Magnetic Deflection of Long Steel-Wire Plumb-Lines

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IN the course of work in the vary deep shaft of the Tamarack Mining Company on Lake Superior, it became desirable to plumb down two points to run off a cross cut to meet one started, from another shaft. This was done: in the latter part of last summer, and a very good account of the operation was given in the issue of Oct. 10, 1901, of the Portage Lake Mining Gazette.

The lines were of No. 24 piano wire, and the weights 50 Ibs. of iron.

At first they were 16.33 ft apart at the top, but they were afterward moved to 17.58 ft. "The remarkable, observation was; that in the first case they were 0.09 ft., and in the second case 0.07 ft farther apart at the 'bottom than at the top.' Naturally, the persons in charge were at a loss to explain the fact. The theory most persistently advanced was that the nearer wall pulled each bob toward it.

Of course, this is hot the case, for the potential in such a space is constant, and even if the attraction claimed were effective it would amount to only enough to move the bob less than 0.001 ft.

Being familiar with the very high magnetization found in the vertical casings in oil and gas wells it occurred to me that the observed deflection might be due to a magnetization of the wires and a consequent repulsion of the two north poles at the bottom. It will be remembered that the vertical component of the earth's field at Lake Superior must be about 0.9 (dip = 77 degs.), and a wire under such conditions of stretching and jarring and bending is in the best way to get [it] magnetized.

A simple calculation will show, however, that the force of repulsion required is too great to be ascribed to a simple repulsion of the two poles at the ends of the wires, for any supposable degree of magnetization in such a wire, by such a field. It is, however, possible that the wires being not perfectly homogeneous would have consecutive poles along their length, and that these might add to the force, and, moreover, there are the masses of iron in the shaft in the way of elevators, ways, cables, etc., which would contribute one way or the other.

In order to test the possible applicability of this theory I made a number of experiments in the research shaft at Columbia University and have found much corroborative evidence.

A bar was mounted so that it could be rotated in a horizontal plane, about its middle point, and at one end a plumb line was placed which consisted of a fine copper wire carrying a non-magnetic bob. At the other end of the bar was another plumb-line, consisting of a soft iron wire about 0.02 inch diameter, with a similar bob. These plumb lines were 75 ft long, and were about 4 inches apart, and their plane coincided with the magnetic meridian. Observation showed that the bobs were about 1/75 inch closer together when the iron was south of the copper than when it was north. In other words, the iron plumb line was pulled about 1/150 inch toward the north by the action of the horizontal component of the earth's field upon the iron wire.

The experiment was varied by taking two lines of the soft iron wire, and measuring their distance apart at the top and bottom. Under these conditions the mutual repulsion gave a deflection of the same order as the pull of the earth's field.

Thus we undoubtedly have an effect upon the lines due to induced magnetism, but again too large to be due to a simple pole at the ends. It was consequently desirable to investigate whether there were poles along the line, and with a very small compass they were investigated along their whole length, with the following result:

Position on wire	South wire	North wire	Effect
Top	Strong south	Strong south	Strong repulsion.
5 ft	Weak south.	Weak south.	Weak repulsion.
10 ft	South.	South.	Repulsion.
15 ft	Weak north.	South.	Weak attraction.
20 ft	North.	North.	Repulsion.
25 ft	North.	Neutral.	Neutral.
30 ft	Weak south.	Neutral.	Neutral.
35 ft	Weak north.	Neutral.	Neutral.
40 ft	North.	North.	Repulsion.
45 ft	South.	South.	Repulsion.
50 ft bot	Strong north	Strong north.	Strong repulsion.

In the plumb lines the upper 25 ft. was of copper wire, that above the point referred to as the "top," in the above table, which is for the 50 ft of iron wire forming the lower two thirds in each plumb line.

The conclusion is evident. Iron or steel wire ought not to be used for plumb lines where accuracy is needed, as they are deflected by the earth's field as well as by each other.

Probably phosphor-bronze would prove most available where great tensile strength is needed.

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