

VOM with calibration circuit measures ignition dwell angle

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To extract the best gas mileage from an automobile engine equipped with the conventional Kettering ignition system, the distributor point gap or dwell angle must be set correctly from time to time. And, though the angle can be measured with a commercially available instrument known as a dwell meter, which has a scale calibrated in degrees, a cheap version may not be accurate, and an accurate one is expensive. The handy volt-ohm-milliammeter (VOM), however, can do the job just as well as the better dwell meters if a suitable calibration circuit is added to it.

A circuit for this function that costs about \$5 in parts is diagrammed below. It includes a constant-current source and a voltage regulator so that the normal volt-

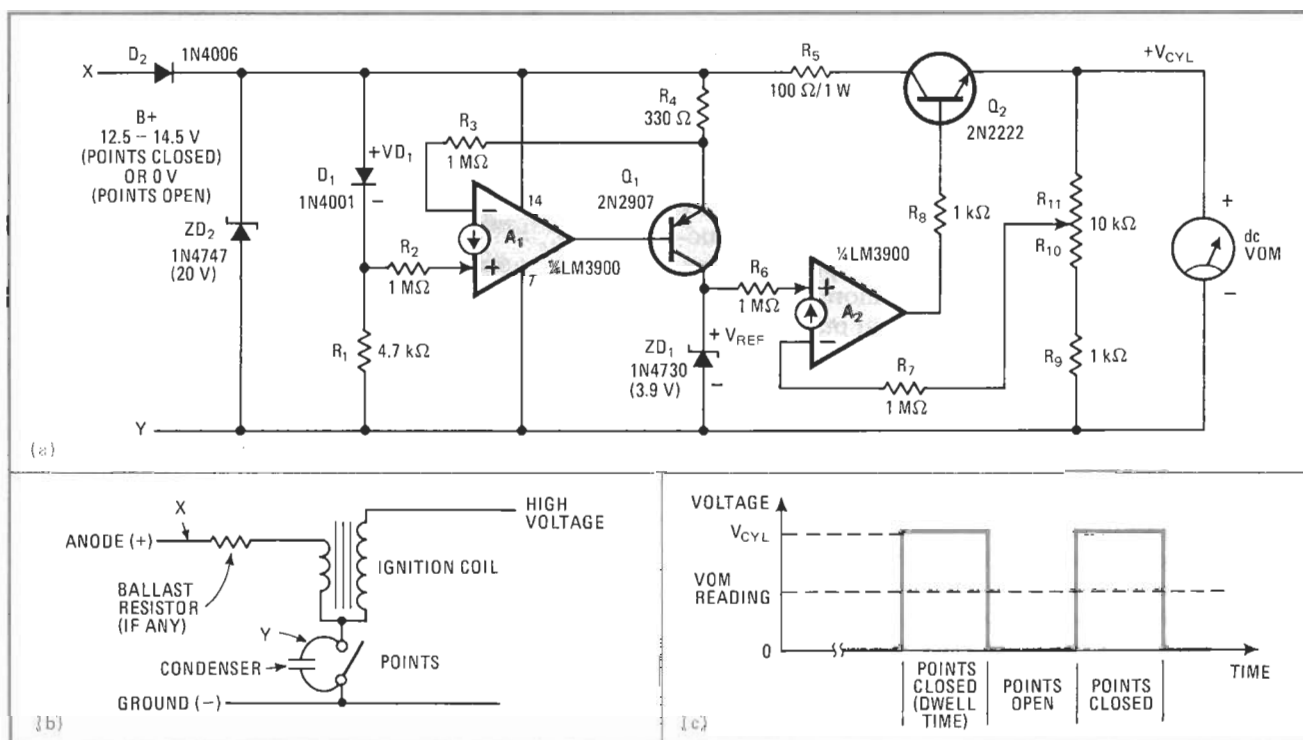
age variation of the car cannot affect the dwell-angle readings. Thus the accuracy of the VOM dwell meter is limited only by the accuracy of the VOM itself.

The circuit uses two of the four Norton operational amplifiers in a low-cost LM3900N integrated circuit. Since these amplifiers can operate from a single voltage supply anywhere in the range from 4 to 32 volts, they are well suited to this application where they tap their power from the low-voltage side of the ignition system.

Amplifier A_1 and transistor Q_1 constitute a constant-current source that provides a current of V_{D1}/R_4 (about 2 milliamperes) into the zener diode ZD_1 whenever a B+ supply voltage higher than the zener breakdown voltage is applied at points X and Y. This steady flow of current, in turn, maintains across the zener diode a constant reference voltage, V_{ref} , which is fed to the noninverting input of feedback amplifier A_2 . Transistor Q_2 functions as a series pass regulator whose output (emitter) voltage, V_{cyl} , is controlled by A_2 . The value of this voltage is

$$V_{cyl} = V_{ref}(R_9 + R_{10} + R_{11}) / (R_9 + R_{10})$$

which cannot be higher than the B+ voltage. Hence if



Dwell idea. Automobile distributor-point dwell angle can be measured with an ordinary VOM plus this circuit that costs about \$5 to build (a). Peak voltage to meter is held constant by regulator; potentiometer is adjusted so that time-average voltage read on meter is easily converted to dwell angle in degrees. Circuit taps ignition system's primary voltage supply for power, so no other battery or power source is required. Protection against reversed connections and short circuits is built in. Calibration circuit is connected to ignition coil as in (b). For best gas mileage, dwell time is adjusted to give VOM reading that corresponds to the dwell angle prescribed by auto manufacturer (c).

the potentiometer (R_{10} and R_{11}) is adjusted to set V_{CYL} at a level substantially lower than the B+ voltage, variations of the latter have virtually no effect on the dwell-angle readings. Since the series pass voltage regulator (Q_2) has very low output impedance, operation is independent of the VOM input resistance.

For convenient and error-free dwell-angle readings on the VOM, a simple initial calibration is needed. This calibration is made by adjusting the potentiometer when the circuit is connected to the car at the X and Y points and the distributor points are closed. (An alternative method is to connect the X and Y leads of the circuit to the anode and cathode of the car battery, respectively, for calibration.) The voltage V_{CYL} is then set to the appropriate value shown in the table.

With the leads properly connected to the primary side of the ignition coil, the system is ready for making measurements. When the distributor points close and open repetitively while the engine is running, a train of rectangular voltage pulses with an amplitude of V_{CYL} is impressed upon the VOM. Because the VOM movement possesses mechanical inertia, the pointer cannot track

SETTING OF V_{CYL} FOR VARIOUS AUTOMOBILE ENGINES		
Number of cylinders in 4-stroke engine	Maximum dwell angle	V_{CYL}
8	45°	4.5 V
6	60°	6.0 V
4	90°	9.0 V

the pulses, so only an averaged voltage is indicated. This average voltage is effectively the dwell voltage. For example, a voltage of 2.7 v indicates a dwell angle of 27°. Rotating the point assembly then adjusts the dwell angle to the value suggested in the service manual for the particular model of automobile.

Diode D_2 and zener diode ZD_2 protect the circuit from accidental reversal of lead connections at X and Y and from high-voltage transients when the points open. Current-limiting resistors R_5 and R_8 protect transistor Q_2 and amplifier A_2 from overloading if the VOM leads are accidentally short-circuited. □