having an unquestionable principle on which to proceed. He ſaid, that he plainly ſaw that the change of variation was very different in different places, and in the same place at different times: and confesses that he had not diſcovered any general principle by which theſe changes could be connected.

Halley’s *Variation Chart,* however, was of immenſe uſe ; but it became gradually less valuable, and in 1745 was exceedingly erroneous. This made Messrs Mountaim and Dodſon, fellows of the Royal Society, apply to the admirality and to the great trading companies for permission to inspect their records, and to extract from them the obſervations of the variations made by their officers. They got all the assistance they could demand ; and, after having com­pared above 50,000 obſervations, they compoſed new va­riation charts, fitted for 1745 and 1756.

The polarity of the magnetic needle, and a general tho’ intricate connection between its positions in all parts of the world, naturally cauſes the philoſopher to ſpeculate about its cauſe. We see that Cortez aſcribed it to the attraction of an eccentric point, and that Bond thought that this point was placed not in the heavens, but in the earth. This no­tion made the baſis of the famous Theory of Magnetilm of Dr Gilbert of Colchester, the first ſpecimen of experimen­tal philosophy which has been given to the public. It was published about the year 1600: he was an intimate ac­quaintance of the great experimental philoſopher lord Bacon, and proceeded entirely according to the plan laid down by that illustrious leader in his *Novum Organum Scientiarum.*

Gilbert asserted that the earth was a great magnet, and that all the phenomena of the mariner’s compaſs were the effects of this magnetiſm. He showed at least that theſe phenomena were preciſely ſuch as would reſult from ſuch a constitution of the earth ; that is, that the positions of the mariner’s needle in different parts of the earth were preciſely the same with thoſe of a ſmall magnet similarly situated with respect to a very large one. Although he had made more magnetic experiments than all that had gone before him put together, still the magnetical phenomena were but ſcantily known till long after. But Gilbert’s theory (for ſo it must be truly esteemed) of the magnetical phenomena is now completely confirmed. The whole of it may be understood from the following general proposition.

Let NS (fig. J.) be a magnet, of which N is the north and S the ſouth pole : Let *ns* be any oblong piece of iron, poiſed on a point *c* like a compaſs needle. It will arrange itſelf in a position *ncs* preciſely the same with that which would be assumed by a compass needle of the same size and shape, having *n* for its north and s its ſouth pole. And while the piece of iron remains in this position, it will he in all reſpects a magnet similar to the real compaſs needle. The pole *n* will at trail the ſouth pole of a ſmall magnetiſed needle, and repel its north pole. If a paper be held over *ns,* and fine iron-filings be strewed on it, they will arrange themſelves into curves issuing from one of its ends and ter­minating at the other, in the same manner as they will do when strewed on a paper held over a real compaſs needle. But this magnetiſm is quite temporary ; for if the piece of iron *ns* be turned the other way, placing *n* where *s* now is, it will remain there, and will exhibit the same phenomena. We may here add, that if *ns* be almost infinitely ſmall in companion of NS, the line *ns* will be in ſuch a position that if *sa, sb,* be drawn parallel to N*c,* S*c,* we ſhall have sa to sb as the force of the pole N to the force of the pole S. And this is the true cauſe of that curious diſposition of iron-filings when strewed round a magnet. Each fragment becomes a momentary magnet, and arranges itſelf in the true magnetic direction ; and when so arranged, attracts the two adjoining fragments, and co­operates with the forces, which alſo arrange them. We throw this out to the ingenious mechanician as the foun­dation of a *complete* theory of the magnetical phenomena. When the filings are infinitely fine, the curves NcS have this property, that, drawing the tangent *ncs,* we always have sa *: sb =* force of N : force of S ; and thus we may approximate at pleaſure to the law of magnetic attraction and repulsion. The public may expect to have ſoon a theo­ry of magnetiſm founded on this principle, and applied with the completest ſucceſs to every phenomenon yet obſerved.

Now, to apply this theory to the point in hand.—Let *ns* (fig. 2.) be a ſmall compaſs needle, of which *n* is the north and *s* the ſouth pole : let this needle be poiſed horizontally on the pin *cd* ; and let *n's'* be the poſition of the *dipping needle.* Take any long bar of common iron, and hold it upright, or nearly ſo, as repreſented by AB. The lower end B will repel the pole *n* and will attract the pole s, thus exhibiting the properties of a north pole of the bar AB. Keeping B in its place, turn the bar round B' as a centre, till it come into the position A'B' nearly parallel to *n's'.* You will obſerve the compaſs needle *ns* attract the end B' with either pole *n* or *s,* when B'A' is in the poſition B'α perpendicular to the direction *n's'* of the dipping neeedle : and when the bar has come into the position B'A', the up­per end B' will show itſelf to be a ſouth pole by attracting *n* and repelling *s.* This beautiful experiment was exhibited to the Royal Society in 1673 by Mr Hindshaw.

From this it appears, that the great magnet in the earth induces a momentary magnetiſm on ſoft iron preciſely as a common magnet would do. Therefore (says Dr Gilbert) it induces permanent magnetiſm on magnetiſable ores of iron, ſuch as loadstones, in the same manner as a great load- stone would do ; and it affects the magnetiſm already im­parted to a piece of tempered steel preciſely as any other great magnet would.

Therefore the needle of the mariner’s compaſs in every part of the world arranges itſelf in the magnetic direction, ſo that, if poiſed as a dipping needle ſhould be, it will be a tan­gent to one of the curves N*c*S of fig. 1. The horizontal needle being ſo poiſed as to be capable of playing only in a horizontal plane, will only arrange itſelf *in the plane* of the tri­angle N*c*S. That end of it which has the same magnetiſm with the ſouth pole S of the great magnet included in the earth will be turned towards its north pole N. Therefore what we call the north pole of a needle or magnet really has the magnetiſm of the ſouth pole of the great primitive magnet. If the line NS be called the axis, and N and S the poles of this great magnet, the plane of any one of theſe curves N*c*S will cut the earth’s ſurface in the circumference of a circle, great or ſmall according as the plane does or does not paſs through the centre of the earth.

Dr Halley’s first thought was, that the north pole of the great magnet or loadstone which was included in the bowels of the earth was not far from Baffin’s Bay, and its ſouth pole in the Indian ocean ſouth-west from New Zealand. But he could not find any positions of theſe two poles which would give the needle that particular poſition which it was obſerved to assume in different parts of the world ; and he concluded that the great terrestrial loadstone had four irre­gular poles (a thing not unfrequent in natural loadstones, and easily producible at pleaſure), two of which are stronger and two weaker. When the compaſs is at a great distance from the two north poles, it is affected ſo as to be directed nearly in a plane passing through the strongest. But *if we* approach it much more to the weakest, the greater vicinity will compenſate for the ſmaller abſolute force of the weak pole, and occasion considerable irregularities. The appear­ances are favourable to this opinion. If this be the real