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VIII. *Some facts relative to the Spheroidal State of Bodies, Fire-Ordeal, Incombustible Man, &c.* By P. H. BOUTIGNY (d'Evreux)*.

IN the year 241, Sapor or Chapour ordered the Magi to do all in their power to persuade them and bring them back to the faith of their ancestors. It was then that one of the pontiffs of the dominant religion, Adurabâd-Mabrasphand, offered to submit to the fiery ordeal "He proposed that eighteen pounds of melted copper, issuing from the furnace, all hot, should be poured on his naked body, on condition that, if he was not injured by it, the unbelievers should yield to so great a miracle. The trial was said to be attended with such success, that they were all converted." The historian adds, with an air of doubt, certainly allowable in such a matter, "We see that the religion of Zoroastre had also its miracles and its legends†."

Now this fiery ordeal, undergone with such success by Adurabâd-Mabrasphand, is in plain truth an experiment of primitive facility and simplicity, and which is anything but miraculous.

I stop here an instant, for I fancy that I see the smile of incredulity rise on the lips of some who do me the honour of listening to me;—that smile, so discouraging to one who is insincere, but which only heightens the ardour of him who intends to practise no deception, and who does all in his power not to deceive himself.

To such persons then I would offer this encouragement; the little that I have still to relate appears improbable, but it is true, and that is enough. Having said this, I continue.

In France, in England, in Italy, wherever I have had occasion to speak of bodies in the spheroidal state, I have met with persons who have put to me this question: May there not be some connection between these phænomena and that presented by men who run barefooted over liquid metal (?) still incandescent, or who plunge their hand into molten lead, &c.‡? To all I have answered, Yes, I believe that there is an intimate relation between all these facts and the spheroidal state. And then, in my turn, I put this question: Have you witnessed the fact which you tell me? And the answer has invariably been in the negative.

I avow that all these *on-dits* and the marvellous legends

* From the *Comptes Rendus* for May 14, 1849.

† *Dictionnaire historique, critique et bibliographique*, t. xxvii. p. 417.

‡ I have alluded to these facts in the work entitled, *Nouvelle branche de Physique, or Etudes sur les Corps à l'Etat sphéroïdal*, p. 36.

which I had read in various works* on the fiery ordeal and incombustible men, admitted without reserve by some, obstinately denied by others, excited my curiosity greatly, and gave me a great desire to verify all these phænomena, and to recall them to the recollection of contemporary observers; for, alas! all this is as old as the world; *nil sub sole novum*.

I wrote first to my friend Dr. Roché, who passes his life in the midst of the blast furnaces of the Eure, and who is the physician of a portion of the Cyclopean population who feed them. I requested of him precise particulars. All that he could ascertain was, that a man named La Forge, of from thirty-five to thirty-six years of age, very corpulent, walked step by step barefooted on the pigs after the casting: but he had not seen this. This was not enough to dispel my doubts.

I then applied to a foundry at Paris, where I was laughed at and shown the door. I retired, hanging down my ears, thinking over the difficulties of verifying a single fact, and such a simple one.

Subsequently I was fortunate enough to meet with M. Alph. Michel, who lives in the midst of the forges of Franche-Comté. M. Michel promised me, with the greatest kindness, to inquire into these facts, and to report upon them if desired.

The following is an extract from the letter which he did me the honour to write to me, dated the 26th of last March:—

“On my return home, I did not fail to obtain information from the workmen of the facts of the case (the immersion of the finger in the incandescent melted metal), and most of them laughed in my face, which did not deter me. Lastly, being one day at the forge of Magny, near Lure, I put the question again to a workman, who answered that nothing was more simple; and, to prove it, at the moment when the metal in a state of fusion issued from a Wilkinson, he passed his finger into the incandescent jet. A person employed in the establishment repeated the experiment with impunity: and I myself, emboldened by what I saw, did the same . . . I may observe, that, in making this trial, none of us moistened his finger.

“I hasten, Sir, to acquaint you with this fact, which seems to support your ideas on the globular state of liquids; for the fingers being naturally more or less humid, it is, I think, to this moisture passing to the spheroidal state, that we must ascribe their momentary incombustibility.”

The following are the experiments which I have made:—

I divided or cut with my hand a jet of melted metal of five

* *Des Erreurs et des Préjugés répandus dans les diverses classes de la Société*, t. xii. p. 183.

to six centimetres, which escaped by the tap, then I immediately plunged the other hand in a pot filled with incandescent metal, which was truly frightful to look at. I involuntarily shuddered. But both hands came out of the ordeal victorious. And now, if any thing astonishes me, it is that such experiments are not quite common.

I shall of course be asked, what precautions are necessary to preserve oneself from the disorganizing action of the incandescent matter? I answer, None;—only to have no fear, to make the experiment with confidence, to pass the hand rapidly, but not too rapidly, in the metal in full fusion.

Otherwise, if the experiment were performed with fear, or with too great rapidity, the repulsive force might be overcome which exists in incandescent bodies, and thus the contact with the skin be effected, which would undoubtedly remain in a state easy to understand.

To form a conception of the danger there would be in passing the hand too rapidly in the metal in fusion, it will suffice to recollect that the resistance is proportionate to the square of the velocity, and, in so compact a fluid as liquid iron, this resistance increases certainly in a higher ratio.

The experiment succeeds especially when the skin is humid; and the involuntary dread which one feels at facing these masses of fire, almost always puts the body into that state of moisture so necessary to success; but by taking some precautions, one becomes veritably invulnerable. The following is what has succeeded best with me: I rub my hands with soap, so as to give them a polished surface; then, at the moment of making the experiment, I dip my hand into a cold solution of sal-ammoniac saturated with sulphurous acid, or simply into water containing some sal-ammoniac, and, in default of that, into fresh water.

Regnault, who has occupied himself with this subject, says, "Those who make a trade of fire handling and holding it in the mouth, sometimes employ an equal mixture of spirit of sulphur, of sal-ammoniac, of essence of rosemary, and onion-juice." All volatile substances, we see, which, in evaporating, render a certain portion of heat latent.

Let us now seek the rational explanation of these facts.

We have the formula $mc t$, which gives the quantity of heat contained in any body.

Let m be the mass expressed in kilogrammes,

c the specific heat of the body,

t its temperature.

But here the factor m must be abstracted, because there is no contact between the hand and the metal in fusion, and the

experiment presents no difference, being made either with 10 kilogrammes of metal, or with 1000 kilogrammes. The sensation which is felt is the same in either case, and this is readily conceived, knowing the repulsive force of incandescent surfaces which is opposed to the contact of any body.

The finger or the hand is then isolated in the midst of the mass in fusion, and thus preserved from the disorganizing action of the incandescent matter. I repeat, that the mass must be abstracted.

There remain the two factors c , t . I will suppose, and it is a sufficient approximation, that the value of $c=0.15$, and that of $t=1500$ degrees, the temperature of the metal in fusion; now the product of 1500 degrees $\times 0.15=225$. Thus the epidermis of the experimenter would only be exposed to 225 degrees of heat. Undoubtedly this is a respectable quantity of caloric, but it is too high, as we shall see.

There is no contact between the hand and the metal; this, in my estimation, is a fact positively established. If there is no contact, the heating can only take place by radiation, and it is enormous, it must be acknowledged; but if the radiation is annulled by reflexion, and it is so, it is as if it did not exist, and, definitively, the operator is, so to say, placed in normal conditions.

I think that I have established, a long time ago, the fact that water in the spheroidal state has the property of reflecting radiating heat*, and that its temperature never attains that of its ebullition; whence it follows that the finger or the hand being humid, cannot rise to the temperature of 100° Centig., the experiment not continuing long enough to permit the humidity to evaporate entirely.

To recapitulate what I have stated on this point, I say,—in passing the hand into any metal in fusion, it becomes isolated; the humidity which covers it passes into the spheroidal state, reflects the radiating caloric, and does not become heated enough to boil. This is all.

I was right then in saying at the outset, this experiment, dangerous in appearance, is almost insignificant in reality.

I have often repeated it with lead, with bronze, &c., and always with the same success†.

* Nouvelle branche de Physique, or *Études sur les Corps à l'État sphéroïdal*, pp. 24 *et seq.* and 132 *et seq.* See also our two letters to the Académie des Sciences, dated the 14th and 21st of July, 1845. In the places indicated will be found the explanation of this phenomenon.

† The experiments on the cast iron were made in the foundry of M. Davidson, at La Villette; and, on the bronze, in that of M. Nérat, Rue Pierre-Lévéé. I am happy to have an opportunity of publicly thanking these gentlemen for their kind assistance.