DRY REED SWITCHES

by B. H. BAILY

FEW simple electro-mechanical devices lend themselves to such versatile applications as the dry-reed switch. Simple in principle and construction as the device is, it seems incredible that it was not developed until fairly recently.

FERROUS SPRINGS

The simplest form of dry-reed switch consists of a pair of ferrous spring contacts sealed into a short glass tube containing an inert gas. The contact ends inside the tube slightly overlap, but are positioned so as to be "normally open".

If a magnetic field of suitable strength is created in the vicinity of the sealed contacts, they become magnetised so that they attract one another. This attraction causes the contacts to close and complete the electrical circuit into which they may be connected. The circuit remains closed until the magnetic field is weakened or removed, when the contacts quickly lose their magnetism, and spring apart.

There are, of course, other variations on the simple version, but the purpose of this article is to provide "food for thought" as to the tremendous scope offered by the simplest, cheapest version of this reliable switch. Just a few of the tremendous number of possible applications are listed later. Let us first consider some of the possible circuit configurations.

SIMPLE SWITCH

Fig. 1 shows a switch operated by the field of a simple bar-magnet. The switch contacts close when the magnet is brought sufficiently close to the switch, and open when the magnet is moved away. The magnet in this case has to be fairly strong.

In Fig. 2 the magnet is replaced by a coil of wire wound around the glass envelope of the switch. This may be done by constructing a bobbin to slip over the switch, or, for up to about 300 turns, it may be hand-wound directly onto a layer of insulating tape over the glass. The normally-open contacts are closed by the passage of direct-current through the winding. Current may be passed in either direction to operate the contacts, but d.c. must be used or the contacts, which respond very quickly to current change, will chatter on frequencies as low as about 50c/s. The number of turns and wire gauge must suit the voltage and current capacity of the operating source, and the total ampère-turns must be sufficient to close the contacts.

NORMALLY CLOSED VERSION

The above examples are of normally open contact types. The same type of dry-reed switch can, however, be used to provide the opposite effect, i.e. a normally closed circuit. Fig. 3 shows such an arrangement, in which a strong magnet is permanently fixed close to the switch, so that its field causes the contacts to be firmly held together. The contacts may then be made to separate by neutralising the field of this magnet either by bringing another magnet of opposite polarity close to the fixed magnet and switch, or by energising a coil wound around the switch and fixed magnet by a direct current, polarised such that its magnetic field neutralises that of the fixed magnet. In the absence of either of these influences or if they were of the wrong polarity, the contacts will again close.

So far, we have dealt with configurations in which the switch contacts are self-restoring; that is, they change back to their normal position as soon as the influence of the externally applied "signal" is removed. The following examples, however, are bistable. Once the contacts are made to close (or open) the new state is maintained automatically, even after the operating "signal" is removed.

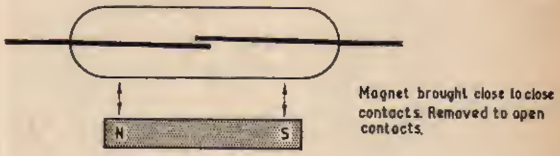

Fig. 1. Normally open switch, mechanical operation

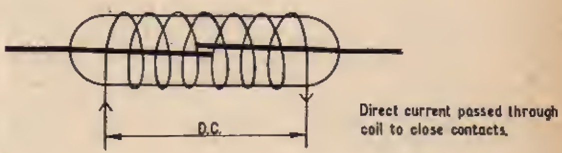

Fig. 2. Normally open switch, electrical operation

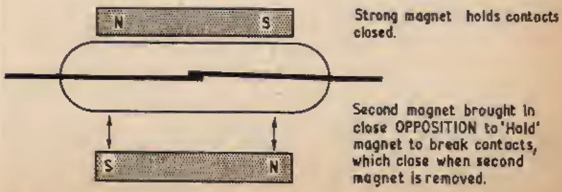

Fig. 3. Normally closed switch, mechanical operation

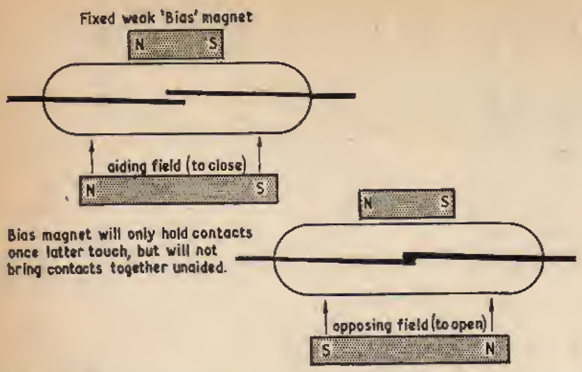

Fig. 4. Bistable or two state switch ("toggle") in which the state is changed by momentary influence of aiding or opposing field of second strong magnet

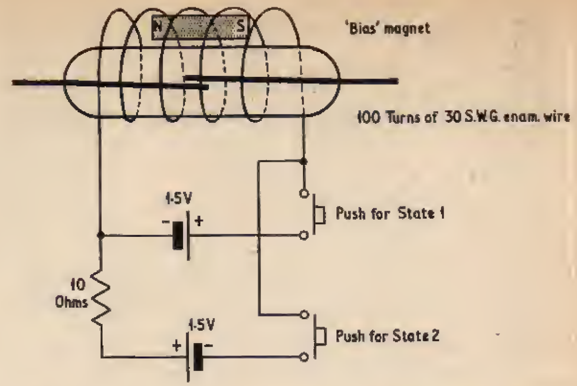

Fig. 5. Electrically operated bistable switch using a two-battery supply

BISTABLE: MECHANICAL CONTROL

Fig. 4 shows one method of producing a "toggle" action, that is, a magnetic bistable switch. A small "bias" magnet is fixed close to the glass envelope of the switch. This magnet produces a magnetic field which, whilst being too weak to cause the contacts to come together unaided, is sufficiently strong to ensure that, once they have been brought together by some external influence, there is sufficient magnetic field strength to keep the contacts together.

If another magnet of correct polarity is now brought near the switch, the "bias" field is strengthened by the lines of force from the second field. Hence, the contacts experience sufficient field strength to cause them to close.

In this instance, the second magnet must be positioned such that its north pole and south pole align with the north and south poles of the bias magnet, respectively. Once the contacts are closed, the second magnet may be removed, and the contacts will remain closed. If, however, the second magnet is now reversed, and again brought close, its reversed field will oppose that of the bias magnet, and the contacts will again separate due to the weakened field. Again, the contacts will not close if the magnet is once more removed, but only if it is brought near, in aiding polarity.

BISTABLE: ELECTRICAL CONTROL

Fig. 5 shows an electrically operated version of the bistable or "toggle" of Fig. 4. The movable magnet is replaced by a coil wound over the bias magnet and switch assembly. A pulse of current through the coil in one direction will close the contacts, whilst a pulse in the opposite direction will open them. Since only a short pulse of current is required to change the bistable from one state to the other, the switching can be performed quite well by using push-button switches.

This results in extremely long battery life, because current is drawn only during the brief changeover period, when one or other of the switches is pushed.

The 10 ohm resistor is included to protect the batteries from accidental surge should both buttons be pressed simultaneously! Even "Pen-Lite" cells can be usefully employed in such a circuit, since they will give good service when called upon to deliver short pulses intermittently, and they are easily accommodated in a small remote control box.

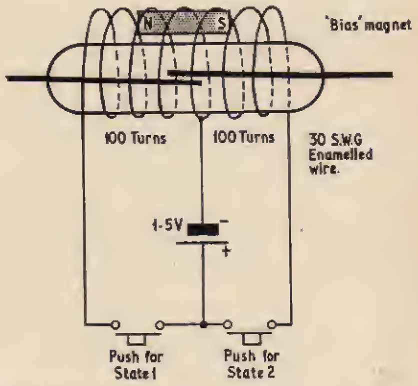

Fig. 6. Single battery bistable switch

Fig. 6 shows a single-battery version of Fig. 5. For this, the winding around the switch is doubled, and the centre-tap brought out as a third connection. Energising one half of the coil will operate the contact, whilst energising the other half will separate them.

SUGGESTED APPLICATIONS

The following are just a few ideas to start the experimenter thinking:

Fig. 1. Door lock controlled by electromagnet. Dry-reed switch could be embedded in a wall or door post, and magnetic "key" used to unlock door. Revolution counter transmitter (magnet rotates).

Figs. 2 & 3. Limit switch: the magnet would be mounted on a motorised door. Door operated cupboard light switch: magnet on door.

Fig. 4. Model train points control. Switch can be mounted on the track with the bias magnet. The operating magnet is carried under the train. Two units are mounted at the approach to and beyond the points to ensure that the points change as required. Limit switch for controlling motorised door action, by triggering contactors.

Figs. 5 & 6. Any application requiring a bistable circuit where no "standing" current for hold-in can be tolerated. Particularly suitable for battery powered remote control of television, lights, radio, or other household appliance.

WINDING NOTES

The coils may be wound by hand directly onto the glass envelope of the dry-reed switch if preferred. Where a fixed magnet is used, i.e. in Figs. 3 to 6, the magnet may be taped onto the glass and the coil wound directly on the whole assembly.

When winding centre-tapped coils, wind the first half, then make a loop in the wire, about 3 inches across, flatten and twist it into a double wire connection for the centre-tap, and continue winding in the same direction until the second half is complete.

MODEL RAILWAY IDEAS

An interesting additional feature of the mechanically operated bistable of Fig. 4 is illustrated in Fig. 7, in which the switch operation is sensitive to the direction in which a passing magnet is travelling. The small bias magnet is again placed close to the reed switch, and the whole assembly is mounted on or near the train track. The operating magnet is mounted vertically on the train, so that the lower pole passes close to the switch assembly as the train passes.

Now, if the train passes in a direction such that the active (lower) operating pole is the same polarity as the second pole of the bias magnet to be passed, the switch will be left in its closed state. If the train passes in the opposite direction, the latter pole of the bias magnet to be influenced will be opposite in polarity to the operating pole, and its field will be momentarily weakened, causing the switch to change and remain in its open state. The train can thus be made to work signals, points, crossing gates, and lights.

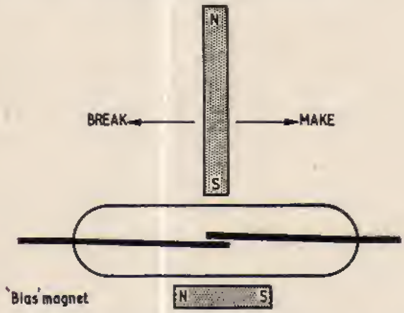

Fig. 7. Method of using a dry reed switch for switching signals on a model railway system

When two trains are used, one may be fitted with an operating magnet with, say, the north pole down, whilst the second train has a south pole pointing downwards. The state to which the switch will now set will depend on which train passes it, and the direction in which this train was moving. For a given direction, one train will produce the opposite effect to the other.

By using more than one switch, one train could be made to divert automatically to a different route from the other train; e.g. a goods train could be made to bypass a passenger platform whilst the passenger train would take an alternative route and perhaps stop at the station.

When mounting the biased reed assemblies, care must be taken not to fix them too close to any magnetic objects. This is particularly applicable to model railway track. Test the rails first with a magnet and if they are attracted, mount the assembly at least ½in away. Similar precautions must be taken when mounting the operating magnet; brass clamps or glue should be used to secure them. ★