

Suck it and see

A vacuum gauge allows you to detect faults and tune an engine for performance and economy. Follow Brian Cox's step-by-step guide to saving money.

IT'S CHEAP, but effective. The modestly-priced vacuum gauge will ensure our classics' engines are tuned to perfection, and thereby cut harmful emissions to a minimum. It can be used to adjust the carburettor and timing, as well as detecting engine faults.

If economy is your objective, it can be fitted as an auxiliary instrument on the dashboard. Maintaining the highest possible vacuum reading at a given engine speed will cut fuel bills.

As a tuning device, the effect of any carburettor adjustment will lead to a better mixture. This results in more of the fuel drawn into the engine being used and less wasted energy. As more power is also being produced by the fuel, so the pistons exert greater impulses on their power strokes, increasing the engine speed for a given throttle opening.

The same applies when using the gauge to adjust ignition timing. A setting that is too far advanced or retarded will result in a lower gauge reading, so our aim must be to obtain the highest steady vacuum reading to ensure maximum power and economy.

Apart from tuning, the vacuum gauge can be used to identify faults including misfiring spark plugs, leaking or sticking valves, a blowing head gasket, incorrect valve timing and poor compression as well as manifold and carburettor air leaks.

You can use a gauge purely as a portable test instrument, or buy one specially for installation on the dashboard to provide a constant check on engine efficiency and economy.

HOW MUCH?

IF YOU settle for a test gauge, these are readily available from



accessory shops. I chose the Gunson Lo Gauge, price £12.81. Apart from engine tests, it also has a scale to test inlet vacuum and outlet pressure of electrical and mechanical fuel pumps.

The Lo-Gauge can be used for balancing air flow in multi-carburettor engines with one carburettor per cylinder (as on motor cycles), provided you use one

per cylinder. It isn't suitable for engines with two or more carbs to a single inlet manifold as on many MG and Triumph sports cars. Gunson's Carbalancer has been designed for this work.

New gauges for dashboard mounting are more difficult to find, but Speedograph Richfield of Nottingham (0115 926 4235) stock new gauges plus fittings

HOW IT WORKS

- Although we look upon vacuum as being some sort of space devoid of air or a form of suction, vacuum is actually a pressure — but a negative pressure that is lower than atmospheric (positive) pressure, which is 14.7psi.

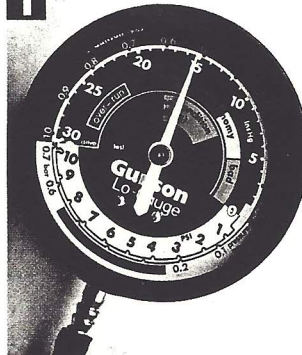
- As atmospheric pressure decreases with the increase in altitude above sea level, an allowance has to be made in the vacuum readings we obtain. The gauge will read lower by 1in for every 1000ft above mean sea level. (An indication of the height above sea level in your area is often found on river bridges.)

- Traditionally, the level of vacuum is measured in inches of mercury (abbreviated to in Hg), a carry-over from the days when a column of mercury was used to measure vacuum. In the text this has been abbreviated to in.

- The motor trade is standardising on the unit of Bar to measure pressure, and other units used are millibar (mbar). 1000mbar equals one Bar. Atmospheric pressure (14.69psi) equals 1013mbar. Pure vacuum, which is unobtainable, is 29.9in Hg.

GAUGE READINGS: WHAT THEY INDICATE

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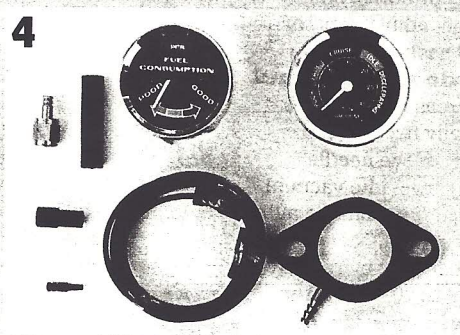
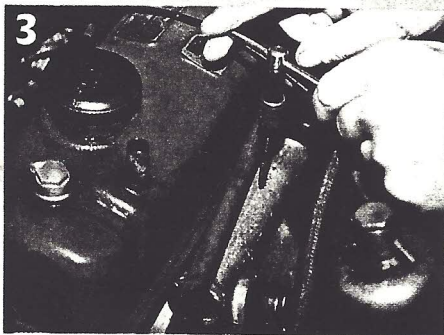
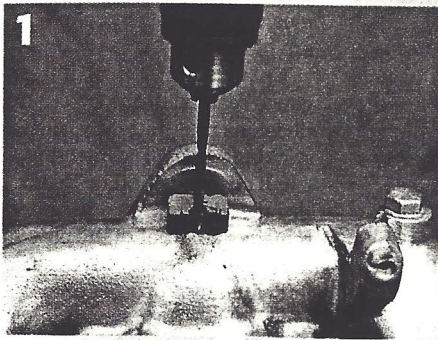
STARTER VACUUM: reading should be 15in, or 12in if engine has twin carbs with balance pipe.

2

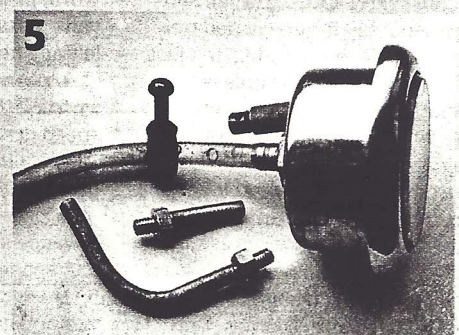


NORMAL VACUUM: at idle around 18-22in (4 cyl), 19-21in (6 cyl), or 15-18in on low compression engines.

CONNECTING UP



- 1** Inlet manifold must be drilled and tapped close to carburettor flange for take-off nipple. Use grease, a magnet or both to prevent swarf entering engine.
- 2** If you don't want to drill manifold, screw nipple into insulation block. You may need longer studs if you do this.
- 3** On twin carburettor engines, take-off point is the centre of the manifold's balancing pipe.
- 4** Smiths economy meter, Speedograph vacuum gauge and various fittings available from Speedograph Richfield.
- 5** To prevent gauge needle pulsating, fit a restrictor to tubing. This one is homemade.



● Whichever type of gauge you choose, it will have to be connected to the car's inlet manifold. Some vehicles already have a connection or pipe in place that can be adapted for the purpose.

● You may be able to use the connector to the distributor for the vacuum advance, provided the pipe leads to the manifold rather than the carburettor. You may also be able to use a brake servo connection on the manifold, or in the case of side-valve Ford models, to the

wiper vacuum outlet.

● If you find it necessary to drill and tap the manifold, this should be done close to the engine side of the carburettor. Alternatively, you can drill and tap a thick spacer and insert it between the manifold and carburettor.

● On cars with twin carburettors, the tapping should be in the centre of the balancing pipe between the manifold inlets.

Use a suitable drill for tapping a 2 or 3BA thread for the take-off nipple. You can also

make a suitable nipple quite easily. I used some thick wall copper brake pipe, which I threaded 2BA. When you have completed your tests, the nipple can simply be replaced with a suitable blanking screw.

● If you have to drill the manifold, you may prefer to remove it from the car to prevent swarf getting into the engine. However, you can minimise the chances of this happening by putting heavy grease on the drill bit and tap, and/or placing a magnet close by to attract the drillings.

and adapters. Secondhand gauges can be found at autojumbles.

CHECKLIST

THE NORMAL vacuum reading for an engine at idling speed, at which the majority of tests are carried out, will be influenced by a number of factors. These include the engine's compression ratio, number of cylinders

and height above sea level.

At sea level a rough guide is 18-22in (4 cylinders), 19-21in (6 cylinders), 20-22in (8 cylinders) or 15-18in on pre-1950 low compression engines. For every 1000ft above sea level, deduct 1in.

The illustrations show either 18in or 20in as normal vacuum readings at idle. Irrespective of the idle reading, needle variations

will be by the same number of inches for any given fault. For example, inlet manifold air leaks will show variations between 18 and 11in or 20 and 13in.

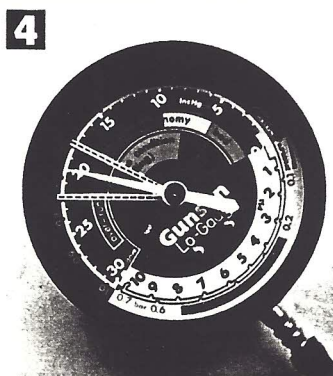
To check an engine thoroughly, you have to carry out the checks systematically. However, if you are sure that only the timing and carburettor need adjusting, you can omit the initial checks and

start immediately with the tuning. Otherwise carry out the following tests first.

Starter vacuum test: first warm up the engine. Then switch off and make sure the choke is off. Ensure the carburettor butterfly is closed completely and with the ignition immobilised, operate the starter for about 15 seconds. If the



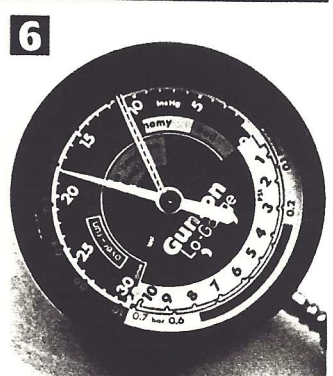
CYLINDER BALANCE: with engine idling, short out each plug. Changes in vacuum reading should be even.



AUTOMATIC ADVANCE: increase engine speed to 1200-1500rpm. Needle should fall and rise as shown.



EXHAUST CHECK: block tailpipe and run engine fast, gauge needle should drop back several inches.



AIR LEAKS: reading 3-8in lower than normal reading at idle indicates leakage in induction system.

BE PRACTICAL Tuning and fault-finding

gauge reading is 15 in or over, there is no leakage past the carburettor butterfly, manifold leaks or hot-spot perforations.

If the reading is low, a piece of cardboard can be inserted between the carburettor and inlet manifold and the nuts retightened. This should give a slightly higher reading. If there is a big increase, butterfly spindle wear may be the cause. No increase points to poorly seated valves or inlet manifold leaks.

Normal vacuum: all subsequent checks are carried out with the engine running at a fast idle (about 850rpm) unless stated otherwise. Note the gauge's reading, which should be steady between 18in and 22in.

If the needle goes back and forth without indicating any definite fault, there is a combination of maladies awaiting correction, which ensuing tests will reveal.

Cylinder balance: for smooth running, each cylinder must develop its full power. By shorting out each plug in turn you should get an equal drop in vacuum reading. This should be

from ½in to 2in. The amount isn't so important as the uniformity, as any cylinder with a lower increase than the remainder is suspect. If only a very small drop is obtained on all cylinders, then the engine is very inefficient. Usual causes are a high tension ignition fault, choked silencer, leaking inlet manifold or worn carburettor.

A drop of say 1½in on three cylinders and ½in on the fourth points to a faulty or loose plug, worn, pistons or bores, faulty valve or tappet adjustment, or leaking head gasket.

Automatic advance and retard: increase the engine speed gradually from idle to 1200-1500rpm. If the needle drops slightly from idle vacuum then rises to about 22in, the auto advance and retard is okay.

A second check is by revving up the engine to 3000rpm. The vacuum gauge needle should drop back just below 5in from 18 or 20in. As it does so, the automatic advance mechanism will operate and engine performance improves. This will be accompa-

nied by a momentary increase around 16-18in before falling back to its lowest reading.

Choked exhaust: if after carrying out the second advance and retard check you release the throttle suddenly, the needle should spring back quickly to its normal vacuum at idle. If it doesn't, a choked silencer or exhaust system may be causing too much back pressure.

Another way to establish this is to block the end of the tailpipe and run the engine at high revs. The needle should drop several inches if the system is sound.

Air leaks: a check for induction air leaks can be made with the engine idling. A leak will be indicated by a steady reading 3-8in lower than the normal 18-20in at tickover, with a tendency to drop further depending on engine speed and amount of leakage.

Faulty head gasket: although a more positive test is provided by a compression test, a vacuum gauge also indicates head gasket leakage. The needle will drop sharply from its maximum reading at idle to 10in or

lower and quickly return to maximum. A greater drop than this means two adjacent cylinders are blowing.

Valve problems: if the gauge reading drops two to five divisions intermittently, suspect sticking valves. Try injecting a small quantity of oil or Redex through the carb as a temporary remedy and proof of the problem.

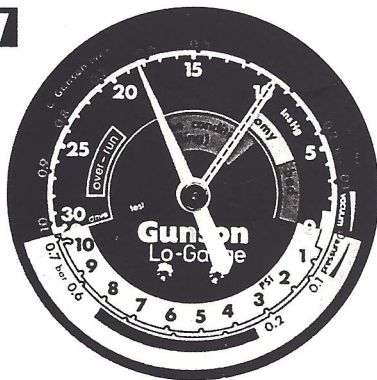
Burned or leaky valves are indicated by a drop of one or more inches from maximum at idle. The drop will be slow at regular intervals if only one valve is affected. Uneven or incorrect valve clearances can give similar readings.

If you have rebuilt the engine and it's overheating, have you got the valve timing wrong? A gauge reading fluctuating between 5in and 10in will confirm this.

Also check the springs for weakness or fracture. Increase the engine speed steadily to the safe maximum limit. A vacuum reading fluctuating rapidly between 10in and 24in and increasing with the engine speed is a definite indication that the

GAUGE READINGS: WHAT THEY INDICATE

7



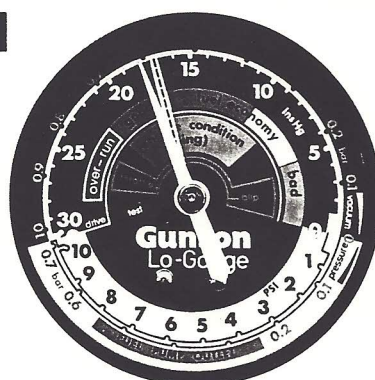
BLOWN GASKET: a sharp drop from around 18in to 10in or below at idle indicates gasket blowing.

8



STICKING INLET VALVE: indicated by drop of up to 6in. Inject Redex through carb to confirm.

9



LEAKY VALVE: a drop of about 1in at idle may be due to a burnt valve, or insufficient clearance.

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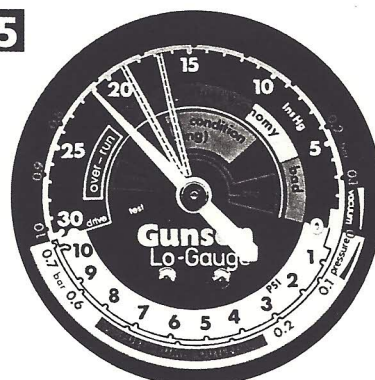
FAULTY IGNITION: chattering needle means weak coil, burnt points, faulty leads or distributor cap.

14



IRREGULAR KICK: plug gap too close or fouled, pitted or burnt cb points, loose auto advance springs.

15



HIGH VACUUM: if accompanied by irregular kick-back, suspect advanced timing or faulty condenser.

springs have become weak.

Leaky piston rings: although a compression test should be carried out for confirmation, the trusty vacuum gauge provides a useful pointer of leakage past the piston rings.

Run the engine at idling speed and fully open the throttle quickly, then close it rapidly. If the reading drops to around 5in and then jumps to 5in above normal idle vacuum reading, the rings are okay. A rise of less than 5in indicates loss of compression due to worn bores or faulty rings.

However, diluted or poor quality oil may also be to blame, so double check with a compression test.

Ignition tests: although we normally rely on electrical tests of ignition equipment, the vacuum gauge has its uses here.

Incorrect plug gaps, leaking ignition cables, burned contact breaker points or a corroded distributor cap will cause an excessive chattering of the needle about 1in either side of the normal idle reading. It's then a case of cleaning or replacing various parts until the chattering stops.

TUNING FOR PERFORMANCE

- Assuming your engine is down on power merely through being out of tune, then the vacuum gauge will ensure it is spot on.

As the tests are carried out with the engine running at idling speed, they will compensate for any wear in the timing gear and thus improve on the manufacturer's ignition setting.

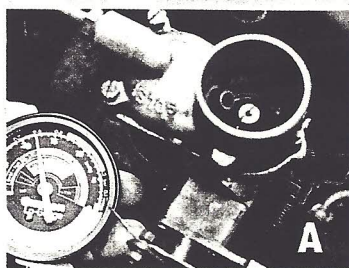
- Start by thoroughly warming up the engine, then connect the gauge and let the engine tick over, noting the vacuum reading.

- Assuming the car has a fixed jet carburettor, adjust the mixture screw for the highest steady vacuum reading that can be obtained (picture A). Blip the throttle and note the effect. If the vacuum reading becomes steadier, adjust the carburettor at a slightly higher

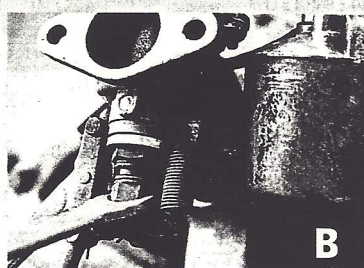
idling speed. Now readjust the carburettor again to obtain the highest steady vacuum reading. Richen the mixture until the needle is about to fall, which is the point that gives the maximum power.

- Adjustment of idling mixture strength on SUs produced until the early 1970s is by a jet adjuster nut, which is screwed up to raise the jet and so weaken the mixture and down to enrich it (picture B). Proceed as above to obtain the best setting.

- Next step is to slacken the distributor clamp bolt, and with the engine still idling advance or retard the ignition until the highest steady reading is obtained (picture C). Then retard the timing until the vacuum gauge reading drops by ½in. The engine should now be tuned to perfection, as a test run will confirm.



Adjust carburettor mixture to give highest possible steady reading.



Mixture on most SU carbs fitted to classics is by screwing this nut up to richen.



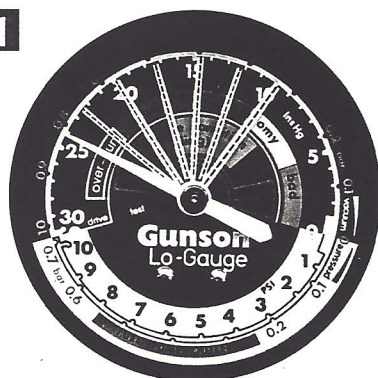
Turn distributor to achieve highest steady gauge reading.

10



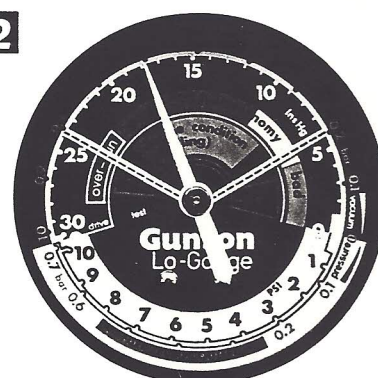
LATE VALVE TIMING: this is indicated by needle fluctuating between 5in and 10in at idle.

11



VALVE SPRINGS: weak springs will cause needle to fall to 10in and fluctuation as speed increases.

12



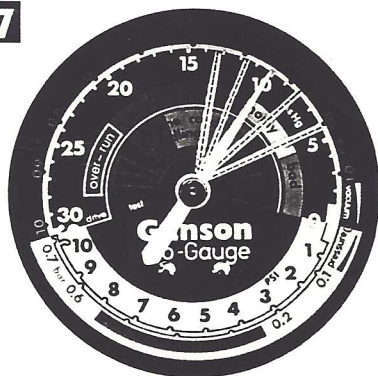
PISTONS: open throttle, close quickly. Needle should drop and jump to 5in above normal if rings sound.

16



LOW VACUUM: if needle floats between 15-18in mixture is rich. Check air cleaner and float level.

17



FAULTY HOTSPOT: low vacuum of 10in with 6-14in needle flicker indicates burnt hotspot plate.

18



LATE IGNITION: a steady needle 2-3in below normal at tickover indicates retarded ignition.