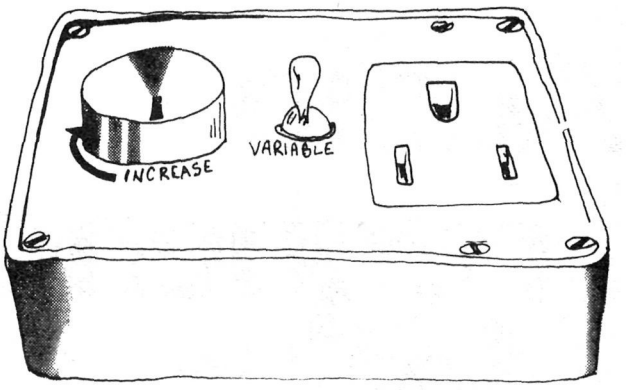
Drill Speed Controller



Variable speed control maintains constant (adjustable) speed regardless of load.

MOST HANDYMEN own a power drill.

There are tens of millions of them in use around the world — and they continue to be used for an ever greater variety of tasks.

Despite their popularity, many power drills have one major drawback and this is that their speed is often too high for many applications.

This is so even with dual-speed models where even the slow speed, typically 300-750 RPM, is too fast for such jobs as drilling masonry or using fly-cutters on sheet metal etc.

The speed controller described here allows infinite variation of speeds from zero to about 75% of full speed, and is provided with a switch to allow normal full-speed operation without disconnecting the drill from the controller. The controller has built in compensation to maintain substantially constant speed regardless of changes in load.

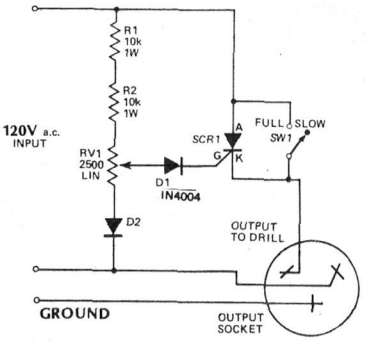
CONSTRUCTION

It must be emphasized that the controller is connected directly to the lines without the use of an isolating transformer. Care must therefore be taken with the construction to ensure that there is no likelihood of any dangerous conditions arising.

The SCR used is a stud mounting type and is mounted by using the solder lug, supplied with it, soldered onto the centre lug of the switch. For loads up to 3 amps no other heat-sinking is required. If a plastic-pack SCR is used a hole may be drilled through the switch lug and the SCR bolted directly to it. However in this case it is advisable to insert a piece of aluminum (about 25 mm x 15 mm) between the SCR and switch lug to act as a heatsink.

Remember that, since the unit operates at 120 Vac all external parts must be grounded. We used a plastic box with a metal lid. But we also used a cable clamp with a metal screw through the side of the plastic box. This screw must be grounded, along with the lid and the ground terminal of the output socket. The ground wire should be continuous that is, it should go from one ground point through to the next and not be separate links. Two ground wires may be soldered to one ground lug. But under no account should two wires be secured under a single screw.

With some SCRs it may be found that the trigger current supplied by R1 and R2 is insufficient. If this is the case an additional 10 k resistor should be placed in parallel with each resistor.



USING THE CONTROLLER

Plug the controller into the wall and the drill into the controller. Select either full speed or variable as required. Note that there is no ON/OFF switch provided on the unit and the normal switch on the drill is used for this purpose. When full speed is selected the drill will run normally and the speed control on the controller will have no effect.

At very low speeds it may be found that drill runs jerkily under no load.

When variable speed is selected, the control will adjust the speed anywhere between zero and about 75% of full speed. There may be a dead zone at both low speed and high speed ends of the control. This is entirely normal and is due to different drill characteristics and component tolerances within the controller.

However as load is applied the speed will smooth out.

When using the drill at less than full speed the cooling of the motor will be considerably reduced (as the cooling fan is on the armature shaft and also runs slower). Hence the drill will get hotter when used at low speeds, and extended periods of use in this mode should be avoided. **O**

HOW IT WORKS

A universal motor, when running, produces a voltage which opposes the supply. This voltage, called the back EMF, is proportional to the speed of the motor. The SCR drill speed controller makes use of this effect to provide a certain amount of speed versus-load compensation.

This controller uses an SCR (silicon controlled rectifier) to gate half-wave power to the drill motor. The SCR will conduct only when a) anode (terminal A) is positive with respect to the cathode (terminal K), b) when the gate (terminal G) is at least 0.6 volts positive with respect to the cathode, and, c) when about 10 mA gate terminal. By controlling the level of the voltage waveform to the gate we effectively control the time at which the SCR turns on in each forward half cycle. By this means we effectively control the amount of power delivered to the drill.

Resistor R1, R2 and potentiometer RV1 form a voltage divider which provides a half wave voltage of adjustable amplitude to the gate of the SCR. If the motor is stationary the cathode of the SCR will be at zero volts and the SCR will turn on almost fully. As the drill speed increases, a voltage develops across the drill thus reducing the effective gate-cathode voltage. Thus as the motor speeds up, the power delivered decreases until the motor stabilizes at a speed determined by the setting of RV1.

Should a load be placed on the drill, the drill will tend to slow down, but as the voltage across the drill also drops, more power is delivered to the motor since the SCR firing-time is automatically advanced. Hence the speed, once set, is maintained relatively-constant regardless of load.

Diode D2 is used to halve the power dissipated in R1, R2 and RV1 by limiting the current through them to positive half-cycles only. Diode D1 protects the SCR gate against excessive reverse voltage.

In the full speed position the SCR is simply shorted out by SW1. Thus RV1 loses control and full power is applied to the drill.