

It is the elementary part of a subject which is always so badly taught, chiefly because it is a general belief that any one can teach a child. We are, therefore, pleased to welcome in Parts I., II. and III., an exceedingly clear statement as to what sections of arithmetic should be taught, and how they should be taught to young children.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

A Machine for Drawing Compound Harmonic Curves

IN NATURE (vol. xx. p. 103) there appears an abstract of a paper by Prof. E. W. Blake on a machine for drawing compound harmonic curves. Prof. Blake is doubtless not aware that this machine is based on a plan proposed by Prof. Perry and myself in our paper on "the music of colour and visible motion," read before the Physical Society, November 23, 1878. In that paper, after the description of our own motion-compounder, will be found the following:—"But it is possible that in our new machine we shall adopt a totally different plan, and one which we think is new. If the two extremities of a long rigid rod have parallel motions perpendicular to the rod, the middle of the rod has a motion equal to half the sum of the extremities. Thus the parallel motions of 2, 4, or 2ⁿ points may be compounded. Similarly for 3 points, one-third of the sum of parallel motions is obtained from the centre of a rigid triangular piece of which the points are the corners; so that by bars and frames of simple construction it is easy to get the sum of the parallel motions of any number of pieces."

But I think that this method which we suggested, and which is the one now described by Prof. Blake, is inferior to the roller-cam principle employed by us in the instrument we constructed, and explained to the Physical Society, in that with the latter in its complete form we can alter, while the machine is actually in motion, the amplitude as well as the phase, by any desired amount, of any one of the component vibrations. This facility, although not possessed, as far as I am aware, by any other motion compounder, is extremely desirable for the varied description of compound curves, whether these curves be merely intended, as in the ordinary forms of such instruments, to show the resultant of two or more vibrations, or be designed, in accordance with the plan of Mr. Perry and myself, to work on the emotions, in the rendering of a new genus of music, by the varied, yet controlled, motions of the body, or bodies, describing these curves.

W. E. AYRTON

Lightning Conductors

ON the night of Wednesday, May 28, shortly after ten o'clock, my father's house at Caterham, in Surrey, was struck by lightning. We had not noticed any thunder before going to our bedrooms, but shortly after doing so we saw a very vivid flash, followed by thunder after an interval of perhaps five seconds; three or four minutes after this there came with a terrific crash the flash which struck the house, and afterwards no more thunders or lightning sufficient to attract our attention while we were intent upon investigating the mischief done.

The house stands high, upon a hill upwards of 700 feet above the sea; it is somewhat higher than any house or other object in its immediate vicinity. Roughly speaking, it may be described as a square block surmounted by a steep tiled roof, the ridge of which runs north and south, and astride upon the ridge stand two chimney stacks of equal height; from one corner of the square block runs away an extension, the roof and chimney stacks of which are upon a somewhat lower level.

Upon the northern chimney stack, at its eastern end, was the lightning conductor, which consisted of the usual hollow rod ($\frac{1}{2}$ inch) at the top, continuous with a flat plaited rope of copper and zinc wire (1 inch in width), carried through glass insulating rings along the slope of the roof, over the rain-water gutter, and down the side of the house into the ground.

The flash first struck the lightning conductor, hurled the rod down, and shattered the chimney-pots and a little of the brick-work; it seems to have followed the chimney-stack down to the ridge of the roof, and there to have divided. That portion of the discharge which passed down the eastern slope of the roof seems to have followed the chain portion of the lightning conductor as far as the rain-water gutter (iron); this it slightly broke, and broke also two panes of glass immediately beneath it, but this portion of the flash could be traced no further, and dead leaves, &c., about the remainder of the lightning conductor would seem to indicate that none had passed down that, at least not any large quantity.

The greater part of the discharge seems to have utterly left the guidance of the conductor, and to have first followed the lead flushing of the chimney stack down the western slope of the roof; a foot or so below the end of the flushing the roof was perforated, and the tiles broken and thrown down; thence, without any disturbance of the intervening tiling the discharge leapt a distance of some 15 feet, perforated horizontally a 9 inch-brick wall, covered on its exterior by weather tiling, and so reached an iron water cistern immediately within this wall. The woodwork about the cistern was started, but not much splintered; thence the discharge passed downwards by way of the water pipes, down two stories to a force-pump in the scullery, and thence, probably, by the pipes, down into the subterranean water-tanks.

But the pump in the scullery was provided with a pipe and tap over the sink, and there was also a small "tell-tale" pipe from the cistern above, designed to show when the cistern had been filled. This also terminated over the sink. Along these some part of the discharge was led, and not being safely conducted away, threw down and shattered the slate about the sink.

The perforation in the brick wall was circular, large enough to easily admit one's finger, and was blackened on its interior; when first found, eight or ten minutes after the occurrence, it was still quite hot.

The practical question that presses for an answer is, what did the lightning conductor do for us? Its selection as the point struck seems as though it brought the discharge upon the house; certainly it, although I believe of the usual construction, was utterly inadequate to carry off, or even direct the course of, the discharge, for a most copious and violently destructive discharge passed altogether from it and down over the opposite or western slope of the roof.

On the other hand, the iron water-tank and its pipe system proved adequate and safe conductors of the electric fluid, which left not the smallest trace of its passage along them until it reached the scullery sink, and there would presumably have done no harm, had it not been for the existence of the tap pipe, which led a portion of it astray. And on both faces of the house the iron gutters and rain-water pipes seem to have proved efficient conductors, for no violently destructive effects were manifested, save the breaking of two panes of glass after the electric fluid reached them. But as I am no electrician I can add nothing useful to the bare narration of the facts. I should add that the soot was very completely and violently ejected into the rooms from the chimneys of the stack struck.

CHARLES S. TOMES

P.S.—Subsequent closer examination of the portions of the lightning-conductor showed that there were traces of fusion of the hollow copper rod at its junction with the rope which had been inserted into it; the sectional area of copper here available for carrying the discharge seems to have been less than that in either the rod or the rope. Slighter traces of fusion existed here and there in the whole length of the rod. In its passage round the water-gutters the discharge cracked each one at its junction with the next segment; that is to say, the iron was cracked wherever the interposition of a little red lead to make the joint tight offered increased resistance to its passage, and the lead flushing of the roof was fused below the perforations in the brick wall, indicating that the whole discharge did not go through the wall to the iron water-tank.

THE effects produced by the recent thunderstorms are so interesting and instructive that I think it worth while to record the results of investigations which I have made personally or had made for me.

On May 31 there was published in the *Times* particulars of the damage done to the church at Laughton-en-le-Morthen, and the conductor was described as a thin corrugated tube of copper made