copper, in order that the copper may become more easily insulated than it would otherwise be if surrounded or encased as usually with gutta percha or other insulating materials, without being first coated with a metal or alloy or combination of metals having comparatively slight degree of conductivity.

*Lecture on Rotary Stability and its Applications to Astronomical Observations on board Ships.** By the Rev. Prof. BADEN POWELL.

The object of the discourse was to explain an apparatus recently contrived, for the purpose of giving perfect stability for the nicest astronomical observations on board a ship pitching and tossing with every wave and gust of wind. This contrivance has been the result of a principle of rotary motion, which, although long since understood and acknowledged in theory, has been but lately considered with regard to its practical results, and when first tangibly exhibited in the gyroscope or free balanced revolver, had excited unbounded surprise. It was forgotten how perfectly similar, and equally paradoxical in its nature, is the common and familiar result of a top sustained by the mere act of spinning in a position from which it directly falls when the rotation ceases. On a former occasion, on the 3d of March, 1854, the Professor brought under the notice of the members the principle of "composition of rotations," and those applications of it which had been formed in certain rotary phenomena of projectiles, illustrated by the gyroscope in its several earlier forms, as successively modified by Bonenberger, Atkinson, Fessel, and Wheatstone, showing the identity of those results on a small scale, with the grand cosmical phenomenon of the precession of the equinoxes. Since that time the same principle had been applied by M. Foucault to prove the earth's rotation on its axis, and which the lecturer said had been pointed out eighteen years before, by Mr. Sang, of Edinburgh, and only not practically accomplished from the expense of the necessary apparatus. The rotary apparatus, which the lecturer proceeded to explain, for giving an invariable plane or platform for astronomical instruments used at sea, was invented by Prof. C. P. Smyth. Two simple first principles in dynamics give the clue to the whole of the applications. 1. The tendency of a body in rotation to retain that rotation in the same place, when perfectly balanced, irrespective of the motion of external objects, which is termed "the fixity of the plane of rotation." 2. "The composition of rotary motion," or that when a force is impressed on a body in rotation, it does not show itself directly, but is compounded with the fixed motion, so that the rotation takes an intermediate direction, or the axis shifts its position in space. This being the cause of the motion of the earth's axis, giving rise to the precession of equinoxes, it is generally called a "precessional motion."

One of the most important desiderata of nautical astronomy has always been the means of observing at sea the eclipses of Jupiter's satellites—so frequently recurring, and affording so simple and direct

* From the London Practical Mechanics' Journal, October, 1853.

a means of obtaining the longitude. Stability on board ship is essential to this, and many schemes have been invented for the purpose of supporting the telescope, and the observer with it, so as to be free from the motion of the ship. In general, to procure this stability, it seemed an obvious resource to suspend any object which it was desired to keep steady by cords from a fixed point in the vessel. But a body thus suspended is like a plumb line; when the point of support is itself set in motion, it acquires a part of that motion, and becomes a pendulum, and it oscillates more irregularly and violently, from the accumulations of motions impressed upon it continually by every fresh motion of the ship. Nairne's or Trwin's "marine chair" for carrying the observer and the telescope was simply an application of this principle. It was found not to answer, as the principle upon which it was constructed tended to perpetuate disturbances rather than destroy them. In these cases the centre of gravity is *below*. If it were suspended in gimbals, so that the centre of gravity should be at the point of suspension, the tendency to oscillate from this cause would be overcome. But still any slight cause might disturb the level; there would be no principle of permanent stability. Thus, to produce this desirable stability for a place or stand on which the telescope is to be rested, we must have recourse to the free revolving disk accurately balanced within gimbals, on its centre of gravity. The balancing must be perfected by means of the adjustable plugs before-mentioned, both in the disk, and in the gimbal frames; the pivots of the gimbals must be of perfect workmanship, to turn with the least possible friction, yet without looseness or displacement. An immense rotary velocity must be communicated to the disk by machinery, of which its suspension must be quite independent, so that the moving power can be instantaneously withdrawn. The Professor stated, that all these conditions are fulfilled in the form of the machine, which, after repeated trials, has been adopted by Prof. Smyth, exhibited by him at the Paris Exhibition, 1855, and successfully tried on board Mr. Stephenson's yacht, "*Titania*," on his voyage to Tenerife, in 1856. A free revolving disk in gimbals, externally turning on pivots horizontally resting on supports fixed to the deck, will suffice to preserve the telescope from all deviation due to pitching and rolling. The addition of another disk, freely revolving in a vertical plane, whose external pivots turn vertically in a frame attached to the top of the former internal frame, the upper pivot projecting through it, and carrying a small platform for the telescope, and the whole, of course, balanced below, will preserve the telescope from any lateral deviations of the ship. And the combination of the two will give a plane retaining its parallelism against all those causes of disturbance. But under favorable circumstances this last cause of disturbance is but small, so that this addition may often be of little importance. Thus we have the whole construction of what the inventor designates as "the compound precessional free revolver stand."

The Professor concluded by taking a summary view of the whole subject. By direct consequence from the simplest acknowledged mechanical principles, the gyroscope, when its equilibrium is slightly disturbed,

demonstrates the precession of equinoxes, explains the boomerang, and sustains itself in the air against gravitation. When its equilibrium is undisturbed, it exhibits to the eye the actual rotation of the earth; and when restricted to one plane, it acts as a magnetic needle without magnetism, or spontaneously rotates in parallelism with the earth. To these remarkable, diversified, and somewhat paradoxical applications, there is now added another of far higher utility—that it gives perfect stability for the nicest astronomical observations on board a ship pitching and tossing with every wave and gust of wind.

Before the Royal Institution.

For the Journal of the Franklin Institute.

Chemical Examination of the Commercial Varieties of "Common Salt," or Chloride of Sodium. By CAMPBELL MORFIT.

Referring to the composition of the natural sources of the commercial varieties of chloride of sodium, such as salines, bay and sea waters, it is very reasonable to suppose that the derivative substance should comprise all or many of the constituents of the original material. These constituents are chlorine, bromine, iodine, fluorine; sulphuric, nitric, phosphoric, boracic, and silicic acids; sodium, potassium, magnesium, calcium, aluminum, iron, oxygen, and insoluble matter. Though only a portion of those that may be present are in appreciable amount, the examination was very exact, and with a view to detect any or all of them, however minute might be the trace. As lead and copper vessels are sometimes used in the manufacture of salt, there was also a search for any traces of those metals that might have been thence derived. The proportion of accidental water was likewise determined.

Fluorine.—This element was not found in any of the specimens, notwithstanding the great care with which it was sought. One hundred grammes of salt were dissolved in pure water and treated with a solution of chloride of calcium. The precipitate was collected on a filter, and after being thoroughly washed, rinsed off into a leaden cup and heated upon the sand bath, first to expel water, and then with sulphuric acid under a glass cover for some hours, but without obtaining the least corrosion of the glass. The salt was not treated directly, because the large quantity necessary to give an accurate result causes a copious elimination of chlorine, which would interfere with the reaction, and be otherwise inconvenient and disagreeable. Doubtful, too, whether the fluorine existed wholly or only partially in soluble combination, I preferred treating together both the insoluble residue of the salt and the precipitate formed from it, by chloride of calcium which carries down any fluorine that may be present.

Iodine.—Previous experimenters have reported the presence of this element in some salts, but I could not detect it, though I applied the most delicate tests, and operated on the large quantity of 100 grams. It remains, doubtless, with the bromine in the mother water.

My first essays were with chloride of palladium, which was added to a clear and dense solution of 100 grammes of salt: but even after a