SMART KIT NR 1120

R.P.M. INDICATOR WITH LEDS

GENERAL DESCRIPTION

Many cars do not have a specific indicator showing the engine revolutions per minute. Maybe such an indicator was originally considered to be obsolete.

Nevertheless, a car engine r.p.m. indicator is very usefull. The driver, based on certain characteristics of the engine, can combine the engine and the gear box according to the load on the car and the general driving conditions. These engine characteristics are shown at the car's manual. Some of them are:

- maximum revolutions per minute, - revolutions at which the engine outputs maximum torque, - revolutions at which the engine outputs maximum power, etc.

The benefits of using such information properly are:

- increased driver and passenger safety, - increase in engine performance, - increase in engine life span, - decrease in fuel consumption.

The circuit that will be described in detail, makes up a precise and easy to use r.p.m. indicator. It can be installed at any petrol engine.

The reading consists of a light bar which is made by a series of LEDs. Its round shape gives the impression of a needle instrument. The "thousand" r.p.m. values are indicated by LEDs. Any dangerous engine operating zone is indicated with a chan ge at the bar's colour.

You should note that the r.p.m. indicator's circuit does not interfere with the mechanical or electronic ignition system that the car might use.

TECHNICAL SPECIFICATIONS

- Power supply voltage 13.8 V DC
- Current consumed at full scale deflection 0.24 A
- Input impedance 100 K
- Maximum reading (deflection) 7,000 r.p.m.

HOW IT WORKS

The circuit of the indicator can be seen at figure 1. It is divided in three distinct parts:

(A) The display part. This is arranged as a Bar Graph Meter. In practice, it is an analog voltmeter which has an LED bar graph as output. It consists of IC3, IC4 and IC5 integrated circuits of the LM 3914 type, manufactured by National Semicond uctor.

Each LM 3914 accepts a DC voltage level as input and drives a group of 10 LEDs which form an analog indicator. The group of the three integrated circuits creates a continuous bar as output. This bar consists of 28 LEDs and its length depends on the voltage level present at point 5.

(B) The converter part. This part receives the series of pulses that are generated by the mechanical or electronic ignition system and converts it into a corresponding voltage level at the output. This voltage level depends on the number of pul ses received and it is measured by the three integrated circuits that make up part (A).

Part (B) is formed around IC2 which is an integrated circuit of the LM 2917 type, by National Semiconductor. This is a frequency to voltage converter.

IC2 contains internally the three circuits described below:

(1) A circuit to produce a steady current to charge C5. Each time that the r.p.m. indicator input, which is connected to the ignition system, changes its state from ON to OFF and back to ON again, at a frequency Fin, C5 is charged and discharge d by a steady current. Its voltage varies between two voltage levels whose difference is equal to the fraction of the supply voltage (Vcc), divided by 2 (Vcc/2). The charging current pulses that are produced in this way create a voltage drop across P1. This is Vo and is given by the formula: Vo = Vcc x Fin x C5 x P1. C7 simply filters this voltage without distorting it. In this way, it also adjusts the speed of response of the meter to the changes of Fin, that is, the changes of the engine speed. The value of C7 is chosen so as the indicator to follow the changes in engine speed of a high speed engine without delaying its readings.

(2) A buffer circuit. This receives voltage Vo and applies it across R4. It then drives it via R5 and the filter formed by C11 and R7, to point S. This is the input of part (A) which is formed by IC3, IC4, IC5. The voltage is measured at this point.

(3) A voltage stabilizer circuit. This uses a zener diode and the limiting resistor R1. The circuits formed around IC2 are thus not affected by variations in the supply voltage and, so, Vo is strictly equivalent to the input frequency Fin.

(C) The LED driver part. This circuit drives the anodes of the bar LEDs with positive voltage pulses. The circuit is formed around IC1, T1 and T2. The generated pulses last for 40 u seconds and are repeated every 60 u seconds. They are produced by the timer circuit IC1, of the 555 type, and elements R7, R8, C9 and C8. A circuit is also formed around T1, T2, R9 and R10, in order to amplify these pulses. This circuit is used in order to increase the brightness of the LEDs used for t he bar and also to decrease the power dissipated at the output circuits of IC3, IC4, IC5. Consequently, this reduces the heat generated by these integrated circuits as the LEDs are turned on and off at a frequency of 10 KHz, without being not iced by the human eye.

Finally, the whole circuit is protected against any interference present in the car's wire installation. This is done by the filter which is formed around L1, C1, C2 and C10 and is present along the power supply line coming from the car install ation.

CONSTRUCTION

First of all let us consider a few basics on building electronic circuits on a printed circuit board. The board is made of a thin insulating material clad with a thin layer of conductive copper that is shaped in such a way as to form the necess ary conductors between the various componenrts of the circuit. The use of a properly designed printed circuit board is very desirable as it speeds construction up considerably. It also reduces the possibility of making errors. Smart Kit board s also come pre- drilled and with the outline of the componets and their identification printed on the component side to make construction easier. To protect the board during storage from oxidation and assure it gets to you in perfect conditio n, the copper is tinned during manufacturing and covered with a special varnish that protects it from getting oxidized and also makes soldering easier.

Soldering the components to the board is the only way to build your circuit. Your success or failure greatly depends on the way you do it. This work is not very difficult and if you stick to a few rules you should have no problems. The solderin g iron that you use must be a light one and its power should not exceed 25 Watts. The tip should be fine and must be kept clean at all times. Special sponges that are kept wet are available so as to wipe the hot tip on them and thus get rid o f any accumulated solder residues. If the tip cannot be cleaned any more, then it should be replaced.

There are many different types of solder in the market and you should choose a good quality one. This should contain the necessary soldering flux in its core. This will ensure a perfect soldering at all times. DO NOT use any extra soldering flux apart from the one already included within the solder. Too much flux can cause many problems and is one of the main causes of circuit malfunction. If nevertheless you have to use extra flux, as is the case when tinning copper wires, clea n it very thoroughly after finishing your work.

In order to solder a component correctly, you should apply the following steps:

- Clean the component leads with a small piece of emery paper.

- Bend them at the correct distance from the component's body and insert the component in its place on the board.

- You may find some times a component has heavier gauge leads than usual. They may be too thick to enter in the holes of the printed circuit board. In this case use a mini drill to enlarge the holes slightly. Do not make the holes too big as th is will make any soldering difficult afterwards.

- Take the hot iron and place its tip on the component lead while holding the end of the solder wire at the point where the lead emerges from the board. The iron tip must touch the lead slightly above the printed circuit board.

- When the solder starts to melt and flow, wait till it covers evenly the area around the hole, and the flux boils and gets out underneath the solder. The whole operation should not take more than 5 seconds. Remove the iron and allow the solde r to cool naturally without blowing on it or moving the component. If everything was done properly, the surface of the joint must have a shiny, metal-like finish and its edges should be smoothly ended on both the component lead and the board track. If the solder looks dull, cracked, or has the shape of a ball then you have made a dry joint and you should remove the solder (with a pump, or a solder wick) and redo it.

- Take care not to overheat the tracks as it is very easy to lift them from the board and break them.

- When you are soldering a sensitive component it is good practice to hold the lead from the component side of the board with a pair of long-nose pliers. This will divert any heat that could possibly damage the component.

- Make sure that you do not use more solder than it is necessary as you are running the risk of short-circuiting adjacent tracks on the board, especially if they are very close together.

- When you finish your work, cut the excess of the component leads off and clean the board thoroughly with a suitable solvent to remove all flux residues that still remain on it.

The assembly of this indicator is simple, but one must pay particular attention to the connection of the three printed circuit boards that constitute the system. You must therefore follow very closely all the assembly instructions that follow.

All components must lay close to the board. Their leads must be tightly bended on the board so as not to let them free to move until they are soldered in their proper positions. More specifically, resistors R11, R12, R13, R14, R15 and R16 on th e kit's board B, must be installed vertically, as it is shown on the schematic layout of the board. In this way, a part of one of the leads of each resistor, equal to the height of the resistor's body, will have to be covered by a piece of i nsulating tube, equal in length , to the resistor's body. It is also important to note and follow the polarity of the electrolytic capacitors present at each board. These are shown on the schematic layout diagrams of each board. The componen t leads that are left below the board level must be cut at a length equal to the radius of the circular pad that they will be soldered on. Use a suitable lead cutting tool for this job. Given the fact that space is scarce on the boards, you must be particularly careful while cutting and soldering any component leads. You must use a 25W soldering iron for this purpose, alongside with good quality solder. Do not use any soldering flux. The tiny quantity of solder that will be po ured on the board pad after the soldering iron is removed, must be shiny, with a metal-like look, and should cover the whole of the pad.

Before you start assembling the parts of the circuit, you must locate each individual board of the kit.

The kit contains three printed circuit boards, A, B, and C. Board A makes-up the front end and includes the LED bar display. Board B contains IC3, IC4 and IC5. Board C contains IC1 and IC2 and their peripheral components.

These three boards are installed one behind the other. Board A is the front end with boards B and C following behind it.

Hold each board separatelly. By looking from the side showing the schematic layout diagram, you should see a series of holes made for connecting purposes. These are marked with a series of English letters. A description of how to connect the k it boards follows below. During this connection, these connection pins will be connected to their counterparts on the other boards, with thin, single cored, wires that will cross each one of the boards. The rest of the connecting points betw een the boards will be connected with flexible wires that will go through the oval holes that have been drilled on each board.

The three boards are placed one behind the other, with A being first and B,C following in this order. They are held together with two long screws. The nuts that will be put on these screws will keep the boards apart at a distance equal to the h eight of the components of each board, without letting them touch on the board behind the front one.

Start the assembly with board A. Install all LEDs at the same, rather low, height. If you are not sure, you must take note of fig. 2a and 2b, where the LED anode and cathode are shown. Alongside, a practical guide of how to spot the LED anode, is also provided there. This is based on the fact that the LED produces light when it is forward biased.

Take care of the way the LEDs are installed. When their soldering is over, they should not be bended or left sideways. There should be an equal distance between them and at a steady radius from the board centre. The LED colours correspond to t he various engine speed ranges. They are shown at fig. 3.

Install and solder resistors R17, R18 and R19.

Solder a white wire at point 4 and a black one at point 3. Make these two wires to go through the oval hole which is underneath the board.

Go ahead with the construction of board B.

First, install and solder all jumpers, J1 though J6. Then, install and solder the IC3, IC4 and IC5 bases. Pay particular attention for the dot on their body to match the dot shown at the schematic layout diagram of the board.

Install and solder R11, R12, R13, R14, R15 and R16. They must be installed at a vertical position. A piece of insulating tube must be put on the naked part of their lead.

Install and solder C10 and P2. Solder a piece of orange coloured wire at point 6, a piece of black wire at point 3 and a magenta one at point 5. Make all these wires to cross through the oval hole underneath the board. Place IC3, IC4 and IC5 on their bases. Note that the point on their body should match with the one on their base and the one shown at the schematic layout diagram of the board. Make sure that all of their pins are properly alligned with the base contacts before you press the integrated circuits onto them. Otherwise, one, or more, of the pins may be bent, in which case, it will not make contact and the circuit will not work.

Go ahead with the construction of the third board.

Install and solder all resitors and capacitros. Make sure the polarity of the capacitors matches with the schematic layout diagram of the board. Install and solder P1, C1, transistors T1 and T2 and the bases of IC1 and IC2. Make sure that their

characteristic dot matches the schematic layout diagram of the board. Take three long pieces of wire. Solder a black one at point 3, a red one at point 2 and a yellow one at point 1. Make these wires to go through the oval hole underneath th e board. Place IC1 and IC2 on their corresponding bases, paying attention so as all their pins to make proper connections and the special dot on the body to match the schematic layout diagram of the board.

Place the three boards one behind the other, with board A at the front and boards B and C, following at that order. Hold them together by placing two long screws through them. Take care for trimmers P1 and P2 to be at the same side. While push ing each one of these screws through the boards, place two plastic spacers and two nuts on each screw. These should be put in a way so that each should be adjusted so as to leave just enough distance between the boards for the components not to touch the previous board.

Make the white wire of board A to cross board B's oval hole and then solder it at point 4 of board C. Solder the black wire of board A at a point 3 of board B. Solder the black wire of board B, to point 3 of board C. Solder the orange wire of b oard B at point 6 of board C. Solder the magenta wire of board B at point 5 of board C.

Use thin, single cored wire, across boards A and B so as to connect the corresponding points on the board, according to their letters (point A on board A will be connected with point A on board B; point B on board A will be connected with poin t B on board B and so on for all points that are labelled with a letter in this way, on each board). Cut any piece of wire that extends beyond board A. Make sure that all of these wires are straight so as not to touch with each other and crea te a short circuit.

The indicator needs to be calibrated before it is installed in a car. For this purpose, a power supply unit is needed. You will use a 220V/12V - 0.5 A transformer, a rectifier bridge and a 10 k/0.5 W resistor. These will be connected as shown at fig.4.

Before you proceed to calibrate the circuit, you must find out the sort of engine that your car has. Then proceed to calibrate the indicator as described below.

Supply the indicator with 12V DC. The positive (+) lead is connected to point 2 of board C and the negative lead (-) is connected to point 3 on the same board. The LEDs showing the thousand r.p.m. units an the one showing 0 rpm, will light up.

Measure the voltage at the cursor pin of P2 on board B. Adjust P2 so as to have exactly +3.00 V DC there. It is better to use a digital multimeter for this measurement. Then, connect the yellow cable coming from point 1 on board C, to the outp ut of the rectifier bridge mentioned above, in the external power supply unit. Supply the power supply's transformer with 220 V AC. Consult fig. 4 for these connections.

Adjust P1 on board C so as to measure a suitable voltage for the type of engine you have. Consult the table provided below in order to find the correct measuremnt corresponding to your engine.

Number of cylinders	RPM reading
2	6000
3	4000
4	3000
6	2000

Four stroke engine

Number of cylinders	RPM reading
2	6000
3	4000
4	3000

Two stroke engine

IF IT DOESN'T WORK.

If something appears not to be working right, then inmmediately disconnect both the 220 V AC and 12 V DC. Carefully inspect visually the boards so as to spot any mistakes or any bad craftmanship. More specifically,

- Check your work for possible dry joints, bridges across adjacent tracks or any soldering flux residues.
- Check all external connections to and from the circuit.
- Check one-by-one, all the components VERY CAREFULLY. Check and, or, change any component that overheats, looks suspicious or has been distorted.
- Have you installed a component the wrong way round or in the wrong place?
- Have you overheated a component during soldering?
- Have you short-circuited any neighbouring tracks on the printed circuit board?
- Have you used any soldering flux? You should throw it away. The solder contains any flux that is needed for a good soldering.

If all the above have been checked and were found to be alright, or were fixed, then try to reconnect the power supply to the circuit. If it still doesn't work, then do not hesitate to call us. Our technicians will be happy to solve any problem s you might have relative to this kit.

If you still do not manage to fix it, you can always bring the kit along to us for testing and repair. You will have it back soon afterwards, fixed and in working condition.

After finishing with the assembly and calibration of the circuit, it can be put in one of the usual circular instrument boxes available in any store selling car accessories. Consult fig. 5 in order to install your indicator on your car.

In the case that the car already uses the SMART KIT NR 1058 electronic ignition circuit, the special connections shown in fig. 6 must be followed.

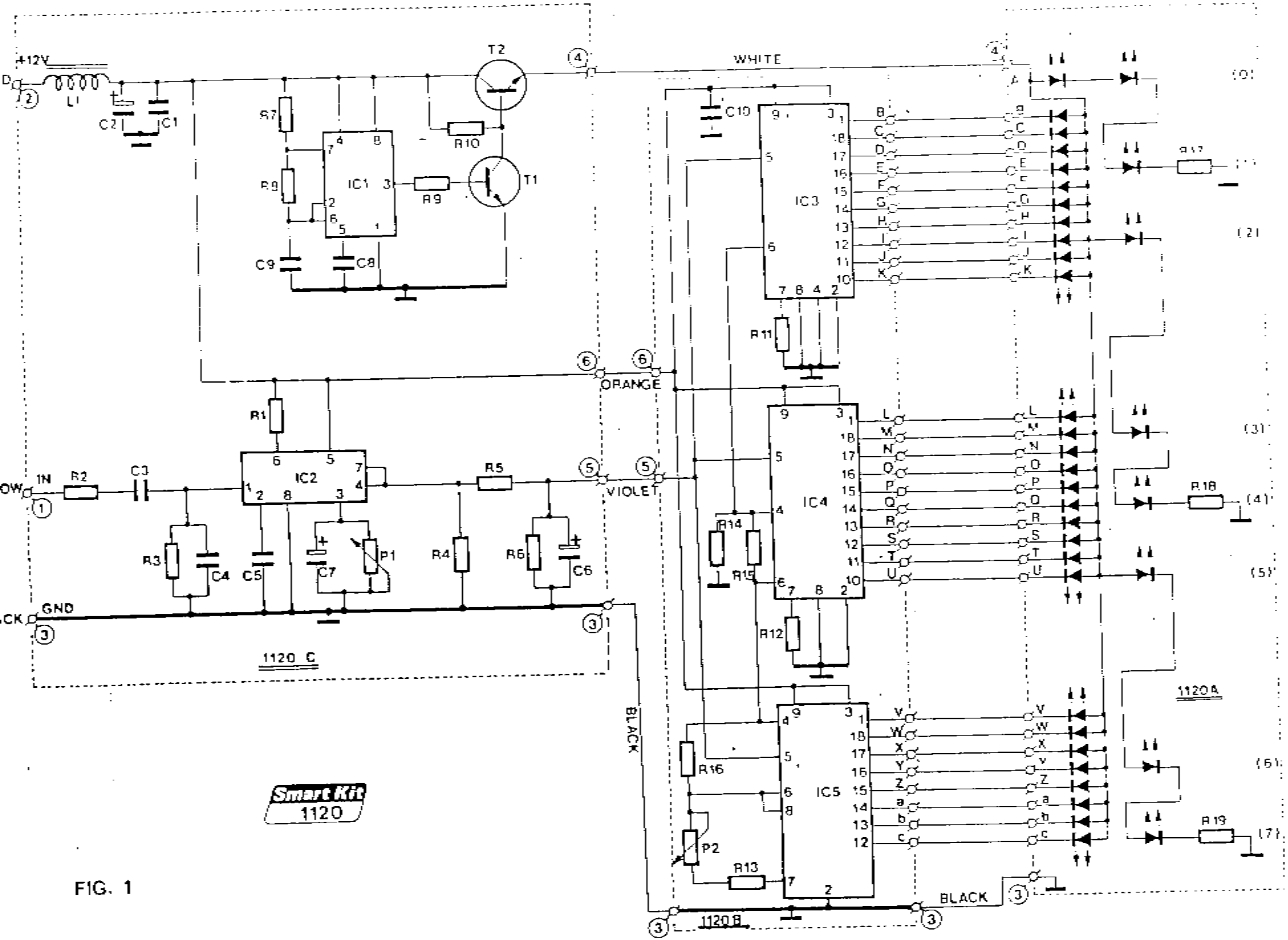
+12V
L1
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R18
R19
P1
P2
T1
T2
IC1
IC2
IC3
IC4
IC5
IN
GND
WHITE
ORANGE
VIOLET
BLACK
1120 C
1120 B
1120A
Smart Kit
1120
(0)
(2)
(3)
(4)
(5)
(6)
(7)

FIG. 1

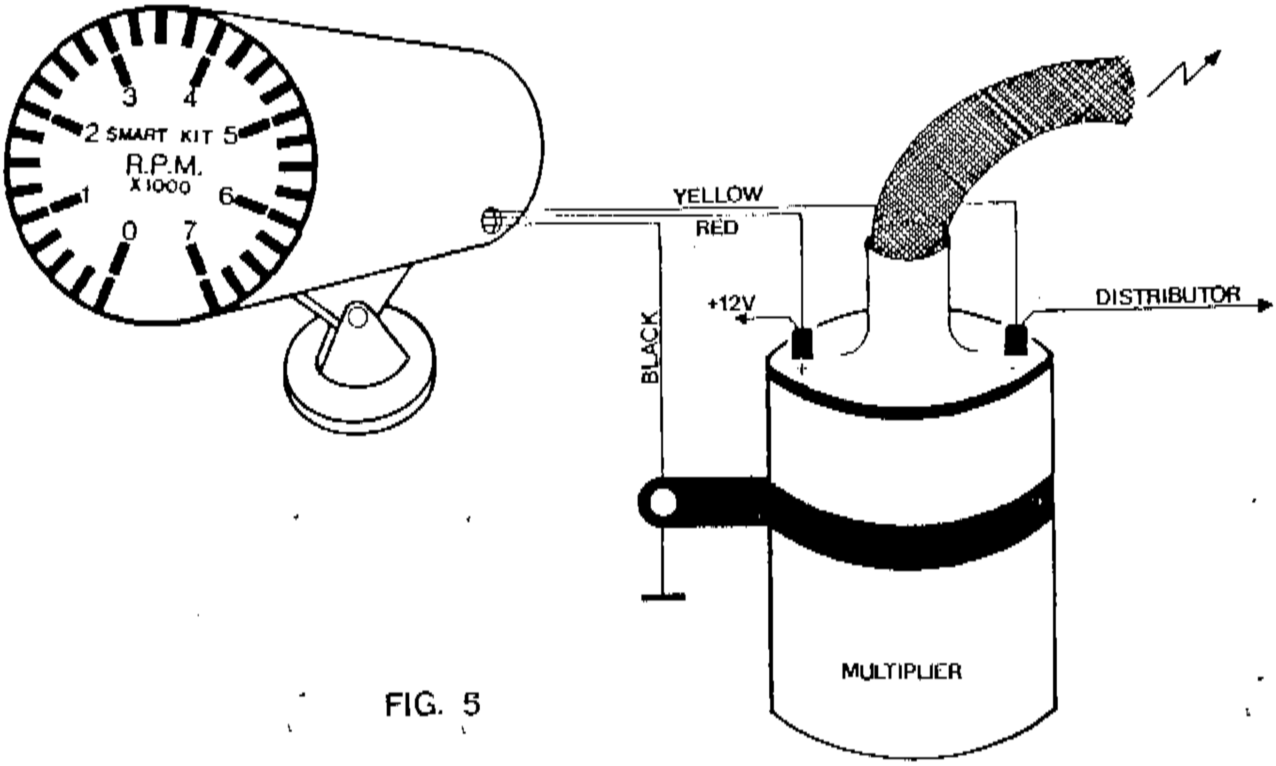
3
4
2 SMART KIT 5
R.P.M.
X1000
1
6
0
7
YELLOW
RED
BLACK
+12V
DISTRIBUTOR
MULTIPLIER

FIG. 5

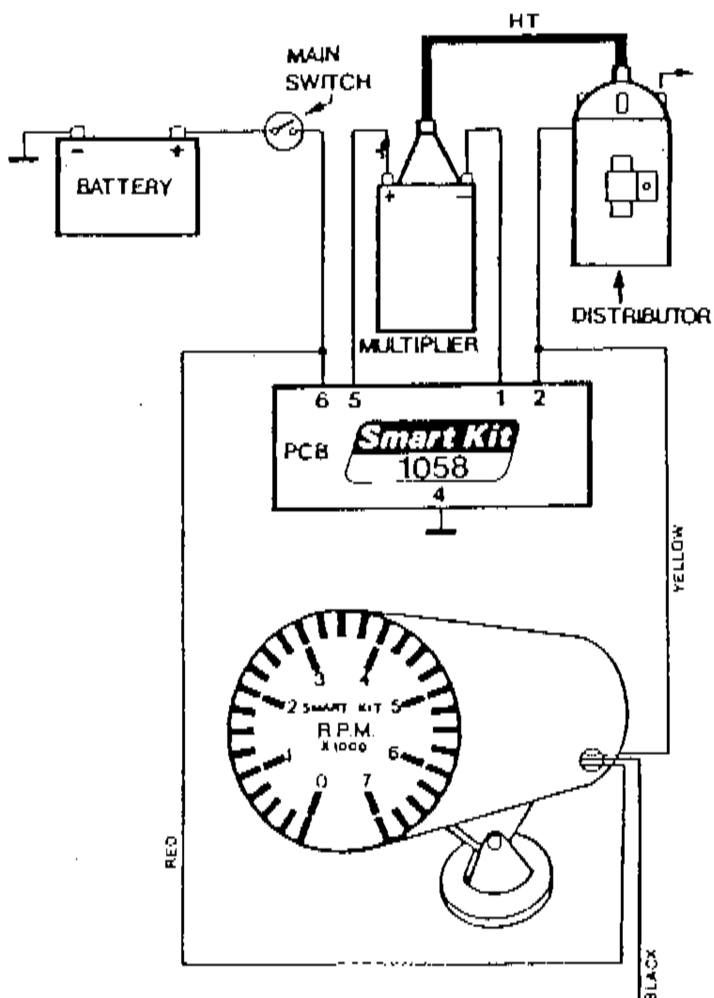
HT
MAIN SWITCH
BATTERY
MULTIPLIER
DISTRIBUTOR
6 5 1 2
PCB
Smart Kit
1058
4
YELLOW
RED
BLACK
2 SMART KIT 5
R.P.M.
X1000

FIG. 6

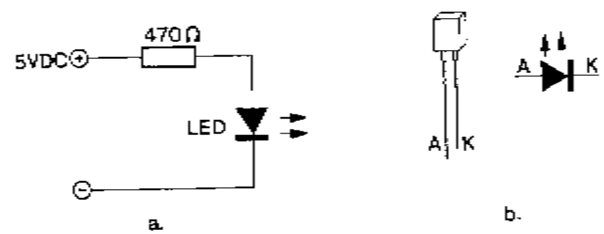

FIG. 2

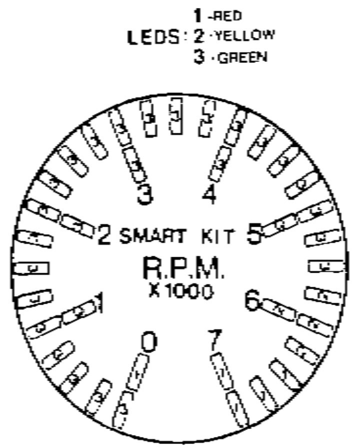

FIG. 3

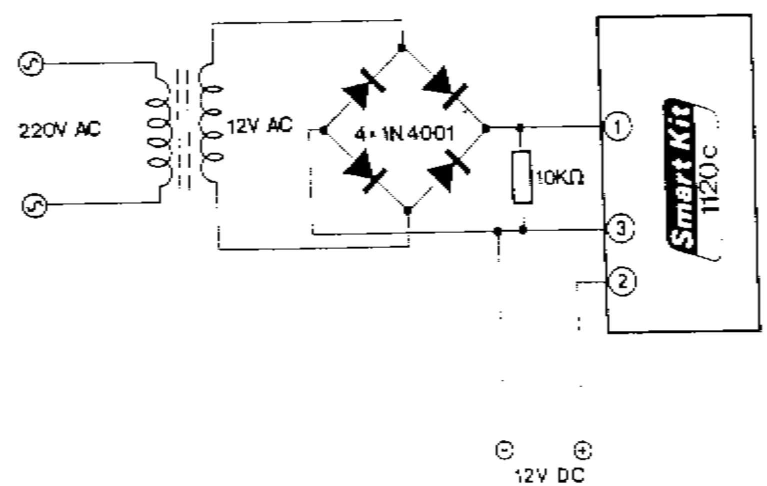

FIG. 4