MAGNETISM

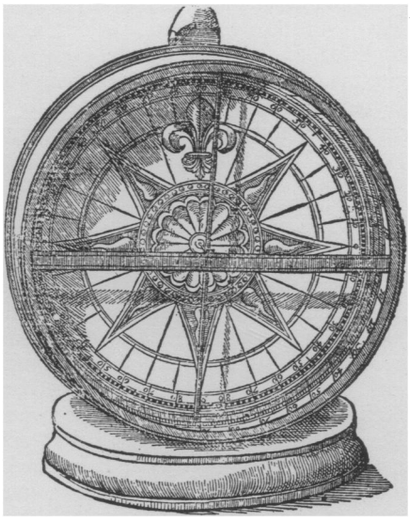
Classics of Science: The Dip of the Magnetic Needle

In constructing Gilbert's instrument, a satisfactory, if less durable, case may be made from heavy cardboard with a celluloid cover. All the care which he advises is necessary to balance the magnetic needle exactly.

WILLIAM GILBERT OF COLCHESTER, PHYSICIAN OF LONDON, ON THE LOADSTONE AND MAGNETIC BODIES, AND ON THE GREAT MAGNET THE EARTH. A new physiology, demonstrated with many arguments and experiments. A translation by P. Fleury Mottelay. New York, 1893.

Inclination

We come at last to that fine experiment, that wonderful movement of magnetic bodies as they dip beneath the horizon in virtue of their natural verticity; after we have mastered this, the wondrous combination, harmony, and concordant interaction of the earth and the loadstone (or magnetized iron), being made manifest by our theory, stand revealed. This motion we have so illustrated and demonstrated with many experiments, and purpose in what follows so to point out the causes and reasons, that no one endowed with reason and intelligence may justly contemn, or refute, or dispute our chief magnetic principles. Direction, as also variation, is demonstrated on the plane of the horizon whenever a magnetic needle poised in equilibrium comes to a rest in any fixed point of it. But inclination (dip) is seen to be the motion of the iron bar, first balanced on its axis and then excited by a loadstone, from that point in the horizon, one end or pole tending toward the earth's centre. And we have found that this inclination differs in the ratio of the latitude of each region. Now this movement is produced not by any motion away from the horizon toward the earth's centre, but by the turning of the whole of the magnetic body to the whole of the earth, as later we will show. Nor does the needle descend below the horizon in the ratio of the degrees of the elevation of the pole in the given region, and with an equal arc of the quadrant in any oblique sphere, as later will be seen. But how much the needle dips in every horizon can now first be ascertained by means of an instrument (which, however, is not very easily constructed), just as in sun-dials when the needle returns to points in



DIP INSTRUMENT. A reproduction from the above-quoted book of Gilbert's design for a magnetic dipping needle and its case

the horizon, or as in the mariner's compass.

The Instrument

Get a circular planed board with diameter at least six finger-lengths, which is to be fasted to one face of an upright square post and to rest on a wooden base. Divide the periphery of the instrument into four quadrants, and then each quadrant into ninety degrees. In the centre of the instrument drive a brass nail, and in the centre of its head bore a small hole well reamed and smoothed. Adjust to the instrument a circle or ring of brass about two finger-breadths wide, with a transverse plate or flat bar of the same metal fastened across the middle of the ring and serving for horizon. In the middle of this horizon bar bore another hole which shall be exactly opposite to the centre of the instrument, in which a hole was already bored. Next get a steel wire such as is used for compass needles, and at the exact middle of it and at right angles to it pass a very thin iron axis through it so that the middle of the axis and the middle of the needle shall exactly meet; let this inclination (dipping) needle, the ends of the axis having been inserted into the holes, be suspended so that it may move freely and evenly on itself in most exact equilibrium, and so must be rubbed with a powerful loadstone, else it does not dip at the true point or goes beyond it and is not always at rest in it. A larger instrument can also be employed, of ten or twelve finger-lengths diameter, but in that case there is more trouble in balancing the needle exactly. Care must be taken to have the needle of steel, also that it be straight, and that the sharp points of the axis on both ends be at right angles with the needle itself, and that it pass through the very centre.

The Needle and the Earth

As in other magnetic movements there is strict agreement and a clearly visible, sensible accordance between the earth and the loadstone in our demonstration, so in this inclination is the accordance of the globe of the earth and the loadstone posi-

(*Just turn the page*)

ARCHÆOLOGY

Lost Mexican History Found

Another page of Mexico's past has just come to light. One of the precious books of Bernadino de Sahagun, famous colonial historian who came to Mexico 400 years ago, has been discovered in a secret archive in the Vatican at Rome, and published for the first time in America in the Mexican Historical Review by Zelia Nuttal, well-known woman archæologist of Mexico City.

The book is called "Coloquies and Christian Doctrines By Which The First Twelve San Franciscan Friars Converted the Indians of New Spain." It has both an Aztec and a Spanish text. The religious authorities of New Spain considered it dangerous to perpetuate the memory of the idolatrous practices of the Indians, and most of Sahagun's works were suppressed when the Inquisition was established in Mexico in 1572.

Sahagun came to Mexico in 1529, mastered the Aztec language, and began to make researches on the religious and social customs and history of the native races prior to the Conquest in 1547 using an original method to get the most reliable information. He called together the elders of the tribes and the most learned men of the town, and got them to put down what they knew in their own hieroglyphics, and explain to him in Aztec as well.

He worked without aid and against the opposition of his superiors for many years, and when he was an old man he was forced to destroy and revise the fruits of his work. His own history, however, which is one of the most noted records of its kind, tells, by the volume of work he actually did, how much has been lost.

News-Letter Features

Born over six years ago of the demand and interest of those individuals who had caught a glimpse of *Science Service's* news reports to newspapers, the SCIENCE NEWS-LETTER has since proved interesting to laymen, scientists, students, teachers and children.

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Dip of Magnetic Needle

(*Continued from page* 43)

tive and manifest. The true and definite cause of this great and hitherto unknown effect is as follows: The loadstone moves and revolves until one of its poles, being impelled toward the north, comes to rest in its predetermined point on the horizon; the pole that comes to a stand looking north is (as appears from the foregoing rules and demonstrations) southern, not northern, though till now every one has supposed it to be northern because it turns to the north. An iron wire or versorium touched with this pole of the stone turns south, and is made northern because rubbed at the south end of the stone; just as when the point of a versorium is magnetized in that way it will be directed toward the earth's south pole and to that will turn, while the other end, the crotch, will be southern and will turn to the northern regions of the earth (the earth itself causing the motion), for thus does direction result from the bearings of the stone and the needle, and from the earth's verticity. But inclination (dip) is when the needle accurately that it may not turn away from any one degree or point marked on the circumference more than from any other, but may rest easily at any one point. Have the instrument fastened upright to the face of the post, and on the edge of the base set a very small magnetized versorium [compass]. The needle thus nicely balanced, now rub skilfully at both ends with the opposite poles of a loadstone, but do this with the greatest care lest the wire be in the least bent; for unless you do all this with great skill and dexterity, you will reach no result. Next get a second brass ring, a little larger than the first, so as to go round it, and to one rim fit a cover of glass or of very thin mica; this, when placed over the other ring, encloses the whole space, and the needle is protected from dust and currents of air. The instrument being now complete, set it up perpendicularly with the small versorium on the base, so that when thus erected exactly upright it may tend to the true point of the magnetic direction. Then that one of the needle's ends which in northern latitudes looks to the north dips below the horizon; but in southern latitudes the end of the needle that looks south tends toward the earth's centre in a certain ratio (afterward to be explained) of the latitude of the region in question from the equator on either side. But the needle turns to the body of the earth, its south end pointed to the north, in any latitude away from the equator. For it is a fixed and unchanging law that exactly beneath the celestial equator, or rather on the equator of the terrestrial globe, the magnetic inclination or dip of the needle is *nil*; and in whatever way it may have been excited or rubbed, it rests exactly on the plane of the horizon in the inclination instrument, provided it be first duly balanced. The reason of this is, that the needle, being at equal distance from the two poles, does not in its rotation dip toward either, but stands balanced, pointing to the level of the equator, as it does when mounted on a sharp point or floating free and unhindered on water.

But when the needle is in any latitude from the equator, or when one of the earth's poles is raised (I do not say raised above the visible horizon, like what is commonly reputed to be the pole of the revolving world in the heavens, but raised above the horizon of the centre or above its own diameter, equidistant from the plane of the visible horizon, which is the true elevation of the earth's pole), then inclination appears and the needle dips in its meridian towards the body of the earth.

William Gilbert, more properly Gilberd, was born at Colchester, England, May 24, 1544, and died November 30, 1603, either in London or in Colchester, where he was buried. In 1558 he entered Cambridge University, and there is a tradition that he attended Oxford as well. In 1569, at the age of 25, he took the degree of M. D. After spending some time in travel and the practice of his profession on the Continent, he returned to England. He became a Fellow of the Royal College of Physicians in 1573, and filled several of its offices, becoming President of it in 1600. The next year he was appointed Physician-in-ordinary to Queen Elizabeth, who, upon her death in 1603, left him an annual pension to further his philosophical studies. In the comprehensive manner of the Elizabethans, Gilbert combined with his profession the study of chemistry and astronomy, but his fame rests upon the compilation of isolated observations of magnetic and electric phenomena, supplemented by many striking experiments and observations of his own, which he published under the title De Magnete in 1600. The extract here quoted is from the first complete translation of this work from Latin into English. Another translation was made by S. P. Thompson in 1900. The fact that the book waited three hundred years for translation into the native tongue of the author is probably due in great part to the death of the author, probably of plague, only three years after its publication. His library, instruments and loadstones, which he willed to the College of Physicians, were destroyed in the Great Fire of London.