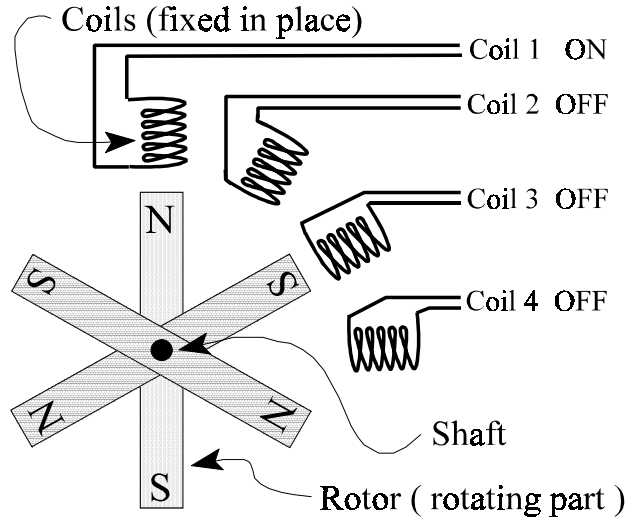
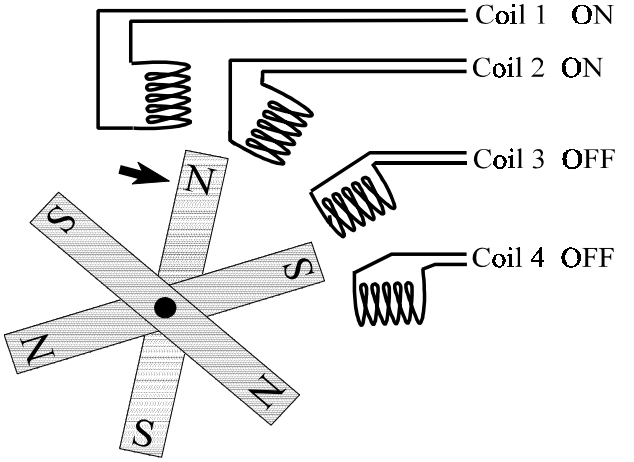
STEPPING MOTORS

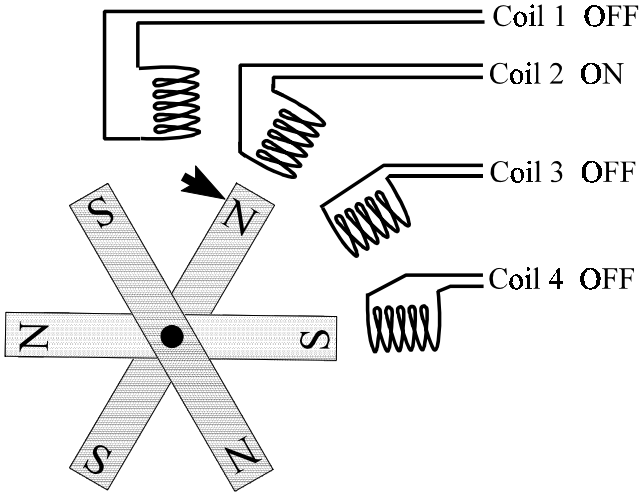


To the left is a schematic representation of a stepping motor. The fixed coils are connected to a power supply such that when energized they produce a magnetic south pole one the end toward the rotor.

Initially only one coil (shown here as coil #1) is energized and it attracts the nearest north pole on the rotor which is the rotating part of the motor.



Next the coil # 2 is energized. Then the north pole on the rotor is drawn to a position halfway between the faces of coils #1 and #2.



For the next step, coil #1 is de-energized and the north pole on the rotor is drawn to rotate toward coil # 2. This stepping process continues with energizing coils #2 and # 3 and then just coil #3, and so on. Thus the shaft of the motor rotates by fixed steps.

For the stepping motor on the Michelson

Interferometer system, a complete cycle of energizing the coils is given below:

Phase	Coil that are ON	Leads that are ON
1	1	1
2	1,2	1,3
3	2	3
4	2,3	3,2
5	3	2
6	3,4	3,4
7	4	4
8	4,1	4,1
1	1	1

Note that due to lack of forethought, the labeling of the coils and the leads do NOT match. This is reflected through the subsequent connection to the driving circuit, the computer interface card, and computer program.

Inside the computer is a data acquisition card that has digital output channels. That is there are places to connect wires that are either ON or OFF (i.e. either 0 or 5 volts is present). Which of these two voltage will be present is under the control of the computer. A group of 8 lines are grouped together and one specifies the electrical value for all eight lines at once by writing a single byte (8 bits) to a special location on the card. For example to energize only leads # 1 and # 4 on writes:

000 1001 in binary or
9 = 8 + 1 in decimal

Recall in binary
1111 1111 =

$$\begin{array}{c} 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1\quad 1 \\ 2^7 + 2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^1 + 2^0 \\ 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 \end{array}$$

= 256 in decimal.

The four digital output lines that the computer uses to control the stepping motor do not go directly to the stepping motor because the power requirements are too high. Instead the lines control four transistors and it is outputs of these transistors that actually energize the coils of the stepping motor. A resistor is added in series with each coil to limit the electrical current through any given coil. A schematic of this circuit is shown below.