

PHILOSOPHICAL TRANSACTIONS.

June 21. 1675.

The CONTENTS.

A New Essay-Instrument invented and described by the Honourable Robert Boyle, together with the Uses thereof: The Discourse consists of three parts; The first shews the Occasion of making it, and the Hydrostatical Principle 'tis founded on; The second describes the Construction of the Instrument; The third represents the Uses, which, as relating to Metals, are; 1. To discover, whether a proposed Guiny be true or counterfeit. 2. To examine divers other Gold-coyns, and particularly half-Guinys. 3. To examine the new English Crown-pieces of Silver. 4. To estimate the goodness of Tin and Pewter. 5. To estimate the Alloys of Gold and Silver, and some other Metallin mixtures.

The first Section.

Shewing the Occasion of making this new Essay-Instrument, together with the Hydrostatical Principle 'tis founded on.

TO give you now a more explicite and particular Account, than I had then time to do, of the Instrument which you saw tried at the Royal Society, I shall inform you, on what Grounds I devis'd it, and then annex some Observations about the Fabrick and the Uses of it.

You may remember, that many years ago I shew'd you a little glafs-Instrument, consisting of a bubble, furnished with a long and slender stem, which was to be put into several Liquors, to compare

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pare and estimate their Specifick Gravities, and which I made use of to some purposes, for which it is not, that I know, as yet employed. But afterwards considering this little Instrument somewhat more attentively, I thought the application of it might easily be as 'twere inverted, and that, whereas 'twas employed but to discover the differing Gravities of several Liquors, by its various degrees of Immersion in them, it might be employed to discover the Specifick Gravities of several appended Solids, by its being more or less depressed by them in the same Liquor. For 'tis clearly deducible from the Grounds of the Hydrostaticks, that any solid Body heavier than Water, looses in the Water as much of the weight it had in the Air, as Water of equal bulk to the immersed Solid would weigh in the Air; and consequently, since Gold is by far the most ponderous of Metals, a piece of Gold and one of equal weight of Copper, Brass, or any other Metal, being proposed, the Gold must be less in bulk, than the Copper or Brass. And by this means if both of them be weighed in the Water, the Gold must loose in that Liquor less of its former weight than the Brass or Copper; because the baser metal as well as the Gold, grows higher by the weight of a bulk of Water equal to it; and the baser metal being the more voluminous, the Correspondent Water must weigh more than that which is equal to the Gold.

This Hydrostatical Principle may be evidently proved from what has been demonstrated in a *Mathematical* way, by the most subtile Archimedes *de Insidentibus humido*, and his Commentators; and those that are either unacquainted with, or distrustful of such

Ratiocinations, may find the Principle made out in a
 V. Hydrost. *Physical* and *Experimental* way in another Paper.
 Varadox. Whence I concluded, that I might safely infer, that the floating Instrument abovementioned would be made to sink deeper by an ounce, for instance of Gold hanging at it under water, then by an ounce of Brass or any other Metal, which by reason of its greater bulk than Gold, loosing more of its weight by the Immersion, must needs retain less, and so have less power to depress the Instrument 'twas fastned to. Which Conclusion, you will easily believe the event did upon trial exactly justify; and I presume you will as little doubt, that the Conclusion will also

also hold (though the disparity be not so great and conspicuous) in reference to other Metals, as Lead and Tinn, that differ in specific Gravity.

To give at once an Instance of the Truth and Use of this Notion, I was induced to fit the Instrument, that was grounded on it, for the examination of Guinys, which are by far the most usual Gold-Coins that pass in *England*. And though the exactness and diligence of our Ingenious Friend Mr. *Slingsby* allows us to expect, that no injury that care and skill can prevent shall be done to that Coin, yet because some Goldsmiths and others retain fears of being deceived by the fraudulent and subtile Artifices of false Coiners, I thought it might not be amiss to furnish them with an easie and practical way of distinguishing a true Guiny from a counterfeit. And though I hope I need not tell you, that I look not upon the Instrument I shew'd you at *Gresham Colledge*, as capable of examining Gold and other Metals with as much nicety as by other Methods one may Hydrostatically do; yet this little Trifle may on some occasions be preferable, since the Instrument, which is not dear, being once fitted, there is no need to have either exact Sca'es, or skill in Hydrostaticks, or any knowledge of Arithmetick, and yet the difference of a true Guiny from a counterfeit will not only be sufficiently, but conspicuously, made to appear, and the operation will be much sooner performed than in the other way, and very much sooner and cheaper than by the Methods commonly employed by Goldsmiths and Refiners. For, in our way the Coin is not defac'd or injur'd by cutting, pnnching, &c; nor is there any need of Touchstones, or Aqua fortis, and yet the tryal is so quickly made, that perhaps near twenty Guinys may be examined one by one, in about a quarter of an hour: I say, *one by one*, because that if the Instrument be designed and fitted for such a purpose, *many* Guinys may be tried *at once*. But whether the Goldsmiths will make use of this way, I leave them to determine; it being sufficient for me, *to* have gratified such *Virtuosi*, especially the Disciples of Vulcan, as have given occasion to expect this Trifle will be acceptable unto them; and *to* add this Instance to those I have elsewhere given by way of proof, That by

the knowledge of Causes men may employ exceedingly differing means to produce the same Effects (as, in our Case, Gold, that Chymists and Say-masters are fain to examine by the fire, we examine by water) and that Philosophical Truths, and particularly Hydrostatical ones, are not lightly to be despised as airy and empty Speculations, since they may be sometimes applied to practical Uses, to which at first sight they seem to have no relation at all.

The second Section.

Describing the Construction of this Instrument.

I Proceed now to the *Construction* of the Instrument it self, in which are to be consider'd the *Matter* and the *Form*.

The *Matter* may be Glass, Copper, Silver, or almost any other solid Body, that is, or may be made, fit to float in the water, with a Guiny hanging at it, and of a Texture close enough to keep out the water. For, if any of *that* should, by soaking or otherwise, get in, it may alter the Gravity of the Instrument, and render it deceitful.

My first Trials were made with bubbles of Glass, furnish'd with slender stems, Hermetically sealed at the top; and these, when one can procure an Artificer that can blow them well, are both the *gentilest* and the *cheapest*, and for some of the Uses, that may hereafter be mentioned, they are almost the *only* ones that can be fitly employed. But, besides that 'tis not easie to meet with Artificers that can give Glass the right bigness and shape, those, as all other Instruments of glass, being very frail and subject to be broken; the safest way and more durable is, to make them of some Metal, especially either Copper or Silver, (of which the former is far more cheap, and the other more gentile, but either will serve well;) in regard they are less heavy, and, being more stiff, will maintain their figure better than Gold or Lead. Copper and Silver will also suffer themselves to be beaten into plates thin and yet strong enough, and are not so subject to rust as Iron and Steel. But in some cases, especially in want of metallin Instruments, we may make use of well season'd wood, laid over with some China Varnish, or some other that is very close.

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As to the *Form* of the Instrument, it consists of three parts; the Ball or Globulous part; the Stem or Pipe; and that which holds the Coin.

The Ball or round part consists of two thin concave Plates of Copper, or other Metal, exactly soder'd together in the middle; and at the distantest parts from the Commissure there ought to be left two opposite holes, one in each Plate, for the two other parts of the Instrument. This middle part, though for brevity sake we name it the Ball, should not be exactly round, but, for the Conveniency of swimming, of an almost Elliptical or Oval Form, or rather somewhat inclining to that of a very deep double Convex Glass; or it may be of any other shape that shall be found fittest to make the Instrument keep its erect posture steadily in the water. The *bigness* of it must be somewhat greater or less, as the Plate is made thicker or thinner: But the general Rule for its Capacity is, that it should contain as much Air, as may serve to keep the whole Instrument, when furnisht, if need be, with its ballast and clog'd with a Guiny, from sinking beneath the top of the Stem, which *Stem* is the next part to be taken notice of.

If the Instrument be to have its Ballast (if I may so call it) *within* its Cavity, it will be convenient, if not necessary, that it should be hollow, like a Pipe, exactly closed at the upper end; but where the Ballast is to be placed *without*, the Pipe should be made solid, as of a piece of Wire, or a little Cylinder of some lighter matter that will not soak in water: But, whether it be hollow or no, it ought to be made very slender, that the different depressions of the Instrument in the water may be the more notable. And for the same reason it ought not to be too short, especially if it be to be applied to other uses than the examining of Guinys.

The Instrument, I most use meerly for *Guinys*, hath its Ball about the bigness of a small Hen-egg or rather less, and the Pipe between four and five Inches long, being soder'd on to the Ball at the uppermost of the two holes abovementioned; at the undermost of which is insertet and soder'd the undermost part of the Instrument, which I call the Screw, or the Stirrup, because some-

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times 'tis made of a piece of wire, that a little beneath the bottom of the Ball is bent round, so as to stand horizontally, that, the Guiny being laid on it, it may be supported by it, as the foot is by a stirrup; and in this way a piece of Coin is the most readily put on and taken off. But the more secure way is, instead of the bent wire, to imploy a very short piece of Brass with a broad slit in it, capable of receiving the edge of the Guiny, which with one turn or two of a small and slight lateral screw may be kept fast in it, and readily, the operation being ended, taken out again.

If you desire to examine not only Guinys, but greater Gold-Coins and Metalline mixtures, it would be convenient, that the undermost stem and the screw be made by it self, that it may be at pleasure thrust upon the stem and taken off again. For by this means, if the ball of the Instrument be made large enough, you may have room to put on, as occasion shall require, one, two or three flat and round pieces of Copper, Lead, &c. with each of them a hole in the middle, fitted to the size of the stem, so that they may be put on as near the lower part of the ball, as you think fit, and then the screw may be thrust on after them, not only to take hold of the Coin or Metalline mixture to be examined, but to support the plate, if need be; and by a variety of such plates, which may be taken off and put on at pleasure, the same Instrument, if (as I was saying) the ball be competently large, may be adjusted sometimes to a Guiny, sometimes to a Coin of Gold or Silver, or to a Metalline mixture twice or thrice as heavy as a Guiny in the Air.

The Instrument being made of a convenient bigness and shape; to adjust it for the use of examining Guinys, you must by the help of the stirrup or screw, hang, at the bottom of it, a piece of that Coin which you know to be genuine, and, having carefully stoppt the Orifice of the stem, if it be a pipe, (that no water may get in at it,) immerse the Instrument leisurely and perpendicularly into a Vessel full of clean water, till it be deprest almost to the top of the stem, and then letting it alone, if being settled it continue in the same station and posture, your work is done; but if it sink quite under water, you must lighten it either with a file,

or by scraping or grating off a little of the ballast-plate above-mentioned ; or, if you have put any weight into the Cavity to poise it, by taking out some of that, till you have made it light enough : But if, when you leave the Instrument to it self, it emerge, you must then add a little weight to it, either by putting into the stem, if it be hollow, some dust-shot, filings of Lead, or some other minute and heavy Body, or else by putting on the short stem above-mentioned, that comes out beneath the ball, a flat, round, and perforated piece of Lead of weight, sufficient to enable the Guiny to depress the weight as low as 'tis desired : Which being done, a mark is to be made just at the place where the surface of the water touches the stem, and then taking out your Instrument, substitute in the place of your Guiny a little round plate of Brass, of the same weight, or a grain or two heavier, in the Air ; and putting the Instrument into the water as before, suffer it to settle, and make another mark at the intersection of the stem and the Horizontal surface of the Water.

About this way of adjusting our Instrument, the following Particulars may be noted :

If a Screw be employed to sustain the Guiny, the Coin ought to be so placed, that one half, according to the estimate of the Eye, may be on the right hand, and the other on the left hand of the screw ; that the Instrument being depressed may continue in an erected posture, and not swerve to an inclin'd.

Though when the stem is hollow, and the Instrument too light, it may seem the better to add Quicksilver than any other weight, because of its fluidness, and great specifick gravity ; yet, unless the Instrument be of glass, 'tis not safe to employ Mercury, because 'tis apt to dissolve the soder.

If the Marks be made of a white Colour, they will be so much the more conspicuous : And these marks may be made, if the pipe be hollow, by making round Impressions with a small file, and encompassing them with little Circles of fine wire of Silver, Gold, &c. And, if the stem be solid, it may then be either quite perforated at the requisite places, and have the holes filled with chawed Mastic, or some such white substance that dissolves not in water, or else have little holes, that pierce not quite through, stuck
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into it, and these may likewise be filled with the same substance, which, if further distinction be desired, may have some parts of it differinglly coloured before they be employ'd.

Twill be requisite, to imploy in adjusting the Instrument one of the heaviest Guinys you can get, to depress the Instrument as low as 'tis like to be by any piece of that Coin, least otherwise meeting with one considerably heavier than that you made use of, the Instrument may be thereby made to sink to the very bottom of the water.

The Reason why 'tis above prescribed, that the Instrument be immersed *almost*, not quite, to the *Apex* of the stem, is, because I have found, that *Guinys* are not all precisely of the same weight, nor all waters neither; and therefore 'tis safest, to leave a small part of the stem, as an eighth, or, in longer Instruments, a quarter of an Inch, extant above the water, that we may secure the Instrument from being by a heavier Guiny made quite to sink.

I foresee, it may be hence objected, that these Contingencies may make our Instrument useles: To which it is not difficult to answer, that, though some *Guinys* weigh a grain or two more than others, it is not that will frustrate the use of our Instrument, and less will the difference of our waters do it, since (as I have observed in another Paper, where I mention some Trials of this kind) having examined and compared together the specifick gravities of (common) Pump-water, Thames-water, and Rain-water, I found the difference far more inconsiderable than one would have thought, and consequently unable to keep Hydrostatical Trials of Metals from being accurate enough for practice, and more exact than those troublesome and chargeable ones that are commonly relied on.

These Answers to the recited Objections, will be made good by this, That 'tis not a doubtful or inconsiderable difference, that appears upon the differing depressions of the Instrument, that are made by a true Guiny, and by a piece of Brass or of Copper, of the same weight with it in the Air. For, in the Instrument lately describ'd, though smaller than most that I have imployed, the distance betwixt the mark to which the Gold, and
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that to which the other Metal, though Copper, depressed it, was, by measure, about an Inch and three quarters ; so that it is not every small variation of Circumstances that can make it doubtful to him that employs our Instrument, whether a Guiny be true or counterfeit.

But Philosophical Candor forbids me to conceal, that there may, (though 'tis like there very seldom will,) happen a case, wherein, though the Principle, our Instrument is framed on, will hold good, yet the practical Application may be unsecure. For, if a Falsifier of money have the skill, by washing or otherwise, to take off much of the quantity or substance of the Guiny without altering or impairing either the figure or the stamp, the piece of Coin will not be able to depress our Instrument to the usual mark, and may thereby make it be judg'd *counterfeit*, when 'tis indeed but *too light*.

But on this occasion 'tis to be consider'd, that neither the Touchstone, nor Aqua Fortis, nor Antimony, nor the Cupel, can shew us, whether a piece of Coin propos'd have its just weight, but only, whether the Metal be true Gold : And therefore our Instrument need not pretend to do more than discover the Genuineness of the Metal ; but whether the Coin have the just weight the Law requires, is to be judged by the Bailance ; as each single piece is wont to be in most of the Gold-Coins of *Europe*, and is in *England* in reference to *Angels* and *twenty shilling Peices*, and all the other Coins of *Broad Gold*, as they are now called. And yet it may be further consider'd, that our Instrument does more than it need pretend to : For, without a pair of Scales, it presently shews, that the propos'd Guiny, if it be not counterfeit, is otherwise abused ; and though it does not clearly determine, whether that likewise proceed from the want of specifick Gravity in the Metal, or from the Coins having been washed or otherwise fraudulently lessen'd ; yet it *probably* resolves the doubt, because, if the want of weight appear by the Instrument to be very great, as it usually does where the piece

has been robbed of some of its substance, (especially if it be so much as is reported of some *Guinies*, that of late are said to have been found wanting to the value of near four shillings;) 'tis a strong Presumption, that 'tis rather washed, &c. than counterfeit. For, men will scarce venture their Lives to steal but three or four grains from a true Guiny, and much less from a false one. And they that counterfeit, are not wont to be so sparing as to make their Coins too light. However, our Instrument will in these Cases be sure to prompt him that uses it to employ the Ballance, which will presently assist him to resolve his doubt. For, if the suspected Coin have in the Air its due weight, 'twill argue, that the great lightness of it in the water proceeds from the Metals not being true Gold, or, at least, of its not being of the requisite fineness; and, if it want much of its due weight in the Air, 'tis very probable, for the Reason above-intimated, that 'tis wash'd, &c. rather, than of another metal than Gold; and however may be lawfully refused to be taken in payments, and perhaps afford a just ground of questioning him that utters it. And if one would, for curiosity, be further satisfied, whether the Metal be Gold or no, one may add to the Coin (as will be hereafter taught) as much sterling-Gold, as will make it, in the Air, of the Weight of a Guiny, and then examining it by weight in the water, he will presently discover whether it be Gold or not.

There comes into my thoughts another possible way of counterfeiting *Guinys*, but because 'tis very likely that Coiners will not light upon it, and it cannot be practised on any of the *Guinys* already coined, the fear of teaching bad men a skill that probably they will not otherwise acquire, makes me forbear to mention it, though the fraud may be quickly discovered, sometimes by the bare Eye, and always by our Instrument, and the Ballance; whereof publick Advertisement may be given, if there shall appear need of it.

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And now I have this to add about the Construction of this Instrument, that perhaps it would not be very difficult to propose a much more accurate and elaborate Contrivance, if 'twere thought fit to propound any that would require an extraordinary skill in the Artificer to make it, and some considerable skill or dexterity in the Person that is to use it; but the slight Construction, hitherto described, seem'd to suit better with my Principal aim, which was, to propose at present an Instrument as simple, cheap, and easie to be employed and kept in order, as I could well examine *Guinys* with; little doubting but that the Principle, upon which this is framed, being well understood and considered, will, if it be found useful, be further improved by new Applications and more Artificial Contrivances.

Explication of the Figures.

In Fig. 1. AB, the Stem or Pipe.

C E, the two parts of the Ball soder'd together.

E C D E, the Ball it self.

F, the Screw.

G, the Stirrup, somewhat represent'd out of its place.

H, the Mark to which a Copper-plate, of equal weight in the Air with the Guiny, depresses the Instrument.

I, the Mark to which a true Guiny sinks it.

Fig. 2. is the Screw by it self, to be put upon or taken from the (short) undermost stem of the Instrument.

Fig. 3. the perforated plates of Lead or other metal, to be put on as ballast upon the undermost stem.

Fig. 4. the undermost

Stem with a perforated Ballast-plate put upon it.

Fig. 5. the Stirrup, that may be employed instead of a Screw.

Fig. 6. A B C, the Glas-instrument.

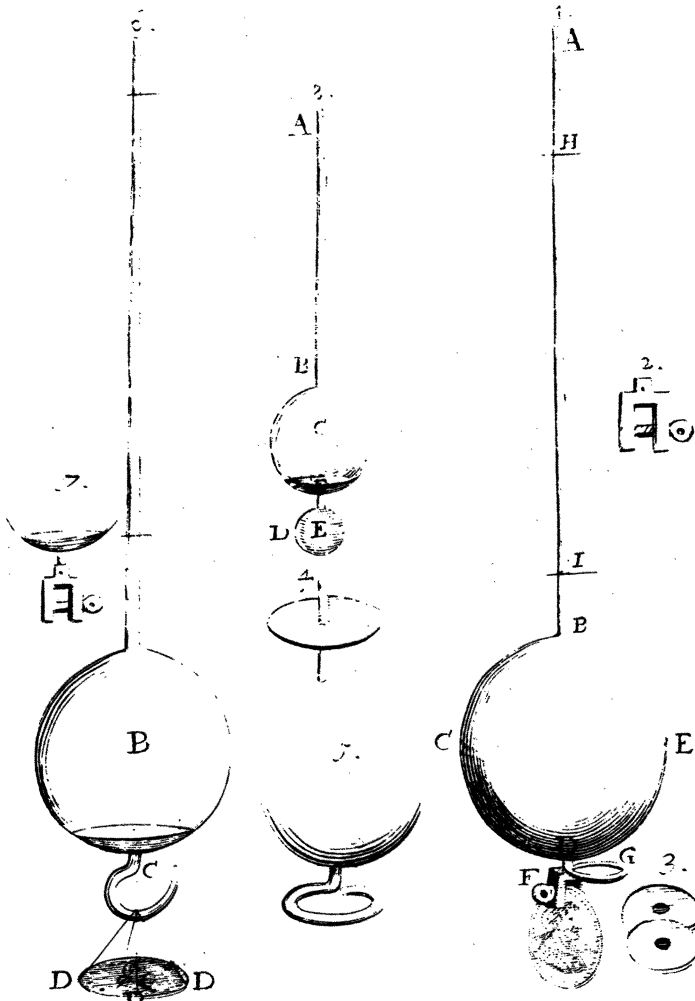
D D D, the Coin hanging at the bottom of it, and supported by four horse-hairs, or slender strings of silk.

Fig. 7. The undermost Stem of the Glas-Instrument, to which, being straight and solid, a Screw is fastned on with horse-hair, or otherwise.

Fig. 8. A B C D, the small Glas-Instrument for estimating the specifick gravity of Liquors. (of which an account may be expected in our next.)

E E, the Quicksilver and Water that is employ'd as Ballast to sink it in an erected posture.

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The Third Section.

Representing the Uses of this Instrument as relating to Metals.

THere is in the nature of the thing such a Connection between the *Fabrick* and *Use* of our Instrument, that I could not well describe it without plainly intimating the Principal uses of it. Wherefore I shall here but summarily repeat those that are delivered already, and make a more explicit mention of those few, that have been either omitted, or but lightly touched.

The I. Use.

The first use, and that which was mainly intended, is, easily and cheaply to discriminate true Guinys from counterfeit, without defacing or any ways injuring the Coin. But of this use I have spoken largely enough already, and therefore shall advance to the next.

The II. Use.

Any other kind of Gold-Coin that is near about the weight of a *Guiny*, may be examined by our Instrument after the manner above delivered; but more easily, if it want of the weight of a *Guiny* than if it exceed it. For in case it be heavier, as is a Twenty shilling piece of broad Gold, the Ballast, whether internal or external, of the Instrument must be taken off, that so heavy a Coin may not quite sink it; whereas, if the Coin propos'd be lighter than a *Guiny*, one may add as much Gold (of the same alloy) beaten into thin plates, as, with the Coin propos'd, will make up in the Air the weight of a *Guiny*. For then this aggregate, being examin'd as if it were a *Guiny*, will discover in
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the Water, whether the Coin be right or counterfeit. I shall add, that, if the piece, to be examined, be not much heavier than a Guiny, it may be convenient to pass a very small perforated plate of Copper or Lead over the upper stem (or pipe,) so as to make it rest upon the ball before the Instrument is adjusted. For, by this means nothing need be altered *beneath the Ball*; and such pieces of metal (of which several differinglly heavy may be easly provided) being thin and light, will not, (as trial has shewn) make the Instrument top-heavy, though one of them be plac'd above the Center of Gravity, and may be very readily taken off, and (if need be) scrap'd or fil'd to lighten the Instrument, when an extraordinarily heavy Guiny, or a Coin somewhat more weighty than a Guiny, is to be examin'd.

But to return to what I was saying about adding a weight of Gold to a piece of propos'd Coin; in order to this use it will be necessary, that the Slit or Aperture at the bottom of the Instrument, which is to be shut and open'd by the lateral Screw, be made (as it easly may without Inconvenience) wide enough to receive double the thickness of a Guiny, that so different Coins, as *English, French, Spanish, &c.* and the Grain-weights, necessary to bring them to the weight required (in the Air,) may be securely fasten'd to the Instrument by the Screw.

If the Ball be large, and the Pipe well proportioned to it, Coins, that do not much exceed the weight of a Guiny, may be examin'd without much altering the weight of our Instrument, provided it be at first adjusted so, as that a Guiny will not depress it so far as not to leave a considerable part of the pipe above water, that the Coin heavier than a Guiny may not be able to draw it quite under water.

According to the Method above described, may *half Guinys* be examin'd. For, if the Instrument be good, it will shew a manifest difference, if, instead of an intire Guiny, you fasten in the screw a half Guiny that you know to be true, and that which
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is suspected to be counterfeit ; adding a grain-weight or two of Gold in case the proposed Coin needs it ; I say, a *grain-weight of Gold*, because, if it be of *Brass*, of which the grain weights, commonly used, are made, it will loose in Water more than it should of the weight it had in the Air ; and therefore it will be useful to such as intend to try several sorts of *English* Coins, as *Angels, Two and twenty shilling pieces, double Guinys, &c.* to have by them a numerous set of grains, (about whose shape, by the way, one need not be curious, that not being material) made of a thin plate of sterling Gold.

The III. Use.

If the Instrument be skilfully fitted for such a purpose, it may be made to serve to examine some sorts of *white money* less heavy than half Crowns. And because it may be useful to know in general what Coins may, and what may not, be examin'd by this or that particular Instrument propos'd, I shall here add a general way that is not difficult for finding this out ; namely *first*, by weighing the piece of Gold or Silver in the Air, and afterwards in the Water, and subtracting the latter from the former, to obtain the difference of the two weights : And *next*, by weighing also in the Air and in the Water a piece of Copper, or Brass, if *this* be the likeliest to be employed in counterfeiting the Coin, and observing likewise the difference between those weights. For, the lesser of these differences being subtracted from the greater, the remains will shew, how much the true piece of Coin will outweigh the other in the water, and consequently if so many grains, as this residue amounts to, being added to the weight of the lighter metal, do make a sufficiently manifest depression of it below the Mark it would stay at without that addition, one may probably conclude, that the difference between a true and counterfeit piece of Coin propos'd, will be discoverable by the Instrument.

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The cheapness of these slight Instruments being considered, it may be expedient for Goldsmiths and others, that have frequent occasions to examine various sorts of Coin, to have a several Instrument adjusted for each of them, to save themselves some pain and trouble. But if the Ball be made large, and fitted with a stem slender and long enough, one may quickly by changing the balast-plates, as occasion requires, fit the same Instrument to examine Coins of differing metals, and of very differing weights. For one of these, made of Copper, serves me to examine both Guinys and Crown-pieces of Silver, and half Crowns too; and it may be easily made to serve also for divers forreign Coins.

The IV. Use.

'Tis a great complaint of Pewterers, that the Tinn they buy of the Miners or Merchants is often adulterated with Lead, as they find to their prejudice when they have made Vessels of it. And many others, that are Buyers, complain much more of divers Pewterers for putting too much Lead into their Pewter, because Lead is by many times cheaper than Tinn. On these accounts I shall add, to the other use of our Instrument, something that relates to Tinn and Pewter. Though I must take notice, that some Tinn may perhaps be found a little heavier *in specie* than ordinary, although no fraud intervene; because I have observ'd some Tinn (as I elsewhere relate) to contain some, though but a very little, proportion of Gold or Silver. But this being no usual case, I shall proceed to say, that the Pewterer may judge, whether the Miner or Merchant have deceived him; if, taking a piece of Tinn that he knows to be pure, and is of a convenient weight, he observes how much it depresses the Pipe, and then makes the like observation with an equal piece of the Tinn suspected to have Lead or some other Metal in it. For if this depresses the Instrument much lower than

than the other, 'twill justify the suspicion: Since as Gold being the heaviest of Metals, cannot be alloy'd by any other that will not depress our Instrument less than Gold can do; so Tinn, being the lightest of Metals, cannot be mixed with any other that will not sink it lower than unmixt Tinn, (still supposing the weights to be the same in the Air.)

And as for the Buyers of Pewter, 'twill be easie for them (if they think it worth while) to find by our Instrument, if there be too much or but enough of Lead mixt with the Tinn in an assign'd portion of Pewter of a convenient weight to be examin'd by it. For, having once observed, how much the Instrument is depress'd by a piece of two, three, or four Drams; or even an Ounce weight of Pewter, which is known to be good, and to contain such a proportion of Lead in reference to the Tinn, if you load the Instrument with an equally heavy piece of any other mass of Pewter propounded, if the Instrument sink deeper, 'twill be a sign, that the former proportion of Lead may be very *probably* argued to exceed in the mixture; I say, *probably*, because perhaps 'tis possible to embase Pewter by mixing not only Lead but other Mineral Substances, whose specific gravity is not well known: But yet I say *very* probably, because the addition of too much Lead is the most gainful way of adulterating Pewter. And the other things that some imploy, as *Regulus of Antimony*, *Tinn-glass*, *Copper* and *Speltar*, are seldom used in great quantities; and if I thought it worth the while, I could facilitate the Discovery even of these by adding, what I have observed of their differing specific Gravities, and some other things that I think fitter to be here omitted than to have time and words spent upon them,

The V. Ufe.

The laſt uſe, I ſhall now mention of our Inſtrument in reference to Metals, is, that it may aſſiſt us to eſtimate the quality of Metalline Mixtures, whether in Coins or other Maſſes, and to gueſs at the proportion of the Ingredients that compoſe them. For, ſince we have formerly ſeen, that the ſame Inſtrument, employed to examine Guinys, ſerved alſo for Crown-pieces of Silver that wanted of an Ounce leſs than a twentieth part of that weight, 'twill be eaſily granted, that the ſame Inſtrument, and more eaſily, that a larger one, may be ſo fitted, as to help Goldſmiths, Chymiſts and others, that are not acquainted with Hydroſtaticks, to make ſuch an eſtimate as will not much deceive them of the fineneſs of Gold and its differing Allays with Silver or ſome other determinate Metal.

In order to this, the Inſtrument may be fitted to ſink to the tip of the Pipe with ſome determinate weight of the fineſt Gold, as of 24 Carats, as they call that which is moſt pure and fine. But 'twill be convenient, that this Metal, in the Air, be juſt an Ounce, or half an Ounce, or ſome ſuch determinate weight, that is commodiouſly diviſible into many *aliquot* parts. Then you may make a mixture that contains a known proportion of the metal wherewith you allay the Gold; as if it hold 19 or 15 parts of Gold, and one of Silver; and, letting the Inſtrument ſettle in the Water, mark the place where the Surface of the Water cuts the ſtem or pipe. And then putting-in an other mixture, wherein the Silver has a new and greater proportion to the Gold; as if the former be an eighteenth or a fourteenth part of the later, you may obſerve, how much leſs than before this depreſſes the Inſtrument, and ſo you may proceed with as many mixtures or degrees of Allays as you think fit, or can be diſtinguiſhed conveniently on the ſtem; being alwayes careful, that, whatever
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be the proportion of the two Ingredients, the weight of the Mass in the Air be just the same with that of the pure Gold, which we have lately supposed to be one Ounce, or half an Ounce.

By the same method may be examin'd the differing Alloys of pure Silver upon the admixture of such and such determinat proportions of Copper or any other Metal lighter *in specie* than Silver; and by the same way, with a slight variation, 'twill not be difficult to estimate, how much divers Coins, whether of Silver or Gold, are more or less embas'd by the known ignobler Metal that is mixt in the piece propos'd.

And though this way of determining the Alloys of Metals be not so exact as is possible to be propos'd by the help of Hydrostaticks and Calculation; yet it may be very useful to Chymists, Goldsmiths, Refiners, and others, that are unacquainted with Hydrostatical matters, to make without trouble or supputation estimates that will not *much* deceive them, and perhaps will come nearer the Truth, not only than the estimates wont to be made by the Touchstone, but perhaps too, than some of those that divers make with trouble, and inconvenience, and charge. And indeed I was chiefly invited to communicate this Trifle and spend so many words about it by the request of some Ingenious Disciples of *Vulcan*, who thought they perceived, that, by this way, they could oftentimes make better estimates of the success of their graduating, and some other, operations upon Metals, than otherwise they should be able; this way greatly accommodating them by this particular advantage, that they may from time to time try the degrees of purity, and some other considerable alterations of their mixtures, without at all destroying or injuring them, though they have not yet attain'd the pitch they aim at and expect; whereas, if they happen to be too forward, as often they are, in examining the Productions of their Labours by the cupel or severe Cementations, what they would try may be destroyed or spoilt in its way to a perfection, which

otherwise, in their opinion, it might in due time be brought to.

Perhaps it may not be amiss on this occasion to add as an Improvement of this *fifth* Use of our Instrument, that it may be employ'd to examine other mixtures besides allay'd Coins, and that, if the Instrument be adjusted to an Ounce, for instance, of pure Copper, it may help men to make an estimate of the Alloy of Tinn, or the quantity of it that is oftentimes added to Copper, to make differing sorts of Bell-metal, and of those metalline *Specula*, whether plain or concave, that are call'd Steel-glasses, as also of Soders consisting of certain proportions of Silver and Brass, or Copper; in all which, and divers others, the discovery of the proportion of the Ingredients may, on some occasions, be useful to Tradesmen, as well as desirable by *Virtuosi*. And though I have observed, that, by mixture, Tinn and Copper acquire a specific gravity somewhat differing from what their Ingredients promise; yet, since the Instrument is to be fitted for such estimates, not by calculation, but by tryals, the estimates may be made near enough to the Truth,