

justing the compasses, that they should be tried in every position, a table of variation being made out for every degree of listing over. The paper was illustrated by drawings of the vessel and of her rigging which possessed peculiarities, and also by several tables for the correction of the compasses.—*Proceed. Inst. Civ. Eng.* Min. Jour.

On the Law which Governs the Discharge of Elastic Fluids under Pressure, through short Tubes and Orifices. By W. FRONDE, M. Inst. C. E.

The subject of the paper admitted of a much longer communication than could be read at one meeting, and the train of reasoning was such as could scarcely be perfectly entered into on merely hearing it read; nor is it possible, within our limits, to give a complete analysis of a paper, which, for accuracy of perception, closeness of reasoning, and terseness of diction, has rarely been equalled in any scientific society. A succinct review of it must suffice. The law proposed was a modification of that which has been usually assumed—viz: a simple application of that which holds good with respect to non-elastic fluids; this law is, generally, that the velocity of issue is directly as the square root of the pressure, and inversely as the square root of the density: but this law neglects wholly the reaction that must arise from the expansion necessarily taking place in the course of issue. The nature of the action was illustrated by the following example:—If a balance be supposed, with an equal weight in each scale, one of the weights being a spiral spring, like that of a spring balance compressed lengthwise with its axis vertical, and held in a state of compression by a cord. Now let the cord be suddenly reversed, so that the spring is enabled to extend itself vertically; the scale in which it stands will obviously be depressed, the spring reacting on it as it expands upwards, and continuing to press till wholly relaxed; or if the scale in which it stands were ascending by a preponderance given to the other scale, the rate of its ascent would be in the same way retarded. The amount of the retardation would depend on the strength and the weight of the spring, and on the length to which it would extend itself when released. Now in the discharge of an elastic fluid, there is an action strictly analogous, operating continuously, however, instead of *per saltum*, the strength and weight of the spring being represented by the elasticity and density of the fluid, and the length to which it would extend itself by the degree of expansion, in the course of issue. The reduction in quantity of discharge, due to the action, was to be measured by the velocity imparted by expansion, to each particle of the elastic fluid in course of issue, the velocity of each particle after expansion, would be its velocity before expansion, multiplied into the rate of expansion, and the primary force must be subdivided in generating each additional unit of velocity, so that the portion applicable to the generation of velocity before expansion, would be the whole force divided by the rate of expansion; thus, the velocity before expansion would be divided by the square root of that rate. For instance, an elastic fluid expanding four times in course of issue, would be discharged

with only half the velocity of a non-elastic fluid, under the same circumstances of pressure and density. This modification was shown to fulfil the general dynamical law "that a given force, acting for a given time, will produce a given momentum, whatever be the weight of the mass acted upon." This seemed to be the essence of the law for non-elastic fluids, but it was disregarded by the unmodified application of that law to elastic fluids, in which there would be a great accession of velocity of particles issuing under a given pressure, without any reduction of quantity discharged in a given time; if, however, the quantity be reduced as proposed, in the ratio of the square foot of the density, and the velocity be accelerated in the same ratio—the final momentum would be the true equivalent of the pressure. This, in its practical application, explained what was inexplicable by the ordinary theory; the difficulty experienced from the back pressure of the waste steam in locomotive engines, and a diagram was given, showing, that at 60 miles per hour, this would be at the least equivalent to 8 lbs. per inch throughout the stroke, thus showing a loss of nearly 50 H. P. As applied to the case of air, discharged into an exhausted receiver, the result was highly curious. The rate of discharge, instead of increasing throughout as the degree of vacuum was increased, would be maximum at 15 in. of vacuum, although nearly uniform for many inches above and below that point; it would, however, progressively decrease above that point, because the expansion would increase in a higher ratio than the pressure, and ultimately, at the point of perfect vacuum, it would be at a minimum (indeed stationary, were air perfectly elastic), because at that point the expansion would be infinite, but the pressure only finite—viz: 30 in. of mercury. Experiments made, by permission of Mr. Brunel, with the South Devon Railway atmospheric apparatus, confirmed the theory. The line traced by an indicator apparatus was shown to accord very closely with one traced by this theory, whilst it was widely at variance with the result of the ordinary theory.

Ibid.

Valuable Alloys.

The *Paris Scientific Review* has published for the benefit of the industrial workers in metals, the best receipts for composing all the various factitious metals used in the arts.—The following are a few:—Statuary bronze—Darcet has discovered that this is composed of copper, 91·4; zinc, 5·5; lead 1·7; tin, 1·4. Pinchbeck—copper, 5; zinc, 1. Bronze for cannon of large calibre—copper, 90; tin, 10. Bronze for cannon of small calibre—copper, 93; tin, 7. Bronze for medals—copper, 100; tin, 8. Alloy for cymbals—copper, 80; tin, 20. Metal for the mirrors of reflecting telescopes—copper, 100; tin, 50. White argentan—copper, 8; nickel, 3; zinc, 3½—this beautiful composition is an imitation of silver to the degree of 750·1000. Chinese silver—Mons. Meurer discovered the following proportions—silver, 2·5; copper, 65·24; zinc, 19·52; nickel, 13; cobalt of iron, 0·12. Tutenague—copper, 8; nickel, 3; zinc, 5. Printing characters—lead, 4; antimony, 1. For small types and for stereotype plates—lead, 9; antimony, 2; bismuth, 2.

Ibid.