



## LXIV. The electric column considered as a maintaining power, or first mover for mechanical purposes

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be specimens of native chrysocolla; they proved indeed to be carbonate of copper, but it had formed round longitudinal nuclei of red oxide of copper, so that probably these substances had been copper nails or small pieces of copper used in the building, converted by the action of the air, during so many centuries, into oxide and carbonate.

The ancients, as it appears from Theophrastus, were well acquainted with verdigrise. Vitruvius mentions it amongst pigments; and probably many of the ancient greens, which are now carbonate of copper, were originally laid on in the state of acetite.

The ancients had beautiful deep green glasses, which I find are tinged with oxide of copper; but it does not appear that they used these glasses in a state of powder as pigments.

The greens of the Aldobrandini picture are all of copper, as was evident from the action of the muriatic acid upon them.

[To be continued.]

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LXIV. *The Electric Column considered as a maintaining Power, or First Mover for mechanical Purposes.* By GEORGE JOHN SINGER, Esq.

THE power of the electric column as a source of mechanical action, was first discovered and applied by that excellent philosopher M. De Luc, the admirable inventor of that important instrument; and it is to his active discrimination and unceasing exertions we are indebted for the principal mechanical arrangements which have been employed to render the variable action of the column equal to the production of a constant though unequal motion.

The principal object of such an attempt is to enable an observer to measure the actual variation in the power of the column at different times, and under dissimilar circumstances; and, by a comparison of these changes with the usual meteorological phenomena, to ascertain if any connexion can be traced between the spontaneous electricity of the column, and the natural electricity of the earth and the atmosphere.

For this purpose any arrangement may be employed which is capable either of producing or maintaining the motion of light substances by the immediate action of the column; and that will be most eligible which produces this effect most certainly, and by the least complex means.

With columns of small power, the frequency with which the leaves of Bennet's electrometer are made to open, and strike the

sides of the glass, during their contact with one extremity of the column, for a certain number of seconds, becomes a measure of the comparative power of the instrument at different times: but its distinct expression is prevented by the tendency of the gold-leaves to stick to the sides of the glass; and this arrangement is therefore by no means fitted for permanent observations.

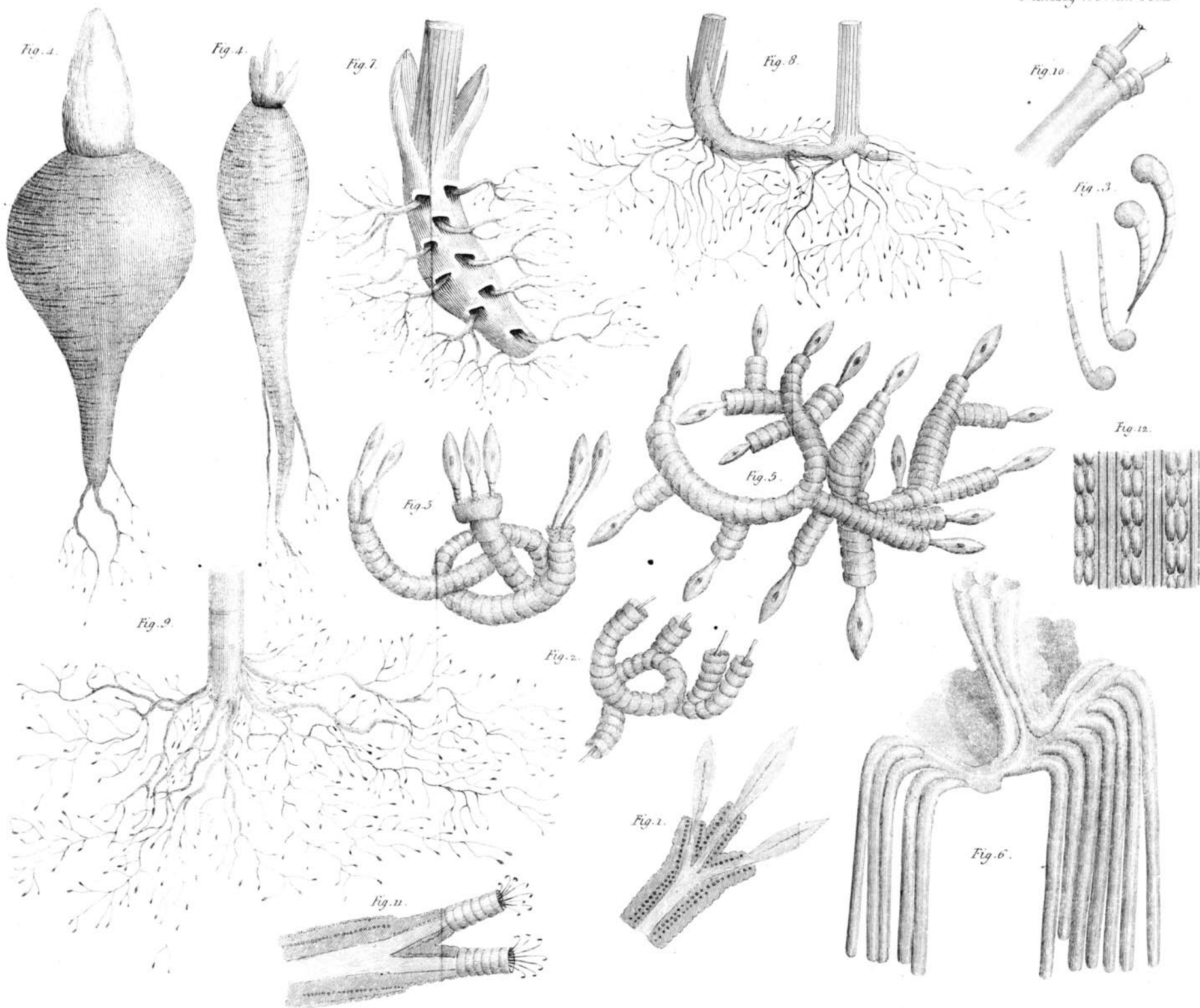
When an insulated conducting substance is freely suspended between two balls, or bells, connected respectively with the opposite ends of the column, I have found that motion is constantly produced, if the weight of the pendulum, and the distance of the bells, are *exactly* proportioned to the acting power of the column at its *mean* rate of intensity: but if these circumstances are not strictly attended to, the motion will soon cease; and the want of complete success in the original experiments of M. De Luc, and of Mr. B. M. Forster most probably arose from this cause; for, in the construction of a number of instruments on this plan, I have had but one failure, and in that instance the apparatus was finished in such haste as to preclude a proper attention to the circumstances above stated.

Fig. 1. Plate VII, represents the arrangement of my Electric Chime. A series of about 1600 groups of zinc, silver, and paper disks, are disposed in two columns, separately insulated in a vertical position; the positive end of one column is placed lowest, and the negative end of the other, their upper extremities being connected so as to form in effect one series, having at each of its extremities a small bell; between the bells a small ball is suspended by a thread of raw silk, so as to hang at an equal and very small distance from each of them if unelectrified. The action of the column occasions this ball to vibrate between the bells and produce an electric chime, in which the variable action of the instrument at different times is indicated by an increased or diminished velocity of ringing. There is a circular groove in the base of the instrument which receives the rim of a glass shade, by which dust and moisture are prevented from impeding its action.

Fig. 2 represents a convenient modification of the arrangement devised by M. De Luc, and to which he has given the name of *Aërial Electroscope*. It is constructed nearly in the same manner as the chime, but has balls at its lower extremity instead of bells. From the positive end a wire W proceeds upwards a few inches parallel to the column, and is then bent into a hook to serve as a support to the pendulum, which consists of a fine silver wire to which a gilt pith-ball is attached. This

\* This Plate will be given with the next number.

pendulum,



pendulum, being in conducting communication with the positive extremity of the column, will necessarily recede from it and approach the opposite ball; but it is prevented from actual contact with that ball by a brass fork F, across which a very fine silver wire is stretched. This wire discharges the electricity of the pendulum, and at the same time produces a kind of jerk which prevents the pith-ball from sticking: the pendulum now falls again into contact with the positive ball, but becoming again electrical recedes from it and again strikes the cross wire; and in this way, if properly constructed, may continue its vibrations for an unlimited period.

I have sometimes made a variation in this apparatus, by removing the cross wire and the conducting support of the pendulum, and by substituting for it a pith-ball suspended by a silk thread, and accurately proportioned in weight and size to the medium power of the column. By this means the motion occurs over more space than in either of the preceding arrangements, and is therefore more obvious, and well calculated for observation, as the irregularity is considerable, and may be noticed when the temperature of the surrounding medium varies but slightly.

During my employment of the very extensive series of columns I have constructed, I have frequently attempted to produce a rotatory motion by the direct action of their electrical power, but hitherto the attempt has continued unsuccessful; by indirect means, however, the same object has of late been very ingeniously obtained. In October last, my friend Mr. Lightfoot, a very active philosopher, who has made many interesting observations on this subject, first suggested the employment of an inflexible pendulum as a means of converting the reciprocating motion usually produced by the column into a source of rotatory movement; and the correctness of this idea was soon afterwards practically verified by my pupil Mr. F. Ronalds, who with the assistance of a watchmaker has made a very successful and truly ingenious arrangement, by which a simple and curious electrical clock is produced.

The rotatory motion obtained by this indirect means, is however rather curious than useful; for it is scarcely so correct an indication of the power of the column as the simple pendulum, and requires a much more extensive series to keep it in motion; it cannot therefore be preferred for the usual purposes of observation, and has I fear very little chance of becoming at all useful as a time-keeper; for the variable action of the column must render it a most irregular maintaining power, which it will be very difficult, if not impossible, to correct effectually.

The most elegant and at the same time the most simple movement yet produced by the action of the electric column appears to

to be that employed by Signior Zamboni, who has made some interesting discoveries on the general structure of the instrument. He employs a vertical needle supported by a delicate pivot or knife-edge a little above its centre of gravity, the position of which may be readily altered by means of a sliding weight attached to the lower extremity of the needle, which may by that means be so adjusted as to possess the properties of an accurate scale-beam, and will maintain its oscillations over a considerable space by a very slight impulse.

The upper end of the needle, for at least an inch, is formed of varnished glass; and on this a ring of gold, or a gilded ball of pith or cork, is fixed; the axis of the needle is supported midway between two vertical columns insulated, but connected together at bottom, so that the upper ends of the columns become the positive and negative extremities of the series; the upper and insulated extremity of the needle comes in contact alternately with each of these ends, receives its electrical state, and recedes towards the other, where the same process ensues; and thus the vibrations of the needle are maintained with great constancy over a considerable space.

Fig. 3 represents the form I have employed for this construction: the needle is supported by a brass arm which slides on one of the columns; it is suspended by a delicate pivot, and has at its summit a fine varnished glass tube to which a gilded ball is affixed; the lower extremity of the needle is provided with a sliding weight, by which the relation of the centre of gravity to the point of suspension is accurately adjusted: to render the contacts perfect, and least liable to change, the gilded ball does not strike the brass caps of the columns, but touches alternately two gold wires connected with them.

In this construction the needle is not moved by the direct attraction of the column; but being once put into a state of vibration, its motion, which would naturally decline, and finally terminate by the operation of friction and by the resistance of the air, is renewed at each contact by the impulse of electrical attraction, which is alternately exerted on the needle in opposite directions by each extremity of the column; and as this attraction does not sensibly act on the pendulum until it is very near the attracting surface, its operation commences when it is most wanted, and, without materially affecting the action of the pendulum in any other way, occasions it to describe constantly equal arcs at every vibration.

It is obvious, that by connecting a proper lever and ratchet-wheel with the axis of the needle, motion may be readily communicated to indexes, or to other wheels; and this I am informed has been done during the past year, by some experimentalists

talists on the continent. I have since tried the experiment, and find it succeeds perfectly, but requires a more extensive series to overcome the increased friction.

An effect very nearly resembling the action of the beam of a steam-engine may be produced by placing the needle in a horizontal instead of a vertical position. For this purpose it should be constructed in the same manner as an ordinary scale-beam; having equal arms terminated by gilt balls, and its point of suspension above its centre of gravity. If a needle of this kind be insulated, and placed with one of its balls a few inches above the positive extremity of a powerful column, whilst the opposite ball is similarly situated with respect to the negative extremity, it will, when once put into a state of oscillation, continue to move with considerable regularity, and with a momentum which renders it probable that, by the application of a proper mechanical arrangement, a tolerably regular source of rotatory motion would be obtained.

I have now completed a series of columns comprising upwards of 50,000 groups of a peculiar and powerful arrangement, but have not as yet combined them so as to institute any accurate experiments on their effects; but I trust it will not be long ere I have leisure to accomplish this object.

London, May 1, 1815.

G. J. SINGER.

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LXV. *On the Coal and Stone Strata of Durham.* By  
NAT. JOHN WINCH, Esq. of Newcastle.

*To Mr. Tilloch.*

SIR,—IF your correspondent who writes under the signature of "A Constant Reader," in the *Philosophical Magazine*, has access to the papers of the Geological Society of London, I beg leave to recommend him to inspect the numerous sections of collieries situated in this vicinity, which are deposited in the library of that Institute. By taking this trouble, he will soon perceive that strata of stone and coal vary not only in thickness, but are sometimes replaced by beds of different descriptions at places by no means distant from each other; and of course that a single section, such as that adopted by Mr. Forster, can convey but a very inadequate idea of the stratification of this part of the kingdom. But should his residence be out of town, the following information relative to the Newcastle grindstone bed may prove acceptable to him. On Gateshead Fell and Wickham Banks (see the Map of Durham) this stratum is 11 fathoms thick, and lies 38 fathoms above the High Main Coal; it is also  
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