XXXIV. *On ſome new Methods of ſuſpending Magnetical Needles.* *By* John Ingen Houſz, *Body Phyſician to their Imperial Majeſties, and F. R. S.*

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THE very great utility which navigation derives from the uſe of compaſſes, has been the principal reaſon, that ſo much labour has been beſtowed by many ingenious men in ſearching the beſt method of ſuſpending magnetical needles, and that ſome Academies of Sciences have propoſed conſiderable premiums to be given to him who ſhould ſucceed the beſt in this important object.

It has been, and is ſtill, a general complaint, that ſuch needles as were by their ſize and figure ſuſceptible of the greateſt magnetical power, and which were executed with the greateſt exactneſs, and perfectly balanced, were, for this very reaſon of their ſuperior accuracy, ſo eaſily put in motion, that the ſlighteſt ſhaking of the floor, occaſioned by the obſervers walking in the room, communicates to them ſuch a great quivering motion as to drag them out of their direction, and to render a conſiderable time

time requisite before they are again fixed in the true magnetical meridian.

Since the late Dr. KNIGHT has improved so greatly the method of communicating a considerable magnetical force to steel bars, needles have been impregnated with a much greater and more permanent polarity than it was possible to give them before, and the construction itself of compasses has been considerably improved. But the subject seems not yet to be exhausted.

The degree of magnetical power or polarity to be communicated to steel well hardened seems to depend in some respect on the proportion which the surface of the piece of steel to be impregnated bears to its bulk; so that a thin lamella of steel, weighing for instance ten grains, will acquire more magnetical force than a little lump of steel of the same weight. Thus a small magnet, composed of a great many thin lamina of steel pressed together, may be made so strong as to support 150 times its own weight, and even more, which has never yet been done by a compound heavy magnet.

If the too great quivering and horizontal motion, or the too great restlessness of a strong magnetical needle, is in some way or other counteracted by the methods hitherto adopted, the needle is in some danger of stopping near the true magnetical meridian, without always pointing

pointing directly in it; becauſe near this very place the power of direction of the needle may be ſo weak as not to overcome the reſiſtance, which was oppoſed to its free horizontal circular motion.

I thought, in the courſe of laſt year, that a great part of the above mentioned difficulty might be taken away by different methods, ſome of which are the following.

EXP. I. I placed an ordinary magnetical needle, ſupported upon its point, in a china baſon, and poured water into it, ſo as to cover the whole needle. The needle loſt a great deal of its reſtleſſneſs, was influenced by the approach of a magnet at a conſiderable diſtance, and ſeemed to point as well as before to the magnetical meridian, though with a ſlower motion.

EXP. II. I took a ſtrong flat magnetical needle, having in its center a round hole, but no cap. I fixed to this needle as much cork as was neceſſary to make it juſt ſwim upon the water in a baſon. I fixed a ſmooth braſs pin in a vertical poſition, ſo that it paſſed through the hole in the center of the needle, to prevent its ſwimming to the ſides of the baſon. This did tolerably well: the needle moved to the magnetical meridian with a ſlow motion.

EXP. III. I then took the needle uſed in the firſt experiment, and fixed upon it as much cork as was requiſite

just to make it fink. I placed a point under it, fo that the needle with the cork was kept a little below the furface of the water, bearing upon the point with a very inconfiderable weight. This anfwered nearly as in EXP. II.

EXP. IV. I fixed to the center of a fmall, but ftrong, magnetical needle a filver wire; to the other extremity of this wire I fixed a fmall fteel-working needle, very much hardened. I ftuck the point of this working needle to the lower extremity of a fteel magnet, placed in a vertical pofition and highly polifhed. This whole apparatus was placed in a glafs cylindrical veffel, filled with water fo far as to cover the point of the working needle. The horizontal magnetical needle, thus fufpended, was remarkably quick in directing itfelf into the magnetical meridian, and was very eafily difplaced out of its direction by the approach of a magnet at a confiderable diftance.

The greateft difficulty I found in this contrivance was, that a little jerk fhook the point of the working needle from the vertical magnet; and that a heavy magnet could not be fufpended from the point of a working needle, but required a tolerably good magnet rounded at its extremity, where it was fufpended from the vertical magnet, or a thick piece of iron rounded in the fame manner, by which means, however, the horizontal magnet

magnet did not move ſo freely. The firſt difficulty could be eaſily diminiſhed by letting the working needle paſs through a ſmall and ſmooth hole in a glaſs or metallic plate, to controul its vibrating motion, and by adapting to it a ſhoulder, by which it ſhould ſtop upon the glaſs or metallic plate, and from which it ſhould be taken up again, by ſliding the vertical magnet a little down ſo as to touch the point of the working needle, and to lift it up again into its former place. The ſecond difficulty could, I think, alſo be in a great meaſure obviated by employing, inſtead of a common magnetical needle, a thin ſteel tube (of which I will ſpeak by and by) which is only a little ſpecifically heavier than an equal bulk of the liquid. By this means a ſmall vertical magnet could be made to ſupport a large one, even of a conſiderable abſolute weight, of which weight, however, the vertical magnet ſhould ſupport almoſt nothing, it being counter-balanced by the fluid in which it is immerſed.

In the experiment, as I had made it, I could not perceive, that the horizontal magnetical needle was influenced by the vertical magnet, which would probably be the caſe if the vertical one was much out of the vertical line, and too near the horizontal needle.

EXP. V. I adapted to a flat ſtrong magnetical needle two caps, turned one againſt another, ſo that the needle could

could be ſupported on either of the caps, and turned with either ſurface upwards. I fixed on one of the flat ſurfaces, on each ſide of the center, a thin glaſs tube, hermetically ſealed, of ſuch a ſize, as made the whole together dip in the water ſo deep that only a ſmall part of the glaſs tubes remained above the ſurface of the water. I then depreſſed the needle entirely under the ſurface of the water by thruſting a metallic point in the cap which was uppermoſt, and fixing this point to the cover of the baſon: thus the needle, kept under water, bore againſt the point only with that ſmall degree of preſſure which the very inconſiderable difference of ſpecific gravity, which it had above an equal bulk of the water, could give it, which did not amount to above a few grains of weight. Thus this needle, loſing nothing of its polarity, loſt very near the whole of the reſiſtance of its weight, and at the ſame time that quivering motion and reſtleſſneſs, which it had in the air, moving ſmoothly in a medium, which could only obſtruct its too great vibrations (almoſt in the ſame way as aſtronomers ſtop the vibrations of their plumb line by hanging the weight in water or oil) without obſtructing (but retarding only) its tendency to the magnetic meridian, liquids preſſing equally on all ſides.

To

To prevent this needle from being ſhook off the point, and wandering about in the baſon, I placed alſo a metallic point underneath, upon which the under cap muſt bear if the needle ſhould by any cauſe deſcend from the upper point, or if I ſhould chuſe to make the whole ſink by increaſing its weight.

Having now found, by experience, that a ſtrong magnetical needle did point to the magnetical meridian near as well under water as in the open air, and that by the reſiſtance of the medium much of its too great verſatility was taken away; I wanted to try, what degree of magnetiſm could be given to a thin ſteel cylindrical tube, as a needle made in this ſhape could be as light as required without being incumbered with cork or glaſs tubes; but finding no ſuch tubes ready made, I tried one made of tin and found it ſuſceptible of a much greater magnetic virtue than I expected, conſidering that the iron plates of which it is made are neither ſufficiently hardened for this purpoſe, nor approach enough to the nature of ſteel; beſides that, being covered with a pewter coating, they cannot be expoſed to the bare friction of a ſteel magnet.

This experiment, however, afforded me a certain proof, that a magnetic needle, made of a thin ſteel tube,

would be fufceptible of a ftrong polarity, fo as to ferve for the purpofe here intended.

But as the two agate caps, if fixed in the middle of the fubftance of the tube, would interrupt fome part of the continuation of the fteel, and thus leffen the magnetic power, the points of fufpenfion would be better foldered or fixed upon the furface of the tube itfelf, and the agate caps fixed upon the fupport underneath and above the tube; fo that fuch a needle fhould be the reverfe (in refpect to the fufpenfion) of the common needles. Another advantage would be derived from fixing the points of fufpenfion upon the needle itfelf, *viz.* that by the motion of the fluid in which it fwims, it would be lefs apt to acquire a too ftrong waving or undulating motion.

If it fhould be found difficult to make very thin fteel tubes properly hardened, a piece of fteel could be fcooped out fo as to conftitute the half of a tube; the other half could be made of another fimilar piece, or perhaps better of thin brafs, or any other metal, and they might be foldered togther.

It would, perhaps, anfwer the fame purpofe if a fteel magnet was fhut up in a thin tube of glafs or fome metal.

I fhould

I ſhould think, that there could be no great difficulty to adapt to theſe kind of needles a thin glaſs, metallic, or enamelled plate, ſerving inſtead of the card in the common nautical compaſſes, and to make uſe of them in azimuthal compaſſes.

A card, if it is not required to be ſtuck upon the needle, might be fixed to the bottom of the glaſs baſon deſtined for this apparatus.

Common water would be, perhaps, the beſt medium for theſe different contrivances, if ſteel was not ſo eaſily ruſted by it, if the needle was covered with ſome varniſh or metal unalterable in water, and if in cold weather it was not ſo apt to freeze; and therefore, I think, ſome of the thinneſt expreſſed oils would anſwer the purpoſe better. Linſeed oil, when it has ſubſided, is very clear and tranſparent, and is not ſubject to freeze, at leaſt in the common cold of our climates; beſides, it increaſes the magnetical power of ſteel, as Dr. KNIGHT found. If it thickens by time, it may be changed.

The glaſs baſon containing ſuch a compaſs ſhould be kept full of the liquid to the cover, to obſtruct undulating motions.

The plate joined to this paper is not made to ſerve as a model of a compleat apparatus, as the drawing was made from

from fancy. It is deſtined only to convey an idea of the invention. I make no doubt but that ingenious artiſts would ſoon greatly improve this rough ſketch, if the contrivance ſhould be found by experience to anſwer at ſea.