deviation of the compass on ship-board by an iron plate; for should circumstances require the removal and replacement of the compensating plate in high northern latitudes, its magnetism might be so altered by the effect of rotation as materially to injure its compensating property. The means of avoiding this disagreeable consequence are pointed out.

Observations to determine the Amount of Atmospherical Refraction at Port Bowen in the Years 1824-25. *By Captain* W. E. Parry, *R.N. F.R.S.; Lieutenant* Henry Foster, *R.N. F.R.S.; and Lieutenant* J. C. Ross, *R.N. F.L.S.* Read June 15, 1826. [*Phil. Trans.* 1826, Part IV. *p.* 206.]

The author commences by observing, that on attempting the various methods proposed by astronomers for ascertaining by actual observation the amount of atmospherical refraction at low altitudes, they all proved impracticable at Port Bowen, by reason of the intense cold, which rendered it impossible to use the repeating circle or other similar instruments. The method therefore proposed by Lieutenant Foster, and modified by Captain Parry, which was found successful, was, to place a board edgeways and truly horizontal on that part of the high land behind which a given star set, and observe the moments of its disappearance. Then, determining at leisure the zenith distance of the upper edge of the board on the return of the sun, and in weather better fitted for delicate observations, the stars fixed on were α Aquilæ and Arcturus; and the paper before us gives a detailed account of a series of observations of the moments of disappearance of both these stars, and also of the zenith distances of the boards employed by the several observers enumerated in the title. In some cases also, the reappearance of the star below the board was observed, thus giving an observation at another altitude, and the angular breadth of the board was afterwards measured by a micrometer from the station of observation.

Description of a Percussion Shell, to be fired horizontally from a common Gun. By Lieutenant Colonel Miller, *late of the Rifle Brigade, and now unattached. Communicated by* R. I. Murchison, *Esq. F.R.S.* Read November 16 and 23, 1826. [*Phil. Trans.* 1827, *p.* 1.]

In this paper, the author first considers the theory of rifles, with which the subject of it is intimately connected; and regarding it as an admitted principle, that irregularities in the flight of shot arise from irregularities either in their surface or substance, shows how the rotatory motion of a rifle ball, by presenting every part uniformly to the action of the resisting medium, obviates the effect of these irregularities. The spiral or rotatory motion of the ball in rifles, is generally supposed to arise wholly from the re-action of the grooves in the barrel, or from the indentations made by them in the surface of the ball; but the author, taking into consideration the powerful action of the air on projectiles, is led to conclude that the rotation

of a grooved ball may be sustained during its flight, or even produced originally by the resistance of the air acting on the inclined planes formed by the grooves, on the same principle as the rotation of the sails of a windmill. These considerations led the author to conceive the possibility of giving the spiral motion to grooved shot fired from a plain barrel; an idea which, he remarks, seems to have also occurred to Mr. Robins, who left, however, no clue to enable us to discover the nature of his plan. He accordingly commenced a series of experiments for the purpose, and, abandoning all idea of success with spherical shot, adopted the cylindrical form. His first trials were made in the summer of 1821. Hemispherical ends were adapted to cylindrical shot, but abandoned, it being found desirable so to dispose the weight as to give the greatest possible length to the shot; grooves of various dimensions were tried, and were found not to answer when narrow, but required to be wide enough to allow their sides to be exposed, from one end to the other, to a current of air blowing straight between them.

In 1822, some further experiments were made at Woolwich, with grooved leaden shot fired from musket barrels, and with wooden shot from a $5\frac{1}{2}$-inch howitzer, in which the shot, being received on targets, or in banks of earth, were in numerous instances found to have flown in the manner expected, *i. e.* point foremost. Similar trials with grooved leaden bullets from a plain barrel, were made in 1823, to the extent of several hundreds; and the balls, when well made, were always found to fly end foremost. Large wooden grooved shot were also fired from a 24-pounder, at Kinsale Fort, and on some occasions by night with lighted fusees in their sides, by which contrivance it was distinctly seen that the spiral motion was acquired and maintained steadily throughout their flight.

Having thus proved the possibility of communicating the spiral motion to a grooved shot from a plain barrel, it next occurred to the author, that a shell so constructed, and flying always with one end foremost, might be made to explode by percussion. This he accomplished by forming his shell into a cylinder terminated by a conical apex, in which is formed a vent communicating with the cavity of the shell. This vent is plugged with an iron peg, under which is placed a pellet of percussion powder, and which, on the point of the cone striking a hard substance, is driven in and ignites the percussion powder, which immediately communicates with the bursting charge.

Several shells of this construction were fired against Kinsale Fort from a 24-pounder, and exploded on striking it; and the author goes on to describe a great variety of trials with iron shells of different sizes, and fired under different circumstances, both at Kinsale Castle and Leith Fort, in all of which a considerable amount of success was obtained, and in some cases the explosions of the shells took place on striking at 800, 850, and even 1200 yards.

Further experiments were tried at Woolwich in 1826, on the hull of a 28-gun ship, during three successive days. Out of thirty-one shells fired at her, at various ranges from 330 to 450 yards, eleven exploded on striking; one of which took effect on the mainmast and

set it on fire, and the rest did more than usual execution in the hull of the vessel. Others were fired against a bank and target at 800 yards, and when dug out were found, in several instances, point foremost.

The author concludes this paper with some observations on the theory of such shells, and with remarks on their proper shape and proportions, and the practical purposes to which they may be applicable.

On the relative Powers of various metallic Substances as Conductors of Electricity. By Mr. William Snow Harris, *of Plymouth, Surgeon. Communicated by* J. Knowles, *Esq. F.R.S. November* 14, 1826. Read December 14, 1826. [*Phil. Trans.* 1827, *p.* 18.]

The principle on which the author proposes to found a numerical estimate of the conducting powers of metallic bodies, is, that these powers are in some inverse ratio of the heat evolved during the passage of an electric charge through them; and his mode of applying this principle to practice, consisted in the inclosure of wires of the different metallic bodies to be examined, in a given volume of air contained in a glass vessel, and pressing on a column of coloured liquid in a tube of small diameter communicating freely with it. The heat developed in the wire by the discharge of a battery of given surface charged to a given tension, being communicated to the air in the globe, expands it, and raises the liquid in the tube through a space, which, being read off on an attached scale, becomes a measure of the heat.

After describing the precautions used to insure results comparable with each other (such as those employed for obtaining an equal electric discharge in each experiment from a battery of 25 square feet of coated surface, the drawing of all the wires through the same holes to secure this exact equality of diameter, &c.), he proceeds to state the results of an extensive series of experiments. The simple metals tried were copper, silver, gold, zinc, platinum, iron, tin, and lead; and the heats evolved from each were found to be in the order in which they are here set down, that from copper being the least, and from lead greatest, of all the substances tried, being in the proportion of 6 to 72, or 1 to 12. The following are the principal conclusions to which his experiments have led him.

The conducting powers of silver and copper are alike, also those of iron and platinum, and those of zinc and brass. That of lead and tin, he states as being in the ratio of 2 : 1, being an obvious inversion of the ratio, and the same he observes of zinc and gold. Gold to copper, he states as 2 : 3; zinc to copper or silver, as 1 : 3; platinum or iron to copper or silver, as 1 : 5; tin to copper or silver, as 1 : 6; and lead to copper or silver, as 1 : 12.

The conducting powers of metals when alloyed are variously affected. Thus, the conducting power of gold and copper, or gold and silver, when alloyed together, is worse than that of either metal separately, and the difference increases with the quantity of the metal of inferior conducting power present. On the other hand, alloys of