we proceed, in the next place, to aſcertain the relation between the velocity of the ſhip and that of the wind, modified as they may be by the trim of the ſails and the obliquity of the impulſe.

Let AB (fig. 4, 5, and 6.) repreſent the horizontal ſection of a ſhip. In place of all the drawing ſails, that is, the ſails which are really filled, we can always ſubſtitute one ſail of equal extent, trimmed to the ſame angle with the keel. This being ſuppoſed attached to the yard DCD, let this yard be firſt of all at right angles to the keel, as repreſented in fig. 4. Let the wind blow in the direction WC,and let CE (in the direction WC continued) repreſent the velocity V of the wind. Let CF be the velocity *v* of the ſhip. It muſt alſo be in the direction of the ſhip’s motion, becauſe when the ſail is at right angles to the keel, the abſolute impulſe on the ſail is in the direction of the keel, and there is no lateral impulſe, and conſequently no leeway. Draw EF, and complete the parallelogram CFE*e,* producing *e*C through the centre of the yard to w*.* Then wC will be the relative or apparent direction of the wind, and C*e* or FE will be its apparent or relative velocity: For if the line C*e* be carried along CF, keeping always parallel to its firſt poſition, and if a particle of air move uniformly along CE (a fixed line in abſolute ſpace) in the ſame time, this particle will always be found in that point of CE where it is interſected at that inſtant by the moving line C*e*; ſo that if C*e* were a tube, the particle of air, which really moves in the line CE, would always be found in the tube Ce. While CE is the real direction of the wind, C*e* will be the poſition of the vane at the maſt head, which will therefore mark the apparent direction of the wind, or its motion rela­tive to the moving ſhip.

We may conceive this in another way. Suppoſe a cannon-ſhot fired in the direction CE at the paſſing ſhip, and that it paſſes through the maſt at C with the velocity of the wind. It will not paſs through the off- ſide of the ſhip at P, in the line CE: for while the ſhot moves from C to P, the point P has gone forward, and the point *p* is now in the place where P was when the ſhot paſſed through the maſt. The ſhot will therefore paſs through the ſhip’s ſide in the point *p,* and a perſon on board feeing it paſs through C and p will ſay that its motion was in the line C*p.*

Thus it happens, that when a ſhip is in motion the apparent direction of the wind is always ahead of its real direction. The line wC is always found within the angle WCB. It is eaſy to ſee from the conſtruction, that the difference between the real and apparent directions of the wind is ſo much the more remarkable as the velocity of the ſhip is greater: For the angle WCw or EC e depends on the magnitude of Ee or CF, in proportion to CE. Perſons not much accuſtomed to attend to theſe matters are apt to think all attention to this difference to be nothing but affectation of nicety. They have no notion that the velocity of a ſhip can have any ſenſible proportion to that of the wind. “Swift as the wind” is a proverbial expreſſion; yet the velocity of a ſhip always bears a very ſen­ſible proportion to that of the wind, and even very fre­quently exceeds it. We may form a pretty exact no­tion of the velocity of the wind by obſerving the ſhadows of the ſummer clouds flying along the face of a country, and it may be very well meaſured by this me­thod. The motion of ſuch clouds cannot be very diffe­rent from that of the air below; and when the preſſure of the wind on a flat ſurface, while blowing with a ve­locity meaſured in this way, is compared with its preſ­ſure when its velocity is meaſured by more unexcep­tionable methods, they are found to agree with all deſirable accuracy. Now obſervations of this kind fre­quently repeated, ſhow that what we call a pleaſant briſk gale blows at the rate of about 10 miles an hour, or about 15 feet in a ſecond, and exerts a preſſure of half a pound on a ſquare foot Mr Smeaton has fre­quently obſerved the ſails of a windmill, driven by ſuch a wind, moving falter, nay much faſter, towards their extremities, ſo that the ſail, inſtead of being preſſed to the frames on the arms, was taken aback, and flutter­ing on them. Nay, we know that a good ſhip, with all her ſails ſet and the wind on the beam, will in ſuch a ſituation ſail above 10 knots an hour in ſmooth wa­ter. There is an obſervation made by every experienced ſeaman, which ſhows this difference between the real and apparent directions of the wind very diſtinctly. When a ſhip that is ſailing briſkly with the wind on the beam tacks about, and then ſails equally well on the other tack, the wind always appears to have ſhifted and come more ahead. This is familiar to all ſeamen. The ſea­man judges of the direction of the wind by the poſition of the ſhip’s vanes. Suppoſe the ſhip foiling due weſt on the ſtarboard tack, with the wind apparently N. N. W. the vane pointing S. S. E. If the ſhip puts about, and ſtands due eaſt on the larboard tack, the vane will be found no longer to point S. S. E. but perhaps S. S.W. the wind appearing N. N.E. and the ſhip muſt be nearly cloſe- hauled in order to make an eaſt courſe. The wind ap­pears to have ſhifted four points. If the ſhip tacks again, the wind returns to its old quarter. We have often obſerved a greater difference than this. The ce­lebrated aſtronomer Dr Bradley, taking the amuſement of ſailing in a pinnace on the river Thames, obſerved this, and was ſurpriſed at it, imagining that the change of wind was owing to the approaching to or retiring from the ſhore. The boatmen told him that it always happened at ſea, and explained it to him in the beſt manner they were able. The explanation ſtruck him, and ſet him a muſing on an aſtrononfical phenomenon which he had been puzzled by for ſome years, and which he called the aberration of the fixed stars. Every ſtar changes its place a ſmall matter for half a year, and returns to it at the completion of the year. He compared the ſtream of light from the ſtar to the wind, and the teleſcope of the aſtronomer to the ſhip’s vane, while the earth was like the ſhip, mo­ving in oppoſite directions when in the oppoſite points of its orbit. The teleſcope muſt always be pointed ahead of the real direction of the ſtar, in the ſame man­ner as the vane is always in a direction ahead of the wind; and thus he aſcertained the progreſſive motion of light, and diſcovered the proportion of its velocity to the velocity of the earth in its orbit, by obſerving the deviation which was neceſſarily given to the tele­ſcope. Obſerving that the light ſhifted its direction about 40", he concluded its velocity to be about 11,000 times greater than that of the earth; juſt as the intelli­gent ſeaman would conclude from this apparent ſhifting of the wind, that the velocity of the wind is about triple that of the ſhip. This is indeed the beſt method