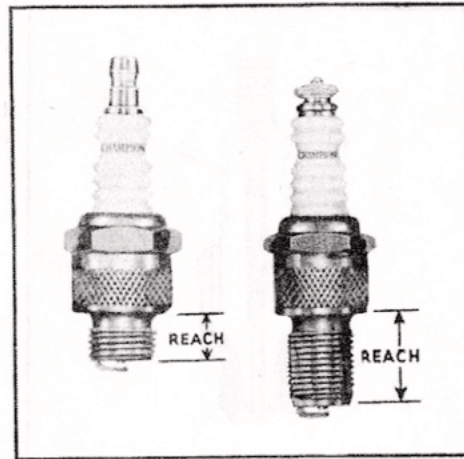
Special Alloy Electrodes are the result of intensive metallurgical research supplemented by years of laboratory and field testing. The alloy provides maximum resistance to erosion due to the heat and products of combustion, assuring longer spark plug life. Gap designs utilized in various Champion plug types are those which provide easier starting, smoother idle and better all-round performance in their particular application.

The Sillment Seal, another exclusive Champion development, eliminates overheating of spark plugs due to excessive compression leakage. Compressed as a dry powder between the center electrode and insulator, and between the shell and the insulator, this seal remains effective for an indefinite period under all operating conditions. The result is longer service life and wider, more uniform spark plug heat range.

These **exclusive** and **patented** features are products of specialization and continual product improvement. Working in close cooperation with leading engine manufacturers and fuel suppliers, Champion's unexcelled research, engineering and production facilities always have been devoted to the one task of making better spark plugs. This policy is the foundation for Champion's traditional sales leadership and performance superiority.

SPARK PLUG SIZES

Wide variations in engine design necessitate a number of spark plug thread sizes and thread lengths or "reaches". At present most engines use $\frac{7}{8}$ "-18, 18mm, 14mm or 10mm thread sizes. A few stationary engines utilize $\frac{1}{2}$ " pipe or even $\frac{3}{4}$ " pipe thread spark plugs, but these are in the minority. Thread length may differ, depending on the use of cast iron or aluminum cylinder heads, while many European engines require extra long spark plug reaches. In all cases the proper spark plug type to install is specified in the Champion Size Chart, available upon request.



THREAD LENGTH OR "REACH"

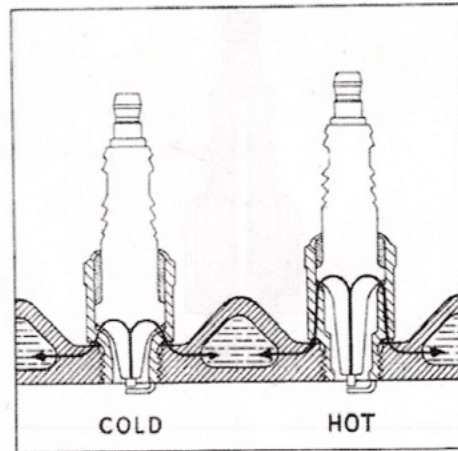
SPARK PLUG HEAT RANGE

Spark plugs also are made in a number of "heat ranges" to satisfy a variety of possible operating conditions. Heat range simply refers to the ability of a spark plug to conduct heat away from its firing end.

Those types having a long insulator firing end transfer heat slowly and are used where combustion chamber temperatures are relatively low. Such a condition may be found during sustained idling, stop-start service and similar "light load" operation. The requirement here is to sustain spark plug temperature in order to burn off normal combustion deposits and avoid fouling.

Spark plugs having a short insulator firing end transfer heat away rapidly and are used where combustion chamber temperatures are relatively high. This condition is associated with high speed running, heavy loads and similar "severe service". Spark plugs operating under these conditions must remain cool enough to avoid pre-ignition and excessive gap erosion.

Unless otherwise specified, the spark plug types recommended in the Champion Size Chart are for all normal operating conditions.

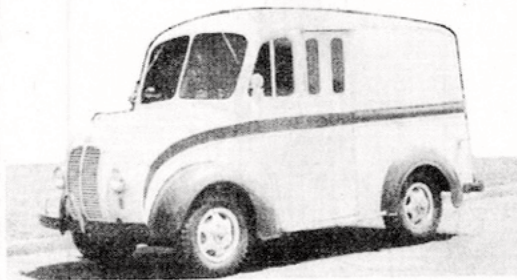


HEAT FLOW PATHS IN "HOT" AND "COLD" TYPE PLUGS

In a few cases where abnormal service conditions are encountered, hotter or colder types should be installed for optimum performance.



HEAVY SERVICE REQUIRES "COLD" PLUGS

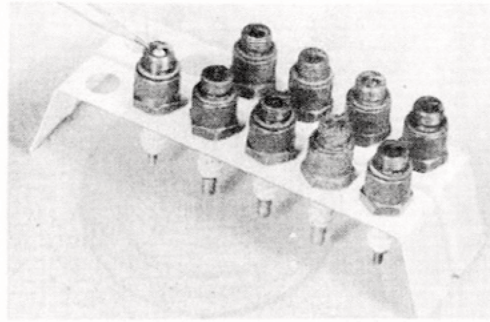


LIGHT SERVICE REQUIRES "HOT" PLUGS

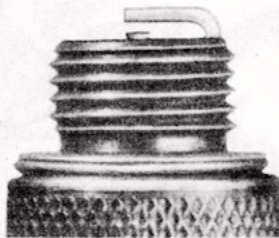
ANALYZING SERVICE CONDITIONS

It is an established fact that so-called spark plug troubles are seldom traced to faulty spark plugs. Instead, difficulties usually result from (a) poor spark plug installation, (b) abnormal operating conditions which necessitate hotter or colder spark plugs, and (c) engines in need of overhaul or adjustment.

Used spark plugs together with their gaskets are usually the best guide to the type and source of trouble. Therefore, it is good practice to inspect each plug and its gasket as they are removed from an engine. Placing the spark plugs in a holder will keep them in the order of removal, and will assist in locating possible trouble.

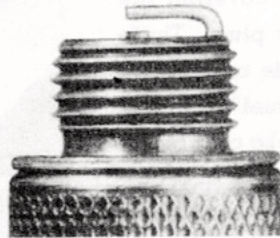


EXAMINE SPARK PLUGS
AND GASKETS



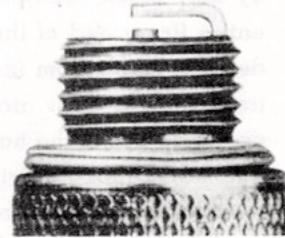
NORMAL

A gasket which is compressed to about three-quarters original thickness, with smooth parallel surfaces, indicates that the spark plug was properly installed and tightened.



TOO TIGHT

Gaskets which are compressed too much or too little reveal improper tightening during installation. Rough, corroded surfaces also indicate gasket seats were not cleaned before installation. In any case, resulting compression leakage may have overheated the spark plugs, causing excessive electrode erosion.

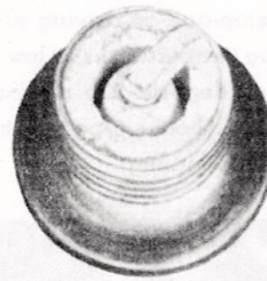


TOO LOOSE



NORMAL
(Mixed High and Low Speed)

Brown to greyish tan deposits and slight electrode wear indicate correct spark plug heat range and mixed periods of high and low speed driving. If the whole set looks this way, chances are cleaning and regapping are all that's required.

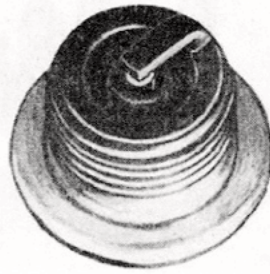


NORMAL
(Constant or Low Speed)

White to yellowish deposits indicate constant speed or slow speed city driving. Deposits have no effect on performance if the plugs are cleaned thoroughly at 3,000-4,000 mile intervals. Remember to "wobble" plug during abrasive blasting.

Service Procedure—Clean and re-gap these spark plugs according to the recommended procedure. Use new gaskets and reinstall to the proper torque tightness.

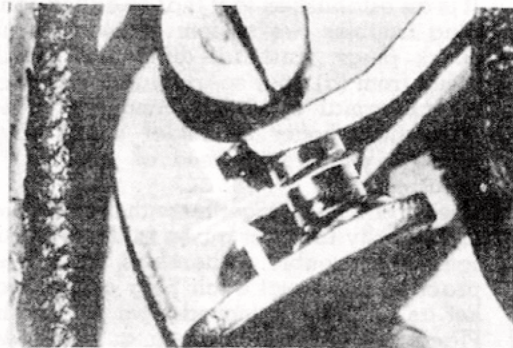
ANALYZING SERVICE CONDITIONS



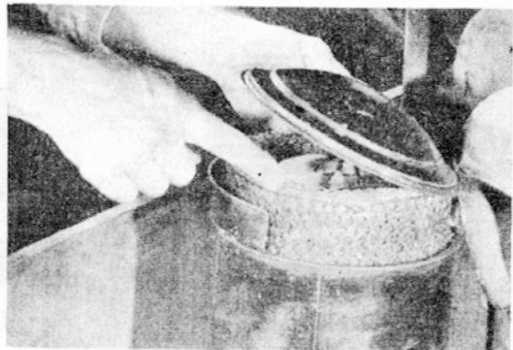
GAS FOULED

Gas or fuel fouling usually is identified by dry, black, fluffy deposits covering the entire firing end of the spark plug. These deposits result from incomplete combustion traceable to over rich air-fuel mixtures, excessive use of the hand choke or a faulty automatic choke. Dirty air filters also can restrict normal air flow to the carburetor enough to cause fuel fouling. In addition, defective breaker points, coil, ignition cable or battery connections can reduce voltage supplied to the spark plug and cause misfiring. If fouling is evident in only a few cylinders, sticking valves may be causing the trouble.

Excessive idling, slow speeds under light load, or stop-and-go driving also can keep spark plug temperatures so low that normal combustion deposits are not burned off. In such a case, hotter type spark plugs may alleviate gas fouling.



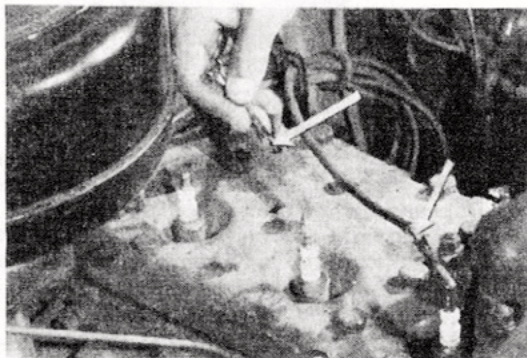
✓ WORN, IMPROPERLY SET BREAKER POINTS



✓ CLOGGED AIR FILTER



✓ GUMMED, STICKING VALVES



✓ WORN IGNITION CABLE



✓ FAULTY, CLOSED CHOKE

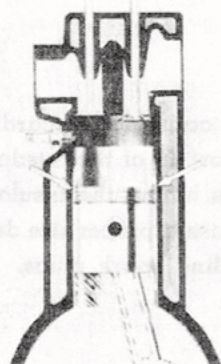
ANALYZING SERVICE CONDITIONS



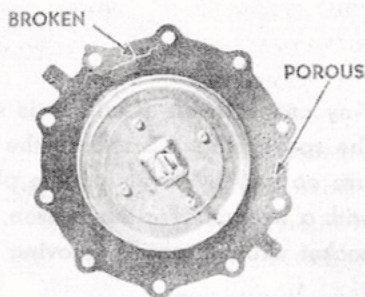
OIL FOULED

Oil fouling, identified by wet, sludgy deposits, is a result of excessive oil entering the combustion chamber. Worn cylinders and piston rings, or excessive valve stem clearances, are the most common causes of poor oil control. On older engines, oil may enter the intake manifold through a broken or porous vacuum booster pump diaphragm.

While hotter type spark plugs will reduce oil fouling tendencies, an engine overhaul may be necessary in severe cases to obtain satisfactory service.



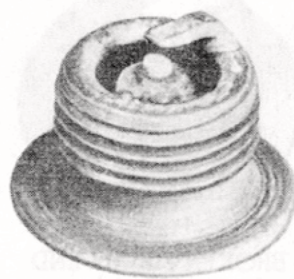
✓ FAULTY PISTON RINGS



✓ FAULTY VACUUM BOOSTER PUMP DIAPHRAGM

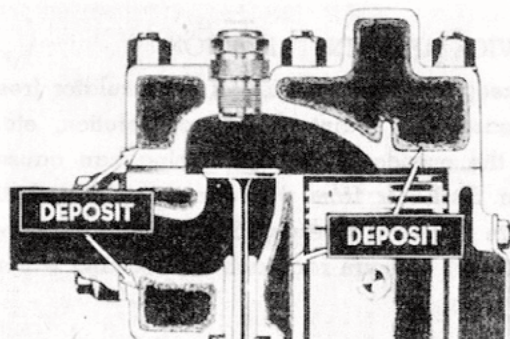


✓ WORN VALVE STEMS OR GUIDES

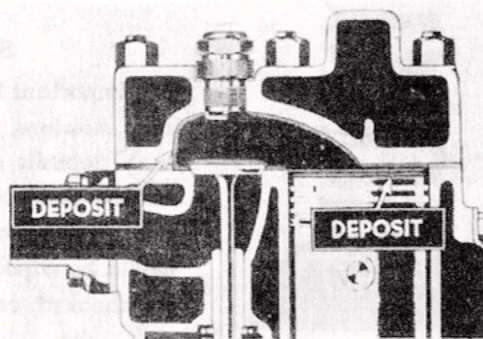


BURNED

Burned or overheated spark plugs may be identified by a white, burned or blistered insulator nose, and badly eroded electrodes. A faulty thermostat, clogged water passages or excessive deposits in the combustion chamber can result in general overheating. If only a few spark plugs are overheated, the cause may be uneven distribution of the coolant or poor plug installation. Improper spark timing or the wrong fuel type also can cause detonation and overheating. In addition, sustained high speed—heavy load service can produce abnormally high temperatures which necessitate use of colder spark plugs.

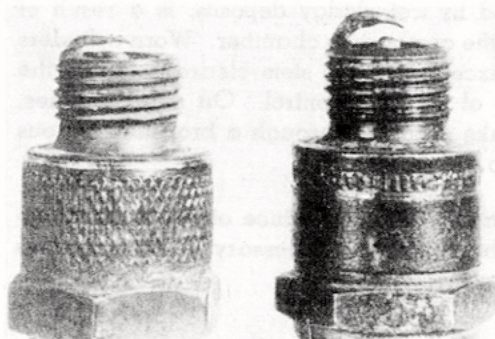


✓ CLOGGED WATER PASSAGES



✓ COMBUSTION CHAMBER DEPOSITS

ANALYZING SERVICE CONDITIONS



WORN-OUT SPARK PLUGS

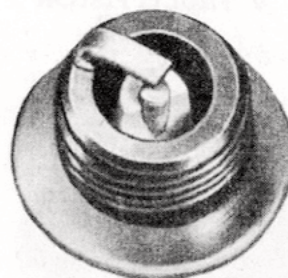
All spark plugs wear out in time, and should be replaced periodically with new Champions to assure maximum economy and peak performance. Spark plugs which test below the "Fair" zone on the "Sparking Comparator" usually should be replaced. Also, if electrodes are eroded enough to make accurate gap setting impossible or if excessive compression leakage is noted new spark plugs should be installed.



CRACKED INSULATOR

Any crack in the insulator is sufficient cause for discarding the spark plug. Cracks in the upper portion of the insulator are caused by dropping the plug or by hitting the insulator with a wrench. For this reason, always use a proper size deep socket wrench when removing or installing spark plugs.

Cracked or broken insulator firing ends result from bending the center electrode while setting the spark gap. To avoid damaging the insulator, bend only the side electrode.



BROKEN FIRING END



DIRTY INSULATOR

SERVICE AFTER INSTALLATION

It is important to keep the upper portion of the insulator free from moisture, grease, dirt, paint, anti-freeze solution, etc. Such deposits on the outside of the spark plug can cause surface shorting or flashover from the terminal to the shell with resulting misfire and hard starting. Spark plug insulators should be wiped off with a clean rag each time oil and water are checked, or oftener.

CHAMPION 2 CYCLE ENGINE TROUBLE SHOOTING CHART

The following tabulation of common engine troubles and their probable causes will prove helpful in diagnosing service complaints.

Occasional Miss at High Speed

- Spark plug gaps too wide
- Weak coil or condenser
- Poor carburetion
- Weak spring on breaker points
- Breaker points improperly adjusted
- Overheated spark plugs

Missing Under Slow Hard Pull

- Weak coil
- Spark too far advanced
- Spark plug gaps too wide
- Partially fouled spark plugs
- Defective ignition cable
- Defective breaker points

Engine Knocks Badly

- Fuel anti-knock value too low
- Spark advanced too far
- Spark plugs overheated causing pre-ignition
- Fuel-air mixture too lean
- Overheated engine
- Excessive combustion chamber deposits

Engine Will Not Idle

- Carburetor jets clogged
- Spark plug gaps too close
- Leaking carburetor or manifold gaskets
- Improper carburetor idling adjustment
- Sticking valves
- Weak coil or condenser
- One or more plugs fouled

Hard Starting

- Weak battery
- Moisture on plugs or in distributor
- Faulty battery cable or ground connection
- Weak coil or condenser
- Spark plugs worn out or dirty
- Carburetor needs cleaning or adjusting

Engine Overheats

- Fuel-air mixture too lean
- Improper ignition timing
- Insufficient water in radiator
- Stoppages in cooling system
- Excessive combustion chamber deposits
- Slipping fan belt
- Insufficient oil circulation

Engine Backfires

- Air-fuel mixture too lean
- Improper timing
- Intake valves sticking

Engine Operation Erratic

- Air leaks in manifold or carburetor connections
- Improper air-fuel mixture
- Fuel tank nearly empty
- Loose ignition system connections
- Water in fuel
- Faulty choke control

CHAMPION SPARK PLUG HEAT RANGE CHART

SPARK PLUGS FOR AUTOMOTIVE ENGINES			SPECIAL SPARK PLUGS FOR EUROPEAN ENGINES			SPECIAL SPARK PLUGS FOR RACING ENGINES		
Thread Size	Heat Range	Type Designation	Thread Size	Heat Range	Type Designation	Thread Size	Heat Range	Type Designation
7/8"-18	HOT ↕ COLD	3 Com. 2 Com. L. 20 C-4 1 Com. 0 Com.	14 mm 1/2"	HOT ↕ COLD	L-8 L-10 L-10S LA-10 L-11S LA-11 LA-14 LA-15	18 mm 1/2" Reach	HOT ↕ COLD	R-3 R-7 R-1 R-2-S** R-11 R-11-S** R-2
18mm	HOT ↕ COLD	10 Com.-64, 9 Com.* 9, C-15* 8 Com. 15-A C-7 7 6 Com. 5 Com., H-17-A* 4 Com., H-16-A*	14 mm 3/4" Reach	HOT ↕ COLD	N-8B NA-8 NA-10 NA-12 NA-14 NA-19	18 mm 3/4" Reach	HOT ↕ COLD	R-15 R-16 R-17 R-18
SPECIAL SPARK PLUGS FOR OUTBOARDS AND 2-CYCLE ENGINES								
14mm	HOT ↕ COLD	J-14 J-12 J-11 J-8 J-7 J-6 J-5 J-2	14 mm 3/4" Reach	HOT ↕ COLD	J-12J J-11J J-8J J-7J, HO-8A† J-6J J-3, HO-3† K-3	18mm (Diesel)	Long Regular	36 901
14mm 7/16" Reach	HOT ↕ COLD	H-12 H-11 H-10 H-9 H-8	14mm 7/16" Reach	HOT ↕ COLD	HT-10J H-10J	18mm (Hesselman)	Long Extra Long	49 DL-8C D-8
10mm	HOT ↕ COLD	Y-8 Y-6 Y-4-A	14mm 7/16" Reach	HOT ↕ COLD		1/2" Pipe	Extra Long Extra Long Long Long Regular Regular	34 32 31 33 30 A-25
						3/4" Pipe	Regular Long	37 38

Plugs have equal performance... We are changing our 18mm numbering system... Asterisk () indicates type designation to be discontinued.
†Specially designed for Homelite Engines.

* Plugs have equal performance. We are changing our 18mm numbering system. Asterisk (*) indicates type designation to be discontinued.

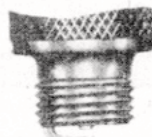
AUTOMOTIVE TYPES			
Thread Size	CHAMPION TYPES	TO REPLACE	
		AC	AUTOLITE
7/8"-18	3 Com. 2 Com. L. C-4 20 1 Com. 0 Com.	78L-Com. 77L-Com. 78-S 78, 77-Com., 76-S, 76 75-Com., 74 73-Com.	TT1, TT10... T9 TT8, TT, T5 TT4
18 mm	10 Com.-64, 9 Com.* 9, C-15* 8 Com. 15-A C-7 7 6 Com. 5 Com., H-17-A* 4 Com., H-16-A*	88L-Com. 88, 87S-Com. 85-Com., 86-Com., 87-Com. 85S-Com. 86 84 83-Com., 83S-Com. 82, 82-Com., 82S-Com. 81S-Com.	B11 BR10, BT-10 B9, BR8, BT8 BT BT6 B5, BR4, BT4 B3, BT3
14mm 3/8" Reach	J-12 J-11 J-8 J-7 J-6 J-5	48, 48X, 47-Com. 46, 46X, 46-5, 46-Com. 45, 45-Com., 44-5, 44-5 Com., 45R 44, 44-Com., 43-5 43-Com., 42-5 Com. 42-Com.	A11, AR10, AT10 A9 AR8, ARS, A7 48-140, 48-165 A5, AR5, AN5, AT6 AR4, AT4 A3, 48-250
14mm 1/2" Reach	H-11 H-10 H-9 H-8	46L 43L, 45L-Com. 43L-Com. 43L	ARL8 AL7 ARL5 AL5
10mm	Y-8 Y-6 Y-4-A	M-8, 108 106, 104 104-Com., 103-Com.	P6, PR6 P4 PR4

Torque Wrench Chart

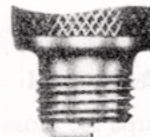
Ft. lbs. torque for tightening plugs

Plug Thread	Cast Iron Head	Aluminum Head
10mm	14	11
14mm	30	27
18mm	34	32
7/8"-18	37	35

Spark Plugs with "J" Type Ground Electrodes



"J" TYPE



REGULAR

The following plugs with "J" type ground electrodes are available for Outboards and other 2-cycle engines

5M-J, J-12J, J-11J, J-8J,
J-7J, J-6J, H-10J, HT-10J

NOTE: "J" type ground electrodes are cut off at center line of plug.