

8. *The double Horn mentioned above, belonging to Sir Hans Sloane: Whether they crossed each other on the Animal, is uncertain: It is most likely they did not, but that by drying they were crossed by the Corrugation of the Skin that joins them together: However, I have drawn them as they appeared to me. The strait Horn is 25 Inches long, the curved one somewhat shorter, and the Two Diameters of the Bases 13 Inches.*
9. *The concave Bottoms of the above double Horns, as they adhere to the same Piece of Skin.*
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IX. *An Account of a Comparison lately made by some Gentlemen of the ROYAL SOCIETY, of the Standard of a Yard, and the several Weights lately made for their Use; with the Original Standards of Measures and Weights in the Exchequer, and some others kept for public Use, at Guild-hall, Founders-hall, the Tower, &c.*

Read June
16. 1743.

WHEN there were some time since prepared by Order of the ROYAL SOCIETY, to be kept in their Archives here, and also in those of the *Royal Academy of Sciences at Paris*, Standards of the *Yard Measure*, as also of the *Troy* and *Averdupois Weights*; an Account of which was
some

some Months since published by Order of the COUNCIL of the SOCIETY in these *Transactions* * : It was not at all the Intention of the SOCIETY, to determine what was the absolute legal Length of the *Yard*, or the real and legal Weight of the said several *Pounds*; but only to lodge and preserve, in those respective Places, Two Measures, and Two Sets of those Weights, sufficiently near to what were in common Use, and well agreeing with each other, for the Purpose of comparing together, by some certain Standard, to which recourse might be had in either Kingdom, the Success of such Experiments made either in *England* or in *France*, in which Measure or Weight might particularly be concerned.

And for the same Reason, the Gentlemen of the *Royal Academy of Sciences*, were pleased to take care to have the Length of their *Half-Toise* set off on both the Brass Rods, upon which the *English Yard* had been already laid off, and to provide Two Brass Weights of *Two French Marcs* each; one of which was sent over hither, when one of the Brass Rods, just mentioned, was again returned over to the SOCIETY. And it was the Proportion only between *These* several Standards, that was proposed to be laid down in the said Paper published in these *Transactions*; without intending thereby to ascertain the just and legal Proportions between the Weights and Measures of both Nations. Though it is not to be doubted, but that this Measure of the *French Half-Toise*, and the *French Two Marc* Weight, are, like the *English*, sufficiently agreeable to what are there constantly used.

* N^o 465. p. 185.

But as some Gentlemen have since been desirous to know, how far those Standards really agreed with the Original ones, as they are looked upon to be, in the *Chamberlain's Office* of His MAJESTY's *Exchequer*, as well as with those kept for public Use, at *Guild-hall*, at *Founders-hall*, with the *Watchmakers Company*, and in the *Tower of London*. Mr. *George Graham*, F. R. S. was thereupon requested, with such other Assistance as he should find necessary, to take upon him the Comparison of the said several Standards; which he has accordingly done, and carefully viewed and examined the same, at the *Exchequer*, on *Friday* the 22d of *April* last, in the Presence of the *President* of the SOCIETY, the Right Honourable the Earl of *Macclesfield*, the Right Honourable the Lord *Charles Cavendish*, *John Hadley*, Esq; *William Jones*, Esq; *Peter Daval*, Esq, and *Cromwell Mortimer*, M. D. one of the Secretaries; and at *Guild-hall*, *Founders-hall*, and the *Tower*, on the *Wednesday* following, the 27th of the same Month, in the Presence of all the same Persons, Mr. *Daval* only excepted, who happened to be otherwise engaged that Day. All which Gentlemen were received with the greatest Civility and Regard, by the several Officers who have the Care and Keeping of the respective Standards in Question; who most readily favoured them with the free Use and Inspection of the same; and several of which were themselves also pleased to attend the Examination.

And, as the COUNCIL of the SOCIETY have now thought fit to direct an Account to be here published of these Trials and Experiments: We shall first, for Order-sake, begin with the *Measure* of the *Yard*; and then

then proceed to what concerns the several Weights of the *Troy* and *Averdupois Pounds*.

The Standards of Length now used in the *Exchequer*, are Two squared Rods of Brass, of the Breadth and Thickness of about half an Inch; the one called the *Yard*, and the other the *Ell*. The Ends of neither are exactly flat and parallel, or, if they were so once, they have since suffered some Bruise or Damage, and that possibly by the impressing near each End the Seal of a crowned *E.*; by which it appears, they were placed here during the Reign of Queen *Elizabeth*, and, probably, at the same time when the several Standard-weights, hereafter mentioned, were lodged here also.

To these Rods there belongs a substantial Brass Bar, of about the Length of 49 Inches, the Breadth of an Inch and a half, and the Thickness of an Inch: On one Edge of this Bar is a hollow Bed or Matrix, fitted to receive the square Rod of a *Yard*; and on another, a like Bed fitted to receive that of an *Ell*: And into these Beds they usually fit the *Yard* and *Ell* Measures brought to be examined and sealed at this *Office*. The square *Yard* and *Ell* Rods fit sufficiently well into these respective Beds, so as neither to rub or shake very sensibly; yet, as neither the Ends of the Rods, or of the hollow Beds, are accurately flat and parallel, the greatest Lengths of those Beds must, of necessity, be somewhat greater than the greatest Lengths of the Rods intended to be placed in them: By which greatest Lengths of those Rods, and which were looked upon by all the Gentlemen present, as the real and proper Lengths of those Rods, are meant the Distances of Two parallel Planes or Checks, so placed

placed as to touch the Rods respectively at both Ends.

Besides all which, there also remains in this Office an old Eight-sided Rod of Braſs, of the Thickneſs of about half an *Inch*, very coarſely made, and as rudely divided, into *Three Feet*, and One of thoſe *Feet*, into 12 *Inches*. This is marked near each End with an old *Engliſh* H crowned; and is ſuppoſed to have been the old Standard of a *Yard*, lodged there in the Time of King *Henry* the Seventh, and uſed as ſuch, till the other above-mentioned, and now accounted the Standard, was made to ſupply its Place.

Now, as the *Yard* is from very old time mentioned in our Acts of Parliament, as containing *Three Feet*, or 36 *Inches*; and the *Ell* is not therein particularly deſcribed, though univerſally reputed equal to *one Yard and a Quarter*, or to 45 *Inches*; we ſhall in the following Compariſon ſuppoſe, that the Length of the ſquare Braſs *Yard Rod*, here kept, and marked with a crowned *E*. by that Length meaning, as above, its greateſt Length between Two parallel Planes, to be the true and genuine Length of the *Engliſh Yard*, or of *Three Engliſh Feet*: And with that Length we ſhall compare the others here mentioned, expreſſing how much they reſpectively exceed, or fall ſhort of, this ſuppoſed Standard Meaſure.

To examine all which, Mr. *Graham* was provided with very exact and curious Beam-Compaſſes of different Sorts, and adapted to the ſeveral Purpoſes they were to be uſed for. One of theſe was by parallel Cheeks intended for the taking the Lengths of the Standard Rods above-mentioned to be kept in the *Exchequer*: Another was by rounded Ends, one of

B b b b

which

which was moveable, designed to take the Lengths of such Standards as consist of hollow Beds or Matrices, like those already spoken of at the *Exchequer*, and the others, to be presently mentioned, at *Guild-hall*: And a Third Beam-Compass was fitted in the common way, with nine Points, for the taking off, or laying down, such Measures as are marked out by the Distance of Points or Lines, on any plane flat Superficies. All which Compasses were severally so contrived, as to be lengthened by the turning of a fine Screw, one of whose Revolutions answered accurately to the 40th Part of an *Inch*, and to which there was applied an Index, shewing, on a small circular Plate with 20 Divisions, the broken Part of a Revolution; and whereon the Place of the Index might, by the Eye, be estimated to about the 10th Part of a Division; whereby the Motion of the moveable Cheek, End, or Point, might consequently be judged of, to about the 8000th Part of an *Inch*.

But Mr. *Graham*, when he determined by these Instruments the following Particulars, desired it might be observed, that although the Alterations of the Compasses were sensible to so small a Quantity; it was not to be supposed the Measures here taken with them, could be estimated to the same Exactness. The Hand cannot judge with so much Nicety, of the Shake of a Rod, when applied between the Cheeks, or when let into one of the hollow Beds or Matrices above-mentioned: Neither can the Eye, though assisted with a Magnifying-glass, pretend to see, with that Accuracy, the Place of the Compass-points, when applied to the taking off a Measure, set out by Points or Lines, on the plane Surface of a Rod or Rule.

Rule. All he therefore thinks possible, and that he has found he could several times together, under the same or like Circumstances, be consistent in, is to take such Measures to about the 1600th Part of an Inch.

We shall, however, in what follows, give those Measures as they actually did come out, in Revolutions, Divisions, and Tenths: All which are also, for the Convenience of the Reader, in a second Column, reduced to the common *Decimals* of an *Inch*; and, in a Third, to the *Vulgar Fractions* of the same.

It may further be noted, that the absolute Quantity of all Measures, any ways inscribed on Standards of Metal, must, from the Nature of Things, vary with the Alterations in the Heat or Coldness of the Weather; and, for that Reason, the exact Proportion between any Two Standards, taken at different times, cannot be expected to be found the same to the most perfect Degree of Exactness, unless the Temperature of the Air shall at those different times have been the same, or that a proper Allowance has been made for the Alteration of it. Yet, in the present Case, as all the several Measures referred to, are inscribed on the same Metal, Brass, as none of the Differences we are concerned about are very great, and as the Change of the Weather was not very considerable between the Days of Trial; it has been thought this last Consideration might safely be neglected, in setting down the following Particulars. Which are, that

The greatest Length of the
 Matrix of the *Yard Measure*, at the *Exchequer*,
 exceeded the square
Standard Yard by - .

$$\left. \begin{array}{l} \text{Rev. Div.} \\ 0 : 8,2 = .0102 = \frac{1}{97.56} \end{array} \right\}$$

The *Yard* inscribed on
the *Royal Society's*
Rod, exceeded the
same by . . .

$$\left. \begin{array}{l} \text{Rev. Div.} \\ 0 : 6,0 = .0075 = \frac{1}{133.3} \end{array} \right\}$$

The old Brass Standard
at the *Exchequer*,
marked with the
crowned *D*, fell short
of the same by . .

$$\left. \begin{array}{l} 0 : 5,7 = .0071 = \frac{1}{140.3} \end{array} \right\}$$

The Standard *Ell Rod*,
at the *Exchequer*, ex-
ceeded 45 *Inches*, of
such as the Standard
Yard contains 36, by

$$\left. \begin{array}{l} 1 : 19,5 = .0494 = \frac{1}{20.25} \end{array} \right\}$$

At *Guildhall*, the Standards of long Measure there used, are only Two Beds, or Matrices, the one of a *Yard*, and the other of an *Ell*, cut out of Two of the Edges of a substantial Brass Bar, much like that at the *Exchequer*, but not altogether so thick; which Bar is sealed with the *Exchequer Seal*, and marked at both Ends with *C. R.* crowned; and also, as it seems, with *W. M.* crowned in like manner. But there are here no Rods fitted to these Beds; so that all that seemed requisite and proper to be done, was to take both the greatest Lengths of these Beds, and also the least Lengths of the same; the last being nearly the Lengths of such square Rods as might be so fitted into the Beds, as to go in every way close, and without sensibly shaking: And, upon taking the said Measures, it appeared, that

The greatest Length of the *Yard Bed*, at *Guildhall*, exceeded the Standard *Yard*, at the *Exchequer*, by . . . } Rev. Div.
 $1 : 14,7 = .0434 = \frac{1}{23.04}$

The least Length of the same *Bed*, exceeded the said Standard of a *Yard* by }
 $1 : 11,7 = .0396 = \frac{1}{25.2}$

The greatest Length of the *Ell Bed*, at *Guildhall*, exceeded 45 *Exchequer* Standard *Inches* by }
 $1 : 15,5 = .0444 = \frac{1}{22.5}$

The least Length of the same *Bed* exceeded the same Number of like *Inches* by . . . }
 $1 : 0,7 = .0258 = \frac{1}{38.6}$

The Standard of a *Yard*, in the *Tower of London*, belongs to his MAJESTY'S *Office of Ordnance*, and is kept in the *Drawing Room* there: It is a solid Brass Rod, about Seven-tenths of an *Inch* Square, and about 41 *Inches* long; on one Side of which is laid off the Measure of a *Yard*, divided into *Three Feet*, and each *Foot* into 12 *Inches*: The First *Foot* has the *Inches* divided into Tenths, the Second into Twelfths, and the Third into Eighths of an *Inch*, and the First *Inch* of all is divided into a Hundred Parts, by diagonal Lines. This Rod is said to have been provided by the late Mr. *Rowley*; it is sealed with the *Exchequer* Seal, and Two other Seals of G. R. crowned, near one of the Ends, together with his MAJESTY'S Mark commonly called the *Broad Arrow*. And the

the Length of the *Yard*, or of the *Three Feet* inscribed upon it, exceed the foremen-
 tioned *Exchequer Standard* } ^{Rev. Div.}
 of a *Yard* by } $0 : 8,9 = .0111 = \frac{1}{90}$

The *Standard Yard*, belonging to the *Clockmaker's Company*, was delivered to them from the *Exchequer*, by Indenture, the 4th of *September*, 23 *Car. II. A. D.* 1671. It is a *Brass Rod* of Eight Sides, near half an *Inch* in Thickness, scaled with the *Exchequer Seal*, and *C. R.* crowned, near each End; and whereon the Length of the *Yard* is expressed, by the Distance between Two upright Pins, or small Checks, filed away to their due Quantity: This was procured by *Mr. Graham*, to be brought to the *President's House* of the *ROYAL SOCIETY*, on *Saturday* the 7th of *May* last, where all the above-named *Company* then met, to collate their respective Notes of these several Trials, all which were found to agree with each other: At which last Meeting, *Mr. John Machin*, of *Gresham College*, the other Secretary of the *SOCIETY*, was present also: And the Length of this last *Yard Measure* was then tried, and found to fall short of the *Exchequer Standard Yard Measure*,

now very carefully added } ^{Rev. Div.}
 on the Middle Line of } $0 : 16,8 = .021 = \frac{1}{47.62}$
 the *ROYAL SOCIETY'S* }
Brass Rod, }

Now, as to the *Weights*, those in the *Chamberlain's Office* in his *MAJESTY'S Exchequer*, and which are esteemed the *Standards*, are a *Pile*, or *Box*, of hollow *Brass Troy Weights*, from *CCLVI Ounces* downwards, to the 16th Part of one *Ounce*, all severally marked with a crowned *E.*: But they have no *Penny-*

Penny-weights, or *Grain Weights*, that are any ways esteemed or looked upon as Standards.

The Weight mentioned in all our old Acts of Parliament, from the Time of King *Edward* the First, is universally allowed to be the *Troy Weight*, whose *Pound* consisted of Twelve *Ounces*, each of which contained Twenty *Penny-weights*: And as the Pound is the Weight of the largest single Denomination commonly mentioned in those Acts, Twelve *Ounces* taken from the Pile of *Troy Weights* above-mentioned, as there is no single *Troy Pound Weight*, must now be reputed the true Standard of the *Troy Pound*, used at this Day in *England*.

Besides which *Troy Standards*, there are also kept in the *Exchequer* the following Standards for *Averdupois Weights*: That is to say, a *Fourteen Pound Bell Weight* of Brass, marked with a crowned *E.* and inscribed

XIII. POUND AVERDEPOIS.
ELIZABETH. REGINA.

1582.

as also a *Seven Pound*, a *Four Pound*, a *Two Pound*, and a single *Pound*, like *Averdupois Bell-Weights*, and severally marked as follows, excepting the Variations for the Number of *Pounds* in each respective Weight.

VII. A.

AN^o  D^o

E. L.

1588.

A^o REG. XXX.

With which are also kept a Pile of flat *Averdupois Weights*, from 14 *Pounds* down to the 64th Part of a *Pound*.

When

When the *Averdupois* Weight came first to be looked upon as a lawful Weight, does not appear; but by these Standards it is plain, it has been used as such, ever since the Reign of Queen *Elizabeth*. And as the Weight of 15 *Pounds Averdupois*, has before been made use of, in determining the Proportion between the Weight of this *Pound* and that of the *Pound Troy*, we shall begin by giving the Counterpoise of the said 15 *Pound Averdupois*, as it was found in *Troy* Weight: From whence we shall deduce the Proportions of those *Pounds*, and afterwards compare the same with the like Proportions, deduced from the *Seven Pounds*, and single *Pound Bell-Weights*, and the single *Pound* flat Weight above-mentioned: All which Weights were taken in the Presence of the above-named Noblemen and Gentlemen, by Mr. *Samuel Read*, Scale and Weight-maker near *Aldersgate*, who brought to the *Exchequer* a large Balance of his own for that Purpose, and which, when loaded with 15 *Pounds* at each End, was very readily turned with Six *Grains*; as a lesser one he brought also for examining the single *Pound* Weights, was with half a *Grain*. He also brought with him what he called his own Standard *Penny* and *Grain* Weights, to supply what was necessary to make the Counterpoise of the *Exchequer* Weights: With all which the Result was, that

The Standard 14 *Pound*, and single *Pound Averdupois* Weights, taken together, were, upon a Medium of Four Trials, after counterchanging the Weights in each *Bason*, changing the *Basons*, and then again counterchanging the Weights, found to be counterpoised by 218 *Troy Ounces*, 13 *Penny-weight*,

weight, 23 *Grains* and One-fourth. From whence the *Averdupois Pound* is deduced equal to 6998.35 of such *Grains* as the *Troy Ounce* is reputed to contain 480 of; and the *Averdupois Ounce*, of which 16 are supposed to make a *Pound*, is found equal to 437.4 like *Grains*.

Again: The *Seven Pound Bell Averdupois Weight*, with the same Scales, and upon a Medium of Four like Experiments, counterchanging, as before, both *Weights* and *Basons*, was found to be counterpoised by 102 *Troy Ounces* One *Penny-weight*, and 21 *Grains*. According to which, the *Averdupois Pound* comes out equal to 7000.7, and the *Ounce* to 437.54 *Troy Grains*.

Again: The single *Bell Averdupois Pound*, with the lesser Scales, on the Medium of Two Experiments, counterchanging the *Weights*, the *Basons* not being moveable, was found to weigh 14 *Troy Ounces* 11 *Penny-weight* and 18 *Grains*; or was equal in *Weight* to 7002, and the *Ounce* to 437.62 *Troy Grains*.

The single *Averdupois Bell Pound*, against the flat *Averdupois Pound Weight*, was found, on a Medium of Two like Experiments, to be heavier by Two *Troy Grains* and a half: Whence the flat *Averdupois* single *Pound Weight* weighs only 6999.5, and the *Ounce* 437.46 *Troy Grains*.

The ROYAL SOCIETY'S *Averdupois Pound* was, in like manner, found to be lighter than the *Exchequer* single *Bell Pound Weight*, by One *Grain*.

And their *Troy Pound Weight* to be lighter than the Eight and Four *Ounce Troy Weights* at the *Exchequer*, taken together, by half a *Grain*.

The *Founders Company* of *London* are; by their Charter from King *James* the First, authorized and directed to have the sizing and marking of all manner of *Brass Weights*, to be made or wrought, or to be uttered, or kept for Sale, within the *City of London*, or *Three Miles* from the same. And the *Weights* delivered to them from his *MAJESTY'S Exchequer*, and now kept in their Hall, as their Standards for the Uses above-mentioned; are a Pile of flat *Brass Troy Weights*, from *CCLVI Ounces*, down to the 16th Part of an *Ounce*, all sealed with the *Exchequer Seal*, and marked with *C. R.* crowned 1684. and a Stamp of the initial Letters of the Maker's Name: As also a Set of Bell *Brass Averdupois Weights*, sealed and marked in like manner. And here the following Trials were made, before the above-named Gentlemen, by Mr. *Read*, but with a large Balance, commonly used for Trials at the Hall, in their Office for that Purpose; and found to turn with about the same Weight as the former; and also with a lesser one, turning in like manner under these Circumstances, with about half a *Grain*, which Balance belonged likewise to the Hall, as did also the *Penny* and *Grain Weights* made use of, but which were not kept by them as Standard Weights.

And here it was found, that, on a Medium of Four Trials, made in like manner as before, at the *Exchequer*, that 15 *Pounds Averdupois*, being their 14 *Pounds*, and single *Pound Standard Weights*, were counterpoised by 218 *Troy Ounces*, 15 *Penny-weight* and 23 *Grains*: Whence the *Averdupois Pound* is deduced equal to 7001.53, and the *Ounce* to 437.59 *Troy Grains*.

Again:

Again: The single *Averdupois* Standard Pound weighed, on a Medium of Two Experiments, counterchanging the Weights, as before, 14 *Troy Ounces*, 11 *Penny-weight*, $16\frac{1}{2}$ *Grains*: Or was equal to 7000.5, and the *Ounce* to 437.53 *Troy Grains*.

Again: This Standard *Averdupois* Pound, at a Medium as before, outweighed the ROYAL SOCIETY'S *Averdupois* Pound, by Two *Grains* and One-eighth: And the *Troy* Standards of Eight and Four *Ounces*, taken together, outweighed the ROYAL SOCIETY'S single *Troy* Pound Weight, by Two *Grains* and One-eighth, at a like Medium.

At his MAJESTY'S *Mint* in the *Tower of London*, their Standard Weights are only a Pile of *Troy* hollow Weights, from CCLVI *Ounces*, down to the 16th Part of One *Ounce*, without any *Penny* or *Grain* Weights. The larger of these Weights, as low as the VIII *Ounce-weight*, are marked with *A. R.* crowned, and inscribed PRIMO MAII, A° DNI. 1707. A° REGNI VI°. The III and the II *Ounce* Weights are only marked with *A. R.* crowned, without the Date; and the lesser have only the *Exchequer* Seal, and the *Rose* and *Crown*, being the Mark of his MAJESTY'S *Mint*, as all the larger ones have also. And here it was found by Mr. *Joseph Harris*, one of the *Affay-Masters* of the *Mint*, with a very curious Balance of his own, fixed in a *Glass* Lantern, and which he was well assured might in such Circumstances be depended upon to less than half a *Grain*; and with the Addition of so many *Penny* and *Grain* Weights belonging to his Office as were necessary: that

The ROYAL SOCIETY'S whole *Troy Pound Weight* weighed, at a Medium, less than the *Eight Ounces* and *Four Ounces* of these Standards, taken together, by *Two Grains* and *Three-eighths*.

That the ROYAL SOCIETY'S *Averdupois Pound* weighed in *Troy Weight* by these Standards, *14 Ounces 11 Penny Weight 16 Grains* and *Seven-eighths*; or *7000.87 Grains*.

That the ROYAL SOCIETY'S *Pile of 16 Ounces Troy*, was lighter than *16 Ounces* of these Standard Weights, by *Four Grains* and *Three-fourths*.

And lastly, That the ROYAL SOCIETY'S *Eight Ounces* and *Four Ounces* together, taken from their *Pile*, weighed lighter than their single *Troy Pound Weight*, by *Five-eighths* of a *Grain*.

X. *The Description of an Instrument for reducing a dislocated Shoulder; invented by Mr. John Freke, Surgeon of St. Bartholomew's Hospital, and F. R. S.*

GENTLEMEN,

Read June
23. 1743.

I Should not have presented this to you, but to shew in how small a Compass the whole Power which can be made use of in reducing a dislocated Shoulder can be contracted. If therefore a Machine for this Purpose be not portable, it matters but little to an afflicted Patient Ten Miles off, how good an Instrument is out of his Reach.

This