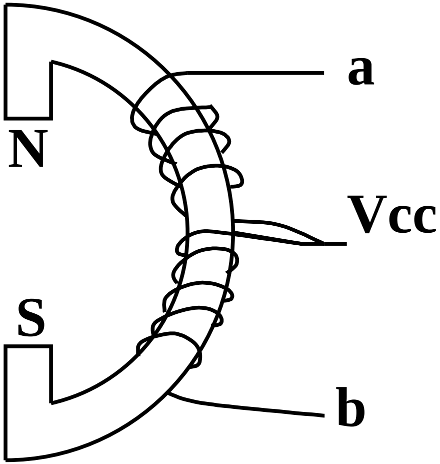
Stepper Motors

- Stepper motors move in discrete steps. Hence the name.
- It is very easy to control these using microcontrollers because stepping is controlled by switching events.
- Amount of movement is easy to track by simply counting the number of steps.
- Speed can be controlled by varying the wait time between steps.

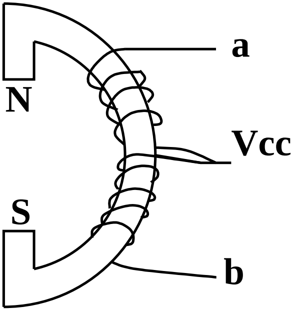
Magnetic poles in a stepper motor



- The motor has electromagents whose magnetization direction can be reversed.
- In the given figure, If the center tap is connected to Vcc and the end 'a' is grounded, (with 'b' open or connected to Vcc), one direction of magnetization will result.
- If we ground 'b' instead, (keeping 'a' open or connected to Vcc), the opposite direction of magnetization will be produced.

There are other ways of reversing magnetization in the pole piece.

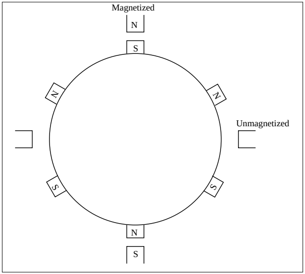
Magnetic poles in a stepper motor



- By using an H bridge, the center tap can be kept open.
- Now one direction of magnetization can be created connecting ‘a’ to ‘High’ and ‘b’ to Low.
- The direction of magnetization can be reversed by connecting ‘b’ to ‘High’ and ‘a’ to low.

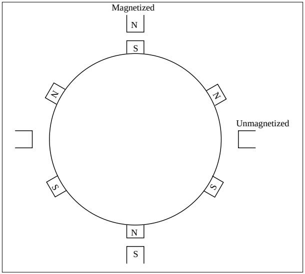
This is the way we are going to use the stepper motor in our lab.

Stepper Motor Construction



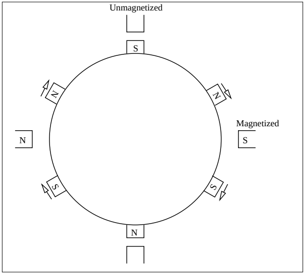
- The stepper motor has electromagnets for stators.
- Only two electromagnets are shown here, a vertical one and a horizontal one.
- In real motors, there are a large number of such poles.
- The rotor contains permanent magnets.
- The number of rotor magnets is 1 larger than the stator magnets.

Stepper Motor operation



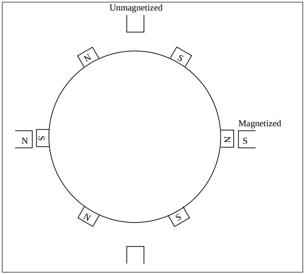
- We start with the case when the vertical stator magnet is energized, with magnetization as shown.
- Notice only the vertical stator poles are magnetized.
- The figure shows the rest position.
- Because of the magnetic forces, there is a "holding torque"
- This is a characteristic of stepper motors.

Stepper Motor operation



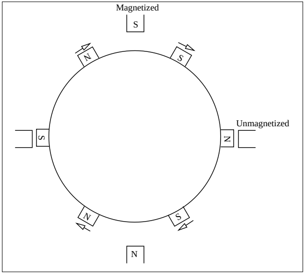
- Now suppose the vertical stator pole is de-energized, and horizontal poles are energized with magnetization as shown.
- Notice that only the horizontal stator poles are magnetized now.
- Arrows show the direction of force on the rotor poles.
- All arrows combine to form a clockwise rotary torque.
- This will cause the rotor to move in a clockwise direction.

Stepper Motor operation



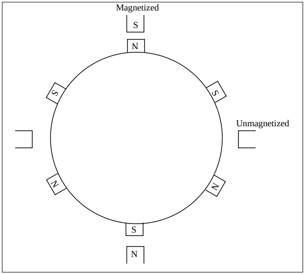
- As a result of clock wise rotation, the rotor moves by 30^o and then stops.
- The system is in equilibrium now.
- This position also has a “holding torque”
- Any attempt to rotate it further will be resisted.
- Thus the motor rotates by 30^o and stops.

Stepper Motor operation



- Next we de-energize the horizontal magnet and energize the vertical magnet in the opposite direction.
- This time, only the vertical stator poles are magnetized.
- Arrows show the direction of force on the rotor poles.
- All forces constitute a clockwise torque.
- Therefore the rotor will again move in clockwise direction.

Stepper Motor operation



- On application of reversed vertical field, the rotor moves clockwise by 30^o.
- The system is in equilibrium now.
- This position also has a “holding torque”
- Any attempt to rotate it further will be resisted.
- Thus each step moves by 30^o and then stops.