wires. The power of multiplication does not, as Dr Seebeck proved in 1820, increase with the number of wind­ings in the uniting wire, as the resistance to transmis­sion increases with the length of the wire, thus dimin­ishing the conducting power of the wire. Professor Orested improved the multiplier@@1 by adding a bent mag­net, as shewn at JKL, fig. 66, which can be placed so as to repel the nearest end of the needle, or index, or to attract it. In the position in the figure the first of these effects is produced ; but by turning the angle of the bent magnet towards the needle, the second effect is produced. By causing the pillar which carries this magnet to approach to, or recede from the needle, the directive power of the needle may be made scarcely sensible. In this state the instrument will shew the difference in the voltaic effects produced by two pieces of metal, which differ only by 1/100th of alloy when a powerful liquid is used. Professor Cum­ming, we believe, first suggested the idea of neutralizing the directive force of the needle, arising from the earth’s magnetism, which he did by placing a magnetized needle immediately beneath the moveable or index needle.@@2

M. Nobili has improved this instrument by using two needles, as in fig. 66 ; but he fixed the neutralizing needle S'N', to the moveable one NS, placing the one above the other, with their poles reversed. The two needles are fixed in a piece of straw’ GH, and suspended by a silk fibre at G. The needles were twenty-two lines long, three wide, and one-fourth thick, and GH was five lines. The wire was a copper one, one-fifth of a line in diameter, and thirty feet long, and covered with silk. It made seventy-two evolu­tions round the frame.

M. Lebaillif has extended this principle by using four needles in place of two, each pair being exactly the same as in fig. 66, the one being brought near the upper surface of the coil, and the other near the under surface. In this instrument the increased weight of the needles may com­pensate any additional sensibility possessed by the approxi­mation of the needles to the sides of the coil. The instru­ment is shewn in fig. 67, where *ab, ab* are the four needles, *mnop* the square bobbin, around which the wires are coiled, one or two feet of their length at each end being left free, as at *gi, gf,* that the electric current may enter at the one, and is­sue from the other. Instead of a single wire 300 feet long, M. Lebail­lif employs *five* parallel ones, each end of which is stripped of the silk, and united by strong pressure into a bundle. The electric current thus divided into five parts, flows in five channels, which, according to M. Pouillet, transmit a proportionally larger quantity of electricity, while the diminished intensity produced by a great length of wire, is avoided.@@5

A torsion galvanometer invented by Dr Ritchie,@@4 is shewn in fig. 68. Having covered a fine copper wire with a thin coat of sealing wax, he rolls it about a heated cy­linder, an inch or two in diameter, ten, twenty, or any number of times. The opposite sides of the circular coil

are then pressed together, till they become parallel, and about one or one and a half inches long. The coil W is then fixed on a proper sole, and the ends of the wires connected with two metallic mer­cury cups C, C. A graduated disc of paper is then placed horizontally on the upper half of the coil, hav­ing a black line drawn through its centre, parallel with the middle line of the coil. A small magnet SN, made of a common sewing needle, is then fixed to the lower end of a fine glass thread, while the upper end is securely fixed with sealing wax, in the centre of a moveable index I, as in the torsion balance. This is inclosed in a glass tube T, fitted into a disc of thick plate glass, which forms the upper surface of the box. When a voltaic current passes through the coil W, the needle SN is deflected. The glass thread is then twisted by turning the index I, till the needle is brought back to its former position, and the number of degrees of torsion will be an accurate measure of the quantity of electricity, whose de­flective power over the needle is exactly balanced by the torsion of the glass fibre.

A very ingenious galvanoscope, for ascertaining merely the existence and direction of an electric current, is de­scribed in the Library of Useful Knowledge.@@4 It is shewn in fig. 69, where M is the needle, T the suspending fibre, placed between four vertical spiral coils, the centres of which are brought very near the poles of the needle. The same voltaic current is made to circulate through all the four spirals, which have their turns such as to produce repulsion of the contiguous pole on the one side, and attrac­tion of the same pole on the other side. The wire of the four spiral discs proceeds from the mer­cury cup P, and terminates in another cup N. In this admirable instrument, the current is brought as near as possible to the needle, so that its action is very powerful. The whole force of the four discs is quadruple that of a single one, as they all concur in giving the needle a deviation in the same direc­tion.

Gold-leaf has been employed in the formation of the *gold-leaf galvαnoscope,* which is similar in construction to Bennet’s gold-leaf electrometer. The strength of the cur­rent is indicated by the curvature of the strip of gold-leaf *fh,* fig. 70, which is held loosely by forceps at *f* and *h,* each forceps terminating in a mercury cup, the one, P, being above, and the other, N, below. The gold-leaf is enclosed in a glass case, the middle of which is placed equidistant between the poles M, *m,* of a horse-shoe mag­net. When the electric current passes through the gold-

@@@1 For a perspective drawing on a large scale, of this instrument, see Edinburgh Encyclopædia, art. Thermo-Electricity, plate 522, fig. 11.

@@@a Trans. Cambridge Phil. Soc. vol. i. p 279

@@@\* Pouillet's Elemens de Phys.. Exp liv. v. chap. i. sect. 412. and Library of Useful Knowledge, art. Electro-Magnetism, p. 44.

@@@\* Phil. Trans. 1830. p. 218.

@@@. Art. *Electro-magnetism,* part ii. chap, viii. p. 44, fig. 82.