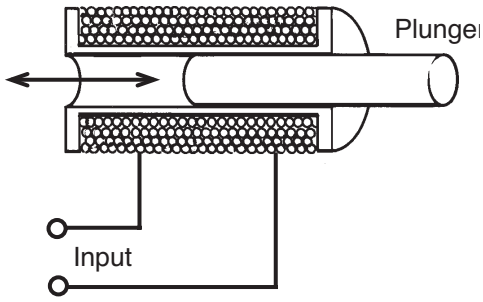
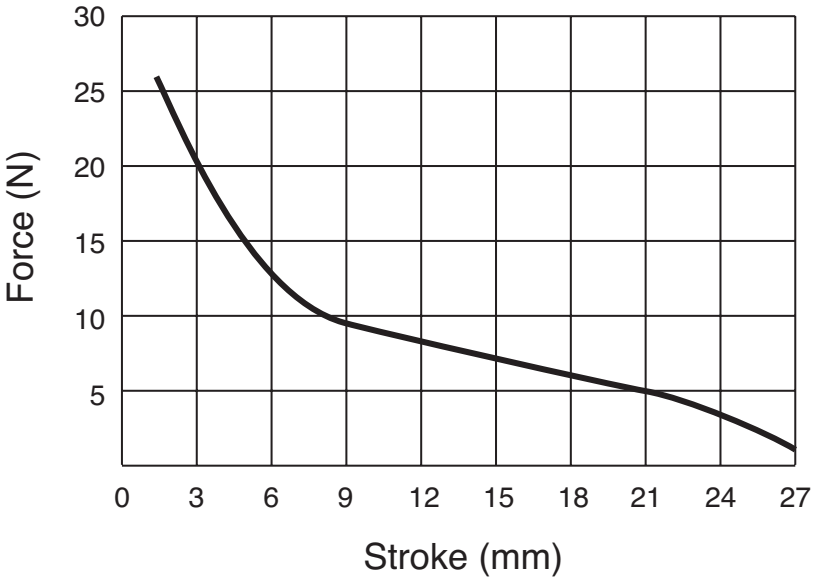
STUDY FILE 3 - SOLENOIDS

A *linear solenoid* (the most common type) consists of a soft iron plunger within a coil wound on a plastic bobbin. When current is passed through the coil, the resulting magnetic field pulls the plunger into the coil with a considerable pulling force.

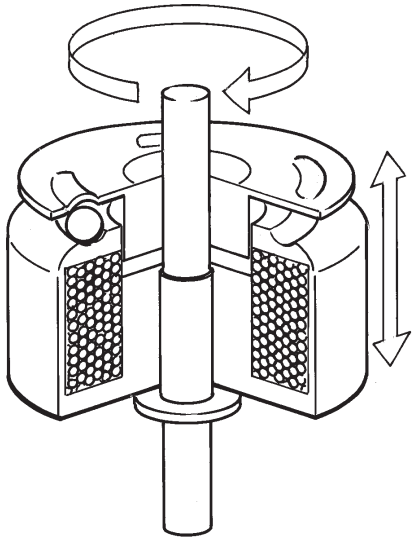


These devices are relatively cheap and very simple; however, the usable stroke of a linear solenoid is quite limited and the force exerted varies according to the position of the plunger within the coil. When the plunger is at its extreme outside the solenoid, the pulling force is relatively weak; as it moves towards the centre it increases. This is shown clearly in a graph of force against stroke distance.



Various mechanisms are used to increase the stroke length of a solenoid; the simplest of these is a lever.

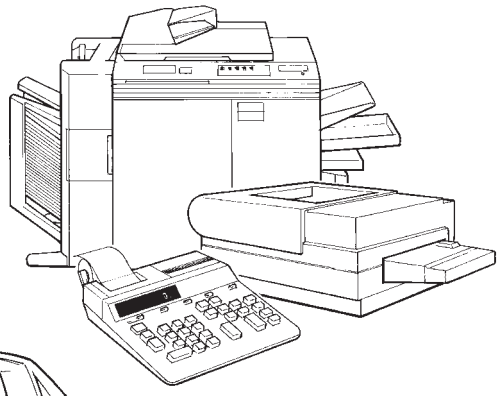
In a rotary solenoid, a spindle turns through a specific angle - e.g. 45' - when the solenoid is energised. This type of solenoid has a plunger and *armature plate*. The plate is separated from the solenoid case by three ball bearings each of which runs in a small inclined plane. When the plunger is pulled into the solenoid coil, it also turns as the ball bearings run down the inclined planes.

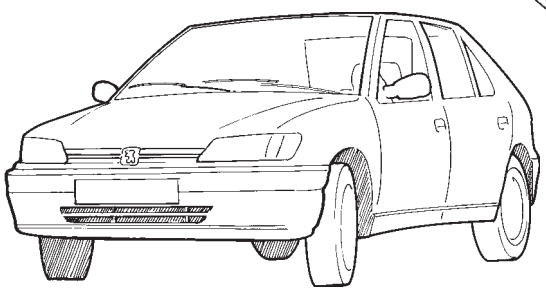


Applications of solenoids

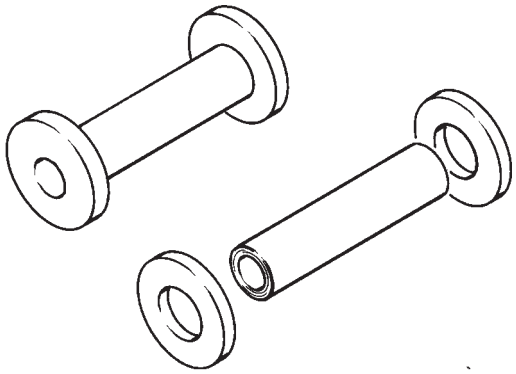
Solenoids are used in so many different products, it would take a large book to list the main applications ! A few examples are given below:

Vending machine
Coin operated ticket machine
Cash register
Toaster
Car
Photocopier
Door lock
Automatic soap dispenser
Photo kiosk
Juke box



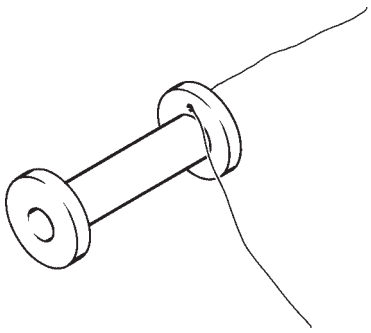


Constructing a solenoid
It is very straightforward to construct a solenoid providing that care is taken not to break the fine copper wire needed for the coil. A suitable bobbin can be made from a plastic, such as nylon, turned on the lathe or even from paper - using the TEP "roll-tube" technique. If a paper tube is made, end caps have to be fitted to keep the wire in position. The most important feature of the bobbin is the wall thickness of the tube; this must be as thin as possible. Mild steel can be used for the plunger and is easily machined for mechanical connection.

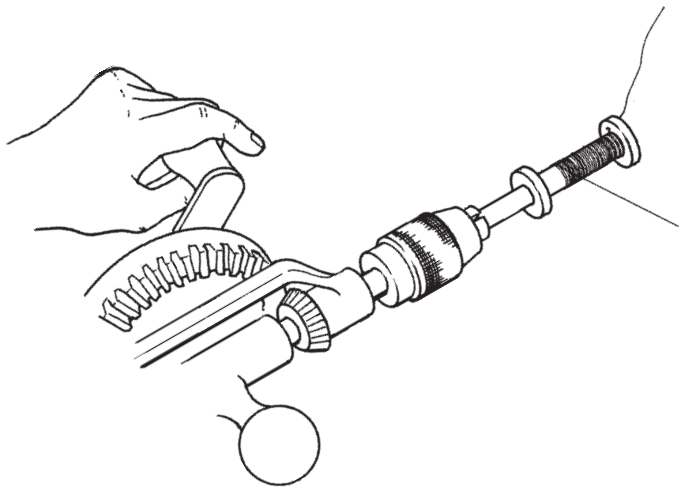


For a typical miniature solenoid, the bobbin can be wound with 00 gauge lacquer-insulated copper wire. The overall length used will determine the pulling force of the solenoid and the electrical resistance of the coil. The resistance should be as high as possible if a battery is used to energise the solenoid. The following steps are a guide to construction:

Step 1
Solder a flying lead to the end of the copper winding and pass this through a drilled hole at the end of the bobbin - leaving sufficient inside the bobbin for mechanical anchorage.



Step 2
Wind the coil neatly backwards and forwards on the bobbin. A hand drill offers a very convenient method of doing this.



Step 3
Solder the end of the winding to a second flying lead and pass this through a drilled hole in the end of the bobbin. Test for coil continuity before finally covering the whole winding with adhesive tape.