III. *Remarks upon some Experiments in* Hydraulics, *which seem to prove, that the Forces of equal moving Bodies are as the Squares of their Velocities.* By Mr. John Eames, F. R. S.

THE Result and Substance of these Experiments is, That the Velocities of any Fluid, for Instance Water, issuing out at equal Orifices made in the Sides of Tubes, or Vessels filled up to different Heights, and kept full at those Heights, above the Orifices, are found to be as the square Roots of those Heights respectively. Thus, when the different Heights above the Orifices are as the Numbers 1, 4, 9, 16, &c. the Velocities of the Particles of Water, issuing out, are found to be as the Numbers 1, 2, 3, 4, &c.

The Argument drawn from these Experiments, in Favour of the Opinion, that the Forces of equal Masses, or moving Bodies, are proportional to the Squares of their Velocities, runs thus. All the Particles of Water, being of the same Nature, and uniform, every single Particle issuing out with Two Degrees of Velocity, must move with 4 Times the Force of any other single Particle, that moves but with One Degree of Velocity; because the Force with which it moves, is the Effect of a Cause 4 Times greater; namely, the Pressure of a Column of Water, whose Height is 4 Times greater.

Thus, again, a Particle of Water running out, with 3 Degrees of Velocity, must move with 9 Times the Force of a Particle moving with but 1 Degree of Velocity; because that Force is the Effect of a Cause 9 Times greater, viz. the Pressure of a Column 9 Times higher:

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Since no lefs than a Column 9 Times higher, is found, by Experience, neceffary to make the feveral Particles of Water iffue out with 3 Degrees of Velocity. So that, in thefe Two Inftances, it feems to be certain, that the Forces communicated, are as the Squares of the Velocities. And that it is fo univerfally, is argued thus: The Preffures are as the Altitudes, and the Altitudes as the Squares of the Velocities of every fingle Particle; therefore the Preffures are as the Squares of the Velocities; but the Preffures are the Caufes of the Forces, with which the feveral Particles of Water iffue out, or move; and therefore fince Effects are proportional to their Caufes, the Forces with which the feveral Particles iffue out, and move, are as the Squares of the Velocities.

REMARK I. The Fault committed in this Reafoning, and which quite runs through it, is the miftaking a Part of the Effect for the Whole. The entire Effect of any of thefe Preffures is, not barely a certain Number of Degrees of Velocity, in any fingle Particle, but certain Degrees of Velocity in a certain Number of Particles, and that certain Number of Particles, in a given Time, is, confeffedly, as the Degrees of Velocity.

REMARK II. And this leads me to a Second Remark, which is, That the entire Effect of thefe Preffures being taken into Confideration, feems to overturn this new Rule in Mechanicks for computing the Forces of moving Bodies, which is, *That the Forces are as the Quantities of Matter multiplied by the Squares of the Velocities.* And this I fhall endeavour to make out thus: The Gentlemen who advance this new Rule, at the fame Time that they affert the Velocities, in the Cafes of the Experiment above-mentioned, to be as the

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Square Roots of the Altitudes, do alfo confefs, that the
Quantities of the Fluid, preffed out in equal Times, are
as thofe Velocities. For thus an ingenious Profeffor a-
broad tells us in his *Epitome Element. Phyf. Math.*
Part. 2ᵈᵃ· Cap.iv. p.665. " *Quantitates fluidorum ex*
" *utroque vafe exeuntium in eodem tempore funt inter*
" *fe velut celeritates, adeoque in fubduplicata ratione*
" *altitudinum fluidorum fupra foramina.* Now if
this be true, that the Quantities of Water flowing out
in equal Times, are as the Velocities, then the Forces
cannot be as the Quantities of Matter multiplied by the
Squares of the Velocities: For then the Effects, inftead
of being proportional, would be more than in Proporti-
on to their Caufes. Thus, the Effect of a Preffure of
a Column of any Fluid, as Water, 9 Inches high, in-
ftead of being but 9 times greater than that of 1 Inch
above the Orifice, will be no lefs than 27 Times greater.
For the Velocity being at this Height triple, the Quan-
tity of Matter in a given Time will alfo be triple;
which laft, multiplied by the Square of the Velocity,
gives 27 for the Force communicated by a Preffure of
9 Inches in Altitude, while the Force communicated by
the Preffure of 1 Inch, is but as 1. So that the moving
Forces produced will be as 27 to 1, while the Caufes
producing thefe Forces, are but as 9 to 1, *i. e.* Three
Times too little for fuch a Purpofe.

Thus again, if the Velocities be as 1 and 4, the
Quantities of Water iffuing out will be as 1 and 4;
but the Effects, or Forces produced, according to the
new Rule, will be as 1 and 64; though the Preffures,
which communicate them, are but as the Altitudes,
which are as 1 and 16. Whereas, to produce fuch Ef-
fects, the Altitudes of the latter Column ought to have

been

been as 64; *i. e.* 4 Times greater than by Experience it is found to be.

REMARK III. I cannot but obferve, in the laft Place, that the common Rule of eftimating the Forces of moving Bodies by the Quantities of Matter multiplied by their Velocities, is rather confirmed by thefe very Experiments. For then, according to the old Maxim, Effects are proportional to their Caufes, the Forces communicated will be as the Forces communicating, or Preffures. Thus let the Altitude, and confequent Preffure of any Column of Water be 9 Times greater than the Altitude of another; then the Velocity of every fingle Particle of Water preffed out will be triple, and the Number of Particles iffuing out in a given Time will likewife be triple; therefore the Force refulting from thefe Two multiplied together, according to the common Rule, will be 9, proportional to the Preffure, as it ought to be. So again, if the Altitude be 16 Times greater, the Velocity will be quadruple, and the Number of the Particles quadruple, and the Force produced the Product of thefe Two; *i. e.* 16, ftill proportional to the Altitude, or Preffure.

And univerfally, the Forces communicated, according to the old Rule, are in a Ratio compounded of Two others, One of the Quantities of Matter, and the other of the Velocities: The Ratio of the Velocities, by the Experiments, is the Subduplicate Ratio of the Heights, and the Ratio of the Quantities of Matter is, by Confeffion, likewife the Subduplicate of the Heights: Therefore the Compound of thefe 2 is the Ratio Integra, or fimple Ratio of the Heights; in which Ratio are the Preffures themfelves,which produce thefe moving Forces: So that, according to the common Rule, the Effects are

always,

always, as they ought to be, proportional to their Caufes.

After the fame Manner the ingenious Mr.'s *Gravefande* once argued; for thus he reafons in Paragraph 355 of *Phyfices Elem. Mathematica*, Firft Edition.

" *Non tamen eandem cum profunditate proportio-*
" *nem fequitur Velocitas, licet preffio, ex quâ Veloci-*
" *tas oritur, in eâdem ratione cum profunditate*
" *crefcat. Quantitas motûs quæ in liquido produci-*
" *tur, eft effectus totus preffionis, & hæc quantitas*
" *ad inftar preffionis augetur. Ratio autem quanti-*
" *tatis motûs eft compofita ex ratione Velocitatis, &*
" *quantitatis materiæ motæ, hîc materia mota eft a-*
" *qua, quæ ex foramine exit, cujus quantitas, ma-*
" *nente tempore, cum celeritate crefcit; dupla erit,*
" *fi hæc dupla fuerit, in quo cafu motûs quantitas eft*
" *quadrupla, id eft, augetur ut quadratum celerita-*
" *tis, quod pofitâ celeritate quâcunque femper obti-*
" *net; crefcit ergo hoc quadratum ut preffio, id eft, ut*
" *altitudo liquidi fuprâ foramen ex quo profluit aqua.*

IV. *A Copy of a Letter from* Dr. David Kinneir, Coll. Med. Edingb. Soc. *to* Dr. Campbell, Coll. Med. Lond. Soc. Honorar. *touching the Efficacy of* Camphire *in* Maniacal *Diforders.*

S I R,

IN Converfation, t'other Day, on the Subject of our Profeffion, I told you how fuccefsfully I had us'd Camphire in *Maniac* Diforders, which hitherto never
has