

Correspondence.

Terrestrial Magnetism.

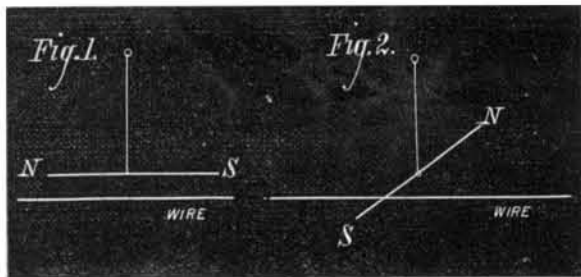
To the Editor of the Scientific American:

In your issue of August 14 appeared an interesting article on the subject of terrestrial magnetism, so-called, in which the views entertained by Humboldt, Hansteen, and Gauss were clearly outlined. During the past year, I have devoted considerable attention to the phenomena of the earth's electricity, and my experiments have demonstrated that there is no such thing as terrestrial magnetism in the sense in which the term is usually employed. To use the term terrestrial magnetism is to indicate that the earth is a magnet, whereas the force which is characterized as terrestrial magnetism stands, with relation to magnetism, precisely as the galvanic current stands with relation to an electromagnet.

I began my experiments in full view of the phenomena set forth in the article to which allusion has been made, namely: The observed declination of the magnetic needle, and its inclination, and the intensity of its action, as well as the facts that these phenomena not only vary in one place from another, but in the same place with time, and that the needle is subject to disturbances from natural phenomena, such as the aurora borealis. I had, in addition, the important premise that currents of electricity are continuously flowing round the earth (I use the expressions "currents" and "flowing" merely as convenient terms), as is every day demonstrated in lines of telegraph connecting with the earth and without the battery.* That these earth currents are mainly generated by the sun's light and heat falling upon the surface of the earth, there cannot be the slightest doubt. That the electricity thus generated is of two well known forms, thermic and frictional, there also can be no doubt; nor would it be difficult to estimate the immense volumes on electricity generated in a day by the impact of the light waves upon the earth's surface.

With these acknowledged facts and observed phenomena, in connection with the results of some experiments of my own, it became an easy matter to show that the surface of the earth is an immense electric helix, or a series of sections of helices or electric belts, whose right angles are the poles.

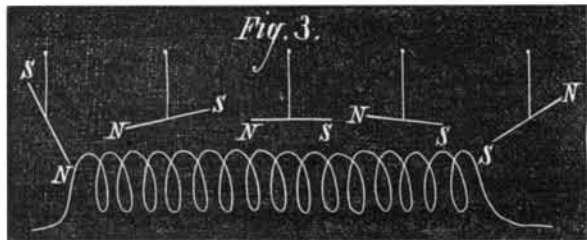
Taking as a basis the two facts that earth belts of electricity exist, and that their direction is east and west, we are at once brought face to face with the phenomena of deflection of a magnetized needle by the electric current, discovered by Ersted in 1819, namely, that, if a magnetized needle be suspended parallel to a wire conductor, the moment an electric current is sent through the wire the needle assumes a position at right angles to the wire, or nearly so, thus:



In Fig. 1 is seen the suspended magnetized needle with its poles parallel to the wire. In Fig. 2 is seen the result when a current of electricity is sent through the wire. And here we have in miniature the cause of the direction of the compass needle. The wire in Fig. 2 represents the earth currents flowing east and west; and, as in this experiment, the compass needle is beyond doubt caused to point north and south by the earth currents, which, flowing east and west, must inevitably cause the needle to assume a right angular direction, which, as we know, is north and south.

But we have not yet made sufficient progress. We have, it is true, satisfactorily accounted for the direction of the needle, but we have not accounted for the dipping of the needle, which, at the poles, is equivalent to its assuming a direct vertical position. Let us examine further.

As the electric belts, surrounding the earth, and moving east and west (at least as rapidly as the diurnal revolution of the earth), must form belts or circles of less and less diameter as we approach the poles, so at the poles we must have the effects of the ends of a helix or coil of wire; and what are these effects from a helix in which the electric current is flowing? Perhaps I cannot better answer and illustrate than by a diagram of a helix with a compass needle suspended in various positions with respect to the longitude of the helix.



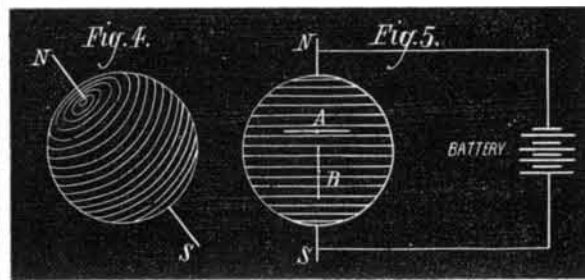
In Fig. 3 it will be observed that, at the longitudinal center of the helix, corresponding to the earth's equator, the needle, being equally affected by both terminals of the helix, preserves a horizontal position, but that, as we approach the terminals, the needle dips and finally inclines to enter the helix. In this simple form we have all the phenomena of the direction and dip of the compass needle, the electric cur-

*In long ocean cables, these earth currents are so strong that they often seriously interfere with the working of the instruments.

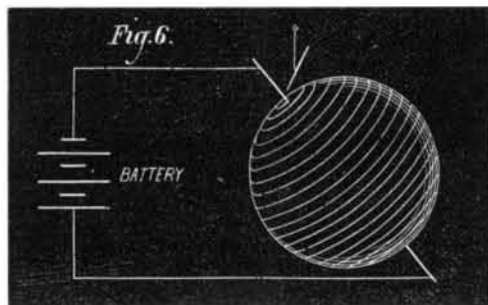
rent, flowing in the coils of the helix at right angles to the needle, corresponding exactly with the electric belts encircling the earth, which flow at right angles to the needle and produce precisely the same results.

The effects of the currents flowing in a helix, it is thus seen, are in every way the same as the effects of the electric currents encircling the earth east and west. The theory that the phenomena of the magnetic needle are due to the existence in the earth of a great magnet or a series of magnets, is not only utterly improbable, in view of the phenomena observed, as it renders the phenomena impossible; but it is utterly and wholly superfluous, since we have in the electric earth belts ample force, and a force which we know could not possibly fail to produce the phenomena. Deschanel, one of the greatest of practical students of natural philosophy, well says: "The actual phenomena of terrestrial magnetism are not in very close agreement with the results which would follow from the presence of such a magnet * * in the earth's interior, nor do they agree well with the hypothesis of two interior magnets inclined at an angle to each other, which has also been proposed. It would rather appear that the earth's magnetism is distributed in a manner not reducible to any simple expression." Thus the problem is abandoned in the glamour of an hypothetical terrestrial magnetism; yet the same author gives a diagram of the lines of equal intensity in the phenomena of the magnetic needle, and these lines are from east to west, precisely as the direction of the electric earth belts, and are closely allied to the isothermal lines. The thermal electric belts encircling the earth, it became apparent to me, must correspond to the isothermal lines, and this has been shown to be the case.

Although satisfied with the results of my experiments, I determined to pursue the subject more thoroughly, for the purpose of demonstrating the correctness of my deductions beyond the shadow of a doubt, and I constructed a wooden globe sixteen inches in diameter, and wound it with a single layer of copper wire, in a spiral running east and west with respect to the imaginary poles. When completed, it was as shown in Figs. 4 and 5.



I then placed a suspended compass needle near the surface of the globe, so that, when no current was traversing the lines, the needle stood in the position shown at A. The instant the battery was applied, however, so as to give the electricity the direction of the earth's belts or currents, the needle assumed the position shown at B, pointing to the north and south poles of our miniature world. Thus in our great world, as in this miniature world, the earth's electric currents, moving in the direction of east and west, deflect the magnetic needle to right angles, so that it points north and south. By varying the strength of the current from the battery, by changing the position of the needle with respect to the north and south poles, and by so connecting the battery with different parts of the helix surrounding the miniature globe as to preserve the isothermal lines of force, so as, in a word, to imitate all the varying strengths and disturbances of the earth's electric currents, I was charmed to witness in the minutest details all the inclinations, declinations, and disturbances of the needle that we witness on the earth, due to the intensities of the electric belts in various localities,



and to numerous electric disturbances. Perhaps I cannot show more clearly than by a quotation, not only the fact that the phenomena of the magnetic needle are due to the electric earth belts, but that these electric belts are continuous, and in large part thermal and frictional, proceeding from the sun's heat and light:

"Besides the gradual changes which occur in terrestrial magnetism, both as regards direction and intensity of force, in the course of long periods of time, there are minute fluctuations continually traceable. To a certain extent, these are dependent on the varying position of the sun; but over and above all regular periodic changes, there is a large amount of irregular fluctuations which are invariably connected with exhibitions of aurora borealis. They are sensibly the same at stations many miles apart, and they affect the direction and amount of horizontal much more than of vertical force" in the magnetic needle.

As we approach the poles of our miniature globe with the needle, it gradually loses its horizontal direction, dipping downward, just as we observe when we approach the poles of the earth, until we reach one of the poles, when it becomes vertical and tends to plunge into, and to one side of, the helix, as indicated in Fig. 6.

The problem is clear enough when we recall to mind that as we travel northward upon the earth from the equatorial electric belt, the north pole of the needle inclines downward at the rate of about 1° for 1° of latitude, until we reach the north magnetic pole, latitude 70° 5' N., longitude 96° 45' W., at which point the needle points directly down to the earth.*

Of the many interesting details of the phenomena observed in my experiments, it is impossible to treat in the space of a single article. At some future time I hope to present the facts more in detail.

What we have learned and what we now know, so far as human knowledge based upon practical experiments can extend, may be summed up as follows:

That the earth is not a great magnet, but that the phenomena of the magnetic needle are due to the electric earth currents, which flow at right angles to the earth's axes.

These are, in brief, the bases of the argument:

1. No placing of magnets in the earth can account for the variations of the magnetic needle.

2. Even if, by a cumbersome and overdrawn hypothesis, magnets could be placed in the earth to produce the effects observed at different places, the variations would still be unaccounted for, for the reason that such magnets would be permanent and without fluctuation.

3. The magnetic theory is utterly superfluous, for the reason that the electric belts surrounding the earth, which we know exist, could not exist without causing the magnetic needle to point north and south.

4. These electric belts, being thermic and frictional, must vary in localities, and according to the situation of the sun with respect to the earth. This we know to be the case, for we not only find the thermic belts of equal intensity, as exhibited in the direction of the needle, closely allied to the isothermal lines, but we find that the needle's perturbations are dependent upon the situation of the sun and auroral displays.

5. The electric belts, not only theoretically, but by actual practical experiment, as we have seen, satisfactorily account for all the observed phenomena.

Washington, D. C.

W. E. SAWYER.

Repairing the Independence Bell.

To the Editor of the Scientific American:

Working in a railroad repair shop, I saw a machinist fit pieces into broken locomotive cylinders, and the idea of repairing the bell on the same principle suggested itself. The process is as follows: A piece is slotted out by a machine (see dotted line in engraving) and the surface is scraped perfectly true; then a pattern is made, and a casting in bell metal is made from it. This piece is planed and scraped to fit perfectly into the slot. This is done with the same nicety as making a patch for a broken locomotive cylinder. To fasten it in its place, an oven is constructed with a door large enough to admit the bell. The bell will stand upside down, on an iron truck, with a wheel under it, so that it can be put in and taken out of the oven conveniently. The oven must be heated by a clear fire, free from smoke, and the flames are



not to touch the bell. The bell and the piece are to be put into the oven, and the door closed, till they become heated hot enough to melt silver solder. Then remove the bell and piece from the oven, and treat the sides of the crack and piece with muriatic acid, prepared as silversmith's acid for soldering. Then coat the sides of the crack and piece with silver solder. Do this part expeditiously, and free the surfaces from dross; then, while the bell is hot and the solder in a soft adhesive state, insert the piece in its place. Have at hand two large pieces of iron (shaped like the inside and outside of the bell), red hot, with suitable tongs for holding them. These are to be used to keep up the heat if necessity requires it. When the soldering is completed, allow the bell to cool off.

I do not propose that the bell be used very roughly when repaired by this process; but I have no doubt it would be a great pleasure for the people to hear the old bell peal forth with clear tone once more.

Ashley, Pa.

CHARLES SMITH.

Ascertaining the Altitude of Clouds.

To the Editor of the Scientific American:

Your correspondent, C. G. Forshey, claims that, by a method which he relates, he has ascertained the altitude of some thunder or storm clouds to be as great as 13 miles.

For amusement, I have often computed the distance to

*It will be noticed that, in the illustrations, I have merely indicated the electric poles, without reference to the axes of the earth, which are slightly different.

some object struck by lightning from a passing cloud, by applying the familiar laws which govern the speed of light and sound: and while thus engaged, I found that, by the application of the same laws, I could also determine, with nearly the same accuracy, the height of the cloud whence the lightning proceeded.

When a flash is seen, it starts from different parts of a cloud, frequently from directly overhead; and after collecting its complement of volume and force (the work of an instant), it leaps to the earth from a quarter of the cloud often quite distant and unlooked for. Upon seeing a flash, starting, say, overhead, I begin counting seconds. After an interval, perhaps of 7 or 8 seconds, rumbling thunder is heard, first overhead, then in various portions of the cloud, differing in loudness according as the different initial forks of lightning differ in distance; then all following the wake of each electric chain, until, in 15 seconds, it concentrates in the final crash. Distance to the object struck, about 3½ miles; height of the cloud, about one mile and a half. When an object is struck close by, these sounds proceed in reversed order. The prolonged rumbling sounds, heard before and after a stroke of lightning, are not all reverberations, but are in great part true detonations of the electric fluid while it is gathering up from the different and very unequally distant quarters of the cloud, before its discharge to the ground.

By my method of computation I find storm and thunder clouds to range from two miles high down to the very ground. I submit my plan with the hope that it will be fairly tested.

Lynchburg, S. C.

The Keely Gas.

To the Editor of the Scientific American:

I notice, in an article headed "Gems from the Keely Motor," in your issue of July 24, the following statement: "It is a vapor of so fine a quality that it will penetrate metal, and is lighter than hydrogen." I contend that such a substance would be contrary to the laws of Nature.

It is well known that the molecules of all substances increase and decrease in size in proportion to the specific gravity of the substance, the lighter substance containing the larger molecules. This may be demonstrated by pouring as much water into a glass as it will hold, then taking a liquid of a heavier specific gravity than water, and adding a portion to the water in the glass. We find that the quantity added before the glass overflows will be in proportion to the difference between the specific gravities of the two liquids. If you then repeat the experiment, but add a liquid lighter than water, you will find that the volume will be increased and the glass will overflow, the quantity overflowing being exactly the same in volume as that which you added. This is explained in the following way: On filling the glass with water, a portion only was filled, there being vacancies between each and every atom of water; on adding a heavier liquid, the atoms of said liquid, being smaller than the atoms of water, pass between them, filling up the vacancies; and until a sufficient quantity has been added to fill those spaces, it does not increase the volume of water; but on adding the lighter liquid, the atoms of which are larger than those of the water, they do not pass between them, but immediately increase the volume and overflow the glass.

If this be correct, and I have good reason to think it is, it at once proves the impossibility of such a substance as this so-called cold vapor is described to be; for it is plain that it would be impossible for the larger atoms or molecules of the cold vapor to pass between the smaller molecules of metal. Were the specific gravity of the cold vapor heavier than metal, instead of being lighter than the lightest known substance, it would be more practicable.

Monticello, Pa.

E. G. ACHESON.

The Remarkable Electric Phenomenon.

To the Editor of the Scientific American:

Regarding the statements relating to the singular electric phenomena described on page 100 of your current volume, as being in some respects opposed to hitherto observed facts, I decided to investigate the case thoroughly, and ascertain in the first place what the facts were, and then see whether they were in accord with previous observations. For this purpose, I sent one of my assistants to the house where the electrical displays occurred, furnished with the proper instruments for making careful and accurate measurements of the resistances of the rods, pipes, and other conductors about the premises.

The first measurement taken was to ascertain the resistance between the two pipes leading to and from the heater. This was found to be less than 0.01 of an ohm, and most of that was probably due to the connections of the galvanometer. Of course this proved conclusively that no sparks ever passed between these pipes, and Mr. Baldwin, the occupant of the house, said that the published statement was wrong in this regard.

The resistances of the supply pipe, overflow pipe, waste pipe, and lightning rod were then measured, with the following results: Resistance of the lightning rod = 161 ohms; of waste pipe = 284 ohms; of overflow pipe = 15 ohms; of supply pipe = 0. The house stands on a hill on the dividing line of a slate and limestone formation, and the lightning rod has been placed in the fissure of the rock to the depth of perhaps 6 or 7 feet, and is therefore partially insulated; and its normal resistance is doubtless much more than 161 ohms, which was found while everything was wet, a rainstorm having come up just before the tests were made. A resistance of 161 ohms in the lightning rod, however, is sufficient, in my opinion, to occasion all the phenomena of discharge which have been observed during heavy storms. The sup-

ply pipe is iron, and leads directly to a spring half a mile distant, where the best earth connection in the country is found. Owing to the insulating quality of the foundation upon which the house rests, the house constitutes one side of a leaky condenser, of which the slate and limestone form the dielectric, and the earth the opposite side. When a thunderstorm occurs, the whole house is charged in a greater or less degree; and as the earth connection of the lightning rod is insufficient to carry all the electricity which it receives, the electricity is discharged through every available channel, of which the supply pipe is the best. In light storms, the phenomenon would not be noticed; it becomes very marked in heavy ones.

In this case the supply pipe was the safety valve of the house. The proprietor of the house was advised to connect the lightning rod to the supply pipe by a large copper wire, which will probably terminate the curious phenomena which have been observed.

I trust the time will soon come when lightning rods will be erected by persons possessed of sufficient electrical education as to be able to tell whether they have a resistance of 161 ohms or of 0. Probably no important business at the present time, is as a rule, entrusted to a class of men so utterly ignorant of their duties as this one. In every case where a building supplied with a lightning rod is destroyed by lightning, the parties who put up the lightning rod ought to be prosecuted. A vigorous course of treatment of this sort would soon convince these people that a reasonable amount of study of the laws of electricity is necessary for their own safety as well as that of their patrons.

I wish that every electrical phenomenon which occurs could be promptly and carefully investigated by competent, practical electricians. Why cannot the scientific departments of our colleges undertake this service? It would furnish a fund of accurate information which would prove of very great practical value.

New York city.

GEORGE B. PRESCOTT.

Purification of Hen Houses.

Advice like the following, which we find in the *Live Stock Journal*, is always in order:

As the hot season advances, poultry keepers should not neglect the purification of the fowl houses. Proper sanitary measures must be taken, or health and successful poultry raising cannot be expected, nor is it deserved. Lime is an excellent purifier, and, when carbolic acid is added to the whitewash, will effectually keep away vermin from the walls. After every cleaning of the floor it should be sprinkled with carbolic acid; dilution, twenty of water to one of acid. This is one of the best disinfectants and antiseptics known, and is not used as much as it deserves. The roosts should be sprinkled with it every week. This whitewashing should be done twice at least, better three times, a year. The nests of sitting hens should be sprinkled with carbolic acid to keep off vermin; and the coops also, where young broods are kept for a time, should be purified in this way. If a hen gets lousy, the dilute acid will destroy the lice, if put under the wings, and on the head and neck. Wood ashes are excellent to be kept in fowl houses for hens to dust themselves with. They are much more effectual than sand; but sand should also be kept for a bath. Without proper attention to these matters, poultry keepers cannot expect to succeed.

BORING BITS.

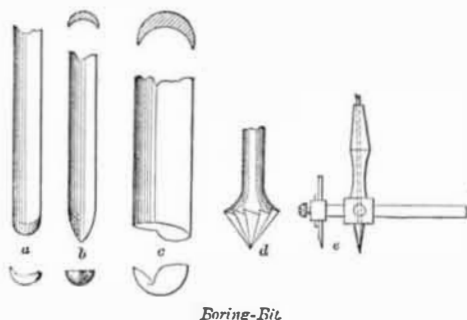
In continuation of our article on augers, published on page 123 of our current volume, we give the following illustrations and description of the various kinds of boring bits in use. The engravings are selected from the pages of Knight's "Mechanical Dictionary."*

In Fig. 1 and succeeding illustrations, various forms of bits are given. The gouge bit *a* (Fig. 1), before the invention of the pod, spoon, and twisted bits, resembled the half of a reed split longitudinally, and had a sharp end like a gouge.

The change to the spoon bit, *b*, was merely giving a conoidal end to the tool, which enabled it to enter more accurately at a given spot. This is the dowel bit used by coopers.

The nose bit or shell auger, *c*, has a long barrel, and the large sizes are used by the pump makers, and called pump bits.

Fig. 1.



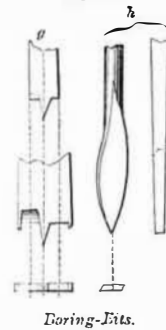
The chamfering bit, *d*, for opening holes so as to admit the conical heads of the ordinary wood screw, consists of a conical reamer with teeth.

The expanding center bit, *e*, consists of a shank and center point, and a chisel-shaped cutter, whose distance from the center is regulated by slipping the bar, like that of a beam compass, in the socket of the head, a set screw maintaining it at its adjustment. This serves for cutting out disks, or for cutting circles for inlaying.

* J. B. Ford & Co., publishers, New York city.

For cutting hard wood, such as the finger and key holes

Fig. 2.



Daring-Bits.

of flutes, bits are employed with a square point and two diametrical cutting lips, *g* (Fig. 2); the smaller one approaches very closely the character of a drill.

The French bit, *h*, for hard wood, is a drill, and as such is used in a lathe head. The center point and two sides merge into an easy curve, which is sharpened all the way round and a little beyond the largest part.

The German pod bit, *k* (Fig. 3), has a long elliptical pod and a screw point. It makes a taper to the end of the hole unless it is driven clear through.

The spiral ribbon, *m*, is a bar having a half round section. This is twisted so as to throw the flat side to the exterior to form the outside of the cylinder; the inside is not filled up by the metal, but makes a hollow spiral, and the bottom end has a single cutting lip.

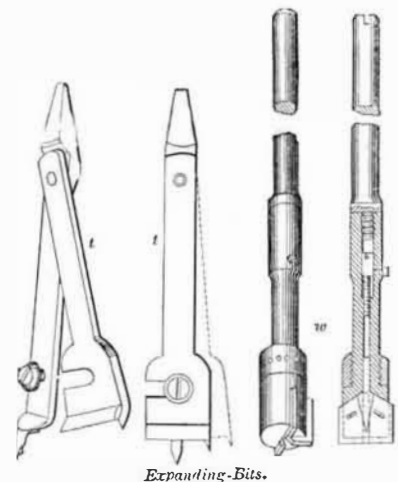
The twisted flat bar, *n*, assumes the form of a doubled threaded screw, no vertical vacancy existing in the twist.

The spiral rib bit, *o*, is known, especially in England, as the American bit and has a cylindrical shaft, around which is twisted and brazed a single fin or rib.

Behind the worm, as in example *p*, may be a small diametric mortise for the reception of a detached cutter which has the nicking point and cutting lip of the ordinary center bit. The cutter is kept in its central position by a square notch which embraces the central shaft of the bit, against which it is forced by a wedge.

The grooved bit, *s*, has a cylindrical stem and spiral groove. One form of expanding bit, *t*, Fig. 4, has a central portion which has the point, and a hinged portion which carries the scribe and the router. The movable portion is set by a screw, so as to regulate the radius of the hole.

Fig. 4.



Expanding-Bits.

Another form, *w*, has three radial cutters, which are expanded by means of a taper wedge and an axial screw. The latter is operated by a screwdriver, whose end is introduced into the socket, the threaded end of which is the means of securing it to the brace.

A Roman Tunnel in Algiers.

Several civil engineers, engaged with the surveys for a water conduit from Touja to Bougie, have made a very interesting and important discovery. A mountain which was situated in the proposed line of the conduit was to be tunneled for a length of 500 yards; and in searching for the most suitable place the engineers discovered an ancient tunnel 6 feet 8 inches in height, and 19 feet 7 inches in circumference. It is supposed that this is the same tunnel mentioned in an epigraph found at Lambéoc, according to which the tunnel was built in the reign of Antonius Pius, the plans being proposed by a veteran of the Third Legion, named Nonius Datus. Finding works like this after a time of 2,000 years, we cannot but be greatly astonished at the power, energy, and genius of a nation which produced, with the limited means available at those times, such gigantic structures.—*Stummer's Ingenieur.*

Successful Swimming Across the English Channel.

Captain Webb, after failing in his first endeavor to swim from Dover, England, to Calais, France, has succeeded in his second attempt, and has traversed the distance, some twenty-one miles, in twenty-two hours and forty-three minutes. This is certainly the most wonderful feat of swimming ever accomplished. Captain Webb wore no life-preserving apparatus whatever, but swam without clothes.

It is not difficult to imagine a man possessing muscular power sufficient to sustain such extraordinary exertion, but that it could be exercised during so long a sojourn in the water, the effect of which is to cool the body below its normal temperature, and so largely diminish the vital force, is surprising.