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MR. G. F. LAWRENCE exhibited two human skulls recently dredged up from the bed of the Thames.

MR. A. P. GOODWIN exhibited some fire-sticks from New Guinea, and made some observations on the Natives encountered on Sir William MacGregor's expedition to Mount Owen Stanley.

MR. FRANCIS GALTON exhibited a new instrument for measuring the rate of movement of the various limbs, and read the following note:—

A NEW INSTRUMENT *for measuring the* RATE *of* MOVEMENT *of the various* LIMBS.

By FRANCIS GALTON, F.R.S.,

Vice-President Anthropological Institute.

[WITH ZINCOGRAPH.]

DIFFICULTY has been found in making courses of experiment on the rates of muscular movement in different persons. This is partly due to the tedium of observing with a blackened cylinder and a vibrating tuning fork, or with a broken electrical current and a Hipp's chronograph, or other apparatus of the kind. More especially is it due to the violence and to the somewhat uncertain direction of the movements to be measured.

In the laboratory that I set up in 1884 in the International Health Exhibition, the instrument used for the purpose was a stout sliding bar, struck forward by the fist. As soon as it started, it released a fixed spring that had been deflected to one side, and which thenceforward vibrated across the bar. A pencil attached to the free end of the spring, left a sinuous trace on the bar, and the number of bends in the trace in any space was proportionate to the time taken by the bar to travel through that space. By using an appropriate scale the absolute mean velocity during any given period was easily read off.

But it proved that few persons delivered their blow in a straightforward manner. They usually struck the deal bar to one side and often broke the apparatus, and when I replaced it with a bar of harder wood, they still broke it, and hurt themselves rather severely at the same time. Experience showed the necessity of eliminating this difficulty and danger. Whatever may be the violence or the direction of the blow, the recording apparatus should be safe, and the person tested should be unable to injure himself.

The method adopted in the present design is perhaps most simply explained by referring to the action of a spring measuring tape. When the end of one of these is pulled out and then let go, it springs sharply back, the tape running cleanly through a slit. Suppose for a moment that it runs back more quickly than the hand could follow it, then, if the end of the tape is retained in the hand that gives the blow, the tape will run through the slit at the exact rate at which the blow is given. It cannot go quicker, because the hand retards it; it will not go slower, because the spring urges it on. The hand need not be near to the tape; it may be connected with it by a long thread, and the action of the apparatus will remain unaltered. The instrument then would be quite out of reach of harm. In this way, a violent movement full of danger to most instruments is translated into a swift movement of a mere thread, running smoothly between eye holes in a straight line.

Having thus got a thread moving smoothly with the same velocity as the arm, the next question is how to measure that velocity. I do it by gravity. The thread during part of its course is arranged to travel vertically, and passes through a small inverted cone, to which it is fixed. The thread then passes loosely through a cylindrical bead of white ivory, whose bottom rests on the face of the cone. When the moving thread is suddenly arrested, the bead is tossed up to a height dependent on the velocity of the thread at the time when it was arrested. The momentary pause of the white bead, after it ceases to ascend and before it begins to descend, enables the height it has attained to be easily read off, upon an appropriate scale, which tells at how many feet per second the string was moving at the instant before it was checked.

The instrument that I show has worked well, but doubtless admits of much improvement in detail. It is exhibited in its present early stage for the benefit of criticism and suggestions.

The proportions of the instrument have been guided by the fact that the issuing thread must be at about the level of the shoulder, and that the scale must be opposite to the eye of the experimenter. It was also thought best to arrange the scale so as to show velocities between, about 5 feet and 30 feet per second. To do this, and at the same time to keep the scale of a convenient size, the velocity of the bead must be mechanically reduced to a fraction of that of the free end of the string. In my instrument I have reduced it to one-third. This being premised, the principle of the machine is here shown in diagrammatic form. In the actual machine there are some differences of detail, and an adjustment is added for readily bringing the bead to the zero position, when the machine is at rest. A piece of thin pianoforte wire is interpolated for the bead to run on, and the check is given by a small india-rubber ball on the string striking home against a fixed cork buffer. It is not of the least consequence that the check should be sharp; all that is necessary is that its motion should *begin* to be checked when the bead is at zero. Then the bead leaves the cone, and henceforward behaves as a free projectile.

We must satisfy ourselves that the spring can pull the thread more quickly than the arm can follow. This is easily done by seeing that the ball is tossed up considerably higher, when the string is allowed to run home unrestrained, than it does when it is held in the hand that delivers the blow.

I find considerable regularity in the readings, when the conditions under which the blow is delivered are similar, but a small alteration in those conditions may make a considerable alteration in the results. It is remarkable how greatly a movement of the wrist may increase the velocity of the hand. We see an effect of this kind in a thrown ball, which travels vastly quicker than the wrist of the hand that throws it. The question of the best measures to take, and the best conditions under which to take them, deserves careful consideration, and I should be grateful for suggestions. One good test position seems to be, to stand behind, and slightly pressing against a horizontal bar that lies lower than the elbow, to plant the feet in chalked spaces, the left foot parallel to the bar, and the right foot pointing to the front, then reaching forward as far as the bar conveniently permits, to seize the tightened string and to draw it back to the vertical post to which the bar is fixed, and from that position to deliver the blow.

For calculating the scale, let $v =$ the velocity of the cone in feet per second at the moment before it is checked at the zero point, and $s =$ the height in inches to which the bead will be tossed, then $s = v^2 \times 0{\cdot}186$ inches. By giving successive values to v the scale is easily calculated. As in my instrument v is only one-third of the velocity of the arm, we have to calculate for values of $v = \frac{10}{3}$ feet per second, $\frac{11}{3}$ feet per second, &c., in order to find the height to which the bead will be tossed, when the velocity of the arm is 10, 11, &c., feet per second, and these latter figures must be inscribed as the calculated heights. The actual velocity of a blow being taken at 20 feet per second, the difference on the scale between it and 21 feet per second, is then the difference between 8·28 inches and 9·13 inches, or nearly an inch, an ample and convenient interval. For calculating according to this scale, if $w =$ the velocity of the arm, $s = w^2 \times 0{\cdot}0207$.

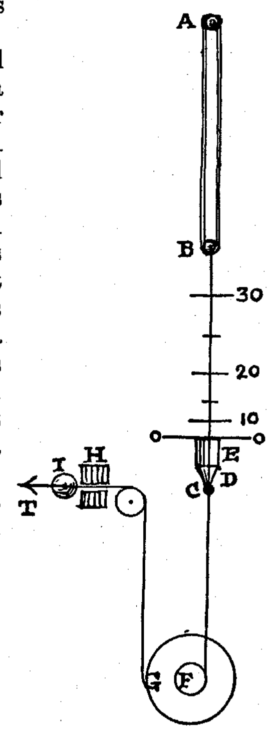
I had hoped to have given more definite results in this paper, but accidental delays in the completion of some carpenter's work have prevented me. Perhaps I may be allowed to add a foot-note before these notes are printed, if there be time and opportunity to do so.

Description of the Figure.

AB. A stretched india-rubber band.

BC. Thin steel wire, upon which the ivory cylinder E runs loosely like a bead. The end of BC passes through an inverted cone D, into which it is fixed.

F, G. Are two grooved wheels fixed together, and turning freely on a common fixed axis. The diameter of F is one-third that of G. A thread passing from C is wrapped a few times round E, to which its other end is fixed. Another thread fixed to F is wrapped a few times round F, and is then carried, first vertically upwards, and afterwards horizontally, by passing over a grooved wheel. It then passes through a hole in a fixed buffer H. On the other side of H it passes through, and is attached to a small india-rubber ball I.



When the machine is at rest the tension of AB causes I to be pressed home against H. When T is drawn out, AB stretches further, D descends, and the cylinder E descends with it. On delivering a blow with the hand that holds the free end of T, C ascends up to the point at which the top of E is brought level with the zero line. There C stops, owing to I coming in contact with the buffers H. Consequently the ivory cylinder E is tossed up as a free projectile, and the graduation to which it ascends is noted. The number attached to that graduation shows the number of feet per second at which T was moving immediately before its motion was checked.

NOTE, OCTOBER 17.—The instrument has worked regularly at my laboratory after a little experience had suggested some minor amendments in detail. The chief of these was to greatly lengthen the elastic band, by passing it over a pulley at the top and bringing it thence downwards to the bottom of the frame. This greatly increased the uniformity of the strain and it makes the action very smooth.

The person experimented on stands with his back to a wall and strikes at the end of a long feather so placed that when the fist reaches the feather the india-rubber ball strikes the buffer. Care is taken that the wrist does not bend. I have not as yet worked up the results. The machine was made for me by Groves, 89, Bolsover Street, W. F. G.

Dr. G. W. LEITNER delivered a verbal address, of which the following is an abstract by Mr. A. L. Lewis :—

On the ETHNOGRAPHICAL BASIS *of* LANGUAGE, *with special reference to the* CUSTOMS *and* LANGUAGE *of* HUNZA.

By Dr. G. W. LEITNER, Ph.D., LL.D., &c.

DR. LEITNER, in commencing his address, referred to his communications to the Anthropological Society in 1869, respecting the first results of his enquiries in Badakhshan, and to the Ethnological Society in 1870, when he brought to the meeting his Yarkandi, Niaz Muhammed ; and also to his communication to the Anthropological Institute in 1874, when he introduced to it Jamshêd, the first Siah Posh Kafir, a supposed blue-eyed descendant of the Macedonian colonists in the Hindukush, who had visited this country, and who, having since been sent back to his own country, had returned to Europe, and had died fighting against the Russians in the Herzegovina. The speaker said that he had wished to introduce on the present occasion a member of