



**BABANI PRESS No.13**

**ELECTRONIC  
NOVELTIES  
FOR THE  
MOTORIST**

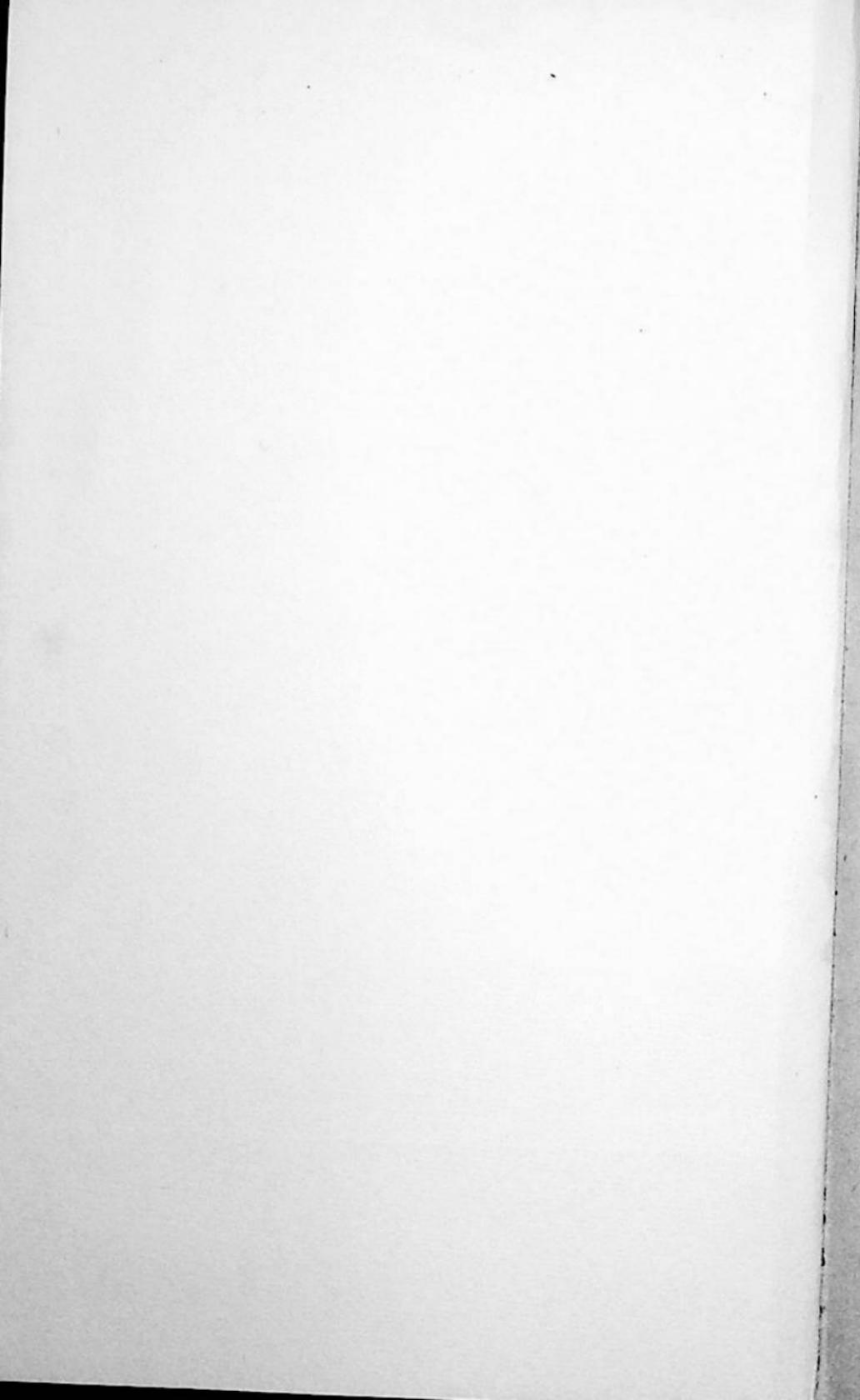
**BY**

**B.B. BABANI**

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**Historie v/d Radio**

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Although every care is taken with the preparation of this book the publishers will not be responsible for any errors that might occur.

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## SPECIAL NOTE FOR AMERICAN READERS

In order to help readers of this book, a table of transistor and diode equivalents showing American types that may be used in place of the British types shown in the circuits in this book.

British	U.S.A. Types
AC122	RS276-2004.2N2429.SK3004
AC125	RS276-2005.2N1190.SK3004
AC126	RS276-2004.2N2429.SK3004
AC128	RS276-2004.2N1373.2N4106.SK3004
AD166	RS276-2006.2N456.SK3009
ADZ11	RS276-2006.2N1146.SK3009
ASY24	RS176-2023.2N2906.SK3114
ASY48	RS276-2023.2N2906.SK3114
ASY56	RS-2023.2N
ASZ17	RS276-2006.2N352.SK3009
AUY21	RS276-2006.2N352.SK3009
BAX16	RS276-1139.1N914.1N916.1N3070.1N4009 1N4150.1N4151.1N4448.SK3016
BC107	RS276-2009.2N2921.2N3568.SK3020
BC108	RS276-2009.2N3565.SK3020
BC283	RS276-2023.MPS6518.MPS6519.SK3114
BCZ63	RS276-2023.SK3118
BY114	RS276-1139.SK3016
BY126/50	RS276-1114.1N3193.1N4002.1N4006.SK3032
BY127	RS276-1114.1N4006.1N4007.SK3033
BYX21LR	RS276-1139.SK3016
BZY88C6V2	RS276-621.1N709A.SK3058
BZY88C6V8	RS276-621.1N710A
EM401	RS276-1139.1N3193.1N4002.SK3016
OA95	RS276-1102.1N34A.1N56.SK3087
OA210	RS276-1114.1N4006.1N4007.SK3033
OC170	RS276-2005.2N641.SK3008

HIGH POWER 12V MULTILAMP FLASHER UNIT

This emergency aid may save the lives of drivers and passengers. The unit is very simply built and it is suggested that it be mounted behind a triangle of red reflecting plastic. The three legs of the triangle should be approximately 18" high x 2" wide x  $\frac{1}{4}$ " thick, and the four 18W 12V lamps mounted behind the triangle. A further piece of plastic 16" x 2" may be fixed by a hinge at the back of the triangle as an easel type support. Assemble the electronic circuitry on a piece of Veroboard and mounted it behind the triangle by screwing it to any convenient place.

For best results run this unit off the car's 12V battery. Use heavy duty twin flex lead of minimum 60 foot length. One end of the lead connect permanently to the positive and negative points on the flasher unit. The other end should have a pair of battery clips fitted showing the correct polarity. In use these are clipped on to the car battery.

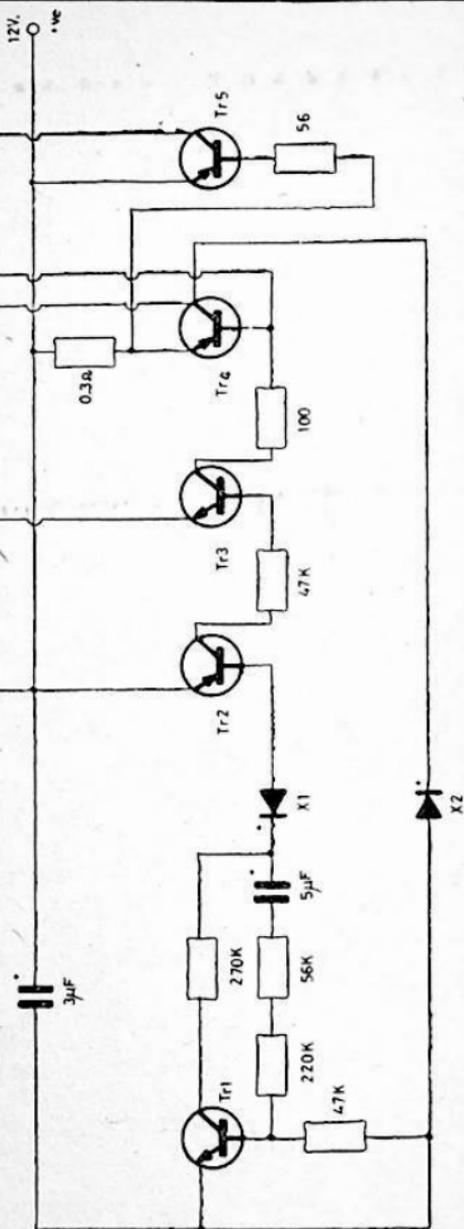
Use this multilamp flasher whenever the car has stopped at night for emergency repairs or type changing. The flasher triangle should be placed as far to the rear of the car as the lead will allow. This gives adequate warning to all following vehicles that an emergency stop has taken place and avoidance tactics must be made.

COLD WEATHER CAR STARTER

The simple little device using three transistors will start any car even when the temperature is well below freezing. It is particularly useful for cars with run down or poor batteries. The circuit is self-explanatory. The auxiliary battery is two 6V lantern type batteries wired in series so that a 12V supply is available at this point. The whole unit should be built up on a piece of aluminium 10 s.w.g. size 6" x 3" and this metal chassis must be insulated from the car chassis.

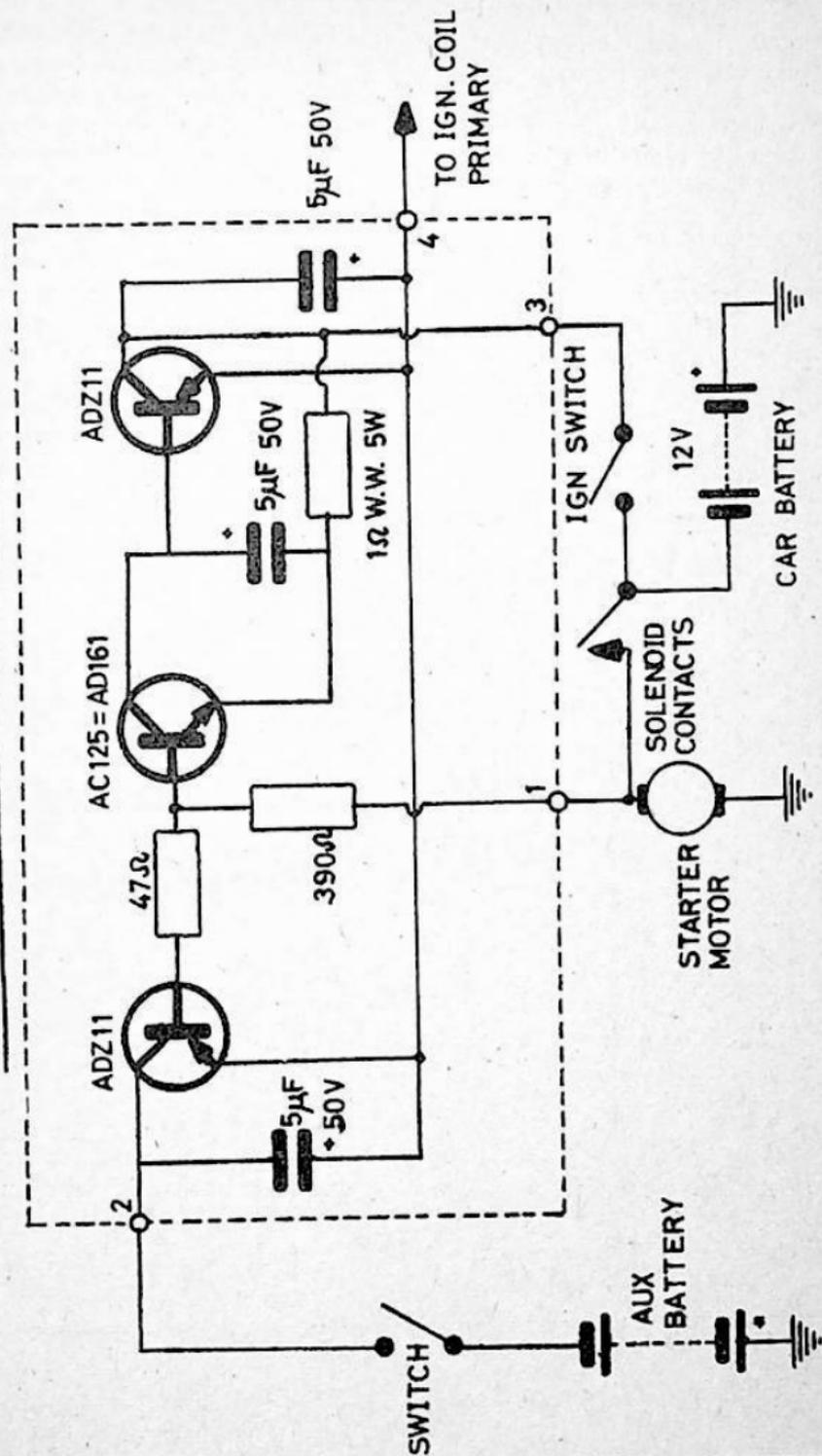
Connect the output of the cold weather starter to ignition coil winding marked SW. The function of this unit is completely automatic once the auxiliary switch is closed and if desired the unit may be mounted under the dash board of the car at the coolest place possible. After the car starts, open the auxiliary switch on the unit to conserve the life of the lantern batteries.

Tr1 = Tr3 = BC208 = BC383 = 40450  
           = BC107 = BC182 = BFY44  
 Tr2 = Tr5 = BC283 = BC205 = BC206  
 Tr4 = AUY21 = ADZ11 = AUY31 = AS216  
 X1 = X2 = BAX16 = BAY18 = BAY87



HIGH POWER 12V MULTILAMP FLASHER UNIT (85 FLASHES PER MINUTE)

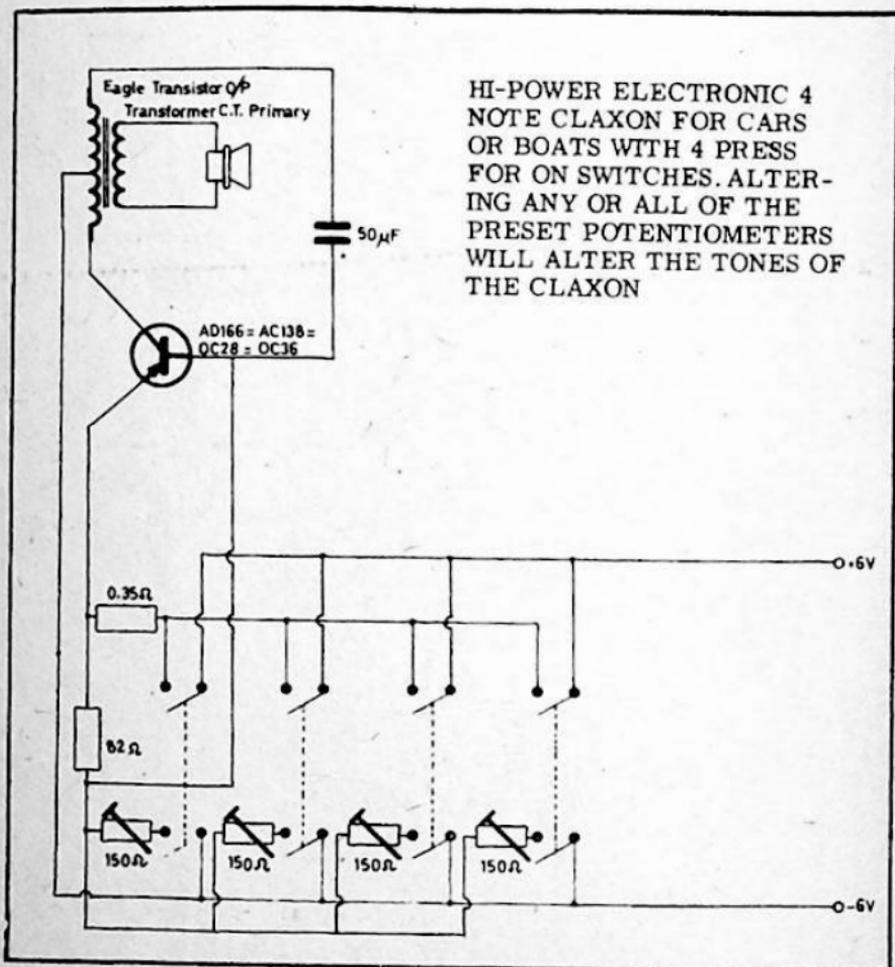
# COLD WEATHER CAR STARTER



## HIGH POWER 4 NOTE CLAXON

This very simple circuit will produce an extremely loud claxon warning and is superior in performance to many expensive multi-note continental horn. However, readers must realise that it is illegal when using a unit like this, on a car, to cause the notes to rise and fall by switching on and off any two of the four press switches alternately. Therefore, use this claxon either by pressing 1, 2, 3 or all 4 press switches at the same time.

Its use on a boat is not restricted with the same conditions. The builder of this fine piece of equipment may select the tones he likes by pre-adjusting the potentiometers.



## BRAKE WARNING LIGHT FAILURE INDICATOR

WE HAVE SEEN MANY DESIGNS OF INDICATORS WHICH WARN WHEN A BRAKE LIGHT HAS FAILED. MOST WERE QUITE INGENIOUS, BUT ALL SUFFERED FROM THE SAME OBJECTION - THEY WERE EITHER TOO EXPENSIVE OR TOO INVOLVED TO WARRANT MR. AVERAGE FITTING THEM TO THE FAMILY CAR. THIS DESIGN SHOULD CHANGE ALL THAT .....

Most systems we have seen relied on a solid state device sensing the current across a low resistance placed in series with the lights. While this works very well, it involves a lot of messing around with the brake switch wires and the line to the lights themselves.

Other systems use a light sensing device (usually an LDR) to determine whether or not light is coming from the bulb when power was applied. This arrangement does alleviate some of the former problems, but introduces new ones of its own, in that wires must be run back to the indicator lamp on the dashboard, and also that the brake light housing may have to be modified to accommodate the LDR.

But our brake light indicator requires only one break in the line - and if your car is typical of the majority these days, you won't even have to cut the wire; there will be a barrel type connector available at a convenient point for the circuit to be intercepted.

Another advantage of our indicator is that it works equally well on either polarity electrical system, with no changes necessary.

The heart of our system is a dry reed switch. The one used, the XS7 is an economy type.

This, and the price of an indicator bezel, is the only real cost. The other parts, a few inches of wire and a couple of tagstrips, can probably come from the junk box. Even if you have to buy them, they won't cost more than a few pence.

Briefly, the construction and operation of our indicator is as follows. Wound around the reed switch is a coil of wire. This wire is connected in series with the wire from the brake pedal switch to the brake lights. One end of the reed switch connects to this same line, the other end connects to the indicator lamp, and the other side of the indicator lamp connects to the chassis.

When the pedal is pressed, the brake light switch is turned on. Current flows through the brake lights via the coil. When current flows in the coil it becomes an electromagnet. If the magnetic field is strong enough the contacts of the reed switch will close, allowing the bezel lamp to light. When the brake is released, the whole system returns to

normal. Thus, every time the brake pedal is operated the driver is given a visible indication that the brake lights are working.

On the other hand, if there is no current, or insufficient current, the reed will not close and the indicator lamp will not light. This warns the driver that there is a fault somewhere in the brake light system.

From this simple description it will be realised that the system is almost completely "fail safe". Regardless of what can go wrong, from a burnt out indicator lamp to welded contacts in the reed switch (a most unlikely situation anyway), the result will always be to draw the driver's attention to it. And having done that, it has served its purpose.

A major requirement which this system must satisfy is that it will indicate the failure of only one lamp in the normal two lamp brake light system. This is not hard to do, and a few simple facts about the reed and the lighting system will make it easy to understand.

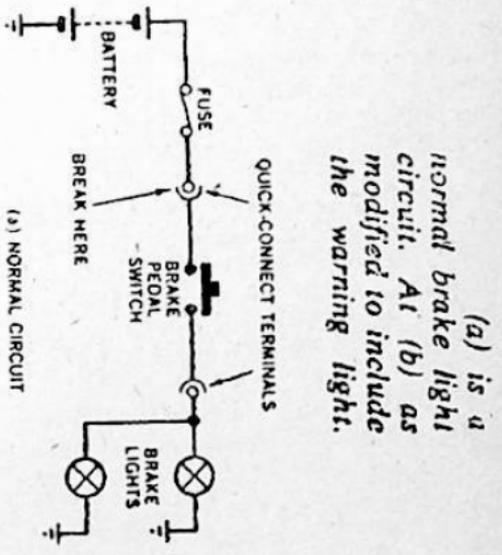
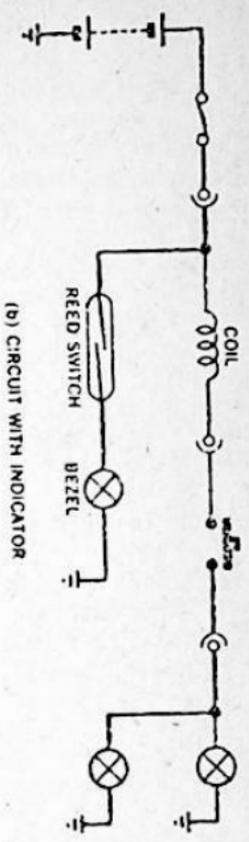
There are two strengths of magnetic field needed to operate a reed switch. One is the "operating" field, needed to close the contacts and the other is the "holding" field, needed to hold them together. The operating field needs to be - typically - about three and a half times stronger than the holding field.

When a lamp is cold, its filament resistance is much lower than when it is hot; typically the cold resistance would be only about one eighth of its hot resistance. This means that, at the moment of switch-on, the lamp will draw, for a brief instant, about eight times its normal running current.

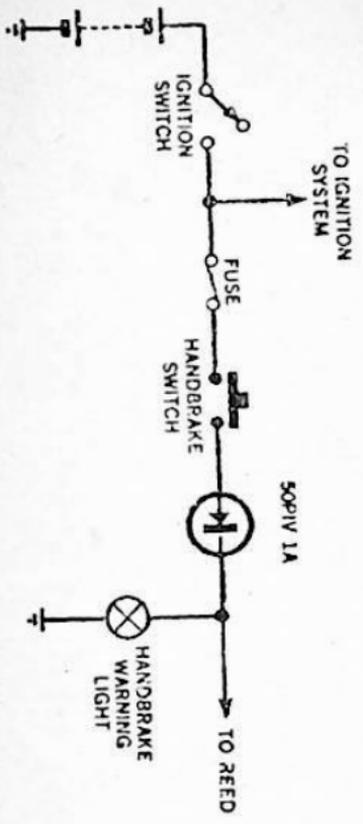
We make good use of these two facts. They enable us to adjust the sensitivity of the system so that the reed will just hold in reliably on the current needed to operate two lamps. If one lamp should fail, there will not be enough current to hold the reed in.

In this regard we are fortunate that the cold surge of the lamps is so much greater than their running current. Otherwise, we could not adjust the system for such a critical value of holding current and still ensure that the reed would pull in reliably. As it is, the reed will pull in reliably on the surge current from only a single lamp, but it will not hold in, resulting in only a brief flicker.

In practice, this simply means winding the correct number of turns around the reed switch. This isn't hard even if your brake light system is not the same as the one we used. In our case we took an educated guess and tried 12 turns, which turned out to be spot on. We did try adding and subtracting from this number, but this only confirmed that our original figure was correct.



(a) is a normal brake light circuit. At (b) as modified to include the warning light.



How the system may be wired to allow the handbrake warning light to double as a brake light failure indicator.

If you have a 12 volt system, with 18 to 20 watt bulbs, this figure will not be very far off the mark for you, too. But just in case, here is how to select the number of turns.

Start by winding 12 turns of wire (16 to 20 S.W.G.) directly onto the glass case of the reed switch. Leave a couple of inches at each end, in case you need to add more turns. With a multimeter, check the wires from the brake pedal switch, identify which is the "hot" lead from the battery, and disconnect it.

Connect the hot lead to the junction of the coil and reed switch and the other end of the coil to the vacant brake switch contact. (See circuit diagram.) Connect one side of the indicator light to the reed switch and the other side to the frame of the car.

Now press the brake pedal. Both brake lights should be on. Check to see if the indicator light goes on and stays on. If it does, good. If not, add one or two turns.

Next, remove one of the brake lights from the circuit. In most cars, this involves no more than separating a quick connect terminal, or removing the bulb. Press the brake pedal. The indicator lamp should give a brief flash and then go out. If it does not, add another turn or two until it does. If it comes on and stays on while the pedal is pressed, remove turns, one by one, until it goes out.

We have not described a 6 volt system, as there are not many 6 volt cars on the road these days. But there is no reason at all why the idea will not work with a 6 volt system.

Once the unit is working properly, it can be assembled. We found that the simplest arrangement was a pair of 3 lug tagstrips mounted on a scrap piece of aluminium.

Two leads run from the indicator to intercept the brake line, the most convenient place normally being at the brake light switch, as explained in the coil testing discussion. The leads should be terminated in barrel type connectors to suit those already used in the car.

One other arrangement which comes to mind involves the handbrake warning light with which most modern cars are fitted. With only a little additional effort, this could be made to double as the brake light indicator. There appears to be no objection to this from an operational point of view, and it could be achieved quite simply by connecting the lead from the reed switch direct to the brake lamp, in parallel with the existing connection.

However, one possibility must be considered. If the car is parked with the handbrake on and the brake pedal is pressed, for example by the driver simply using it as a footrest, a circuit will be completed to the ignition

coil. At the very least this is undesirable, since it could lead to overheating of the coil. In some other circumstances it might even be dangerous.

This objection can be overcome by a simple modification, as shown in the amended circuit. A silicon rectifier diode of at least 1A, 50PIV rating is connected between the handbrake switch and the lamp. The 50 PIV 1A Diode can be a 1N3193 or BY126 or BY174.

In this position, it will be reverse biased in the circumstances mentioned, and will not conduct. Under normal running conditions, it will be forward biased with the ignition switch and handbrake on, and the lamp will light. If the footbrake is pressed, the lamp will light because of the direct connection to footbrake indicator.

While this arrangement involves the cost of a diode, it saves the cost of the indicator bezel, and the overall cost should be about the same. It also has the advantage of not requiring that a place be found to mount the indicator bezel and that the installation will look rather more professional.

Either way, this little device may well save some embarrassment if it warns, in time, that all is not well with your brake lights.

#### 12V CAPACITOR DISCHARGE (CD) IGNITION UNIT

After investigating the economics and performance of the various transistor ignition systems, I have concluded that the only worthwhile set-up is the so-called "capacitor-discharge" system. This costs a little more to construct than the standard transistor ignition but the saving in not having to purchase a special coil largely compensates for this. As far as efficiency is concerned, it wins hands down every time, and must therefore be the logical choice for anyone who is dissatisfied with the standard ignition on his car.

The system to be described is reasonably inexpensive to construct and is reliable in operation. It is absolutely conventional in all respects, simple to put together and easy to get working if the layout and instruction are followed reasonably closely.

The heart of any capacitor-discharge system is the converter circuit whose function is to step up the 12V DC from the battery to 250-300V DC ready for application to the coil primary. The circuit shown here is a push-pull transformer-coupled converter utilising square-loop material for the transformer core. (3E grade

ferrite is used, as it is cheap and although it does not have a strictly "square" hysteresis loop, its saturation level is well defined and it is quite satisfactory for this application). A description of the operation of the converter can be found in almost any book on transistor theory so will not be repeated here.

The transformer must be carefully hand-wound on a ferrite toroid of dimensions shown (figure 1) and of 3E grade ferrite. A suitable core is supplied by Mullard. Wind the primary on first. This consists of two coils, bifilar wound, of 20 turns each of 22SWG copper wire. Wrap it up with plastic tape to hold it in place. Then wind a base-drive winding of six turns of the same wire at each end of the primary. Make sure all the ends are identified in some way, a bit of coloured sleeving is ideal for this, and tape the whole thing so far. The secondary may now be wound to fill the rest of the available space. That is several layers adding up to 450 turns of 29SWG. Having completed this the whole thing may be taped up to hold it altogether, and some robust lengths of wire soldered to the ends of the secondary to prevent the fine wire being broken in an awkward place. The transformer may then be mounted on a piece of Veroboard as shown in figure 6. Assemble the rest of the converter components on the Veroboard including the diodes and the 330K resistor, fit the transistors to the case-cum heat sink and wire them up to the board with long leads.

Check all the wiring so far and, if O.K., connect a 12-volt battery to the circuit (observing the correct polarity).

A whistle at about 8KHz should be heard. This indicates the converter is functioning. If no whistle is heard, disconnect the power immediately and reverse the connections to one of the base-drive windings. The converter should now function and a voltmeter placed across the 330K resistor should show about 270V DC. Having got the converter working, the SCR circuit may be wired up on the board, along with the trigger circuit. This is straight forward and should be easy enough referring to the photograph of the layout and the circuit diagram.

The layout should be followed reasonably closely, or false triggering of the SCR may result. At one stage in the development the SCR was picking up hash from the converter and triggering continuously. Obviously, a defect of this type would not improve the performance of any motor car engine. Incidentally, a trigger circuit using a unijunction transistor was tried originally and although it worked 100 per cent it was discarded in favour of the circuit shown, on the grounds of cost.

When the wiring has been completed and thoroughly checked, the unit may be tested, before hooking it up to a car by connecting a coil to the appropriate terminals with a spark gap of about  $\frac{1}{4}$ " connected to the secondary. (This is important as the coil insulation may be broken down if it is omitted.) Apply power and ground the "breaker points" terminal. Upon break-



ing this ground connection a thin blue spark should snap across the spark gap. With a standard 100 : 1 coil the output voltage will be about 27KV, more than adequate for ignition purposes.

The shape of this 27KV pulse is important too. With this system a very short rise time is possible, i. e. a 'sharp' pulse is generated and this is more effective at ionising the gas at the plug points than a pulse of slower rise time, such as is produced by a conventional transistor ignition system. Note that a 250 : 1 or 300 : 1 low inductance primary transistor ignition coil will work just as well as the standard coil, but will produce an even higher output which may cause trouble if the HT leads and distributor cap on the car are not in new condition.

The prototype has been fitted to a Mk. 3 Ford Zephyr for about 3,000 miles and has proved completely reliable. Improvements in performance that have been noted are:

1. Easier starting on cold mornings and smoother running when cold.
2. Gas mileage up from 22.6 mpg to 24.4 mpg (measured over 1,000 miles of everyday driving, in both cases).
3. Slightly better pulling power on hills.
4. Top speed in 3rd gear (4 speed transmission) increased from 60 mph to over 70 mph.

A few words on mounting the unit might not go amiss. It should be screwed to the fire wall or inside guard under the bonnet but not in such a place as to receive a blast of hot air from the radiator. The transistors do not run all that hot mounted on the case as shown but a cool airstream is desirable. Also care should be taken to ensure that mud and water cannot splash all over the unit. It should not be mounted inside the passenger compartment as the high pitched whistle emitted may be very irritating. Leads should not be run much over three feet, especially the lead to the coil SW terminal (caution - this carries 260 volts). It is not necessary to remove the condenser fitted across the car's points.

**NEGATIVE EARTH.** The negative earth version is somewhat simpler, as the pulses from the breaker points are already of the correct polarity to trigger the SCR into conduction directly. (The positive earth circuit uses a transistor to invert trigger pulse polarity).

The only requirements, therefore, are that the trigger circuit provides a pulse of the correct amplitude and duration from a sufficiently low impedance source. These factors are taken care of by the circuit in figure 3.

It should be noted that at extremely high rpm, contact bounce can cause erratic firing. It is possible to prevent this by ensuring that the SCR gate is isolated from the breaker points for a short period after each firing pulse. This can be accomplished by including a diode and discharge network as shown in figure 4.

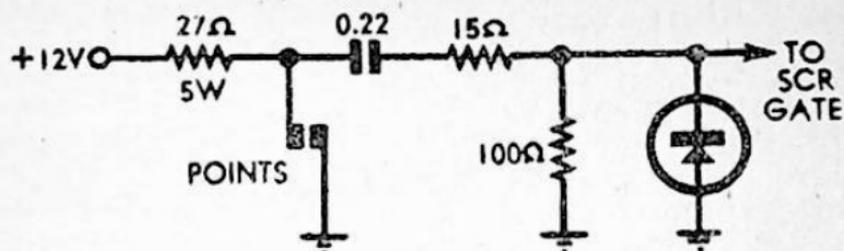


Figure 3

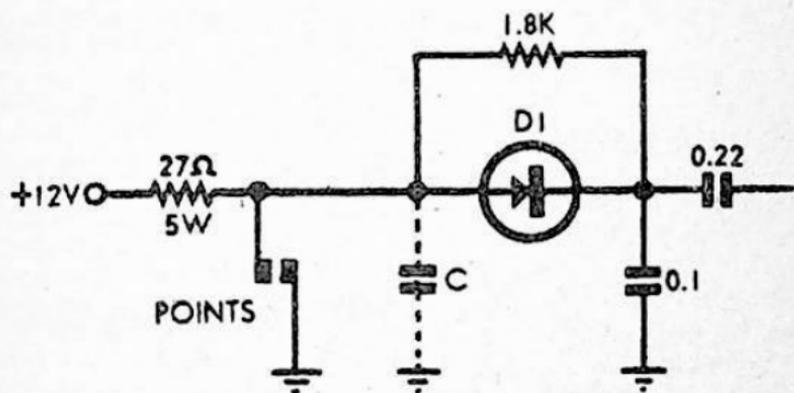


Figure 4

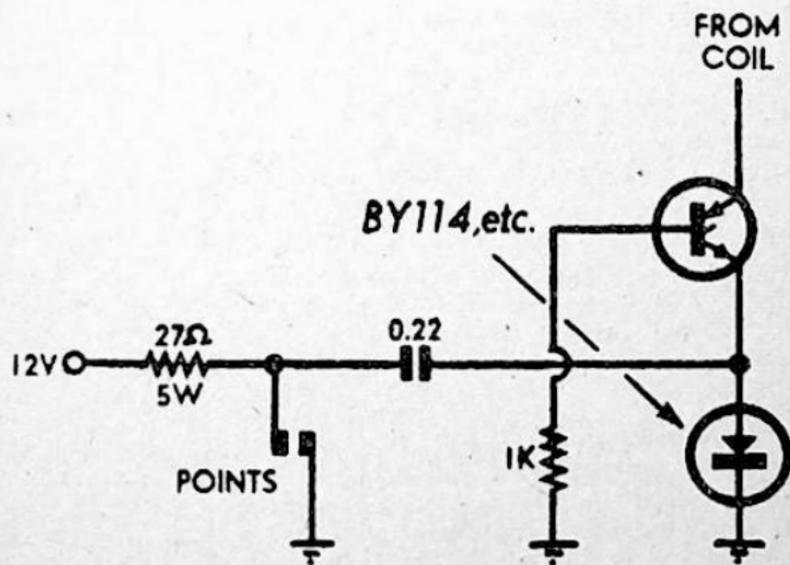


Figure 5

The voltage on the capacitors reverse biases the diode immediately after firing. The voltage bleeds off in about 0.6 milliseconds and the SCR cannot be fired during this period. (At 8000 rpm, a six cylinder engine fires approximately every 2.5 milliseconds, so this delay does not impose a rpm limit.) D1 is any 150 mA 50P1V (or more) silicon diode. Capacitor C (shown dotted) may be added to reduce RF interference, if this is a problem. Its value should be about 0.22 $\mu$ F.

CATHODE INJECTION. It may be noted in passing that it is possible to trigger an SCR with negative pulses by injecting them at the cathode. This has not been tried by the writer but may provide a cheaper and simpler circuit for the positive earth version. The circuit, figure 5, is suggested as a basis for experimentation.

### PARTS LIST

#### Converter Transformer

Primary 40T CT, 22SWG bifilar wound  
Base drive - 6T 22SWG (2 windings)  
Secondary - 450T 29SWG

#### Semiconductors

2 x 2N443 Transistors  
1 x AC128 Transistor  
4 x SD-1C Diodes (any 500mA 400P1V type)  
1 x SCR - Motorola type MCR - 2605-6 (any 400V 6A  
type will do)  
1 x Diode, OA95, OA85, or similar.

#### Resistors

1 x 330K, 1 x 1.5K, 1 x 560 ohms, 1 x 470 ohms, 1 x 100 ohms,  
1 x 47 ohms all at 10 Watts.  
1 x 22 ohms, 1 x 15 ohms, 2 x 10 ohms all at  $\frac{1}{2}$  Watt.

#### Capacitors

1  $\mu$ F/400V polycarbonate  
1 0.22 $\mu$ F/50V polycarbonate  
1 250 $\mu$ F/25V electrolytic

#### Sundries

Veroboard, screws, etc.  
Aluminium case measuring 5 $\frac{1}{2}$ " x 4" x 1 $\frac{1}{2}$ "

## 6V CAPACITOR DISCHARGE (CD) IGNITION UNIT

OVER THE PAST FEW YEARS THERE HAS BEEN A GREAT AMOUNT OF INTEREST CONCERNING CAPACITOR-DISCHARGE IGNITION SYSTEMS. THE SYSTEMS DESCRIBED TO DATE HAVE BEEN FOR 12-VOLT VEHICLES. MANY READERS HAVE REQUESTED INFORMATION ON A 6-VOLT CIRCUIT AND THIS ARTICLE HAS BEEN PRODUCED TO SATISFY REQUESTS.

Although cars with 6-volt electrical systems are no longer being built, there are many 6-volt vehicles still on the road today. Probably most are pre-1968 Volkswagens, and when it is considered how many of these vehicles alone are still in use, there must be a sizable number of our readers who are interested in such a project.

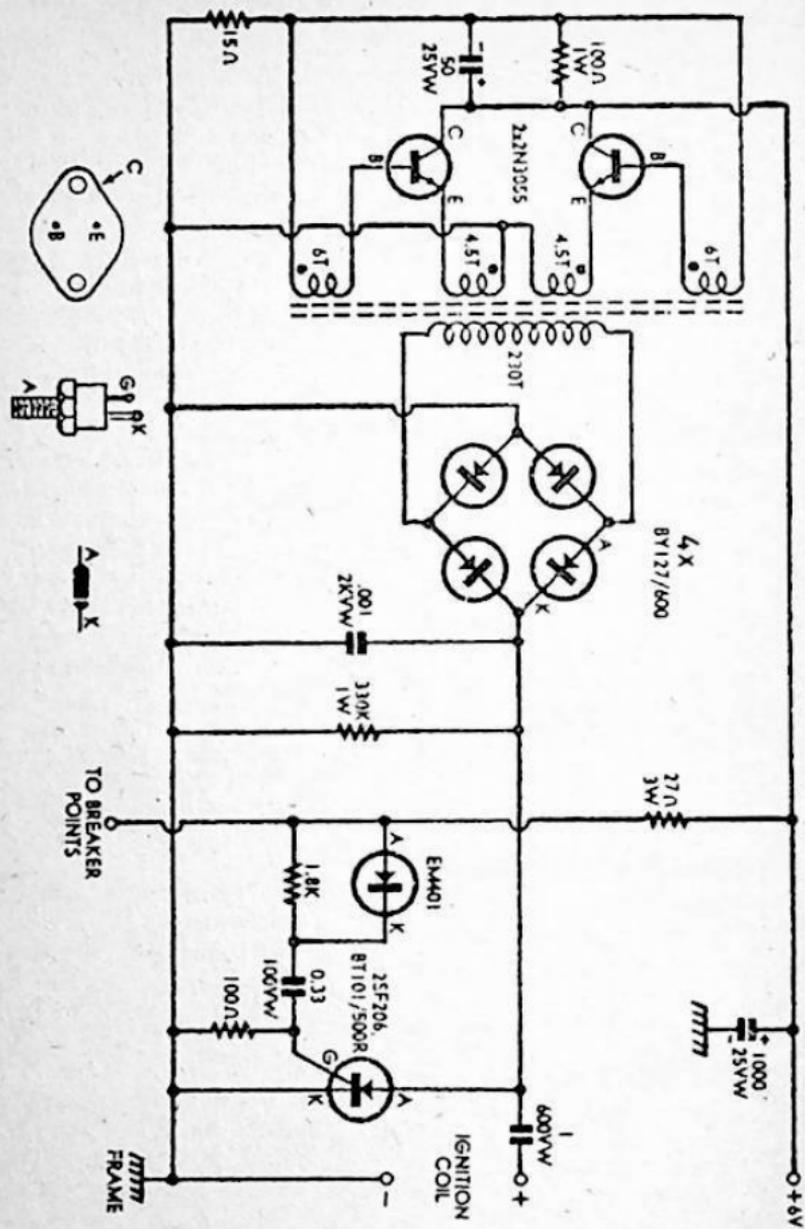
Some readers may regard the installation of a CDI system on a vehicle such as the VW as a waste of time and money. After all, the engine has very modest performance so that any performance improvements are likely to be minimal. From the point of view of acceleration times from 0 to 60 mph, this view is entirely justified. However, the main improvements are noticeably better engine smoothness and flexibility, and easier starting, particularly when the engine is hot. The improvement in petrol economy will be small, especially when compared with a well tuned car with conventional ignition.

Perhaps the biggest advantage of the CDI system is reduction in maintenance of distributor points and spark plugs. Do-It-Yourself enthusiasts will tend to belittle this, but for the person whose time is strictly limited, even this reduction is worthwhile.

Design of the unit is straightforward and is based on a circuit published by the Applications Laboratory of Standard Telephones and Cables Ltd. The converter consists of two silicon NPN power transistors in a common-collector transformer coupled oscillator. Self-starting under full load conditions is ensured by the inclusion of the resistor network supplying base current to the transistors.

The square wave voltage impressed across the primary windings by the transistors appears across the secondary winding, multiplied by the turns ratio to around 350 volts with a 6-volt input. This is rectified by a bridge rectifier to charge the 1 $\mu$ F/600VW "dump" capacitor via the primary of the ignition coil.

A silicon controlled rectifier (SCR) is used to discharge the dump capacitor back via the coil primary and thus apply the full capacitor voltage to the coil. This is "stepped up" by the secondary winding to fire the spark plugs. The capacitor voltage of around 350 volts is much higher than that developed inductively in the coil primary by a conventional ignition system so that the available "spark energy" is much higher. In



The circuit for the 5V capacitor discharge system.

In addition, the "rise time" of the voltage across the plugs is considerably faster than for conventional ignition so that fouled plugs are easier to fire.

While the dump capacitor is being discharged, the converter stops functioning and does not restart until the SCR reverts to the "blocking" (or non-conducting) state. The 100uF capacitor across the 100 ohm bias resistor improves restarting of the converter to ensure good performance at high spark repetition rates. The charging time of the dump capacitor is approximately 3 milliseconds and the converter frequency around 3KHz.

Since the dump capacitor is charged very rapidly, there is a risk that the SCR will be turned on by the rapid rise time of the voltage across it - this is so called "dv/dt switching". This tendency is avoided by connecting the .001uF/2KV ceramic capacitor between anode and cathode of the SCR and also by the 100 ohm resistor connected between gate and cathode. The latter component also reduces the risk of the SCR being turned on by its own leakage currents.

When the spark repetition rate is low, i. e. when the car is idling, the converter tends to charge the dump capacitor to much higher voltages than if the spark rate is higher. This could be termed the "load regulation" of the converter and it is improved by the 330K/1W resistor connected across the SCR. Actually, the load regulation of the converter is quite good and the system works satisfactorily at spark repetition rates up to 300Hz, far higher than is ever likely to be required on 6-volt vehicles, as 300 sparks per second is equivalent to 9000 rpm with a 4-cylinder motor or 6000 rpm with a 6-cylinder motor.

With a 6 volt system, variation of the input voltage is far more of a problem than load regulation referred to above. In a typical 6-volt vehicle the input voltage to the converter could vary from as low as 4.5 volts when the battery is almost flat and attempting to crank the motor, to as high as 8 volts when the generator takes over the battery load at high speed. As it is, the converter works reliably with input voltages from 3.5 to 9 volts. It will work with even higher voltages but there is the danger of damaging the SCR.

Positive-going trigger pulses are generated by the distributor points with the aid of a simple network consisting of two resistors, a diode and a capacitor. When the points are closed, current flows through the 27 ohm resistor. When they open, the 0.33uF capacitor is charged up via the 27 ohm resistor and diode and the charging current triggers the SCR. When the points close, the capacitor discharges via the 1.8K resistor.

One of the advantages of solid state ignition is that the points are relieved of the arduous duty of carrying and "breaking" the heavy coil currents, so that point wear is much reduced. However, if the current is reduced too much, the distributor points become fouled by oxidation and by oil fumes inside the distributor housing. Eventually, triggering of the SCR becomes

unreliable. Ideally, the points should carry about 200 to 500mA to maintain a self-cleaning action. The 27 ohm resistor sets this current at around 220mA - a compromise between cleaning action of the points and heat dissipation inside the CDI case.

No steps have been taken to include a "point bounce" suppression circuit. With most of the cars that the unit is likely to be used point bounce should not be a problem since engine speeds are relatively low. Another reason for not including such a feature, is that it is difficult to obtain suitably high amplitude trigger pulses using UJTs with a 6-volt supply, and if transistors were used to do the same job, power transistors would be required. In practice we have found the trigger circuit shown quite satisfactory for Volkswagens.

**CONSTRUCTION:** The prototype unit was constructed in a cadmium plated steel box measuring approximately 6 in x 2½ in. The main requirement for a suitable box is that it should seal out dust and water spray. If a steel box is used, the lid should have a cork gasket.

Construction can logically begin with the winding of the converter transformer. This uses two ferrite half-cups and a single section bobbin. The secondary is wound on first, 230 turns of 26 S.W.G. double tough enamel (DTE) copper wire. DTE wire is used to allow the secondary to be wound without insulation between layers.

Winding the secondary can be done with the aid of a hand drill clamped in a vice. Two large flat washers, a long bolt and nut can be used to clamp the bobbin - the bolt is held in the drill chuck. The inner washer should be suitably notched to allow the winding start to lay flat along the chuck during winding.

Begin by soldering the start of the winding wire to a 3 in length of 5/.0076 (or similar) PVC hookup wire. Lay this across the width of the bobbin and anchor it with a short length of electrical insulation tape. Wind on 260 turns as evenly as possible. Cover this with two layers of insulation tape and terminate the finish in the same way as the start.

Leads for the primary and feedback windings need not be terminated as for the secondary - just leave the starts and finishes of the windings about six inches long and cover with spaghetti sleeving. The starts and finishes should be securely anchored on the bobbin with insulation tape. The primary windings are wound over the secondary, and the feedback winding last. Both feedback and primary windings are wound bifilar, i. e. both sections of each winding are wound simultaneously, with two wires together wound as one wire. There is no real need to label the windings as each uses a different gauge. The primary winding is 4.5 turns bifilar, 20 S.W.G. The feedback winding is 6 turns bifilar, 24 S.W.G.

Place the completed winding in the two cup core halves, ensuring that the faces of the core halves are clean before clamping. If there is dirt on the core faces, the cores may either crack when they are tightened

together, or the resultant air gap may prevent proper operation of the converter. Having clamped the cores, the transformer may be impregnated. The prototype was impregnated using epoxy insulating varnish.

First step in assembling the components inside the case is to install the 2N3055 power transistors on each end of the case, using mica washers and silicone grease to improve heat conduction. Under normal operating conditions the transistors become only moderately warm to the touch and the heatsink area provided by the steel case or diecast box is quite adequate.

The rectifier diodes should have a voltage rating of at least 600 volts, and a high surge current rating since they have to carry the "back-swing" of the dump capacitor discharge current. Diodes recommended are the BY127/600.

The recommended SCR is the 2SF206 from STC. The 2SF206 has a blocking voltage rating of 600 volts. 400 volt SCRs such as the C20D should be used as the converter output voltage rises above 400 volts with battery voltages above 7 volts.

The SCR does not require a heatsink but is mounted for convenience using a small L-shaped bracket made from a  $1\frac{1}{2}$  in x  $\frac{3}{4}$  in piece of 16 S. W. G. aluminium. The SCR is electrically isolated from the bracket using mica washers supplied at purchase. The bracket is mounted inside the case using two screws, nuts and lockwashers. All screw connections must have lockwashers otherwise everything will vibrate loose within the first 10 miles.

For maximum reliability, an oil-impregnated paper capacitor rated for high discharge currents should be used for the dump capacitor. Peak discharge currents as high as 25 amps are quite typical for this circuit and under these conditions polycarbonate, and in particular, polyester capacitors are a very dubious proposition.

All the small components in the circuit were mounted on two small tag-boards. Wiring layout is not critical except for the following point. The earth return for the coil primary must not be made via the car body, but must have a separate earth return lead back to the converter. Supply wires to the converter and the coil primary wires must be in heavy duty automotive wire to avoid unnecessary voltage losses.

Presuming that the transformer is the last component to be installed, proceed as follows:

A suitable hole is drilled in the case to take the transformer clamping bolt. The bolt is passed through the case, through the transformer core, through a flat washer and lockwasher, and then the nut screwed on. Do not overtighten otherwise the core will crack.

The primary and feedback windings are connected as follows:

For the primary winding, connect the start of one section to the finish of the other and connect the junction to the negative supply. Connect the other ends to the transistor emitters. Proceed similarly with the feedback winding, connecting the start of one section to the finish of the other; the junction goes to the junction of the 100 ohm and 15 ohm resistors. The other ends of the windings connect to the transistor bases. If all is well, the converter should emit a whistle when the supply is connected. If not, swap the base connections to the transistors and it should start. Current drain when the unit is operating correctly will range from 400mA when the engine is idling, to around 4 amps at 300 spark rate.

An octal changeover plug was installed in the author's unit to enable easy change between conventional and capacitor discharge ignition. However, this feature is somewhat of a mixed blessing because contact resistance may develop in the plug pin connections, so that the plug itself can be a possible source of unreliability.

The prototype was installed on a 1965 VW 1200. It is mounted on the firewall, adjacent to the fan housing, on the same side as the ignition coil. Since it is mounted in the air stream to the fan intake, it runs quite cool. If the unit is mounted in a conventional car it should be mounted on the bulkhead, as far from the engine as possible, and be protected from possible water spray.

Brackets are needed to mount the unit to the firewall. These can take the form of two flat steel strips, 6 in x 1 in, screwed or welded to the back of the case. The unit is mounted by four long screws (with nuts and washers) which pass right through the firewall, into the passenger compartment.

Spark plug and point settings were left as set for conventional ignition. There seems to be little point in deliberately increasing the spark plug gaps to obtain a better flame front - this places a higher load on the insulation of the coil, ignition leads and the distributor housing and means that the settings have to be redone if there is need to change back to the conventional ignition.

All ignition leads and spark plug connections must be in top condition with CDI, as the higher voltages will rapidly find any weaknesses in the system and cause misfiring. The author made up insulating spacers to suspend the ignition leads away from the fan housing and from each other to avoid misfiring. The insulators clip over the inlet manifolds and are made of a material similar to Paxolin or SRPB (synthetic resin paper board). These measures may not be necessary if double insulated high tension cable is used.

## PARTS LIST

- 1 Case with mounting brackets (see text)
- 2 FX2243 ferrite cup cores
- 1 Former
- 2 2N3055 or BDY20 silicon NPN power transistors
- 4 BY127/600 silicon power diodes
- 1 BY126, BY174 or 1N3193 silicon diode
- 1 BT101/500R silicon controlled rectifier

## CAPACITORS

- 1 x 1000uF/25VW electrolytic
- 1 x 50uF/25VW electrolytic
- 1 x 1uF/600VW paper
- 1 x .33uF/100VW polyester
- 1 x .001uF/2KV ceramic

## RESISTORS

- 1 x 330K/1W, 1 x 1.8K/ $\frac{1}{2}$ W, 1 x 100 ohms/1W, 1 x 100 ohms/ $\frac{1}{2}$ W, 1 x 27 ohms /3W, 1 x 15 ohms / $\frac{1}{2}$ W.

## MISCELLANEOUS

Double-tough enamel copper wire (20, 24 and 26 s.w.g.), heavy duty hook-up wire, spaghetti sleeving, miniature tagboard, octal plug and socket (optional), grommet, power cable clamp, screws etc.

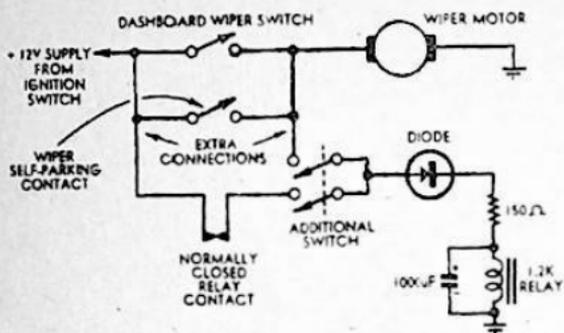
## PULSED WIND SCREEN WIPERS

ONE OF THE DEVICES WHICH HAS COME IN FOR A LOT OF ATTENTION IS THE WINDSCREEN WIPER. HERE ARE TWO DESCRIPTIONS OF HOW TO ACHIEVE PULSED OPERATION, SUITABLE FOR VERY LIGHT RAIN CONDITIONS.

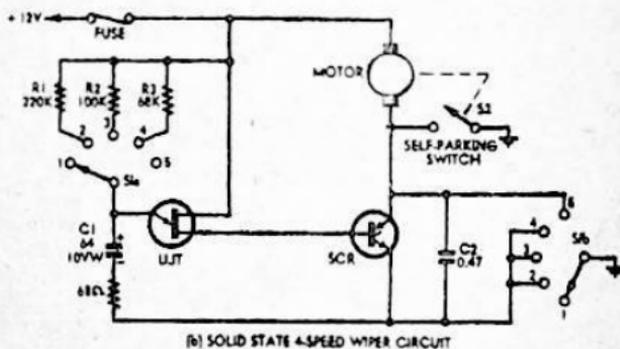
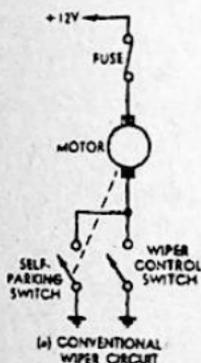
The following describes a modification I made to the windscreen wiper circuit of my car to eliminate the annoyance of running the wipers continually in light showery weather. It has the effect of causing the wipers to give one sweep, park, and pause 5 seconds before another single sweep. It could be fitted to any car having self-parking electric wipers.

I found that the values given on the circuit gave satisfactory results for most light showery conditions.

On closing the additional switch, the wiper operates immediately and the relay picks up after a delay of about half a second, determined by the 150 ohm resistor and the capacitor, and opens its contact. After one complete sweep, the self-parking contact opens, the motor stops.

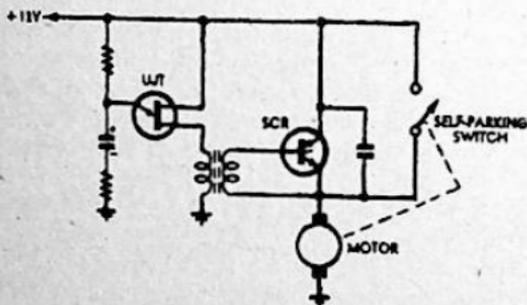


At left: A simple modification to the windscreen wiper circuit provides pulsed operation at a selected rate.



S1 POSITIONS:

- 1 OFF
- 2 8 SECONDS BETWEEN WIPES
- 3 4 SECONDS BETWEEN WIPES
- 4 1 SECOND BETWEEN WIPES
- 5 NORMAL



UJT : 25H12 (S.T.C.)  
2N2646, 2N2160 (G.E.)  
SCR : MCR1104 (MOTOROLA)  
C20 (G.E.)  
BTY79 (PHILIPS)

and the capacitor begins to discharge through the relay, which eventually de-energises, closing its contact. This sets the wiper motor going again, and re-energises the relay coil.

The diode (any low power type) is necessary to prevent the capacitor from discharging through the motor instead of the relay. Polarities are shown for a negative earth car.

If variable timing is desired, a rotary switch could be used to switch in more or less capacitance. (1000uF gave 5 seconds, 1500uF gave  $7\frac{1}{2}$  seconds with the 3000 telephone relay used). Or possibly a switch pot, with the rheostat in series with the relay coil, could be used.

#### SOLID STATE VERSION

I adapted the accompanying circuit from a note in the Motorola Semiconductor Circuits Manual and it has worked very satisfactorily in my vehicle for some months.

A simple unijunction transistor trigger circuit provides a range of repetition rates dependent on R1, R2 or R3 (selected by S1) C1, and the standoff ratio of the UJT. When SCR is triggered by UJT, the wiper motor begins to operate and closes the self-parking switch S2. S2 short-circuits the SCR, turning it off, and carries the motor current for the remainder of the wiping cycle at which time the motor stops (S2 opens). The wipers remain in the rest position until the next UJT trigger pulse initiates another wiping cycle. C2 protects the SCR and the contacts of S2 from voltage transients caused by opening of the motor circuit.

In my circuit the control switch S1 selects: off; 8, 4, and 1 second between wipes (approximately) and full speed. Some experimentation with resistor values is necessary, depending on the range of speeds required, the value of the timing capacitor C1 (50 to 100uF) and the UJT characteristics. The SCR can be any type rated at 4 or 5A RMS or more, at a PIV of 25V or more.

The low duty cycle makes a heat sink unnecessary. All components are wired between the control switch S1 (a two-pole, five-position wafer switch) and a lug strip mounted on the rear of S1. The control switch is mounted on the dashboard of the original control switch.

The circuit shown is applicable to vehicles having motor control in the chassis side. For vehicles with control on the active side, a simple pulse transformer is required, as indicated.

## PULSED WINDSCREEN WIPERS

Previous articles have dealt with pulsed windscreen wipers and the problems created by modern dynamic braking systems. Here is a simple pulser suitable for both old and new cars.

As previously stated most car manufacturers are now using permanent magnet wiper motors, with dynamic braking. This last "feature" has meant the scrapping of the simple SCR controlled unit, and it is now almost essential to return to the relay system.

The circuit to be outlined can be used with all wiper systems (both positive and negative chassis) provided the builder can decide how many relay contacts the system requires, and where they should be placed.

The circuit operates as follows: On closing S1, C1 will charge slowly through R1, VR1 and the N/C (normally closed) relay contacts. The charging time of C1 can be varied within the range of three seconds to 20 seconds by adjustment of the dash mounted VR1. The charging continues until the voltage across the capacitor reaches about six, at which point Z1 breaks down, passing current through the base/emitter junction of TR1, turning this transistor on and energising the relay.

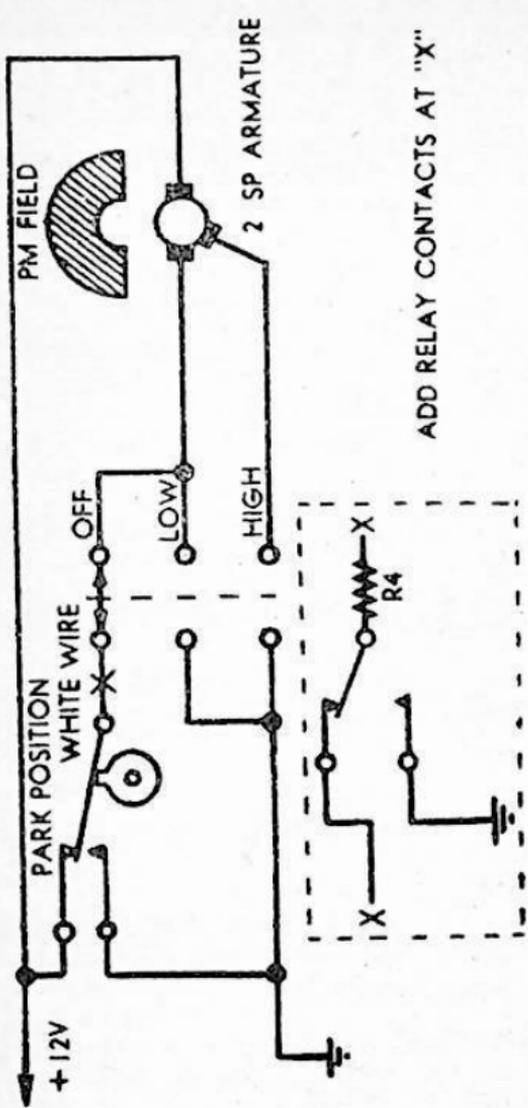
The relay contacts changeover to supply TR1's base current from C1 via R3. Also connected is R2, which takes about one second to discharge C1 to 0.75V, at which point TR1 releases the relay. With the return of the relay contacts to their original position, the cycle continues.

The result is a variable "OFF" time followed by a fixed "ON" times. The "ON" time allows the wiper to reach a position where the braking contacts open and the parking contacts close, thus completing a single "wipe" for each relay operation. Resistor R4 reduces the starting current, and prevents the motor overheating.

For correct operation, the relay contacts in the capacitor circuit should be of the make before break type. I modified a standard change-over set simply by "dishing" the N/C spring leaf downward near the indexing tab. This creates a gap between the tab and the buffer block and, when the relay is energised, the modified spring travels upward with the central leaf until the control and upper contacts meet. The result is a make before break contact set.

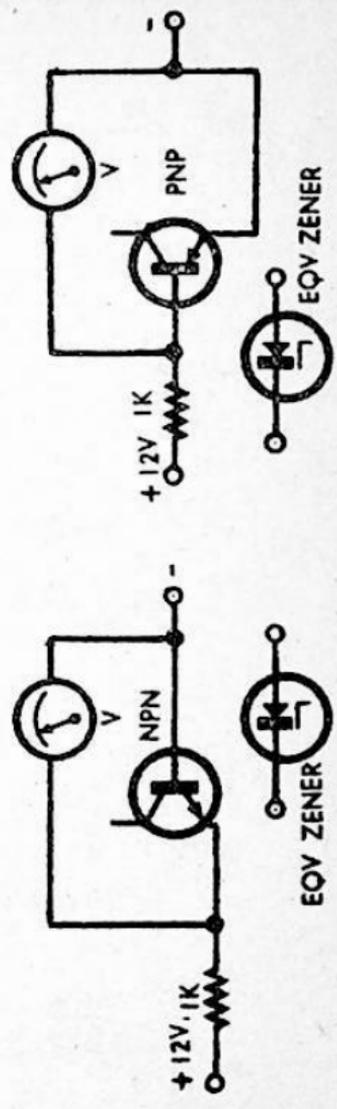
Zener diode Z1 can be replaced with a silicon transistor if use is made of the emitter to base breakdown voltage. (This is in the range four to 10V for most transistors). One method of finding the approximate  $BV_{ebo}$  of a transistor is shown.

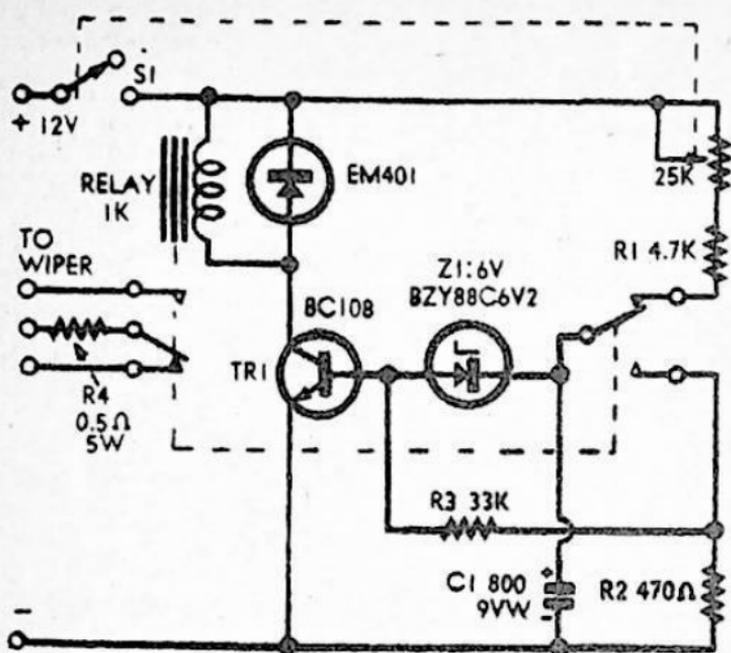
**Setup for modern wiper systems using permanent magnet motors and dynamic braking.**



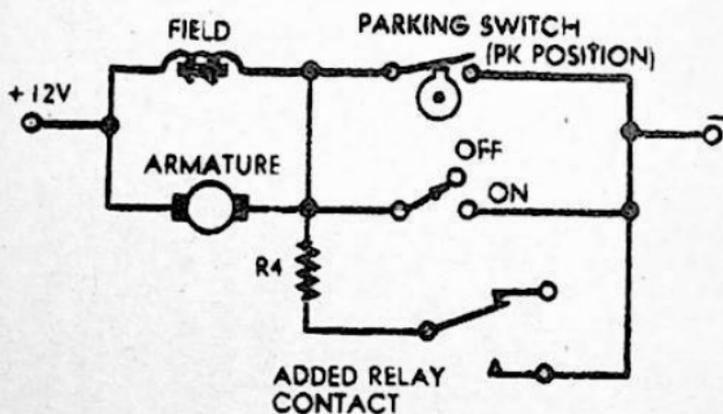
ADD RELAY CONTACTS AT "X"

**Simple test setups for determining "zener" voltage of BVebo of silicon transistors for use in place of a zener diode.**





*Circuit of the complete wiper control system. It initiates a single wipe, followed by up to 20 seconds pause, as selected.*



*Setup for older wiper systems.*

Zener voltages in excess of 6.5V may prevent the unit from operating with low battery voltage. With the recommended values the unit will operate with voltages as low as 10. The transistor used to replace the zener diode was a 2N2646 (NPN), but a 2N3638 (PNP) also breaks down at 6V. Unfortunately, BC108s break down at eight to nine volts and are not suitable.

The housing I used for the unit is a baby powder tin. This is modified by removing the sprinkler assembly (Hit the inside of the sprinkler with a hammer while supporting the surrounding lid on blocks of wood) and covering the resulting hole with a square metal plate bolted at each corner.

Attached to the lid is a bracket to support the relay along with the remaining components on a Veroboard panel. Other work required is a hole for the wiring to pass through the lid, a metal strap around the body of the unit for mounting and a coat of paint. Prior to painting, the glossy finish should be removed with emery paper.

The installation of the unit differs for each make and model of car. As a guide I include two examples.

(1) Early wiper systems: This system has a single speed motor with a wound field.

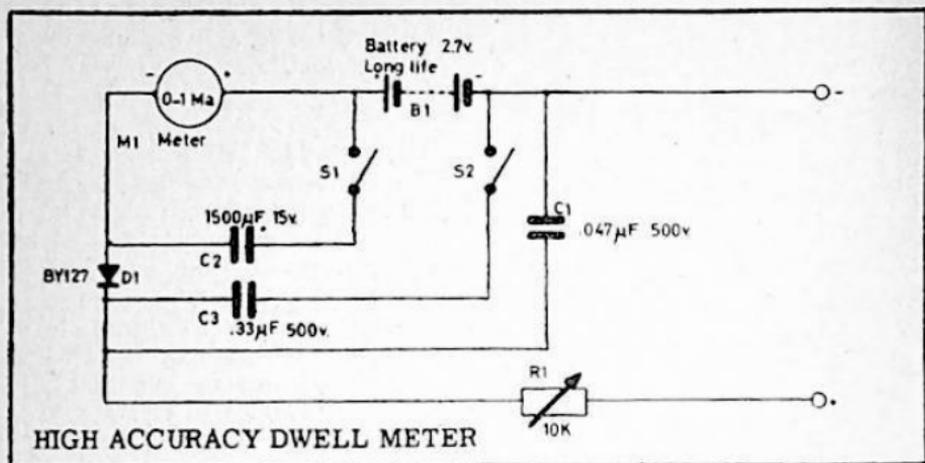
In operation, the relay bypasses the dash switch, which remains in the "OFF" position, for sufficient time for the parking switch to make and continue for one sweep.

(2) Recent system: This system has a permanent magnet field, two speed armature, and dynamic braking.

The changeover contacts open the brake circuit and then apply power to the armature low speed brush. (Dashboard switch is off). Once the wipers are in motion the cam operated contacts parallel the relay contacts, allowing the relay to be released and the wiper action to continue until one complete sweep has been made. Thus the wiper will give a single low speed stroke for each relay operation.

The relay used should have a coil resistance within the range 500 ohms to 1500 ohms. Before using, connect the relay to a nine or ten volt supply and confirm that it will operate from this voltage.

## HIGH ACCURACY DWELL METER



### USING THE DWELL METER ON YOUR CAR

- Switch off C2 and C3 by opening S1 and S2.
- The plus lead from the Dwell Meter must now be connected to the CB marking on the ignition coil.
- The negative lead should be connected to the earth.
- Switch on ignition but do not start car. If the contact breaker points are closed, the meter will read. If the points are open, just touch starter momentarily until the points are in the closed position. Then adjust the 10K pot. R1 so that the meter shows full scale reading. Start engine and watch the meter. You require, for correct Dwell angle, a scale reading of approximately 2/3rd of the full scale deflection.

If you have no external adjuster on your distributor that allows you to alter your points with engine running (this external adjuster is fitted to a number of American made distributors i.e. Delco etc) switch off, then switch C2 into circuit by closing S1 followed by steps 'B', 'C' and 'D' as above. Remove top central lead (HT) from the distributor. Take off distributor cap and rotor and then turn the engine with the starter reading the Dwell meter whilst the engine is being turned. If the needle is jumping erratically, switch capacitor marked C3 by closing the switch S2. Now stop cranking, adjust your points, turn your engine again with the starter but do not run it. If necessary, adjust again until you get the correct reading i.e. 2/3 of the full scale.

These instructions are suitable for cars with negative earth. If your vehicle is one of the older types using positive earth, simply reverse the leads on the meter.

## AUTOMATIC BATTERY CHARGER

HERE IS OUR FIRST FULLY AUTOMATIC BATTERY CHARGER. IT WILL DELIVER CURRENTS UP TO 4 AMPS INTO EITHER 6 OR 12 VOLT BATTERIES, WITH FULL PROTECTION AGAINST OVERLOAD OR MISUSE, BUT CAN BE LEFT CONNECTED FOR INDEFINITE PERIODS WITHOUT DANGER OF OVERCHARGE

Anyone who has ever been caught with a flat battery in a car knows only too well how inconvenient this can be. It is true that this happens less frequently than it used to, as a result of the many improvements in the electrical systems of modern cars, but is equally true that it is usually more serious nowadays since the average modern car, be it a manual or automatic, cannot be cranked.

And batteries can still go flat in spite of the better generator/alternator and control systems. Lights or appliances may inadvertently be left on, extremely low winter temperatures may place an undue load on the starter, or a combination of short runs, use of headlights and, perhaps a battery that has seen better days, may easily add up to a situation where the load is more than the battery can supply.

Quite apart from these external conditions, the battery itself aggravates the situation by being less efficient at low temperatures. As an example, a half-charged battery has on the average 60% starting power at 80 degrees F, which could fall to a mere 30% at 32 degrees F. Everything is thus against the battery at low temperatures.

For this reason many motorists still like to keep a charger in their garage, either to get their car back on the road when the worst happens or, better still, to prevent it from happening when the likelihood can be foreseen. Unfortunately, many of us leave it till the last moment and thus get caught in a situation that demands the battery to be charged in the shortest possible time. Whilst a 50 - 100 amp quick-charger would no doubt be the ultimate solution in this instance, it is for many people not the most practical in terms of hard cash. A compromise is clearly required and largely with economy in view we settled for a design that could deliver up to 4 amps. At this rate it will only take a relatively short time to charge a battery sufficiently to enable it to crank the engine.

At the same time, we felt that a charger with this output rating should incorporate some safety features such as complete overload protection and a means of indicating reversed lead connections.

Another desirable feature would be the inclusion of a reduced charge rate once charging neared completion. This arrangement allows the charger to be permanently connected to a battery without any danger of overcharging. It would thus be ideally suited to permanent or semi-permanent installations where batteries are required to intermittently supply large



loads. In this type of situation such a charger should quickly recharge the battery and then continue to trickle charge, keeping it in ready state for the next demand.

Finally, we felt it desirable to include some means to indicate the end point of the charging cycle.

All of the above features have been included in our new charger. A point we took particular care in was to ensure that the charge rate was sufficiently reduced towards completion of the charge. This is particularly important for small batteries such as fitted to motor-bikes, as an excessive charging rate, especially towards the end point, can easily damage these.

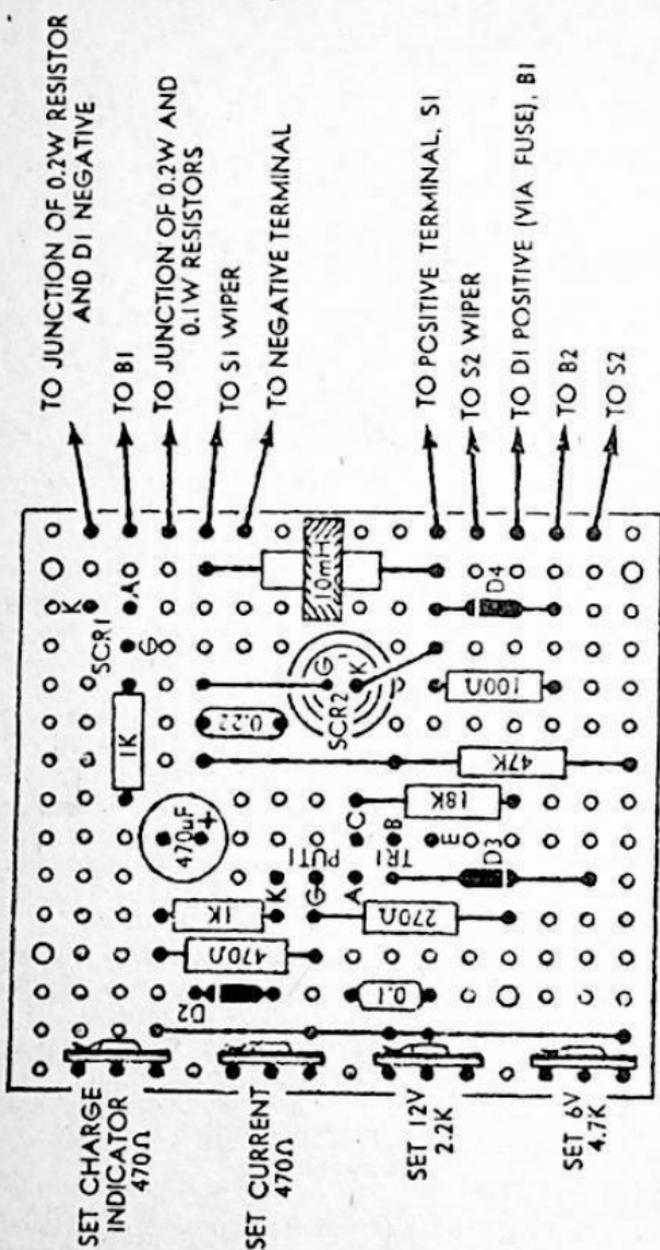
We found it necessary to include some means of regulating the output from the charger. A feedback signal is taken from the charger output terminals and hence information about the battery's state of charge can be monitored. In addition, the circuit has been arranged to compensate for mains fluctuations.

The arrangement is a good deal more sophisticated than found in most battery chargers which generally rely solely on the rise of battery terminal voltage to reduce the charging rate. As such it is also a good deal more effective and foolproof than these. For example, without regulation, a mains variation of plus and minus 10 per cent can vary the charging rate with a normal charger by as much as 2 amps. Another feature of the regulating circuitry is that it permits the relatively inexpensive addition of overcurrent protection of the self-resetting type.

Despite the many functions performed by the circuit, we have been able to keep it fairly simple. The heart of it is a silicon controlled rectifier, SCR2, which is "phase-controlled", or made to conduct at various points in the half-cycles of a rectified but unfiltered input fed to it from a transformer and bridge rectifier. The SCR is triggered into conduction by pulses fed to it from a programmable unijunction, PUT1, which is controlled in turn by a regulating transistor Tr1.

The PUT is essentially connected as a relaxation oscillator, locked to the incoming supply frequency. The output pulses generated by the PUT are supplied to the gate of the SCR via the 0.22uF coupling capacitor. Control over the phase relationship between the gate pulse and anode voltage of SCR2 is achieved by Tr1. The transistor is in turn controlled by the feedback signal mentioned earlier. Because this signal contains a fair content of ripple, a filter capacitor is required to smooth the waveform before it is applied to the transistor.

To provide a reference voltage against which the feedback voltage can be compared a zener diode (D3) is used. Trimpots VR2 and VR3 set the control circuit constants for correct operation with 12 and 6 volt batteries. The full setting up procedure is given at the end of the article.



Most of the charger components and circuitry mount on this strip of Veroboard panel, viewed here from the component side with the trimmed conductor strips superimposed in light grey.

To provide the overload protection mentioned earlier, the output current is sensed across the 0.1 ohm resistor which has VR4 connected in parallel with it. The voltage developed across this resistor is fed via D2 to the base of Tr1, causing it to conduct once a preset voltage is exceeded. This automatically prevents the output current from rising beyond the predetermined level.

The charge indicator mentioned earlier consists of an indicator lamp B1 driven by SCR1, a small economy SCR. SCR1 is triggered into conduction by the voltage drop across VR1, which is proportional to the charging current. Thus while the charging is taking place at a relatively high level, SCR1 is triggered into conduction at the start of each half-cycle and the lamp remains alight, but when the charging process nears completion and the current drops, there is insufficient voltage drop across VR1 to trigger the SCR, and the lamp extinguishes.

The type numbers nominated on the circuit for SCR1 are for devices with a very high gate sensitivity. This is essential for correct circuit operation, as only a low voltage is available across the 0.22 ohm current sensing resistor. The voltage could conceivably be increased by increasing the resistor, but this would increase the circuit losses unduly, and would also risk unsatisfactory operation with 12V batteries due to lack of available voltage.

The gate pulses applied to SCR1 contain both amplitude and phase information. This is ideal as it permits the lamp to gradually dim as the charging rate reduces. It does not, however, dim to the stage where it can no longer be easily seen. Before this can occur the amplitude of the gate pulses reduce to a level too low for the SCR to trigger. Thus the phase of the gate pulses control the brilliance of the lamp while the amplitude controls the on-off state. This gives essentially a go/no-go readout which is much easier to interpret, especially by an inexperienced operator, than an ammeter reading. In addition it is also a good deal cheaper than even the smallest and simplest ammeter.

For optimum results VR1 should be set so that the indicator turns off when the current falls below 0.5A. The terminal voltage of a 12V battery will at this point be between 14 and 15 volts and the battery can thus be considered fully charged for practical purposes. Leaving the charger to run beyond this point will simply cause the battery to receive a continuous trickle charge.

Connecting a charger to a battery is often a confusing business for the inexperienced or sometimes even for the experienced. To minimise the risk of wrong connection we have fitted our charger with a reverse polarity indicator. The indicator consists of nothing more than a pilot light and diode connected in series across the output terminals. The diode is arranged to conduct only when a negative voltage is applied to the positive terminal, thus giving indication of a reversed connection, be it at the battery or the terminals of the charger itself.

For the indicator to effectively serve its purpose, however, it is essential that the ON/OFF switch is in the 'off' position before the battery is connected, regardless of whether power is supplied to the charger or not.

If the battery is connected the wrong way around with the switch in the 'on' position, the main SCR is forced into conduction. It receives its trigger pulse as a result of the voltage differential set up between cathode and gate upon the sudden connection to the battery. (The 0.22 $\mu$ F capacitor keeps the gate momentarily at ground potential whilst the cathode is suddenly lowered in potential.) Once the main SCR has fired, the current flows straight through the bridge rectifier and then back to the other terminal.

It should now be fairly obvious why the fuse has been placed after the bridge rectifier rather than before it. The fuse will thus offer final protection should the operator fail to follow the correct procedure. Note also that the ON/OFF switch is connected across the gate and cathode of the main SCR rather than in series with one of the supply lines to the output terminals. This arrangement minimises the chance of high contact resistance being placed in circuit due to a worn or faulty switch. It also reduces the current requirements of the switch itself and thus permits the use of a smaller and cheaper type. Pulses from either the PUT or battery are inhibited with the switch in the 'off' position, so that its operation is quite unambiguous.

The final item in the circuit that bears discussion is the power transformer. It will be noted that we have specified a type which is especially designed for use in battery chargers. Since the voltage from the transformer secondary is accessible (via the diodes and SCR) to the operator, the insulation qualities of the transformer must meet high standards.

Construction of the charger is reasonably straightforward. We used a standard instrument case to house the instrument, measuring 7" x 4" x 4" (W x H x D) and fitted with a turnover lid.

All circuit components excepting the main SCR, the bridge rectifier and the two sensing resistors have been mounted on a piece of 0.2in grid Veroboard measuring 3 $\frac{1}{2}$ " wide by 3" long.

The 0.22 and 0.1 ohm sensing resistors are mounted on a separate tag-strip away from the main circuit board, to minimise heat transfer from the resistors to the board. The board itself has been so laid out that the four trim pots (VR1 to VR4) face the bottom of the case, to permit their adjustment through holes in the bottom of the case.

Layout of the circuitry is not critical, and deviation from the presented layout should present no difficulties. Make sure, however, that the bridge

and SCR are given adequately sized heatsinks. If separate heatsinks are used for the bridge and SCR, use at least 20 square inches of 16 gauge material for each. Note that the SCR is required to be mounted with insulating washers, unless of course the heatsink itself is insulated from the chassis. In the prototype the SCR is insulated.

Order of assembly is not critical, but it is probably easiest to assemble the board first with attached flying leads. These can then later be soldered to the switches etc, after it has been mounted into position. Make sure that heavy gauge leads are used between the bridge rectifier and output terminals.

To keep the overall cost of the project to an absolute minimum, we have taken some pains in selecting budget-priced components. All semiconductor devices were chosen from the economy lines of various manufacturers. Likewise pilot lights and switches were selected primarily with regard to cost and performance. A point to note about the pilot lights is that they should preferably be visible from the side as well as from the top. Being able to view the pilot lights from almost any angle makes the charger much easier to use.

Finally, the setting up procedure. In all, four adjustments must be made. The first two concern the voltage settings.

Before these can be made, however, it is necessary to connect a 1000 $\mu$ F electrolytic capacitor of at least 25VW in parallel with a 100 ohm 5W resistor across the output terminals, to provide the circuit with a simulated battery load. Next, switch on and set the 12V/6V switch to the 6V position. Adjust VR3 for an output of 7.7 volts. Now set the switch to the 12 volt position and adjust VR2 for an output of 15.5 volts.

Setting the current limit trimpot VR4 must be preceded by turning it fully anticlockwise, i. e. the wiper should be closest to the negative output terminal. Then, with an ammeter connected across the terminals (use highest available range on ammeter initially) adjust VR4 until the current reads 5 amps. The reason for setting it to 5 amps rather than 4 amps is to allow for the positive temperature coefficient of the sensing resistor. After a few minutes operation, the current will be seen to fall back to the required 4 amps. The voltage selector switch may be in either position for this adjustment.

The final adjustment to be made is that to VR1. This adjustment controls the point at which the CHARGE indicator turns off. For normal operation the battery can be considered adequately charged when the charging current falls below 0.5 amps. However, if an earlier indication is required, the setting can be chosen to turn the indicator off at a high current.

The following is the procedure for the 0.5 amp setting. With the voltage selector switch in the 12 volts position, connect an 8.2 ohm 5W resistor across the terminals. This should give an average or DC current close to 0.5 amps. You can monitor the current if you wish with a DC ammeter

and adjust the load resistor to give the exact current. Now adjust VR1 so that the lamp extinguishes, then bring it back till the light just comes on again. If you require a higher turn off point, you will need to adjust the load resistor accordingly and then adjust VR1 to the required level.

The charger must always be switched off before the clips are disconnected from the battery. Failure to do so will result in sparks being generated, which can lead to an explosion in and around the battery. This is because both oxygen and hydrogen are generated by the battery during the charging cycle, and these under favourable conditions form a very explosive mixture. Unfortunately too little attention has been focused on this in the past, which has led to many near fatal accidents.

This completes the description on our first fully automatic battery charger. We think that it will have considerable appeal for those requiring an instrument that is easy to use and almost completely foolproof.

#### PARTS LIST

- 1 Instrument case 7" x 4" x 4" with turnover lid
- 1 Chassis to suit case
- 2 SPST toggle switches
- 2 12V bezels, one green, one red
- 2 Terminals, one black, one red
- 1 Fuse holder, front loading
- 1 Power transformer. Pri240V  
Sec 17V at 4A DC
- 1 Veroboard  $3\frac{1}{2}$  in wide x 3 in long with 0.2in grid
- 1 RFC 10mH
- 1 10A fuse

#### SEMICONDUCTORS

- 1 C20D or BT101/500 silicon controlled rectifier
- 1 C103Y silicon controlled rectifier
- 1 D13T1 PUT
- 1 BC108 silicon transistor
- 1 BZY88/C6V8 zener diode
- 2 BY126, BY174 or 1N3193 silicon diodes
- 1 PA40 bridge rectifier

#### RESISTORS

- 1 x 0.1 ohm, 1 x 0.22 ohm all at 5 watts 10%, 1 x 100 ohm,
- 1 x 270 ohm, 1 x 470 ohm, 2 x 1K, 1 x 18K, 1 x 47K all at  $\frac{1}{2}$ W 5%,
- 2 x 470 ohm, 1 x 2.2K, 1 x 4.7K trim pots

#### CAPACITORS

- 1 x 0.1uF, 1 x 0.22uF polyester 50VW. 1 x 470uF/10VV electrolytic, printed wiring board type.

#### SUNDRIES

- 4 Rubber feet, 1 Cord Clamp, 1 Mains lead, plug, grommets,
- 4 spacers, bolts, nuts, solder etc.

## CAR BURGLAR ALARM UNITS

THOSE WHO HAVE HAD THE UNPLEASANT EXPERIENCE OF THEIR CAR BEING BROKEN INTO AND RIFLED IN THEIR ABSENCE WILL APPRECIATE THIS IDEA FOR A CAR BURGLAR ALARM. OPERATED BY THE AUTOMATIC DOOR LIGHT SWITCH, IT CAUSES THE HORN TO SOUND A FEW SECONDS AFTER AN ILLEGAL ENTRY HAS BEEN MADE INTO THE VEHICLE.

When set, the car burglar alarm sounds the horn for a pre-determined time when either front door is opened. The on/off switch is inside the car, so the unit has built-in delays for entering and leaving without operating the alarm. To leave the car without triggering the unit a delay occurs after S1 is closed. The delay results from the time taken from C2 to reach Z1 break-down voltage when charged through R5. With C2 charged, opening the door will cause TR1 and TR2 to conduct, with almost 12V appearing across R3. At the same time, C1 is charged and will hold TR1 on after the door is closed.

To allow the car to be entered with time to switch off the unit before it operates, the voltage across R3 feeds the delay (R7, C4 and Z2) at TR4. If the unit is not switched off TR4 conducts, picking up the relay, and the horn sounds. The horn will continue to sound until C1 discharges, causing TR1 to reduce the potential across R3 until it drops below that required for Z2 to hold TR4 in the conducting state.

The sequence detailed above occurs if the door is closed quickly after the illegal entry has occurred. However, if the door is left open, C1 would not discharge, and the horn would then operate continuously, until the car's battery was flattened. To prevent this, an additional transistor (TR3) has been added. This has a delay circuit similar to that of TR2 and TR4. When triggered, and the door is left open, it discharges C2, which cuts off TR2 and opens the supply to TR4, thus stopping the horn.

For a more detailed system, further switches may be added, as shown in the circuit. These could be at any point where thieves could gain entry (back doors, bonnet and boot, for example). When connected as shown, they will not operate the roof light.

### NOTES :

D4 protects TR4 by providing a path for the back EMF generated when the relay operates.

The relay contacts are in parallel to distribute the large current drawn by the horn, and thereby contributing to longer contact life. The horn relay contacts and earth contacts should be heavy gauge wire.

D1, D2 and D3 block positive feeds via the lamp, etc.

R11 and R12 provide discharge paths for C2 and C3.



The circuit should operate with relay coil resistances of between 200 ohms and 1K.

Substitute transistors could be used. When components other than those specified are used, it may be necessary to alter the values of the following resistors, bearing in mind that the lower the value of resistance, the shorter the delay time, and vice versa :

R5, to set excite time (about 10 seconds).

R1, to set horn operating time (45 to 60 seconds).

R7, to set enter time (about 10 seconds).

R8, to set horn time for open door (45 to 60 seconds).

The circuit is designed for negative earth systems. For positive earth, reverse all diodes, zeners, and capacitors, use NPN instead of PNP transistors, and vice versa.

## STOP THIEF

### 6 CIRCUITS FOR CAR IMMOBILIZERS

Car immobilizers are intended to make cars that little bit more difficult to steal, and it is hoped that the would be thief will move on to another vehicle that may not present such problems to him. Car immobilisers cannot prevent the determined professional car thief.

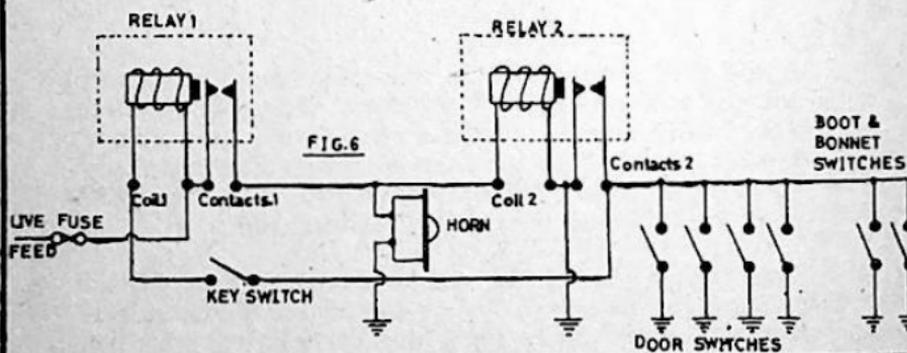
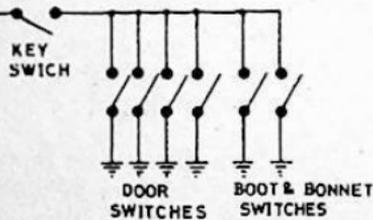
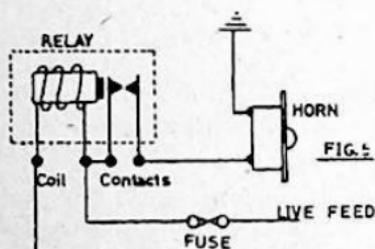
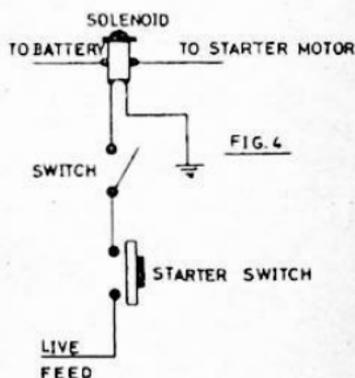
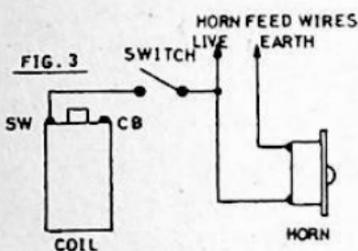
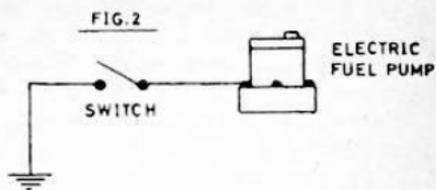
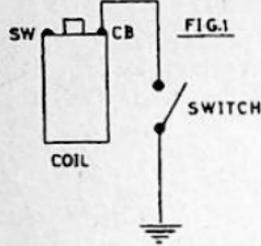
Figures 1 - 4 show four simple methods of immobilizing cars using only a switch and lengths of wire.

Fig. 1 A switch is placed between the CB contact of the coil and earth. When the switch is open the ignition coil will operate normally, however, when closed the coil is earthed, having the effect of closing the contact points and stopping the engine from firing. The switch should be concealed, but yet be in a position for easy operation by the driver either inside the car or outside as long as it is well protected from weather conditions or road dirt.

Fig. 2 The circuit immobilizes the electric fuel pump of the car, but it has a distinct disadvantage in that the car may be able to be driven a few hundred yards due to fuel remaining in the carburettor and fuel lines.

Fig. 3 A lead with a switch in it is connected from the SW contact of the ignition coil to the live feed of the horn. When the switch is closed, the horn will immediately sound when ignition is switched on. This system is of no use if car horn can operate when the ignition is switched off, however, it is quite a simple matter to re-wire the horn so that it only functions when the ignition is switched on.

Fig. 4 This circuit functions by simply placing another switch in series with the starter switch of the car and for the ignition circuit to be completed enabling the car to start, this extra switch must be closed.



## SIMPLE ALARM

Fig. 5 A simple circuit allowing an alarm horn to be sounded if the car doors, bonnet or boot are opened, the horn will cease if the doors are re-closed.

### Circuit Operation:

The circuit is set by closing all doors, bonnet and boot and setting the keyswitch. If a door is opened, the door switch makes a circuit to earth. Hence current from the battery flows through the relay coil and causes the contacts to close, which connect the horn directly to the battery and cause it to sound.

If the door is then closed, the relay coil circuit is broken and the relay contacts will open thus disconnecting the horn from the battery.

N.B. The same notes apply, about continuous rating for components, for this circuit as they do for the Alarm With Hold Relay. This is due to the fact that if a door is left ajar for any length of time, the horn will be sounding for that length of time.

## ALARM WITH HOLD RELAY

Fig. 6 The previous alarm circuit has a distinct disadvantage in the fact that when a door is reclosed the alarm stops. This may mean that when somebody has gained entry to the interior of the car, they may work without further disturbance and the car radio, cassette player or other valuable property etc. can readily be removed.

This circuit overcomes the problem by incorporating a hold relay. Once the alarm is set, the opening of a door will sound the horn and even when that door is reclosed the alarm will continue until it is switched off by the keyswitch.

### Circuit Operation

The alarm is set by closing the keyswitch, after all doors, bonnet and boot are closed. If a door is then opened, the door switch makes circuit to earth and the following happens:-

Current flows from the battery through coil (1) of relay (1) and hence contacts (1) close. This then allows the current to flow through the horn which consequently sounds

As coil (2) of relay (2) is in parallel with the horn, the current also flows through this and contacts (2) close which cause a parallel earthing circuit to that of the door switches to be created.

Now even if the door that started the alarm is closed, the parallel earthing circuit that has just been made will hold the horn on and the only way to stop the alarm will be by breaking the circuit with the keyswitch.

N.B. (i) It must be remembered that in normal use a car horn is only sounded for relatively short periods at a time and is only designed for such duty. This circuit may call for the horn to be sounding for considerable lengths of time and, hence, to avoid normal components being burnt out a continuous rating is essential for the horn and relays.

(ii) As an alternative to a keyswitch, a concealed toggle or press switch etc. may be used. If this type is used, be sure that where it is mounted is protected from the weather and corrosion. If a double pole switch is used then one of the other immobilizer circuits shown can be used in conjunction with the horn alarm.

#### EMERGENCY AMMETER

The writer was recently faced with the need to check the behaviour of his car's electrical system, in particular whether the alternator was capable of carrying all the load which could be imposed on it - headlights, mobile radio gear, etc. - even when the engine was only idling.

As no ammeter was available, either in the car or as a separate item, this presented a problem. The final solution is so simple, it may appeal to others.

A multimeter, set to the 0-1mA range (also 100mV in most meters), was connected between the chassis terminal of the battery and the chassis proper or, in other words, directly across the lead from battery to chassis. While the resistance of this strap is low, it was reasoned that there would still be a small voltage developed across it when several amps were flowing through it.

Switching on the headlamps gave a deflection of about three minor divisions (6mV) - not much, but enough.

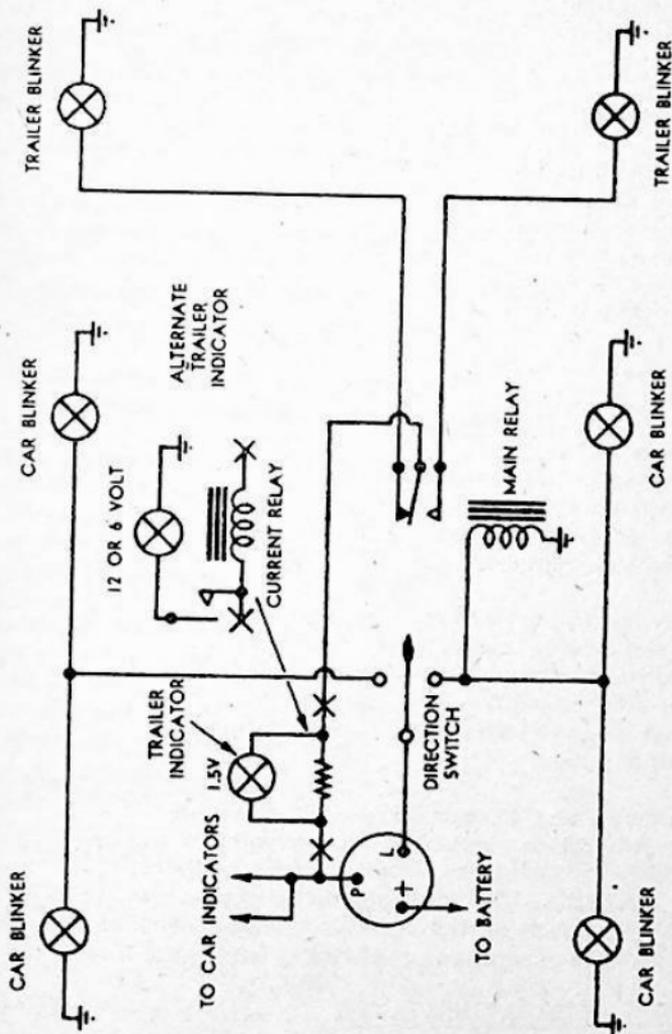
Then the engine was started and run at idling speed. The pointer swung back past zero, indicating a charge condition. Reversing the meter connections sent the pointer up the scale a couple of divisions even with all auxiliary circuits switched on, indicating that the alternator was not only supplying all these, but charging the battery at a significant rate also.

While there is no suggestion that this is a substitute for an ammeter, it is a quick and easy way of checking the system's behaviour.

#### ADDING FLASHERS

The requirements of any trailer blinker system may be summarised as :

1. An indicating light in the car that flashes with the trailer lights and will not operate if the plug or bulb are open circuit.
2. Connecting the trailer should not alter the flashing rate or render the car indicators unable to show a faulty bulb. This objection does occur if the trailer lamps are simply connected in parallel with the car lamps



ADDING FLASHERS TO A TRAILER

Requirement (1) may be satisfied by fitting either a current relay in series with the trailer lamp, or by using the voltage developed across a series resistor to light a 1.5 volt indicator lamp. Use of a relay allows either a 6 volt or 12 volt indicator lamp to be used and is equally suitable for either 6 volt or 12 volt systems. The series resistor system reduces the voltage to, and therefore the brilliance of, the trailer lamps by the 1.5 volts needed to operate the indicator lamp. This is not a serious loss with a 12 volt system, but usually cannot be tolerated with a 6 volt system.

Requirement (2) was satisfied by operating the trailer lamps from the pilot light terminal of the flasher. This works in unison with the main blinker contacts, but the pulses still have to be directed to the right or left in accordance with the direction switch setting. This would be most easily achieved if the direction switch had an extra set of contacts, but this is seldom the case. The alternative is to use a relay with a set of changeover contacts, directing the signals to (say) the right when the relay is not energised and to the left when it is energised.

The relay coil is then wired to be energised by the left contact on the direction switch.

This relay can be an ex-G. P. O. type suitable for voltage of the system. A 1,000 ohm (or smaller) coil should suit a 12 volt system, or a 500 ohm (or smaller) a 6 volt system. It should have a set of changeover contacts, or a set of normally open and normally closed contacts which can be wired into this configuration.

If a current relay is to be used to operate the indicator light it can be a conventional relay or, as I used, a dry reed switch. In either case the coil will need to be of only a few turns of heavy gauge wire. The turns needed are determined from the ampere/turns required to operate the relay (refer reed switch data sheets) divided by the current taken by one trailer lamp.

If a series resistor is used to operate the indicator lamp it can be made from a short length of resistance wire wound on a higher value resistor or an insulated rod. Turns should be spaced and held with glue, tape, or epoxy. The wire may be salvaged from an old heating element. The value of the resistor should be such as to develop 1.5V when the current for one blinker (at 10.5V) flows through it.

### TURN INDICATOR

**FOR THOSE WHO FORGET TO CANCEL THEIR TURNING INDICATORS  
HERE IS A SIMPLE AUDIO OSCILLATOR WHICH WILL REMIND YOU.**

When the trafficator switch on my van failed, the replacement had no provision for mounting a warning light. I therefore produced the following device which has worked perfectly ever since.

It is a Hartley oscillator with a fundamental frequency somewhere about 1KHz. Though designed for 12 volts I have tested it on 6 volts and can guarantee that it will work, though output is slightly lower. For 24 volt systems a transistor with higher ratings would be needed.

There is no need to use a new speaker - the one I am using had been discarded because of a slight voice coil scrape.

Fit one of these to your car and you'll never forget your blinkers are on and mislead other motorists. It's also a great conversation piece and passenger puzzler.

The following alternative transistors may be used in place of AC128:

AC117 - AC153 - AC180 - AC193 - 2SB370 - 2SB415

### LIGHTS 'ON' WARNING

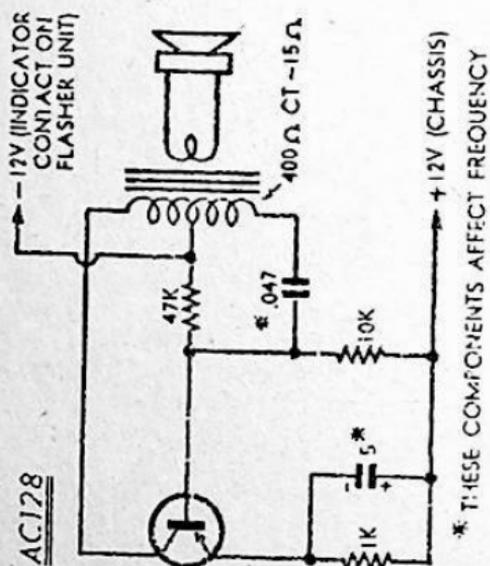
Recently road safety authorities have been asking motorists to drive with their side lights on in the daytime in bad weather to improve vehicle visibility. As my dash lights are not obvious in daylight I have twice inadvertently left the lights on after parking and have been greeted by a flat battery on my return later.

I was therefore prompted to devise a gadget which would warn me if the lights were left on after the ignition was switched off. I decided on a buzzer for the signal, as a light might not be noticed on a bright day. After toying with various circuits using relays and silicon diodes I evolved the simple circuit shown.

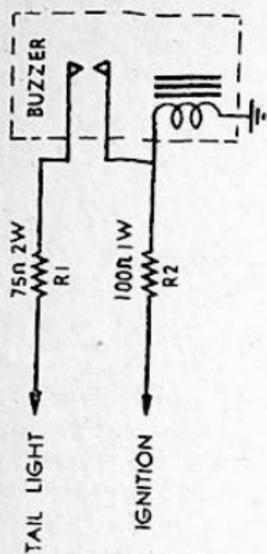
The supply for the buzzer (a 12V door buzzer, 25 ohm coil) was taken from the tail light contact on the light switch. This contact is activated in both the 'side' and 'headlight' positions. A resistor (R1) was connected in series with the buzzer to reduce the loudness, as it was found that the buzzer was too noisy in the confined space of the car.

To inhibit the buzzer action when the ignition is switched on, current is fed from the ignition circuit directly to the buzzer coil, i.e. not via the buzzer contacts. Thus the armature is permanently attracted to the electromagnet, the contacts held open, and the buzzer cannot function. Resistor R2 is used to limit the current through the buzzer to no more than is necessary to provide a positive inhibiting function. In addition, R1 and R2 collectively prevent any interaction between ignition and light switches.

The two leads from the buzzer were connected directly to the light switch and the ignition switch. In the latter case, the "accessory" ignition contact was used, rather than the normal ignition contact. This allows the buzzer action to be inhibited - by turning the ignition switch to the "accessory" position - while the lights remain on, should this be desirable during any condition.



Turn Indicator Warning



'Lights On' Warning

## VOLTAGE REGULATOR

THE ELECTRICAL SYSTEM OF THE MODERN MOTOR CAR USES MECHANICAL SWITCHES FOR THE VITAL FUNCTIONS OF CUT-OUT VOLTAGE REGULATING AND CURRENT LIMITING. WHILE THESE ARE CAPABLE OF DOING A GOOD JOB WHEN CORRECTLY ADJUSTED, THEY ARE LIKELY TO WEAR, STICK, PIT AND OTHERWISE DETERIORATE. THE ALL SOLID STATE SYSTEM DESCRIBED BELOW IS CLAIMED TO BE FREE OF ALL THESE PROBLEMS, AS WELL AS OFFERING OTHER WORTHWHILE ADVANTAGES.

At the time of writing, this regulator has been operating for nine months without fault in a car. The total cost is about £4.00 in parts and it fits into the same space as the original electro-mechanical regulator.

In place of the conventional mechanical 'cut-out' the system uses a diode; a 1N3491-R by Delco. This is a push fit diode which is fitted into a  $\frac{1}{2}$ -inch hole drilled into the generator assembly. This diode could be fitted in the positive lead, but thermal considerations dictate that it must be mounted on a reasonably large heat sink (100 sq. in.) which - in the positive lead arrangement - would have to be isolated from chassis. In addition this heat sink must not have any thermal contact with the regulating power transistor (2N441) heat sink because of leakage problems associated with high temperature on germanium transistors.

Other modifications which need to be made are:

The generator negative brush must be insulated from chassis. The field winding connections need to be modified so that both are insulated from chassis.

The maximum dissipation of the 2N441 is 6W and hence it can be mounted on a heat sink with a total area of 18 sq. in., assuming a worst case ambient temperature inside the engine compartment of 50 degrees C (122 degrees F). In my case, I mounted it on a chassis in which all the associated wiring was housed. A mica washer was used to electrically insulate the transistor case from the heat sink.

Because the cut-out diode is in the negative lead, and the present system employs a cut-out in the positive lead a phase inverter is required for the generator tell-tale light. The phase inverter circuit is shown in the dotted block of the circuit diagram.

The operation of the voltage regulator is best explained by first considering the resistors R1 R2 and R3. These form an adjustable voltage divider across the battery. When battery voltage is low the divider voltage is low and the BCZ63 (Zener diode) does not conduct. Therefore, the 2N3644 transistor does not conduct and all current through



resistor R8, is directed into the regulating power transistor (2N441), hence full output is obtained from the generator.

As the battery voltage rises, the zener diode begins to conduct, supplying base current to the 2N3644 which in turn diverts current through R8 away from the 2N441 base. Hence, field current drops and lower generator current results. Adjustment of voltage limit is obtained by varying potentiometer R2.

Current limitation, to protect the generator under extreme conditions such as a flat battery and/or very high engine speeds for long periods is provided by means of the .01 ohm resistor (R6). When current flows through the battery a voltage is developed across R6. This voltage is applied across the base emitter junction of the 2N3644 constituting a forward bias on the transistor. As before, this reduces field current and generator current to an acceptable limit. Adjustment of this limit is obtained by varying potentiometer R7, which varies the initial bias on the 2N3644. The .01 ohm resistor consists of 20in of 1/8in diameter steel fencing wire.

To adjust the system first connect an ammeter into the battery lead and turn down the voltage limit potentiometer R2 to zero (to prevent the voltage limit from working). Start engine and rev to 2000 rpm. Adjust R7 until the desired current is obtained (20 to 30 amps).

Adjustment of voltage limit can be achieved by two methods.

- (1) If the battery is fully charged it will have a voltage of 13.5 to 14.1 volts and hence the voltage limit may be adjusted to give a fully charged current of 3-5 amps.
- (2) If the battery is in a partially discharged condition, connect a 0.5 ohm resistance in series with the battery lead and connect a voltmeter between the "hot" side and chassis. Adjust the voltage limit until the voltmeter reads 14.0 volts.

This method of setting up should be accurate enough, but a final touch up of R2 and R7 may be needed. Once set up the potentiometers should never need to be adjusted again, even when a new battery is installed.

#### LOW COST REVERSING LIGHT

I was confronted with the need to fit backing lights to my car. As the car was new, I did not wish to mar the appearance by fitting additional lights, so I fitted the following additions to the flasher circuit, to make the flasher lights double as reversing lights.

I bought a reversing switch and fitted it to the place provided on the gearbox. Most cars - even fairly old ones - have provision for the switch on the gearbox. The reason for this is that in the past, only the luxury versions had reversing lights, but the gearbox housing used was the same as in the standard models. This is especially true of Continental cars.

As can be seen from the circuit diagram, the rear orange turning indicator lamps can be used as reversing lights merely by passing the flasher mechanism, and isolating the front and rear circuits by means of silicon diodes. This method does not alter the outward appearance of the vehicle, but the increased night safety plus the low cost - the price of four diodes plus the switch - should make this idea popular with owners of both old and new model cars.

Some readers may have cars with no provision for a gearbox switch. If this is the case, a switch could be mounted on the dashboard to perform the same function. If this is used, there should be some sort of warning lamp to indicate that the reversing lights are on.

The diodes should have a PIV at least equal to the maximum voltage likely to be generated in the car's electrical system, and a current rating equal to the surge (cold) current of the lamps. The largest flasher lamps appear to be 18W types; 1.5A at 12V or 3A at 6V. Assuming a cold resistance of about one eighth of the hot resistance - which appears to be typical - the surge current in a 6V system could be about 25A.

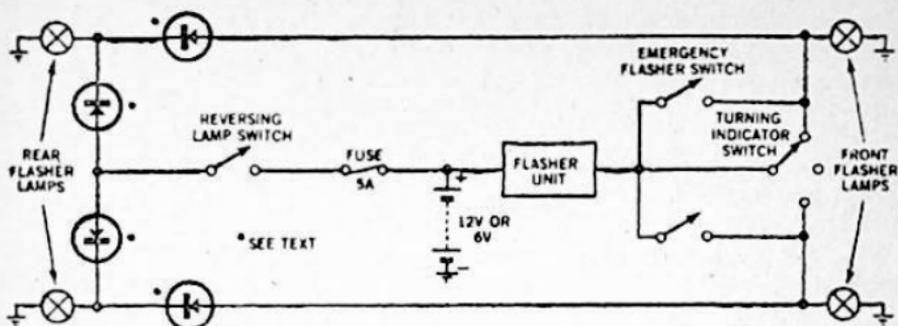
On the basis of these figures, the most logical choice is the type of diode used in vehicle alternator systems. These are usually rated at 25A continuous, with a surge rating well in excess of this, and a PIV of around 200. A typical type is the BYX21L/200. This type of diode also represents about the best value for money available, considering the ratings and the safety margin which they represent.

Also, with ratings of this order it may be permissible to omit the two diodes isolating the front flasher lights, particularly in 12V systems. This would mean that the front lights would be energised as well as the rear ones, but there does not seem to be any serious objection to this.

#### MOTOR CYCLE SAFETY CUT OUT UNIT

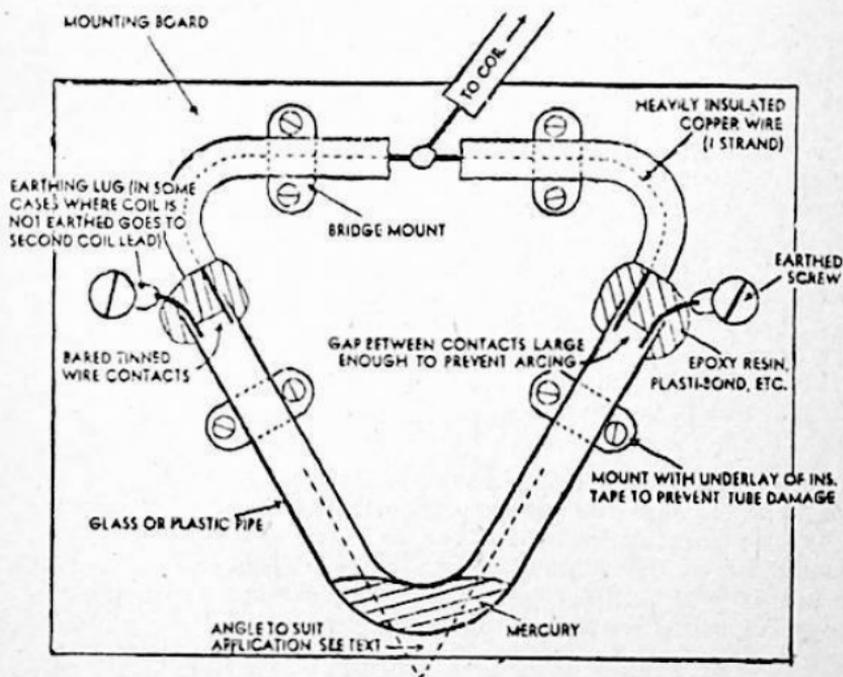
If a motor-bike turns over (in an accident or a sharp turn), the rider is exposed to a great deal of danger from the cylinder, or cylinders on the engine bursting or having their heads blown off. Added to this is the danger of spilt petrol igniting off sparks from torn exhaust pipes or burst cylinders, not to mention the hazard of fast moving chains and cogs. Most of this danger can be eliminated by turning the engine off in a crash, but this is hard to do in the split second between impact and separation of rider and machine.

This device is useful in these circumstances, is cheap and easy to make and needs little maintenance. It consists of a piece of bent plastic or glass tubing in which a globule of mercury is free to move. Should the bike tilt too far, the mercury shorts the ignition coil to earth, stopping the engine almost instantly.



The addition of four diodes, a reversing light switch, and a fuse, added to a conventional flasher circuit, enables the flasher lights to double as reversing lights.

## Low Cost Reversing Light For Cars



## MOTOR CYCLE SAFETY CUT OUT

The unit is mounted on a suitable board ( $\frac{1}{4}$ in masonite etc.) wrapped in foam rubber and placed in a wooden or metal box mounted vertically across the frame parallel to the handlebars and away from the engine.

The angle at the bend is chosen to suit the application. If too large, the bike will stop when rounding a corner; if too small, the engine may not cut out. The correct angle will lie between about 20 and 110 degrees.

### AUXILIARY LIGHTING FOR CARS

READERS WISHING TO ADD FOG LAMPS ETC. TO THEIR CARS MAY BE INTERESTED IN THIS ARTICLE FROM A CONTRIBUTOR WHO HAS ALREADY BEEN THROUGH THE EXERCISE. EVEN IF YOUR REQUIREMENTS DIFFER, MANY OF THE IDEAS MAY BE USEFUL.

There is no great technical revelation in the circuit and to some it may seem over complicated but its functioning is logical and the many options are readily mastered. The components, other than the driving lights themselves, cost under six pounds, half of which was spent on a trafficator switch. Four simple disconnections and a few mounting bolts undone make the system easily removable and just as easily installed in the next car.

The circuit shown provides independent selection of a number of lighting combinations but, at the same time, ensures that the legal requirements concerning the auxiliary lights are satisfied.

Selection of either fog or spot light is made in the first instance by S1, a switch originally designed as a trafficator switch. The one used in the author's case was a Hella type 51/25-46. Among other features, this switch has an indicator light in the end of the lever. It is designed to be strapped to the steering column and is most conveniently located on the right hand side of the column behind the normal trafficator switch.

This switch selects a 12V supply from either the ignition switch (fog and side light position) or the high beam headlight line (spot light position). This latter connection means that the spot light will operate only when the headlights are switched on and on high beam. For obvious - and legal - reasons it is essential that the spot light be switched off when the headlights are dipped in the face of oncoming traffic.

The moving arm of S1 connects to the coil of a normally open relay which, when energised, connects the main 12V supply to S2, S3 and, via the diode, the side light circuit. Switch S2 selects the fog light and S3 selects the spot light. Each circuit is monitored by a pilot light. The diode in the side light circuit prevents unwanted activation of the auxiliary light circuits when the side lights are activated via the headlight switch.

As well as giving direct control of each light to suit particular driving conditions, S2 and S3 also provide isolation in the event of either lamp being damaged, by reason of their vulnerable position when mounted on the bumper bar. They bestow a further advantage in that, when both are "off", the side lights alone can be selected, as for wet weather driving. Since they are controlled by the ignition switch they are unlikely to be left on, even if the visual reminder is ignored.

On the other hand, the circuit ensures that if the fog light only is to be used (headlights off) as is sometimes beneficial in thick fog, the sidelights are automatically activated, thus satisfying a legal requirement.

Any good quality switch may serve for S2 and S3, but the writer used the Lucas type 31828. As well as being a well made and reliable switch, it has the advantage of automotive type push-on terminals, which simplify connection.

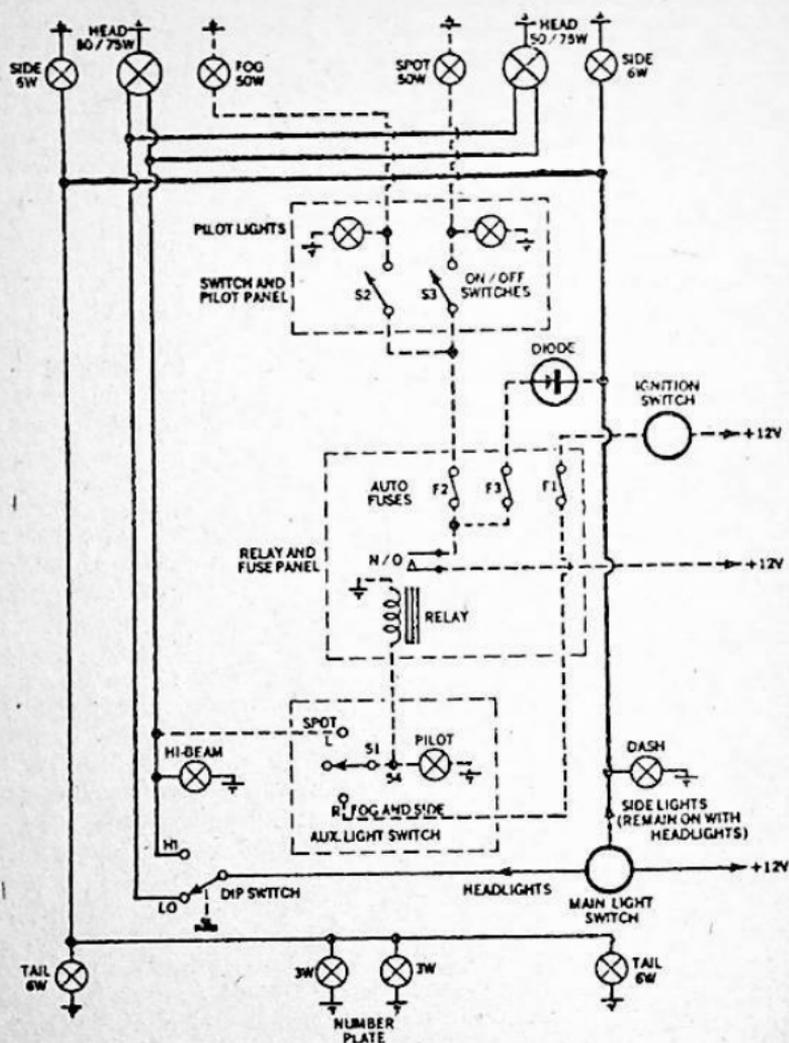
The light on the S1 lever, as supplied, is wired to serve as a visual reminder that one or other of its functions has been selected, and that it should be switched off when the car is parked, or when the function is no longer needed.

A BYX21LR (reverse polarity) heatsink mounting diode was chosen in preference to a stud mounting type. The heatsink was insulated from chassis and its position carefully chosen so as to minimise the risk of accidental shorts. The anode (case) of the diode is connected to the fuse F3. The cathode solder connection should be protected by sleeving and taping. This diode is a Philips automotive type with large rating margin for this duty, more than sufficient for the theoretical inrush current into cold lamps.

Fault protection is essential in preserving the reliability of the car's basic lighting system, and functions associated with the ignition switch. Lack of space in this particular car prevented the installation of a fuse in the direct 12 volt supply but by using thick plastic sleeving on this wire and by careful installation throughout, the chance of a fault before the fuses has been minimised. A fuse in this line is recommended and it should be placed as close as possible to the cut-in point.

The combination of a spot light on the right, and a fog light on the left was chosen because experience has shown that, when using a spot light with headlights, the fog light is a useful fill-in in the area under the spot light, especially when cornering and avoiding potholes.

On the other hand, when driving in fog, without headlights, the spot light can be a useful addition to the fog light, provided its angle is capable of being depressed sufficiently. Used in this way it helps balance road illumination, helps the driver to keep to the left of the centre line (if there is one!) and provides two lights instead of one.



NORMAL LIGHTING CIRCUIT

AUX LIGHTING CIRCUIT

The circuit shows the relevant portion of the existing wiring (solid) and the additional wiring (dotted). Wiring will vary with the make of car, but the ideas discussed in the text could be applied to most, with minor modifications.

Note that the Hella trafficator switch previously referred to may present a problem when used with some of the later model cars. This is due to a trend towards thicker steering columns which, in some cases, may be tapered as well. Any column circumference greater than eight inches is close to the limit of adjustment afforded by the switch's steel mounting strap.

To overcome this problem, lengthening the strap by pop-riveting in an extra length might do. Alternatively, a panel-mounting three-position switch with an extra long operating lever could be used. A separate indicator light for circuit activation would then be required. Depending on space, accessibility to the driver, etc. three locations which might be considered for this switch are the dash itself, the relay panel, or the individual switch/pilot light panel, with appropriate design changes. The main problem will be avoiding positions which interfere with other controls or are prone to knocking by the knees when the driver enters or leaves the car.

#### LOW VOLTAGE FLASHER UNITS

THIS BRIEF ARTICLE DESCRIBES TWO CIRCUITS FOR FLASHING WARNING LAMPS WHICH CAN BE USED ON PARKED MOTOR VEHICLES, TRAILERS, BOATS AND STATIONARY OBSTRUCTIONS. IN ADDITION, A SUITABLE MODIFICATION IS SHOWN WHICH ALLOWS THE FLASHER CIRCUITS TO BE AUTOMATICALLY SWITCHED ON AT NIGHTFALL AND OFF AGAIN AT DAYBREAK.

The lamp flasher circuits described here are intended to fulfil a need which, although not universal, is very real to those who may require such a device. However, they will no doubt appeal to a number of experimenting readers who will find a diversity of uses for a flashing lamp.

Primarily though, the lamp flashers are intended as warning devices for use on parked or broken-down vehicles, caravans, trailers or other stationary obstructions. Possibly the most useful application would be as a warning for approaching traffic when changing a wheel or carrying out other repairs on the roadside at night. Further applications might include mooring buoy indicators or other navigational requirements.

The main requirement for a portable warning flasher is that it should have low average current drain to ensure prolonged battery life. This condition is satisfied, without reducing lamp brightness, by having a very short duty cycle in which the lamp is switched on for short bursts only. For the circuits presented here, the ratio of on time to off time is about 1 to 5.

Two circuits are presented, the first of which is a low current unit for portable or continuous operation (figure 1). Using a 12V 250mA pilot lamp with duty cycle of about 18 per cent, the average current drain

is reduced to approximately 44mA. For portable operation the supply could be made up from two 6V lantern batteries connected in series, providing an operating life of several hundred hours.

As an alternative arrangement, a 6.3V 300mA pilot lamp could be used in the same circuit without any alteration, except for the power supply which could be a single 6V lantern battery. With this configuration the average current drain will be increased to about 50mA, slightly reducing the battery life.

It will be noticed that the supply voltage is shown connected to the circuit via a diode bridge network. The purpose of the network, which is the same as a bridge rectifier used in AC to DC power supplies, is to make the circuits insensitive to supply polarity. Thus the transistors are protected against the inadvertent application of wrong supply polarity which could have disastrous effects. Suggested diode types to use in both circuits are 1N3193 or BY126 or BY174.

The polarity protection provided by the diodes will be of particular value when the flasher is to be constantly connected to supplies of unknown polarity; or where darkness prevents the identification of battery polarity. However, if the flasher is to be permanently connected to an external or self contained supply the diodes will not be necessary, and may be omitted.

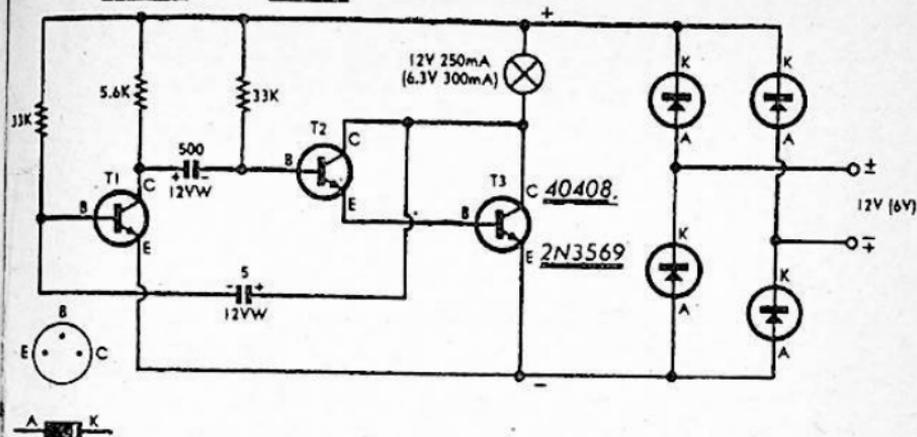
The second flasher circuit, of which there are also two versions (figure 2), is designed to operate from a 12V auto accumulator with intermittent current levels of up to 1 amp. We used auto tail-lamps, in the mock-up circuit, having ratings of 6 and 12 watts or 0.5A and 1A respectively. However, with short duration flashes the average current consumptions are quite modest.

With a 6 watt lamp and a duty cycle of about 15 per cent, average current drawn by the lower power version is around 225mA. However, if a 12 watt lamp is used the duty cycle is increased slightly to about 19 per cent with an average current consumption of about 350mA. Nevertheless, the current drain imposed on an auto accumulator by even the 12 watt unit is still quite modest.

Again, the supply voltage is connected via a diode bridge network for transistor protection. As the high current circuit is intended for exclusive use with an automobile accumulator as an emergency warning light, the protection network should be considered as essential. In this case the diodes or bridge rectifier should have at least a 1-amp rating.

The fundamental circuit configuration and operation of both flasher circuits is quite conventional, being that of an astable multivibrator. The duty cycles are similar, the differences comprising a few minor variations of component values. For a brief description of circuit operation we will restrict our comments to the second high current version.

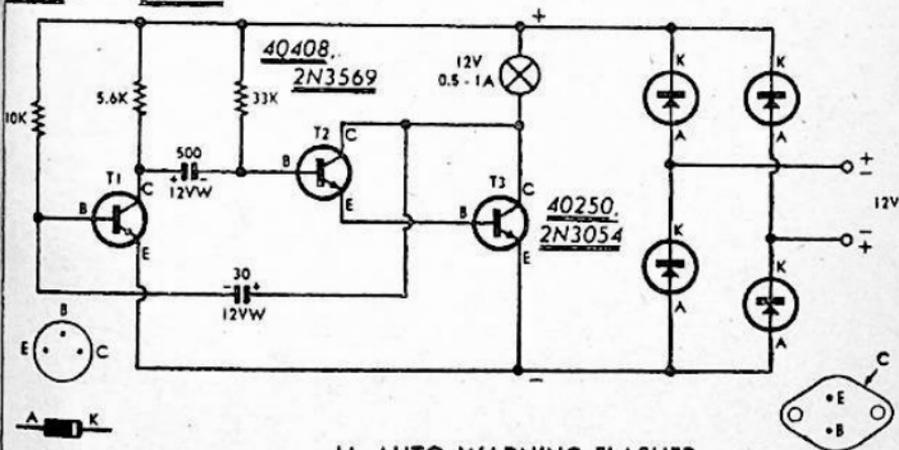
2xBC108, 2N3565



250mA AUTO WARNING FLASHER

Figure 1

BC108, 2N3565

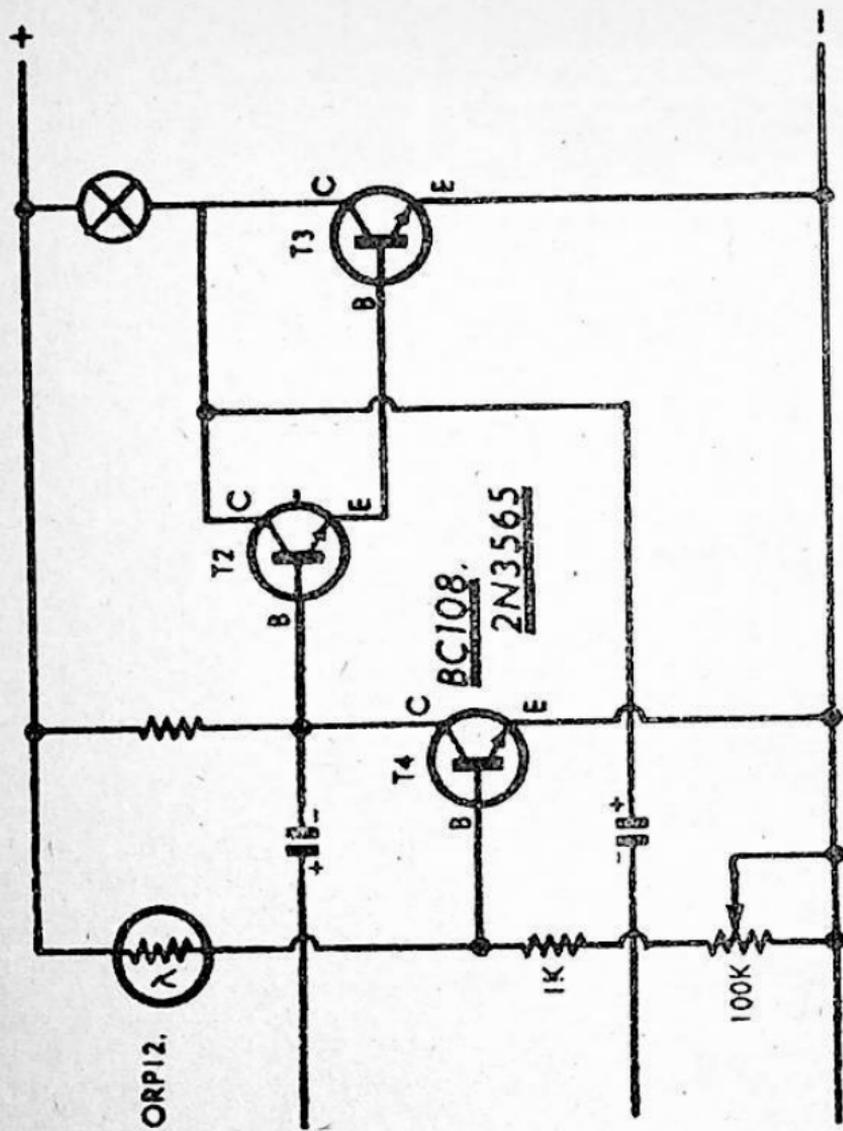


1A AUTO WARNING FLASHER

Figure 2

Circuits for two lamp flashers, a low current unit and a high current version, are shown above. The flasher circuit with a current capacity of up to 1/4 amp and operated from 6 or 12 volts is shown in the top block, while a 1-amp 12-volt version is shown below.

A modification for either circuit making them light activated. The extra components required include a transistor, LDR, potentiometer and one resistor.



MODIFICATION FOR LIGHT CONTROLLED FLASHING

Figure 3

For convenience assume that initially the Darlington configuration of T2 and T3, which drives the lamp, is cut-off with collectors at full supply potential and lamp extinguished. This condition causes the 30uF capacitor to charge through the base of T1, holding that transistor conducting and in saturation till the capacitor has almost fully charged.

When charging current can no longer saturate T1, its collector voltage tends to rise to supply potential and the 500uF capacitor commences to charge into the base of T2. As before, the charging current causes the Darlington pair to saturate and light the lamp for the period it takes to charge the 500uF capacitor. When the capacitor is charged, T2 and T3 are returned to the cut-off condition, the lamp is extinguished, and the cycle repeats with T1 driven into saturation.

Darlington pair configurations have been used in both flasher circuits to reduce the level of saturating base current required by the lamp driving transistor. By emitter follower action T2 provides the large base current required by T3 to permit saturation with the low collector load resistance provided by the lamp.

Even with the large current gain achieved by compounding T2 and T3, the base current required by T2 is considerably larger than the saturating base current of T1. For this reason the 500uF capacitor coupling into the base of T2 is relatively large even though the on-time of T2 and T3 is very much less than T1. With only a single transistor driving the lamp, rather than the Darlington pair, the value of the base coupling capacitor would be many times larger than the present 500uF. So large, in fact, as to be impractical.

In some situations it might be convenient to have the flashers as described switched on and off by the ambient light conditions; for instance, on an unattended mooring buoy. This can be quite easily arranged by incorporating a light dependent resistor in the circuit. The appropriate modification, suitable for either flasher circuit is shown in figure 3.

An additional transistor is used in conjunction with the light dependent resistor to effectively hold the Darlington pair in a cut-off condition while ever light is falling on the LDR. When the LDR is not illuminated its resistance is very high, T4 cannot conduct, and the Darlington pair will become saturated. A 100K potentiometer is provided to adjust the level of illumination at which the flasher will commence to operate.

## RADIO OPERATED GARAGE DOOR OPENER

The radio ham who has a transmitter in his car can use his sending set to open his garage door by radio control. We do not recommend this scheme for use by unlicensed experimenters, since at least 10 to 20 watts transmitter power is required, and this amount of power fed into the automobile antenna meets the requirements of a radio station.

Figure 40 gives the circuit schematic of the receiving apparatus installed in the garage. The front end of the receiver employs a crystal detector, therefore no power is drawn by the equipment when it is idle. This is an essential feature, since there are no tubes to be kept burning when the equipment is not in use.

Coil L1 has been selected for 6-meter operation. However, if the car transmitter operates on some other frequency, L1 may be changed to suit the used frequency. The receiver circuit gives positive operation at distances up to 15 feet between the car and the garage-door antenna, which is ample for all practical purposes. At the same time, the receiver is not sensitive enough to be operated erroneously by signals from local stations.

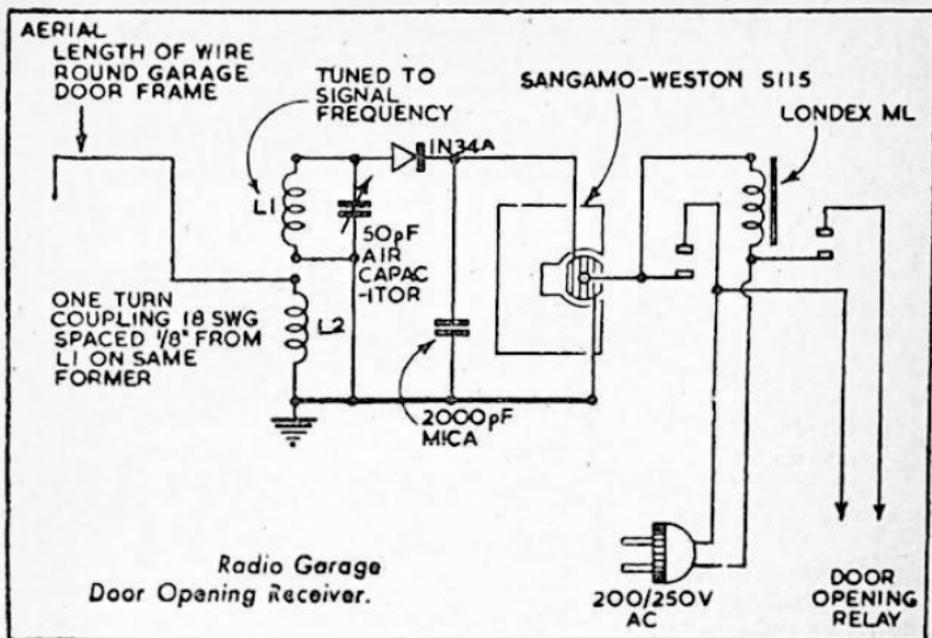
To adjust the receiver initially, turn on the transmitter and rotate the 50 $\mu$ fd. tuning capacitor in the receiver to the point where the relays operate. Tune-in the signal "on the nose". The receiver tunes rather broadly, so that the transmitter frequency can deviate appreciably without control action being lost. To operate the system, it is necessary only to drive up near the garage door, switch on the transmitter, and hold the control signal until the relay-controlled motor system has completed the job of opening the door.

The crystal diodes are employed in the receiver-relay unit. One of these is a 1N34-A radio detector. The other, a 1N56 high-conduction diode, supplies 6 volts DC for operation of the Model 712 relay.

## SIMPLE R. F. AMPLIFIER FOR INCREASING SENSITIVITY OF PORTABLE TRANSISTOR RECEIVERS

This extremely compact circuit will increase by up to 20 times the sensitivity of any portable receiver. This is especially of use when this type of set is used in a car which due to the metal body and chassis tends to restrict the performance of average portable receivers.

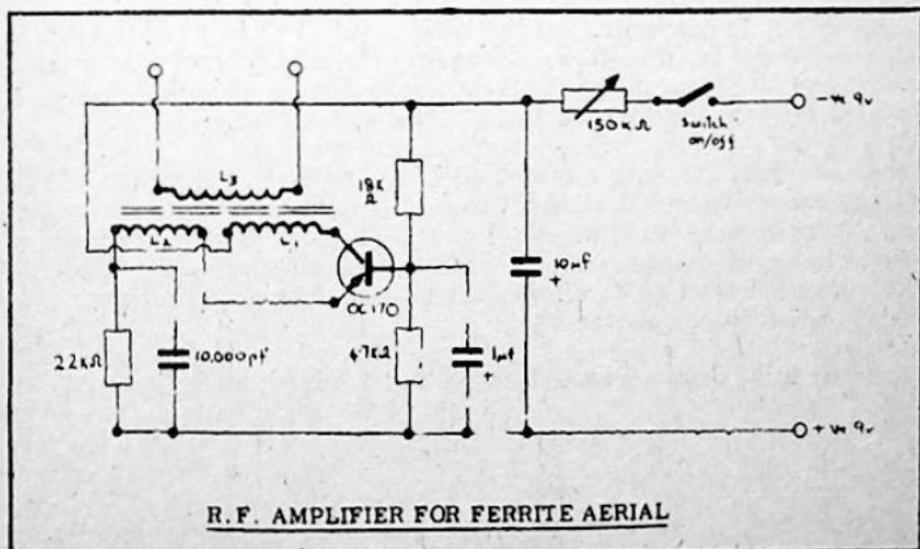
The effect of this little amplifier is to increase the "Q" or goodness of the ferrite aerial in the receiver.



In case of difficulty in obtaining the original diodes, the following equivalents will work in this circuit:-

1N34A = OA81-OA85-OA91-AA118  
AA132-AA133

1N56 = OA85-AA136



The windings L1 and L2 which slide over the original ferrite rod each consist of 15 turns 30 s. w. g. copper covered wire wound on a small piece of paxolin or paper tubing of a diameter that will allow it to slide fairly tightly over the original medium wave winding on the ferrite aerial.

L1 and L2 are wound 1" apart from each other on paxolin or paper tubing and sealed in place with a small dab of fast drying lacquer and then approximately centralised on the original ferrite medium wave coil which is shown in the drawing as L3.

### FLASHING CIRCUIT USING THYRISTORS

By courtesy of Thorn - AEI Valves and Tubes Ltd we include the following emergency flashing circuit using thyristors.

A circuit design for two Brimar 2N2926 transistors

One of the main virtues of a thyristor is its ability to withstand the heavy switch-on currents associated with incandescent lamps. This therefore makes it a logical choice for lamp flashing applications.

This particular circuit is ideal for use as a transport warning flasher having been designed to operate from a 12V car battery. The flash rate is approximately 1 per second and the current drawn from the battery, about 2A. The device is self-starting, once power is applied and will operate reliably from fluctuating supply lines.

#### METHOD OF OPERATION

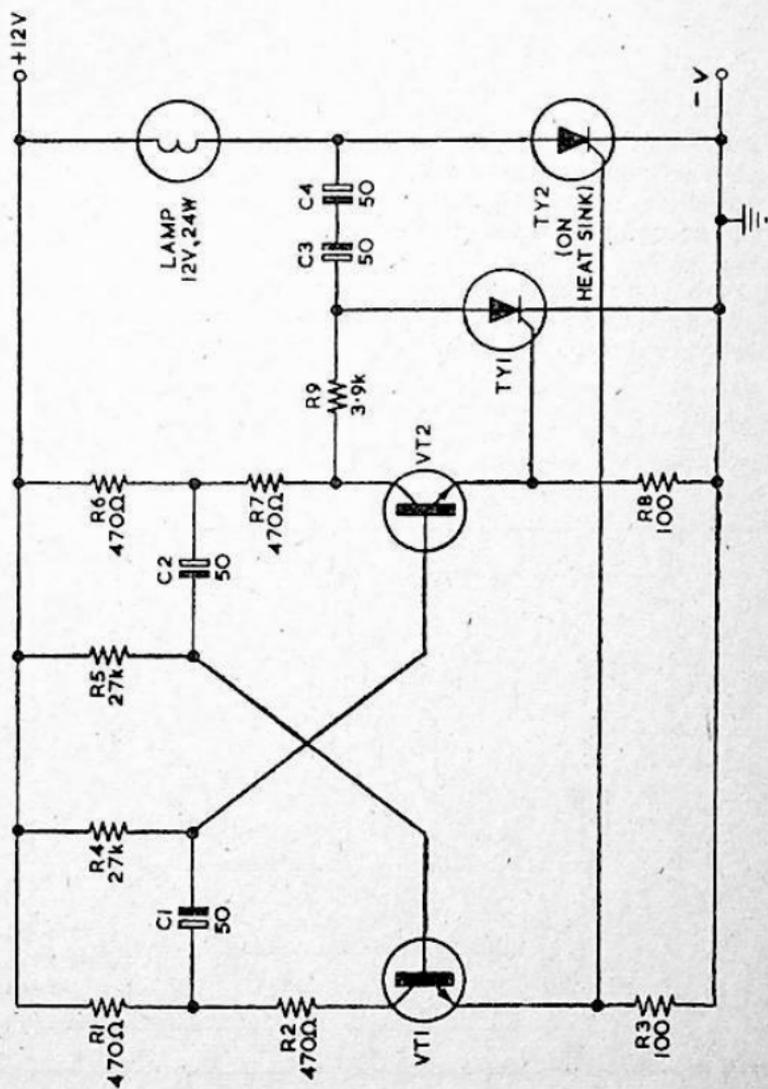
An astable multivibrator VT1 and VT2 produces a train of pulses developed alternately across R3 and R8, emitter resistors in VT1 and VT2 respectively. These pulses are applied in turn to the gates of two thyristors. TY1 and TY2.

Assume TY2 is conducting and the lamp is on. TY1 is off and its anode potential is, therefore, +12 volts. The next pulse from across R8 triggers TY1 on and TY2 is turned off by the commutation pulse coupled to its anode via capacitors C3 and C4.

TY1, however, conducts momentarily, discharging C3 and C4. It cannot conduct continuously since the H. T. voltage supply to its anode, via R9, is derived from the collector of VT2 which is bottomed when producing a pulse across R8. By making the switching on and off of TY1 independent of TY2, failure to flash caused by both thyristors being on together is prevented.

The next pulse from across R3 triggers TY2 and the cycle is completed.

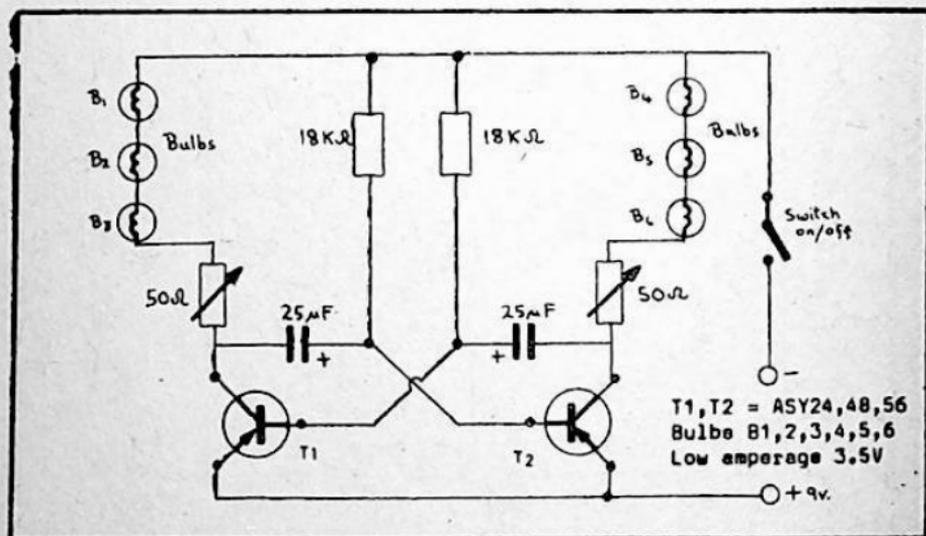
# FLASHING CIRCUIT USING THYRISTORS

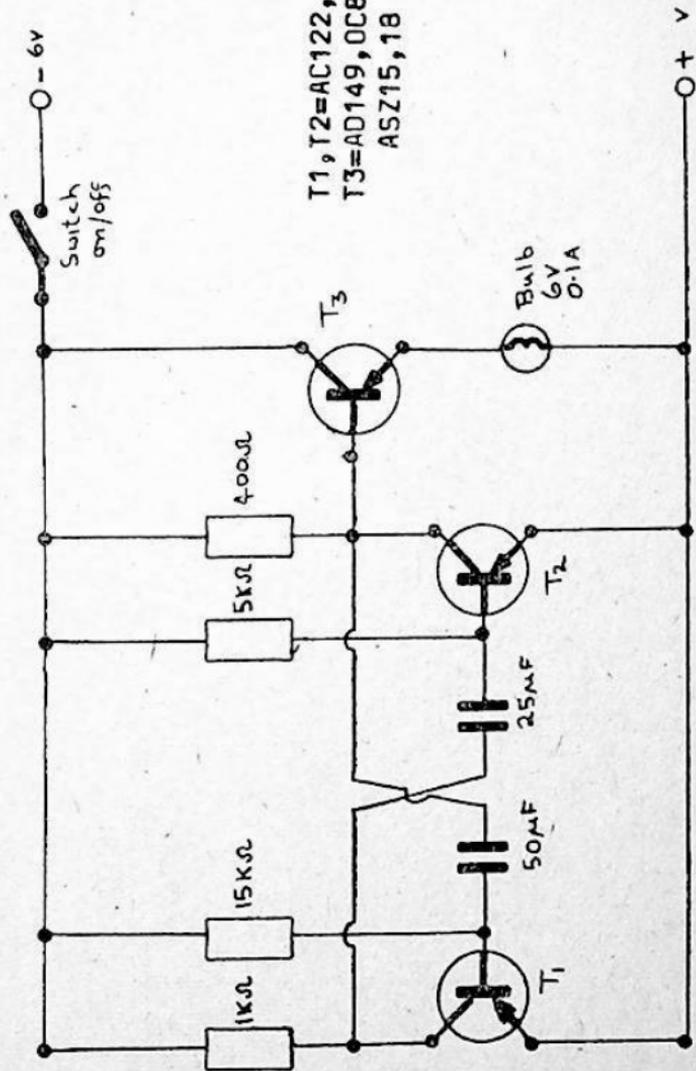


VT1 & VT2 TYPE 2N2926 (MINIMUM  $h_{fe} = 55$ )  
 TY1 & TY2 TYPE C106F1  
 ALL RESISTORS  $\frac{1}{2}W \pm 10\%$

It is convenient to operate the astable multivibrator from the same H. T. supply as the thyristors. If the positive plates of the cross-coupling capacitors C1 and C2 were connected directly to the collector terminals, the large negative swing at the collector of each transistor, as it conducts, would be transmitted to the base of the opposite transistor, and, in this case, would exceed the reverse breakdown voltage of the base-emitter junction. By dividing each collector load into two equal components and connecting the cross-coupling capacitors to the junction of these components, the reverse breakdown voltage of the base-emitter junction is not exceeded.

Included here are a number of circuits for automatic emergency light flasher units of various types. The reason we have included all these is that due to increasing hazardous traffic conditions every car user should carry some form of warning device of this type in his car. It may be placed at a distance to the rear of the car if for any reason an emergency stop takes place. The circuits have all been tested and are practical. The more advanced constructor can build up identical units from these circuit diagrams.

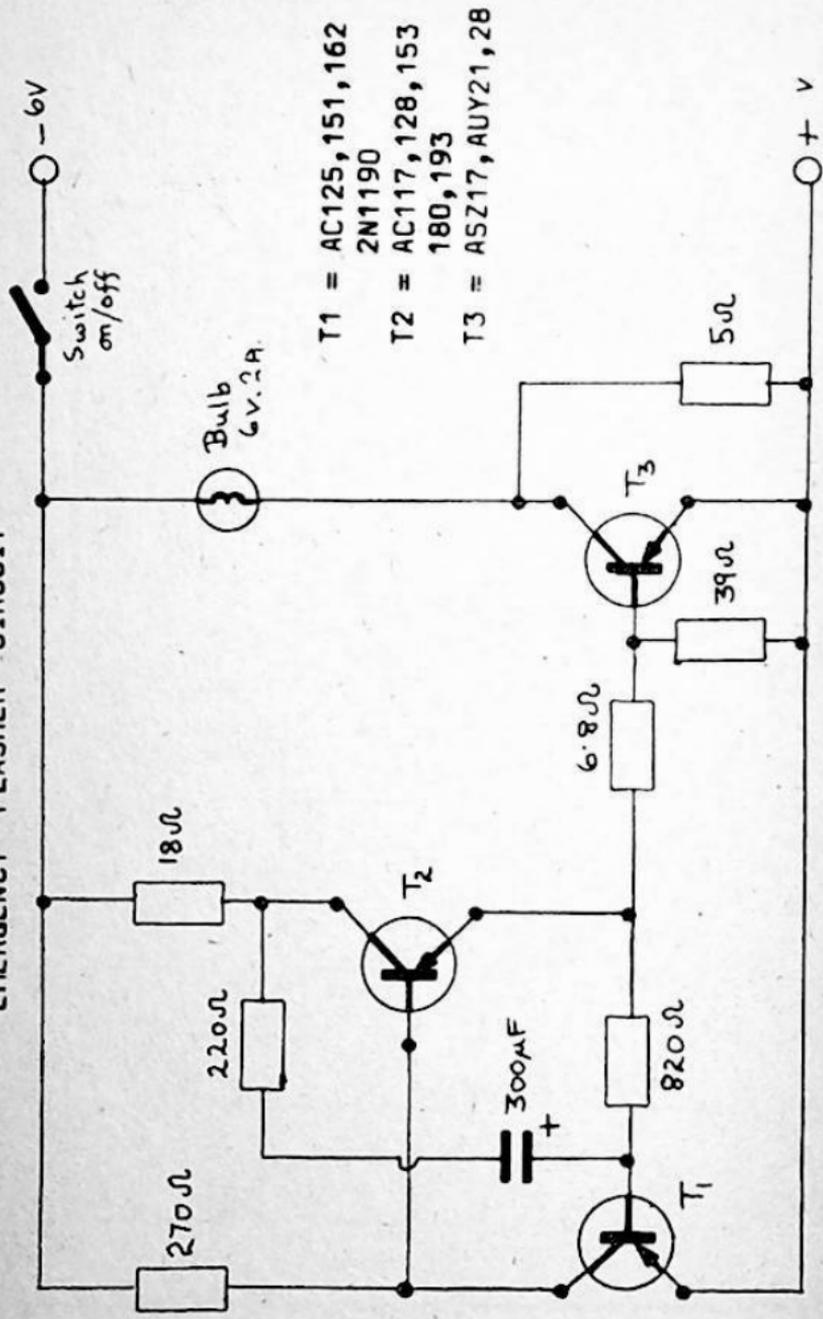




T<sub>1</sub>, T<sub>2</sub>=AC122, 126, 151  
 T<sub>3</sub>=AD149, OC80, 2N2836,  
 ASZ15, 18

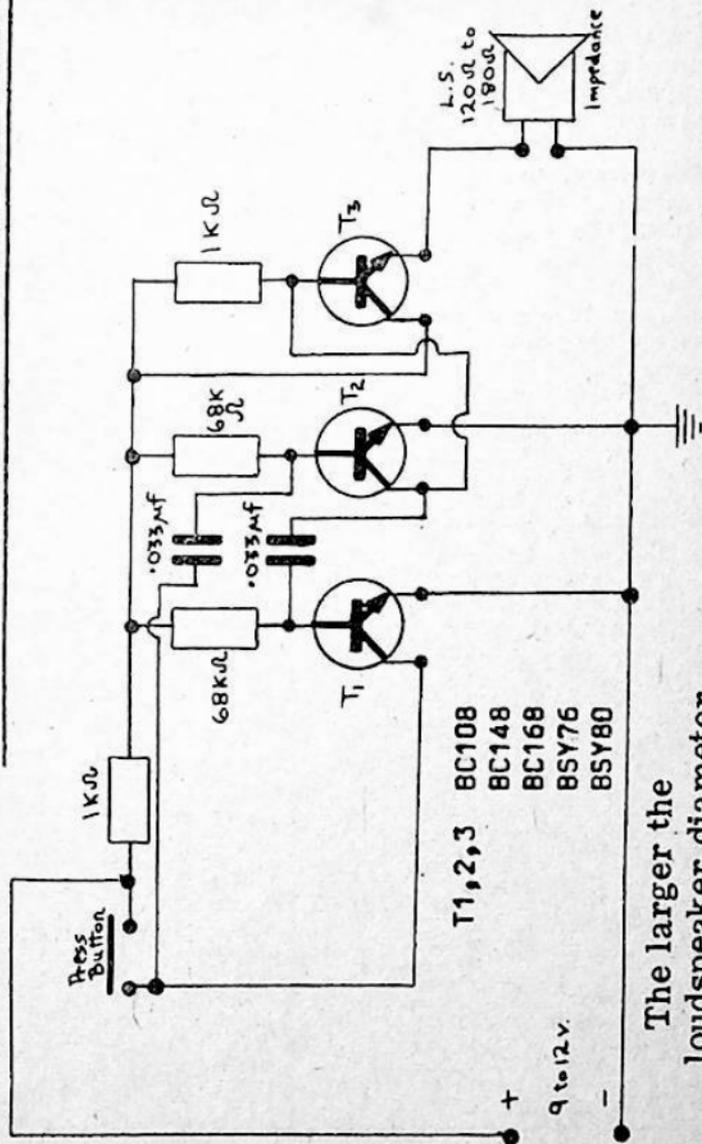
EMERGENCY FLASHER CIRCUIT

# EMERGENCY FLASHER CIRCUIT



- T<sub>1</sub> = AC125, 151, 162  
2N1190
- T<sub>2</sub> = AC117, 128, 153  
180, 193
- T<sub>3</sub> = ASZ17, AUY21, 28

## HIGH POWER SIREN FOR CARS AND BOATS



The larger the  
loudspeaker diameter  
the greater the power output.

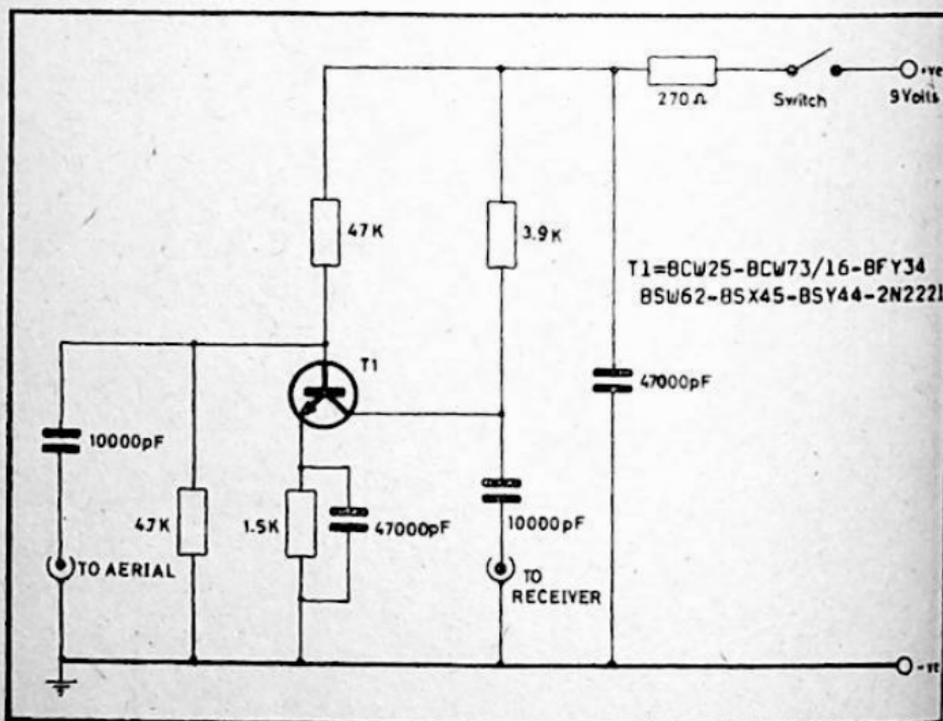
## BROAD BAND AMPLIFIER FOR CAR RADIOS

This broad band amplifier requires no tuning. It increases greatly the station getting ability of most car radios. It works equally well on medium and long wave bands and is very simple to fit.

Fix aerial plug from the car aerial into the amplifier and from the output of the unit connect a short length of car aerial lead-in with an aerial plug at the other end. Insert this into the car radio aerial socket in the normal way.

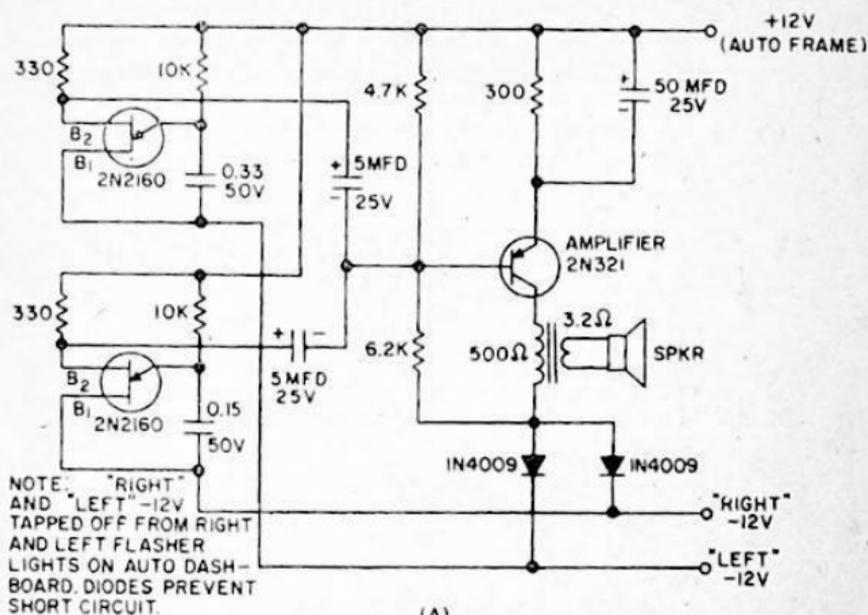
The power requirements of this small amplifier is exceedingly low. Its maximum consumption is about  $1\frac{1}{2}$  mA. It can be left on permanently, if desired. A PP3 battery will last for many weeks when powering this unit.

For improved performance, it is suggested that this little R.F. amplifier be built inside a very small metal case which can also contain the battery.

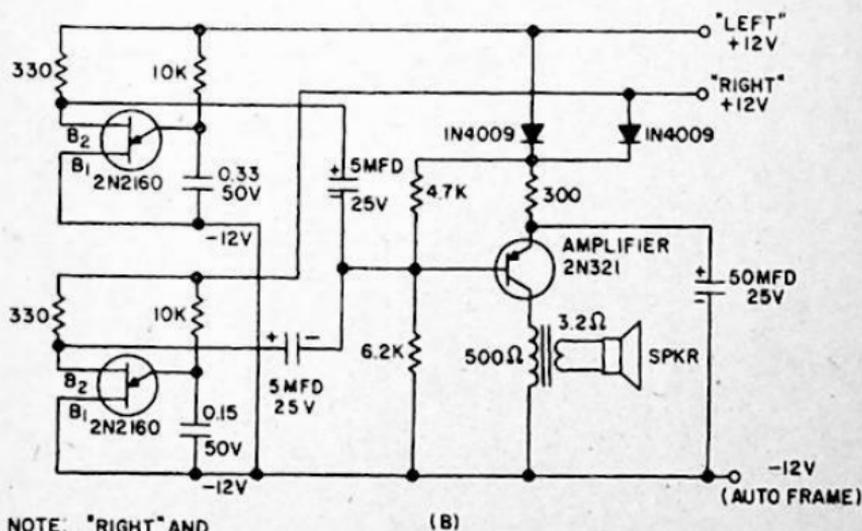


BROAD BAND AMPLIFIER FOR CAR RADIOS

## Circuit by courtesy of General Electric (U.S.A)



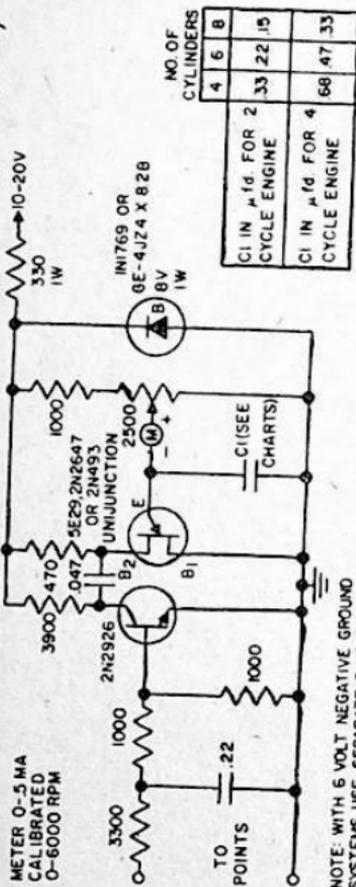
NOTE: "RIGHT" AND "LEFT" -12V TAPPED OFF FROM RIGHT AND LEFT FLASHER LIGHTS ON AUTO DASHBOARD. DIODES PREVENT SHORT CIRCUIT.



NOTE: "RIGHT" AND "LEFT" +12V TAPPED OFF FROM RIGHT AND LEFT FLASHER LIGHTS ON AUTO DASHBOARD. DIODES PREVENT SHORT CIRCUIT.

### AUDIBLE AUTO SIGNAL MINDER

# Circuit by courtesy of General Electric (U.S.A.)



		NO. OF CYLINDERS		
		4	6	8
CI IN $\mu$ Id FOR 2 CYCLE ENGINE		33	22	15
CI IN $\mu$ Id FOR 4 CYCLE ENGINE		68	47	33

## GENERAL AUTOMOTIVE IGNITION INFORMATION

	TWO CYCLE			FOUR CYCLE		
	4 CYL	6 CYL	8 CYL	4 CYL	6 CYL	8 CYL
SPARKS/REV.	4	6	8	2	3	4
SPARKS/SEC. AT 600 RPM	40	60	80	20	30	40
TIME/SPARK AT 600 RPM	25 MS	16.7	12.5	50	33.3	25
SPARK/SEC. AT 6000 RPM	400	600	800	200	300	400
TIME/SPARK AT 6000 RPM	2.5 MS	1.67	1.25	5.0	3.33	2.5
CAMSHAFT SPEED TO CRANKSHAFT SPEED	EQUAL	EQUAL	EQUAL	HALF	HALF	HALF
CAM DEGREES/SPARK	90°	60°	45°	90°	60°	45°
CRANK DEGREES/SPARK	90°	60°	45°	180°	120°	90°

**ULTRA-LINEAR HIGH PRECISION TACHOMETER**  
 (For Automotive Type Ignition Systems with 12 Volt Negative Ground)

The two circuits on Audible Auto Signal Minders are reproduced here by courtesy of General Electric (U.S.A.)

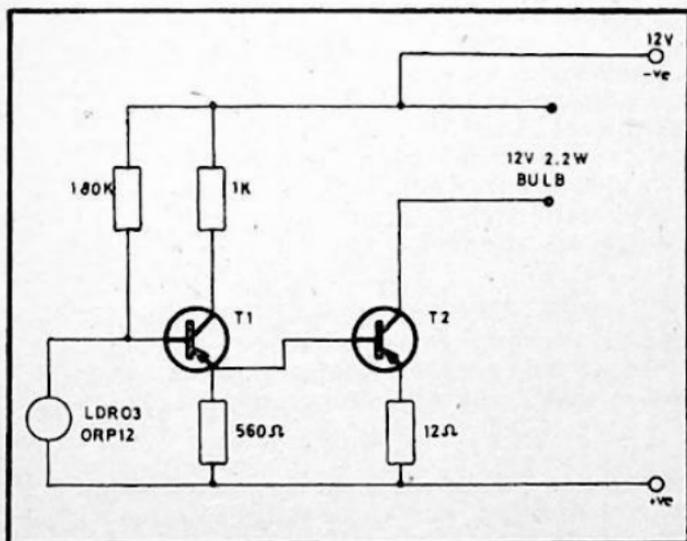
These are intended to remind a driver that he has left his indicator flashers on after turning. A good loud signal is given by the loudspeaker fitted to the unit until the traffic indicator is returned to its central position.

The transformer shown to feed the loudspeaker may be an Eagle type sub-miniature transistor output transformer. Circuit A is for use with 12V positive earth systems and Circuit B for 12V negative earth systems.

### THE 'SUNDOWN' AUTOMATIC PARKING LIGHT

The 'Sundown' automatic parking light will switch on a parking light as soon as dusk falls and in the morning when day light commences it will switch the same lamp off.

T1 and T2 may be AC128-AC153-AC180-AC193. All the resistors are 1 Watt type to allow for safety and the light dependant resistor type LDR03 or ORP12 may also be substituted by a RPY25



THE 'SUNDOWN' AUTOMATIC PARKING LIGHT

## CAR VOLTMETER

### A MOST VERSATILE DIAGNOSTIC INDICATOR FOR POSSIBLE ELECTRICAL TROUBLES ON YOUR CAR.

Readers may be wondering why they should need a meter to tell them the voltage of a battery which is nominally fixed at 12 or 6 volts, whichever the case may be.

The fact is that a vehicle's battery voltage will vary quite widely over a range centred around 12 (or 6) volts and an instrument which can show these fluctuations at a glance will reveal quite a lot about the state of the battery and the rest of the electrical system.

To be of any real value, an auto voltmeter must be accurate to within a small fraction of a volt and easily readable - requirements which immediately prejudice its chances of being selected as an item of standard equipment in production cars.

A voltmeter needs to be a much more refined - and costly - instrument than the average auto ammeter, in which the pointer does little more than deviate from centre, one way or the other, along a sparsely calibrated scale. Yet even the ammeter has been displaced in most vehicles by a simple "no charge" warning light.

Bound up with the question, of course, is the matter of comprehension by the driver. A light which should go out calls for a minimum of mental effort; an ammeter which should read this way or that is rather more mysterious; a voltmeter which calls for definite interpretation presents much larger problem for the uninitiated.

The batteries are constituted from a number of "cells", each of which consists, in turn, of a number of "plates" made from a porous lead composition. The cells are filled with a mixture of sulphuric acid and distilled water which is known as the "electrolyte". The specific gravity of water is 1.0 and of sulphuric acid 1.84 and the two are mixed in the proportions of approximately  $2\frac{1}{4}$  parts water to one part sulphuric acid to produce a normal specific gravity of 1.260 at 77 deg. F.

In a fully charged battery the positive plate consists predominantly of lead peroxide, a chocolate-brown coloured substance. The negative plate is of porous lead and light grey in appearance. At this stage, the acid is of normal strength, with a specific gravity of 1.26, as previously quoted.

As the battery is discharged, decomposition of the electrolyte takes place until, when fully discharged, each of the plates acquires a liberal coating of lead sulphate. During this process the concentration of the acid electrolyte decreases and the specific gravity is a fairly

METER READING 6 - Volt System	ENGINE STOPPED OR IDLING	ENGINE TURNING OVER ON STARTER	ENGINE NORMAL RUNNING (At least twice idling speed)
Below 4.5 volts	Battery "flat". Meter leads or fuse open circuited. Meter reverse connected.	Meter defective, disconnected or improperly wired. If the engine will start and/or run, the battery voltage could scarcely be this low.	
4.5 - 5.9 volts	Battery undercharged or extremely cold. Motor will turn sluggishly and might not start.	Normal range for winter to summer starting.	Generator not charging or voltage regulator faulty. Alternatively, current drain of vehicle's electrical equipment (lights, radio, etc.) exceeds generator output.
5.9 - 6.4 volts	Battery charged. Varies with temperature, type of battery and degree of charge	Meter defective. Voltage could not be this high, if starter is actually turning motor over.	Battery fully charged but generator not working or voltage regulator set too low.
6.4 - 7.5 volts	This high reading is normal for a short period after driving due to battery 'surface charge'. If motor has been stopped for some time, however, the meter is defective and reading high	As above	Normal range for properly functioning generator and regulator. Exact reading varies with battery charge, engine speed, temperature and regulator setting.
Above 7.5 volts	Reading too high for surface charge. Meter is probably defective.	As above	Voltage regulator set too high or contacts sticking. Battery fluid level excessively low.

"DIAGNOSIS BY VOLTMETER"

accurate measure of the state of charge. The specific gravity of the electrolyte in a discharged battery is approximately 1.170.

Although sulphate formation is a perfectly normal part of the discharge cycle, its presence always constitutes a risk. Sulphate has a tendency to harden over a period of time, making it difficult or even impossible for it to return to the electrolyte when we reverse the cycle (charge the battery).

Thus, the further the battery is discharged, the greater is the risk that some of the sulphate will harden if the battery is not immediately recharged. Also, for purely chemical reasons, there is a pronounced tendency for the sulphate to crystallise when the specific gravity falls below a certain figure, representing excessive discharge. Ideally, therefore, a battery should be kept in a fully charged condition as far as possible, fully recharged immediately after discharge, and never excessively discharged.

One method of keeping "tab" on the condition of a battery is to use a device known as a hydrometer, which directly measures the specific gravity of the electrolyte. Unfortunately, however, a hydrometer is a messy thing to use and its readings are subject to some interpretation, because specific gravity will vary with temperature and the different design parameters used by individual battery manufacturers.

We would venture to say that of those motorists who actually possess hydrometers, very few would make regular use of them to check the condition of the battery.

Quite apart from the specific gravity of the electrolyte, it can be shown that the open circuit voltage is a measure of the state of charge, a fully charged cell measuring about 2.1 volts and a discharged one about 1.75 volts. In fact, it is possible to establish a relationship between open circuit voltage and the specific gravity of the electrolyte.

Thus, an accurate voltmeter may be used as a measure of battery charge and, in fact, a device known as an "electric hydrometer" is now standard equipment in most well-equipped service stations.

This device is nothing more than an expanded scale voltmeter which is designed to be connected across a single battery cell, reading directly the cell voltage and, on an adjacent scale, the equivalent specific gravity figure.

The table "Diagnosis by Voltmeter" gives typical readings relating to normal driving conditions. The markings on the meter face, as suggested, summarise this information. A little experience will then enable the individual driver to interpret his own readings when he fits a Voltmeter of this type to his car.

Voltmeters reading 0 - 16 volts are obtainable from good electronic and car accessory dealers.

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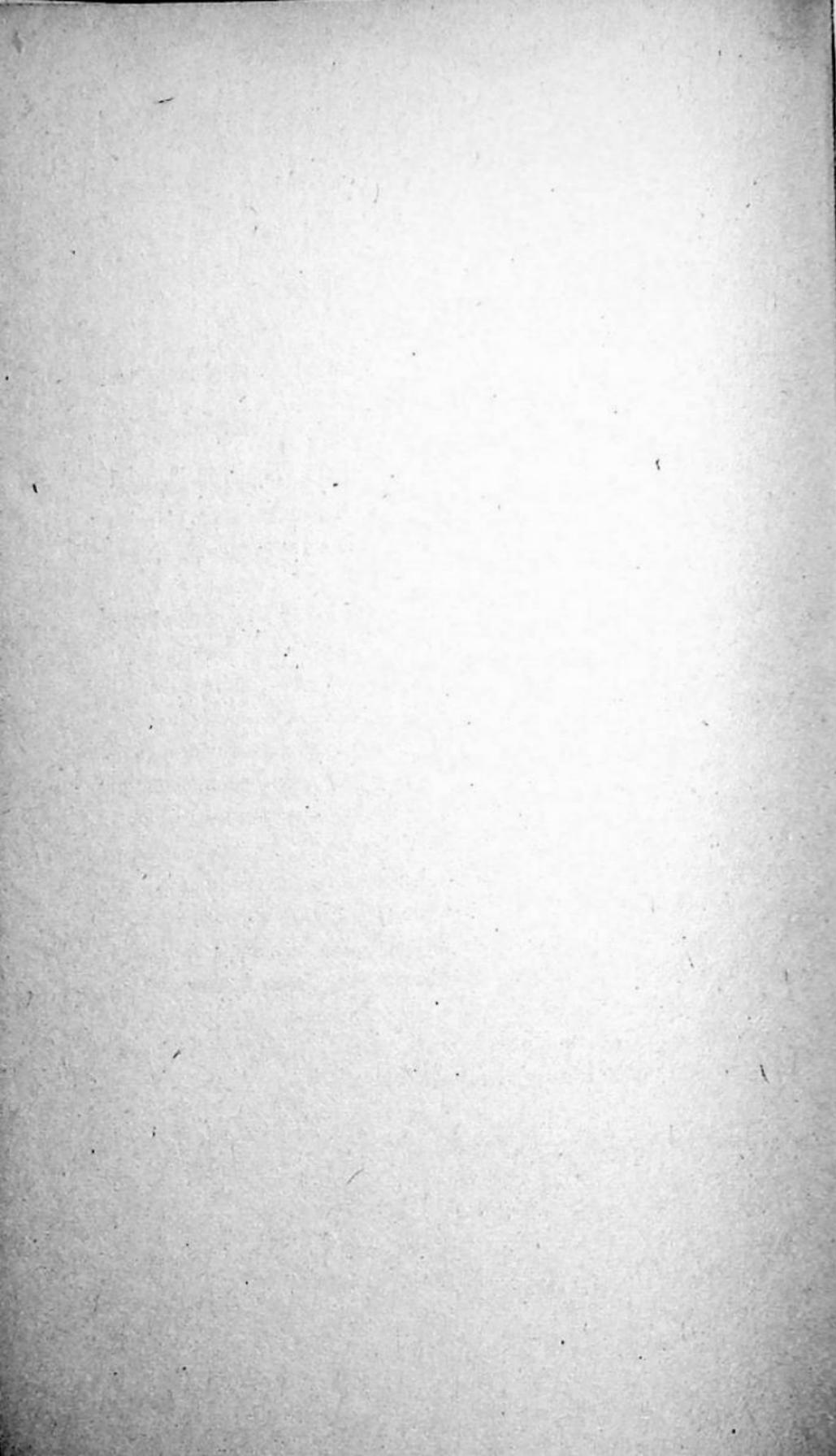
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