currency. In any case there was a very distinct maximum of failures in 1878, succeeded by a sudden reduction, and it occurred at a time differing by less than a year from the corresponding collapse in England. In the Dominion of Canada there was a very strongly marked maximum of failures at the same time as in England, namely, in 1879.

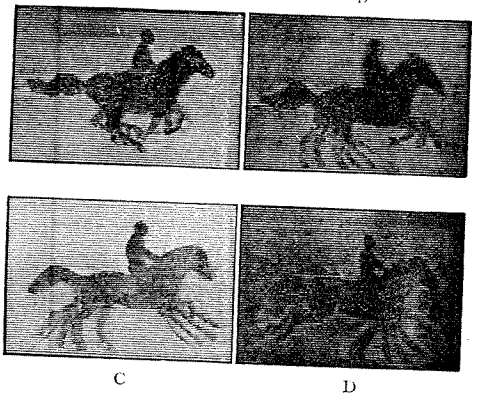
The theory of the solar-commercial cycle and of the partially oriental origin of decennial crises has received such confirmation as time yet admits of. I am, however, fully alive to the weight of some of the difficulties and objections which have been brought forward against the theory. These objections are far from being conclusive, and I may hope to give them in due time a satisfactory answer. But such answer must involve more detail than can be put into a brief article.

W. STANLEY JEVONS

CONVENTIONAL REPRESENTATION OF THE HORSE IN MOTION

IT is of interest to analyse the reason why artists represent a galloping horse in a way unlike any of its real attitudes, as they have been photographed by Mr. Muybridge, and why the critical public have so long acquiesced in these incorrect representations without remonstrance. Partly, no doubt, it is owing to prevalent errors of conception which govern the judgment in its interpretation of a movement that is hard to follow. An excellent instance of this is to be seen in the Academy, in the diploma picture of Mr. Riviere, R.A., entitled "The King drinks." It is a lion lapping water in the wrong way, by spooning his tongue outwards and upwards instead of curling it backwards, like the fingers of the half-closed hand when the knuckles are to the front, an action that may be conveniently studied in the kitten. The error of preconceived ideas partly explains the conventionally extended figure of the galloping horse; but I find the latter to be largely justified by the shape of the blur made on the eye by his rapid and various movements. I wish I could reproduce on a scale, however small, any one of the many plates published in "The Horse in Motion;" but it appears that the copyright of the photographs is disputed, and there are difficulties in the way of doing so, and I must make shift without them.

I find that taking the attitudes of the galloping horse, Phryne, as an example, published in Plate XVI. of the book just mentioned, that her stride has the duration of about six-tenths of a second, and that it has been photographically analysed into twenty momentary attitudes. Also, that these may be arranged in four groups, which I will call A, B, C, and D. I have made photographic composites of each of these groups, and copies of them by the wood engraver are annexed.



A contains six attitudes, in which the legs are crumpled below the body.

B contains four attitudes, in which one or both of the hind legs are on the ground, and the fore legs are pawing in the air.

C contains five attitudes, in which both the fore and hind legs are extended.

D also contains five attitudes; the hind legs are flung back and the fore legs are on the ground.

G

G is the general composite of all the attitudes.

It will be observed that in the general composite the blur somewhat justifies the conventional representation, because though the lower parts of the limbs leave no

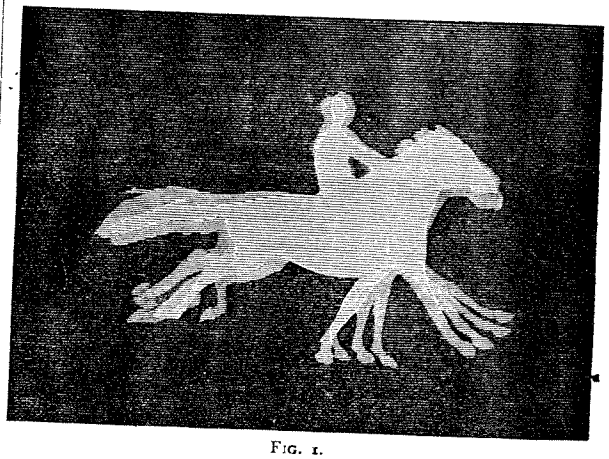


FIG. 1.

definite image at all (less so in the photograph than in the engraving), the upper portions have a distinctly outflung look, and as the artist lies under the same unhappy necessity that plagues the geographer, who,

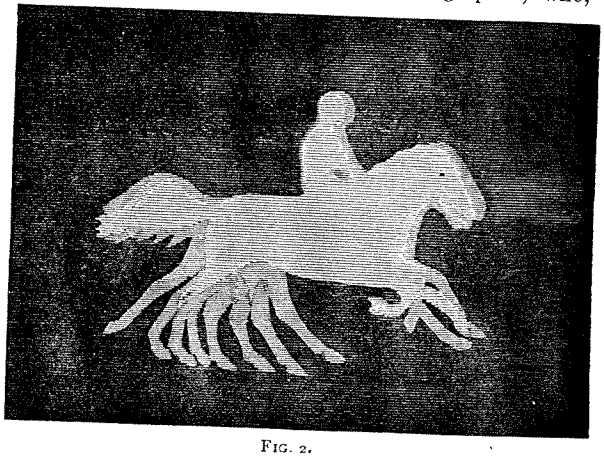


FIG. 2.

when he has to put down a lake or river on the map must put it *somewhere*, although its real position may be uncertain, so the artist thinks he must put the lower parts of the four legs of the horse somewhere, and he is guided

in his decision as to the exact place by the direction of their upper portions.

'I find, however, on trial that another cause of confusion lies in the difficulty of watching closely both the fore and the hind halves of the animal simultaneously. The eye wanders from one to the other and seizes the most characteristic attitudes of each, and combines them into a hybrid monster.

The accompanying composites, Figs. 1 and 2, each from four successive attitudes, will explain the process; it certainly tends to go on in my mind, and probably does

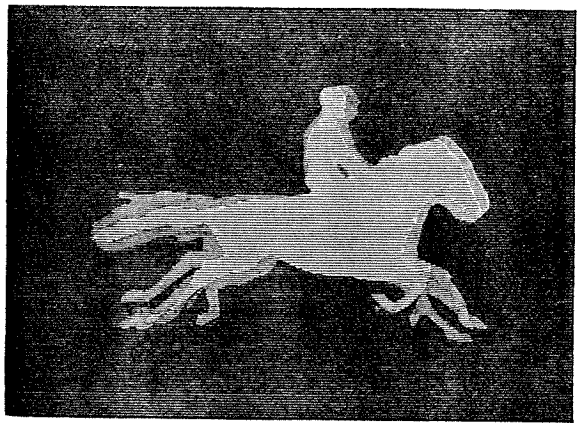


FIG. 3.

so in that of others. The first composite shows the hind legs distinctly; the second shows the fore legs distinctly; and if duplicates of the first and second woodcuts are each divided in two halves and the best defined half of each are united (in a way that might have occurred to Baron Munchausen if a second rider's horse had suffered as his own, and there had been a mistake in piecing them), a result, Fig. 3, is produced that shows a very fair correspondence with a not uncommon representation in sculpture.

FRANCIS GALTON

THE CHANNEL TUNNEL

AT the meeting of the Paris Academy of June 26, M. Daubrée read a note on the geological conditions of the Channel tunnel. The works connected with the tunnel comprise three phases:—(1) Scientific researches; (2) preparatory works; (3) execution of the tunnel itself. The first phase was devoted to purely geological investigation, in the form of minute exploration of the French and English coasts, exact and detailed investigation of the sea-bottom in the Strait, borings made on *terra firma* which verified the nature, thickness, and inclination of the strata, and gave an approximate idea of the hydrological condition. Since 1879 the second phase has been entered on by verifying the previous scientific data, and preparing for the execution of the tunnel itself, experimenting in small galleries with machines and tools capable of being ultimately used in a work of exceptional importance. On the French coast, the geological investigation established a slight bulging of the beds at the place known as the *Quenocs*. On account of this bulging the inclination of the strata, which, in the strait is towards the north-north-east, is found, along the cliffs of Blanc Nez, turned towards the south-east, and the slope which, according to the first orientation, in the neighbourhood of the Quenocs, is about 0·05 m. per metre, is found, in the second, to be nearly 0·09 m. It is important then, to find in what conditions this bulging may modify the physical conditions of the banks forming the base of the Rouen chalk. For this purpose the French Association had dug, near Sangatte, two shafts of a depth of 86 m., which met the gault at 59 m. below the hydrographic zero, adopted in the maps in which the geological explorations of 1875-6 are recorded. The digging of these shafts, one of them 5·40 m. in diameter, showed that all the white chalk and the upper part of the Rouen chalk are water-bearing. These strata had thus to be abandoned.

On the other hand, the base of the Rouen chalk allowed only a very small portion of water to pass. There, then, the tunnel should be pierced, as the stratum appeared to proceed without interruption from France to England. The water penetrating the works is fresh, and of good quality; at the upper part only some slightly salt veins were found. Nevertheless, the communication of the water-bearing strata with the sea is proved by the oscillation of the water-level in the shafts according to the tide, and by the invariable increase at high water. M. Daubrée then refers to further galleries dug on the French and on the English sides, and excavations made with the machines of Col. Beaumont and Mr. Brunton. On the Dover side, the chalk, which on the French side was but little permeable, was, on the English side, quite impermeable. Owing to this circumstance, they were able to begin at the bottom of the shafts, at 29 m. below the French hydrographic zero, a gallery advancing under the sea by following in the stratum an almost regular descending slope of 1-80th, or 12·5 mm. per metre. The bed on the English side, somewhat more powerful than on the French side, presents a very great regularity. Thus the Beaumont machine, which has been used in the perforation, has been easily able to trace a perfectly cylindrical gallery, which has now reached 1800 metres from the shafts, of which 1400 metres are under the sea. So far there has been no access of water. In the banks which form the base of the Rouen chalk, the rock in mass is almost completely dry; the access of water which has been observed has entirely the character of small springs issuing from the joints of fracture or cleavage. The perfectly cylindrical form produced by the Beaumont machine renders the gallery where such leakage occurs easily isolated by means of cast-iron rings prepared in segments easily united, the rings themselves being clamped together to form a tube of any length. When the water spurts out in considerable force, a sort of mastic or minium is successfully employed, which is placed between the segments of the rock, and compressed in the manner of a water-joint by the pressure of the rings against the rock. The mastic also seems to render the joints of the neighbouring rings water-tight. Owing to the excellent make of these rings, they can be rapidly put in position; a complete ring can be placed in half-an-hour, and several experiments in the Shakespere Cliff Gallery have proved that by this simple process the springs encountered can be completely blocked. On account of the slope on which the English gallery descends, its extremity recently reached 51 m. below the hydrographic zero, at a point where the depth of the sea at low water is 5 m.; there is thus 46 m. of chalk between the floor of the gallery and the bottom of the sea.

NOTES

MR. GEORGE GRAY, Honorary Secretary of the Philosophical Institute of Canterbury, Christchurch, New Zealand, writes under date May 20:—"I have been requested to forward you the inclosed resolution passed at a meeting of this Institute May 4, 1882, and to ask if you would kindly insert the same in the Notes of your valuable journal. Resolution proposed by C. Chilton, M.A., seconded by G. Gray and carried:—'That this Institute desires to place on record its high appreciation of the great services that have been rendered to science by the late Dr. Charles Darwin, and its deep sense of the loss that science has sustained through his death.'"