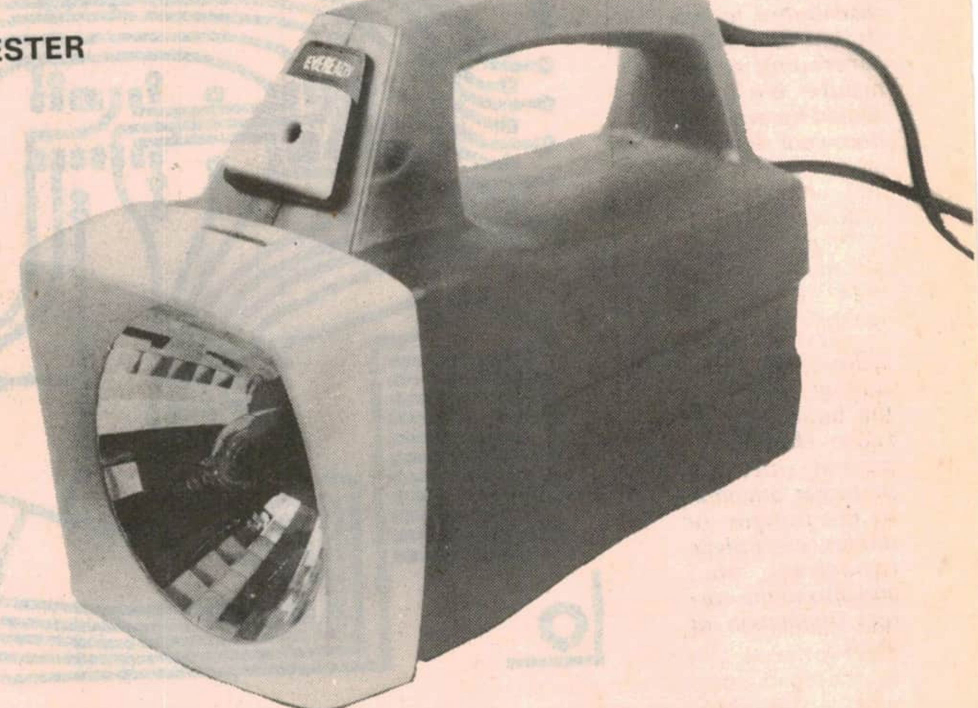
Save money on tune-ups: Build our

Power Timing Light

Power timing lights are a great idea for auto ignition timing but they cost around $60-$80 to buy. Here's one you can build for under $20, using readily available parts.

by ROSS TESTER



While experienced motor mechanics may insist that nothing beats the ear for ignition timing, laymen without "calibrated eardrums" have to rely on more scientific methods to do the job. And the easiest way to achieve this is to use an ignition timing light.

Our last timing light was described in the August 1970 issue. It was a very simple type, using a special neon tube in series with the No. 1 spark plug lead—and nothing else. The energy from the HT pulse ignited the neon as well as the plug, giving a brief flash of red light. If this was placed close enough to the timing marks and pulley, the light from the tube was sufficient to illuminate the marks and notch.

The catch, however, was in the words "placed close enough". Light output from our 1970 timing lights was very limited. It was sufficient in very heavy shadow or at night, but given the level of illumination in the average workshop, it simply wasn't good enough. The author of the 1970 article referred to a previous article using another type of neon in a timing light, and commented how much better the new type of tube was. All I can say is, I would have hated using the earlier one!

Fairly obviously, the answer to the problem was to use a tube having a much higher light output—but the output from any neon tube is limited. In fact, the 1970 tube was about as good as one could hope for in this regard.

Neon tubes were, therefore, not the answer. Our attention then fell on their big brothers, flash tubes (or strobe tubes). Strobe tubes differ from neon tubes in a number of respects, not the least being their gas filling. Neon tubes contain, naturally enough, neon, while strobe tubes contain xenon. The difference is that while neon ionises to a red light, xenon is brilliant white when ionized. Therefore, in terms of illumination, a xenon tube is streets ahead of its neon counterpart.

Another difference is the operating mode of the tube. Neon tubes are generally connected across a voltage source of high enough voltage to break them down immediately. The impedance of the source must be high enough to stop very heavy current flow which would otherwise flow through the ionised gas.

Xenon tubes may be used in this way, but are more usually connected across a voltage source not sufficient itself to ionise the gas, but which will hold the gas ionised if it is ionised by an external source. This source is usually a high voltage pulse coupled in from the outside of the tube, and produced by a trigger transformer. This pulse is usually between 4 and 20 thousand volts. Once again, the impedance of the supply must be high enough to prevent excessive short circuit current flowing when the tube is ionised.

The normal way of operating strobe tubes is to charge a storage capacitor to the required voltage (which can be from 200 to a few thousand volts, depending on the tube), place the tube across the storage capacitor and trigger it. The capacitor then discharges via the tube, resulting in a flash of light no more than a few micro seconds long.

The length of flash is important, as the life of a strobe tube is generally measured in seconds. If the flash is too long, it doesn't take too long before the tube life is used up—especially at high frequencies. To keep the flash duration down it is important the capacitor/tube circuit has as low an impedance as possible—both for the life of the tube, and to get as brilliant a flash as possible.

For this reason, most types of capacitors are entirely unsuitable for the role of storage capacitor. Electrolytics especially are very, very poor—in fact, they are liable to blow up if used as a storage capacitor (discharge currents exceed 50A). In fact, even the capacitor we are using is not recommended in this role, but for a number of reasons which we will go into later, it is the most practical.

So much for the tube & capacitor—but what of the power supply? As we said, we needed a fairly high voltage (around 300-400V) to operate the tube. What we didn't want was a mains supply—apart from the bulk, the cost would have been quite high.

The power supply in July 1975 CDI immediately suggested itself. It was small, lightweight and, above all, wouldn't break the bank. It also had a feature ideally suited to strobe applications—if the output was shorted (such as happens when the tube fires) the oscillator simply stops working, and starts operating again when the short is removed.

So it didn't matter that the supply impedance was low—with no output, the tube would simply turn off as soon as the storage capacitor emptied—and the impedance was low enough to ensure the capacitor filled very quickly after each flash.

Thus encouraged, we tried the idea out using a "ratted" CDI unit. By connecting a tube across the storage capacitor and placing a short where the coil would normally go, we were able to make the tube flash exactly as intended.

Then we started thinking about the method of triggering the coil. As we said before, the tube needed a source of EHT at around 4kV to trigger reliably. Most power timing lights use a capacitive pick-up on the No. 1 lead, amplify this and trigger a transformer via an SCR and capacitor—in fact, a mini CDI!

Then the thought occurred that we already had a source of EHT right where we were working—that generated by the ignition itself. Sure, the voltage was a bit higher than needed, but would that matter? A phone call to the importers of the tube soon answered that question in the negative, so my next step was to try this idea out. Unfortunately, we had only one CDI, which I had used for my mock-up. Clearly, we needed another—to work as a CDI!

So I built up another CDI unit (hence my car now has one fitted too!) and connected it up as intended using a coil and simulated points. I connected a piece of hookup wire to the EHT side of the spark gap, with the other end wrapped in a helix around the tube. It worked like a charm, as long as the EHT lead was kept separated.

It appeared, then, the only problem would be insulation between the EHT lead and the rest of the circuit. But everything else appeared to be satisfactory electrically.

Incidentally, to avoid confusion in this article, we are calling all voltages above a few kV EHT. In normal automobile parlance, there are two voltage levels, —LT (low tension, 12V) and HT (high tension, 15kV+). However, when CDI is fitted, and with our timing light there are three voltage levels: LT, 12V; HT 300-400V; and EHT 30kV+.

The next hurdle was the presentation. In the interests of reliability and ease of construction, I wanted everything on a printed circuit board, but hadn't thought much about a case.

Then I thought of the Eveready "Commander" torch, as used (in part) for our "Optomin" project. This is quite reasonably priced, and has a good reflector, suitable for the flash tube.

The printed circuit board I have produced is therefore designed to fit into the Eveready Commander torch, but there are probably other torches which would be as suitable, providing the PCB fits in the case.

Before starting actual construction, take both the PCB and the case, and place the board copper side up on the outside of the bottom of the case. Mark carefully the 3 mounting hole positions. It is much easier to do this before any components are on the board.

Construction can begin with the small components—resistors, capacitors & diodes. Solder them on the board, spacing all resistors about 1 mm or so off the board for air circulation. Next, you can make up the oscillator transformer.

This consists of two FX2242 half cups and a Delrin DT2180 bobbin. In many cases, the bobbin will come with the 375T secondary already wound on. But if you have to do it yourself, and also for information on the primary and feedback windings, refer to the CDI article on page 46 of the July issue.

Note particularly the comments regarding insulation between windings and cleanliness when assembling the cores. To place the transformer on the board, put one long bolt through the board from the underside (with a washer) and place a washer & nut on top. Screw up tightly, but do not force or the halves may crack. Solder the leads into their various positions, followed by the transistors.

While we do not think it is absolutely necessary, we have placed a "U" shaped heatsink under the transistors. When you consider the amount of time taken to time an engine, the transistors should not get too hot, but to ensure 100 per cent reliability the heatsink is included.

Note that because the transistor collectors are connected together, there is no need to use mica washers or insulating bushes. However, a thin smear of heatsink compound won't go astray.

Both transistors must be secured by two screws and nuts to the pattern. As this forms the collector circuit, the bond must be secure electrically, as well as mechanically. We made sure of this by soldering the nuts themselves to the copper pattern, after polishing them with a very fine file. It is sometimes difficult to solder the base and emitter leads close to the body of the transistor, so if this is the case clean them with a razor blade.

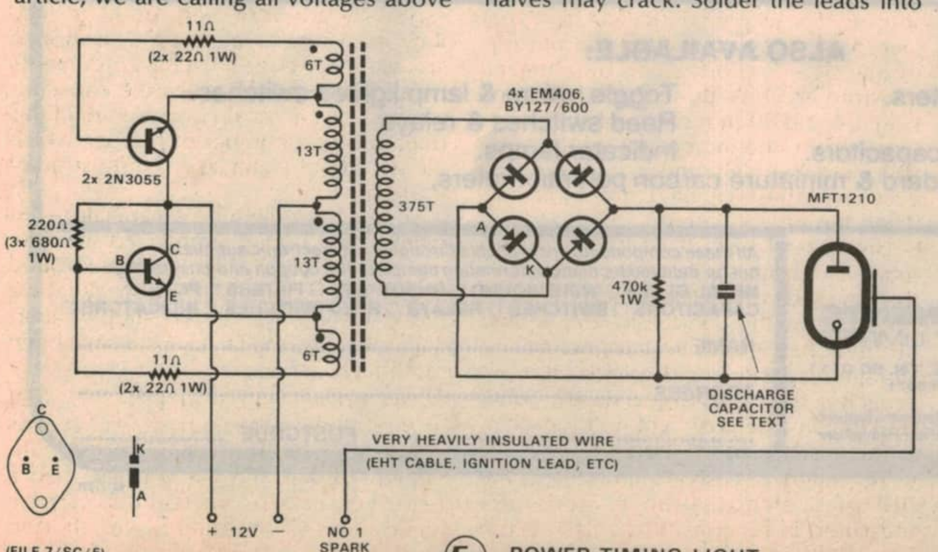
Regarding the discharge capacitors, we have chosen 0.47uF 630VW polycarbonate types, connected in parallel as required. The choice is for a number of reasons, bearing in mind what we said before about the role this capacitor has to play. It must have low impedance—these do; it must also have high voltage rating, and again these do. It must as well have a high discharge current rating—these don't, but they are better than many others.

Above all, polycarbonate capacitors are reasonably priced. Unlike most discharge type capacitors, which sell for many dollars, these cost around 75 cents. And it's up to you how many you use. While there is room on the PCB for six (3uF), we used four in our prototype which we considered gave more than adequate light.

The light output of the tube is proportional to the amount of capacitance—but remember, the brighter the light, the shorter the life of the tube. While the tubes may not be too expensive, the trouble lies in getting the old one out.

The reflector of the torch is made of a metallised plastic, and, as such is a conductor. (This is a point to watch with the EHT.) First disassemble the reflector by unscrewing the light and holder, and prising off the backing plate. These can be discarded. The metal collar around the neck of the reflector must be removed, and this can be quite a problem.

It takes quite a bit of "knife & forking" to remove it, but it will come away. Incidentally, the reflector can be removed from its housing to do this, but take care not to touch the reflector material inside. Once on, fingermarks cannot be removed, and polishing, even with a lens cloth, will only mar the surface further.



EA POWER TIMING LIGHT

Readers may recognise the circuit as being, almost identical to the CDI published last July. A strobe tube changes it to a timing light.

Once the collar is removed, the neck can be shaped to take the tube. This can be done with a file or, because it is plastic, with a soldering iron. Mount the tube horizontally across the reflector so it lies this way when assembled. File (or melt) the plastic so the tube is a firm, but not tight, fit.

The tube is mounted from the front to allow for the exhaust nipple, but before it is mounted a helix of wire must be wound around the tube for the ignition pulse. This is easiest done by using two strands from the length of lead which is going to be the ignition pick-up wire.

This lead has to carry the full EHT from the plugs, and so must have pretty good insulation. Two choices are available: copper cored ignition lead; or TV EHT cable. We used the second. While it may not have high enough ratings, we were unable to make it break down. TV EHT cable should have ratings around 30kV, while the EHT with a CDI might be 40kV or more.

In fact, all wiring within the case should be done with EHT cable, because this increases the insulation between leads where they cross. Thus cable rated at 30kV gives 60kV between leads, and so on. Unfortunately, we could only buy EHT cable in red, so the lead should be marked adequately to show whether it is EHT or the positive or negative supply rails.

For the EHT pick-up lead, cut approx. 1 m (more or less depending on the distance from your No. 1 plug to the timing marks) and strip off the insulation from the last 50 mm. Carefully cut off all the strands except two. Each strand is wound in a 2-turn helix around a leg of the tube so they meet at the top, where they can be twisted together and carefully soldered (take care not to touch the tube with the solder or iron).

To hold the ignition lead in place before glueing, stick some insulation tape right around both leads of the tube and the ignition lead. This may be left in place under the glue.

Now the tube may be glued into place in the reflector. The best material is fast-setting "Araldite" epoxy. This not only holds the tube in place, but also provides insulation between the EHT lead and the reflector. Without the insulation, there will be arc-over.

It may be necessary to provide a number of coats of glue to provide this insulation—hence the reason for using the fast set variety. The whole of the bottom of the tube should be set in epoxy, including the end of the EHT lead. It may be necessary to place tape over the bottom of the reflector opening to stop the Araldite oozing through.

Once the tube assembly has set, solder short lengths (100 mm) of EHT lead to each of the tube leads. These can then be soldered to the PCB. Note that the strobe tube is not polarised.

Both battery leads and the EHT lead are brought out through the rear of the case, the battery leads in line with the handle and the EHT lead right in the middle of the back. Both leads should be knotted inside the case

We make use of the torch switch to turn the inverter on and off. The EHT is left connected all the time (it's very hard to fit a switch rated at 50kV inside a torch case!). Battery leads are of polarised figure 8, one of which (it doesn't matter which) is soldered to one side of the switch. EHT cable is soldered to the other side of the switch and threaded back through the torch case. Make quick, clean joints—otherwise you may distort the plastic with heat and impair switch action.

The other battery lead is joined to another length of EHT cable, and insulated with tape. This is threaded back through the handle also, so that both pieces of EHT cable can then come back through the body of the torch.

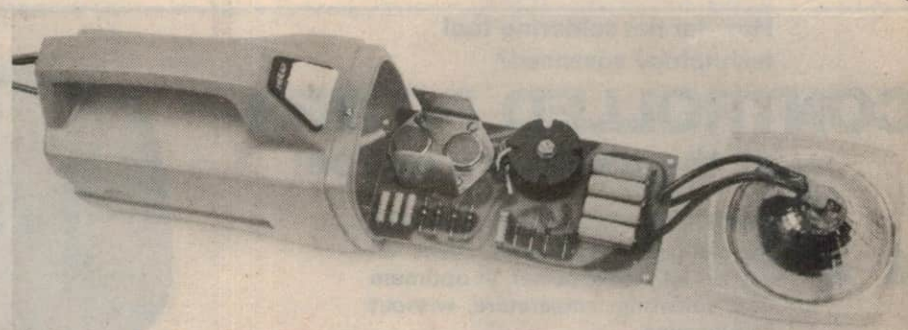
These are then soldered to the copper side of the board in their respective + and − positions. As we said, the leads should be marked to ensure their is no chance of a mix-up between +, − and EHT. If in doubt, check with a multimeter.

When the leads are soldered in place, the EHT lead can be threaded through its hole from the inside, and pulled through. Don't at this stage, try to place the board inside the case, because operation should be checked first.

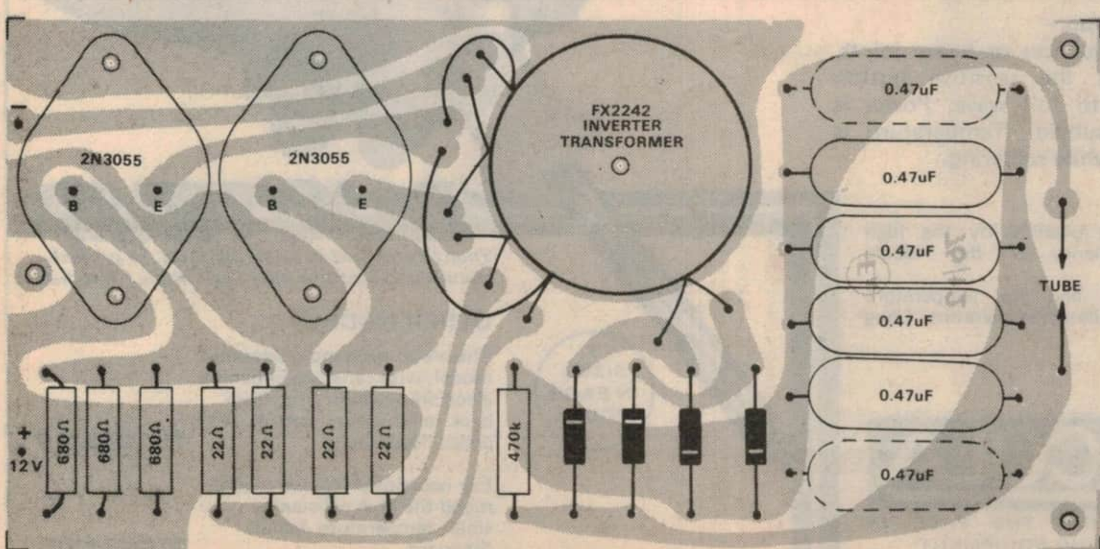
First of all, check inverter operation by connecting to a 12V supply (eg, a car battery!) and seeing if the inverter whistles. If not, try swapping the leads to either the emitters or bases (not both). When you have the inverter working, measure the voltage across the storage capacitor. It should be around 300-400V.

Now bare some of the wire at the EHT lead, and connect this to any spark plug lead. With the inverter turned off, start the engine. Before turning the inverter on, check that there are no arc-overs at either end of the EHT lead—ie, at the plug or around the tube. There should be very faint flashes within the tube itself—this is normal.

Now turn the inverter on. The timing



This "strung out" shot shows all components. The PCB slides into the case and is held in by three screws.



Component layout on the PCB, shown actual size to facilitate copying. All resistors are 1W types. Our PCB is fibreglass, but SRBP would do as well.

light should begin flashing in sympathy with the spark plug to which it is connected. If it does, and there is no evidence of misfiring when the engine is revved to, say, 2000 rpm, the timing light is a "goer" and is ready for final assembly.

If there is evidence of misfiring, or arc-over, there is too much drive to the tube, and some of the helix should be removed. As little as one turn might be all that is necessary.

Carefully slide the board back into the case, taking care not to foul any of the leads as you do. Pull the EHT lead back as you go. With the reflector fully in, there should still be a slight amount of slack in the EHT lead with the knot hard against the rear of the case.

Mounting the board inside the case is a little tricky. The rear screw is very difficult to get to, so is best made a "captive" type by Aralditing a nut to the top of the board. The two front screws are easy to get at, and present no problem.

With the screws in position, the reflector housing may be pushed into position, and locked in place by its screw. The timing light is now finished.

For those contemplating a device of this type, a description of its use is probably quite redundant—but for the sake of the amateur whose interest may be more electronic than mechanical the following information is provided:

The ignition timing is a very small part of the overall tuning process, but it is a very important part for efficient operation of the engine. Before timing, the spark plugs should be checked and, if necessary, re-gapped or replaced, and the distributor points should be re-set or replaced if necessary.

For the novice who is not used to strobe lights near moving machinery, a very wise precaution is to remove the fan belt before attempting timing. At certain engine speeds, the timing light can make the fan appear slow or even stopped, with risk of injury if mistaken.

The ignition timing is normally referenced to No. 1 cylinder—however, there are exceptions, so check the workshop manual. The timing mark is normally located on the crankshaft pulley, but it may be on the flywheel with an inspection plate to undo before timing can proceed. The timing mark will coincide with the reference marker or scale at the correct point in the piston cycle.

The exact point will vary from vehicle to vehicle and even model to model, but will normally be from about 4° to about 10° before top dead centre (BTDC). Some cars may have a scale marked on them, with 0° as TDC, and a range of degree marks each side. Others may have the same scale, but with a mark at the timing point (e.g. –8°). Consult the workshop manual, or your local garage, who will be able to show you the mark or tell you the correct point.

The timing is altered by rotating the body of the distributor. You will find a bolt holding the distributor tight in position—loosen this slightly and disconnect the vacuum advance line before starting timing.

Timing should be conducted with the engine running at idling speed. If you have no tachometer, adjust the idling screw on the carburettor up or down until the engine just runs smoothly.

Connect the + and – leads of the timing light to the battery of the car (check that light is operating by briefly switching on & listening for the whistle) and then connect the HT lead to the top of No. 1 plug or to No. 1 lead at the distributor.

Then hold the timing light so it plays on the area of the timing mark and (preferably have someone else) start the engine. The lamp will flash and the timing mark appear stationary somewhere near the reference mark. Rotate the distributor until the timing mark and the reference mark coincide.

Once the timing is completed, lock the distributor back into position. Reconnect the vacuum advance line, and check the timing again. As the engine speed is increased the timing mark will appear to move in the opposite direction to the rotating shaft.

And there you have it. A timing light which will help keep your car running smoothly, at less than a quarter of the cost of a commercial model.

PARTS REQUIRED

1 "Commander" torch, modified as described
1 PC board, code 76/t12
1 pair FX2242 ferrite cup cores
1 DT2180 Delrin former
2 2N3055 silicon NPN power transistors
4 EM406, BY127/600 silicon power diodes
1 MFT1210 flashtube
CAPACITORS
2, 4 or 6 0.47/630VW polycarbonate (see text)
RESISTORS (5 or 10%, 1W)
1 470k, 3 680 ohms, 4 22 ohms
MISCELLANEOUS
Double tough enamelled copper wire (26, 28 and 32B&S), spaghetti sleeving, epoxy adhesive, EHT cable as required, 23/.0076 hookup wire as required, 3 nuts & bolts, 16 aluminium for heatsink, solder, silicone grease, etc. Note: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with higher ratings may generally be used providing they are physically compatible. Components with lower ratings in this case must not be used.

This full size drawing of the transistor heatsink can be used as a template. Hole sizes are not critical—ours were ⅛in. A smear of silicone grease between the transistor and heatsink will improve thermal conductivity.