XI. Extract of a memoir on elasticity

C. Barruel

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pretation is obvious, because the new inoculation will not supply them with patients.

I was treated with some derision the other and am every day: a person said, that, as he had inoculated many for the cow-pock, he knew the complaint, and its treatment, better than myself.

I am greatly sorry the disease above spoken of is so well known among the cow-people, as many eminent men will lose great sums in the year by the small-pox being superseded.

Query, Whether Fame, with her babbling tongue, some future time, may not convey rustic vaccine intelligence to some metropolitan friends, and so overturn your excellent Institution, which, I am informed, is on the tapis*?

Dear Sir, believe me,

With the greatest deference and respect,

Your most humble Servant and Pupil,

Winslow, Bucks.

J. TURNER.

XI. *Extract of a Memoir on Elasticity.* By C. BARRUEL†.

THE author of this memoir endeavours to explain the cause of the elasticity of bodies by the help of caloric. After laying it down as a principle, that this fluid is eminently elastic; that it is interposed between the integrant molecular of bodies, which is proved by their porosity; he hopes, from these two principles, to deduce consequences leading to this result. But whatever may be assigned as the cause of elasticity, caloric, at any rate, has a great share in the phenomena which it exhibits.

The different systems adopted by philosophers respecting the cause of elasticity, are, in the author's opinion, either vague or evidently erroneous. It cannot, he thinks, be ascribed to a repulsive force, with which the molecular are endowed, and which increases as they approach; for the

* It appears, by the vaccine inoculation in the country, that medical assistance was scarcely necessary

† From the *Annales de Chimie*, No. 97

existence of this force is merely hypothetical. Nor can it be said that the elasticity is owing to air interposed between the molecularæ, since the phenomena of elasticity manifest themselves in vacuo.

C. Barruel is of opinion, that if we should ascribe the cause of elasticity to caloric, this question would remain to be answered, Why is caloric so eminently elastic? We know, indeed, says he, that the affinity of molecularæ of water to those of sponge, into the pores of which they introduce themselves, produces an increase of the volume of that sponge; but the cause of the reciprocal attraction of these different molecularæ remains unknown. Besides, we could not refuse to admit that the elasticity of caloric would arise from the property which the molecularæ of this fluid might have of repelling each other: a property the more probable, as it is observed in the electric fluid, with which caloric has so great an analogy. In a word, we may be satisfied with admitting its elasticity as a fact from which we set out, as from an incontestible principle.

The author then proceeds immediately to his object, and examines in what manner caloric acts upon bodies. It dilates them by means of a reciprocal affinity between it and their molecularæ. These affinities are variable; but it is certain that, in regard to the same substance, they decrease in proportion as the distances increase, and that their action is at length reduced to zero.

Now, if we suppose a given quantity of caloric inclosed in a receiver incapable of acting on this fluid, it will every-where diffuse itself in an uniform manner. If we then introduce a molecule of matter, the caloric will be unequally condensed around it, in virtue of the unequal action which it exercises on the parts of the fluid at different distances from it, and it will be surrounded by a kind of igneous atmosphere, composed of strata of different densities. If a second molecule be introduced, the same effects will take place, and every thing will remain in the same state as long as the molecules are at a distance from each other equal to the diameter of their atmospheres: nothing is changed but the temperature. [ut when the molecularæ are brought so near each other th at

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their distance is less than that diameter, their atmospheres will be compressed, and the parts in contact will assume more density and a higher temperature, and which is not in equilibrium with that in the rest of the receiver. These parts deprive themselves of a portion of their caloric, which is distributed among the other strata of these atmospheres until the equilibrium is restored.

When the molecules are made to approach each other gently, the compression of the atmospheres and their re-establishment take place peaceably; but if the molecules are brought into contact abruptly, the caloric is disengaged with the greatest violence. It is to this rapid disengagement of caloric, strongly compressed, that we ought to ascribe the detonations of the super-oxygenated muriatic of pot-ash and of gun-powder.

The molecules assumed, for example, retain a portion of the compressed caloric as long as they obey the force which makes them approach each other. When they arrive at that distance at which they exercise an action on each other, their attractive force is greater or less than that with which their atmospheres tend to recover their former state. If the molecules, then, be left to themselves, in the first case the system retains its present state; in the other case it will resume its primitive state; and it is in this that the greater part of the phenomena of elasticity seem to consist. This reasoning may be applied to every body, the molecules of which are separated from each other by a certain quantity of caloric.

C. Barruel pays attention also to the circumstances under which the elasticity of a body may be manifested, and to the means proper for increasing or producing this property. These circumstances are, compression, a sudden shock, and flexion. In either of these circumstances it happens that the adherence of the molecules either is or is not overcome. In the first case the molecules are put out of their sphere of activity, and the body is said to be brittle. In the second case the body is flexible, but the caloric interposed between its molecules withdraws, or does not withdraw itself, from compression. If it withdraws itself, there is only one dis-

placement of the particles of the body, which is then said to be ductile. If it cannot withdraw itself, it yields or resists. When it yields, the body is soft; when it resists compression, it experiences the effects of it as long as the molecularæ are compressed; it then tends to recover its former state; and this is what renders bodies elastic.

There is no body perfectly soft, ductile, or elastic. Nature presents none which under compression does not suffer a portion of caloric to escape. Thus a body is never perfectly elastic, because the quantity of caloric compressed, being less than the total quantity, cannot restore itself with the same force as if this fluid had remained in its entire state, and cannot keep the molecularæ of the body separated at the same distance as before compression. Besides, the velocity with which it restores itself is also less than that which produced the compression, for a part of this velocity has been destroyed by the entire mass of the compressed body.

A body is more flexible according as it contains more caloric between its molecularæ. This very compressible fluid permits concave molecularæ to approach each other without the convex molecularæ being obliged to separate from each other, as if there were not caloric interposed between them.

The preceding observations may serve to throw some light on various phenomena of elasticity. A blade of copper not hammered evidently remains in that state into which it is put by bending, because the molecularæ of the concave part express, by approaching each other, that portion of caloric which adheres least to them. The other portion, which does not escape, is indeed compressed; but the excess of the spring is compensated by the excess of the adherence of the molecularæ brought together: the body remains in that state in which it is placed.

If the blade has been hammered, it loses by that operation a portion of caloric; the other portion remains compressed; and, when this blade is bent, the compression of the fluid is increased. The excess of spring which it acquires is not counterbalanced by the excess of the adherence of the molecularæ: it tends to restore itself; and the body passes to that state which is called *elastic*.

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The compression and re-establishment of caloric may serve to explain also the oscillations of the molecularæ of a tube of glass terminated by a ball of the same nature, when rubbed with a moistened sponge in order to obtain from it acute tones. The molecularæ of the tube having, by the extension which it experiences, quitted the position proper for their equilibrium, tend to return to it; and as by the velocity acquired they go beyond the term from which they set out, the interposed caloric is compressed, it re-establishes itself with a force equal to the compression, and repels the two parts of the tube to the distance at which they were at first, which occasions an oscillatory motion until it has been destroyed by the resistance of the air.

We might, strictly speaking, explain, without the intervention of caloric, the elasticity of the string of a violin, or of a bell, put into vibration: but from what has been said, it seems to act the most conspicuous part.

Elasticity manifests itself with less energy in liquids than in solids, and yet the former contain more caloric. The reason is plain; it is because their molecularæ, being exceedingly moveable, they can easily withdraw themselves from the compressing forces; but they are elastic, since they have the property of transmitting sounds, and of recoiling back on themselves.

It must have been remarked, that the accumulation of caloric diminishes the spring of solid or fluid bodies: in gaseous bodies, on the other hand, this elasticity is increased by the accumulation, because these bodies, being held in solution in the caloric, participate in its mechanical properties, and chiefly its elasticity.

To increase or produce elasticity in certain bodies, we must employ means proper for bringing together their molecularæ, and keeping the caloric in a state of great compression. The harder, therefore, that a body is, provided it is not so in the extreme degree, the more it will be elastic. It becomes, indeed, less flexible; but this inconvenience may be remedied by rendering the body thin, since its molecularæ will then be less displaced during flexion. There are two things, then, to be considered in elasticity; the rapidity of the

the displacement of the parts put in motion, and the extent of the displacement, which depend on flexibility.

Allaying and tempering favour the increase of elasticity; because, these operations, by bringing the molecuæ nearer to each other, compress the caloric, which tends afterwards to re-establish itself. All these facts have induced the author to conclude, that caloric has at least a great share in all the phenomena exhibited by elasticity.

XII. *On the Efficacy of Yest in the Cure of those Diseases known by the Name of Putrid*.*

A REMEDY, which contains much fixed air, has been lately started by the Rev. Mr. Cartwright, which merits the highest attention. Seventeen years ago, says this gentleman, I went to reside at Brampton, a very populous village near Chesterfield. I had not been there many months before a putrid fever broke out among us: finding by far the greater number of my new parishioners much too poor to afford themselves medical assistance, I undertook, by the help of such books on the subject of medicine as were in my possession, to prescribe for them. I early attended a boy about fourteen years of age, who was attacked by this fever; he had not been ill many days before the symptoms were unequivocally putrid. I then administered bark, wine, and such other remedies as my book directed. My exertions, however, were of no avail; his disorder grew every day more untractable and malignant, so that I was in hourly expectation of his dissolution. Being under the absolute necessity of taking a journey, before I set off I went to see him, as I thought, for the last time, and I prepared his parents for the event of his death, which I considered as inevitable, and reconciled them in the best manner I was able to a loss which I knew they would feel severely. While I was in conversation on this distressing subject with his mo-

* The contents of this article cannot be too generally known. How many valuable lives are yearly lost by putrid sore throats, fevers, &c. which might be saved to the community, and to their relatives, if the cure here recommended were generally known and resorted to! with proper medical aid, however, where it can be had. EDIT.

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