Elementary Electronics

Your electromagnet - putting it to work

A relay is an electromagnetic remote control switch. A buzzer is an electromagnetic noise generator. Both are easy to make from the electromagnet we described last month.

by Ross Tester

A relay and a buzzer are very similar in theory of operation and can be built from nearly identical parts. The major difference is in how the circuit is wired. We describe here a simple device that can be used for both purposes.

All you will need to make this project is your electromagnet, a few scrap pieces of aluminium, two spring terminals, a piece of wood to use as a base board, an old (but not rusty) hacksaw blade, six small wood screws and four nuts and bolts — two ⅛in and two 3/16in. You should have some wire already attached to your electromagnet. (If you don't have a ⅛in Whitworth tap, you will need an extra two ⅛in nuts. We will explain this later.)

Start by drilling and cutting out the four pieces of aluminium from the patterns given. The holes and slots are best drilled before you cut out the pieces — it is much easier to hold a larger piece of aluminium! Where slots are shown, simply drill two or three holes close together and form them into a slot using a fine file.

Next, make some holes in the base board for the woodscrews, using the pattern shown. You can do this with a small drill, or by hammering in a small nail and removing it.

The holes in the vertical sections of the "U" bracket may be ordinary ⅛in, or preferably, tapped ⅛in Whit. If the hole is tapped, only one fastening nut is necessary, but if it is not, two nuts, one each side of the bracket, will be required to hold the contact screw steady.

The screws mentioned in the last paragraph should be pointed. This may be done by first winding a nut on to the screw, then filing the end to a point with a fine file. Once the point has been made, the nut can be wound off to rethread the screw.

The reason for pointing the screw is that we want to make good electrical contact between the screw and the blade and a point has a much better chance of making contact than a flat end. You will have to polish the blade as well, at the point where the screw makes contact. We use a piece of hacksaw blade rather than an ordinary piece of steel, because the "armature" (which the blade becomes) relies on a springing action for its operation.

If you use the end of a hacksaw blade there will be one 3/16in dia hole already drilled in it. If not, you will have to drill two holes. Use the holes in the largest bracket as a guide for drilling the holes in the blade. The holes should match up exactly, as mechanical rigidity at this end is important if the buzzer is to operate correctly. Both these holes should be 3/16in dia.

After you drill the holes, you can snap the required length of blade off. It is easiest to fasten the required length into a vyce, and then snap the blade by bending it close to the jaws of the vyce. You need approximately three and a half inches of blade. Do not worry if it is slightly more than this, but don't use less. Sufficient blade movement may not be realised if you do. Once cut, the blade (or armature) may be screwed to its mounting bracket.

All brackets may now be screwed to the base board. The screws holding the armature bracket are not completely tightened, to allow it to be moved around to get the optimum position for operation.

Attach the spring terminals in the positions shown. You can screw the terminals directly into the wood by making holes for them slightly smaller than the screwthread, and screwing them in under pressure. Although the thread is not intended to be used as a woodscrew, it works quite satisfactorily.

Place the electromagnet in its mounting brackets, and tighten it with the nut on the "head" end. There should be a short length (approx 1/16in) protruding at the shaft end.

Figure 1. Electromagnet connected for use as a relay. The circuit which lights the lamp is separate from the one which operates the electromagnet — except that in this case we have used the same battery to energise both circuits.

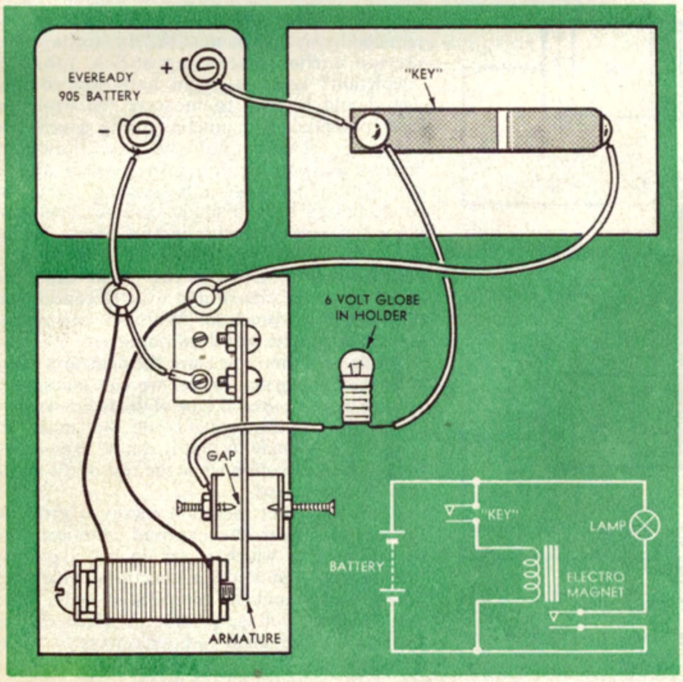
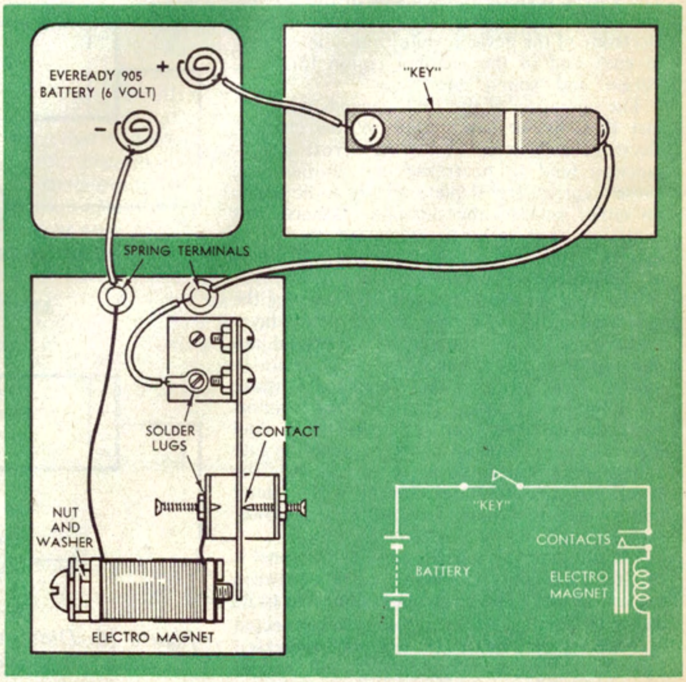


Figure 2. Electromagnet connected for use as a buzzer. Wired in this way the electromagnet turns itself on and off hundreds of times per second, thus producing an audible tone.



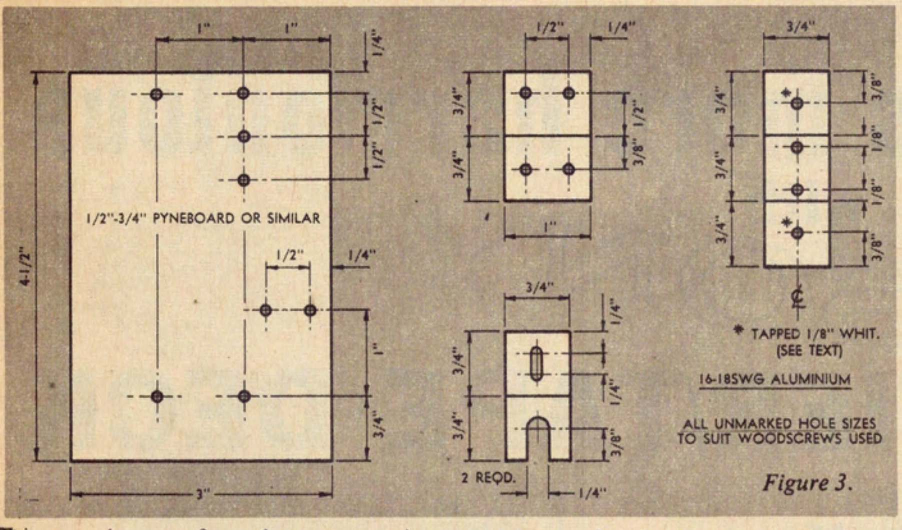


Figure 3.

This may be seen from the accompanying drawings. The flat of the hacksaw blade should be another 1/32in away from the end of the bolt. Once you have all the pieces in the correct position, tighten up all screws.

Now take the two pointed contacts, and insert nuts all the way on to them. Place a solder lug under one of them, and put them into the holes in the "U" bracket. If you do not have tapped holes, put another nut on the contact to hold it in position. Screw the outer contact into the hole until it just touches the blade when it is at rest. Hold the contact in this position, and tighten the nut(s) hard against the bracket. Repeat for the other contact, but this time hold the blade against the electromagnet, and adjust the screw until it just touches the blade in this position. Then tighten the nut(s).

Now all you have to do is wire the components together, and this will depend on whether you want to make a relay or a buzzer — or both!

The relay is probably the most simple, so we will explain it first. By wiring the electromagnet directly into a source of current (a battery), the coil is energised and the bolt becomes a magnet. This attracts any ferromagnetic material in close proximity — in this case, the blade. By making the blade part of another circuit, we can control the other circuit without actually touching any of the components in it.

In practice, a relay is usually used for the control of a high voltage or high current circuit by means of a low power circuit. In an automobile, for example, horns and starters are operated by relays to avoid having to route heavy wiring carrying high current to the inside of the car.

To make the relay work, you must loosen the outside nut and remove the screw far enough to make sure that it will not touch the blade in any way. Then connect the circuit up as shown in figure 1. When you are sure that everything is correct, connect the battery.

If the circuit is correct, the lamp should be out. If it is on, check to see that the screw you just loosened is not touching the blade. If this is not the case, something is wrong with your wiring.

When you get it operating correctly, examine the circuit diagram and note that the circuit which lights the lamp is completely separate from the electromagnet circuit except for the battery connections. We use the same battery for convenience, but the lamp could be connected to another battery of a different voltage or to another power source without affecting the operation of the electromagnet-and-key circuit.

Now we will show how the electromagnet can be used as a buzzer. All you need do is replace the screw you loosened before, and loosen the other screw you were using as the relay contact. Connect the circuit as shown in figure 2. It will help if you have some kind of key between the battery and the coil. Besides saving the battery, you will be able to experiment with Morse code. If you haven't got a proper key, you can fashion one from tinplate by following the simple diagram in figure 4.

However, we must point out that using such a key will certainly be detrimental if you seriously try to learn Morse code. A proper hand action must be developed, and this can only be learnt by much practice, on a proper key. Good keys are available quite reasonably from disposals sources. Such a key is a "must" if you are to develop good Morse technique.

First, let's see how a buzzer works. As in the relay, the electromagnet is operated by connecting it to a battery via a switch. When the switch is turned on, current flows through

(Continued on Page 141)

WARNING: On no account should this simple relay be used to control anything other than a few volts from a battery. DO NOT attempt to use this as a control for mains voltage. Stick to batteries — they are much safer.

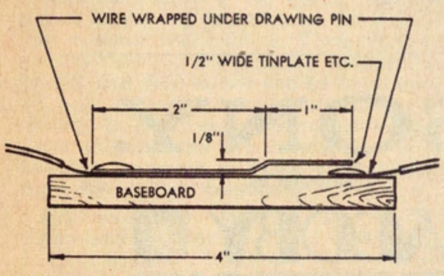


Figure 4. A simple key for experimenting with Morse code can be made from a strip of tinplate and two drawing pins as shown above.

SIMPLE BUZZER . . . from page 89

the armature and contact, through the electromagnet, and back to the battery.

Suppose, however, that at the instant we turned the electromagnet on, contact was broken. Current would stop flowing, the bolt would no longer be magnetised, and the armature would immediately spring back to its rest position.

This is exactly what happens with the buzzer — the armature breaks contact with the contact screw, current stops, and the armature springs back. But when it springs back, it makes contact, and once more is attracted towards the bolt. Contact is broken, and the armature springs back. This process is repeated hundreds of times per second, and this movement, pushing against air in its way, produces the audible "buzz".

Once set up, briefly touch the key. A "buzz", naturally enough, will indicate that the buzzer is working properly. However, it is more than likely that it will not work first time. There are two things which will probably require adjustment. One is the set screw for the contact, and the other is the distance of the blade from the bolt. First of all adjust the screw with a screwdriver, holding the nut(s) with a pair of pliers.

If this doesn't work, then try moving the blade closer to the bolt. If none of these work, try adding another battery in series with the other(s). If this doesn't work, then there is probably something wrong in your wiring.

Our buzzer worked quite satisfactorily down to four and a half volts (three cells in series), but was much better on a single six-volt lantern-type battery (Eveready type No 509). It may be necessary to go as high as seven and a half volts, or even nine, but this is unlikely.

One final point we might raise about this buzzer. You may notice, particularly if you have moist fingers, that the buzzer gives you a tingle when you touch certain parts of the wiring. We can already hear the questions: Where does this tingle come from? Is it dangerous? What is the voltage and current?

We can assure you that it is not dangerous. The current flow would be in the order of one to 10 milliamps, and the amount of current at which danger starts is over 10 milliamps, according to electricity supply authorities.

The tingle you feel comes from the coil, or more precisely, from the collapsing magnetic field and the coil. What happens, briefly, is this: When the contacts break, current from the battery stops, and for an instant of time there is no current flow, but there is still a magnetic field around the core. Then this field rapidly dies away. When this happens, we have a changing magnetic field cutting across the coil of wire.

This changing field cutting across a coil "induces" an emf (electro-motive force) into the coil. Believe it or not, this emf can be well over 200 volts. In our buzzer, for example, we know that it was well over 120 volts. How did we know?

An easy but novel way to determine the order of magnitude of the voltage is to use miniature neon bulbs. (We understand that one of our advertisers, Circuit Components A/asia P/L, 460 Bexley Rd, Bexley, NSW, have neons available for 30 cents each plus 25 cents packaging and posting.)

Connect the neon in series with a 1000 ohm resistor, and connect it across the buzzer, that is, between the armature bracket and the contact bracket.

Press the buzzer key, and note what happens to the neon. It should be glowing brightly. As it takes at least 60-70 volts to turn the neon on, we can reasonably assume that the emf induced is at least 60 volts. More neons connected in series would also light up, until the number of neons multiplied by roughly 60-70 exceeded the emf induced. Our buzzer lit two neons, but not three.