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THE
U S E
OF THE
HYDROSTATIC
BALANCE
MADE EASY:

AND

Applied particularly to the Purpose of detecting counterfeit GOLD COIN.

With several TABLES and CALCULATIONS relative to the Weight of GOLD.

By J. B. BECKET.

B R I S T O L :

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U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
WASHINGTON, D. C.



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P R E F A C E.

FROM the gradual advancement of human knowledge, and the various assistances that are found necessary to the perfection of every material discovery, it is never to be expected that the first discoverer of any science, should be able to place it in so advantageous a point of view, as to render it at once distinct, and extensively useful.

THE DISCOVERER sufficiently establishes his credit, if he is able to demonstrate the truth of his THEORY, and but seldom attempts giving to the world a practical or introductory treatise on the subject. This has generally fallen to the lot of those who have been contented to follow the track marked out for them by a superior hand; till experience has, at length, taught them that, in order to pursue the enquiry to advantage, they are sometimes obliged to make various *deviations* from the old track; and, finding it necessary to obtain a more distinct view of the separate parts of their subject, they have proceeded, by experiment and investigation, to form a regular analysis of the whole. This has generally thrown a stronger light upon the object, and it has appeared clear and satisfactory to every attentive observer: But, as new experiments are continually leading to new discoveries, we are, after all, constrained to conclude, that almost every branch of practical science admits of unlimited improvement.

It is evident that those arts have approached the nearest to perfection, that have been illustrated by the most familiar descriptions, so as to render them plain and intelligible to every

P R E F A C E.

every enquirer. YOUTH have, by such means, been agreeably led on in their pursuits of *science*; and, since *this* has been exhibited with rather less *systematic dignity* than formerly, the man of inferior capacity has easily acquired the most useful part of that knowledge, which was once deemed peculiar to the PHILOSOPHER.

THERE is, at least, one farther advantage arising from plain and familiar analyses,—that they have an immediate tendency to diffuse a knowledge of the useful arts among all classes of mankind; whereby every one may have it in his power, to compare the different effects arising from the different situations of things; and the artist not only gains the best information of those who have gone before him, but is likely to be led into the most sure track for making farther discoveries and improvements.

THE science of HYDROSTATICS, comprehending the nature of *fluids* in general, has been studied and cultivated by the most ingenious men, as a source of agreeable entertainment, and of extensive utility; being applicable to the most necessary and common occasions of life; and the *theory* having been already made sufficiently clear by various writers on the subject, my present design is merely to draw up a plain compendium of the principal uses of the HYDROSTATIC BALANCE, in order to facilitate the practice of this useful instrument to those who are unacquainted with it.

THIS appears to be the more necessary at present, because, in the circulation of *money*, the public are now more liable to be deceived by that which is *counterfeit*, than by that which has been fraudulently rendered short of weight. The late salutary regulation respecting the weight of gold coin, having effectually prevented the iniquitous practice of CLIPPING, the only remaining expedient for the *destroyers* of money, seems

P R E F A C E.

seems to be that of *making* it ;—but were the use of the hydrostatic balance to become general, it would undoubtedly put as effectual a stop to base and counterfeit COINING ; and in this light it appears to be an object worthy of considerable attention.

IT is somewhat to be regretted, that most explanations of the use of this instrument, appear frequently enveloped in a cloud of mathematical calculations, which has doubtless prevented many from using it, or giving any attention to the subject. This method, indeed, is commonly made use of by those who have been conversant in such studies, because *quantities* may be more concisely expressed this way than by common arithmetic. But a knowledge of mathematics is by no means necessary to that of the hydrostatic balance, which may be used to very good purpose by every person who is capable of using a pair of common scales.

WERE the question to be put to many people who have been deceived by counterfeit money, “ Why don't you furnish yourself with a Hydrostatic Balance ? ” The probable answer would be, “ I know nothing of hydrostatics, and should scarcely be able to use one properly—besides, they are troublesome, and perhaps not always to be depended upon.”—The fact is, that these balances have been made of so many different forms, some of them so inconvenient and tedious in the operation, and others so extremely inadequate to the purpose, that many persons who are unacquainted with the principles, seem dubious of the real utility of any of them.

PERHAPS the only construction that may at all times be relied on, is that of the *equal Lever*, in the form of a common scale-beam ;—this is likewise the most simple and easy in its application, and might be rendered altogether as portable as any other kind.

P R E F A C E.

In the following small tract, I have endeavoured to render the use of this balance, in determining the specific gravity of different substances, perfectly intelligible to those who are acquainted with arithmetic no farther than the general rule of proportion :—The certain method of finding whether or not a piece of coin be *current gold*, is shewn merely by *weighing*, without any calculation ; and its quality and value may be immediately seen by the inspection of a table calculated for the purpose.



C O N T

C O N T E N T S.

*U*SE of the Hydrostatic Balance in determining the
Quality of GOLD, &c.

Description of the Balance, and its Appendages, 4.

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E R R A T A.

Page 9, line 13, *for 4800 read 480.*
— line 15, *for 351 read 35, 1.*



THE



T H E
U S E
O F T H E
HYDROSTATIC BALANCE,

In determining the quality of GOLD, &c.



THE principal and distinguishing qualities of pure GOLD are the simplicity, minuteness, and close cohesion of its parts; whereby a greater number of those parts is contained in less space than of any other body that we know of.

As all bodies weigh in proportion to their quantity of matter, the specific weight of Gold must therefore be superior to that of all other metals.

It follows from hence, that if Gold be adulterated with any other metal, its *specific gravity*, or comparative weight, must be *less* in proportion to the quantity of *Alloy*: Therefore the *weight* of Gold is a sure criterion of its quality.

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In order to determine the precise quantity of Alloy compounded with Gold, the Gold must be weighed with some other mass as a *standard*, and their relative gravities computed.

For this purpose it is necessary that the standard should be of one fixed and determinate gravity, and liable in the smallest degree to variation. *Fluids* are, by far, the most convenient, and *pure rain water** the least objectionable of any other.

From various hydrostatical experiments, it is found, that when any substance is immersed in a fluid specifically lighter than itself, it loses as much of its own weight, as is equal to the weight of a quantity of the fluid, of the same bulk as the substance weighed in it; and the fluid gains as much weight as the body weighed in it loses.

Hence it is extremely easy to compute the specific gravity of gold, or any other metal, by means of an accurate **HYDROSTATIC BALANCE**; and thereby immediately determine its quality and real value.

If a piece of gold be first weighed in air, in the usual manner, and its precise weight, in grains, remarked;

* *Rain Water* is generally preferable, but, as this is seldom to be obtained perfectly pure, clear spring Water will answer the purpose nearly as well.

marked; when it is afterwards weighed in water, it will be found to weigh considerably less. If its weight in water be subtracted from what it weighed in air, the difference will shew the *loss* it has sustained by being weighed in a denser medium: The *weight in air* being then divided by the *loss in water*, the quotient shews the *specific gravity*, or how many times gold is heavier than water.

On the contrary, the specific gravity of *sterling gold* being known, if the *weight in air* of any piece of gold coin, be divided by the *specific gravity* of sterling gold, the quotient shews what ought to be its *loss* when weighed in water, and if it be found to lose more, the gold is bad, or has too great a quantity of alloy.

Gold is about 18 times as heavy as common water; the specific gravity of sterling gold being to the weight of water, as 17,793 to 1; if therefore a Guinea weighs in air 129 grains, when weighed in water it must lose 7,25, or $7\frac{1}{4}$ grains of its weight, because $7,250 : 129 :: 1 : 17,793$; —so that a quantity of water, equal in bulk to a sterling guinea weighs $7\frac{1}{4}$ grains.

The method of computing *in what proportion* the quantity of alloy in counterfeit gold exceeds that which is allowed to *standard*, (which is 22 Carats of fine gold § to 1 of silver, and 1 of copper)

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will

§ The Specific Gravity of which is nearly about 19,15.

will be mentioned hereafter ;—I shall first describe the HYDROSTATIC BALANCE, and the method of applying it to use.

Of the HYDROSTATIC BALANCE.

THE BEAM of this Balance ought to be at least eight inches in length, but, for accurate experiments, one of ten inches is preferable; made of tempered steel, the slenderer the better, so that it may turn with the lightest weight, and balanced on its center in such a manner as to vibrate very slowly. It should be made to rest on a stand; a *pendant* beam being not only inconvenient for the purpose, but is liable to various inaccuracies.

To the BEAM is adjusted a pair of scale-pans, which may be taken off at pleasure; there is also another smaller pan of equal weight with one of the others, furnished with shorter strings, so as to admit a vessel of water to be placed under it. When the balance is used for hydrostatic purposes, this pan is to be suspended at one end of the beam, and one of the common scale-pans at the other.

The glass BUCKET is to hold any solid body intended to be weighed in water, and is to be suspended by the horse-chair, to the hook at the bottom of the small scale; there is a weight to be placed in the opposite scale, in order to balance the bucket exactly in water.

The

The brass TONGS are likewise for the same purpose, and to hold such substances as cannot conveniently be put into the bucket.

The small brass NIPPER is intended for the weighing of Gold coin; which may be much more accurately weighed in this, than in the *Bucket*; which, indeed, is designed to be used only for such substances as cannot well be placed in the *Nipper* or *Tongs*;—the beam will turn much easier with either of these, than with the other.---- A scale-beam, loaded at each end with a considerable weight, is insensible of the addition of a small one; besides, the resisting medium of water, through which the whole surface of the bucket and its contents must pass, prevents the vibration of the beam, and renders the operation both tedious and uncertain.

The glass SOLID is made use of in determining the specific gravity of Fluids.

N. B. Each of these Appendages has its respective Weight for a *balance in water*, distinguished by different marks.—These weights are intended to balance them *exactly*; but they may not always be correct; water varies considerably in its density, according to the temperature of the air; in hot weather it is lighter, in cold heavier; in the former case the balance-weight may appear rather
too

too light, and in very cold weather too heavy. Whenever this happens, the equilibrium must be restored by the addition of a small weight, dropt into the Scale that requires it, before any hydrostatic experiments can be performed with accuracy. —From hence it is natural to conclude, that the specific gravity of the same substances will be different at different times; this variation however, is so small, particularly in the weight of gold, as not to be regarded in common experiments.

In order to find the precise specific gravity of any substance, it will generally be requisite to compute the *decimal parts* of a grain; the better method therefore, of weighing, is by *tenths* of a grain, rather than by eighths, sixteenths, &c.—for which purpose, I have divided the grains by *decimals*, viz. into 1, 2, 3, 4, and 5 tenths, which, in the calculation, may be termed 5, 50, 500, &c. as the case requires.

Method of finding the SPECIFIC GRAVITY of SOLIDS.

Let the Substance be first accurately weighed in air, setting down with a pen the weight in grains and decimal parts; then hang on the small water-scale to one end of the beam, and place under it the glass vessel, pouring in water till it is filled within about three quarters of an inch from the brim: Let the body to be weighed be then placed
in

in the Nipper, Tongs, or Bucket, as is most convenient: and, immersing it in the water, let it be suspended by the horse-hair, to the hook at the bottom of the water-scale:—Observe that the same weights which balanced the body in air, are in the opposite scale, and likewise the proper *balance-weight*: Care also must be taken that no *air-bubbles* adhere to any part of the substance in the water, which will render it apparently lighter. The opposite scale to that which contains the substance, will now greatly preponderate; weights must therefore be taken out of it, or rather, (which will be found much more convenient) weights must be put into the *water-scale*, till the equilibrium be exactly restored. The pen and ink then finish the operation—divide the *weight in air*, by the *loss in water*, that is, divide the number of grains in the large scale, by those in the small one, and the quotient will shew the specific gravity, or how many times heavier the substance that was weighed is than water. If the weight in the small scale be *subtracted* from that in the other, it will shew the *respective gravity* of the weighed substance, or the weight with which it will be evenly balanced in water.—An example or two will render this still more plain.

EXAMPLE I.

Let a new sterling Guinea be weighed in air, and it will be found to weigh full 129 grains; fix it

it in the *nipper* suspending from the water-scale, and immerge it in the water (the balance-weight of the nipper being in the opposite scale) it will then appear to be lighter, but if $7\frac{1}{4}$ grains are put into the water-scale, the equilibrium will be restored, which shews that the guinea is good, or that sterling gold is 17,793 times as heavy as water, for so the specific gravity will turn out.—
Again,

EXAMP. 2.

Suppose a Guinea is suspected to be bad or counterfeit gold; tho' upon weighing it in air it is found to be of its full weight, or 129 grains,|| yet if, after weighing it in water, it is found to lose more than 7,25 (suppose 8,12) what is its specific gravity?

As the loss in water is to the weight in air, so is 1 to the specific gravity; therefore $8,12 : 129 :: 1 : 15,886$. so that 129,00 divided by 8,12 gives 15,886 for the specific gravity, which shews that the gold is much worse than sterling.

EXAMP. 3.

If a piece of silver weighs 636 grains in air, what is the specific gravity, supposing it to lose 60,7 when

|| This is *nearly* the weight of a new Guinea, but not strictly so—its real weight (valuing Gold at £ 3 17 10½ per Ounce) is 129,438, or nearly 5 dwts. $9\frac{1}{2}$ grains: The loss in water will therefore be 7,27.

when weighed in water? $60,7 : 636 :: 1 : 10,478$
 the specific gravity; by which it appears to be
 good silver.

EXAMP. 4.

How much heavier than water is Flint-Glass?
 A piece of white flint-glass weighed 169,05; and
 lost 50,60

$$50,60 : 169,05 :: 1 : 3,341$$

so that it was somewhat more than $3\frac{1}{4}$ times heavier
 than its bulk of water.

EXAMP. 5.

Mercury, tho' properly a fluid, is to be weighed
 as a solid; thus, put 1 ounce, or 4800 grains of
 Mercury into the glass Bucket, and weighing it in
 water, it will be found to lose nearly about 351
 grains; Mercury therefore is heavier than water as
 13,67 to 1.

The method is the same for most other solid
 substances that are specifically *heavier* than water:
 for those that are *lighter*, the process is somewhat
 different.

When any thing floats on the surface of a fluid,
 it displaces just so much of the fluid as is equal in
 weight to the weight of the whole floating body.
 Suppose a hollow cube of tin, 2 inches square, to
 weigh

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weigh 1 ounce; this being floated on water may be supposed to sink in it half an inch, or one fourth part of the whole: If so, a body of water 2 inches square, and half an inch thick, must weigh 1 ounce, equal to the weight of the cube, which would be 4 times specifically lighter than water. The cube would require an additional weight of 3 ounces to immerse it totally in the fluid; the *respective* gravity of the water, to the cube, is therefore as 3 to 1, and consequently a bulk of water equal to the cube, would weigh 4 ounces.

From hence, the method of weighing light substances specifically, is as easily conceived and put in practice, as that of weighing the heavier ones. Tho' several different appendages have been made to the hydrostatic balance for this purpose, they appear in general to be unnecessary, as most substances that are not too large to go into the brass Tongs, may very accurately be weighed in it.

EXAMP. 6.

Suppose it was required to find the specific gravity of a piece of dry *beech-wood*, weighing 59,50 grains.

Having set down the weight of the wood in air, fix it in the Tongs, and suspend the whole to the water-scale, placing the balance-weight of the
tongs

tongs in the opposite scale.—In the foregoing experiments, we let the weights with which the substance was weighed, *remain in the scale*, — we are now to *take out* all of them, except the *balance-weight*; and, upon immersing the tongs and wood into the water, they will appear to be *lighter* than the tongs alone. That adding a weight to one end of a scale-beam, should make the other end preponderate, seems to be as *paradoxical* as the *weighing of levity*; but it ceases to be so when we consider that no bodies ascend by means of their *levity*, but by reason of the greater density of the medium in which they are immersed. The wood pulls the tongs upward with a force equal to the *respective gravity* of the water, so that it requires as much weight to restore the equilibrium, as the wood is lighter than its bulk of water. Small weights are therefore to be put into the water-scale, till the balance be even; and *the weight of the wood in air*, added to these small weights, will be *equal to the weight of a bulk of water of the same size as the wood*;—consequently the *specific gravity* will be *as the weight of such a bulk of water is to the weight of the wood in air*.

When I weighed the wood, I put 16,70 grains into the water-scale, before the balance became even. 16,70 added to 59,50 (the weight of the wood) make 76,20, therefore

76,20 : 59,50 : : 1,000 * : ,781 the specific gravity of the Beech.

EXAMP. 7.

A piece of very dry *Cork*, weighing in air 24,3 grains, required 149,2 to be put in the water-scale, to restore the balance.—149,2 added to 24,3 make 173,5 (the weight of a bulk of water equal to the cork.)—As 173,5 : 24,3 : : 1,000 : ,152 the specific gravity of the cork ;—7 times lighter than water.

The specific gravity of another piece of cork was ,241, or about 4 times lighter than water.

N. B. In weighing of those bodies whose pores readily imbibe the water, the quicker the experiment is performed, the more likely it is to be correct.

Method of finding the SPECIFIC GRAVITY of FLUIDS.

That which is meant by the term *specific gravity* of bodies, being nothing more than the difference, or comparative weight of those bodies to that of common water, we might easily find the specific gravity

* In hydrostatic calculation, water, as the standard from which all the respective gravities are taken, is reckoned as unity or 1, 10, 100, 1000, &c. as the case requires.

gravity of any kind of *fluid*, by weighing a quantity of it against an equal quantity of water; but, as a *solid* body, when immersed in a fluid, loses as much of its weight as a bulk of the fluid equal to the body weighs, a more convenient and accurate method, is the immersion of a *solid*, of some determinate weight, in the fluid whose specific gravity we desire to know.

For this purpose is the conical piece of *solid glass*, belonging to the hydrostatic balance; whose weight, both in air and in water, being known, shews immediately the weight of the fluid into which it is suspended; the solid being borne up by the fluid in a proportion equal to its respective gravity.

Suppose the glass solid to weigh in air 1464 grains; and that, when it is suspended from the water-scale, and immersed in water, it loses of its weight 445 grains; this would be the weight of a bulk of water equal to the solid. The balance-weight for the solid must be made just equal to what it weighs in water, i. e. 1019 grains.

Whatever fluid is to be weighed, let it be put into the glass recipient;—suspend the solid to the hook of the water-scale, and let it hang freely in the liquor, putting the balance-weight in the opposite scale.—If the fluid be heavier than water, the solid will rise in it,—if lighter, it will sink to the
the

the bottom of the recipient. In either case small weights are to be put into the lighter scale, till the balance be made even.

1. When the fluid is *lighter* than water, the weight *gained* by the glass solid is to be *subtracted* from the weight of a bulk of water equal to the solid, [445] and the remainder is the weight of an equal bulk of the fluid, or its specific gravity to water.

EXAMP. I.

When such a glass solid as the above was immersed in *Brandy*, it balanced 38,2 grains more than in water; this taken from 445,0, leaves 406,8; therefore the specific weight of the brandy was to water as 406,8 to 445.

To reduce it to its proper terms——multiply the difference [38,2] by 1000, (the denominator of water) and divide the product by 445;——As $445 : 38,2 :: 1000 : 86$ ——Subtract 86 from 1000, there remain ,914 the specific gravity of the brandy.

From hence it appears, that the brandy weighed 86 parts in 1000, or about $\frac{1}{12}$ less than water.

EXAMP.

EXAMP. 2.

In *Rum*, the solid balanced 40,3 grains more than in water,—As $445 : 40,3 :: 1000 : 91$ —91 from 1000, remain 909.—The specific gravity of the rum to water was therefore ,909—or about $\frac{1}{11}$.

EXAMP. 3.

When the solid was immersed in highly rectified *spirit of wine*, it balanced 73,6 more than in water; therefore $445 : 73,6 :: 1000 : 165$ —165 from 1000, remain ,835, or $\frac{1}{6}$.

It appears from these examples, that the *Hydrostatic Balance* is a most certain and correct instrument for determining the *strength of spirits*; perhaps more so than the most accurate *Hydrometer* that has yet been made for that purpose.

It is of considerable consequence to distillers, and dealers in spirituous liquors, to know the precise point of strength which is termed *proof*: Though this, indeed, is rather arbitrary than any fixed standard; but the degree of strength, which, I am informed, is now called merchantable *proof*, fixeth the specific gravity of the spirit to water at ,930.

930 taken from 1000, leaves 70, therefore $1000 : 70 :: 445 : 31,15$. So that in *proof spirit*,

rit, a glass solid of the weight above-mentioned, must balance 31,15 or about $31\frac{1}{4}$ grains more than in water.

It may easily be found in what proportion the spirit is *above* or *below* proof, by observing what quantity of *water* or *alcohol* is necessary to be mixed with it, in order to bring it to the above standard; and it might be immediately known, by comparing the weight of the spirit with that of water, if the specific gravity of both, when compounded, remained in the same ratio as when separate: But, as it is found that, when water is mixed with spirit, the specific gravity of the compound is *greater* than that of the water and the spirit before they are compounded, the calculation must therefore turn out incorrect,—for instance,

A quantity of the *rum*, before-mentioned, equal in bulk to the glass solid, weighed very nearly 405 grains—an equal bulk of water, 445 grains;—suppose then, that in order to reduce the rum to *proof*, one *fifth part* of water was to be mixed with it;

$$\begin{array}{r}
 \text{Water} \quad - \quad 1 \quad = \quad 445 \\
 \text{Rum} \quad \quad - \quad 4 \quad = \quad 1620 \\
 \hline
 \qquad \qquad \quad 5) \quad 2065 \\
 \hline
 \text{Mean weight} \quad = \quad 413
 \end{array}$$

By

By this it appears that a quantity of the compound, equal in bulk to the glass solid, should weigh, 413 grains, and consequently that the solid, when immersed in it, should balance 32 grains more than in water; in which case it would still be somewhat above proof.

But, upon trial, it will be found to balance not much more than $29\frac{1}{2}$, and that there must be but little more than *one seventh* part of water mixed with the rum to reduce it to the given standard.

Immediately after water is mixed with spirit, the compound appears *lighter*; but in a few hours afterwards, when the particles of each are more intimately united, its bulk diminishes, and consequently the specific gravity increases.

From a few experiments of this kind, the theory will appear sufficiently plain; and a table might easily be formed for shewing by inspection what quantity of water is necessary to be put to any given quantity of spirit, to render it true proof; but, as this is rather a deviation from my present design, I shall refer the reader to a tract published by Mr. B. MARTIN, in *Fleet-street*, intitled, *The Theory of the genuine Hydrometer illustrated*, in which the principles of this part of hydrostatics are explained, and the great uncertainty and imperfection of the common *Hydrometer* pointed out.

D

2. When

2. When fluids are specifically *heavier* than water, the glass solid, as before observed, will *rise* in such fluid, (the water balance-weight being in the opposite scale,) and appear to be lighter; small weights are therefore to be put in the water-scale, till the equilibrium be restored; and the *loss* which the solid sustains by being weighed in the heavy fluid, is to be *added* to the weight of a bulk of water equal to the solid—the sum shews the specific gravity of the fluid to water.

EXAMP. 4.

Suppose it was required to find the specific gravity of *sea-water*, or how much heavier it is than rain-water.

Let the solid be suspended, as usual, to the water-scale, and immersed in the sea-water; putting the balance-weight in the opposite scale. It will require 11,6 grains to bring it to an even balance.

$$\text{As } 445 : 11,6 :: 1000 : 26.$$

The specific gravity is therefore 1026; which shews that Sea-water is 26 parts in 1000, or $\frac{1}{38}$ heavier than Rain-water; or that there must be 1026 measures of Rain-water, to weigh as much as 1000 measures of Sea-water.—The method is the same for every other fluid specifically heavier than water.

The

The specific gravity of *salt* and *water*, in equal quantities (in measure) is 1205; or, about $\frac{1}{3}$ heavier than common water.

Method of discovering the Proportion of ALLOY mixed with GOLD.

The specific gravity of *sterling* or *money* gold, as before observed, is 17,79, which is the standard made use of in the following calculations, as it comes the nearest to the average weight of the current British coin. The specific gravity of pure or very fine gold is, indeed, considerably more; in some tables it is made 19,64, but I never met with any so heavy as this. The specific gravity of good *silver* is 10,37. Of *copper* 8,83.

If then, a mass be compounded of *gold* and *silver*, the specific gravity of the compound may be thus found, without the use of the balance.

EXAMP. I.

Suppose a mass of metal, half *gold* and half *silver*, [in weight] to weigh in air 258,8 grains, what must be the specific gravity of this compound, to an equal bulk of water?

RULE—Compute what must be the *loss in water* of the proportional part of each metal, by dividing

its weight in air by its specific gravity : Add the two sums together, and by this product divide the weight of the whole mass ;—the quotient will shew the specific gravity.

	Weight in air.	Loss in water.
Ratio of the Gold	129,4	7,27
————— Silver	129,4	12,47
	<hr style="width: 50%; margin: 0 auto;"/> 258,8	<hr style="width: 50%; margin: 0 auto;"/> 19,74.

258,8, divided by 19,74 gives 13,11 the specific gravity of the compound mass.

EXAMP. 2.

If a *Guinea* be adulterated with *copper*, in the proportion of 4,39 *gold*, and 1 *copper*, what is its specific gravity ?

Say—If a mass, weighing 5,39 grains, contains 1 grain of copper, how much will be contained in a mass weighing 129,4 ?

$$\text{As } 5,39 : 1 :: 129,4 : 24.$$

The guinea must therefore contain 24 grains of copper, and 105,4 of gold.

Loss in water of 105,4 grains of gold	= 5,93
<hr style="width: 50%; margin: 0 auto;"/> 24,0	— copper = 2,71
<hr style="width: 50%; margin: 0 auto;"/> 129,4	<hr style="width: 50%; margin: 0 auto;"/> 8,64

129,4 divided by 8,64 gives 15 for the specific gravity.

The

The same method may be used for determining the specific gravity of any other mass, though compounded of three or more different metals, provided the ratio of each metal be known.

The *reverse* of these examples must therefore be the rule for discovering the proportion of alloy mixed with gold, after its specific gravity is found by the balance.

EXAMP. I.

What is the proportion of gold and silver in a mass (weighing 258,8 grains) whose specific gravity is found to be 13,11 ?

RULE—Compute what must be the loss in water of a mass of *gold*, of equal weight with the compound, and likewise of a mass of *silver*, of the same weight ; subtract the loss of gold from that of the compound—the remainder is the ratio of silver ;—subtract the loss of the compound from that of silver—the remainder is the ratio of gold.

Loss in water of	258,8	grains of gold	=	14,54
—————	258,8	—————	silver	= 24,94
—————	258,8	the compound	=	19,74

14,54 taken from 19,74 there remain 5,20——
 19,74 from 24,94 remain likewise 5,20 ; by which it appears that the weight of the gold and silver is in equal proportion—agreeably to the first preceding example.

EXAMP.

EXAMP. 2.

If a *guinea*, of its full weight, or 129,4 grains, be adulterated with *copper*, and its loss in water found to be 8,64, what quantity of copper is mixed with it?

$$\begin{array}{r} \text{Loss of 129,4 grains of gold} = 7,27 \\ \text{————— 129,4 ————— copper} = 14,65 \\ \text{————— 129,4 the compound} = 8,64 \end{array}$$

7,27 from 8,64 remain 1,37—8,64 from 14,65 remain 6,01—so that the proportion of the copper is to that of the gold as 1,37 to 6,01; or, (agreeably to the second preceding example) as 1 to 4,39 *i. e.* 24 grains of copper, and 105,4 of gold.

If it be required to find the respective *bulk* of each metal in the compound mass,—First, find its specific gravity, and then subtract the specific gravity of the *inferior* metal from that of the *compound*, and the remainder shews the ratio of *gold*; then, if the specific gravity of the *compound* be subtracted from that of the *gold*, the remainder is the ratio of the *inferior* metal.

It must be observed that, in the preceding examples, the quality of the alloy, with which the gold is compounded, is supposed to be *known*, together with its specific gravity: But this is seldom the case—it is not often discoverable with what
par-

particular metal or metals a counterfeit guinea is adulterated, much less their exact *specific gravity*, which is necessary to be known: The foregoing experiments then, may appear to be calculated more for amusement, than for any real utility, in determining the *value* of bad gold. This conclusion, however, would be rather too precipitate,—such experiments and calculations have not only a tendency to familiarize the subject, but they lead directly to the desired point.

Gold may be made to retain a very specious appearance, and yet be rendered much worse than *sterling*, by being adulterated with inferior metals,—*silver*, *copper*, some kinds of *brass*, &c. and though the weight of these, after the mass is compounded, cannot be precisely ascertained, nor consequently the exact ratio of the *gold*; yet, by taking the *mean* specific gravity of the metals generally used for adulterating of gold, and attending to the weight, colour, &c. of the compound, a pretty correct judgment might be formed of the nature of the *alloy*; and if this be *nearly* true, the hydrostatic examination cannot be very erroneous, but will generally prove sufficiently accurate.

As a sterling *guinea*, when weighed in water, is found to lose $7\frac{1}{4}$ grains of its weight, if it loses more than this, the usual method has been to reckon the gold so much worse than sterling, by allowing or deducting from its value, a certain sum
for

for every grain that it loses more than $7\frac{1}{4}$; and perhaps, a more correct method cannot be taken, if that sum be adequate to the weight of the alloy.

A piece of good *silver*, of equal weight with a *guinea*, (or 129,4 grains) when weighed in water, loses of its weight 12,47 grains, which is 5,2 more than the *guinea* loses :

$$5,2 \quad \text{pence.} \quad : \quad 252 \quad : : \quad 1 \quad \text{pence.} \quad : \quad 48,4$$

If therefore a *guinea*, or other piece of gold coin, be adulterated with *silver*, *four shillings*, at least, must be deducted from its value, for every grain that it loses more than it would lose were it sterling gold.

A piece of *copper*, of equal weight with a *guinea*, loses in water 14,65, which is 7,38 more than a *guinea*.

$$7,38 \quad \text{pence.} \quad : \quad 252 \quad : : \quad 1 \quad \text{pence.} \quad : \quad 34$$

So that, if sterling gold be adulterated with *copper*, *two shillings and ten-pence* is to be deducted from its value for every deficient grain;—and the same method will ascertain the proportion for every other species of alloy.

Counterfeit *guineas* are seldom found to be adulterated with *silver* alone, but more generally with *copper*, with a small quantity of *silver*; or with metals whose weight is nearly equal to that of *copper*.

From

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A TABLE of the proper Loss in Water of STERLING GOLD, the Specific Gravity of which being 17.79; from 1 Grain to 240.

Weight in Air.	Loss in Water.	Weight in Air.	Loss in Water.	Weight in Air.	Loss in Water.	Weight in Air.	Loss in Water.	Weight in Air.	Loss in Water.
1	0,056	49	2,75	97	5,45	145	8,15	193	10,85
2	0,11	50	2,81	98	5,50	146	8,21	194	10,91
3	0,17	51	2,86	99	5,56	147	8,26	195	10,96
4	0,22	52	2,92	100	5,62	148	8,32	196	11,00
5	0,28	53	2,97	101	5,68	149	8,38	197	11,07
6	0,34	54	3,03	102	5,74	150	8,44	198	11,14

From the mean weight of these metals, compared with different *assays* that have been made of counterfeit gold, it appears that, if *three shillings* be allowed for every grain deficient in the specific gravity, it will come nearer to the truth than any other sum, and may generally be relied on as sufficiently correct.

To prevent any error, or loss of time in calculation, I have annexed a table of the proper loss of *sterling gold*, when weighed in water, by the inspection of which (and the small table of *decimals*) it may be immediately seen how much almost any piece of gold coin is worse than sterling.

The use of these tables is obvious—for instance, suppose it was required to know the quantity of gold, or the value of a bad *guinea*, weighing in air 128 grains, (which is pretty nearly the weight that most counterfeit guineas are made) and whose loss in water is 8 grains:—By the table it appears that 128 grains of sterling gold ought to lose in water 7,20 grains. 7,2 taken from 8, leaves ,8 ———and by the table of decimals it appears that 8 tenths of a grain deficient is = 2s. 4d. $\frac{3}{4}$, and so much is the gold worse than sterling. The value of the guinea, then, (allowing 2d. $\frac{3}{4}$ for the deficiency of its proper weight) is 18s. 4d. $\frac{1}{2}$.

Though this method of determining the *value* of gold may not always be *precisely correct*, it never

can vary from the truth in any great degree, but will always be found sufficiently near for common purposes; and merely to find whether or not a piece of coin be *current gold*, the method before directed is not liable to error, but, with such a balance as hath been described, may be known to absolute certainty. The only necessary precaution is to mind that the water be fresh,* so that the balance-weights may produce a due equilibrium: The *guinea* being then evenly balanced, first in air, and afterwards in water, if it loses no more than $7\frac{1}{4}$ grains, it is good or sterling gold; but if it is found to lose half a grain more, it has too much alloy to be current.

THE HYDROSTATIC BALANCE being in itself so simple an instrument, and the method of applying it to use, in detecting bad money, so extremely easy and certain, it seems rather to be wondered at that it is not at this time in general use; when every person finds himself liable to be daily deceived by light or counterfeit coin; The principal reason, perhaps is, that the best balances are seldom sold without an apparatus of different appendages, which has not only enhanced the price double to what they might be rendered for, but has likewise made the method of applying it to use, appear complex and troublesome; and the common instruments, in the form of *steelyards*, &c. pretend-
edly

* If the water be *warm*, it will be lighter, and consequently the gold appear heavier than it really is.

edly made for *hydrostatic balances*, are found to be quite inadequate to the purpose, and—in short, worse than nothing. All that is necessary for readily detecting of counterfeit coin, is a good scale-beam on a convenient stand, with a hook to one of the pans for suspending a pair of small nippers—and a glass of water. These might always be ready at hand for occasional use—always depended upon—and but little more time taken up in the operation than weighing in the common manner.

It may sometimes be of use to know what quantity of pure or *fine gold* is contained in a given mass;—this may easily be found by the preceding rules, if, instead of dividing by the specific gravity of *sterling gold*, we make use of that of *fine gold*, which is nearly about 19,15 or 19,20:—for example,

What quantity of fine gold is contained in a *gold ring*, adulterated with *silver*, weighing 64,5 grains, and whose specific gravity is 15,89?

Proceed as before directed (page 21) and the ratio will stand thus,

Loss in water of 64,5 grains of fine Gold = 3,37	
64,5	Silver = 6,23
64,5	the Ring = 4,06

3,37 taken from 4,06 there remain 0,69—
4,06 from 6,23 remain 2,17; so that the weight

of the gold is to that of the silver as 2,17 to 0,69
or as 3,14 to 1.

22 Carats of *fine gold*, whose specific gravity amounts to 19,15, will admit of 1 carat of *silver*, and 1 of *copper*, to reduce it to *sterling*, or the specific gravity of 17,79; therefore, if sterling gold be valued at £3 : 17 : 10 per ounce, the gold whose specific gravity is 19,15 is worth £4 : 4 : 11 an ounce, or 7 shillings more than sterling gold.

As it will frequently be necessary for those who are concerned in buying or refining of gold, to know the value of different quantities, at different prices per ounce; to such as are not possessed of Mr. ETHERIDGE'S Gold Tables, which are by far the best that I have seen, the following will be of use.

Table of the Value of GOLD,

At £, 3 : 17 : 0 per Ounce.

Grains.				Pennyweights.				Ounces.			
gr.	£.	s.	d. q.	dwt	£.	s.	d. q.	oz.	£.	s.	d.
1	—	—	1 3	1	—	3	10	1	3	17	—
2	—	—	3 3	2	—	7	8 1	2	7	14	—
3	—	—	5 3	3	—	11	6 2	3	11	11	—
4	—	—	7 2	4	—	15	4 3	4	15	8	—
5	—	—	9 2	5	—	19	3	5	19	5	—
6	—	—	11 2	6	1	3	1	6	23	2	—
7	—	1	1 1	7	1	6	11 1	7	26	19	—
8	—	1	3 1	8	1	10	9 2	8	30	16	—
9	—	1	9 1	9	1	14	7 3	9	34	13	—
10	—	1	7 1	10	1	18	6	10	38	10	—
11	—	1	9	11	2	2	4	11	42	7	—
12	—	1	11	12	2	6	2 1				
13	—	2	1	13	2	10	— 2				
14	—	2	2 3	14	2	13	10 3				
15	—	2	4 3	15	2	17	9				
16	—	2	6 3	16	3	1	7				
17	—	2	8 2	17	3	5	5 1				
18	—	2	10 2	18	3	9	3 2				
19	—	3	— 2	19	3	13	1 3				
20	—	3	2 2								
21	—	3	4 1								
22	—	3	6 1								
23	—	3	8 1								

Pounds.			
lb.	£.	s.	d.
1	46	4	—
2	92	8	—
3	138	12	—
4	184	16	—
5	231	—	—
6	277	4	—
7	323	8	—
8	369	12	—
9	415	16	—
10	462	—	—

I have

I have chosen the sum of £ 3 : 17 : 0 per ounce for Gold, as a *mean* of its fluctuating value ; if it be *more* or *less* than this, the value of any quantity, at any price, may be easily found by the table, in the following manner,—first set down the value of the required quantity of gold at £ 3 : 17 : 0 per ounce by the table ; then, if it be valued at *more*, for as many PENCE as the value exceeds £ 3 : 17 : 0 add to the sum after the rate of ONE PENNY per ounce.

——Suppose it be required to know the value of 5 oz. 5 dw. 16 gr. of gold, at £ 3 ; 18 : 3 per ounce.

	£.	s.	d.
By the table, the value of 5 ounces is	19	5	0
—————5 pennyweights	0	19	3
—————16 grains	0	2	6½

But £ 3 : 18 : 3 is 15 pence more than

£ 3 : 17 : 0, therefore, for the 5 ounces,

add 5 times 15 pence, or - - - 0 6 3

5 dwts is $\frac{1}{4}$ of an ounce, for which add

15 farthings or - - - - - 0 0 3½

The proportional part of the 16 grains need not be regarded, as it scarcely amounts to an halfpenny.

—————

The value of the gold is therefore - 20 13 4½

What

What is the value of 2lb. 3oz. 8dw. of gold, at £ 3 : 17 : 10 per ounce?

	£.	s.	d.
2lb. (at £ 3 : 17 : 0) is	92	8	0
3oz. - - - - -	11	11	0
8dwts. - - - - -	1	10	9½
For the 2lb. add 24 times 10 pence, or	1	0	0
For the 3oz. — 3 times 10 pence, or	0	2	6
For the 8dwts. - - - - -	0	0	4
	106 12 7½		

Value of the gold, at £ 3 : 17 : 10, 106 12 7½

If the gold be valued at *less* than £ 3 : 17 : 0, the same method may be used, only instead of *adding*, *subtract* after the rate of *one penny* per ounce, for as many pence as the value of the gold is under £ 3 : 17 : 0. — For example, what is the value of 1lb. 9oz. 2dw. 6gr. of gold, at £ 3 : 16 : 2 per ounce?

	£.	s.	d.
1lb. (at £ 3 : 17 : 0) is	46	4	0
9oz - - - - -	34	13	0
2dwts. - - - - -	0	7	8¼
6gr. - - - - -	0	0	11½
	81 5 7¼		

Value of the gold, at £ 3 : 17 : 0, 81 5 7¼

For 1lb. 9oz. subtract

21 times 10 pence, or	0	17	6	}	0	17	7
For 2dwts. - - - - -	0	0	13		80	8	0¼

Value of the gold, at £ 3 : 16 : 2, 80 8 0¼

Table

Table of the Value of SILVER,

At 5 *Shillings* per Ounce.

Grains.					Pennyweights.				Ounces.			
gr.	£.	s.	d.	q.	dwt	£.	s.	d.	oz.	£.	s.	d.
1	—	—	—	0,5	1	—	—	3	1	—	5	—
2	—	—	—	1	2	—	—	6	2	—	10	—
3	—	—	—	1	3	—	—	9	3	—	15	—
4	—	—	—	2	4	—	1	—	4	1	—	—
5	—	—	—	2	5	—	1	3	5	1	5	—
6	—	—	—	3	6	—	1	6	6	1	10	—
7	—	—	—	3	7	—	1	9	7	1	15	—
8	—	—	—	1	8	—	2	—	8	2	—	—
9	—	—	—	1	9	—	2	3	9	2	5	—
10	—	—	—	1 1	10	—	2	6	10	2	10	—
11	—	—	—	1 1	11	—	2	9	11	2	15	—
12	—	—	—	1 2	12	—	3	—				
13	—	—	—	1 2	13	—	3	3				
14	—	—	—	1 3	14	—	3	6				
15	—	—	—	1 3	15	—	3	9				
16	—	—	—	2	16	—	4	—				
17	—	—	—	2	17	—	4	3				
18	—	—	—	2 1	18	—	4	6				
19	—	—	—	2 1	19	—	4	9				
20	—	—	—	2 2								
21	—	—	—	2 2								
22	—	—	—	2 3								
23	—	—	—	2 3								

Pounds.			
lb.	£.	s.	d.
1	3	—	—
2	6	—	—
3	9	—	—
4	12	—	—
5	15	—	—
6	18	—	—
7	21	—	—
8	24	—	—
9	27	—	—
10	30	—	—

The

The value of any quantity of Silver, at any price, may be known by this table, in the same manner as that for Gold, viz. by *adding* or *subtracting* after the rate of *one penny* per ounce, for as many *pence* as the value of the silver is *more* or *less* than *five shillings*.

What is the Value of 1lb. 4oz. 12gr. of silver, at 5s. 5d. per ounce?

	£.	s.	d.
By the table, 1lb. at 5s. per ounce, is	3	0	0
4oz. - - -	1	0	0
12gr. - - -	0	0	1½

The required value being 5d. an ounce more,

For the 1lb. add 12 times 5 pence, or 0 : 5 : 0

For 4oz. - - - - - 0 : 1 : 8

Value of the silver, at 5s. 5d. per oz. 4 : 6 : 9½

If the value of the Silver be *less* than 5 shillings, *subtract* as before.

THE STANDARD POUND WEIGHT OF SILVER is 110z. 2dw. of fine silver, and 18dw. of copper. The *specific gravity* of such fine silver must therefore be 10,52; because 222 pennyweights of silver of that gravity, and 18 pennyweights of copper, of 8,83, will produce 1 pound of *sterling silver*, or a compound whose specific gravity is 10,37.

Table of the Value of GOLD,

At the present Price allowed by the Bank of *Eng-land*, viz. 3*l.* 17*s.* 10*d.* $\frac{1}{2}$ per Ounce.

Grains.				Pennyweights.				Ounces.							
gr.	s.	d.	q.	dwt.	£.	s.	d.	q.	oz.	£.	s.	d.	q.		
1	—	1	3,787	1	—	3	10	2,9	1	3	17	10	2		
2	—	3	3,575	2	—	7	9	1,8	2	7	15	9	—		
3	—	5	3,362	3	—	11	8	—,7	3	11	13	7	2		
4	—	7	3,150	4	—	15	6	3,6	4	15	11	6	—		
5	—	9	2,937	5	—	19	5	2,5	5	19	9	4	2		
6	—	11	2,725	6	1	3	4	1,4	6	23	7	3	—		
7	1	1	2,512	7	1	7	3	—,3	7	27	5	1	2		
8	1	3	2,300	8	1	11	1	3,2	8	31	3	—	—		
9	1	5	2,087	9	1	15	—	2,1	9	35	—	10	2		
10	1	7	1,875	10	1	18	11	1—	10	38	18	9	—		
11	1	9	1,662	11	2	2	9	3,9	11	42	16	7	2		
12	1	11	1,450	12	2	6	8	2,8							
13	2	1	1,237	13	2	10	7	1,7	lb.	£.	s.	d.	q.		
14	2	3	1,025	14	2	14	6	—,6	1	46	14	6	—		
15	2	5	—,812	15	2	18	4	3,5	2	93	9	—	—		
16	2	7	—,600	16	3	2	3	2,4	3	140	3	6	—		
17	2	9	—,387	17	3	6	2	1,3	4	186	18	—	—		
18	2	11	—,175	18	3	10	1	—,2	5	233	12	6	—		
19	3	—	3,962	19	3	13	11	3,1	6	280	7	—	—		
20	3	2	3,750									7	327	1	6
21	3	4	3,537									8	373	16	—
22	3	6	3,325									9	420	10	6
23	3	8	3,112									10	467	5	—

As

As I have, at different times, taken the precise specific gravity of a great number of various pieces of English Coin, with a view of ascertaining the quality of the Metal; it may at least be entertaining, if not useful, to some persons, to see the variation in the *intrinsic value* of the Specie issued in different Reigns: I intended, indeed, to have arranged these in a comparative view with different *foreign coins*, but have not yet collected a sufficient quantity.

I have frequently found a considerable difference in the hydrostatic weight of the current coin of the same *reign*, and sometimes in that of the same year's coinage. This difference may be merely accidental. A piece of metal that has been forcibly *hammered*, will have a greater specific gravity than the same metal only *cast*. The different force, therefore, that is used in laminating, or even the impression of the mill, may produce some variation in the specific weight of different pieces of coin, made from the same metal. It is evident then, that weighing a few single pieces of coin in the hydrostatic balance, is by no means sufficient to determine the relative value of a coinage; but if a sufficient number be weighed, and the average of the whole computed, the result will be much more conclusive. In the following tables I have generally taken the mean weight of several pieces, weighed both separately and together.

COPPER coined in the reign of

	Mean Specific Gravity.
GEORGE I. - - - - -	8,76
GEORGE II. - - - - -	8,82
GEORGE III. 1771 - - - - -	8,84
GEORGE III. 1772 and 1773 - - -	8,86

SILVER.

Silver coined in the Reign of EDW. VI.	10,254
ELIZABETH - - - - -	10,284
JAMES I. - - - - -	10,186
CHARLES I. - - - - -	10,260
In the time of the Interregnum -	10,292
CHARLES II. - - - - -	10,280
JAMES II. - - - - -	10,310
WILLIAM & MARY, & WILLIAM III.	10,352
ANNE - - - - -	10,288
GEORGE I. - - - - -	10,337
GEORGE II. - - - - -	10,250

GOLD.

CHARLES II. - - - - -	17,561
WILLIAM and MARY - - - - -	17,676
WILLIAM III. - - - - -	17,560
ANNE - - - - -	17,800
GEORGE I. - - - - -	17,725
GEORGE II. - - - - -	17,758
GEORGE III. - - - - -	17,780

Whether the intrinsic value of a coinage be in a ratio exactly correspondent to its specific gravity, I shall not take upon me to determine; it is pretty clear, however, that the Gold of the present, and late reigns, is considerably better than that of CHARLES or WILLIAM; and the difference between the latter, and that of ANNE is remarkable.

A TABLE of the SPECIFIC GRAVITY of various METALS.

Fine Gold from 19,000 to - - -	19,500
Gold generally deemed standard -	18,888
Sterling Gold, when coined* - -	17,793
Portugal Gold, ditto, from 17,511 to	17,750
Lead - - - - -	11,266
Fine Silver from 10,500 to - -	11,000
Sterling Silver, when coined - -	10,378
Fine Copper - - - - -	9,000
Sterling Copper, coined - - -	8,830
Plate Brass, roll'd hard - - -	8,500
Cast Brass from 8,100 to - - -	8,300
Iron from 7,500 to - - - - -	7,800 - <i>Cast 7.372</i>
Block Tin - - - - -	7,320
Diamonds of <i>East-India</i> (mean weight)	3,519
Ditto of <i>Brazil</i> (ditto)	5,513

* * * If the decimal point be taken away from the above specific gravities, or if the spec. grav. of any substance be multiplied by 1000, the product will shew how many ounces avoirdupois are contained in a cubic foot of each substance. A cubic foot of Water, therefore, weighs 1000 ounces, *i. e.* very nearly $62\frac{1}{2}$ pounds avoirdupois; or, *75lb. 10oz. 16dwt.* troy.

I might

* The variation in the specific gravity of some Guineas coined in the reign of Charles II. and others of George III. has been 0,348; I have met with some of the latter whose S. G. is 17,848, others of the former no more than 17,500.

I might have enlarged this table of specific gravities very considerably, by the addition of various other substances, but must have been obliged, for want of leisure and opportunity, to have taken them upon trust, from other tables ready calculated to my hands:—Upon the perusal of many, I have found them so extremely variable from each other, and, in general, so extremely variable from the truth, that I thought it much better to omit them.

Since all bodies are subject to expansion by heat, and to contraction by cold, and as some substances expand by heat much more than others, it will follow, that the relative gravities of bodies are, in some small degree, liable to constant mutation. This, I believe, was first observed by M. HOMBURG, and after him by M. EISENCHMID, who by various experiments, found the absolute weight of a cubic inch of several kinds of fluids, to be considerably greater in winter than in summer, and instances the following.—A cubic inch of *Water* (the weight of which is nearly about 253 grains in temperate weather) is 3 grains heavier in winter than in summer: A cubic inch of *Brandy* 10 grains;—of *Spirit of Nitre* 20 grains;—*Spirit of Vitriol* 5 grains;—*Oil of Vitriol* 12;—*Milk* 5;—*Vinegar* 6. —But to be correct in this, it is necessary that the degrees of heat or cold should be specified by the thermometer.

It was before observed that, in order to perform any hydrostatic experiments accurately, it is necessary that the respective *water balance-weights*, belonging to the *nipper, bucket, &c.* should produce an exact equilibrium, and that if they did not, *small weights* (the 20th or 30th part of a grain) might be put into the lighter scale, in order to produce a balance. This method will do very well for some purposes, when small, heavy substances are to be weighed, such as a piece of gold coin, &c. but when precision is required, the alteration of the balance-weight may produce too great an error. To be always correct in these experiments, it is necessary that the water we make use of should be always of one determinate weight; and the balance-weights should never be altered by filing, or other means, after having been once accurately adjusted to a *temperate* standard. The best method of trying the weight of the Water is by suspending in it a body of pretty large contents, such as the glass solid before mentioned: If, in cold weather, this appears to be rather lighter than the balance-weight, the water is heavier than it ought to be, and it may be brought to the fire for a minute or two, or a little warm water added to it, till it is rendered sufficiently light. If, when the weather is hot, the water appears too light, by the solid's subsiding in it beyond an equilibrium, a few grains of common *salt* dissolved in it, will increase the gravity to the point required.—The heat or cold-

coldness of the weather may produce some little variation in the specific weight of the bodies themselves, that are to be weighed, but *solid* bodies, in general, are much less affected than *fluids*.

The following TABLE being very useful and necessary for Expedition in weighing of different Substances by Grains, preventing Loss of Time in Computation; it is intended to be cut out of the Book, and placed in immediate View, when the Hydrostatic Balance is made use of.

A T A B L E

For reducing Pennyweights into Grains, and
the contrary.

* * In Troy Weight, 24 Grains make 1 Pennyweight, 20 Pennyweights 1 Ounce, 12 Ounces 1 Pound.

Dwts.	Grains.	Gr.	Dwts.	Gr.	Gr.	Dwts.	Gr.	Gr.	Dwts.	Gr.	Gr.	Dwts.	Gr.
1	24	25	1	1	53	2	5	81	3	9	109	4	13
2	48	26	1	2	54	2	6	82	3	10	110	4	14
3	72	27	1	3	55	2	7	83	3	11	111	4	15
4	96	28	1	4	56	2	8	84	3	12	112	4	16
5	120	29	1	5	57	2	9	85	3	13	113	4	17
6	144	30	1	6	58	2	10	86	3	14	114	4	18
7	168	31	1	7	59	2	11	87	3	15	115	4	19
8	192	32	1	8	60	2	12	88	3	16	116	4	20
9	216	33	1	9	61	2	13	89	3	17	117	4	21
10	240	34	1	10	62	2	14	90	3	18	118	4	22
11	264	35	1	11	63	2	15	91	3	19	119	4	23
12	288	36	1	12	64	2	16	92	3	20	120	5	—
13	312	37	1	13	65	2	17	93	3	21	130	5	10
14	336	38	1	14	66	2	18	94	3	22	140	5	20
15	360	39	1	15	67	2	19	95	3	23	150	6	6
16	384	40	1	16	68	2	20	96	4	—	160	6	16
17	408	41	1	17	69	2	21	97	4	1	170	7	2
18	432	42	1	18	70	2	22	98	4	2	180	7	12
19	456	43	1	19	71	2	23	99	4	3	190	7	22
20	480	44	1	20	72	3	—	100	4	4	200	8	8
21	504	45	1	21	73	3	1	101	4	5	300	12	12
22	528	46	1	22	74	3	2	102	4	6	400	16	16
23	552	47	1	23	75	3	3	103	4	7	500	20	20
24	576	48	2	—	76	3	4	104	4	8	600	25	—
25	600	49	2	1	77	3	5	105	4	9	700	29	4
		50	2	2	78	3	6	106	4	10	800	33	8
		51	2	3	79	3	7	107	4	11	900	37	12
		52	2	4	80	3	8	108	4	12	1000	41	16

Ques: what the Val: of an Oz Troy of Silver
 proper to the Span Dollar of 17: 8

Value of $\frac{1}{2}$ Sil^r

5 " 2 $\frac{1}{4}$ m Oz. the Doll^r weigh^t 17: 8 will be worth 4 " 6

5 " 2 $\frac{1}{2}$ " " " " " 4 " 6 $\frac{1}{4}$

5 " 3 " " " " " 4 " 6 $\frac{1}{2}$

$\frac{1}{4}$ " " " " " " 4 " 6 $\frac{3}{4}$

$\frac{1}{2}$ " " " " " " 4 " 7

$\frac{3}{4}$ " " " " " " 4 " 7 $\frac{1}{4}$

5 " 4 " " " " " 4 " 7 $\frac{1}{2}$

$\frac{1}{4}$ " " " " " " 4 " 7 $\frac{3}{4}$

$\frac{1}{2}$ " " " " " " 4 " 8

5 " 5 " " " " " 4 " 8 $\frac{1}{4}$

$\frac{1}{4}$ " " " " " " 4 " 8 $\frac{1}{2}$

$\frac{1}{2}$ " " " " " " 4 " 8 $\frac{3}{4}$

$\frac{3}{4}$ " " " " " " 4 " 9

5 " 6 " " " " " 4 " 9 $\frac{1}{4}$

$\frac{1}{4}$ " " " " " " 4 " 9 $\frac{1}{2}$

$\frac{1}{2}$ " " " " " " 4 " 9 $\frac{3}{4}$

5 " 7 " " " " " 4 " 10

$\frac{1}{4}$ " " " " " " 4 " 10 $\frac{1}{4}$

$\frac{1}{2}$ " " " " " " 4 " 10 $\frac{1}{2}$

$\frac{3}{4}$ " " " " " " 4 " 10 $\frac{3}{4}$

5 " 8 " " " " " 4 " 11

$\frac{1}{4}$ " " " " " " 4 " 11 $\frac{1}{4}$

$\frac{1}{2}$ " " " " " " 4 " 11 $\frac{1}{2}$

$\frac{3}{4}$ " " " " " " 4 " 11 $\frac{3}{4}$

5 " 9 " " " " " 4 " 11 $\frac{3}{4}$

By the KING'S PROCLAMATION, dated the 24th of JUNE, 1774, the following Regulation in the Weight of GOLD COIN, took Place on the 15th of JULY following.

“ AND we do hereby farther declare and command, That, from and after the Fifteenth Day of JULY next ensuing, all *Guineas, Half-Guineas, and Quarter-Guineas*, more deficient in Weight than the Rates specified in the following Table, be not allowed to be current, viz.”

	Dwts.	Gr.
“ Guineas coined since the 31st of December, 1771, - - - - -	5	8
“ Half-Guineas, during the same Period	2	16
“ Guineas coined prior to 1st of January, 1772, - - - - -	5	6
“ Half-Guineas, during the same Period	2	14
“ Quarter-Guineas, during the same Period	1	7

As the Standard Weights for weighing Gold Coin are now issued by legal Authority (stamp'd with an *Imperial Crown*, by the proper Officer of his Majesty's Mint) it is necessary that every Person should be provided with a Set of these Weights, in order to avoid all Disputes concerning the Weight of Money.—And it may be proper to observe, that the Words of the Act of Parliament “ *more deficient in Weight—be not allowed to be current,*” evidently imply, that those Guineas, &c. that are *not more deficient* than the Weight specified, are allowed and deemed to be *current*; though they may not *preponderate* in the Scale. A Draught, or Turn of the Scale, which Custom has established in the weighing of common Commodities, is by no means requisite in the weighing of Money, which is not required to be *heavier* than the specified Weight.

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To the P U B L I C.

HAVING for some Time past given considerable Attention to the HYDROSTATIC BALANCE, and observed several Imperfections in the usual Construction of that Instrument, which have rendered it troublesome and uncertain in the Operation; I have attempted to make some Improvements in the Form, so as to render it easy in its Use, and certain in its Effects.—How far I have succeeded herein, must be left to Experience to determine. I have, however, now fitted up several of these Balances, which I may venture to say are ACCURATE, and by observing the printed Directions, may be relied on as precisely correct. They shew immediately whether or not a Piece of Coin be *current Gold*; and the real Value of it, in case it be not, is seen by the Inspection of a Table calculated for the Purpose.—They answer every Purpose of the common Scales, in weighing Money, &c. in the usual method, and of the Hydrostatic Balance, in taking the Specific Gravity of different Substances, with the greatest Accuracy, and may be rendered very commodious for the Pocket. The *Grain-weights* are, for greater Precision, nicely divided into *Decimals*, and all the other Weights exactly correspondent.

These Balances, and all other kinds of Money Scales, will be sold on very reasonable Terms; and as I am determined to dispose of none but such as I have either adjusted or examined with my own hands, I would hope they may be most safely relied on.

The *Gold Coin Weights*, for weighing without the Use of Grains, which, from their convenient Form and Accuracy, have given general Satisfaction to the Public, are still continued to be sold, by

Their obedient Servant,

Corn Street,
BRISTOL, 1775.

J. B. BECKET.