of manganese and sulphuric acid, oil of bitter almonds was immediately evolved, and on boiling a second portion with hypochlorite of lime, the very peculiar chlorinated oil described in a former paper was also abundantly produced, thus clearly indicating the presence of cinnamic acid. A third portion of the crystals was dissolved in alcohol and left to spontaneous evaporation; it yielded after some time the fine rhombic prisms so characteristic of cinnamic acid when it is crystallized out of alcohol, mixed however with some long acicular crystals, having all the appearance of benzoic acid. I think myself warranted to conclude therefore that Botany Bay resin contains cinnamic acid mixed with a very little benzoic, in which respect it resembles balsam of Tolu, which contains both cinnamic and benzoic acids, though fortunately in much greater abundance.

*Action of Nitric Acid on the Resin.*

When the resin is treated with moderately strong nitric acid in the cold, a violent action ensues with the evolution of nitrous fumes. The resin is completely dissolved if the quantity of the nitric acid is considerable. The colour of the solution is dark red, but by boiling it becomes of a bright yellow colour. The liquid should be evaporated to dryness on the water-bath, to get rid of the great excess of nitric acid. The residue forms a mass of fine yellow crystals, consisting chiefly of carbazotic acid, but mixed with some oxalic and a little nitrobenzoic acids. The nitrobenzoic acid is evidently derived from the cinnamic acid in the resin. The carbazotic acid is easily separated from these other acids by converting it into carbazotate of potash, which is easily purified by one or two crystallizations, and then by decomposing the salt with muriatic acid, pure carbazotic acid may be obtained.

0·3823 grm. of the acid, dried at 212° F., gave 0·442 $CO_2$ and 0·049 HO.

| | Found. | Calculated numbers. |
|---|---|---|
| Carbon . . | 31·53 | 31·37 |
| Hydrogen . | 1·42 | 1·30 |
| Oxygen . . | 67·05 | 67·33 |
| | 100·00 | 100·00 |

0·3975 grm. of the potash salt, decomposed by sulphuric acid and then ignited with carbonate of ammonia, left 0·1300 of sulphate of potash = 17·68 per cent. of potash; calculated quantity 17·60.

The silver salt was also formed by boiling the acid with carbonate of silver. It is a very soluble salt, which crystallizes in fine red-coloured needles. 0·8975 grm. of the salt gave 0·372



Cl Ag = 31·22 Ag, or 33·53 per cent. oxide. The calculated numbers are 31·27 per cent. of silver = 33·59 oxide.

The quantity of carbazotic acid which Botany Bay resin yields when treated with nitric acid is so great, and it is so easily purified, that this resin seems likely to prove the best source of that substance. When the resin is subjected to destructive distillation in an iron or copper retort, it yields a very large quantity of a heavy acid oil mixed with a very small quantity of a neutral oil, which is lighter than water. If however the resin has been previously digested with alkaline lyes, so as to remove all the cinnamic and benzoic acids it contains, the heavy oil is obtained as before, but none of the light essential oil. The acid oil is readily soluble in potash and soda lyes; in its smell and properties it resembles creosote; when it is digested with nitric acid, it is wholly converted into carbazotic acid, and when a slip of fir-wood is dipt in it, and then moistened with either muriatic or nitric acid, the deep blue colour passing quickly into brown, so characteristic of hydrate of phenyle, is immediately produced, with which substance the oil appears completely identical. The light oil above mentioned, the quantity of which is extremely small, is separated from the hydrate of phenyle by saturating it with an alkali and distilling the mixture in a glass retort with a gentle heat. In smell and properties it resembles benzine, and is most probably a mixture of benzine and cinnamene; unfortunately the quantity obtained was so small, that I was unable to subject it to more particular examination.

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## LXXIV. *On the Constitution of Matter.*

*By* H. Sloggett, *Esq.*

*To Richard Taylor, Esq.*

Sir,

HAVING observed in your Journal for December 1845 some remarks on Prof. Faraday's speculation on the constitution of matter by Mr. Laming, wherein he attempts to show, that by a peculiar way of considering the theory of atoms the conducting and insulating powers of bodies appear more intelligible than on any other doctrine, I have been induced to send you a few ideas of mine on the subject, with a hope that you may not consider them unworthy of insertion.

The test of the truth of any hypothesis, is its accordance with all known facts; and any discrepancy, even a single one, between a theory and experiment, is, if not cleared up, fatal to its validity. The one-fluid theory, in electricity though preferable to its rival in perhaps all other respects, has hitherto been incapable of being generally received, on account of its giving unsatisfactory results when submitted to mathematical analysis. In endeavouring to obviate this difficulty, I conceived the object completely attained, by a supposition somewhat analogous to Mr. Laming's, though essentially different in respect to the assumption of solid atoms. As we know matter only by its properties, it certainly seems more rational to call those properties themselves matter, than to invent an imaginary substance with inseparably attached attributes.

In Mr. Laming's theory I can see no vindication of the theory of solid atoms, because it is not necessary for them to be admitted. He might consider the term "atom" to signify nothing more than "centre of attraction." With this qualification I agree with him, that different atoms are naturally associated with different quantities of electricity; arising, however, from different degrees of power in the atoms, or centres of attraction. An objection apparently arises, *in limine*, to his supposition of incomplete external strata. How are they to remain incomplete when placed in circumstances adapted to supply them with as much electricity as would be necessary to complete them? Or in other words, why should they not retain the electricity which they have once received? I have mentioned this objection because it appears to be an essential point in Mr. Laming's paper, and because it is in fact the only one, except that before mentioned, so far as it goes, in which his hypothesis differs materially from my own. It will be proper to premise, that by the word atom, I mean nothing more than a centre or combination of centres of attractive or repulsive force; those combinations of centres, when they occur, occupying the same point; implicating, in opposition to the usual notion, that matter may be penetrable. It is necessary that this be remembered, because the word in its common sense involves circumstances incompatible with another meaning.

Philosophers have long considered it established that the atoms of bodies attract each other; and it cannot but be admitted that a repulsive principle between them is just as clearly evidenced. Hence we have just grounds for the assumption that the atoms of bodies are both attractive and repulsive of each other. But this is an inconsistency if an atom be but a single principle, and as there is abundant proof of the existence of an agent distinct from matter in bodies, there are ample reasons for attributing the attracting property to this agent (electricity), and the repulsive power to the matter itself. But it remains to be shown how these are to be united in order to explain the effects which appertain to the action of bodies in general on each other, as well as those which are produced by the agency of electricity.



We assume, then, that the atoms of matter are mutually repulsive of each other, but attractive of those of electricity; and that the atoms of electricity are in like manner self-repulsive and attractive of those of matter. This hypothesis is not new, it was invented long ago to satisfy the Franklinian theory of electricity; but its application has not, to my knowledge, been successfully made. My object here is briefly to show its consistency when rightly applied.

Suppose the centres of matter far more powerful and less numerous than those of electricity. Each atom of the compound will thus consist of an atom (in the sense before stated) of matter surrounded with an atmosphere (so to speak) of electricity, of variable density, in a somewhat similar manner to the air surrounding the earth. This must have a definite limit at some distance from the centre, where the repulsive power of the whole quantity of electricity surrounding the matter on an atom of electricity equals the attractive power of the matter for the same atom; so that beyond this limit none can exist in connexion with the atom. Accordingly every particle of matter will appropriate to itself a definite quantity of electricity dependent on its inherent power; and when any excess above this quantity occurs in a body, it becomes positively electrified, and negatively electrified when there is a deficiency. This admitted, we may enunciate thus: In all bodies, in their natural state, there are two principles reciprocally combined, mutually attractive but each repulsive of itself. If there be an excess of either principle, in one instance the body in which it may occur becomes positively, and in the other negatively electrified.

This will be observed, in effect, to be expressing the two-fluid theory. A simple illustration will exemplify the similarity.

Suppose a conducting sphere charged positively. All its atoms being duly combined with as much as they can retain, it is evident that the superfluous electricity thus thrown on them must, by its elastic property, fly off from them, subject only to an inferior attractive and repulsive force, it being as it were without the effective range of the central forces. Unless retained on the body by a non-conducting medium, it would necessarily fly off entirely. This both the old theories teach us. But how will the case stand when the excitement is negative? This is a question which the partisans of the vitreous and resinous hypotheses were accustomed triumphantly to ask. Indeed I have never seen it answered; arising from no assigned position being given to electricity in its combination with matter. This being done, the solution is easy, and if it be done satisfactorily, the two-fluid theory must be estimated as nothing but a superfluity. In a sphere, the combined atoms of matter concentrate their power in its centre. Thus the exterior atoms have their atmospheres less strongly attached to them than the interior ones, since the tendency of all the combined atoms to attract electricity to the centre of the sphere is greatest at the surface, varying as the distance from the centre; and because this tendency and the force with which the atom attracts its atmosphere are in opposition. Now it is manifest that a force must act when the resistance to it is least; hence if electricity be abstracted from the sphere it must be from the surface, or rather from the atoms on the surface. If the surface be not covered with a non-conducting medium, the atoms will necessarily supply their deficiency from the contiguous conducting ones, and thus cause an equilibrium. It has however yet to be shown how negatively electrified bodies repel each other; indeed electrical attraction and repulsion generally must be explained before the validity of the theory can be assented to; but as both the received theories do this in a nearly similar manner to the present one, it need not now be entered upon. My object has been briefly to prove the sufficiency of one electric agent to elucidate what it has been considered possible to do only by two, and by so doing to furnish a basis for the explanation of the whole series of electrical phænomena. Statical electricity has alone furnished exercise for legitimate theory; and although the identity of it and voltaic electricity has never been doubted, the connexion between their effects has received no solution. The relation between the atoms of bodies and statical electrical excitement, here suggested, seems to furnish a clue by which dynamical electricity may become more intelligible. By dynamical electricity, I mean voltaic effects generally. This may perhaps more clearly appear by considering the influences to which the particles might be conceived to be subject. In order to this, we must have some standard by which we may compare different atoms or centres of matter; so we will assume an unit for that purpose. Not that an atom must consist of one unit only, but that different atoms may consist of different definite units.

Let the repulsion between one unit of matter and another be called R, the repulsion between units of electricity $r$, the attraction between units of electricity and matter $a$; let the respective quantities of matter in two different atoms be M and $m$, and the respective quantities of electricity E and $e$.



Then the repulsion which these atoms exercise on each other will be represented by

$$M m R + E e r. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (A.)$$

And the attraction will be

$$M e a + m E a. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (B.)$$

Imagine a case of equilibrium, then

$$M m r + E e r = M e a + m E a.$$

Now all those quantities are variable; and it is easy to perceive that the attraction and repulsion will vary with varying values of either of the quantities. At present we wish to know the effect of increase or diminution of the quantity of electricity on an atom.

Now suppose the attraction and repulsion equal, and we get

$$\underset{(1)}{M e a - M m R} = \underset{(2)}{E e r - E m a}.$$

Diminish E then (2) becomes less than (1), and consequently B becomes less than A; that is, the repulsion becomes in excess. This is on the assumption of $m a$ being greater than $e r$. Increase E, and in like manner the attraction becomes in excess. In a similar manner might it be shown that an increase or diminution of $e$ would cause a corresponding attraction or repulsion. Still more so, then, must this occur when both E and $e$ increase or diminish together. This is an evident reason for the repulsion existing between bodies negatively electrified. But its more important feature is the view it would give of voltaic excitement; indicating that the current is simply the appropriation of the electricity holding the elements of the liquid compound in combination, to the formation of the new compound which is essentially always in process. It will not be necessary now to trace any further the effects of this mode of considering the constitution of matter. I have said thus much merely as a preliminary necessary for its reception. Whether similar views may have been entertained before, I know not, but they have been my own for a considerable period past, and in their elucidation of all the facts on which I have tried them, there seems to be greater consistency than on many other suppositions which I have met with. It may be worth while to allude to the manner in which the property of conduction is treated by this theory: it would appear that no body is a perfect conductor; the relation between conductors and non-conductors being merely a question of time and velocity; for each atom of a body exercising an attraction and repulsion on free electricity in it, the facility of transmission will depend on the ratio and intensity of those forces, these again depending on the quantities of electricity and matter in the atoms. This has been merely hinted at, not for explanation, but to show that the theory gives the property referred to, to inherent powers in bodies themselves, and not to the space in which they are situated, and by which they are surrounded. My reasons for considering the atoms of bodies as mere centres of force, have not been given, as they are connected with other subjects on which you may not be able to afford space for entering.

I am, Sir,
Yours, &c.,
Henry Sloggett.

Killigrew St., Falmouth,
Jan. 19, 1846.

## LXXV. *Experiments and Observations on the Mechanical Powers of Electro-Magnetism, Steam, and Horses.* By the Rev. William Scoresby, D.D., F.R.SS. L. and E., *Corr. Memb. Inst. Fr., &c., and* James P. Joule, *Secretary of the Literary and Philosophical Society of Manchester, Mem. Chem. Soc., &c.**

At the last Meeting of the British Association, Dr. Scoresby described a magnetic apparatus of very great power, and gave an account of some experiments he had made with a view to test its capabilities for exciting electrical currents. The coils employed in those experiments were hastily constructed, and by no means calculated to produce a maximum effect. We agreed, therefore, to construct and try more efficient ones on the first opportunity.

Two kinds of revolving armature occurred to us as worthy of trial. One of them consisted of a hollow tube of drawn iron, 24 inches long, $1\frac{5}{8}$th inch in diameter, and $\frac{3}{16}$ths of an inch thick in the metal, bent into the shape of the letter U. It had a saw-cut along its entire length, in order to prevent the circulation of electrical currents in the substance of the iron. Each of the legs of this armature was wound with 274 feet of covered copper wire, $\frac{1}{10}$th of an inch in diameter. The other armature consisted of two bars of iron, each 20 inches long, 4 inches broad, and $\frac{3}{8}$ths of an inch thick. These bars were bent edgeways into the form of a semicircle, and then fastened together with the interposition of a piece of calico in order to prevent currents in the iron as much as possible. Each leg of this armature was furnished with two coils of covered copper wire $\frac{1}{10}$th of an inch thick. The two coils that were nearest the iron were each 276 feet long; and each of the other two coils was 296 feet long.

* Communicated by the Authors.



Having placed the two straight steel magnets (each of which was 4 feet 4 inches long, 4 to 5 inches square, and had poles of $7\frac{1}{2}$ square inches surface) side by side, in a horizontal position, and with two of their poles connected by a suitable armature, we placed the *hollow electro-magnetic armature* on the axis of a revolving apparatus, in such a position that the poles of the armature could revolve at the distance of about $\frac{1}{4}$th of an inch from the poles of the steel magnets. The coils were arranged for quantity, and connected by means of a proper "commutator" with platinum plates (each exposing an active surface of 5 or 6 square inches) immersed in a dilute solution of sulphuric acid. The maximum amount of decomposition was effected when the armature revolved 500 times per minute. At this velocity $\frac{3}{4}$ths of a cubic inch of the mixed gases were collected per minute.

Having removed the hollow armature, we now fastened the *flat semicircular armature* upon the axis. When this armature, with its four coils arranged for quantity, was rotated at the rate of 500 revolutions per minute, we collected as much as 1·4 cubic inch of the mixed gases per minute. With the same velocity of rotation, two inches of steel wire, $\frac{1}{90}$th of an inch thick, were raised to a bright red heat; and one inch of the same kind of wire was fused.

Great as the above effects undoubtedly are, in comparison with previously recorded results, we expect to be able to augment them very much by causing the armatures to revolve opposite the *true poles* of the magnets, and not, as heretofore, opposite their ends. It is proper also to observe, that on account of the imperfect hardness of many of the steel bars*, the magnets did not possess one quarter of the power due to Dr. Scoresby's principle of construction. We have not, however, hitherto cared to reconstruct the apparatus, because our principal object in the present research was to make experiments with the machine working as an engine, for which purpose the magnets were quite powerful enough.

The battery employed for working the machine as an engine, consisted of three cells of Daniell's constant arrangement. In each cell the copper element exposed an active surface of two

* The bars of which the magnetic apparatus was constructed were of various lengths, but of otherwise uniform dimensions, viz. $1\frac{1}{2}$ inch broad and $\frac{1}{4}$th of an inch thick. The thickness and mass were found too great for effective hardening, at least for obtaining a degree of hardness capable of sustaining the severity of the magnetic test. Œconomy and facility of arrangement were the reasons for adopting this construction, rather than the more certain and effective one of *hard thin plates*, described by Dr. Scoresby in his "Magnetical Investigations."