a string into action, it would be necessary to wait till two particles were moving on paths with a common normal—an occurrence which must be infinitely rare. When Prof. Lodge says "an infinite mass can absorb any amount of momentum, without receiving a trace of energy, &c.," he forgets that the term "infinite" is only relative, "an infinite mass" being one whose change of velocity (or kinetic energy) consequent on a given change of momentum is negligible *for the purpose in hand*. It would not, I imagine, suit Prof. Lodge's purpose to suppose psychic forces might do a *little* work, so long as it was only a *very little?*

May I remind him of the old paradox, "What would happen if an irresistible force were brought to bear against an immovable post?" EDWARD T. DIXON.

12 Barkston Mansions, South Kensington, July 24.

THE discussion on this topic has gained in clearness by Prof. Lodge's conceding that "the same question—What determines the direction of the transfer of energy?—may doubtless be asked in connection with inanimate activity; . . . but in neither case do I know the answer."

Perhaps some more precision may be attained by expressing the question in other words.

The principle of conservation of energy reigns over the *quantitative* relations of all processes in nature, but it does not give any explanation of the *qualitative* changes of those processes. These changes and their conditions must in every case be found out by special experience. But, nevertheless, they are, in every accessible case, found to be subjected to fixed laws. A given substance undergoes evaporation or chemical transformation—dependent on or necessarily bound up with changes of heat into energy of molecular motion, or into chemical energy, or *vice versâ*—at a distinct degree of temperature, or under distinct conditions of electrical action. Inexplicable as these transformations of quality or form of energy remain for us, there is nothing undetermined in them, neither have we any right to such a supposition for the qualitative changes going on in plants and animals—their quantitative relations being likewise governed by the principle of conservation of energy.

But there is another phase of the question. Some unknown material changes in the brain are connected with phenomena of consciousness. Nothing can be more fallacious than to consider consciousness as a form of energy, and to suppose it in a relation of equivalence to such forms. How it is, that what to our physical conception, or outer sense, are processes in the brain (which, as such, may be more clearly understood in future), are, at the same time, to our psychical conception, or inner sense, phenomena of consciousness, or acts of will, is a question beyond the domain of physical science, and capable of elucidation only by transcendental philosophy. Whoever wishes for more light here, must study the "Kritik der reinen Vernunft," especially the chapters "Von den Paralogismen" and "Die Antinomien."

Schopenhauer, and others after him, have considered our power of will, or our conscious directing of motion, as the key for all qualitative processes in nature, these being considered as, in their essence, acts of will. But this is cutting the knot by means of a metaphysical assumption. D. WETTERHAN.

Freiburg, Badenia, July 27.

IN reading over the remarks of Dr. Lodge and Prof. Morgan upon Dr. Croll's views as to the direction of force, it appears to me that both have missed the point. Dr. Croll did not mean that a force at right angles to another does no work, but simply alters the direction. His view is that the change of direction is not caused by a force. Dr. Lodge says it is, although he acknowledges that the second force does no work. Further, Dr. Croll says, with regard to the first force, that its direction is quite apart from the force. The force cannot direct itself. This is the crucial point before we get to a second force or to a right angle. I fully acknowledge the importance of Dr. Lodge's principle, but it is not simply the indorsement of Dr. Croll's idea.

Prof. Morgan thinks Dr. Croll's view no argument in favour of theism. It does not prove that mind can or does affect matter. Perhaps it does not directly prove this, but, within its range, it seems to me an effective reply to mechanical atheism. We see direction, and if this does not come from force it must come from some other source. We know of no other source but mind. To talk of mind affecting matter denies the essence of mind by which it is distinct from matter, and makes it a mechanical *ab extrâ*. But try to banish it and it will come in somewhere. "Tamen usque recurret."

Dr. Croll's position seems to me to affect the first law of motion. Uniform motion in a straight line is in no way connected essentially with force, if his view is correct.

Dr. Lodge's principle appears to affect the second law of motion, and also the doctrine of impact and transference of force.

Further, it affects gravity. Gravity is always at right angles to the first law of motion, and therefore gravity is not a force; for that can not be a force which never exercises force.

T. TRAVERS SHERLOCK.

Congregational Church, Smethwick, July 25.

Technical Education for Farmers, Farriers, and Engine-Drivers.

KNOWING that you take very great interest in the various questions relating to technical education, I may give you a few particulars of an experiment which the Devon County Agricultural Society recently made at its Exmouth meeting. Being desirous of giving farmers, farriers, and those generally interested in the welfare of horses, some information on the scientific principles which underlie a proper performance of the duties of the farrier, and the correct form and mode of attachment of horses' shoes; and also of giving farmers and engine-drivers some practical and scientific instructions on the working and care of steam-engines, the Society approached the County Council with a view to a grant in aid of their object. The proposal was very warmly taken up by Mr. Lethbridge and other gentlemen who are well known for their active interest in education and other matters important to the welfare of the county, and a grant was obtained.

The Society secured the services of Prof. F. Smith, head of the Army Veterinary School, Aldershot, and of Mr. W. Worby Beaumont, and by these gentlemen lectures were given on each of the three days of the Society's meeting at Exmouth. The weather was very unfavourable on two days, but notwithstanding this the attendance at the lectures was large, and on the second and third days was larger than was expected, and was fully up to the accommodation provided. The audiences were remarkably attentive and appreciative, and in every respect the experiment proved successful. Many who were sceptical before the lectures of their value to working men, became convinced that not only is it possible to give working men information which is useful in an important degree in their daily work, but that the men are themselves quick to appreciate its value. I may mention that on one of the days nearly two hundred shoeing-smiths and a large number of farmers attended the horse-shoeing lectures, and on one day seventy-eight engine-drivers entered for the lecture on the steam-engine, and there were also in attendance a large number of working and gentlemen farmers.

Totnes, July 29. JOHN L. WINTER.

THE ERUPTION OF VESUVIUS OF JUNE 7, 1891.

THE suggestion that I published in several newspapers has been fully confirmed—namely, that the second alternative type of eruptive character would be pursued by the volcano. Now for a period of over a month lava has continued to dribble forth, activity has returned to the central vent, and no great changes have occurred.

The throat of the volcano commenced to be cleared on June 9, the vapour forcing its way up from the crater bottom through the choke of loose materials, and rose above as a column carrying with it much dust; at the same time the powerful vapour blast issuing from the upper extremity of the lateral rift, of which mention is made in my first letter, soon stopped. Each day I was kept informed of the state of the volcano by the kindness of Messrs. Ferber and Treiber, the director and engineer respectively of the Vesuvian Railway.

On June 15 I considered it right to again visit the

mountain, and had the good fortune to be accompanied by Messrs. H. Elliot, A. Green, Linden, Newstead, and Treiber, several of whom are excellent photographers, so that with two of my own cameras we were able to make an extensive pictorial record of some very unique formations.

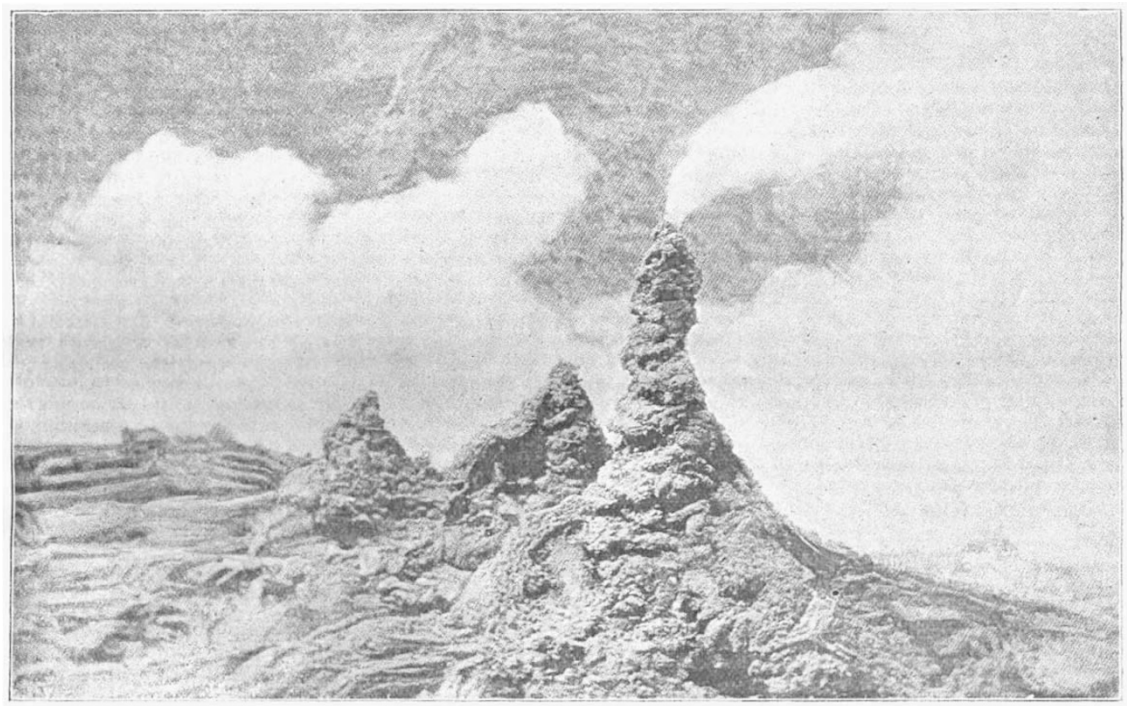
At the point of issue of the lava, at the junction of the foot of the great Vesuvian cone and the Atrio del Cavallo, the first lava had cooled sufficiently to walk over it, but beneath our feet could still be seen in a few holes the flowing lava. At the foot of the great cone, and extending for half way across the Atrio along the radius of the eruptive rent, as if this had continued so far, were a series of driblet cone fumaroles. We counted seven complete and well-formed examples, besides numerous abortive ones. Most were giving out intensely heated vapour, which was liberated from the lava flowing beneath, and which soon carbonized a piece of wood placed in it. Around the lips of the upper opening, hæmatite with fused chlorides of potash, soda, iron, copper, &c., were being condensed from the vapour, and trickling down the outer surface of the fumarole, consolidated as curious vari-coloured stalactites of very deliquescent nature.

The lava had first flowed towards the escarpment of Monte Somma in a fan-like manner, so that the eastern extremity reached that great natural section just beneath the Punta del Nasone. Still following the natural inclination of the ground, it turned to the west, and on June 15 was opposite dyke 16 (as marked on my large geological map just published, and on the dykes themselves), advancing at a very slow rate.

The lava is a vitreous and coarse-grained rock, especially in regard to the included leucite crystals, whilst the surface is, with one exceptional tongue, of the corded or "pahoehoe" type. This is due to the magma being one that has been simmering since January in the chimney of the volcano, so that most of its dissolved H_2O has been boiled off, and so allowing it to cool without the formation of scoria from the vapour that otherwise would escape after its exit. Leucite I have also demonstrated to be formed while the magma is simmering under low pressure with free escape for vapour in the upper part of the volcanic chimney.[1]

At the summit of the great cone the crumbling in of the edges was constantly going on, but the upper extremity of the lateral rift at the foot of the cone of eruption and at the summit of the great Vesuvian cone had nearly ceased to give forth vapour. Along the line of rent on the mountain side no fumaroles or other signs of activity were visible except quite at the foot, where those commence of which I have spoken.

Up till June 26 there was a struggle to clear the upper part of the volcanic chimney of the impeding materials, which were constantly being added to by the slips from the crater's edge; but on that evening a dull red glow was visible in the crater bottom, showing that a fairly clear passage had been temporarily made for the continuous escape of vapour, and also that the lava was at no very great depth from the summit of the volcano. This of course indicates that the lateral opening was insufficient to drain off much of the lava which occupies the chimney above the level of the lateral outlet. Had such evacuation really taken place, the eruption would have assumed enormous proportions, from the actual amount of lava above the tap, but more from frothing up of that below that level in consequence of the relief of pressure that in that case would occur. Of course, during all these days the ejection of dust with the smoke occurred, giving the latter that peculiar dark grey colour. Further destruction of the crater edge took place, so as to partly block the outlet, and it was not till our next visit that it again cleared.



On June 30 I again visited the crater, in company of my friend Mr. A. Green. All the summit of the great cone

[1] See H. J. J.-L., "Geol. M. Somma and Vesuvius," Q.J.G.S., vol. xl.; and "Relationship of the Structure of Igneous Rocks to the Conditions of their Formation," Scient. Proceed. R. Dublin Soc., vol. v., N.S.

was covered by a thick coating of dust and sand, upon the surface of which were the usual white and yellowish-green chloride crusts seen on such occasions, so rich in copper as to plate with that metal the iron nails of our boots. The crater had considerably enlarged, the edges were in an extremely unstable state, with often considerable strips marked off by cracks parallel to the free edge, so that, with a slight push by a stick, it was possible to detach large masses of the materials which form the sides of the crater in the recent cone of eruption. So dangerous were the edges, that it was but in two places that my experience indicated as being safe to approach and look over, and that even with several precautions; so that the fatal accident to Señor Silva Jardim, who lost his life here but a few hours after our departure, is not to be wondered at.

On looking down some 45 to 50 m. beneath us, we could see the glow from a mouth some 2 or 3 m. in diameter. The walls of the crater were concave, so that although overhanging at the top, yet a plumb-line let fall from the edge would strike the bottom of the cliff. The crater bottom was roughly plain, due to the combination of a talus all round, and an attempt at a cone encircling the main vent. It will be thus seen that the crater cavity was of the form of a convex-sided cylinder, or more simply barrel-shaped, with its upper diameter some 50 to 55 m.

With much difficulty we made our way around to the north side of the cone of eruption, which had now lost its usual loose scoria surface, which was buried beneath a thick coat of sand and dust, covered with a thin saline crust on its surface. The upper limit of the radial rift, which we were prevented from examining three weeks previously, on account of its giving out so much vapour as to constitute the temporary escape aperture of the volcano, had now become quiescent, so that we could fully examine it. Only a current of hot air was now issuing from it, but I was able to collect some fine masses of crystallized molysite and kremersite from its edges. Its average breadth was about 0·50 m., where it traversed old compact lava, but of course it disappeared as soon as it reached the looser materials. The real azimuth of its orientation, which we could now determine with greater accuracy than when we were walking over hot rock and enveloped in hot irritating vapours, proves to be, as it radiates away from the axis of Vesuvius, about 15° west of north. It curves then a little to the north, and near the foot of the great cone it again assumes nearly the same azimuth as at starting, an arrangement which is quite evident when the Vesuvian cone is regarded from the Punta del Nasone. From that, the highest point of Somma, the lower extremity of the rift lies a little to the right or west, and faces that part of the Somma ridge which corresponds to the upper extremity of the Vallone Cancherone.

In the forenoon of June 30 much dust had fallen at the lower railway station, of which we collected some bagsful. It is the usual fine sandy material of these eruptions, and consists of the pulverized materials of the cone of eruption.

Having passed the night at the lower railway station, the next day we crossed the Atrio, ascended to the western extremity of the ridge of Somma, and followed it along so as to get a general bird's-eye view of the whole scene of the eruption, and take photographs of the more important points. As one stands on the Punta del Nasone and embraces that magnificent view of Vesuvius and the Atrio del Cavallo, one sees at their feet the new lava-stream in the form of the letter L, the horizontal portion of which is still being prolonged down the Atrio towards the Fossa della Vetrana. In the middle of the ridge we found a thin coating of fine red dust which had reached thus far from the crater. Much of the Atrio was also covered by the same material. Scaling the cliff face just beyond the Cognulo di Ottajano to the Atrio del Cavallo, we again visited the lower point of the outburst. Most of the beautiful fumaroles were in a state of ruin, and lined by good-sized crystals of hæmatite and mixed chloride crusts. Here the lava was quite solid, though at one point was a hole, some 50 m. from the base of the great cone, where we could see the molten rock flowing lazily along about a metre beneath our feet. The lava at the end of the flow was making considerable progress to the westwards, and stood opposite dyke 13.

Since then, few changes have taken place in the mountain: the crater still gets larger, dust is thrown out, and the lava descends. These phenomena are capable of continuing for months if the drainage opening does not enlarge.

As the eruption progresses, I will send you further details. H. J. JOHNSTON-LAVIS.

THE PRODUCTION OF MUSICAL NOTES FROM NON-MUSICAL SANDS.

THAT I have succeeded in producing musical notes from sand that was never before musical, and am also able to produce similar results from certain mute or "killed" musical sands which have been temporarily deprived of their musical properties, has already been announced in the *Chemical News* (vol. lxiv. No. 1650).

It is not necessary now to give the details of the numerous experiments which led up to this discovery; it will be, perhaps, sufficient for present purposes, to state that in November 1888 I published a paper[1] in which I propounded a theory to account for the cause of musical sounds issuing from certain sands. After giving various reasons for my conclusions, I said:—"It occurred to me, then, that the music from sand was simply the result of the *rubbing together* of the surfaces of millions of perfectly clean grains of quartz, free from angularities, roughness, or adherent matter, in the form of clinging fragments investing the grains, and that these microlithic emissions of sound, though individually inaudible, might in combination produce a note sufficiently powerful to be sensible to us."

Having described numerous experiments, and drawn attention to the hopeful results obtained from the "millet-seed" sand, my paper concluded with the following:—"From what I have now told you, I think we may conclude that music may be produced from sand if (1) the grains are rounded, polished, and free from fine fragments; (2) if they have a sufficient amount of 'play' to enable them to slide one against the other; (3) if the grains are perfectly clean; and (4) if they possess a certain degree of uniformity in size, and are within a certain range of size."

On June 20 last I visited Studland Bay for the purpose of carrying out some new experiments. I found that the musical patch emitted tones louder and more pronounced than I had ever heard them there before. The best results were obtained by drawing a thick deal rod, on to the end of which I had fixed a resonator, over the surface of the sand; sounds produced in this way were heard unmistakably for a considerable distance. The patch averaged 7½ yards in width, and ran parallel with the trend of the shore for some hundreds of yards. The sand on the sea side of the patch was fine, and emitted notes of a high pitch; that on the land side was coarse, and emitted notes of a lower pitch. The rod drawn across the patch gave, therefore, a great variety of pitch. Many other interesting facts cannot now be referred to, but it is important to state that some of this sand, when taken off the patch, and struck in a box, gave out notes as it did *in situ*. On trying this sand subsequently at home, the *coarse* emitted distinct

[1] Read before the Bournemouth Society of Natural Science.