MAGNETISM.

CHAPTER VII.

Native Magnetism of the Load-Stone—Attractive and Repulsive Forces of Permanent Magnets—Component parts of the Magnet—Induced Magnetism.

NATIVE MAGNETISM OF THE LOAD-STONE.

As a preliminary to the consideration of electro-magnetism, it is necessary to explain the mysterious existence of the attractive and repulsive nature of matter commonly known as permanent magnetism. This is the more necessary as some of the telegraph systems have, as parts thereof, the conjunctive force of permanent and electro-magnetism.

Fig. 1.

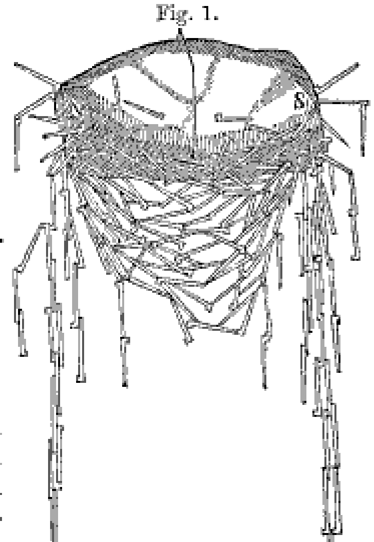


Fig. 1 represents the native load-stone, found in the earth in different parts of the world. In the figure, the polarity of the stone is shown and its attractive force, by nails suspended by it.

It is an ore of iron, compounded of iron and oxygen. Recently, I saw large quantities of this ore near St. Louis, Missouri. It was in a mountain of iron. The discovery of the load-stone has been attributed to a shepherd, named Magnes, who observed its attraction to his iron crook, when tending his flock on Mount Ida, and from whom it is supposed the name of magnet is derived; though, according to other accounts, the load-stone first came from Heraclea, in Magnesia, and one of its ancient names was *lapis*

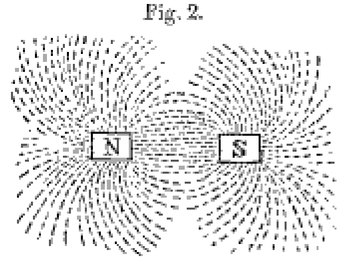
Heracleus. Plato and Euripides called it the Herculean stone, because it commanded iron, the strongest of all metals.

VARIATION OF THE NEEDLE DISCOVERED BY COLUMBUS.

To what extent the earth is filled with the load-stone no one can form any idea. In connection with this, may be considered the magnetic polarity of the earth, and the magnetic or mariners' needle. The needle has been used for several centuries, but the variation of the compass needle, in different latitudes, was first noticed by the discoverer of America. Irving's Columbus says, viz.: "On the 13th of September, 1492, he perceived about nightfall that the needle, instead of pointing to the north star, varied but half a point, or between five and six degrees, to the northwest, and still more on the following morning. Struck with this circumstance, he observed it attentively for three days, and found that the variation increased as he advanced. He at first made no mention of this phenomenon, knowing how ready his people were to take alarm; but it soon attracted the attention of the pilots, and filled them with consternation. It seemed as if the laws of nature were changing as they advanced, and that they were entering into another world, subject to unknown influences. They apprehended that the compass was about to lose its mysterious virtues; and without this guide, what was to become of them in a vast and trackless ocean? Columbus tasked his science and ingenuity for reasons in which to allay their terrors. He told them that the direction of the needle was not to the polar star, but to some fixed invisible point. The variation was not caused by any failing in the compass, which, like the other heavenly bodies, had its changes and revolutions, and every day described a circle around the pole. The high opinion that the pilots entertained of Columbus as a profound astronomer, gave weight to his theory, and their alarm subsided."

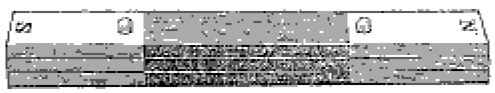
THE FORCES OF PERMANENT MAGNETS.

Fig. 2.



Place the ends of a magnet under a piece of paper on which are scattered some iron filings; in a moment the filings will be seen to arrange themselves in curves, as represented in figure 2; the greater part of the filings being collected over each end of the magnet, and spreading out in curvilinear directions toward the two ends. Very few of the filings will collect on the spot over the centre of tne magnet. When thus arranged, each one of the filings is magnetic, with distinct polarity, with attractive and repulsive powers, as the magnet beneath the paper. The magnetism in the particles, as to quantity, depends upon their respective proximities to the magnet poles. The farther they are from it, the less is their power. The curves formed are owing to the more distant attractive influence affecting them.

Fig. 3.



A straight permanent magnet is represented by figure 3. This form is called a compound permanent magnet, because it is made of more than one bar, and it retains magnetism. By this uniting of several magnets, the power is increased. The similar poles of each must be placed together.

Fig. 4.

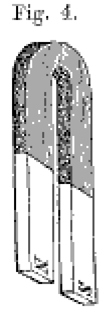
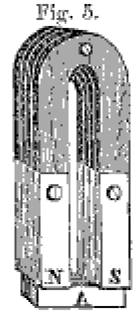


Fig 4 is a horseshoe or U-magnet. It is the bar magnet bent in the form represented in the figure, for the purpose of getting the attractive force of the two ends of the magnet to act at the same time upon the same matter. Figure 5 is the same as figure 4, compounded. The two poles of the magnet are exercised in the attraction of the piece of iron A, which is called the keeper. It is called thus, because it aids to keep the magnetism in the bars. The moment that A comes in contact with the poles N and S, it becomes magnetic, with distinct polarities. The south pole of it, is next to the N, or north pole of the magnet. The terms *north* and *south*, to indicate the polarity of the magnet, was given to the needle about the year 1600, conformably to the views entertained of terrestrial magnetism. The end of the needle that pointed toward the north was called the *south* pole, and that toward the south was called the *north* pole. The poles of the earth were supposed to be magnetic, and that the needle was affected by them, upon the principles of the present known laws, concerning the attractive and repulsive nature of magnets. Like poles repel, and opposite poles attract. The north pole of one magnet attracts the south pole of the other.

Fig. 5.

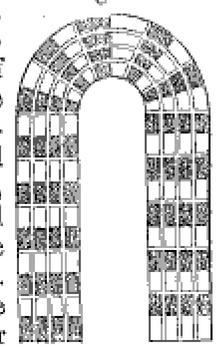


In examining the distribution of electricity, in a circular plane, it was found that the thickness of the electric stratum was almost constant from the centre, to within a very small distance of the circumference, when it increased all on a sudden with great rapidity. It has been believed that a similar distribution of magnetism took place in the transverse section of a magnetic bar; and by a series of magnetic experiments, results have induced some philosophers to believe that the magnetic power resides on the surface of iron bodies, and is entirely independent of their mass. On the other hand some are of the opinion that the magnetic force commences as a focus at the centre of the mass, and fully culminates at the surface.

COMPONENT PARTS OF THE MAGNET.

A magnet is considered as composed of minute invisible particles or filaments of iron, each of which has individually the properties of a separate magnet. It is assumed that there are two distinct fluids—the *austral* and *boreal;* and under the influence of either in a *free* state, the bar of iron or other metal will point to the north or south poles of the earth, according to circumstances. It is within these small particles or metallic elements that the displacement or separation of the two attractive powers take place; and the particles may be the ultimate atoms of iron. A magnetic bar may, therefore, as represented in figure 6, be composed of minute portions, the right hand extremities of each of which possess one species of magnetism, and the left hand extremities the other species; the shaded ends being supposed to possess *boreal*, and the light end *austral* magnetism. The ends of the bar, when either straight or U shaped, are charged with boreal or austral magnetism, and the ends are called by those respective terms. More commonly the ends of the magnet are called the "north" and "south" poles, for the reasons before mentioned.

Fig. 6.



These fluids exist in a combined state, and in certain proportions they are united to each molecule or atom of the metal, from which they can never be disunited except by their decomposition into separate fluids, one of which in a permanent magnet is always collected on one, and the other on the opposite side of each molecule.

INDUCED MAGNETISM.

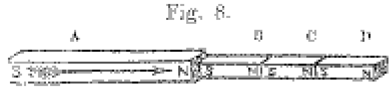
In order to communicate magnetism from a natural or artificial magnet, to unmagnetized iron or steel, it is not necessary that the two bodies should be in contact. The communication is effected as perfectly, though more feebly, when the bodies are separated by space. Figure 7 represents a bar, magnet M, and an iron rod B, near together. By the

Fig. 7.

influence of the magnet M upon the principles of induction, the rod B partakes of the magnetism of M, the end N becoming *boreal* and the end S *austral*. If the rod B be brought in contact with the bar M, the induction will be much stronger.

If to the north pole (fig. 8) of an artificial steel magnet A, is placed a soft iron bar, B, the end S of B will in-

Fig. 8.



stantly acquire the properties of a *south* pole, and the opposite end N, those of the north pole. The opposite poles would have been produced at N and S, if the south pole S of the magnet A, had been placceed near the iron B. In like manner, the piece of soft iron B, though only temporarily magnetic, will render another piece of iron, C, and this again another piece, D, temporarily magnetic, north and south poles being produced at the ends. This represents compound induction.

It is important for the reader to observe the pointed analogy between the phenomena of magnetic attraction and repulsion, and those of electricity. In both there exists the same character of double agencies of opposite kind, capable, when separate, of acting with great energy, and being, when combined together, perfectly neutralized, and exhibiting no signs of activity. As there are two electrical, so there are also two magnetic powers; and both sets of phenomena are governed by the same characteristic laws. So also in the last experiment, the magnetism inherent in B, C, D, is said to be *induced* by the presence of the real magnet; and the phenomena are exactly analogous to the communication of electricity to unelectrified bodies by induction, the positive state inducing the negative, and the negative the positive, in the parts of a conductor placed in a state of insulation, near an electrified body. Where two or more wires are suspended on the same set of poles, the voltaic current transmitted on one wire will escape to the other wire by induction, though not to a very great extent. If the wires are placed near together, more or less of the electric influence will pass from one to the other. Figure 9 is another representation of the inductive principle. Plunge a U-magnet into a cask of nails and on withdrawing it the nails will adhere to the magnet and to each other as represented in the figure. If the magnet be placed in connection with iron filings, they will collect on the poles as seen in figure 10.

If the north pole of a bar magnet, figure 11, be placed on the centre of a circular plate of iron, a south polarity is given

Fig. 9.

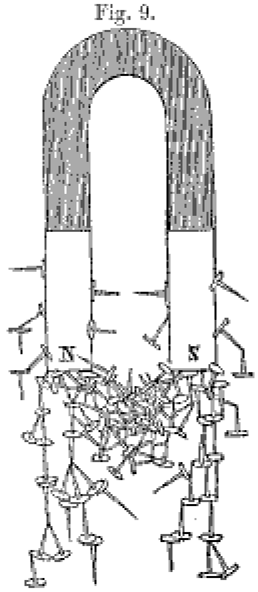


Fig. 10.

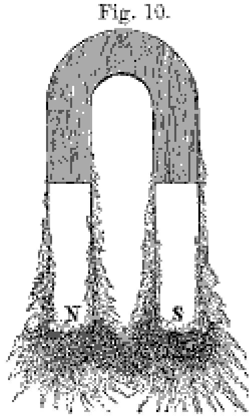


Fig. 11.

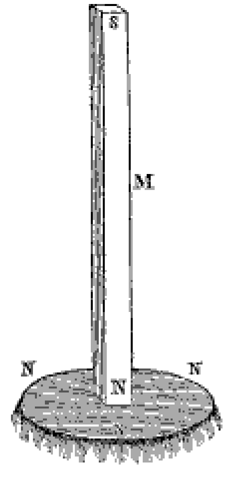


Fig. 12.

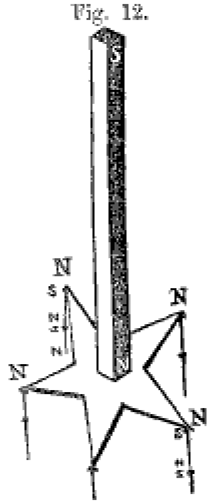
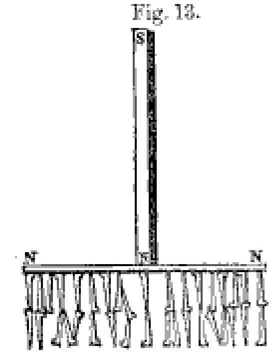


Fig. 13.



to the metal or plate touching the bar, and the under part becomes north, and from it will be suspended iron filings when they are brought in contact with the plate. If the plate is cut in the form of a star, as represented by figure 12, each point becomes a stronger north pole. The part of the plate in contact with the bar is south, and the line of induction extends to the points. If nails be suspended from the points the polarity of the respective pieces will be as represented in the figure.

If the north pole be placed on the middle of the bar of iron, as seen in figure 13, the part of the horizontal bar becomes a south pole, and the respective ends become north. The bar N N becomes magnetically two pieces of iron, each with its south pole terminating at the bar S N. If pieces of iron wire of equal lengths be suspended from a magnetic pole, they will not hang parallel. The lower ends will diverge from each other in consequence of their having the same polarity, as seen by figure 13.

If a bar magnet be broken into two pieces the polarity of each piece will at once be formed as seen by figure 14. These halves may be broken with the same result, each section having a full charge of the magnetic influence.

Fig. 14.

The magnetic needle is a very slender magnet mounted on a pivot, as seen in figure 15, or it may be otherwise suspended.

Fig. 15.

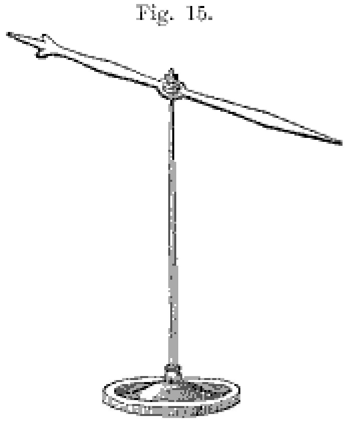


Fig. 16.

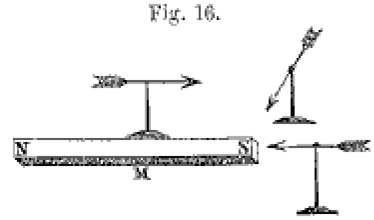
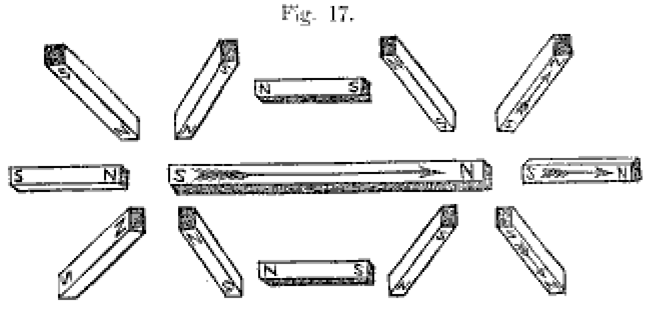


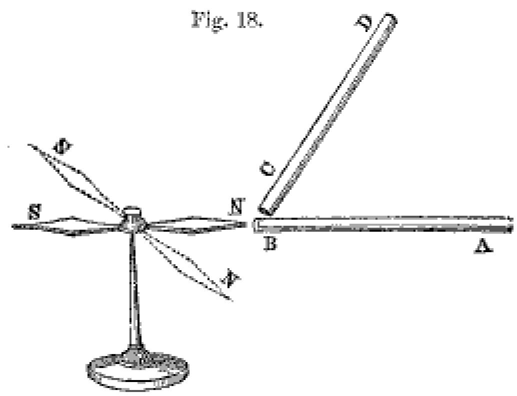
Fig. 17.



One end of the needle is north and the other end is south. Figure 16 represents a bar magnet, and the three needles or arrows, indicate the direction of the magnetic force. The arrow-heads are of north polarity, and the two to the right are influenced by the south polarity of the magnet bar N S. The south pole of the bar and the north poles of the needles attract each other. The needle over the centre of the bar magnet is equally influenced by the polarity of the bar N S, and it cannot deviate from a parallel. Figure 17 represents the different positions necessary to place magnets to make them harmonize in their respective influences or forces one with the other. If the various small pieces were arrows, their polarities would be as represented in figure 17, conjunctively with the larger magnet in the centre.

An unmagnetized bar, suspended in the direction of north and south, formed as figure 15, will assume temporary magnetism inductively from the earth. The end of the suspended rod directed toward the north pole, becomes south, and the end toward the south will receive north polarity. Figure 18 represents a bar of iron, A B, placed in a horizontal position to the

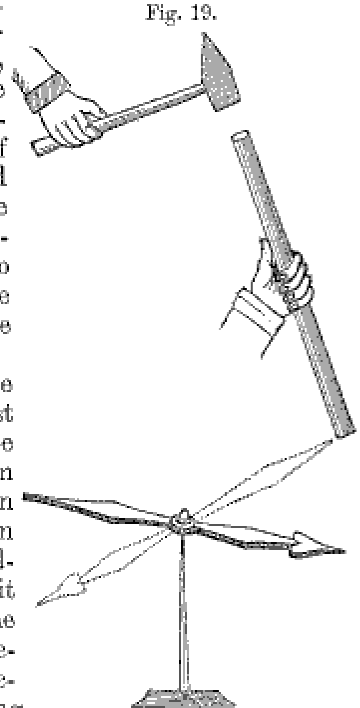
Fig. 18.



north pole of a magnetic needle, N S. The pole as thus placed is attracted by the bar. Keeping the end B in the same place, raise the end A so as to bring the bar into the position C D. As the bar is raised, the north pole recedes from C, as indicated by the dotted lines in the figure. The strongest action is exerted when the bar is in the line of the dip, or in this latitude, nearly vertically over the needle. Change the positions of the bar, and the needle will be changed. By this experiment the reader will find that the bar of iron has become polarized with magnetism.

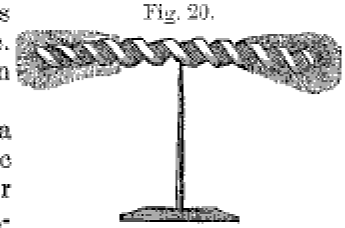
Figure 19 represents the charging of a bar of iron by percussion. Hold the bar in the line of the dip, and its lower end brought near to the north pole of a magnetic needle. In consequence of the polarity of the iron, received from the earth, the needle will slightly swing from its normal position. Strike the end of the iron rod with a hammer, and immediately the magnetic force in the bar becomes greatly increased, and the needle swings to the bar as seen in the figure, the south pole of the needle to the north pole of the bar.

Fig. 19.



Take a piece of iron wire, place it in a vertical position, and twist it powerfully. The twist will be seen to sustain iron filings as seen by figure 20. This is very often seen by the telegrapher when making joints in the wire. Balance the twist on a pivot, and it will at once assume polarity. The end which was downward becomes the north pole. The telegrapher will observe, when filing the wire to make the joints, filings adhere to the ends of the wire. This magnetism is produced upon the principles of percussion.

Fig. 20.



I have thus briefly presented a few explanations of the magnetic force imparted to metals, and for further and more detailed information the reader can refer to the standard works on electrical and magnetic phenomena.