THE FLOATING BALANCE.

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An interesting example of the laws of the equilibrium of floating bodies combined with a well-known illustration of the specific gravity of gases is afforded by the apparatus illustrated in the cut. It is essentially a balance in which the ordinary fulcrum is suppressed and replaced by a floating cylinder. As the resistance offered by water to the slow movement through it of a floating body is almost nothing, it follows that a very sensitive balance may be thus constructed. The experiment in which it is represented as employed is the weighing of carbonic acid gas.

The balance beam is made of a thin strip of wood. A piece of printer's "furniture," used in setting up pages, is a good material for this purpose. It is set into a short pin, also of wood, which is driven into a wooden cylinder. The latter should be an inch in diameter and three or four inches long. The pin should be inserted half way between the ends. Into the cylinder directly opposite the pin a wood screw is inserted. A disk of lead is soldered to its head. This acts as a handle by which to turn it, and also as additional counterpoise. It is for the end of maintaining a sensitive but at the same time stable equilibrium that the weighted screw is used.

At each end of the beam, hooks are arranged as shown for attachment of the pans or other receptacles. They are made of iron or brass wire; and are firmly secured to the beam. They are carried downward so as to bring them in line with a point slightly above the axis of the cylinder.

For the weights, a scale pan of mica may be used. If carbonic acid or nitrous oxide gas is to be weighed, a light paper box, three or four inches on each edge, takes the place of a second pan. Thread is used to suspend them.

A tin reservoir of the shape indicated has a socket soldered to its bottom. By this it is held on a standard as shown. The upright piece should also pull out of the base, so as to make the whole portable. For weights or counterpoises, little bits of wire, tin, and tinfoil may be employed.

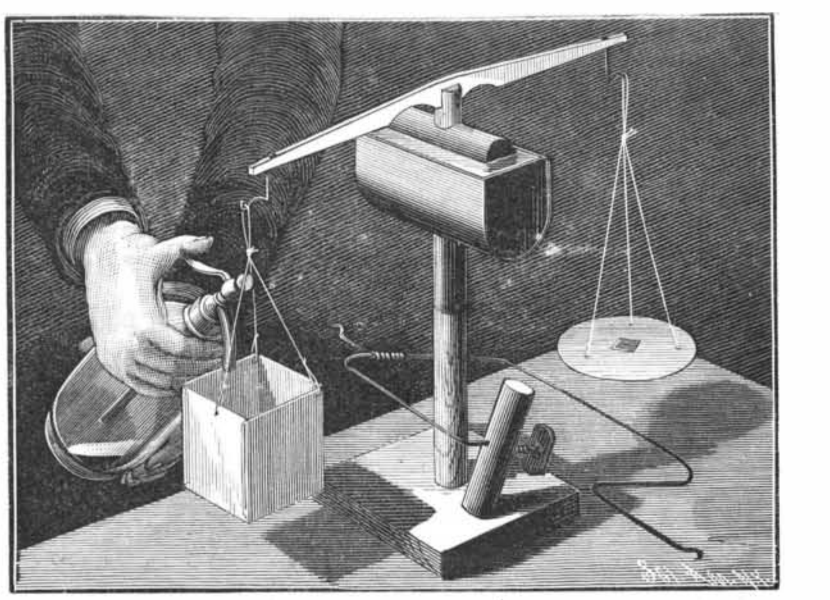
The cylinder is introduced into the empty reservoir and water is poured in until the cylinder floats up near the level of the upper edge. The entire surface of the cylinder should be well moistened. The balance now has to be brought into equilibrium. This is done by hanging the pans in place, and by using weights or the counterpoises we have mentioned. When in equilibrium, it is examined as to its stability. If it is sensitive to one-seventh grain (10 milligrammes), it is good enough. If not, the screw under the water must be screwed further in.

By repeated trials the sensitiveness can be accurately adjusted. To allow the beam sufficient motion, it is well to cut out two pieces on each side of the cylinder. As it is very important that it should be rigid, these notches must not be made too deep. When to be used in weighing a gas, the box is carefully counterpoised, and the balance is made as sensitive as possible. If now the box is filled with carbonic acid or nitrous oxide gas, that end of the balance immediately descends, although nothing is visible.

Another form of the balance beam is shown lying at the foot of the apparatus. For wooden beam and supporting pin a bent wire is substituted of the form indicated. By careful bending and sliding, the two pan-hooks can be brought to the proper level, and the experiment performed with quite as good satisfaction as in the other form.

Carbonic acid gas may be made by pouring vinegar upon baking soda. A pickle bottle or preserve jar answers for the operation, and in a few seconds it can be filled with the gas. By careful manipulation this can be poured out like water into the box suspended on the balance beam. Nitrous oxide, or laughing gas, is made by heating nitrate of ammonia. A great deal of water is evolved along with it. If to be used in the experiment, it must be caught by displacement of air, as it dissolves in water, thus precluding the use of the hydraulic trough.

Finally, a very ready source of carbonic acid gas is suggested in the illustration. After a mineral or soda water siphon has been exhausted of its liquid contents, it still contains a considerable quantity of gas. By inclining the siphon to one side, so as to keep all water away from the end of the glass tube, the gas may be drawn off by opening the valve. The best plan is to fill a pickle jar or other bottle from the siphon, and thence to pour the gas into the counterpoised box. If the siphon is used directly, the force of the escaping gas will tend to agitate the balance unless the cock is opened with extreme care. In all cases the experimenter must be on his guard, and allow no water to enter the box.



THE FLOATING BALANCE.

Creatures We Breathe.

The supporter of the doctrine that the particulate ingredients of the atmosphere are the chief cause of the insalubrity of cities will find much to sustain his contention in the brief but suggestive paper contributed by Dr. Frankland to the current number of the *Nineteenth Century*. From the facts presented, the proposition might easily be maintained that "a man carries with himself the elements of his own destruction." Many arguments of a seemingly valid sort may be educed from hygienic and antiseptic systems, calculated to prove that a germless atmosphere would be far more profitable to the majority of mankind than the atmosphere with which we have at present to be contented; and this notwithstanding the somewhat contrary position which Dr. Frankland takes at the commencement of his paper, for he thinks it would require but little persuasion to convince most of us that air without organisms would be undesirable indeed. He proceeds to illustrate this view by a reference to the great utility and value of one micro-organism at least, the yeast fungus, which is so widely and universally distributed, and whose disappearance from the breathing medium would cause us to "forego those numerous, complex, and much appreciated pleasures which are derived from the consumption of alcohol in its various forms."

For our own part, we believe there is already sufficient evidence to warrant a belief that the presence of micro-organisms in the respiratory fluid is very undesirable; while we confess at the same time that their exclusion would be practically impossible. Undoubtedly, many of the germs in the air we breathe are for the most part harmless in their nature, though it is probable that even the innocuous varieties may require a slight expenditure of energy on the part of the human organism to neutralize the effect of their activities, since it is hardly likely that the act of destruction of a bacterium is unattended with the employment of some kind of force, and we know that the active protoplasm of living bodies is capable of destroying bacteria. Indeed, the theory implied in these considerations may be expanded.

We may conceive, for example, that deterioration of health by a general weakening of the whole body might be the cause of many diseases, not so much by the agency of the mere debility as by the circumstance that the deterioration afforded the opportunity for the growth and development of organisms which, under the ordinary circumstances of good health, would have been quickly destroyed by the inherent vitality of sound tissues. The experiments of Pasteur and Tyndall, and the observations of Miguel and Frankland, bear abundant testimony to the existence of a law which may not be expressible in such definite terms as that the number of microbes in the atmosphere varies inversely as the square of the distance from human habitations, but which, nevertheless, forcibly reminds one of this physical law. Pasteur exposed twenty flasks containing putrescible substance in the open country of Arbois, and found that eight became turbid or contaminated with microbes. Of twenty exposed in the lower heights of the Jura Mountains, only five became affected, while of twenty others exposed at the Montanvert, close to the Mer de Glace, at a height of 6,000 feet, only one flask developed microbes. Miguel, by observations made at Montsouris, in different seasons of the year, has shown how the distribution of microbes is dependent on the surroundings.

Frankland, employing a more recent and more accurate method, has shown very clearly that the maximum number of micro-organisms is to be found in the hottest months of the year. Thus, in a volume of air equal to about two gallons (ten liters) collected on the top of the Science and Art Department buildings at South Kensington, at a height, therefore, of some 70 feet from the ground, and so removed from any local disturbance of the air, he found that in August the number of micro-organisms exceeded 100, while in January there were but 5. There was a gradual rise in numbers from May to August, after which the fall in number was much more sudden. In the country the number of atmospheric micro-organisms was very appreciably smaller; and the more remote the place of observation is from houses, and from the frequented thoroughfares of traffic, the dust of which is always rich in refuse organic matter, the freer does the air become from suspended microbes.

In reading Dr. Frankland's paper one cannot but be struck with the remarkable concomitant variation between the number of micro-organisms and the unwholesomeness or wholesomeness of the places investigated. Every medical man knows the value of mountain air and of a sea voyage, and it is only in these places that the atmosphere can be said to be free from micro-organisms. The interiors of railway carriages are, as we all know, apt to become foul, but Dr. Frankland's estimation that more than 3,000 organisms were found to be falling on the square foot in one minute while the train was passing half way between Cambridge and London, one window of the compartment being shut and the other only open four inches at the top, gives a mathematical expression to the fact, which, if any were wanted, is sufficient explanation of the fatigue of a journey, without invoking the aid of the theory of nerve vibration to account for the prostration which many suffer after a prolonged ride in the train. In point of numbers, however, the atmosphere of a barn where flail thrashing was in operation puts the railway compartment in the shade, for there were no less than 8,000 organisms falling on the square foot in one minute. The injurious effect of theaters and crowded places of amusement would find a sufficient explanation in the yield of micro-organisms, without taking any account of the diminution of oxygen or the increase of carbonic acid. At a conversazione at Burlington House the number of organisms reached 432 per ten liters of air.—*Lancet.*

A Sea Telephone.

A dispatch from Cincinnati, Ohio, says: At Fernbank, ten miles from this city, are the workshop and laboratory of Harvey B. Cox, a young electrician, who, though known to but few here, is attracting the attention of scientists and electricians in this country and Europe by his inventions, in which he is as prolific and ingenious as Edison. His latest device is a trumpet to be used for telephoning at sea, on which he has been working for some months. The invention is the outgrowth of his discovery of the great distance an echoed or reverberated sound will carry and the discovery that speaking trumpets, if made to give the same fundamental note, would vibrate and produce the phenomenon known in acoustics as "sympathy." With this trumpet, conversation in an ordinary tone of voice was carried on between persons four and a quarter miles apart. People siting at their windows or on their porches a mile away conversing in an ordinary tone could be distinctly heard, and in a couple of instances they were told the nature of their conversation and admitted that such had taken place. By listening to the whistle of a train, and tracing it to and beyond Fernbank to Lawrenceburg, Ind., it was found that the instrument has a well-defined range of twenty-six miles; that is, a loud sound like a locomotive whistle or the rumbling of a train can be distinctly heard at a distance of thirteen miles in every direction. Conversation was readily carried on between two gentlemen on high hills on opposite sides of the Ohio River, about four and one-half miles apart. Tests made on the water showed that the trumpet was even more available than on land. The instrument will be patented as soon as perfected. A name has not yet been chosen for it. Mr. Cox has a great many other curious and valuable devices, both electrical and mechanical, but none as curious as his sea telephone.

Carbonic Acid Gas as a Fire Extinguisher.

The fiery, untamed soda-water tank, which has chiefly distinguished itself since the advent of hot weather this year by bursting and killing or maiming its attendants, has made a new departure, says *Fire and Water*, and now appears in the role of a most efficient extinguisher of fire. Some days ago at Louisville, Ky., a boy carried a lighted candle into the cellar of a drug store, and in some unexplained way set fire to a vessel full of varnish, which blazed up through a grating in front of the building as high as the second floor. Before, however, the flames could gain headway in the building, the heat had melted the lead pipe connected with the newly charged soda fountain, and the flames were instantly extinguished.