

WATER AS A SCIENTIFIC GENIE

The Surprising Principle of the Hydrostatic Paradox, and the Great Power That It Enables Man to Concentrate, Though It Creates No New Force.

A correspondent in Boston confides his puzzlement over the fact that water at rest presses upward as well as sideways and downwards. Well, the truth is that behind that fact stands one of nature's greatest paradoxes, which has made many a thoughtful person rub his eyes on first getting a glimpse of it. I was myself a small boy in a country school, but already a devoted subject of Caliph Haroun-al-Raschid's magic kingdom, when I made the acquaintance of the great and wonderful genie named the Hydrostatic Paradox.

It is mingled in my memory with Summer morning fragrance and the songs of bobolinks coming in through open windows from fields of new-cut hay. The genie made his first appearance to my eyes in the pictured pages of "Parker's Primer of Natural Philosophy." That, I think, was the name; at any rate, I can still see the cover on the book, which was a rich, deep yellow that looked as good to eat as a pumpkin pie. And the book had a delicious smell of its own, too; all new school books had in those days.

The Hydrostatic Paradox genie took me quite off my feet. I not only thought him as wonderful as were the all-powerful friends that Aladdin summoned out of nowhere, but he even seemed to me to make those Arabian Nights stories almost probable. If science had found him, and was ready to vouch for him, then it did not appear so impossible that there might really be, somewhere, mechanical horses, all ready caparisoned, which, upon the turning of a peg in their necks, would fly up into the sky and convey the rider in a single night from China to the centre of Africa. So, for me, philosophy seemed to back up romance.

The first amazing thing that this genie of science had in store was his ability to magnify power—so it seemed—without limit. I found out that if I should take a tube an inch across, pour it full of water, and connect it with a tank of water ten feet wide, I would be able, by pressing down upon the water in the tube, with a force of only one pound, to lift an elephant weighing more than seven tons, if I could only manage to make him stand on a platform covering the water of the tank. Of course, I did not actually try the experiment, not having either the tube, the tank, or the elephant handy, but I believed the word of science that it could be done. I also ignored the detail, which seemed too uninteresting to pause upon in the presence of such a wonder that I should have to push the water in my tube down 1,200 feet in order to lift the elephant one inch.

This unattractive detail, however, contained the whole key to the wonder, as we shall see.

Among the marvels that the great Paradox presented to my dazzled mind were pictures of one small boy gleefully pushing a piston and thereby lifting a mountain, and of the same phenomenal youngster mischievously setting to work to split the great earth asunder by running his magic tube down to a spherical tank of water in the center of the globe. I did not, then, stop to consider the various "ifs" and "buts" involved, the great fundamental principle, with its glorious possibilities of illimitable power, being too good a thing to spoil by mortifying qualifications. What boy would miss the fun of bursting the earth, after it had been promised, for a "take-back" like that?

But later my heated imagination sobered down as the real facts began to make themselves too evident to be ignored. I perceived that this hydraulic genie could do no more than manufacture power out of nothing than I could.

The water simply acted as an agent for the transference of force, to move among themselves, yield to the slightest distorting force, and if a certain pressure is put upon any part of a body of water that same pressure is transmitted to all the other parts, and is felt equally in all directions, down, up and sideways. That the pressure is felt in an upward direction may be easily proved by pushing an empty dipper bottom downward into a pail full of water. The water rises around the outside of the dipper and overflows the sides of the pail.

It is the force with which you push down the dipper that presses the water upward, the particles of water under the dipper transmitting the pressure to all the other particles of water in the pail.

But even its own weight causes water to press upward. If it were not so there would be no such thing as floating bodies. When water is at rest the pressure at every point within it is equal in all directions, and just sufficient to balance its own gravity. A body which is, bulk for bulk, heavier than water, sinks because its downward pressure exceeds the upward pressure of the water. If it has the same weight, bulk for bulk, it will be in equilibrium when immersed in water. The reason underlying the "hydrostatic paradox" is that, since the particles of water transmit any pressure undiminished in every direction among themselves, if a certain pressure, say a pound, is applied to a small part of a surface of water, say a square inch, that same pressure will be transmitted to every other square inch of the water, so that the total pressure transmitted to 100 square inches will be 100 pounds.

But this is not, as seems at first sight, a multiplication of force; it is simply a concentration analogous to that effected by a lever, for just as if you are going to raise a weight of 1,000 pounds by pressing down with a force of 10 pounds on the lever, you must have the outer arm of your lever 100 times longer than the inner one, so to produce 1,000 pounds pressure in a hydraulic press from an initial force of 10 pounds you must move the small piston 100

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