Heathkit of the Month #73:
by Bob Eckweiler, AF6C

AUTOMOTIVE TEST EQUIPMENT
Heathkit ID-29
Automotive Tune-Up Meter

Figure 1: Heathkit ID-29 Automobile Tune-up Meter (Shown less plastic case).

Introduction:
In late 1970 I ordered my first new car, a Datsun 240Z; being in high demand at the time, it finally arrived the next June, the day before Field Day. In April of 1971, my previous car, a 1964 Volkswagen bug, swallowed a valve severely damaging the engine. With the help of a neighbor I got the block repaired and the engine rebuilt, and with the help of Jack - W6LOH, I got the engine back into the car. That got me started on doing my own tune-ups and mechanical repairs that didn't require major facilities.

The '71 240Z has standard point ignition and a six-cylinder engine with dual Hitachi SU carburetors. The engine compartment is uncluttered and working on the engine is a joy. One could even easily change the oil filter from above. When I was told a gentleman was starting a 240Z sports car club, I quickly got involved as one of the charter members of ***Group Z***. The club had many attractions, one being a class offered by ***Our Pride***, a garage specializing in the Datsun. They taught us how to tune our Z up. Of course, setting the point gap with a feeler gauge versus an instrument left a lot to be desired. So when I saw an automotive tune-up meter offered by Heathkit I ordered one pronto. That kit is the ID-29 - Figure 1.

The Heathkit ID-29:
The Heathkit ID-29 Automotive Tune-Up Meter was introduced in 1969, too late to make that year's major catalog. The first reference I found was in an ad in the Milwaukee Journal for June 26th 1969. This ad was placed by the local Heathkit retail store showing a retail price of $35.95. Another ad was found in Popular Science in January of 1970 (figure 2) with a price of $29.95. The ad still called the kit 'new'.

The ID-29 provides three functions:

- The dwell function measures the dwell of the points. This is the percent of distributor rotation the points stay closed, charging the coil, prior to opening. This determines the energy that gets stored in the coil, especially at higher RPM, and can affect performance. Dwell is measured in degrees of one revolution of the distributor that the points remain closed.

- The tachometer function measures engine RPM. Just as you adjust an IF transformer for maximum audio output, you make carburetor adjustments by RPM. The ID-29 has two RPM ranges, 0 - 1,500 RPM and 0 - 4,500 RPM full scale.

- The volts function is that of a simple 0 - 15 VDC voltmeter. A handy tool to have right there at the car when checking wiring.

The ID-29 mounts in a brown injection molded plastic case (more about that later). It has a meter on the left and two rotary switches vertically aligned on the right. A storage compartment below the panel houses a two conductor test lead with red and black insulated alligator clips. It also has room for the calibration cable

METER SCALES (Top to Bottom):

Scale 1 (top):	0 - 15 (x100 RPM) also
Scale 1 (top):	0 - 15 Volts DC
Scale 1 (bottom):	0 - 45 (x100 RPM)
Scale 2 (top):	Dwell 8-cyl. 10° - 45°
Scale 2 (bottom):	Dwell 4-cyl. 20° - 90°
Scale 3 (top):	Dwell 6-cyl. 15° - 60°
Scale 3 (bottom):	Dwell 3-cyl. 30° - 120°

SWITCHES:

Upper switch
CYLINDERS: 4 position rotary switch
3, 4, 6, 8

Lower switch
FUNCTION: 4 position rotary switch
DC VOLTS, **LOW RPM**, **HIGH RPM**, **DWELL**

Heathkit Automotive Tune-Up Meter Layout
Table I:

Figure 2: Heathkit Ad (Partial) in the January 1970 issue of Popular Science

and any adapters one may want to keep handy. Table I shows the meter scale and switch information. The meter is a large 4-1/2 inch 100 degree movement meter making the scales easy to read, even outdoors or in dim light.

One nice feature of the ID-29 is that it contains no batteries to go dead, or worse leak. Power is derived from the unit under test. When the **FUNCTION** switch is in the **LOW RPM**, **HIGH RPM** and **DWELL** positions the ID-29 draws about 10 ma average power. When in the **VOLTS DC** the meter is a passive 1,000 Ω per volt 15 volt full scale meter - ample for automobile circuit checking. Also included is a connection diagram that attaches to the inside lid of the case, showing the proper way to connect the meter to the distributor coil (See figure 3). It contains enough information that the manual may remain on file while using the instrument.

While most cars of the day used 12-volt negative ground electrical systems, the ID-29 is designed to also operate with vehicles having a six-volt and/or positive ground electrical system without modification.

ID-29 Voltmeter Circuit:
A copy of the schematic is shown in figure 6. When the FUNCTION switch is in the DC VOLTS position, the positive test lead is connected through a filter composed of L1 and C1 to remove any spikes that may occur, and on to the positive terminal of the meter through a precision 15 KΩ resistor. The negative test lead is connected to the negative terminal of the meter through another set of contacts on the FUNCTION switch.

This voltmeter is a low impedance type of meter with an input impedance of 1,000 Ω/V or 15 KΩ since there is only one 15 volt range. Add to that, that some active circuitry is still connected to the input leads and is lowering the impedance even more. Still, for normal car measurements, like measuring the battery voltage, tracing out battery power to a lamp or another load, it will perform quite acceptably.

ID-29 Dwell Circuit:

The dwell is measured simply by applying a fixed voltage to the meter while the points are closed. If the points are closed for a longer period (higher dwell), the voltage is applied longer and the meter, which responds to the average current will read higher. Since the distributor rotates at half the speed of the crankshaft, the maximum dwell time for an 8-cylinder engine would be 360° ÷ 8 or 45°. the maximum dwell time for engines with less cylinders is shown in Table I.

When the FUNCTION switch is in the DWELL position, the test leads are connected across the coil with the proper polarity and the engine is running, square wave pulses appear across the test leads. Due to the inductance of the coil, these square waves contain high voltage transients. A filter composed of L1 and C1 reduce these spikes to a safe level for the electronics. Diodes D1 and D2 protect the dwell circuit from accidental polarity reversal due to misconnection of the test leads.

When the points are closed, a positive voltage is present across the red to black test leads. This voltage is fed to transistors Q1 and Q2, which are wired as a constant current source. As long as the input voltage is within a range of about 5 to 15 volts, the Q2 collector current will remain constant at about 6.5 ma. About 5.5 ma of that current will flow in series through special diodes D3 and D4. These "Stabilator" diodes will have a constant and stable voltage drop across them of about 1.4 volts each at that current. This keeps the voltage at the collector of Q2 at 2.8 volts while the points are closed. When the points are open this voltage is zero. About 1 ma of the voltage at the collector of Q2 is fed through D5, D6 and D7, R3 and the dwell calibration potentiometer. The three diodes provide temperature compensation; their forward voltage drop varying as the temperature changes in balance with the semiconductor junctions in the current regulator. A small part of the remaining voltage is tapped off from the dwell calibration pot and fed to the positive terminal of the meter. The negative meter terminal is connected to the negative test lead.

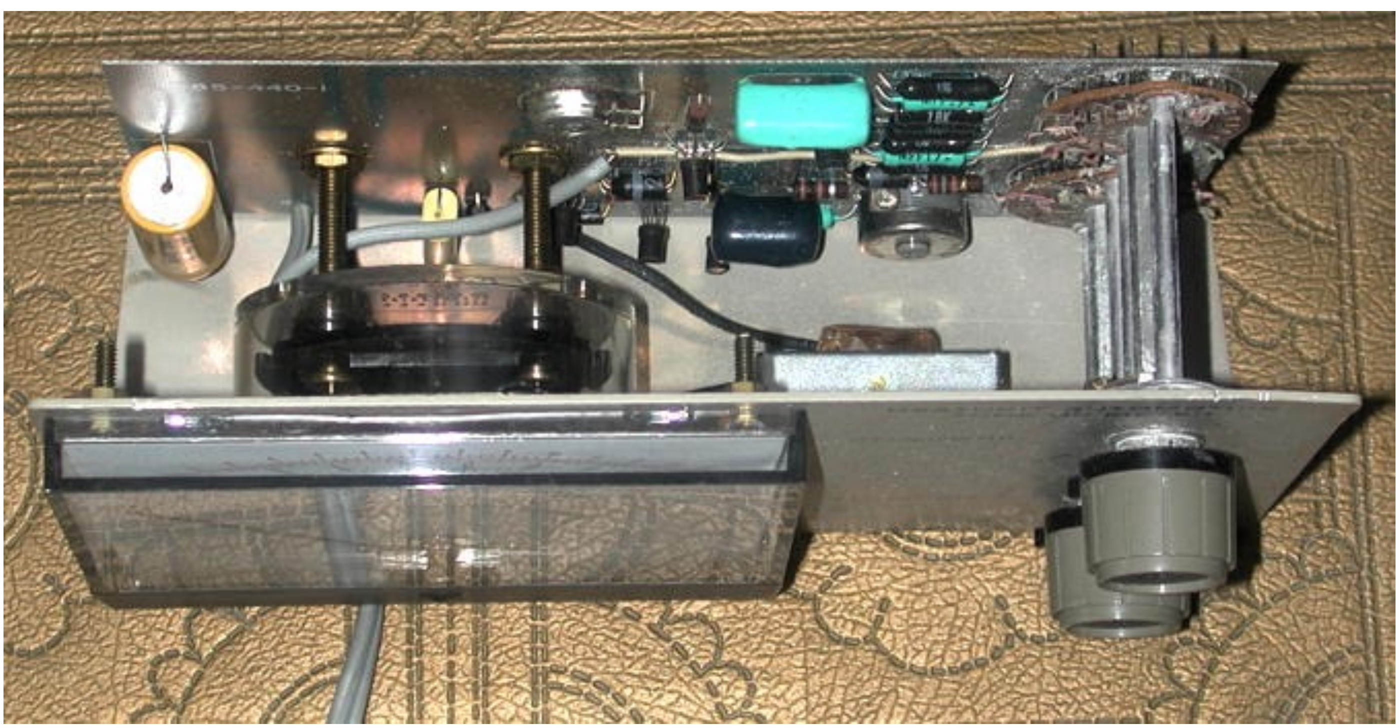

Figure 3: Inside view of the ID-29. L1 choke is partially visible mounted on the chassis bottom, left of center. Note that the circuit board, top, mounts to the two long meter terminals and the switch wafers.

Meter inertia, and the large capacitor across the meter terminals, cause the meter to respond to the average current.

When the test leads are connected across the coil of a running automobile, the collector of Q2 will be at 2.8 volts when the points are closed and zero volts when the points are open. The resulting current will average out through the meter to represent the ratio of the time the points are closed to the time time the points are closed PLUS the time the points are open. The longer the points are closed the higher the meter reads. This reading is independent of the number of cylinders and its related switch and is calibrated in degrees of distributor rotation. The meter has four scales, one each for 3, 4, 6 and 8 cylinder engines. Full scale for each of these scales is 360 degrees divided by the number of cylinders.

ID-29 Tachometer Circuit:

RPM is measured by sending a fixed current through the meter for a fixed period each time the points close. The meter reads the average current, and since the points close more often per minute when the engine is running faster, the meter reading rises with rising engine speed.

When the FUNCTION switch is in either the LOW RPM or HIGH RPM tachometer position, the current regulator acts as it did in the previous section. The voltage at the top of D3 switches between 2.8 volts and zero with the operation of the points. The collector of Q2 is also connected to the base of Q3 so that when the points are closed the emitter of Q3 will be at a regulated voltage of about 2.2 volts. This voltage turns on Q5. The same voltage feeds current through the **TAC**hometer **CAL**ibration control, a temperature compensating circuit consisting of R19 and R21, through the meter and Q5. The same voltage is also feeds current through one of eight precision timing resistors depending upon whether LOW RPM or HIGH RPM is selected and whether 3, 4, 6 or 8 cylinders are selected. Current through the timing resistor charges C3; when the voltage across C3 reaches about 0.6 V, Q4 turns on turning off Q5. Thus each time the points close a fixed pulse for the selected range and cylinder count passes through the meter. This pulse is short enough that it ends significantly before the points open even at the highest RPM of the range selected.

Heathkit got clever here. This circuit will only be stable if there is a way to discharge C3 between pulses. I have to admit I was at a loss until I read Heathkit's own abbreviated circuit description in the ID-29 manual. Discharging C3 relies on the negative spike produced when the points open and the coil field collapses. This reverse voltage passes through L1 and places a large reverse voltage across Q3, breaking it down due to the zener effect and allowing a negative current to travel through the selected timing resistor charging C3 in the opposite direction until D8 starts to conduct. Thus C3 is discharged and actually charged to a slightly negative voltage regulated by the forward voltage drop of D8. Thus after the first pulse, C3 has a stable starting point for each pulse repetition.

Since the meter, when in the DWELL and RPM modes reacts to average current, a 500 µF capacitor is across the meter circuit to help even out the current; otherwise at low RPMs the meter may visibly fluctuate.

ID-29 Calibration:

When the FUNCTION SWITCH is in the DC VOLTS position calibration is determined by

*** Note:**
For safety you may want to be sure the AC line neutral terminal is connected to the non-resistor side of the calibration cable.

This kit was manufactured before AC power cords were normally polarized. However, even that should be checked with a voltmeter as through my lifetime I have encountered AC wall sockets that have been wired backwards.

the precision fixed resistor R18 and no adjustment is necessary.

Calibration in the DWELL position is performed by applying a steady DC voltage across the input terminals and adjusting the **DWELL CAL**ibration pot for full-scale on the meter. Heathkit recommends you do this with a voltage of 6 V and then 12 V. Both should give very close to the same results if the current regulator is working properly.

Calibration in the two RPM positions are performed using a test cable. This cable is built as part of the kit assembly. The cable consists of a short AC power cord with a 10KΩ resistor in series with the hot lead. With the meter in the LOW RPM position, and the **CYLINDERS** switch set to 6, the calibration cable is connected to the meter (red lead to the open end of the 10KΩ resistor). The TAC CAL potentiometer is next adjusted until the meter reads 12 on the 0 - 15 RPM x 100 scale. The calibration cable is then removed; Heathkit warns about leaving the cable hooked up for too long of a period as the cable's resistor may overheat.

ID-29 Assembly:

So much of the fun of buying a Heathkit is the assembly. You have the satisfaction of assembling the kit and see it working. At the same time you acquire hands on experience soldering and identifying and learning about various electronic components. The "Stabilator diode" was new to me prior to building this kit.

This is not a difficult, nor time consuming kit to assemble. It could easily be assembled in one evening by a builder with moderate kit-building experience. Many of the components mount on a circuit board. And since the switch lugs solder directly to the board, and the meter terminals bolt directly to the board, the only

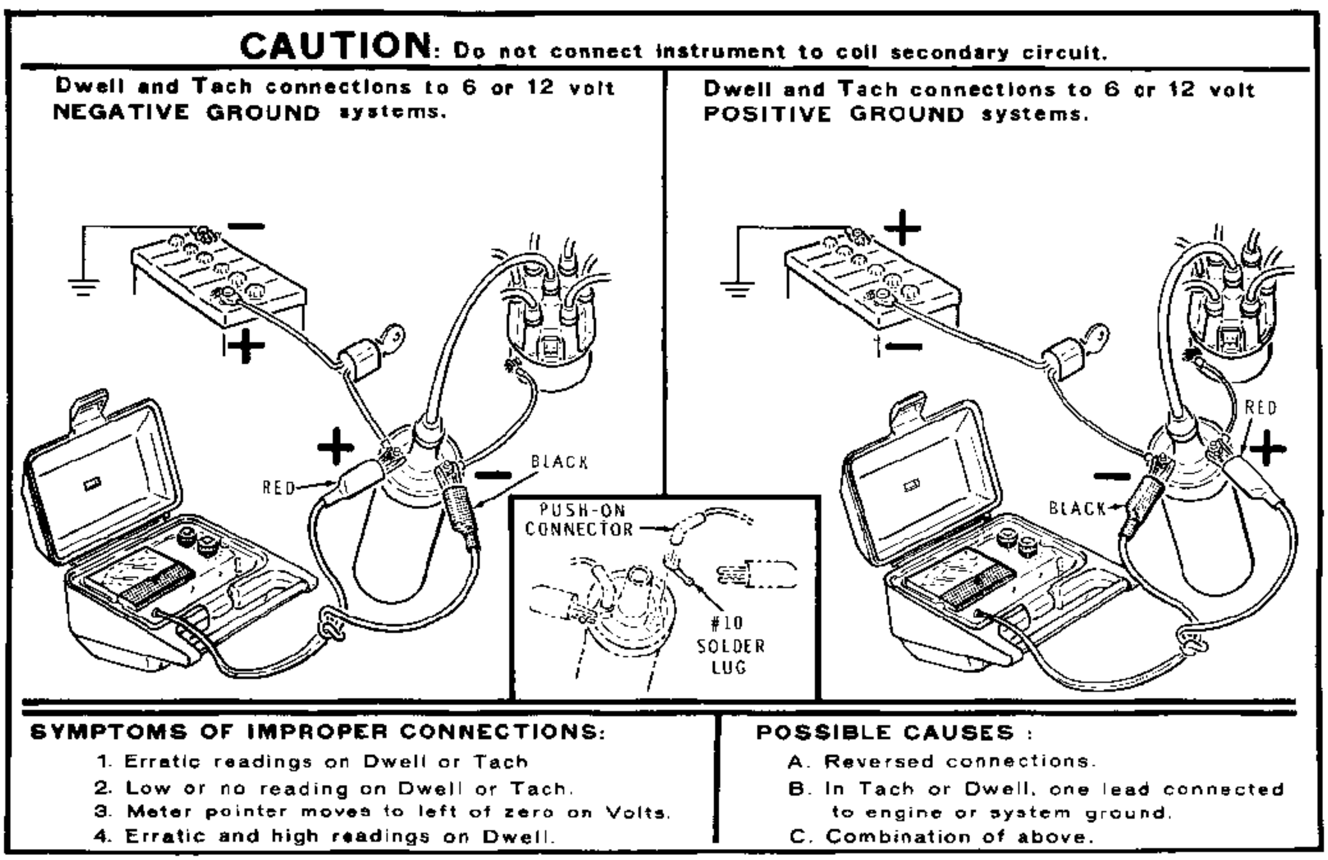

Figure 4: Placard label showing proper connections to automobile coil that is located under the ID-29 lid.

wires you deal with is one jumper on the board, the two leads from the external choke coil (L1), the test leads and the small calibration cable.

First the components are soldered to the circuit board. This consists of 38 components and one 3-7/8" jumper wire.

Next the chassis is assembled. It involves first mounting the meter, the choke, the two rotary switches and sticking on the "Blue and White" serial number label. This assembly is set aside while the test leads have one end prepared for connection to the circuit board and alligator clips and insulating boots attached to the other end.

Finally, the circuit board is attached to the chassis (See Figure 3). It mounts to the two extra long meter terminal screws on one end, and the PC board solder-type lugs on the two rotary switches on the other end. The knobs are then installed and the kit is set aside while the calibration cable is assembled.

After calibration the meter is placed into its case and is ready for use. The kit includes l terminal adaptors to handle distributors with less common types of terminals.

ID-29 Operation:

The operation of the ID-29 automobile tune-up meter is quite basic if you are at all familiar with cars of the early seventies and prior. Of course the voltmeter may be used to measure battery voltage and whether voltage is getting to a lamp, or upon further investigation why it is no doing so, but any VOM can do that. The true value is its other two functions.

Both the dwell and the tachometer functions require the same connection to the car. The two test leads are connected to the terminals of the coil. Red to plus and black to minus. Sometimes this connection requires special adapters some of which are supplied with the kit. The basic connections are shown on a sheet that is attached to the top of the plastic case of the ID-29 (See figure 4). Note that it also shows the connection for positive ground vehicles (You know who you are!)

To measure dwell, set the FUNCTION switch to DWELL and the cylinder switch to the number of cylinders of the car under test. (The cylinder switch really doesn't matter during the dwell test, but if you forget to set it later you will not get the right RPM reading.) with the engine running, the dwell is indicated in degrees on the correct meter scale for the correct cylinder count. Adjust the point gap until the dwell is within the recommended range published by the car manufacturer. Follow their directions on adjusting the point gap, some cars allow you to do it when the engine is running (Be careful of the fan if that is the case). The dwell is usually given over a reasonable range. I always tried to set my 240z at 3/4th the way to the top the recommend range. This setting is usually done at a fast idle. Always rev the engine <u>some</u> to be sure the dwell stays reasonably constant.

To measure engine speed, so handy when adjusting the carburetor, you only need to turn the FUNCTION switch to the LOW RPM or HIGH RPM setting. Tuning multiple SU carburetors is a thesis all on its own. Being able to see small changes in RPM as well as how steady the RPM is staying makes the tuneup much easier.

ID-29 Plastic Case:

If there is one fault with this kit it is the injection molded plastic case that holds the instrument. After a few years of use, even though the unit was stored indoors, the case began to show deterioration. After just moderate use the cover hinge cracked and the cover disconnected from the case. A few years later a large crack developed in the bottom of the case. I never got around to ordering a replacement case from Heathkit. Recently when I went into the cabinet where I store the ID-29, the case had disintegrated into about twenty-five pieces. This same case, Heathkit Part #95-35 ($1.60 in the 1969 manual replacement parts list), is used in in the IM-17 VOM and possibly other kits.

Figure 5: Heathkit ID-29 shown in brown case with compartment for storing test leads and spare fittings. (Photo from an unknown source)

Some later kits, such as the CM-1045, CM-1073, IM-5217 and perhaps others use a newer blue style case that appears identical but perhaps a bit more immune to disintegration.

ID-29 Conclusion:
Except for the disintegrating case problem, the ID-29 served me for many years keeping the Datsun running for a full 240K miles. Right now the car sits in my garage but is going away soon.

Heathkit continued to build the ID-29 until 1975 when it was replaced with the CM-1073 which appears to be almost identical except for appearance and a new plastic case. It sold for $24.95 in the December 1976 catalog. I have not been able to find a schematic nor manual to compare it with the earlier ID-29. Heathkit also made tune-up meters for small engines.

73, from AF6C

HEATHKIT heathkit.com

What's Happening at the NEW HEATHKIT?:
Every once and awhile I take a look at the web-page for the new Heathkit Company. I thought I was in the ***Heathkit Insider Group***, but alas, even though the website hints at more new kits: ***"New-product announcements are out to Heathkit Insiders. (Checked your spam folder?)"***, my mailbox nor my spam bucket received nothing.

The new Heathkit Company does offer some products and parts for existing kits, including replacement cups for their weather stations, an updated dial kit for the HG-10 series of VFO, a display upgrade for the Nixie tube display in the AJ-1510 Stereo Tuner. An upgrade kit for the IG-18 Distortion Analyzer and more. You can view these on their website. You can also buy manual copies from Heathkit for many of their vintage products.

One series of parts I'd like to see them reproduce and resell is replacement meter covers. I know of a few good Heathkit products that have scratched or damaged meter covers. A good place to start would be a cover that fits the V-7A VTVM and other products that use the same style meter.

It will be interesting to see what new products will be introduced soon. One hint of some new ham kits is encouraging!

Remember, if you are getting rid of any old Heathkit Manuals or Catalogs, please pass them along to me for my research.

Thanks - AF6C

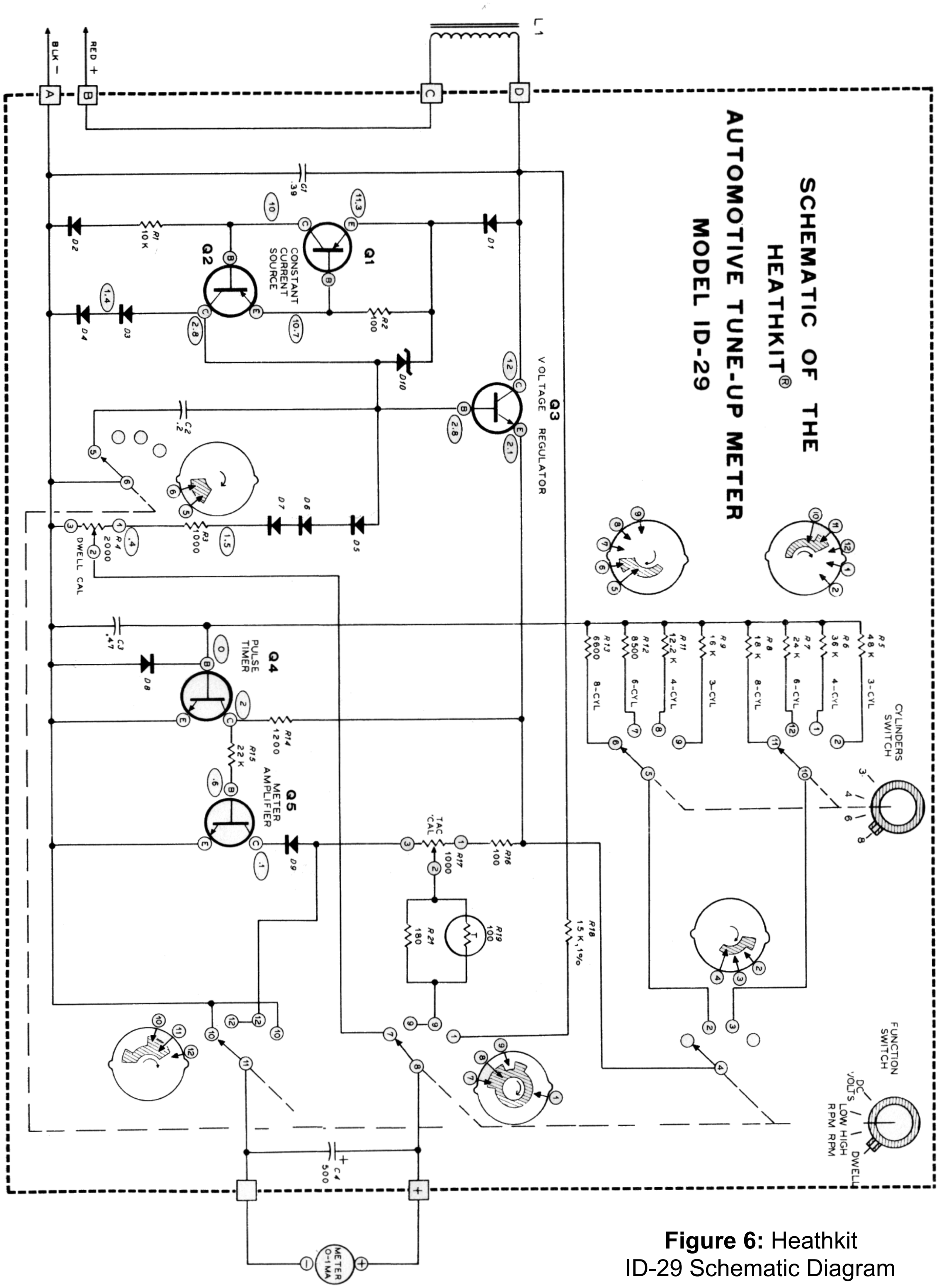

Figure 6: Heathkit
ID-29 Schematic Diagram