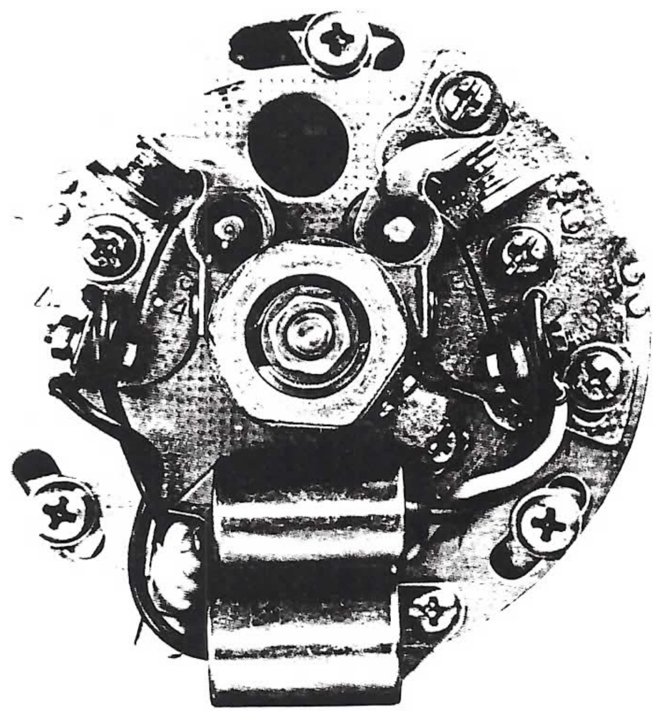
HONDA

MOTORCYCLE ELECTRICAL SYSTEMS



HONDA TECHNICAL SERIES

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EQUIPMENT AND PROCEDURES SHOWN IN THIS MANUAL APPLY TO HONDA MOTORCYCLES AVAILABLE AS OF JULY, 1977. HONDA MOTORCYCLE MODELS FOR 1978 INTRODUCE SOME NEW OR MODIFIED EQUIPMENT AND PROCEDURES THAT ARE NOT COVERED IN THIS MANUAL.

FOREWORD

This manual is designed to provide motorcycle owners, students, and mechanics with a complete understanding of the construction and operating principles of motorcycle electrical systems. A troubleshooting chart is included for the diagnosis and correction of electrical problems.

The manual starts with a simplified description of the basic principles. Subsequent sections describe specific electrical system circuitry, adding technical detail as the reader's comprehension grows.

Special care has been exercised in preparing clear, simple illustrations as an aid in visualizing the complex electrical systems described in the text.

The variety of electrical equipment in use, and frequent design changes, preclude the listing of service specifications. Refer to the factory shop manual for service information on specific electrical components.

Equipment and procedures shown in this manual apply to Honda motorcycles available as of July, 1977. Honda motorcycle models for 1978 introduce some new or modified equipment and procedures that are not covered in this manual.

AMERICAN HONDA MOTOR CO., INC.
MOTORCYCLE & POWER PRODUCTS SERVICE DEPARTMENT

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BASIC PRINCIPLES OF ELECTRICITY AND MAGNETISM

Electric Current:

A basic knowledge of electricity and magnetism is necessary for understanding the construction and operation of motorcycle electrical systems.

Electric current flowing through a wire can be compared to water flowing through a pipe. The laws governing electric circuits are easily explained by this analogy.

Water will flow through the pipe from the full tank to the empty tank (Fig. 1) until the water level is even in both tanks. Pressure (weight of water in the full tank or pressure supplied by attaching a pump) is required to cause the water to flow. A valve can be installed to open or close the water passage.

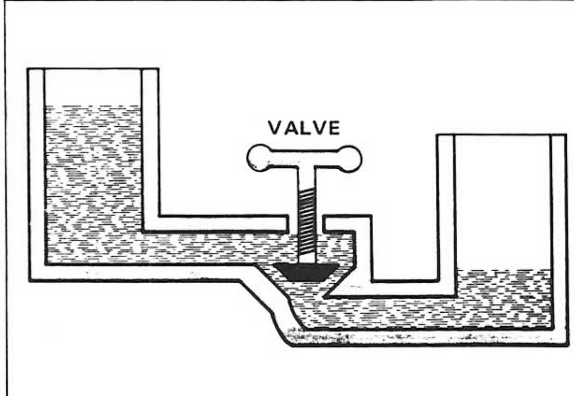

Fig. 1 Hydraulic Analogy to Electrical Circuit

Similarily, electrical current will flow through a wire (Fig. 2) due to electrical pressure created by the battery or a generator. A switch can be installed to open or close the circuit.

Water pressure is measured in pounds per square inch, while electrical pressure is measured in *VOLTS.*

Rate of water flow, measured in gallons per minute, is analogous to rate of electrical current flow which is measured in *AMPERES.*

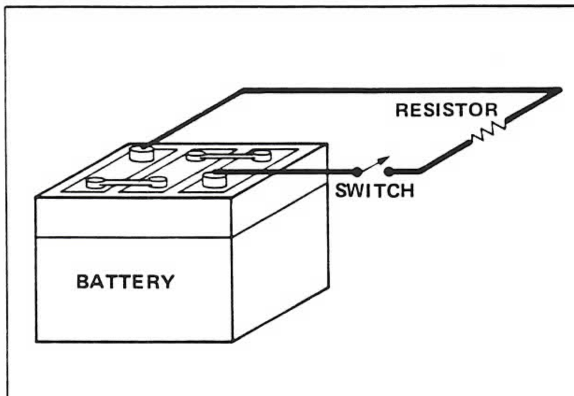

Fig. 2 Electrical Circuit

Water will have a lower rate of flow through a smaller or longer pipe due to increased resistance. Similarily, electric current will have a lower rate of flow through a smaller or longer wire. Partially closing the water valve in Fig. 1 decreases water flow by adding resistance, just as the resistor in Fig. 2 decreases current flow. Electrical resistance is measured in *OHMS.*

BASIC PRINCIPLES OF ELECTRICITY AND MAGNETISM

The relationship between pressure (volts), current flow (amperes), and resistance (ohms) is known as *OHM'S LAW*. Given any two values of a circuit, we can calculate the third value.

OHM'S LAW:

$$\text{AMPERES} = \text{VOLTS} \div \text{OHMS}$$
$$\text{VOLTS} = \text{AMPERES} \times \text{OHMS}$$
$$\text{OHMS} = \text{VOLTS} \div \text{AMPERES}$$

Electrical power is measured in *WATTS.* The analogous hydraulic term would be *horsepower.* Increasing the electrical pressure (volts) or increasing the rate of current flow (amperes) increases electrical power output or consumption (watts).

$$\text{WATTS} = \text{VOLTS} \times \text{AMPERES}$$

Series Circuit:

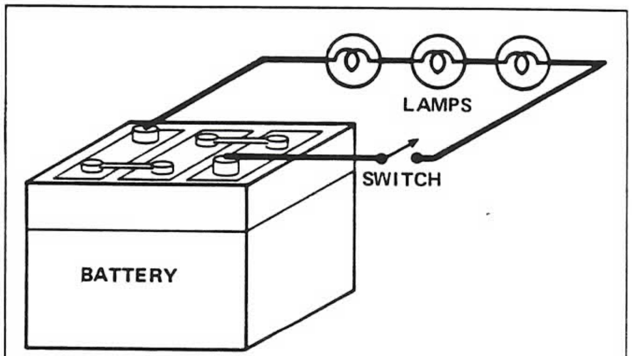

Fig. 3 Series Circuit

An electrical circuit is said to be in *series* when connected as shown in Fig. 3. Current flows through the switch and through each lamp, or other equipment, in sequence and returns from the last one to the battery. A hydraulic analogy to the series circuit is shown in Fig. 4.

In a series circuit, resistance (ohms) increases as the number of lamps or other equipment is increased. As shown by Ohm's Law, increasing the resistance (ohms) will decrease current flow (amperes) unless pressure (volts) is also increased.

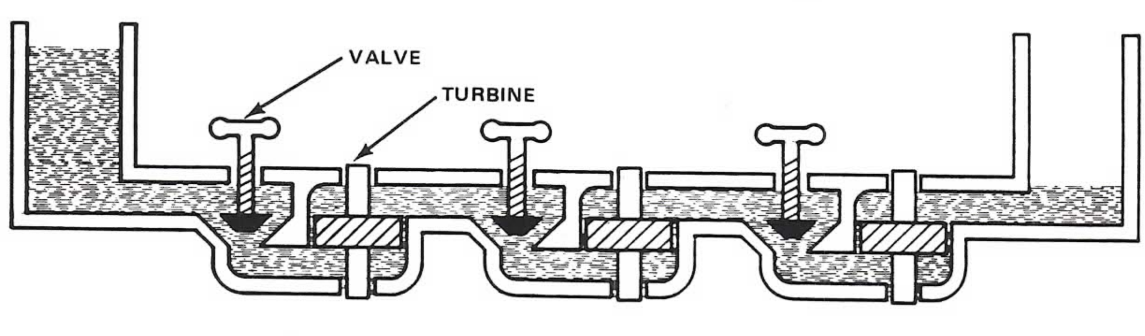

Fig. 4 Hydraulic Analogy to Series Circuit

If one lamp in a series circuit burns out, or is removed, the circuit becomes incomplete, and *all* lamps go out. The same effect can be produced in Fig. 4 by shutting down any one of the turbines. For this reason, motorcycle lighting equipment, such as headlight and taillight, are connected in parallel rather than in series.

Switches and fuses, however, must be connected in series with the equipment they control or protect. When an ammeter is used to check current flow, it too must be connected in series, so that all current in the circuit flows through the meter.

Parallel Circuit:

An electrical circuit is said to be in *parallel* when connected as shown in Fig. 5 & 6. Current flowing through any one lamp or other component will complete a circuit, returning to the battery through a common ground connection or wire. If one lamp burns out or is removed, the others will remain lit. Note that the switch is connected in *series.* When the switch is turned off, the circuit will be incomplete, and all lamps will go out simultaneously.

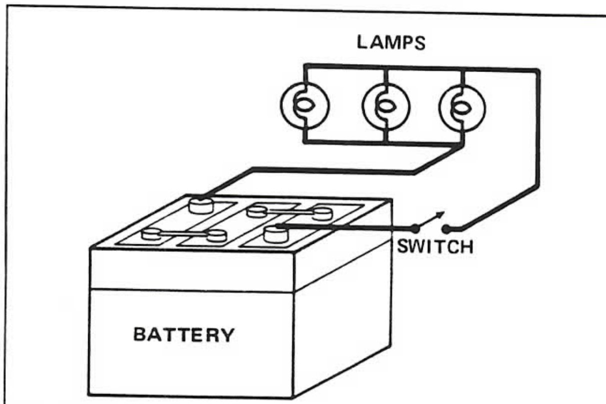

Fig. 5 Parallel Circuit Two Wire System

A considerable amount of wire can be saved by utilizing the frame and engine to complete the circuit. Ground symbols (⏚) shown in Fig. 6 indicate attachment to the frame or engine. A return wire (Fig. 5) is necessary only when the electrical components are mounted in such a manner that they are insulated from the frame and engine.

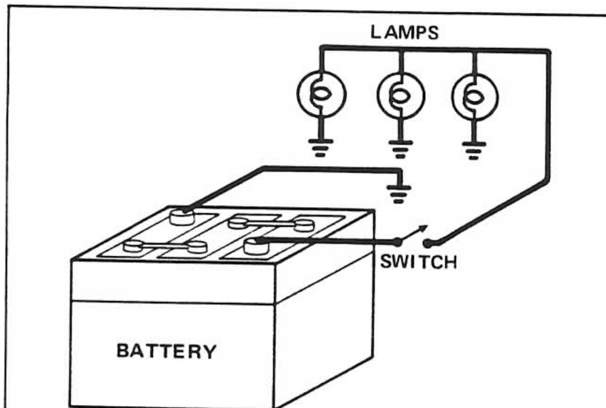

Fig. 6 Parallel Circuit One Wire System

hydraulic analogy to the parallel circuit is shown in Fig. 7. If one turbine is shut down, the others will continue to operate and it can be clearly seen that more water will flow as more valves are opened. Opening additional passages reduces the total resistance. Similarly, as more lights are added in Fig. 5 & 6, the total resistance of the circuit (ohms) is reduced and more current (amperes) flows from the battery to operate the additional lights without requiring a voltage increase.

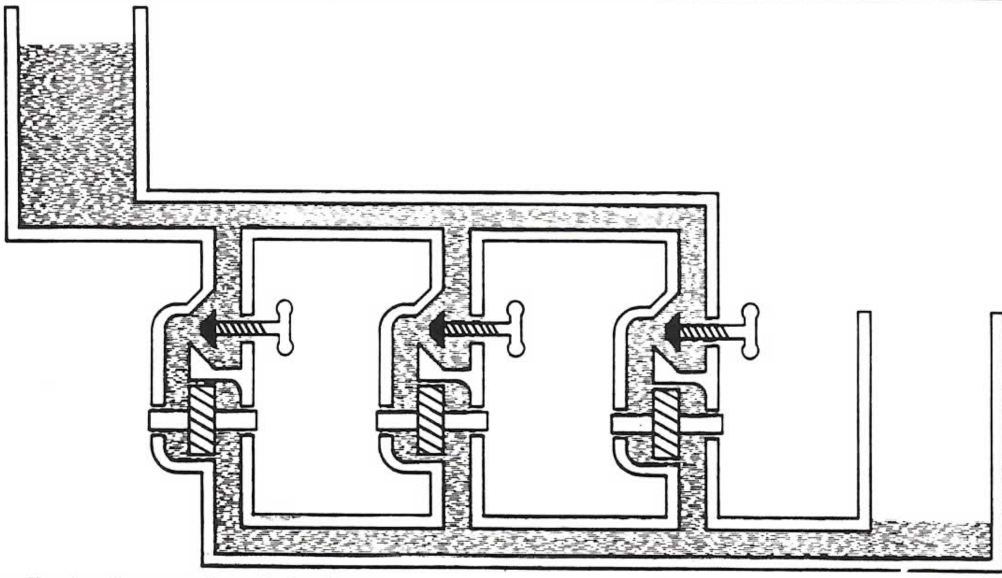

Fig. 7 Hydraulic Analogy to Parallel Circuit

The hydraulic analogy in Fig. 8 is offered as a plumber's conception of a motorcycle electrical system.

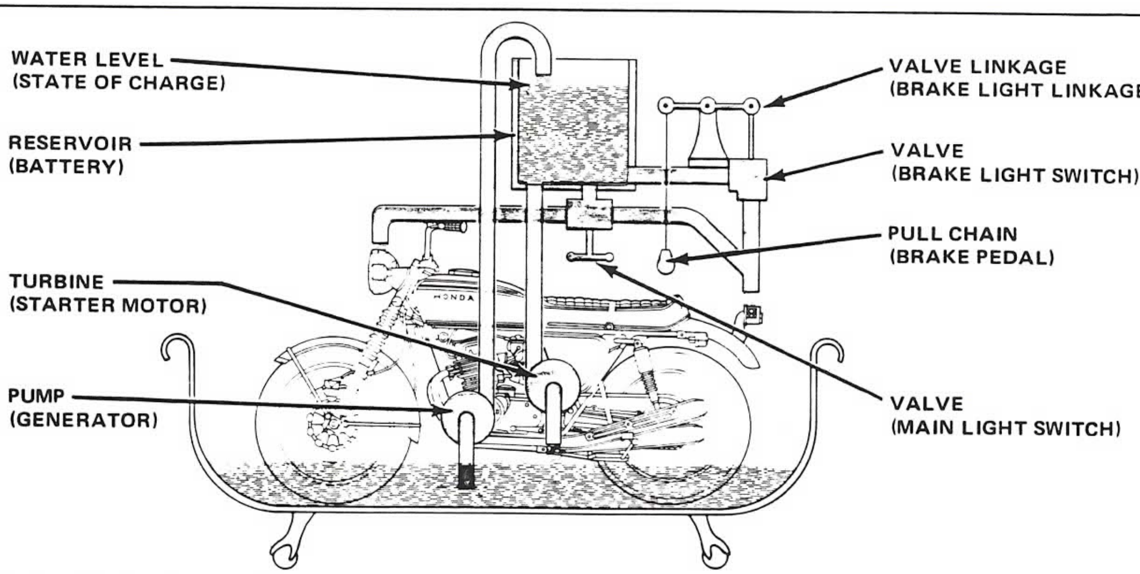

Fig. 8 Hydraulic Analogy to Motorcycle Electrical System

Current Flow.

Electric current does not really flow like water, of course. This is simply a convenient analogy for explaining electrical circuits. Electric current consists of *electrons* (the smallest possible units of negative electrical charge) moving from atom to atom within the wire.

The outer electrons are most easily freed from the atom. When voltage is applied, they will travel a short distance and collide with other atoms. The collision will knock other electrons free, and the process continues with free electrons moving by collision *toward the positive terminal* in the electrical circuit.

Copper wire is a good conductor of electricity because its atoms have a large number of easily freed electrons in their outer orbits. Insulators, such as rubber, glass, and plastics have few free electrons and are poor conductors of electricity.

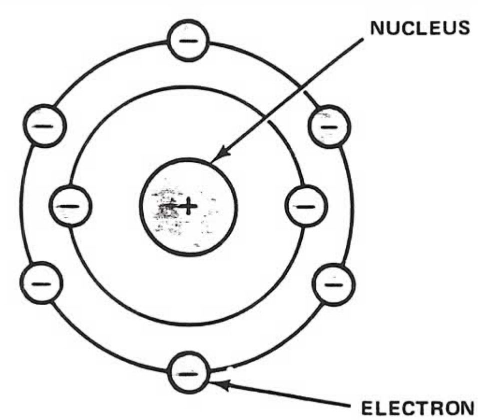

Fig. 9 Atom

Before the nature of electricity was understood, it was thought that "electric current" flowed from the positive terminal of the voltage source, through the circuit, to the negative terminal, and all technical publications were written accordingly.

When it was discovered that electrons flowed from the negative terminal, through the circuit, to the positive terminal, it was too late to change all the books. Nor could terminals be relabeled to reconcile electron flow with old theory, as there was too much old-theory equipment in use, and relabeling terminals would cause confusion.

Thereafter, technical publications referred to "conventional current" (old theory) as flowing from positive to negative, while "electron flow" (new theory) ran from negative to positive.

With the advent of transistor technology, it became useful to consider electric current as something that flows in both directions. The electrons constitute current flowing from negative to positive, while the "holes" vacated by those electrons constitute current flowing from positive to negative.

For most purposes, the direction of current flow is of no concern, so long as you are careful to connect electrical components in proper polarity.

etism:

Magnetism is an invisible force, the nature of which has not been fully determined. The properties of magnetism are well known, however, and we are all familiar with the ability of a magnet to attract, and be attracted by, iron and magnetic alloys.

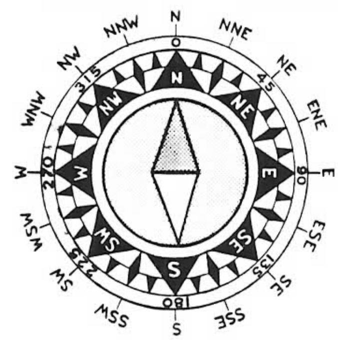

Fig. 10 Compass

Magnetic force is concentrated in the ends of the magnet, called *poles.* The poles are labeled *north* and *south* from the fact that a compass needle, which is simply a thin bar magnet, aligns itself with the north and south magnetic poles of the earth.

Think of the *north* and *south* poles of magnets as "north seeking" and "south seeking" with reference to the earth. This orientation will avoid conflict when considering that the north pole of a magnet is attracted to the "north" magnetic pole of the earth.

Unlike poles (north seeking pole of one magnet and south seeking pole of another magnet) attract each other, while like poles (two north seeking poles or two south seeking poles) repel each other. This principle, which makes a compass operate, is also used to explain the operation of such devices as electric motors and solenoids. The force of attraction or repulsion is increased when the magnets are made stronger or ɘn brought closer together. The force is decreased when the magnets are weaker or farther apart.

Magnetic Fields:

Magnetic lines of force are considered to emanate from the north pole of the magnet, pass through the surrounding space, reenter at the south pole, and complete the circuit by passing through the magnet itself.

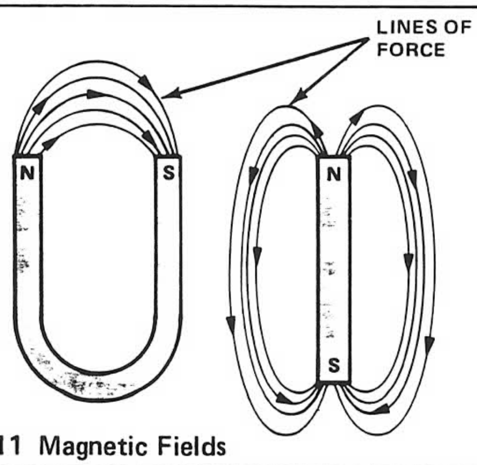

Fig. 11 Magnetic Fields

When a magnet is used to pick up iron particles, most of them will be attracted to the ends (poles) of the magnet. Magnetic force is greatest in the poles because all lines of magnetic force must pass through the poles to complete their circuits. The strength of a magnet is determined by the concentration of these lines of force.

Electromagnetism:

When an electric current flows through a wire, this sets up a magnetic field surrounding the wire. This field is regarded as magnetic lines of force encircling the wire (Fig. 12).

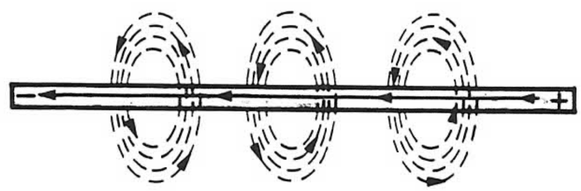

Fig. 12 Magnetic Field Surrounding a Wire

If the wire is wound in a coil, the magnetic lines of force form a pattern which encircles all adjoining loops of the wire (Fig. 13). This establishes a magnetic field which resembles that of a bar magnet, though many lines of force are dissipated between the loops of the coil.

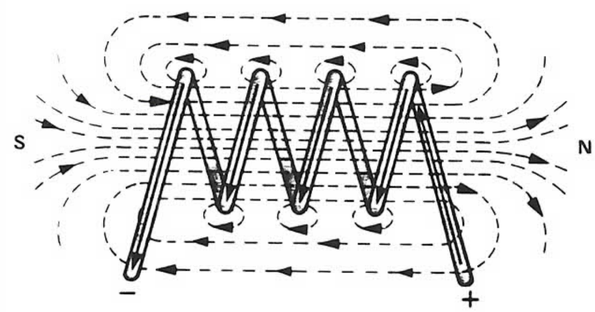

Fig. 13 Magnetic Field of a Wire Coil

When a soft iron core is inserted into the wire coil, the lines of magnetic force inside the coil will tend to travel through the iron (Fig. 14), because it provides a better magnetic path than air. This property of iron, called *permeability*, concentrates the lines of force in the center of the coil, strengthening the magnetic field. The combination of an iron core in a coil wire becomes an *electromagnet*.

When the electric current is switched off, the lines of force collapse, and the soft iron core immediately loses its induced magnetism.

A *soft iron* core is used to produce a *temporary electromagnet* in this manner, but a bar of *steel*, once magnetized, will retain its magnetism indefinitely and is called a *permanent magnet*. The magnets shown in Fig. 11 are made of steel or other magnetic alloy. Soft iron is used as the core of a temporary electromagnet.

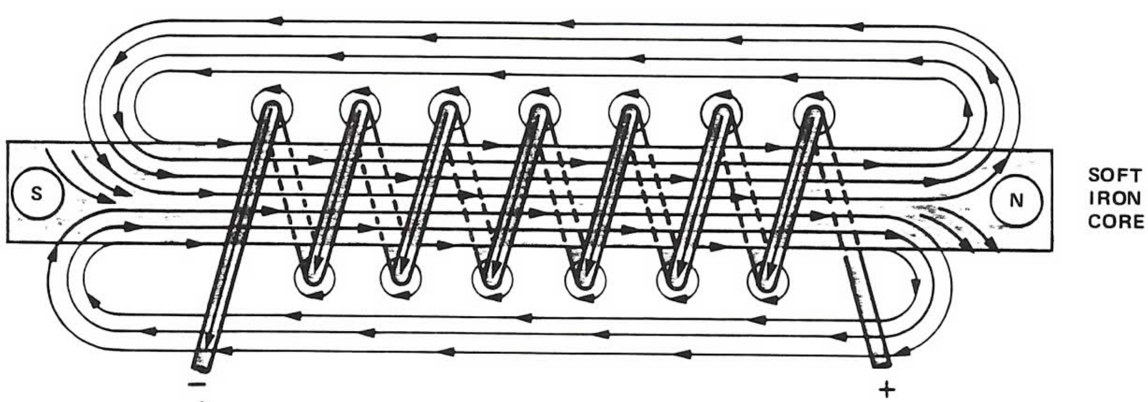

Fig. 14 Electromagnet