OUR FINGERS AS AN AID IN MULTIPLICATION.

Perhaps one of the most difficult tasks in pedagogy —a task which exacts the utmost patience on the part of both instructor and pupil—is the teaching of the multiplication table. Month after month teachers expend their time and use their skill in demonstrating and explaining by all possible means exactly what the product of two numbers represents. Often enough these efforts have been vainly expended. After the children have apparently mastered those products in which the numbers 7 and 8 occur, they pass to those in which the number 9 figures, and while mastering these, often completely forget the preceding series. As a general rule, the products from 2 to 6 are quickly mastered and easily retained; but in multiplying together numbers greater than 6, the child proceeds slowly. Beyond 12, even adults find mental multiplication difficult, and resort to pencil and paper.

A Polish mathematician, named Procopovitch, has given his attention to this matter of multiplication and has invented a system which, for ingenuity and simplicity, leaves little to be desired. Procopovitch had often noticed that children used their fingers in mathematical computations which were at all difficult to them, and hence devised a method of manual multiplication that has been successfully used in many European schools. Procopovitch's system neglects all products involving numbers less than 6, because, as we have already observed, these products are readily learned by most children.

The Polish mathematician first numbers the fingers of each hand. The two thumbs each represent 6, the index-fingers 7, the middle fingers 8, the ring-fingers 9, and the little fingers 10. In order to multiply any two of these numbers, the fingers representing the multiplier and the multiplicand are placed end to end. Beginning with the fingers which have been thus placed together, the number of fingers is counted, proceeding toward and including the thumbs. The sum will be the number of tens contained in the desired product. Below the fingers which have been joined, a certain number still remains. The fingers remaining on the one hand, multiplied by those left on the other hand, will give the number of units, which, being added to the tens, gives the desired product. For example: Suppose that 8 is to be multiplied by 9. The middle finger of the right hand is placed against the ring-finger of the left hand, as shown in Fig. 2. Counting the number of fingers above those which have been placed together, including these, seven fingers, representing 7 tens or 70 in the product sought, are obtained. There still remain on the right hand two fingers, which, multiplied by the one finger remaining on the left hand, give 2 as the number of units. These two units added to the tens already obtained give 72, the product of 8×9. It is, of course, immaterial on which hand the multiplier or multiplicand is taken.

If it is desired to multiply 7×9, then the same method is employed, the index-finger of one hand being placed against the ring-finger of the other hand, as shown in Fig. 3. Counting the number of fingers above those placed together, and including these, 6 tens or 60 will be obtained. Multiplying the three fingers remaining on the right hand by the one left on the other hand, 3 units are obtained, which, added to the 6 tens, give 63 as the product of 9×7 or 7×9.

If it is desired to multiply 6×6, the two thumbs are placed together as shown in Fig. 10. The two thumbs represent here only two tens in the required product, there being no other fingers above those joined. Multiplying the four remaining fingers on the one hand by the four on the other, 16 is obtained. This added to twenty gives $20 + 16 = 36$, the product of 6×6. Figs. 1 to 10 inclusive represent the multiplication of various factors in the series.

The Polish mathematician does not stop here, but extends his system to numbers greater than 10. In the old method, the multiplication of factors composed of two ciphers involved difficulties which, as we have already observed, could be overcome only with the assistance of pencil and paper. In this system of manual multiplication these obstacles are easily surmounted and the results obtained are in every way as remarkable as those already described. In the first series, comprising numbers of two ciphers, the thumb represents 11, the index-finger 12, the middle finger 13, the ring-finger 14, and the little finger 15. When multiplying one number by another, the fingers representing the respective factors are placed together as before. The number of fingers above those joined, including these, will in this case also indicate a certain number of tens. The lower fingers are, however, entirely neglected. In order to obtain the number of units, the fingers which have already given the number of tens are again taken, the number on the one hand being multiplied by the number on the other hand. The product thus obtained is increased by 100 and the sum added to the number of tens. Suppose that 13 is to be multiplied by 14. As indicated in Fig. 11, the fingers representing these numbers are joined. Counting the number of fingers above those which have been placed together, including the latter, 7 tens or 70 are obtained. Taking these same fingers again and multiplying the number on one hand by the number on the other hand, the product 12, representing the number of units, is obtained. Adding to this the constant 100 and the number of tens, there results $70 + 12 + 100 = 182$, the product of 14×13.

Another method could be employed which, although it would lead to the same result, is not so simple. In this second method, the fingers above those which have been joined, including the latter, represent the number of twenties. In Fig. 11, for example, there are on the right hand three fingers and on the left hand four fingers, giving 7 twenties or 140. The remaining fingers, three in number, represent the number of tens, and in this example are equal to 30. Finally the four fingers on the left hand, representing the twenties, multiplied by the three on the right hand, also representing the twenties, give 12 for the number of units. Adding, there results $140 + 30 + 12 = 182$.

In multiplying two numbers each of which is greater than 15, a new series is employed extending from 16 to

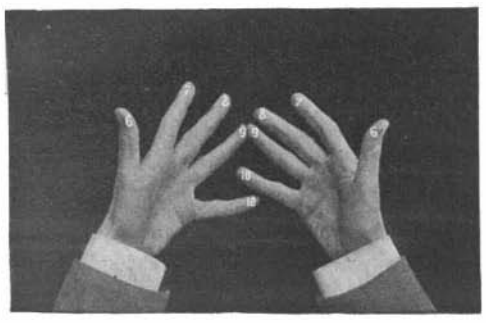

Fig. 1.—Multiplying 9×9.

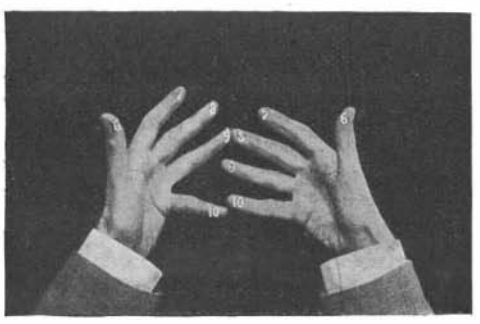

Fig. 2.—Multiplying 9×8.

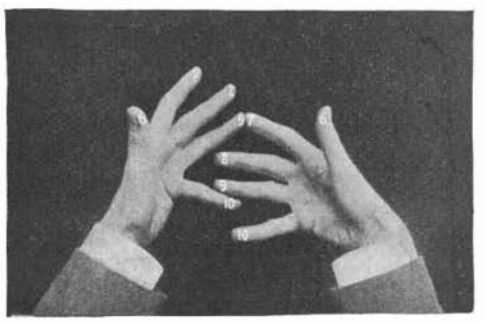

Fig. 3.—Multiplying 9×7.

Fig. 4.—Multiplying 9×6.

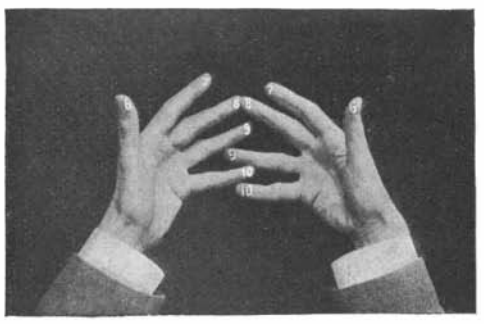

Fig. 5.—Multiplying 8×8.

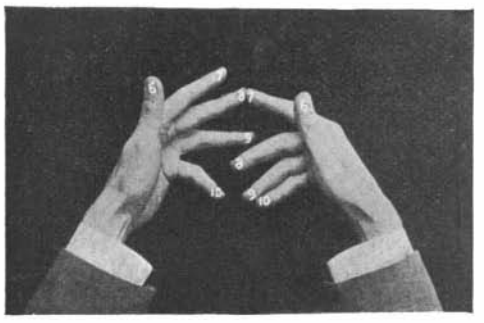

Fig. 6.—Multiplying 8×7.

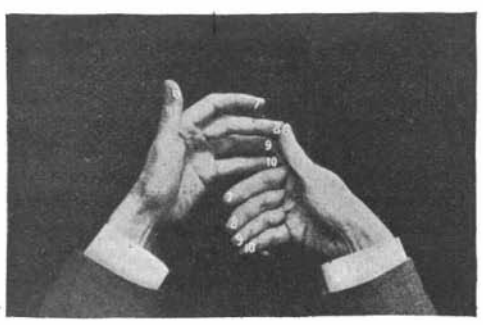

Fig. 7.—Multiplying 8×6.

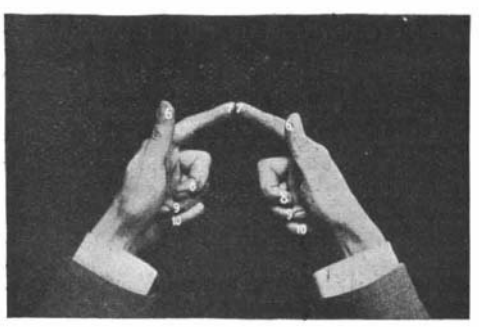

Fig. 8.—Multiplying 7×7.

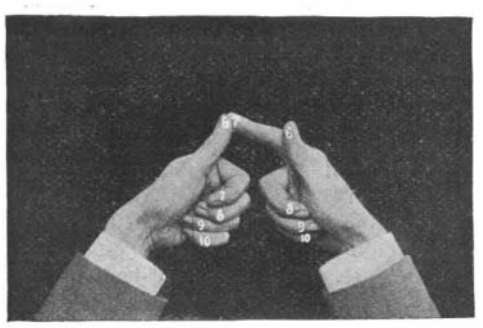

Fig. 9.—Multiplying 7×6.

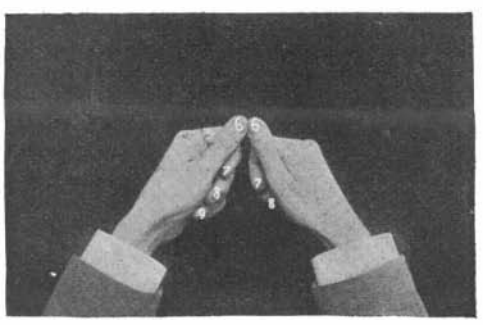

Fig. 10.—Multiplying 6×6.

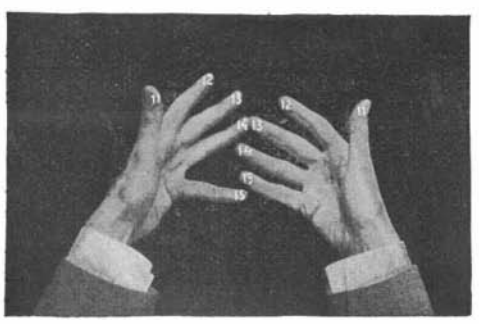

Fig. 11.—Multiplying 14×13.

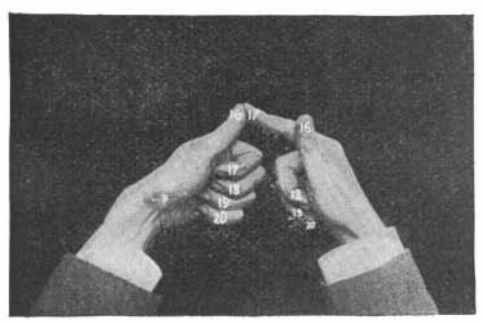

Fig. 12.—Multiplying 16×17.

RAPID METHOD OF MULTIPLICATION WITH THE FINGERS.

20. In this series the thumb represents 16 and the little finger 20. The fingers placed together added to those above give the number of twenties. The constant to be added in this case is 200. If it is desired to multiply 16 by 17, a product not readily obtained by mental calculation, the fingers representing the factors are joined as indicated in Fig. 12. The thumb of the left hand, representing the multiplier, being placed against the index-finger of the right hand, gives, with the remaining thumb, 3 twenties or 60. The four fingers remaining on the left hand multiplied by the three lower fingers on the right hand give as the number of units 12. Adding to this product the constant 200 and the number of twenties, there results 60 + 12 + 200 = 272.

In this manner the series can be extended indefinitely, the only condition to be observed being that the multiplier and the multiplicand should be members of the same series of five numbers. The entire system of manual multiplication rests on this condition.

SPIRIT SLATE WRITING AND KINDRED PHENOMENA.—III.

BY W. E. ROBINSON.

We will now describe a trick which is performed with the aid of two double slates, either tied together or riveted at the corners. They are, of course, brought to the medium by the unbeliever. Both the medium and the stranger sit at the table, and the slates are held under it, the medium grasping one corner and the skeptic the other corner, each with one hand, and the disengaged hands are clasped together above the table. After a time the slates are laid upon the table, the string is untied and the slates are taken apart, but no writing is found. The medium states it must have been because there was no slate pencil, and when a small piece of pencil is placed between the slates and they are again tied with a cord by the medium, he again passes them under the table, both persons holding the slate as before. Presently writing is heard, and, upon the skeptic bringing the slates from under the table and untying the cord himself, he finds one of the slates covered with writing, though but shortly before they were blank. The explanation is simple; the medium does not pass the slates under the table the first time, but drops them in his lap with the side where the string is tied or knotted downward, and really passes a set of slates of his own for the skeptic to hold, the medium supporting his end by pressing against the table with his knee, which leaves his hand disengaged. He now covers the face of the slate which is uppermost in his lap with writing, doing so very quietly and without noise. As he brings the slates above the table he leaves his own in his lap and brings up the skeptic's with the writing side down. The slates are untied and taken apart and shown devoid of writing on the inside, which he claims was caused by not having any pencil inside. The medium now places the pencil upon the slate which was originally the upper one, covers this with what was the bottom slate, which is covered with writing inside on the back or bottom of the slate. This action brings this slate on top, with the writing upon its inside. The slates are again tied together, and, in doing so, the slates are turned, bringing the slate containing the writing upon the inside at the bottom, instead of the top; the string is tied or knotted above the top slate. Of course, when again separated, the writing is found upon the inside of the lower slate. When the slates are passed under the table the second time, the spectator himself is allowed to do this, and the medium with one of his finger nails, while holding his end of the slate, produces a scratching noise on the slate, closely resembling the tracing of a pencil. The slates may be held above the table the second time if preferred

In case two slates are brought which are riveted or screwed together, another method must be employed. The slates are held under the table in the same manner as in the previous tests; the medium is provided with a hardwood wedge and a piece of thin steel wire at one end of which is attached a tiny slate pencil. An old umbrella rib is sometimes used, as it has a small eye at the end through which the pencil is forced. The wooden wedge is pushed between the wooden frames of the slates at each side. The frames and slates will give enough to allow the wire and pencil to be inserted and writing being accomplished with it, after which the wire is withdrawn and then also the wooden wedge. All this is done without leaving any trace or mark behind it. (See Fig. 7.)

Another method of slate writing was performed by a prestidigitateur, but the means employed belong rather to the conjurer than to the spiritualist. This called for the placing of a slate on a table, and, while the committee held their hands upon the slate, the sound of writing was heard, and in a few moments a message was written upon it. The table had a double top, with room enough to conceal a small boy. There was a neatly made trap beneath the table cloth and the top of the table, the cloth being glued around the opening to keep its place. The trap door opened downward, and the boy concealed in the table opened it and did the necessary writing on the slate and again closed the opening. This idea was improved upon by doing away with the boy and the double-top table. The writing was then done with the lights turned down low, and the medium introduced his hand under the table, opened the trap and did the writing, and shut the trap before the lights were turned up. The medium and the committee sat around the table with their hands resting on the slate and each person's hand touched that of his neighbor, so that neither could move without the other being aware of the fact, but the medium's right hand neighbor was a confederate.

Another method of producing writing upon the inside of two slates sealed together is as follows: The table is the same as that previously described. The slates are two single ones hinged together and sealed around the edges in any manner the committee may see fit. One of the slates is a trick slate; the slate itself working on a pivot or hinge along one of its

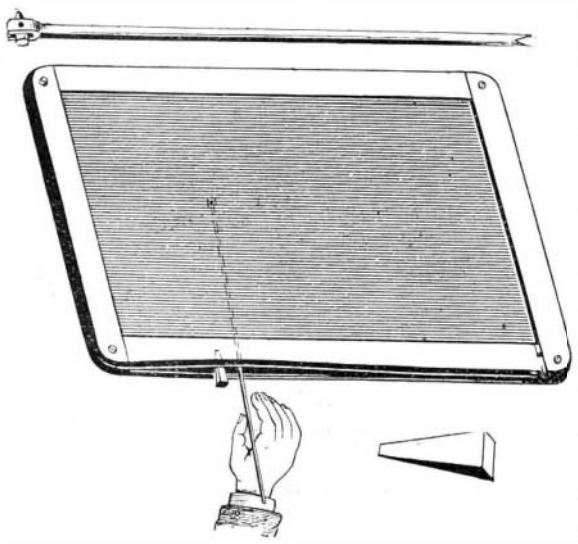

Fig. 7.—WEDGING APART THE SLATES.

sides. (See Fig. 8.) A catch is concealed in the frame of the slate which releases the slate proper and allows it to drop down on its hinge or pivot, so that when the slates are placed on the table they are put directly over the trap on the table, with the hinges of the two slates toward the medium. The medium releases the catch, which allows the underneath slate to drop as far as the table and, when the trap in the table is open, the slate drops with it far enough for the medium to write on that part, also on the slate above it. He then closes both the slates and the trap in the table, and the slates, upon being unsealed, are found covered with writing.

The only thing which now remains to be explained is how the medium gets his hand free to do the writing without being detected. The lamp or gas jet is close to the medium's right hand, where he can reach it. Now all the persons are seated around the table with their hands on the slates, and their hands or fingers touch one another. The medium, taking his right hand away, turns down the light, and his next door neighbor, as soon as the light goes down, feels his, the medium's hand or finger, replaced; at least so he thinks. What really happens is this: The thumb of the medium's left hand is stretched far enough over to touch the hand or finger of the person sitting on the per-

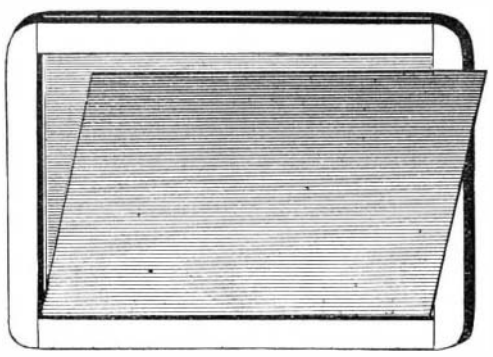

Fig. 8.—THE TRICK SLATE.

former's right hand side. The medium now produces the writing, and when finished, as the gas turns up, he removes his left thumb to create the impression that he has just taken his right hand away for the light. The same trick may be performed above the table on an ordinary slate.

Evils of the Match Industry.

In the manufacture of the ubiquitous match, as is well known, the use of phosphorus entails many miseries and discomforts upon those engaged in the manufacture, they being mostly women and girls. Existing lesions of any kind are thereby likely to become aggravated, owing to the fumes of phosphorus that arise from the "dipping" trough, fumes that are highly irritating to eyes and throat, to lung tissue, and that, by permeating the cavities of the teeth, frequently provoke carious disease of the jaw, leading to hideous deformities, perhaps even to fatality.

Recently attention has been called to the conditions existing in the match factories of Great Britain, and an investigation revealed such a deplorable state of affairs as led to memorializing the Home Secretary. How far these or similar conditions may obtain in the United States and Canada is not known, and perhaps would be difficult to determine, since the "hands" are constantly entering and going or shifting. Further, ordinary commercial ("stick") phosphorus is now very little employed, thanks to the demand for the "parlor" match, which requires the amorphous variety, which is nearly odorless, gives off little fumes, and is but slowly and with some difficulty absorbed by the human economy. If handled with ordinary precautions, amorphous phosphorus is scarcely at all objectionable or dangerous; but, unfortunately, the average employe is apathetic as regards self, and not at all inclined to adopt measures that entail extra care or labor.

Abroad the demand for cheap matches, regardless of character or composition, is much greater than in the United States, and antiquated and cheap methods generally obtain. "Stick" phosphorus continues to be used to a degree not known for many years on this side of the Atlantic. On the Continent of Europe, generally, however, the governmental paternalism is such that it is possible to throw certain safeguards around factories and employes such as would not be tolerated in English-speaking countries. In France and Belgium, for instance, as well as Germany, Sweden, and Norway, certain stringent rules are formulated, that not only must be printed in large and legible type, and posted conspicuously everywhere throughout a plant, but are required to be read as often as once each week to the employes. Further, dining and lunch rooms are provided in connection with every establishment, along with suitable clothing and retiring rooms, lavatories, etc. It is enjoined that no food or drink be brought into the building, except as provided for by the management; consequently, eating and drinking in the workshops are prevented. Even the chewing of gum is prohibited. Before partaking of any meal, and prior to leaving the factory at the close of the day, each individual is required to doff his or her working clothes, and put on uncontaminated garments; the hands must be thoroughly cleansed by means of soft soap and water; the finger nails duly attended to; teeth cleansed, and mouth and throat washed with a gargle specially provided, all of which is enforced by rigid inspection.

Each person seeking employment, moreover, is carefully subjected to examination by the medical officer of the company, who rejects all under sixteen years of age, all possessed of bodily infirmities of any kind, even to a sore or abrasion or slight defect in dentition, or who are "delicate" or anæmic; all must either have been vaccinated or have secured immunity through smallpox. With the first evidence of illness, regardless of source or character, the employe is suspended, but allowed to draw two-thirds wages until fully recovered.

Such procedures, aided by efficient methods of ventilation, have materially lessened the accidents that commonly accrue to the match industry. Among the six hundred people employed in the Pantin and Aubervilliers works in France, despite the use of "stick" phosphorus in "dipping" mixtures, there was not a single untoward result chronicled during 1896 or 1897, which may be considered phenomenal.

For some years the French government has sought newer and more effective and safe methods of match manufacture, and it is constantly, by subsidies, fostering investigations along these lines. The demand of the hour is for a match that will ignite anywhere by friction, that will be free from phosphorus, and that can be manufactured cheaply. The two first desiderata have been worked out, but thus far are effectually handicapped on the score of economy of production. It would seem as if a few hints might be had from Japanese sources. In the "Eastern Insular Empire" a great variety of matches are made, some unique, some startling in the results produced, some from paper, some that ignite without flame, yielding only a coal of fire that persists for several minutes and suitable for the pipe; but their production is in the hands of guilds, who guard their secrets most jealously and who as yet have made no organized attempts at exportation.

The so-called safety match is made with amorphous phosphorus, which also, to insure better ignition—though it should not—appears in the prepared surface that adheres to the container. The "safety" element, moreover is somewhat delusive, since the sparks that attend the ignition fly to considerable distances, and may be—and often are—sources of small fires or even conflagrations. Neither is the prepared surface essential, since these matches may be readily "struck" by passing quickly and lightly over a smooth, dry surface, such as plate glass or polished marble, wood, or metal.

LIGHT is diminished by the interception of glass, as follows: British polished plate, ¼ inch thick, 13 per cent; rough cast plate, ¼ inch thick, 30 per cent; rough rolled, ¼ inch thick, 53 per cent; sheet glass, 32 ounces, 22 per cent.