vertical ſection paſſing through the keel, and dividing the ſhip into two equal and similar parts, at a certain di­ſtance from the ſtern, and altitude above the heel.

ln order to determine the centre of gravity of the immerſed part of a (hip’s bottom, we muſt begin with determining the centre of gravity of a ſection of the ſhip parallel to the keel, as ANDFPB (fig. 56.), bounded by the parallel lines AB, DF, and by the equal and ſimilar curves AND, BPF.

If the equation of this curve were known, its centre of gravity would be eaſily found : but as this is not the case, let therefore the line CE be drawn through the middle C, E, of the lines AB, DF, and let this line CE be divided into ſo great a number of equal parts by the perpendiculars TH, KM, &c. that the arches of the curves contained between the extremities of any two adjacent perpendiculars may be conſidered as ſtraight lines. The momentums of the trapeziums DTHF, TKMH, &c. relative to the point E, are then to be found, and the ſum of theſe momentums is to be divided by the ſum of the trapeziums, that is, by the ſurface ANDFPB.

The diſtance of the centre of gravity of the trape­zium THFD from the point E is = 1/3 IE x DF+2TH DF+TH @@\*.

For the ſame reaſon, and becauſe of the equality of the lines IE, IL, the diſtance of the centre of gravity of the trapezium TKMH from the ſame point E will be 1/3IE×(TH+2 KM) 1/3IE ×(4TH+5KM)

TH + KM +IE, or = TH+KM^∙

In like manner, the diſtance of the centre of gravity of the trapezium NKMP from the point E will be 1/3IE×(KM+2NP) + 2IE×(7KM+8NP) KM+NP KM+NP

&C.

Now, if each diſtance be multiplied by the ſurface of the correſponding trapezium, that is, by the product of half the ſum of the two oppoſite ſides of the trapezium into the common altitude IE, we ſhall have the momentums of theſe trapeziums, namely, 1/6 IE2×(DF+2TH), 1/6 IE2 × (4 TH + 5KM) 1/6 IE2 X (7 KM + 8NP), &c. Hence the ſum of theſe momentums will be 1/6 IE2× (DF+6TH+12 KM + 18 NP+24QS+14 AB). Whence it may be remarked, that if the line CE be divided into a great number of equal parts, the factor or coefficient of the laſt term, which is here 14, will be = 2 + 3 (n—2) or 3 *n—*4, *n* being the number of perpendiculars. Thus the general expreſſion of the ſum of the momentums is reduced to IE x (1/6 DF + TH + 2 KM + 3 NP + 4 QS +, &c. —+ 3n-4 × AB).

The area of the figure ANDFPB is equal to IE × (4 DF + TH + KM + N P +, &c... .+ 4AB) ; hence the diſtance EG of the centre of gravity G from one of the extreme ordinates DF is equal to

IE × (1/6DF+TH+2 KM+3 NP+, &c.+3n-4 AB)

*6*

4 DF + IH+KM + NP+, &c. + 1/2 AB

Whence the following rule to find the diſtance of the centre of gravity G from one of the extreme ordinates DF. To the ſixth of the firſt ordinate add the sixth of the laſt ordinate multiplied by three times the num­

ber of ordinates minus four ; then the ſecond ordinate, twice the third, three times the fourth, &c. the ſum will be a firſt term. Then to half the ſum oſ the ex­treme ordinates add all the intermediate ones, and the ſum will be a second term. Now the firſt term divided by the second, and the quotient multiplied by the in­terval between two adjacent perpendiculars, will be the diſtance ſought.

Thus, let there be seven perpendiculars, whoſe va­lues are 18, 23, 28, 30, 30, 21, 0, feet respectively, and the common interval between theſe perpendiculars. 20 feet. Now the ſixth of the firſt term 18 is 3 ; and as the laſt term is 0, therefore to 3 add 23, twice 28 or 56, thrice 30 or 90, four times 30 or 120, five times 21 or *105* ; and the ſum is 397. Then to the half of 18 + 0, or 9, add the intermediate ordinates, and the

ſum will be 141. Now 397 x 20, or 7940, = 59 feet 141 or 141

4 inches nearly, the diſtance of the centre of gravity from the firſt ordinate.

Now, when the centre of gravity of any ſection is. determined, it is easy from thence to find the centre of gravity of the ſolid, and conſequently that of the bot­tom of a ſhip.

The next ſtep is to find the height of the centre of gravity of the bottom above the keel. For this purpoſe the bottom muſt be imagined to be divided into ſections by planes parallel to the keel or water-line, (figs. 37, 58.) Then the solidity of each portion con­tained between two parallel planes will be equal to half the ſum of the two oppoſed ſurfaces multiplied by the diſtance between them ; and its centre of gravity will be at the ſame altitude as that of the trapezium *abcd,*(fig. 58.), which is in the vertical ſection paſſing through the keel. It is hence obvious, that the ſame rule as before is to be applied to find the altitude of the centre of gravity, with this difference only, that the word perpendicular or ordinate is to be changed into ſection. Hence the rule is, to the ſixth part of the loweſt ſection add the product of the ſixth part of the uppermoſt ſection by three times the number of ſections minus four ; the second ſection in aſcending twice the third, three times the fourth, &c. the ſum will be a firſt term. To half the ſum of upper and lower ſec­tions add the intermediate ones, the ſum will be a se­cond term. Divide the firſt term by the second, and the quotient multiplied by the diſtance between the ſec­tions will give the altitude of the centre of gravity above the keel.

With regard to the centre of gravity of a ſhip, whe­ther it is conſidered as loaded or light, the operation becomes more difficult. The momentum of every dif­ferent part of the ſhip and cargo muſt be found ſeparately with reſpect to a horizontal and alſo a vertical: plane. Now the ſums of theſe two momentums being divided by the weight of the ſhip, will give the alti­tude of the centre of gravity, and its diſtance from the vertical plane ; and as this centre is in a vertical plane paſſing through the axis of the keel, its place is therefore determined. In the calculation of the mo­mentums, it muſt be obſerved to multiply the weight, and not the magnitude of each piece, by the diſtance of its centre of gravity.

A more eaſy method of finding the centre of gravity of a ſhip is by a mechanical operation, as follows; Conſtruct