An inquiry into the English system of weights and measures / by J.H. Alexander.

AN INQUIRY

INTO THE

ENGLISH SYSTEM OF WEIGHTS AND MEASURES.

BY

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ADVERTISEMENT.

The following pages, with the exception of the first paragraph and the last, are a reprint from a Report made more than ten years ago, upon the construction of certain standards for distribution among the counties of Maryland, one of the United States of America.

The original edition is thus referred to for the purpose of explaining certain peculiarities of expression,—such, for instance, as the use of the first person,—which were proper in an official document, but would not be so becoming in an essay for the general reader.

And the matter itself is republished now, as opportune in a period when a strong call is about being made for a decimalization of English Weights and Measures; which, however desirable in itself, ought certainly to be preceded by an historical solution of the origin and development of the existing system.

To such a solution, what follows is offered as a contribution. And the particulars relating to the adoption of the English Weights and Measures by the United States have been included with the view of giving information that is not without significance, but which seems to have been hitherto but slightly availed of in Great Britain.

Oxford,
Nov. 1857.

Ye shall do no unrighteousness—
in mete-yard, in weight or in measure.

LEVIT. xix. 35.

INQUIRY.

THE Weights and Measures now used in Great Britain are the growth or the remains of a system or systems belonging to a time far earlier than the present. Under the first of these phases are supposed to be comprehended the successive variations and modifications which the legalized standards have undergone; while the other aspect is presumed to include all those irregular or discordant measures which occur and are clung to in divers localities, where the habits or chances of a former commerce first introduced them. The examination of this last class is of little practical importance; since, indeed, all the variety it displays is capable of being swept away within the period of one generation, by a judicious dissemination of proper and authenticated standards. But as these very standards, to be suitably authenticated, must have their genealogy, it becomes of high interest to inquire into the affiliations and relationships which have at several times occurred in what may be called the English System. To this Inquiry, then, what follows is devoted; in the aim of making the apparent complexity of that system, its organizations and disorganizations, its accidents and caprices, historically soluble and tolerably intelligible.

For this purpose, I shall not ascend to those remote

times when the footsteps of man begin to lose themselves in the forest of antiquity; I shall not inquire into the primitive origin of all weights and measures, nor examine if the type of ours was cut in a Saracenic, Roman, Greek, or, more Oriental still, Egyptian font—all of which hypotheses have agitated the learned: I excused myself, in the outset, from such discussions. I shall trace the matter no farther, then, than to the first semi-civilized or (as it may be called, under another aspect,) *classical* occupation of Britain.

Exactly nineteen hundred years ago, the Romans made their first entry upon this island. They carried with them at that moment, indeed, only the weapons of war; but a long provincialism, through nearly five centuries, nourished afterwards the arts of peace. The walls of Antonine and Severus, whose traces still remain, and whose name at least will be perpetuated as long as the northern English coal-mines last, attest with what zeal protection was extended to citizens, some of whom had emigrated from Rome itself; and the number of Roman coins, dug up continually at many of the old legionary stations, shew the great degree to which, soon after the invasion, money and its dependent system of weights and measures had been introduced to, and accepted by, the Celtic aborigines.

This acceptation was so generally expanded, as to have influenced the ratio of combination and, in a degree, the nomenclature of the English system of measures to this day. For instance, the Roman foot contained, according to the various remaining proofs of its length, from 11.604 to 11.846 English inches; and the Roman *uncia*, or inch,

(of which, as with us, twelve made the foot) was thence 0.9670 to 0.9855 of our inch. In the application of linear to itinerary measures, it is from them that we borrow the proportion of 5 feet to constitute a *pace*—the length of a double step, or from foot-print to foot-print on the same side; and as with them 8 *stadia*, so with us 8 *furlongs*, make a mile. So in agrarian measures, the Roman *actus*, which lineally was (says Pliny) as far as ploughing "oxen are driven in one straight furrow," and thus corresponds in terms with the English furlong (literally, one *furrow long*) became, when squared, their unitary acre,—equal in content to nearly one and a quarter English roods. It is true that their *jugerum*, which we undertake to translate as *acre*, contained two such square *actus*; but the term implied a yoke of oxen, and the thing was as much as two oxen could, on an average, plough in a day: so that in fact, the *actus* or rood may be regarded, as I have said, to be their true unitary acre—the equivalent of the day's labour of an ox. And just as their habitual acre was an oblong, one of whose sides was the length of a furrow, our acre at this day is an oblong too, and one side a furlong.

Farther, the Romans made the distinction between their nummulary and their commercial, or, in their own terms, the *scale* and the *metrical* pounds; and we have now a troy and an avoirdupois—our mint and our market weight. The index, if not the unit, of this system of weights and of capacity-measures connected with them, was in Italy the weight of the silver denarius at 84 to the pound; and the similar unit was in England, thirteen centuries later, the weight of the

penny sterling, the $\frac{1}{240}$ part of the silver pound. It was upon the multiplication of the money-weight that the system of capacity-measures depended. The measurement and adjustment of volumes being exceedingly difficult, and the mechanical construction of a perfect cube or a perfect cylinder being, even now, next to impossible, the Romans (as the Greeks had found necessary to do before them) regulated the size of these measures by the equivalent weight of their contents in those articles —wine and wheat—which formed the staples of their trade. The Greek equivalents were oil and wheat.

The unit of the Roman liquid capacity-measures, the *congius*, was understood by the Silian rescript or *plebiscitum*, two hundred years before the invasion of Britain, to be such a vessel as would contain 10 nummulary or mint pounds of wine; and its size was recognised, not long afterwards, to be the eighth part of a cubic foot. It is from the weight of a remaining *congius* yet preserved at Rome, and undoubtedly of great antiquity, (though hardly, as its inscription claims for it, a standard of the Emperor Vespasian, by whose name it is generally known,) that the longest estimate of the Roman foot in English inches, which I gave just now, has been derived; upon the assumption, that the wine would be of the same specific gravity as distilled water, and upon the most recent determinations of the weight of the last-named liquid. Should we take, what is most proper, the weight of the wine to have been less than that of the water, and assign to it the mean specific gravity of the European lighter wines, equivalent to (say) 250 Troy grains per cubic inch, this *congius* of Vespasian,

assumed to be perfectly authentic and accurate, would accuse a length for the Roman foot of 11.885 English inches.

On the other hand, the unit of the English liquid capacity-measures was likewise a vessel containing 8 commercial or market pounds of *wine*, (although England never was a vine-growing country, as Italy and Gaul were, and wine was an article of commerce only by import); and its actual size may be inferred, from other proofs, to have been at that time also the eighth part of a cubic foot. The difference in the recital of the weights in the two cases, 10 pounds in the one and 8 pounds in the other, in fact establishes the identity of their proportions (not dimensions), and the origin of the latter. The Roman *congius* was to contain 10 mint pounds of 12 ounces, or 120 ounces; the English gallon was to contain 8 market pounds of 15 ounces, or 120 ounces too: the ounce being, in the respective nummulary and commercial accounts, the same with each.

From these liquid measures, the transition was made proportionately, as it is with us, to the measure of things dry. But on this point, as the Roman writers have not been perfectly explicit, and the English not entirely clear, I may be allowed to enter somewhat upon the details involving the question of the relative values of the commercial and the mint pound; whose distinction, had it been treated of in connection with weights proper, could not have been so well understood as now. This exposition will, besides, help when I come to speak of the early English system.

The Silian rescript before mentioned, (it was in fact a proposition emanating from two tribunes of that family, and accepted in a popular meeting, which sort of laws were termed *plebiscita,*) after saying that the *quadrantal* should be of 80 pounds (*pondo*) of wine and the *congius* 10 pounds (*pondo*) of wine, goes on to say, that the *quadrantal* should be 48 *sextarii;* that the *sextarius* [of wine] should be equal with the *sextarius* of dry-measure (*æquus cum aridorum sextario*); and that the *modius,* which was the unit of dry measures, should be sixteen pounds (*libræ.*)

The use of these two terms for weight shew that they did not both signify the same thing; and the etymology of the terms themselves, even without the collateral testimony by which it is supported, points to the proper application of each. The first (*pondo*) means, originally and simply, *weight;* it was the metallic weight, which, from its permanence and portability, would be very early employed, and especially in the case of counterpoising metal out of which money was to be made. It was therefore both the money-weight and, in fact, money itself. But *libra,* which originally signified the implement used in counterpoising, (peculiarly, among the Romans, an apparatus like our steel-yard; and when the suspension was made in the middle of the bar, so as to require two dishes of equal weight, thence called specifically a *balance*—in Latin, *bilanx,*) when employed to denote a weight, signified the unit of weight employed for demotic and commercial purposes—the *metrical* weight, as Galen calls it; by which, account would be taken of the respective measures of equiponderant

quantities of the two most important staples of their commerce[a].

In accordance with these inferences, the Silian law establishes for wine, one of those staples, the equivalent of a certain measure of it in money-pounds; and for the other, wheat, a definite weight in market-pounds. According to the mode of its translation, it helps us to determine the accepted proportions of these two pounds, respectively.

The rescript says, in terms, that the *sextarius* (a measure very nearly our pint) of wine should be equal with the *sextarius* of dry things. Now this equality may be affirmed in either of three constructions: 1°. the two objects may be identical in *size;* or 2°. they may be identical in *weight;* or 3°. they may be proportionately equal, in *weight and size* combined.

The first of these constructions is that which has most usually been understood by the English writers on this subject; it is that taken by Arbuthnot, for instance, the convenience and ingenuity of whose tables have procured for his estimates a currency which the Dissertations, appended in editions after the first, would hardly have obtained. There are plausible reasons for its having been adopted; viz., 1°. the dimensions of this fractional part of the unit are immaterial to the system,

[a] It is true that at a later period, this name *libra* came to be applied to the money-pound of 12 oz.; the other, *pondo*, went into disuse; and the word *mina* was employed to express the commercial pound: but as the object here is to expose the principles, not the details of the system, it will be proper to continue the nomenclature accepted in the law. This note will be sufficient to warn the classical reader against any mistake.

inasmuch as the unit itself is determined by its weight; and whether the *sextarius* was absolutely large or small, the ultimate equation would be had, by making a smaller or larger number to constitute the unit; and 2°. its dimensions would be immaterial in practice, inasmuch as articles sold by the bushel are rarely, if ever, reckoned by the quart, and still less likely to have been reckoned by the pint, which was about the actual size of the *sextarius* in question. Now we know from accidental authorities, not so old, to be sure, as the Silian law, but not a great deal younger, that an equation as above mentioned was in fact obtained; for counted by measure, the *modius*, which was to weigh 16 *libræ*, contained 16 sextaries; a number that is not aliquot with any integral multiple of the sextaries in wine-measure. To make it thus aliquot, it would have to be reduced in the proportion of 16 to 12, or of 4 to 3, which is not far from the relative specific gravities of wine and wheat in the growth of Italy. This, therefore, gives us the value of the *libra*, or wheat-pound, compared with the money-pound, as 16 to 12; and the ounces being taken as the same in both, while the money-pound contained 12 ounces, the commercial pound contained 16 ounces. This 16-ounce pound we know, from numerous testimonies, to have been current under the Roman republic, as it had been earlier in Attica, and earlier still in Egypt: and a similarly divided weight is current with us to this day, under the name of the avoirdupois pound. Farther, 16 *libræ* of 16 ounces each make up 256 ounces; and 256.5 ounces are precisely the mean of the weights of a *modius* of Egyptian and Greek wheat, in the time of Pliny the Elder.

The second possible construction is that the liquid and dry sextaries should be identical in *weight*. In this regard, both the name of the thing and the rescript of the Silii imply that the liquid *sextarius* weighed the sixth part of 10 money-pounds, *i. e.* $1\frac{2}{3}$ pounds, equivalent to 20 ounces; and hence the dry *sextarius*, and its equiponderant the *libra*, must weigh 20 ounces too. It may be remarked that this also is not far from a recognised wheat-weight: for the *modius*, under this construction, would contain 320 ounces; and the wheat of Clusium, in Etruria, is stated by Pliny in his time to give 312 ounces to the *modius*. Nor is this 20-ounce pound unmentioned by ancient authorities. One of them, Epiphanius of Salamis, (who wrote in the fourth century of our era, but whose writings contain quotations of a much older date,) expressly calls it *mina Italica*—the Italian pound. It is true that an older writer, the physician Dioscorides, bestows this name upon a pound which he says is of 18 ounces; and in so far agrees with the weight that Pliny gives for the wheat raised beyond the Po (Italiâ Transpadanâ), or in what is now called Venetian Lombardy. For he states such wheat (and, as I should infer from his phrase, at a maximum) to weigh, per *modius*, 25 money-pounds, equal to 300 ounces: now 16 pounds of 18 ounces would produce 288 ounces; and if we suppose his statement to have been a maximum, and place the average at (say) 24 pounds, we would have exactly the 288 ounces for the *modius*.

I should not have been so diffuse upon this point, had it not been for the sake of illustrating how many technicalities and modes of account in commerce, arbitrary as they may at first sight appear, have grown out of the

old distinction of wine and wheat weights, combined with the varying weight of wheat in the different countries where such modes of account originated. For instance, in the old Roman times, the long hundredweight was of 125 pounds—almost exactly in proportion to the nett hundred, as the specific gravity of wine is to that of wheat; and, taking the first commercial pound of 16 ounces as the unit of nett weight, in the proportion of the Italian pound just mentioned of 20 ounces. An old English long hundred-weight was of 108lb. for wax, sugar, and some other commodities: but it is stated at the same time that the said pound was of 25 shillings, while the pound for money and medicine was of 20 shillings. The ratio of these pounds is as 12 ounces to 15 ounces, or very nearly as the weights, in Gascony, of wheat and wine; but the nett medicine-hundred and the gross sugar-hundred are in the proportion of 12 ounces to 16 ounces, and indicate therefore the introduction of the Roman avoirdupois pound. Finally, our present long hundred and long ton are in the ratio of 18 ounces to 16 ounces, or that of the weight of Lombardy wheat to the ordinary commercial pound.

Some of the English writers on Weights and Money suppose the origin of these long hundreds to have been in what may be termed the *customs-pound;* by which 12½ or even 20 per cent. was allowed to the merchants for wear and loss: and which allowance, within those limits, might vary according to the more or less perishable nature of the commodity, and the wants of the sovereign or government taking the customs. They paid duties, for instance, on the pound of 18 or 20 ounces, but sold by the pound of 16 ounces. This may

very well have been the historical fact; but what I may term the geometrical fact, viz. the principle of calculating the proportionate allowance and the value in ounces of the respective pounds, seems to me to repose very plainly upon the grounds I have indicated.

To return from this discussion. The third way of construing the Silian law is to suppose that, between the two measures of capacity, the framers of it intended a proportionate equality in *weight and measure combined.* And this seems to me the best founded. I do not deny that dissimilar practices, proceeding upon both of the other interpretations, and leading to the introduction of the various pounds which have been mentioned, may not have grown up even within two centuries from the enactment: but they originated in a misapprehension of the meaning of the law, just as we shall see presently from a similar misapprehension of a written law, accruing in a shorter time, arose the confusion which destroyed the old Saxon proportionate uniformity of standards.

This Silian rescript was no doubt the less lucid, because it aimed at being but the exposition of existing usages, which tradition had made familiar, and which habit had sealed, and would, it was expected, render permanent: but still its very phraseology leads to this last interpretation. The sentence in which the liquid and dry sextaries are mentioned in connection, is the only one where the words "equal with" are employed. Now equality is not identity. And if the statute had meant the two measures to be identical either in volume or in weight, it would have said that the liquid sextary

should be the dry one, or *vice versâ;* just as it says that the *quadrantal* of wine shall *be* eighty pounds, not shall *be equal with* eighty pounds; and again, that the *congius* shall be (not equal with, but) six sextaries.

This rule of interpretation corresponds with the genius of the languages, equally of the translation and of the original; and it is confirmed by considerations which belong exclusively to the syntax of the latter, and from which we are warranted, I think, in supplying the words for expressing the essential idea; to wit—that when a *sextarius* of wine was balanced with a *sextarius* of wheat, the arm of the balance should be *level,* which last word is the literal meaning of the Latin *æquus.* And this is what is meant in saying, that there should be a proportionate equality in weight and measure.

Now a *sextarius* of wine weighed, as has been already said, 20 ounces, allowance being made for the weight of the vessel; and a *sextarius* of wheat (struck) to weigh as much, and with the same tare, would have to be between one-third and one-fourth more capacious. But as wheat is not estimated in such small measures, it was not necessary in the law to refer to them any more than to indicate the principle of adjustment. It therefore ascended to a larger unit, substituting pounds for ounces in the computation; and, deriving that from an even multiple of the *congius,* fixed its ultimate value by *weight.* Thus, two liquid *congii* with wine would weigh 20 mint-pounds, and with wheat, 16 of the same pounds: this last number was taken up as the nominal unitary weight of the *modius;* and in order to retain for it the real weight of the *congius* also, from which it had been

derived, there was applied to it the metrical weight, or *libra*—computed to contain as many ounces (sixteen) as had been found of wheat in the liquid *sextarius*. The ascent, therefore, was made from the *sextarius*,—the transition from the *congius;* and the different pound-weight, which had thus become authenticated, was properly called the *metrical* pound, because it contained just the number of ounces that had been met with in the first step of the process. The Greeks, from whose language the phrase was originally borrowed, used it more appropriately in another connection. With them, it was a *measure* of a pound, not a *weight;* just as our apothecaries now have their fluid-ounce, which is in a literal sense a metrical ounce.

Had the contrivers of this system, neglecting the symmetry between the result with ounces and that with pounds, sought to establish an identity of proportion between the pounds themselves, the *libra* would of course have contained a smaller number of ounces, viz. fifteen; for the 20 mint-pounds of wine contained 240 ounces, and 16 market-pounds of wheat, at 15 ounces the pound, would contain 240 ounces too: but both the variation in absolute weight was abundantly justified in experiments upon the different growths of wheat to be found in the Roman market; and also the commercial pound-weight, although it would have been a *proportionate,* would have ceased to be a *metrical,* pound.

It was possibly an overlooking of this which induced the Roman settlers in Britain, or the Saxons afterwards, when they brought in a new pound, actually to adopt this proportion for the ounces. And they would have

been sustained in this misapprehension, had they resorted to experiment; for the wheat of Gaul, with which the agricultural depression consequent on a military occupation caused them to be principally supplied, weighed, according to Pliny, just 240 ounces (16 fifteen-ounce pounds) the *modius*. This was the lightest wheat of which the Romans knew; and would shew a specific gravity little less than what is accepted at this day.

It is very possible, too, that the fact of the Silian law, as we have seen since with some other laws, hastened the very contingency against which it was intended to provide. Attempting to ascertain and to tie down ideas to words, it did but increase the doubts; and gave rise to innovation, while the aim was only revival. Such an innovation we must consider to have occurred in the assignment, but a few centuries after, of the number of sextaries, (to wit, sixteen,) the aggregate of whose capacities went to make up the *modius*. This was an application of the principle, which the Romans accepted as we do, that other things being equal, the volumes are inversely as the weights; but it was a misapplication of the facts in the particular case. It followed the metrical proportion in terms, on the one hand; but on the other, it introduced a mode of determination for dry capacity-measures, which the law had not recognised, and which the framers of the law could not have adopted, unless they had believed all wheat, of whatever growth, to be of the same specific weight. It recommended itself, however, to general application at first by its correspondence in terms, though not in fact, with the proportions it meant to indicate, and thus by its ease of

remembrance; and it supported itself afterwards under question, by the result of experiments, within the variations that I have already mentioned.

I shall conclude this disquisition, which I hope will not be found too long for the interest of the subject, by presenting in one view the relations of the Roman weights and measures, as far as they admit of tolerable ascertainment, with those that appear some time after the Norman conquest to have been of legal acceptation in England:—

ENGLISH PROPORTION.			ROMAN PROPORTION.	
Foot . . .	1	:	0.9670	Pes; from the Cossutian monument.
Inch . . .	1	:	.	Uncia; in both systems the 1-12th of the foot.
Pace . . .	1	:	.	Passus; in both systems equal to 5 feet.
Mile . . .	1	:	0.9157	Milliare.
Rood . . .	1	:	1.2657	Actus; in both, multiples of a furlong.
Pound (Tower) .	1	:	0.9714	Pondo; Libra of 12 oz.
Ounce . . .	1	:	.	Uncia; in both the 1-12th of the pound.
Pound (Com'cial),	1	:	1.0361	Mina; of 16 oz.
Gallon (Wine) .	1	:	0.9042	Congius; in both the 1-8th of the cubic foot.
		:	0.9620	Congius; the so-called standard of Vespasian.
Gallon (Corn) .	1	:	0.9684	Semi-modius.

This table is sufficient to shew at a glance—what was affirmed a little while ago—the influence which the Roman system had upon the composition, and the denominations even, of the weights and measures accepted more than a thousand years afterwards in England. That it shews the introduction and permanence of the Roman units too, I do not see any necessity for admitting; although such would be claimed by some writers who see in our present avoirdupois pound, for instance, but the restoration of the old Roman weight.

Such acceptation of Roman units seems to me to receive little countenance in the history of the Saxons, both prior to and at the time of their settlements in Britain. Descended from those terrible Scythians and

their most illustrious tribe, the *Sacæ*,—who, as far back as the time of Herodotus, had crossed from Asia over the Dardanelles, or the Bosphorus, or both, and expelling the Cimmerian clans, had settled themselves in and around the Thracian Chersonese,—the "People of the Sword," (as their name implies,) were, at the time of the Roman invasion of Britain, spread north and west, along the course of the Danube and the waters of the Elbe; and occupied under a general name, then recently introduced, but equivalent in signification to the original one, a great part of that portion of Europe which we now call Germany. Finding again in a new Chersonese, and driving from it, their ancestral Cimbric foes, they learned on the shores of the North Sea the art of ships; and even without that famous periplus of the Frank colony of Probus, which served as a fresh stimulus to reap the harvest of the sea, four hundred years of successful piracy would have taught them all the approaches to Belgium, Gaul, and Britain.

About the close of this last period, the Roman Empire—now weakened by excessive extension, maintaining a more doubtful seat because of its already double throne at Rome and at Constantinople, and threatened in both—needed all the help that it had formerly spared for its remoter dependencies. Britain, depeopled even by the legionaries it had supplied, was abandoned by Honorius and the Romans at last and for ever; and the islanders exchanged the comparative security of a colonial existence for a precarious and troubled independence. Split up, perhaps at once, certainly before long, into many local governments, subject to the forays of the Gaelic

and Celtic tribes who had evaded the Roman yoke, and whom the unsentinelled wall of Severus now kept off no more, and menaced from time to time by these very Saxon sea-robbers, the head men of Britain proper, with plausible policy, employed one of these enemies against the other. How this employment was negotiated,—whether Hengist and Horsa were regularly invited over, or, cognizant of the state of affairs, preconcerted themselves to come, or accidentally at hand, were availed of by the ambition or timidity of Gwrtheyrn, (the poetic Vortigern,)—is for our view of no account: the first Saxons came with the prospect before them of a permanent settlement, the additions to their number were frequent, regular, and large; and it is probable, therefore, that along with their language and habits, their maces and swords, they brought their weights and measures.

This point, however, is neither worthy of being treated here with much diffuseness, nor susceptible of any definite conclusion. Within the eight centuries that elapse from the period I have just mentioned, to the time when we meet with a systematic establishment of this matter, the dissevered principalities — usually included under the generic appellation of *Saxon*, though not strictly so—were disturbed by Danish invasions and settlements; and all were ultimately absorbed under a Norman conqueror and his companions. The estimation of the influence proper to be ascribed to each of these events, and its consequences in the modification of weights and measures, demands a scope far more extended than the compass of this Report.

It is true, the constitutions of the Conqueror expressly

declare that no alteration shall be made, in this respect, from the establishment of his predecessors. But that establishment is hardly to be spoken of in the singular number, since his very laws also shew a want of uniformity between the West Saxon and Mercian computations; and we know, besides, that it was himself who abetted in England the then habitual continental computation of shillings and pence, assigning for both relative values quite different from what had been recognized under any of the Saxon customs. It is proper to add, however, that this innovation extended no farther than to the coins; and that the weights and other measures, for all that appears, remained, or at least were intended to remain, regulated by the Saxon standards.

To confine myself, therefore, within a due brevity, I shall treat these standards and their methods of combination under the general aspect of English weights and measures; without distinguishing otherwise than incidentally between what were actually of Saxon, Danish, or Norman origin and habit: and as this relieves from the diffuseness belonging to any chronological order of exposition, I shall condense everything that is to be said down to the present time under classes of Measures, similar to those which have been made in the former part of the Report.

1°. *Measures of Length.*

The name of the unit in this measure—the *yard*—which has subsisted to this day, forbids the supposition of a Roman origin. It means the *girth;* it was, most likely, the average circumference of the unclad chest of

the stalwart Saxon race. In taking such a derivation, they were altogether peculiar: the rest of the continent of Europe measured lineally by the *foot;* the older Asiatic unit was similarly a linear measure, the *cubit.* Both of these last standards were in harmony with the pursuits of the people who employed them; the one with the pastoral repose of the East, the other with the agricultural activity and peaceful thrift of the West. But the warlike Scythians may be supposed to have adopted one more connected with the violent muscular exertion for which they had daily call; they may have perpetuated it in the length of their characteristic swords. It is difficult otherwise to reconcile the name with the thing; although the subdivisions of it, or its computed value, no doubt were early reconciled with the habitual measures of the nations whose territories they occupied. But this early reconcilement must have been made with the *Greek* foot, if we trust anything upon the agreement of measures—not the Roman, from which the Saxon foot systematically varied. It was, however, from the fractional computation of this last, as was given just now in the comparative table, by twelfth parts, or *unciæ,* that the English denomination and proportion of the *inch* was borrowed. We are warranted, then, in concluding that the Saxon yard, when it was generally accepted in Britain, coincided with 3 Greek feet; and it was divided after the Roman account which had been used in the island for half a thousand years, into 36 inches, as at this day.

Such a conclusion may be still admitted, even if we attach credit to the tradition that places the determination of this standard in the time of Henry I.: that a

prince so provident should have revised the measures of his kingdom is quite probable; that one, whose proficiency in knowledge more than common won for him the name of *Beau-clerc*, should have employed proper means and principles, is still more so. There is no physiological impossibility in the coincidence between the old Saxon yard and the length of the monarch's arm, especially if in such arm-length is included, as it was elsewhere, half the diameter of the body; but, historically, the fact altogether is more than doubtful.

More than a century later, a coincidence of another kind, but in the same way, was noticed; and has come down to us in an existing law. The precise epoch of that law is uncertain; in some old editions of the Statutes it is referred to 33° Edward I., A.D. 1305; probably it expressed a much earlier tradition. It says "that

3 barley-corns,	dry and round,	make	the inch
12 inches	,,	,,	the foot
3 feet	,,	,,	the yard
5½ yards	,,	,,	the perch
and 40 perches in length and 4 in width			the acre."

It goes on to exhibit a table for Land-measure; and then, returning to linear measure, winds up by saying, "that the iron yard (*ulna ferrea*) of our lord the King contains 3 feet and no more; and the foot should contain 12 inches; that is, the inch be the 36th of the yard: and 5½ yards ought to make the perch; that is, 16½ feet, measured by the aforesaid iron yard of our lord the King." It is hence plain that the barley-corns, as the inches, were merely indications, not constituents, of the standard; which is expressly the "iron yard afore-

said," very likely dating up to the time of Henry Beauclerc.

Precisely the same indication had been made long before in Wales. In the Venedotian Code, (as it is called in the Ancient Institutions of Wales, one of the recent fruits of the Record Commission of Great Britain,) presumed to contain the laws of Howel Dda, the Welch Alfred, and to have been composed about A.D. 1080, the measures for the mile are given as follows:—

3 barley-corns	in 1 inch
3 inches	in 1 palm-breadth
3 palm-breadths	in 1 foot
3 feet	in 1 pace
3 paces	in 1 leap
3 leaps	in 1 land
1,000 lands	in 1 mile."

The uniform triplicity in this system, up to the land, reminds the student in the Cymraeg archæology of the triads; by which the Welch bards associated in their songs ideas having, or supposed to have, (for the connection is often highly fanciful,) some resemblance or affinity. One of the Codes, even, in the work I have mentioned, is made up of such triad proverbs. No doubt its exemplification, wherever it occurs, had some common origin.

Thirty years before the date of the English statute just now given, the principality of South Britain had been annexed to the crown of England; and Edward of Caernarvon first wore the title of Prince of Wales. The law, therefore, applied in that district; where, either aboriginally or from Saxon proximity, there was an habitual

measure used in fact as the unit of land-measure, which accorded with the English standard. This appears from another passage in the code of Howel the Good, relating to the *erw,* or acre. After carrying on the same multiples from the barley-corns to the foot, this passage recites, that "4 feet are in 1 short yoke." Now 4 feet of 9 inches are 36 inches; just the length of the English yard. I shall not stop to shew how this short yoke may be averred to be in fact the unit of length; but recurring to what I first said, that the subdivisions of inches and barley-corns at least were but coincidences, not constituents, I shall make but one more reference to these Welch laws in illustration. It is the part of the same Venedotian code, prescribing the capacity-measure in which a cow, affirmed by the buyer to have been imposed upon him as a milch-cow, is to be milked: after giving four dimensions of the vessel with great particularity in inches, it winds up by saying that "the inch is the breadth of the judge's thumb."

I have rendered the original word (*ulna*) in the so-called statute of Edward I., unhesitatingly by our word *yard;* because they were both composed of 36 inches. And I presume that the same thing is meant by the *due ulne infra listas,* which, as defining the unitary breadth of all coloured cloths and russetts, occurs first in the Magna Charta of King John at Runnimede; and is regularly repeated through the eight succeeding and still preserved Anglo-Norman Great Charters, down to the very period of which I am speaking. But this *ulna* (a yard) must not be confounded with another *ulna* (an ell), as is sometimes done; nor the words *yard* and *ell*

used as synonyms. The last, the ell, came in later; is supported by a lately-existing standard of Queen Elizabeth's reign, as being a yard and a quarter, or 45 inches; and, in that proportionate length, may be presumed to have been borrowed from the Paris drapers' ell.

The very standard referred to in this statute is not now in existence; but there is good reason for presuming that its absolute dimension has been preserved. A succeeding statute (14° Edward III., A.D. 1340) directed that the treasurer should have made "correct standards of brass for the bushel, the gallon, and weights;" but nothing is said of a measure of length: nor is it until 1491 (7° Henry VII.) that there is any more mention of standards to be constructed. As there was (previous to 1834) in the Exchequer of Great Britain a yard measure of brass (the metal spoken of in the act), with the stamp of this prince; and as in the recall by him, five years afterwards, of erroneous standards of capacity, no reference is made to the length-measure, we may conclude that the late yard was the very one made under this act; that it was a copy of the iron measure of his predecessor; and that, being taken as a full substitute, it led to the disregard and final loss of this last.

The yard of Henry VII. appears to have kept its place as the standard till, in its turn, it was replaced by a yard and matrix in the reign of Queen Elizabeth (30° Eliz. A.D. 1588). This last, though succeeding sovereigns caused others to be constructed, and left in various other depositories, was, for a long time after, the sole Exchequer standard of length.

It was not until 1743 that anything like a critical ex-

amination and scientific determination of these various measures was had. In June of that year, Mr. Graham made, at the instance of the Royal Society, with the assistance of several other members and with a suitable apparatus, the necessary investigation. He compared the two standards I have mentioned at the Exchequer, and an ell (of 45 inches) of Queen Elizabeth at the same place; a yard and ell matrices at Guildhall of Charles II. and William and Mary; a yard of the Clockmakers' Company of Charles II.; and a yard, belonging to the Ordnance, and kept at the Tower, of George I. The mean of all these six yards and matrices

(the ells being omitted) was	36.0058
the yard of Queen Elizabeth being taken as	36.0000
and the old yard of Henry VII. found to be	35.9929

He made also a copy of the Queen Elizabeth standard for the use of the Society,—destined to perform, some time later, a more important function.

In 1758 the House of Commons raised a committee "to inquire into the original standards of weight and measure in this kingdom, and to consider the laws relative thereto." This committee made a first report in the same year, touching the standards; and a second in 1759, touching the statutes: to both of which I shall have occasion to refer again. As far as the measure of length is concerned, the committee found the Exchequer standards in what they considered an unsatisfactory condition; and they preferred to derive the unit they wished to present to Parliament from Graham's copy for the Royal Society, which was regarded as having been better preserved. Accordingly they engaged Mr. Bird, the

most eminent mathematical artist of his time, to make two standard yards from this copy; and they reported one of them with which they were best satisfied, marked with the date 1758, to be accepted as the unit of length. The other, of which they make no particular mention, I consider as being the one subsequently found by Sir George Shuckburgh to be dated 1760. This was attributed by him to another committee raised, as he supposed, in that year: but I have met with no other evidence of such a proceeding, and I take the date to have been affixed upon some later examination by the same committee. This is, however, of very little importance. Both of them, whenever made, were undoubtedly executed by Bird; upon whose skill the committee appear to have unhesitatingly relied. In this particular case, there was indeed the more reason; a trusted workman in the shop of Sisson, where the Royal Society yard was got up for Graham, he had most likely done the mechanical part of that, and so came to be familiar with all the standards. When he attained afterwards a reputation on his own account, he made divers scales of yards and multiples of yards; which were deservedly in high respect, and tended ultimately to modify the standards.

In 1760, bills in conformity with the recommendations of the committee were brought in by the chairman, read twice, amended, and in preparation for being passed by the House; by which, among other things, one of these copies by Bird would have been accepted as the standard yard: but a prorogation occurred before the bills were entirely ready, and so the matter was lost for

that time. As I have always found this occurrence placed in the formal histories of the period under the date I have given, I presume that the one of 1765, attributed to it by a parliamentary report of a Weight and Measure committee in 1816, is either a misprint or an accidental error. At either period, however, there were subjects, if not more important, at least more exciting, to occupy the legislature; just as there were again in 1790, when a fresh committee was appointed to consider the standards, whose investigation (if they made any) left no remaining trace.

About the year 1774, the idea of an invariable and universal unit of linear measure began to develope itself in England, as it did in fact elsewhere; the pages of the scientific journals of that period, as well as of more elaborate authorship, abound with inquiries into the origin and proportions of weights and measures, and with suggestions as to a uniformity which the growth of physical science was every day rendering of more interest. In England especially, the early ideas of Wren and Huygens, in regard to the employment of the pendulum as the measure of length, were being revived; and in the year I have mentioned, and for several following years, the Society for encouragement of Arts, etc., offered a prize to the successful investigator of this or any other method. But the time was not yet ripe for the development; and the call of the Society was only a demonstration of failure. Some time later, in France, indeed, when the phenomena of the pendulum were taken up as collaterals to the metrical system there, Borda shewed how, through a complicated analysis, the mechanical

difficulties could be obviated: but the Saxon intellect, essentially synthetic, waited for a mechanical revelation, or, in our phrase, a practical way. This—the convertibility of the centres of suspension and oscillation—was first suggested by Bohnenberger, more than thirty years, and was independently exemplified by Kater, more than forty years, after the time of which I speak.

The prize-call of the Society, although abortive in its special aim, was however fruitful, indirectly, of momentous consequences to English weights and measures. Not to mention the ingenious experiments of Whitehurst, it stimulated Sir Geo. Shuckburgh Evelyn to a revision of the comparisons of Graham and Bird. In 1798, this *savant* published his results. For making the comparisons, he had procured from Mr. Troughton—an artist, who in all respects filled the place of Bird, and more—a scale of inches, each the thirty-sixth part of the standard yard. Whence Troughton derived his values is not positively known; most probably, by the coincidence, and Troughton's avowed high opinion of Bird's accuracy, from some scale of Bird's make. The mean result of seven measures in the Exchequer, in the Commons' archives, in those of the Royal Society, and in the Tower, gave a value for the yard within $\frac{1}{1000}$ of an inch of what had been assigned by Troughton's scale; and the greatest difference among these and six others, most respectable copies, occurred between the old standard of Henry VII. (which, after all its long use, was only $\frac{7}{100}$ of an inch too short,) and the matrix of Guildhall, (that use would tend to lengthen, and which was $\frac{3}{100}$ of an inch too long,) to the amount of one-tenth of an inch.

	Inches.
Taking a mean on Troughton's scale of .	36.000
the yard of Henry VII. was . . .	35.924
and that of Queen Elizabeth . . .	36.015

If, then, we take the yard of Henry VII. as the equivalent of the iron yard of Edward I., we are warranted in saying that, for all practical purposes, the scale of Troughton and that old standard are identical.

I have insisted the more upon this Troughton-scale of Shuckburgh, because it has come subsequently to be the real standard measure of length in the United Kingdom. In 1818, a royal commission was appointed, according to a resolve of Parliament four years before, "for considering how far it might be practicable and advisable to establish a more uniform system of Weights and Measures;" and one of its necessary functions was, of course, a revisal and comparison anew of the old standards. And such comparison was the more necessary, in order to see how far the adoption of certain ideas which the commission favoured in respect to the basis of a new system, would deviate from what had been recognized in the old. One of these ideas, for instance, was that the standard yard should be derived from the measurement for the Hounslow Heath base-line of the trigonometrical survey, that had been executed some thirty-five years before, by Gen. Roy. The length of this base-line rested upon that of an iron bar of 20 feet (*à traits*), made by a very excellent artist, Ramsden, for the purpose, and ultimately upon a brass scale, the property of the same artist; and both were averred to agree precisely with the Graham Exchequer standard of

the Royal Society. The same agreement was averred also for a Bird scale, the property of Roy. The Ramsden brass scale could not be found; but the other three were accessible. These were all compared in 1820, by the late Capt. Kater, one of the commission, an accurate and skilful observer; and along with them—Bird's parliamentary yard of 1760, which has been before mentioned—another yard scale (*à traits*) of the same artist, constructed for the use of the Anglo-Indian survey under Col. Lambton,—and the Troughton-scale of Shuckburgh. Shuckburgh had already said that the 1760 Bird yard differed from his scale within $\frac{2}{10000}$ of an inch: the result of Kater's comparisons was (taking the Lambton Bird scale, which was the shortest of all, as the zero) as follows:—

	Inches.
Lambton's Bird yard	36.000000
Sir Geo. Shuckburgh's standard . .	36.000642
Bird's Parliamentary yard of 1760 .	36.000659
Roy's Bird scale	36.001537
Royal Society's standard . . .	36.002007
Trigon. survey's Ramsden iron bar .	36.003147

This result, of course, placed the standard of the trigonometrical survey out of the question; and the commissioners recommended, in a second report of 1820, the adoption of Bird's parliamentary yard of 1760 as the foundation of all legal weights and measures. Parliament, four years afterwards, accepted the recommendation, and declared the said yard, under the denomination of the Imperial Standard Yard, to be the "unit or only standard measure of extension" of the United Kingdom;

as it remains to this day. But as the difference, shewn in the above table, between this new imperial standard and the Shuckburgh scale is so slight (only seventeen-millionths of an inch), and as, indeed, six of the twelve comparisons made by Kater between them, and two other comparisons made by Wollaston, the most reliable observer of his day, had resulted in absolutely no difference at all,—the two scales were justly taken at the time to be perfectly identical. In this view, fac-similes of the Shuckburgh scale—executed by the same artist, at private instance—have been extended to the continent of Europe, and serve for the conversion of measures there into those of English estimation, and reciprocally; copies of the English yard and inches, compared by the same observer Kater, have been made by its means for communication to several of the European governments; and finally, it is from a Troughton fac-simile (except as regards the number of inches) of the same scale and apparatus that flow all the comparisons for, and ultimate determinations of, the present Standard Yard of the United States.

I am, therefore, justified by all these momentous consequences, in ascribing to this scale of Shuckburgh the importance that I gave it just now in calling it the *real* standard of Great Britain, and, I might add, of the Anglo-Saxon family. The commission, indeed, (or rather the working member of it, the late Captain Kater,) convey by the language of the scientific account of the new standards of Great Britain and Ireland, committed to the pages of the Transactions of the Royal Society, the idea that their weights and measures "are founded

upon a standard, the length of which is determined by the proportion it bears to that of the pendulum vibrating seconds of mean time in London." But such an idea must be only accepted in a peculiar and restricted sense. If by some all-whelming catastrophe the now existing standards of the English yard and inches should be swept away, it is true that their value (excepting errors of observation) could be recovered from the measure of a pendulum beating seconds in London, or elsewhere, by an appropriate correction; but until then, the value of the yard will always be derived, by a much more patent and unexceptionable experiment, from the Shuckburgh scale, or some sufficiently respectable copy of it. After a catastrophe, similar in kind, but much less in degree than such a one as I have premised—I mean the conflagration of the Houses of Parliament in 1834, and the destruction there of the imperial standards—I have not heard of any resort to the pendulum to effect the restoration of the latter.

If the phrase of the account of Capt. Kater had been, *may be determined*, instead of *is determined*, it would have been literally accurate; but as the case actually stood until 1834, the standard was *not* determined by any reference to the pendulum: the length of the pendulum was determined by reference to the standard. In fact, speaking historically, the pendulum has nothing to do with the standard farther than a coincidence; and speaking popularly, no more than the barley-corns of Edward I. had to do with his iron yard. Speaking scientifically, these averments would of course have to be qualified: but even in this last aspect, the pendulum

is no more an element of the English metrology than it is of the French, where indeed to its interposition is assigned the proper rank. The conduct in the latest establishment of each of these systems serves to exemplify—I will not say the fallacy or the inutility, but—the inconsistency of those aspirations after an absolute and invariable standard, which animated the pursuit in both. The one, claiming to be determined by a phenomenon of Nature's universal law—gravitation—yet reposes, actually and in terms, upon the space between lines traced on a brass bar for Sir George Shuckburgh; which space was obtained by a series of (so to speak) material traditions from and compromises among ancient standards, of origin, if not accidental, at least not refined: the other, more ambitious still, and aiming to girdle the globe both morally and physically, in practice had to measure each successive step of its profound and wide-reaching investigations, by the space included between certain lines on the so-called toise of Peru; which, on its side, grew out of successive traditions from the ancient measures of the kingdom. All this serves farther to shew the interest attaching to every undertaking, like the present, to guard and perpetuate such traditions; and even if one should not be satisfied that standards so handed down bear a sanction of the highest order, (in being symbols of intellectual and moral, instead of merely physical, manifestation,) at least it is not to be doubted that the operations in fixing them are precisely the same, and therefore just as important as those upon which an Establishment for the Universe, were such a thing possible, in its earliest stage must rest.

2°. *Measures of Weight.*

As in the measure we have just now been considering, the distinctive appellation given to the unit indicates a Saxon origin, so also does it in this case. The English pound and penny bore, in ages far remote from ours, the denomination of *Sterling*, or *Esterlin*, as they do now. That this indicates no *Roman* identity, at least, the writers on the subject are nearly unanimous; but the tracings of its etymology, prior to 1745, have been as various almost, and as numerous, as the writers themselves. In that year Martin Folkes, then President of the Royal Society, an accomplished numismatologist, first announced in his Table of English Silver Coins (already referred to), and upon the authority of a verdict relating to the coinage preserved in the Exchequer from the time of Henry VIII., the value of the Saxon pound in terms of Troy weight. The proportion between them, as 15 to 16, or as 5,400 grains to 5,760 grains, excluded all reference to origin from the Romans, and shewed that, after their occupation ceased, a new unit must have been substituted. But this announcement did not settle the derivation either of the name or of the thing; and authors have been as discrepant since as before. Among derivations so omnigenous as *Estâr*, the Saracenic word for the Greek coin the Stater—*Star*, the Hebrew word for an indenture or written obligation—*Steore*, the Saxon word meaning a standard—*Stirling* Castle in Scotland—the speaking bird, the *starling* — who shall judge? The epithet *Easterling*, which to a weight coming from Heligoland, nearly due east from Britain, would be quite appro-

priate, Bp. Hooper denies to it from that quarter, to place it more probably among the rich merchants on the South-east or Mediterranean Sea: though he rejects both, and prefers to find it among the Saracens. Others have discovered, as they suppose, that the mint-workmen came from Germany; and have even fixed the epoch of their advent in the reign of Richard Cœur de Lion. Only one writer, Clarke, has seized the obvious physical and historical analogies; and has presumed it to be the old pound of the Asiatic continent, whence the Saxons came. It was thus, from the moment they planted themselves on the European shore, an Easterling pound; and each successive step in their subsequent western migration only gave fresh reason for the name.

It is impossible now to ascertain positively what the divisions of this pound were, for many centuries after its European use; but the subdivisions of it in account no doubt very soon accorded with those habitual in the provinces under Roman domination. In the earlier times of weights and coins, the mint-pound and the pound of account were identical; the silver coin was a corresponding nummulary weight; and the *denarii*, for instance, (the Roman mint-units after the introduction of silver,) were reckoned at 84 to the pound, because each such piece was, as near as the then imperfect art of coining could make it, $\frac{1}{84}$ of the pound weight of silver. But as the circulation of this money was extended, as experience detected and use magnified the deviations (which would be always on the side of light weight) in the mint, an allowance was made on money paid *in tale* to cover the defect in absolute weight. The kind of

this allowance was the same with, the degree of it not materially different from, what had been before admitted in the exchange between articles sold by measure and those sold by weight; and the coinage itself was after a while regulated accordingly. Thus, to keep to the instance just mentioned, the pound of silver was intended to be cut up into 84 pieces, or *denarii;* it rarely produced that number exactly—first, because it required a certain perfection in the workmanship; and secondly, because the state or the sovereign gained every additional piece that could be coined over that number. But such a discount could not be made, systematically, or for a long time, without detection: a corresponding premium was demanded by those who received money; and the *denarii* appear to have been rated at 100 to the pound, before the imperial necessities had actually changed the coinage from 84 to 96 pieces out of the pound weight, that is, from 7 to 8 in the ounce. This computation was perhaps supported, too, by the Greek commerce: the Roman *denarius* and the later Greek *drachm* hardly differed in weight; and these last had always been by the centesimal count.

At all events, in the earliest times of the Byzantine Empire the *centenionales nummi,* the silver cents, replaced the old *denarii;* the poverty that, like an armed man, followed with irresistible tread the luxury of the successors of Constantine, rendered expedient an actual decrease in the size (keeping, however, the old denomination) of the coin with which the military establishment of the throne was supported; and hence we may trace the use, among the Franks and other nations in

Germany, of the *ceratium* or *quinarius* of 200 to the pound, as their unitary silver coin under the name of *denarius*. It was, in weight, the half-denarius.

Now, if the minting was accurate, and 200 *denarii* (so called) were really struck out of the pound of silver, the same proportionate allowance as before, between weight and tale, would make them pass when counted at 238.5, or, in round numbers, at 240 to the pound. This number of *denarii*, or pence, to the pound was certainly admitted all over Europe not very long after the Saxon occupation of Britain: that it arose from a degradation in the mintage of one-fifth, seems to me deficient in historical proof; at least, those who advance such an opinion have omitted to indicate the precise epoch at which the degradation averred took place.

Whether the Anglo-Saxon count, of 240 pence in the pound, was borrowed from this Frankish count; or whether it originated long before in the proportions of the older Greek pound—from which, for instance, we have derived the weight of the *journey*, (as it is called,) of silver to be minted, viz. 60 lb., or the *Talent*,—I shall not inquire. Both probably, contributed to the result.

With 240 pence to the pound, the universal subdivision of the pound into 12 ounces makes 20 pence to the ounce; a proportion affirmed in the first precise English statute remaining on the subject. It is the same proportion that we have to this day. The division of these pennyweights into 24 grains was the old way of the Romans; who counted 24 *lentes* to a *scriptulum*, or scruple, the smallest of their marked

weights. There is no direct evidence of such a subdivision in the Saxon pound.

It was in accordance with these proportions that the money-weight was regulated, though under different denominations. The pound of silver was reckoned by coins, in shillings and pence; the same appellations used in England now, but conveying neither the same absolute nor relative values as then. The Saxon shilling, or *scyllinga*, was the Roman *sicilicus;* which, as a weight, was $\frac{1}{48}$ of a pound, and, as a coin, corresponded to the value of the old double-denarius or didrachm. Whether the Saxons corrupted this name in Roman commerce either in Germany or Britain, or had it before from an Eastern source, I shall not stop to discuss; the vanity of the Latin authors would have one believe that it was indigenous to their tongue. But the very etymology they give strains and weakens the claim; it is hard to make the sound of *sicilicus* out of *semiunciam secans;* and a more particular investigation than can be afforded here, would perhaps determine our finding the analogue of the term, as we do of the thing, in the Greek *siclus* and Jewish *shekel.* It has, however, hitherto hardly less exercised the ingenuity of philologists than the epithet *sterling.*

Be this as it may, there is evidence as far back as the Dano-Saxon laws of Edward and Guthrum, about A.D. 920, that the shilling was worth 5 pence; and therefore, with 240 pence to the pound, it was just $\frac{1}{48}$ of the latter. In *tale,* they might have been reckoned at 50 to the pound, just as we know was the case of the Greek *drachm* and Italian *denarius;* which serves to

reconcile the arithmetic of some of these laws with the rest. That the shillings fell to 60 in the pound afterwards, would appear from the laws of Athelstan, the successor of Edward the Elder, (about A.D. 924,) in one of which the levy of 4 pence is called the king's shilling; and again, from a law of the Conqueror, which says that the English *solt* is 4 deniers. The number of deniers, or pence, in the pound having remained constant, there must have been in it, also, sixty pieces of 4 deniers each.

Such is the conclusion of some of the English writers; which is of no great concern here either to admit or disprove. I will only remark in regard to the law of Athelstan, whose necessities have been taken as a plausible reason for his lowering the value of the coin, that it is quite likely he should have done, as governments laying a tax not unfrequently do still, viz. allow a premium for early payment. The law itself required from every one whose income was 30 pence, a shilling to be paid within twelve months; now, in estimating a proportionate tax, a shilling of 5 pence is an aliquot part of 30,—it is the sixth part, which was besides exactly the multiple employed in a good many other taxing and penal laws of the period. An income of 60 pence would yield two shillings, and so on. Farther, this proportion of 48 to 60, or of 4 to 5, is exactly the ratio of the mint-pound of 12 ounces and the Saxon commercial pound of 15 ounces; and Athelstan might be very well content, if he got his 4 pence, to let it be called a *shilling*, (as it really was of the market-pound,) and thus allow his subjects the consolation of thinking

that the rate had been fixed upon the computation most advantageous to themselves. Finally, the sway of Athelstan was over the whole of that Octarchy whose dissevered state had been favourable to a want of uniformity in weights and measures. Some of his subjects had been habituated to the computation by the money-pound, while others seem to have used only the proportions of the commercial weight; and between the West-Saxon reckoning and that of Mercia, the central and largest portion of his domain, there was, centuries after, precisely the ratio 25 to 20 in the fines for identical offences. He, therefore, whose prescription that "there be one money over all the king's dominions" is the first of the kind we meet with in Saxon history, may have evidenced his attempt to reconcile these different computations in the very law that rates the old five-penny shilling at four.

To return from this, the pennies themselves appear to have remained for a long time constant. The Saxons called them *pænninga*, or, as in some remaining records, *pending;* in this, certainly borrowing from the Latin *pendo*, inasmuch as this piece was the unit of their coins and accounts. It was the key of the whole English system of weights and capacity-measures long after the Norman times.

But these Norman times brought in with them, as I observed a little while ago, a great change in the relations which the shilling had to the penny; and the former, which fluctuated, as we have seen, according to locality and age, between five and four pennies, became under William the Conqueror, and more uniformly and

clearly still under Henry I., the *solidus* of twelve pence. This word *solidus* was introduced in the later times of the Roman Empire, to distinguish between the two sorts of *aurei*, or gold pieces, which were then current, one of which was just half of the other in weight. The whole one was termed the *aureus solidus*, or simply the *solidus*.

I may remark in passing, that it was from this solid *aureus* that the Danes and Saxons corrupted their word *ora;* which, I have already said, meant in their laws the *ounce*. And this assisted in establishing the computation of 20 penny-weights to the ounce; for the weight of the *aureus* corresponding to that of two *denarii*, and the then value of gold to silver being as ten to one, such an *aureus* was exchanged against 20 *denarii*, or pence. The half-aureus, or gold penny, then exchanged for 10 pence, as we know it did in the time of Pliny the Elder. But afterwards, under the Byzantine Empire, when a substitute for these two *aurei* was supplied by one, that bore likewise the name of *solidus* for its sanction, and was to the former half-aureus inversely as 72 to 84, either a calculation by a strict proportion of weights, or a change in the relative values of gold and silver within what we are assured did occur, or both, made this new *aureus solidus* worth 12 silver pennies of 240 to the pound. The Franks, who used it as a coin, called it a *solidus;* the Danes, who used it so too, called it an *ora:* and both rated it as $\frac{1}{20}$ of their silver pound. The Saxons, who employed it chiefly as a weight, reckoned it as 20 pennies, and therefore equivalent to a mint-ounce.

Later, during parts of the twelfth and thirteenth centuries, this appellation was given in England to a coin of the value of 16 pennies. But this was not the Danish *ora*. It was the Saxon half-mancus; which, being an *aureus*, or gold piece, underwent the same corruption as its predecessor — a corruption which is perpetuated, as in the Portuguese *moidore*, (*moneta de auro*,) in several parts of continental Europe to this day. That this computation of 16 pence to the *ora*, was not formerly applied to other than coin-weights, is plain from a law of Ethelred, the predecessor of Canute, which directs—"ut omne pondus sit marcatum ad pondus quo pecunia mea recipitur; et eorum singulum signetur, ita quod 15 ore libram faciunt." By misapprehending the scope of this, however, some writers have taken the *libra* here to be the money-pound of 240 pence; and thence deduced an *ora* of 16 pence itself. But it is manifest that the pound in question is the commercial pound, that was to be marked by the money-pound, with which it is placed in direct contrast: and it is to be so deduced as that it shall consist of 15 *oræ*, instead of 12, as were contained in said money-pound. I may remark here, that this reckoning of 16 pence per *ora*, or ounce, has survived both the money and commercial pounds from which it originated, and has been transferred to our avoirdupois count. It is hence that in this count we allow 16 drachms to the ounce.

We see, therefore, that the continental *solidus* was not entirely new in England at the period of the Conquest. I have met with the term (for its first occurrence, I believe,) in the Forest-canons of Cnut (or

Canute) the Dane; but it seems to have been legalized as a method of reckoning only after the Normans came. Whether it was actually coined of silver or not, which antiquaries have disputed, is here indifferent; in either case it was sufficiently distinguished from the old Saxon *scilling*, whose name it bore softened into *shilling*, by the latter's being very early termed a *gross*, or *groat*, and kept to its value of fourpence. The conjecture is at least plausible, that this last appellation was bestowed upon the Saxon shilling because it was (*die grosste*) the *largest* actual silver coin of the time.

As a nominal unit in accounts, it is certain that the Anglo-Norman shilling continued for some centuries, not only for money, but for weight. An old law, of uncertain date, but ascribed by some to 51 Henry III., A.D. 1266, and headed an *Assise of Bread and Ale*, gives both the prices and the weights for bread in shillings and pence of the same system. This document has been much criticised, as shewing a carelessness in the arithmetic of our English ancestors; but if any one will take the trouble, as I have done, to go over the thirty-nine articles of calculation in it, he will find that of the six errors which occur on the face of the statute, all but two are attributable to errors of the transcriber, which the insertion of a point in one case, and transposition and addition of one letter in the others, will correct. And of these two, the origin and mode of occurrence is so easy to be seen, that this law will bear a favourable comparison with those that I have detailed in the former part of this Report.

This correspondence of coin and weight continued

until 1301; when Edward I. struck out of the pound of silver 243 pennies, instead of 240, as before. From that time the shillings and pence, as parts of the pound, have been only monetary and nominal.

With the other Dano-Saxon coins, the *mancus*, (*manu-incusa*,) the *mark* (or *standard*), the *thrimsa* (*tremissis*), etc., the aim of the present Report has nothing to do. Those that have been discussed were only taken up because they explained or illustrated the English system of weights; and I shall terminate all that is to be said in regard to coins with a single remark, that a good deal of confusion might have been spared, in discriminating the currency of the same coins in different countries, had due attention been paid to the relative values of the units of weight in those different countries.

Although Ducange had shewn (unexceptionably as we see now) the value of the Sterling or Esterlin pound, as compared with the pounds of Troyes and other places, about the beginning of the fourteenth century, we yet find learned writers after him, and even using his document, speculating upon the troy-pound, which had become domesticated in the English mint, as if it came from Tours or, higher still, from Troy. This last fancy is of a piece with a yet existing early Anglo-Norman charter, that declares the City of London to have been founded and built up after the model of the Homeric Troy; or with the still earlier tradition that would make one of the children of Æneas, wandering either from necessity or choice over Europe, at length settle himself in Britain.

That the troy-pound was not the pound of Tours is plain from the following table; in which I have reduced Ducange's statement, which he took from a register in the Chamber of Accounts at Paris, and that of Folkes from the Mint in London, to pennies sterling. I have added also a similar reduction of the Roman pound; which I have rated according to the estimation of Arbuthnot,—not that I think it correct, but because it is current. I have also made a column shewing the respective values of the mint-pounds, and another shewing the corresponding market-pounds,—both expressed in troy-grains. It will be seen that the Tours pound and the Roman pound are nearly identical.

	Sterling dwt.		Troy grains	
	Ducange.	Folkes.	in Mint-pound.	in Market-pound.
English pound,	240.	240.	5400.	6750.
Limoges do.	236.25	.	5315.6	.
Tours do.	232.50	.	5231.25	.
Troyes do.	255.	256.	5760.	7200. in 15 oz lb. 7680. in 16 oz lb.
Roman do.	232.23	233.14	5245.71	6994.3

It is from the inflections and permutations (so to speak) of these various pounds, but principally of the two last, that the present English standards have resulted. That inflections of this sort should occur is very natural and consistent: from the time of Athelstan, England began to take the rank in continental Europe which she has since carried to such a height; and across the narrow strait dividing the two, the pulses of trade were communicated and typified in the weights and measures of the traders.

It is, besides, as impossible as it is useless to expect,

in a matter of this kind, a precise historical epoch marking when this or that custom or reckoning was introduced. As in the physical so in the political world, the origin of what comes to be a mighty development is often so hidden as to be attributed to chance; while its nourishment and growth are as obscure as if they depended on caprice. Except one,—the French metrical system,—I know no metrology which has a new and independent era of its own, or can point to the register of its birth and baptism. And in this, it may be questioned whether the advantage of historical precision (not to speak of the intrinsics of the system) was not dearly bought in the convulsions of the times that gave it;—whether it is not better to have no baptismal certificate at all, than to have one written, not in ink, but blood. In this regard, the English and French systems are as opposite as their coasts.

When, therefore, the troy and avoirdupois weights now established in England, first came there, would be the subject of a fruitless research: they were blending themselves in the commerce of the country from the earliest times of their existence anywhere. If they did not always shew themselves in a distinct recognition as units, they affected the proportionate computation of the heavier commercial weights. The law, for instance, of King Stephen (not now on record, but mentioned by a writer in a time not long subsequent,) *de ansulis,* etc. proves this. The ansula was the steel-yard; called so from the *ansula,* or hook, by which the articles were suspended. Being of Roman origin, it most likely was graduated to weigh by the Roman market-pound, i. e.

the present avoirdupois pound, which, as seen in the table, was more than a half-ounce heavier than the Saxon pound.

This avoirdupois pound may be what is referred to in an existing statute of 25° Edward III. (A.D. 1351); which says, that the weight called *aunsell* shall be altogether abolished, that every one shall buy and sell by *balances*, and that their weights shall be according to the standard of the Exchequer. It is a little curious that a provision similar in terms should have been found expedient in Maryland more than three centuries after. This is exemplified in the statute against steel-yards carrying *gross* weight.

The name, *avoirdupois*, frequently occurs in the English statutes; but generally as indicative of particular commodities which were sold by weight,—literally *weighable articles*. Its first use, when it may be supposed to refer to a unit of weight—at least the first that I have found—is in the statute of Stamford, as it is called, dating under 3° Edward II., A.D. 1309. But its influence is manifested in a still earlier statute, to which I have already had reference, denominated an *Assise for Weights and Measures*. This act is placed, in the latest publication of Statutes at large by the commission for that purpose, very properly among the laws of uncertain date. In some of the earlier collections, part of it is found under 51° Henry III., A.D. 1266, and part under 31° Edward I., A.D. 1303; and it is sometimes referred to by the title of *Compositio mensurarum* of 1304. Its phraseology shews, however, that it has undergone frequent interpolations, and justifies our attributing it to

some previous time. It rates the pound of money and spices[b] at 20 *solidi* (of 12 pence), the electuary (or medicine) pound at 12 ounces of 20 penny-weights, and the pound for all other articles at 25 *solidi* or 15 ounces. In so far, it agrees with the prescription in the law of Ethelred the Saxon, before quoted.

In this statute there are no less than three different *petræ*, or stone-weights, mentioned; one of 12 lb., the London stone of 12.5 lb., and one of 14 lb. These are within a fraction of the proportions of the commercial pounds of Tours, of London, and of 16 troy-ounces. The ratio of the two last is as 100 to 112, or precisely our present long hundred-weight. I may state here as

[b] Upon this, I submit to the learned whether our English word *specie*, as applied to a metallic weight, does not arise thus. The statute in the text says: "quelibet lb de deñ et speciebus et confeccionibus, utpote in electuario, constat ex xx solidis," &c. Now *species* in the lower Latinity (*espices* in the old French) meant *spices;* which, with pennies (or money) and medical confections, were weighed by the pound of 20 *solidi*. Such a pound, therefore, would be equally understood whether it were called the *money* pound or the *specie* pound; and, without a catachresis, the latter title might very well come to predominate over the former.

That this weighing of spices by the money-pound was from old time habitual, Pliny has long ago shewn. He says, in regard to the Indian pepper, which grows wild,—"et tamen pondere emitur ut aurum vel argentum;"—not that it was as precious by weight as gold or silver, for if it were as precious as the one it could not be as precious as the other—nor that it was bought by weight, for that was the case with a great many articles besides, but that it was bought by the same weights which were used for weighing gold or silver.

As anything which relates to *specie*, in the vernacular sense of it, has an intimate connexion with weights and measures, I hope to be excused for this disquisition here.

the reason for giving in the table *two* commercial pounds of troy-ounces, that, to the best of my knowledge, the pound of Troyes never had a market-pound corresponding with it in the place whence it drew its name. It was the pound of the goldsmiths; who devised it for the purposes of gain, and started it at first, as its proportions shew, by adding one-tenth to the Roman pound. By the latter they sold, by the former they bought. In this, they did exactly what the statute-staple (as it is called) of Edward III. in 1353, affirms was being done then; when it says, "q̄ ascuns marchanz achatent—par un pois et vendent p̄ un autre;" they bought by one sort of pound and sold by another. But when this bullion-pound came into England, the exchange for it in commercial pounds was regulated according to the previous habits of the different districts where the occasion might arise: the West Saxons took fifteen of its ounces, the Mercians sixteen, to make a market-pound.

So, again, in this statute there are two sorts of *sacks;* one of 28 stone, the other of 30 stone. The ratio between these is almost precisely that of the Saxon and the troy 15 ounce pounds. In the time of Edward III., by the statute already referred to regarding the aunsell of 1351, the sack was reckoned at 26 stone of 14 lb. each; in this still retaining the proportion of the troy 15 ounce pound as far as the weight of the stone was concerned; but in the combination for the sacks, adopting a proportion almost identical with that of the Saxon market-pound to the Roman pound.

The computations of hundred-weights are still more various. They are of 100, 108, 110, and 120 pounds.

These are very nearly the ratios of the Saxon pound, the troy 15 ounce pound, the troy 16 ounce pound, and that of the troy bullion-pound to the Roman avoirdupois pound.

One phrase in this statute has been supposed to refer expressly to the troy weight. It had given the weight of the chaldron, by one computation, at 175 stone of 12 lb. apiece, making 2,100 lb.; it then goes on to give another reckoning, by which the chaldron is made to contain 168 stone, adding, "et hoc est secundum *Troni* ponderationem." All the translations that I have seen render this word *Troni* by *Troy;* but it is evident from the numbers that troy weight has nothing to do with it. I know that the whole passage is faulty, and that it has suffered not only by transcribers, but apparently by commentators: yet if, instead of *Troni*, we read *Londi*, (and those familiar with the early English manuscripts will know how easy such a change could have been made by a mere copyist,) it will be cleared up. The London weight required 12.5 lb. to the stone; and 168 stone of 12.5 lb. are just equal to 175 of 12 lb. The chaldrons are thus in the two reckonings the same; it would be very singular if they were not: but the text says nothing about the weight of the stone in the second case, because that followed in its being said to be *according to London weight*. This proportion of 168 to 175 is almost exactly that of the Saxon commercial pound to the avoirdupois pound, and indicates the currency of the latter.

We need not, however, resort to this hypothesis of an error in transcription to sustain the interpretation of a London weight, if we will admit, with some, the in-

fluence (greater than I suppose it ever attained) of the Trojan story to which I just now referred, and which, about the date of this very statute, Geoffrey of Monmouth had contributed to resuscitate. According to that, New Troy, or Troy-novant, is the synonym of London. It is fair to say, nevertheless, that the advocates upon this fiction make quite a different application of it. For instance, Davies Gilbert—one of the Weight and Measure Commission of 1818, by which the present English standards were fixed, and one of the successors of that very President of the Royal Society who re-discovered and proved the Saxon pound—believes (not the legend of Brutus, of course, but) the troy pound to be the old London pound from the time of Edward the Confessor; and he quotes the synonym as proof. But the fact is, that this piece of heraldry was quite extinct in the time of the Confessor; it had been faded for two hundred years before, and was not begun to be re-blazoned for nearly as long a period afterwards.

The troy pound is, however, specifically mentioned, very little more than a century later than the statute just now quoted, in one of 2° Henry V.; and a few years after, that again in one of 2° Henry VI.; the last of which even determines its value. It rates silver plate and bullion of sterling alloy at 30 shillings the pound troy, besides the fashion if it is in piece; saying, that its value as coin was no more than 32 shillings. Now, ever since the thirteenth year of Henry IV., the Tower pound had been coined into thirty shillings; and if the troy pound was worth thirty-two, their proportions must have been as 30 to 32, or as 15 to 16, which is

precisely the proportion given in the verdict establishing the troy pound at the mint.

Troy weight is again mentioned by the statute 12° Henry VII., of which I have already spoken, and which is referred to in the Maryland Act of 1671. It is there used, along with the Roman avoirdupois weight for the combinations of the new capacity-standards of 1496. Some of the English writers have supposed, that it was also at this epoch introduced into the mint; but this is only an inference. Against this, are both the existing coins and the express adoption of the troy weight at the mint in 1526. From this last date, the English nummulary and commercial pounds have been troy and avoirdupois, very nearly as they are now.

The existing English statutes shew that in the reign of Edward III. brass standards, both of weight and capacity-measure, were made and distributed by public authority; the Exchequer contained at one time some standards supposed to be older than those. The linear measure of Henry VII., and his capacity-measures under the laws of 1494 and 1496, have been already mentioned. But in 1743, when Mr. Graham's examination was made, there were no standard weights that could be dated higher than the age of Queen Elizabeth. Taking these as the standard of comparison, the results were as under:—

	Troy pound in Troy grains.	Avoirdupois pound in Troy grains.	Date of Standards.
Exchequer, 12 ounces .	5760.000	7000.1375 .	about 1588.
Founders' Company .	5761.750	7001.0150 .	marked 1684.
Mint, 12 ounces . . .	5761.875	.	do. 1707.
Mint pound	5760.125	.	used in 1742.

The comparisons of Sir George Shuckburgh were made principally with a view to deriving a unit of weight; which he, as Whitehurst had before him, proposed to find in a cubic inch of distilled water. He did not therefore examine the old standards, but compared the weights made for him by Mr. Troughton, with those that had been made by Bird with Harris the assay-master of the mint, and reported to the House of Commons by the Committee of 1758. There were four of these, a one-pound and two-pound weight, in duplicate, resulting as under:—

	Parliamentary	
Troughton's lb.	Mean 1 lb.	Mean 2 lbs.
5760 grains.	5763.715 grains.	5763.850 grains.

The weight which he assigned to a cubic inch of water was expressed in grains, each of which was $\frac{1}{5760}$ of the mean of the Parliamentary standards.

When the Commission of 1818 came to revise his observations, they were found substantially so accurate as to justify an adherence to them; which their acceptation for five-and-twenty years among the learned in continental Europe rendered, besides, so desirable. And as the Parliamentary one-pound weight (called A. 1758), an existing unit, differed the least from the mean result, it was recommended by the Commissioners and adopted by the Legislature as the "unit or only standard measure of weight from which all other weights shall be derived," under the name of "the Imperial Standard Troy Pound." The avoirdupois pound was derived from this standard by the ratio which the experiments of Graham shew to have been habitual for two hundred and fifty years at least, viz. that of 7000 grains to 5760 grains.

The test of value for these grains is supposed to rest upon a permanent and universal natural law—the gravitation of distilled water at a certain temperature and under a certain atmospheric pressure. And the value itself is such, that 252.458 brass grains (but of specific gravity undefined) will be in just equilibrium with a cubic inch of distilled water, the mercury in a barometer standing at 30 inches, and in the thermometer of Fahrenheit at 62°, both for the air and for the water. In testing or recovering the value of the inch, should that be the question, it is presumed to be such as is contained 39.13929 times in the length of a pendulum that, in a vacuum and at the level of mid-tide under the latitude of London, vibrates seconds of mean time. I have already spoken of the theory of this; I will only add that the precise reproduction of the inch or of the unit of weight, by observation of the natural phenomena with which they have been connected, would be a problem requiring the highest and most successful efforts of science and art combined.

3°. *Measures of Capacity.*

The connection, from the most ancient times, between liquid and dry measures authorizes them to be treated together; and their reciprocity, which is a marked feature in the Saxon system, renders such a treatment here peculiarly necessary. I therefore make but one class of both.

So great was this reciprocity, that even the names of some measures came to be interchanged: for example, the gallon—a word originally applicable to liquids only,

and a vessel which, when filled with wine, was the eighth part by *weight* of the bushel of wheat—was employed to signify also a very different measure, the eighth part by *volume* of the bushel; explanatory epithets distinguishing them were not always added; and to this may be traced in part the confusion enveloping the former capacity-standards in England, and the final step there of doing away with them altogether. The very beauty of the system increased its fragility, and contributed to its decay. A similar instance might be alleged from several of the other denominations; the bushel only, which means primarily a textile fabric, has been uniformly held to its signification as a unit of dry-measure. Both of these terms—gallon and bushel—are found in the lower Latinity, before they were borrowed by the Saxons in Britain.

In proportioning at first the measures for substances in drops and in grains respectively, the simple idea seems to have been *equiponderance*. The vintner and the corn-grower, for instance, although their transactions were made by measure, in reality interchanged their commodities by weight; the corresponding measures of wine and wheat, although of very different magnitudes, yet contained the same number of pounds. For any one article, the magnitude of the unit of measure is determinable by the multiplication of linear dimension, though even in such case the easiest and most practical method of estimating or comparing magnitudes is by weight of their contents: but in making transitions among capacity-measures for different articles, it is absolutely necessary to resort to weighing in some part of the process.

And as commerce gradually increased, and a greater number of articles came to be offered in market, the constant reciprocity between magnitude and weight would come also to be more fully acknowledged and applied. Any vessel, after its contents of different articles had been once weighed, would serve either as a capacity-measure for any, or, filled with one, as a weight itself to balance against all others. Thus as between wheat and wine, a vessel first constructed by linear rules to be a certain part of a cubic foot, and found afterwards to contain twelve ounces of wheat, would be found then to contain fifteen or sixteen ounces of wine. According as it contained one or the other, it would be a weight or pound of twelve ounces or of fifteen or sixteen ounces; as determinate in theory, as if it were of metal itself, and more universally applicable in early times, when all metal was too precious to be kept merely as a means for counterpoising. In such application is easy to be seen the origin, both in value and denomination, of the *commercial* pound.

All this is exemplified in the English system, as it had been before in the establishments of other countries. The earliest English law expressly on the subject—the *Assise for Weights and Measures*—which I have before spoken of, and which certainly antedates the fourteenth century, reads (when translated) as follows:—

"By ordinance of the whole realm of England, has been established the measure of our lord the king; to wit, that the English penny which is called sterling, round and without clipping, shall weigh 32 grains of corn in the middle of the ear;

and the ounce should weigh 20 pennies;
and 12 ounces make the London pound;
and 8 pounds make the gallon of wine;
and 8 gallons of wine make the London bushel;
and 8 bushels make the London quarter."

It then goes on with various reckonings by *sacks*, *stones*, and *hundreds*, and winds up with a note on the distinctions between the specie pound of 12 ounces and the pound "for all other things" of 15 ounces—particulars to which I have already referred in speaking of the measures of weight.

The terms of this law point plainly to its parentage. It is a *rifaccimento* of the two systems most extensively recognized in Europe; and some of its proportions go up to the epoch when linear measures of capacity preceded weights. To take these terms in order: the proportion of the penny sterling to the grains of wheat is that of the Roman mint and commercial pounds. There is no direct proof, as I said before, that the Saxon penny-weight was divided into grains; nor is there, that I am aware of, any precise knowledge as to the date when the troy penny-weight came to be counted in grains, either. Both, no doubt, conformed to the Roman reckoning of 24 *lentes* to the *scriptulum*, or *scruple*. This proportion of 24 to 32 (or of 12 to 16) answered very well with the wheat of Italy, but did not correspond in the case of the lighter wheat of Gaul, which the Roman settlers introduced into Britain, and which the troubles of the Octarchy kept as an article of commercial import long after the earliest Saxon times. The introduction of a new pound served, therefore, as the occasion for making the

correction due to the actual correlative weights of the wine and wheat brought to the British market; and this correction was made in taking a commercial pound of 15 ounces. But the old ratio was still left in the count; because, as with the length-measures, the number of grains of corn was only an indication, not a constituent, of the unit; the standard of the whole system exposed in the law just given, was the silver penny, of which 240 went to the sterling or London pound. The disappointment, therefore, of some observers in the early part of the eighteenth century, who could not get 32 grains of wheat to weigh 24 metallic (then troy) grains, and the gratulation of others who could, belong more to the question of patriotism than of accuracy in either physical or historical lore.

How 20 sterling pennies came to constitute the ounce I have already explained; and the reckoning of 12 ounces to the pound ascends to times long anterior to what I have taken as limiting the view of this Report. This duodecimal count, as well as the frequent recurrence of the multiples by 8, both mark the Greek period; when a people, subtle in arithmetic, had perceived and applied the abstract relations of numbers. It would be curious to point out, did my space and object allow, the varied harmonies observable in this very statute; it is enough, however, to say that the number 12 was chosen, because it is the sum of all the aliquot parts (including unity as a divisor) of the first perfect number; or, more popularly, it is divisible into more whole factors than any other number, not a multiple of it. The adoption of 8, as a multiple and divisor, was peculiarly appropriate in capa-

city or cubic measures, because it is the first perfect cube in the decimal series. Hence it was that, in all the elder systems of measures, the liquid gallon was, in dimension, $\frac{1}{8}$ of the cubic foot; and there can be little doubt that it was so still at the time of the origination, if not the passage, of this law.

It is true that the phrase itself of the law does not determine the wine-gallon otherwise than by weight: but even thus, an indirect valuation may be deduced for it in linear measure. The 8 pounds, which were to make the gallon of wine, were not nummulary pounds, but, as is plain from the special note in the statute, commercial pounds; *wine* was among the "all other things" weighed by the pound of 15 ounces. Now, 8 pounds of 15 ounces are 120 ounces sterling; and the sterling ounce being $\frac{1}{16}$ lighter than the troy ounce, 8 sterling pounds are equivalent to 112.5 troy ounces, or 54000 troy grains. The weight of Gascony or Bordeaux wine, repeatedly referred to by name in the English statutes of the period during which the district was an appanage of the English crown, and therefore fairly presumable to have been intended in this, is very nearly (according to the latest determination of the weight of water, and exactly, according to some former observations) 250 troy grains to the cubic inch; which gives precisely ($\frac{54000}{250}$ =) 216 cubic inches to the gallon, or $\frac{1}{8}$ of the cubic foot.

Farther, these 54000 grains are just 10 Saxon mint-pounds. I have already noticed, in speaking of the Roman capacity-measures, the coincidence between the *congius* and the English gallon—both being of the weight of 10 money-pounds; and I notice this weight again to

remark that, with the proportions of 12 and 15 ounces to constitute the wheat and wine pounds respectively, the vessel which contained 10 pounds of wine would hold just 8 pounds of wheat. In fact, some of the older editions of the English statutes have in this very place supplied the words, so as to make it read "8 pounds of wheat make the gallon of wine." Such an alteration, although it makes the deductions no clearer, renders the passage more symmetrical: it keeps the pounds to the computation of 12 ounces apiece; and, combining throughout the proportionate specific gravities of the two staples, it ascends from the weight of wheat to the measure of wine, and thence again crosses over from the weight of the gallon of wine to the measure of the bushel of wheat. With or without this addition, however, the statute finally weighs the bushel, and makes it $\frac{1}{32}$ of the ton.

Such is the analysis of this statute. Under it, and under the old laws which it was intended to re-enact, the gallon of wine was in dimension 216 cubic inches, or a cube whose side was 6 inches—the inch being almost or perfectly identical with its value at the present day; and the bushel must have been (accepting the proportions of the 12 and 15 ounce pounds as the ratio of the specific weights of wine and wheat,) in dimension 2160 inches, or such a vessel as filled with wheat would counterbalance a cubic foot of wine, the tare being the same in both cases. There is no wine-gallon remaining of exactly this size; but the Irish gallon—which we may presume to have been in accordance with this law, which remained till twenty years ago unaffected by the refor-

mations of the English standards; and by which the excellent wine of Bordeaux that one meets with in that island is yet measured—is of 217.6 cubic inches. So small a difference may warrant the supposition that the one was made for the other. If the vessel were a cylinder of the proportions subsequently defined in the first act prescribing a wine-gallon by linear measure, an excess in height by $\frac{1}{25}$ of an inch, above what was due under a constant pressure and temperature to 216 cubic inches, would give rise to the Irish gallon. And so with the bushel, a similar variation (but in the contrary sense) by $\frac{1}{20}$ of an inch would have produced the old Winchester bushel of the Exchequer, of 2145.6 cubic inches. Those who are familiar with the artistical manipulation necessary for capacity-standards at the present day, can best judge how likely would have been, at that period, such variations.

One might therefore plausibly maintain, if so inclined, that the so-called Winchester bushel, actually executed in the time of Henry VII., and found about two centuries later to contain 2145.6 cubic inches, failed, either by its own error, or by the degradation of the standard from which it was copied, to give the just content of 2160 inches aimed at by this or older statutes. And such an opinion would not be precluded entirely by the fact of there having been, at the time of the execution of this copy, a standard in the Exchequer much smaller (2124 inches), dating as of the period of the first successor of the Conqueror: for the difference between the two, coupled with the name of the former, would indicate for its original an age before the Norman settle-

ment, when, as under Edward the Confessor, Winchester was the capital of the kingdom.

I do not, however, myself mean to sustain this opinion. The name of Winchester was recognized for this standard in 1670, under Charles II., (for the first time by any English law, as far as I am aware, although the Maryland Act had so termed it, thirty years before); it is rather an excess of research to trace its title, as some have done, to the statute of Winchester, under Richard II.; and I think, finally, that I shall shew directly a much more natural and direct origination of this bushel of 2145.6 inches, though as long as the proportional gravities of wheat and wine remained uncorrected as being 8 to 10, the bushel of 2160 inches undoubtedly belonged to the undeniable wine-gallon, that was $\frac{1}{8}$ of the cubic foot.

It is hopeless to look for this correction anywhere but in the statutes themselves. We may arbitrarily assume it, as some have done, to have been manifested in the substitution of the troy and avoirdupois pounds for the old sterling and 15-ounce pounds: but what has been said already in this Report will shew, I think, that the troy and avoirdupois pounds have in reality nothing to do with it; different in the place of their origin, and in the epochs of their acceptation, coming in gradually with the articles and phrases of foreign commerce, they could not represent the proportionate gravities of substances, one of which was, at the time of the statute under consideration, extensively grown in Britain. We must admit an instance of most extraordinary balance of errors, or an example of sagacity more than human, if

we suppose that the English lawgivers, abandoning their own old Easterling weights, and going to one climate for a new nummulary pound, had selected from another a new commercial weight, because these two new weights would represent in England—what neither was calculated to do anywhere else—the specific gravities of wheat and water, respectively. And we have then to admit, besides, that the new proportions, so logically composed, do not, after all, represent the specific gravities of wheat and *wine*, which is the very point in question.

If, leaving this mode, we resort to actual experiment, and seek to retrace the steps our ancestors might have pursued, we find an issue hardly less vague. I need not stop to point out the causes of such vagueness, nor why it is unavoidable; I shall merely throw together in a tabular form the chief results which philosophers have sanctioned, or which, as part of national establishment, remain to be quoted this day:—

	Weight under equal volumes.	
	Wheat.	Wine.
Roman proportion of 12 to 16 oz. . . .	144.	192.
Pliny's account of Gallic wheat . . .	144.	186.88
Saxon proportion of 24 to 32 grains . .	144.	192.
Saxon proportion of 12 to 15 oz. . . .	144.	180.
Sir Jonas Moore's experiment on British wheat .	144.	199.32
Oxford Phil. Soc. experiment in 1685 . .	144.	185.21
Experiment on the bushel of 2145.6 inches in 1696	144.	177.55
Troy and avoirdupois proportion in Arbuthnot .	144.	174.86
Troy and avoirdupois proportion . . .	144.	175.
President J. Q. Adams' deduction, 143 : 175, or .	144.	176.22
Standard wheat in Maryland . . .	144.	184.32

The wine in this table is rated throughout at 250 grains troy per cubic inch.

It is apparent from this that observations on a small scale, at least, lead to no accordant or useful result; and to open the combinations of reasoning or error which have produced wine-gallons from 217.6 to 231 cubic inches, and bushels from 2124 to 2224 cubic inches, we must find a key somewhere else.

In fact, a statute of 2° Henry VI., A.D. 1423, which, like the one we have just come from, professes to exemplify the ordinances "of old time," does unlock all the difficulty: by it, the shipping unit—the ton—in which both liquid and dry capacity-measures finally merge, and which by the so-called Act of 1266 had been applied to the measure of wheat, is here extended and applied to the measure of wine. It prescribes, as the old assise of the ton, that

the tun of Gascoigne wine should be	252 gallons
the pipe	126 gallons
the hogshead	63 gallons.

Now, comparing the two assises together, we find the hogshead of wine equiponderant with the quarter of wheat; four of either constituted a ton, or tun, of shipping. But if we keep to the ratio of the 12 and 15 ounce pounds, and apply the terms given in the assise of 1266, we must make the hogshead (not of 63, but) of 64 gallons; such being the number of corn-gallons in the quarter of wheat. The proportionate difference between these two numbers is the discount which our ancestors, not in 1423 only, or in 1353, (when, by another statute, this assise of the tun is also referred to,) but in both these years, as "of old time," found necessary to make upon the commercial pound of 15 ounces, in order

to have the physical equiponderance which both the symmetry of the system and the balance-sheet of the merchant required. This discount results in a commercial pound of ($\frac{63}{64}$. 15=) 14.765625 ounces; and for specific weights of wheat and wine, in the ratio of 144 to 177.1875.

This will be perfectly plain, if any one will take the trouble to tabulate all the results of the several factors in the two systematic developments of these two statutes. I shall present here an extract from such a tabulation :—

WHEAT SYSTEM, *or Nummulary Reckoning.*

Ton.	Quarter.	Bushel.	Gallon.	lb.	oz.	dwt.	Grains of wheat.
1	4	32	256	2048	24576	491520	15728640
1	4	—	252	2016	30240	604800	19353600
Tun.	Hgshd.		Gallon.	lb.	oz.	dwt.	Grains of wheat.

WINE SYSTEM, *or Commercial Reckoning.*

The numbers expressive of gallons and pounds in this table require to be applied inversely to 15 ounces, to give the rational commercial pound; while those from the ounces inclusive are directly in the proportion of the relative gravities of wheat and wine. All lead to the same numerical result.

It makes no difference, whether this proportion was accepted from caprice or by trial; from its near accord with the experiment of 1696 given in the table, it was most probably from the latter. Nor is it even of moment whether it is the *true* proportion, in the sense of a universal natural law; such as has been imagined and eloquently insisted on by a distinguished writer upon the subject in the United States. The simple question is, what was the adopted proportion?—and to this, the

statutes return, I think, a straight and decisive answer. That the answer should not have been listened to before is of no importance.

With this recognized proportion, we may now proceed to the exposition of the various liquid and dry standards which have been constructed at different epochs; and shew how the discrepancies which I have already alluded to had their rise. I may remark first, however, that such capacity-*measures* are with propriety so named: they originated primarily from linear measures, although determined correlatively by weight. The common unit was the foot: the half-foot cubed gave the content of the liquid gallon, which would hold also 8 money-pounds of grain; and corresponding was the corn-gallon (unfortunately termed so), as much larger than the wine-gallon as 177.1875 is greater than 144, and intended to hold likewise 8 commercial pounds of wine. But the corn-gallon, filled with wheat, and the wine-gallon, filled with wine, were equiponderant.

Similarly equiponderant were to be the contents in wine of the unitary foot when cubed, and the contents in wheat of the bushel, whose volume was to that of the cubic foot as 177.1875 to 144; all the relations of the bushel to the cubic foot were similar to those of the corn to the wine-gallon; and as the cube of a foot is 8 times that of the half-foot, so the capacity of the bushel is 8 times that of the corn-gallon.

I need not go through the elementary transformations of these numerical data; it is sufficient to present the results. The wine-gallon of 216 inches thus gives a corn-gallon of 265.78 and a bushel of 2126.25 cubic inches.

The bushel in the Exchequer marked 1091, and now deriving fresh support for that as the true date, was 2124 inches; and the Rumford corn-gallon of 1228 contains 266.25 inches. The Rumford quart gives 264.8 inches; and the mean of the two a gallon of 265.53 inches. Such differences, assuming absolute accuracy in the workmanship, are positively within the influence of temperature at opposite seasons of the year.

Compared with the gallon of 216 inches, the Irish gallon of 217.6 is outside the limits of temperature; and we must suppose either that an allowable error occurred in the workmanship of the standard, or that there was a designed correction of the old Roman assumption of water and wine being equiponderant. Taking the specific weight of water as 1, and the gallon of water at 216 inches, the Oxford experiment in 1685, which found for claret or Gascoigne wine a specific gravity of 0.993, would re-affirm the possible observations made before 1266, and result in an equiponderant wine-gallon of 217.52 inches. But, however this may be, the actual new unit of 217.6 inches corresponds, upon the preceding data, to a corn-gallon of 267.75 and a bushel of 2142 cubic inches. Such a corn-gallon is rather larger than even the Rumford gallon, and indicates therefore the anomaly of the wine-measure unit. But the bushel is no doubt the original of the Winchester bushel; which I take to have been introduced by the Third Henry, surnamed of Winchester, and to have been thus denominated to distinguish it from the other and smaller Rumford measure before in use.

Such was the state of the capacity-standards, down to

nearly the close of the fifteenth century, under Henry VII. In the seventh year of this Prince (in 1491) an act of the Commons requested that standards might be made, for distribution to the counties, conformable to these in the Exchequer; and again in 1495, a statute directed their construction, and closes with a schedule of forty-three county-towns, in which such standards are to be deposited. It gives no prescription as to the assise, farther than that there should be "8 bushels raised and stricken to the quarter of corn; 14 pounds to the stone of wool; and 26 stone to the sack." But in the very next year, 1496, another statute, after referring to the preceding and to its actual execution, recites that the weights and measures made under it, "upon more diligent examination had synz the making of said statute, proved defective and not made according to the old laws and statutes thereof ordeyned within the said realm. Wherefore," it goes on to enact, "that the measure of every bushel contain 8 gallons of whete;

every gallon 8 pounds of whete, troi weight;
every pound 12 unces of troi weight;
every unce 20 sterlings; and

every sterling be of the weight of 32 cornes of whete that grow in the middles of the eare of whete, according to the old laws of this land." It directs, then, that all these erroneous measures be sent back "to be broken, and with the stuff and metal of the same—other new ones be made."

This is the statute referred to in the Maryland Act of 1671; and of which I have already said, that it legalized neither the Winchester bushel nor the habitual

wine-gallon of the province. The Winchester bushel can by no contrivance be made out of it; the Maryland wine-gallon, which contained then (as now) 231 cubic inches, does indeed flow from it, if when it says "gallons of wheat," one supposes it meant gallons of wine: but such a gallon was not legalized by it, for none such was made under it. The wine-gallon of 231 inches was first made legal more than two centuries later (in 1706), by the statute of 6 Anne; although the popular opinion, both in England and in Maryland, for a long time antecedent, had been that such was the true intended size of the gallon. I incline to think that no wine-gallon was made immediately upon this Act.

For in the Exchequer in 1688, when an inquiry was instituted in regard to the Excise, there appears to have been no wine-gallon at all; only corn-gallons. And the wine-gallon at Guildhall, by which the guaging of liquors in the port of London was regulated, and which was currently estimated to hold 231, the Excise-commissioners found to contain but 224 inches. This Guildhall gallon was therefore most probably made under the former statute of 1495, and thus may have contributed to those errors which, more flagrant in the larger measures, induced in 1496 the recall of the latter. Why it was not recalled itself, can now only be conjectured.

The terms of the law of 1495 indicate how the gallon of 224 inches grew out of the old gallon of 216 inches. By that law, the sack of wool was to be 26 stone, and the stone, 14 pounds; so that the sack weighed 364 pounds. By the old laws of the land, the sack was to weigh but 350 pounds. These two different weights

are, as I before observed, in the proportion of the Saxon commercial pound (of 6750 grains) and the Roman avoirdupois pound (of 7000 grains); and this proportion inversely is almost exactly that of the gallons of 224 and 216 inches. The artists of Henry VII. must have weighed by the avoirdupois pound instead of the old easterling 16 ounces. Such a wine-gallon, raised by the constant proportion which I have given before as maintained between the gravities of wine and wheat, would give a corn-gallon of 275.625 inches and a bushel of 2205 inches: if the ratio of 350 to 364 were used, it would give a corn-gallon of 276.41 and a bushel of 2211.28 inches;—neither of them very materially differing from the Exchequer gallon of Henry VII., of 272, and the bushel of the same monarch, of 2224 inches.

These last standards, however, were most likely made under the following Act of 1496. As they had used avoirdupois weight in the construction of the wine-gallon of 225 inches, and as the law now required troy weight to be employed for the wheat-pounds, we may date here the dereliction and final loss of the old ratio of weight between wine and wheat (viz. as 144 to 177.1875) and the adoption of a new one, the ratio between troy and avoirdupois, viz. as 144 to 175. Using this last ratio, the corn-gallon corresponding to the wine-gallon of 224 inches would be 272.22 inches; almost identical with the gallon of Henry VII. A gallon of 272.25 inches is the one used by Arbuthnot in his Tables; and, forty years ago, was actually legalized by act of Parliament.

But this gallon would make a bushel of 2177.78 cubic inches, which corresponds with no existing standard, and is very far from the Winchester bushel, copied by Henry VII., and accepted long before the accession of the House of Hanover. If, then, in the time of George III. such discrepancies could be admitted, we are authorized to tolerate their occurrence in that of Henry VII., and to trace his bushel of 2224 inches from a wine-gallon of 230.4 inches, by the same proportion of troy and avoirdupois weights.

Troy weight was, we know, one-fifteenth heavier than the old sterling weight; and equivalent volumes weighed by the former must be sixteen-fifteenths of those weighed by the latter. Thus a volume of 216 cubic inches weighed in old sterling, and a volume of 230.4 inches weighed in troy, will shew the same weight in the different denominations. A wine-gallon of this last content, raised by the wine and wheat proportion of the old laws of the land, gives a corn-gallon of 283.5, and a bushel of 2268 cubic inches; raised in the new proportion of troy to avoirdupois, its corn-gallon is 280 and its bushel 2240 inches. This last was the aim nearly attained by the large bushel of Henry VII.; and the gallon of 280 inches was exactly reproduced by the standard of 1601 in the Exchequer. The small bushel of Henry VII. of 2124 inches was a copy from, and identical with, the old Rufus bushel; and his Winchester bushel of 2145.6 intended for the Irish bushel of 2142 cubic inches.

That the phrase in the law of 1496—"the *measure* of the bushel"—should be interpreted, like some have

done, as if the English law-makers of that epoch forgot, or misunderstood, the idea of equiponderance to which their people had been habituated for nearly a thousand years, and meant to substitute *measure* for weight, hardly follows, even grammatically: it is disproved, in fact, by the existence of the corn-gallon of 272 inches, which cannot be made out otherwise than by weight. Computed by measure alone, the wine and corn-gallons would have been of the same capacity, viz. 224 or 230.4 cubic inches, and the bushel of 1792 or 1843.2 inches; a shocking violation of the habits of the people, which did not need to have been inflicted in forty-three different places before it made itself felt, but would have reacted before the standards that exemplified it had left the purlieus of the Tower. The legislators of 1496, to be sure, did not appreciate the symmetry of their early system, or they never would have engrafted, without a salvo, troy weight upon sterling; and those who executed their laws may have appreciated it as little and understood it less, or they never would have made three different bushels (and so different) in the search after uniformity: but neither were so steeped in error as to presume, and to act upon the presumption, that wine and wheat were of the same weight. Finally, the phrase of the law of 1496 is, as far as possible, and its numerical quantities exactly, the same with the old laws which it was intended to renovate. The radical mistake, only, was what had originated two centuries before under the first Norman Edward, had been going on ever since, and reached its climax in height, though not all its development in extent and variety, now. This was the

non-conformity between weights and coin; and this made the old laws speak a language hard to be understood, because the things were no longer existing which their words expressed.

From this time, the end of the fifteenth century, until the beginning of the seventeenth century, no new standards appear to have been made by any public authority; the capacity-measures of Elizabeth, like the linear ones, replace those of Henry VII. The law of 1496 did not expressly mention any gallon for wine: but I have already shewn how the habitual popular interpretation must have demanded one, and how it came in the immediate execution of that law to be 224 cubic inches, and in subsequent theory to be 230.4 inches. This last value gave rise to some of the standards of 1601. Of this date, there are gallons of 270.4 and 271 inches; a quart and pint belonging to gallons of 280 and 278.4 inches, respectively; and a bushel of 2128.9 cubic inches. The gallons were copies of the Henry VII. corn-gallon; and the bushel, of the same prince's small one of 2124 inches, which was itself identical with the most ancient standard. The quart and pint were made upon the gallon for wine of 230.4 inches, augmented in the proportion of 5760 to 7000 for the corn-gallon. Such an augmentation gives a content of exactly 280 inches.

This wine-gallon of 230.4 inches was never positively executed; it existed only as an arithmetical deduction from the number of inches in the eighth part of a cubic foot, and therefore might very well, for ease of remembrance, be taken in round numbers as 231 inches. In

point of fact, the round number is exactly divisible by 7; and a cylinder of 7 inches in diameter and 6 inches in height is almost exact in the content. Such was the guage actually adopted about a century later, when the gallon itself was made the subject of a statute. I may remark here, that it was the estimate of 231 inches for the wine-gallon and the positive corn-gallon of 280 inches which produced the ratio of 14 to 17, for a long time accepted between the troy and avoirdupois weights. The comparison of other standards afterwards (about a century ago) modified this into a proportion of 14 to 17.5, and at length into 144 to 175, identical with 5760 to 7000 grains.

That the count of 231 inches was current before the time of the Elizabethan standards, is indirectly proved by a statute of the same reign (13° Eliz. A.D. 1570) relating to the herring-fishery. It appears that informations had been laid against the herring-barrels, which had been usually guaged and allowed in London at 32 gallons wine-measure, for not containing 32 gallons corn, or rather *ale*-measure; and this information was founded, 1°. upon there being no wine-gallon in the Exchequer, the depository of the legal standards, but (as I said before) only corn-gallons; 2°. upon a statute of Henry VIII., five-and-thirty years before, which required the coopers to make barrels for ale to contain 32 gallons, corn-measure; and 3°. upon "the extremity of old statutes in words by some men's construction," as the Act itself expresses it, coupled with an indignant denial. To quash these informations, and preserve the herring-fishery from disturbance, the Act summarily de-

clares, that "thirty-two gallons wine-measure, which is about twenty-eight gallons by *old standard*, shall be the lawful assize of herring-barrels, any old statute to the contrary notwithstanding." The ratio of 32 to 28 is very nearly that of the corn-gallon, derived from the sub-octave of the cubic foot, and exhibited in the Rumford standards of the Exchequer, to a gallon of 231 inches: so that the *old standard* of the law must have been these Rumford measures, and the habitual wine-measure must have been recognized at 231 inches. The *old statute* referred to was doubtless the earliest Assise for weights and measures of 1266 (so called), whose details I have already given.

We may see here a fresh development of the misunderstanding of the Saxon system of measures that was exhibited by the Act of 1496; a misunderstanding which, although plain enough to us now, the phrase of the Assise of 1266, and the singular symmetry and correlation of its terms, contributed to foster. When that Assise says, that "eight gallons of wine make the London bushel," the legislators under Elizabeth seem to have read it as if by volume, not by weight; the gallon *of* wine and the gallon *for* wine they held as synonymous; and as they found no other ancient gallon in the Exchequer but the Rumford measure, which was in volume the eighth part of the bushel of William Rufus, they naturally concluded that to be the *old standard*, and termed it so accordingly. How, or why, there should be a newer smaller standard for wine, they do not, at this session at least, appear to have known: if they had, the occasion was every way proper for saying so.

It is clear that the knowledge on the subject did not increase during the following century: for all that time, no actual standards had been made; and several statutes that were enacted, confined themselves to the enforcement of the measures already existing. One of 22° Car. II., A. D. 1670, prescribing by name the Winchester bushel of the Exchequer, I have already referred to. In 1688, the Excise-commissioners desired to learn why there was one gallon for wine and another for beer; and it was upon this inquiry that the Guildhall gallon was guaged to contain 224 inches, which, although there was reported to have been an Exchequer gallon of 231 inches, they found reason to conclude was the true wine-gallon. Three gallons in the Exchequer (one of Henry VII., and two of Elizabeth) were found to contain 272 inches. Other standards, which I have already mentioned, and which were measured upon a later and more exact inquiry, do not appear to have been examined. As beer and ale were liquids as well as wine, and as the excise-revenue would be augmented by taxing on a smaller gallon, they proposed to adopt the Guildhall measure throughout. But difficulties being, of course, made by those who had to pay the duties, and the opinion of the Attorney-general being solicited in the matter, that officer, after an examination in the statutes said, that he did not know how the 231 inches came to be taken up, inasmuch as there was no positive standard of that size; that the smaller gallon at Guildhall would not be maintained as a legal standard by the courts; that the larger gallons of 272 inches, if adopted throughout, would cause a vast loss to the revenue; and

finally, that it was safer to adhere to the usage. This opinion terminated the question for the time.

In 1696, under William III., an act of Parliament declared that "every round bushel with a plain and even bottom, being 18.5 inches wide throughout, and 8 inches deep, shall be esteemed a legal Winchester bushel, according to the standard in his Majesty's Exchequer." The actual Winchester bushel in the Exchequer had been found at this time to contain 2145.6 inches; and the dimensions adopted in the statute were intended to come as nearly as possible to that capacity, without resorting to small fractions. It was therefore, like the count of 231 inches for the wine-gallon, a compromise for convenience. But it destroyed both the symmetry and the principle of dry measures, in introducing a new and arbitrary method of computation by cubic inches instead of pounds. The same method was very shortly after applied also to the liquid measures.

This was the more to be regretted, because they were at this time upon the verge of discovering the proportions and reasonableness of their earlier standards; they had indeed the key in their hand already. The Oxford experiment in 1685, which I have referred to in the table just now, had made a cubic foot of pump-water to weigh 1000 ounces avoirdupois; and the trial in 1696, which I have also quoted in the same place, shewed the Winchester bushel of wheat to weigh 1000 ounces avoirdupois, too. The ratio from this last gives almost identically the same factor for wine and wheat weights, which is furnished by the old Assise of the tun; and had

they gone on to guage the Rumford measures and the Irish gallon, they would have found at every step most satisfactory coincidences with the ancient laws that Sir Thomas Powis had in vain otherwise tried to reconcile. But having long lost all coincidence in their coin, (for although the English money was still called *sterling*, it bore no relation to the *easterling* pound,) they lacked encouragement in the very first step; they took the gallon of wine to be a phrase as antiquated and vague as the penny sterling: and this novel and accidental coincidence between the cubic foot of water and an inaccurate bushel of wheat, drove them still farther astray. All the speculations of the period laboured to explain, by the avoirdupois weight of water, a system which was founded upon the easterling weight of wine.

In 1700 occurred a new case for inquiry, in which the Attorney-general again figured; but not more successfully now in the forum than before in his chamber. A merchant had paid duties on sixty butts of Alicant wine at the rate of 126 gallons the butt; but the guaging had been by the reputed capacity for the ale-gallon of 282 inches, instead of the actual Guildhall wine-gallon of 224, or the reputed wine-gallon of 231 inches. I call this the *reputed* capacity, because, although the positive standard at the Treasury was admitted by both parties to contain 282 inches, and such was very likely its accurate content, yet such a capacity had not been intended when the standard was made, nor does it conform to any possible theoretical aim. When made for the Treasury, or removed there from the Exchequer, either it was copied from the gallon of 280 inches of 1601, or from the large gallon of Henry VII., which

should have been of 283.5 inches; or it was founded upon the $\frac{\text{avoirdupois}}{\text{troy}}$ ratio, multiplied into the reputed wine-gallon of 231 inches. Such a ratio and multiplication would give dimensions of 280.73 inches. Or, finally, it may have been intended to have been made as much larger than the earliest Rumford measures, as the admitted wine-gallon of 231 inches was larger than the Irish gallon; which, both being of remote antiquity, were very properly suspected to be somehow connected together. This computation gives a content of 281.85 inches. However derived, the round numbers must have been, like the wine-gallon itself and the Winchester bushel, a compromise for the convenience of linear guaging.

When the case was tried, the Crown proved—1°. that by the old Assise of the tun and subsequent statutes, the butt ought to contain 126 gallons; 2°. that by agreement of all the guagers, a wine-gallon was of 231 inches—which content they all ascribed to the Guildhall gallon, though it does not appear to have been re-measured since 1688; 3°. that the Exchequer gallons of 272 inches were for corn only, and the Treasury gallon of 282 specially for beer and ale. The defendant, Barker, proved—1°. that the 126 gallons of the old Assise referred to Bordeaux wine, and that as far back as 1327, at least, a statute of Richard III. admitted the Spanish wines in butts of 140 gallons; 2°. that by the agreement of all the dealers, his butts were of the size that had been habitual as long as any one could recollect; 3°. that by the standard kept at the Treasury, as the law required, he had paid the duty, and that with the distinctions of wine, corn, and ale-gallons he had no

concern. Upon this the suit was given up; but the advice of the Attorney-general, that Parliament should remedy the matter, was followed, and shortly after was passed the statute of 6° Anne (A.D. 1706), by which the gallon for wine was fixed (following the example of the Winchester bushel), by declaring it to be any uniform cylinder of 7 inches diameter and 6 inches high, or any vessel containing 231 cubic inches, and no more. I have not room here to do more than notice a curious coincidence between this determination and what was made for the so-called *congius* of Vespasian, the Roman wine-unit. The proportion between $\frac{1}{8}$ of the Roman cubic foot and Vespasian's measure is almost exactly as 216 to 231, or as $\frac{1}{8}$ of the English cubic foot to the wine-measure of Queen Anne. By what destiny is it that, with nations more than 1600 years apart, there should be this close numerical accord?

A few years after, a statute of 13° Anne legalized the habitual coal-bushel to be of the contents of a Winchester bushel of William III. and a quart; cubically, therefore, it would be 2217.62 inches, struck. The phrase of the law, which requires 19.5 inches in diameter from *outside to outside*, had reference to the base of the cone upon which the heap was to be made; for coal was always sold by heaped measure. In practice they had, besides, a contrivance for making a conical strike.

From this time until the Committee of 1758, there appears to have been no important movement made in regard to the standards. I have already spoken of the labours of this committee, and their late success, with reference to the length-measures and weights: in the capacity-measures they were even more industrious, but

less fortunate. Fifty folio pages of research and speculation attest the interest with which they viewed their subject; and a guaging of the old standards in the Exchequer, elaborate and reliable, (for it was made by Bird,) has furnished the numerical data to all succeeding inquirers. But their very success in the others was prejudicial to this part of their examination; the old sterling weights were hidden from them behind the larger troy and avoirdupois, which they found accordant and pervading; and finally, hearing in the old statutes and the new, the perpetual refrein of *one weight and one measure throughout this realm*, they could not, any more than Sir Thomas Powis, comprehend how such *oneness* could co-exist with two different measures called by the same name. Had the half-peck never been named the gallon, their difficulty must have vanished.

Although, therefore, the proportions of 231 and 282 in the wine and ale-gallons confirmed their favourite troy and avoirdupois, they proposed to do away with the former entirely, and thus realize the aspirations after *one measure:* they would have preferred a gallon of 280 inches, as resting both upon a more accurate and convenient arithmetic, and upon a more ancient and legal precedent. But this last would have required a new establishment of guaging apparatus for the Customs: the Alicant case, which I have just detailed, came to their assistance to prove that the guage by 282 inches, in legal use for domestic fermented liquors, was also a measure for Spanish wines; neither of the three, separately or together, remained in any useful connection with the bushel, the unit of dry measure; and the committee therefore recommended the adoption of the gallon

of 282 inches as the unit of all liquid measure. They do not appear to have reported any model of this standard, as they did of the yard and troy pound, (and, as we read in some of the histories of England, they did of all,) to Parliament.

Of the immediate event of their recommendations I have already spoken, as well as of the less marked labours of a Committee in 1790, which followed upon the invitation of the French Government in that year, for England to join in the enterprise of an universal uniformity of weights and measures. It was not until 1814 that the question was again taken up, and, upon the return of a general peace in 1816, reported to Parliament by a Commons' Committee. I have designedly left this proceeding to be spoken of here, because, as regards the positive measures of length and the weights, they were hardly the subject of discussion. The yard of 36 inches, they thought, should be compared with the pendulum, or perhaps an arc of the meridian, or both, with a view to its permanency: and there was a vague proposition, which I have found in the testimony taken about that time, to alter the avoirdupois weight so that the ounce in that system should be really $\frac{1}{1000}$ of the cubic foot of water; as it had, ever since the Oxford experiment, been counted to be. The committee proposed to attain the same result by altering the standard temperature of the water from 60° or 62° to 56°.5 F.

Their most important suggestions, however, related to the capacity-measures. Like their predecessors in 1758, they thought there should be but *one measure;* and they proposed its ascertainment by the weight of distilled water it might contain. The weight they recommended—

80 lb. for the bushel at 56°.5 F., which gave the gallon 10 lb. and the quart 40 ounces avoirdupois, and made the half-pint exactly $\frac{1}{100}$ of the cubic foot—seems to have originated with Dr. Wollaston; and the controlling reason appears to have been "the advantage of making the subordinate measures in integers." Another eminent philosopher, (Professor Playfair,) testifying to the committee, thought "it would be better to take the bushel at 2160 inches, because it differs but little from King William's Winchester bushel, and because it is in the simple proportion to the cubic foot of 5 to 4;" but he did not seem to be aware that this was in fact the earliest English measure, nor did either of the *savans* hint to the committee that they were in substance going back to the old Roman quadrantal.

Such were the influential recommendations which came before the scientific Commissioners appointed by the Government in 1818. Of the results of their investigation touching the other measures I have already made mention; as to the capacity-measures, they adopted the general principles which one of their number, Wollaston, had already indicated in 1816. A more exact experiment led them to modify some of the details; as, for instance, the temperature, and, along with that, the positive cubic capacities. They reported that "the gallon measure should in future be that which contains 10 lb. avoirdupois of water in ordinary circumstances (that is to say, the temperature of the water being 62° of Fahrenheit's thermometer, and the barometer 30 inches); and that eight such gallons should be a bushel."

I shall not speculate upon the process of thought by which the commissioners arrived at these proportions:

they did not find fit fully to exhibit its train themselves. It is sufficient to say, that the conclusions of their third and final report made in March, 1821, were accepted and affirmed by a select committee of the Lords about two months afterwards; and that at length an Act of 5° Geo. IV. in 1824 (to take effect from January 1, 1826, by a subsequent Act,) legalized these proportions, and declared this gallon so defined, under the name of the Imperial Standard Gallon, to be "the unit and only standard measure of capacity." The Act, however, qualifies this to a certain extent, by saying that it is to be applied to liquids and *unheaped* dry articles; articles habitually sold by *heaped* measure (coal, potatoes, &c.) were to be measured by the bushel of 80 lb., or of 8 such gallons, with a cone of 6 inches in height, and a diameter of base from outside to outside of 19.5 inches, as in Queen Anne's coal-bushel.

Expressed cubically, according to the weight of water as ascertained by the commissioners, the gallon would contain 277.274 inches, very nearly; and the bushel, 2218.19075 inches. These dimensions remain unaltered, so far as I am aware, to this day; though there have been several succeeding laws, restricting or enforcing the terms of the first one; as, for instance, the Act 4 and 5 William IV., which abolishes *heaped* measure. But as from this point our standards and those of Great Britain diverge, it is not necessary to pursue their history any later. I shall close now what I have thought necessary to be said, by presenting in one page a view of the English capacity-measures in their several successive phases, together with the probable analogies which led to their occurrence.

TABLE *shewing the Values in English cubic Inches of the English Liquid and Dry*

	WINE MEASURE.		CORN MEASURE.	
DATE. A.D.	GALLON IN THEORY.	ACTUAL GALLON.	BUSHEL IN THEORY.	ACTUAL BUSHEL.
Ante 1000	216.	. .	2160	. . . .
1000—1266	216.	217.6 Irish gallon.	2126.25	2124 Wm. Rufus of 1091 2124 Hen. VII.,* 1496 2128.9 Elizabeth of 1601
1266—1491	217.6	217.6 do.	2142.	2145.6 Winches. bushel; copy for Hen. VII. 2150.42 do.; Wm. III., 1696
1491—1496	.	. . .	. . .	. . . .
1496—1705	224.	224 Guildhall gallon.	2205.	2224 Hen. VII.,† 1496 2217.62 Coal-bushel of Queen Anne, 1712
	224.	224 do.	2177.78	2178 Bush. of Geo. III., 1805
	230.4	231 by 5 Anne, 1705. [231 Exchequer gall. 1688?	2240.	2224 Henry VII.?
	230.4	231 do.	2268.	. . . .
	231.	231 do.	2245.83	. . . .
1705—1822	231.	231.2 Excheq. gall., 1707.		2150.42 for Corn 2217.62 for Coal
1822—1857	277.27	277.3 Imperial gallon.	2218.19	2218.19 Imperial bushel

* no rim. † rim.

Capacity-Measures at different Epochs, and the probable Formulæ of their Variations.

CORN MEASURE.

CORN-GALLON = 1-8 OF THE VOLUME OF THE BUSHEL.		FORMULÆ.
THEORY.	ACTUAL.	
270.		Wine-gallon = $\frac{\text{Cubic foot (1728 in)}}{8}$. Bushel = $1728 \cdot \frac{15}{12}$. *Earliest Saxon Epoch.*
265.78	266.25 Rumf'd gall. of 1228 264.80 Rumford qt. of 1228	Bushel = $1728 \cdot \frac{15}{12} \cdot \frac{63}{64}$. *Epoch of the Rumford measures.*
267.75		Wine-gall., = $\frac{1}{8} \cdot \frac{1728}{0.993} = 217.5227$. Bushel = $8 \cdot 217.6 \cdot \frac{15}{12} \cdot \frac{63}{64}$. *Epoch of Winchester measures.*
. . . . .		*Transition Period.*
275.625	272 Henry VII., 1496?	Wine-gallon = $216 \cdot \frac{7000}{6750}$. Bushel = $8 \cdot 224 \cdot \frac{15}{12} \cdot \frac{63}{64}$.
272.22	272 Henry VII., 1496 271 Elizabeth, 1601 EE. 270.4 do. do. E. 272.25 Geo. III., 1805	Bushel = $8 \cdot 224 \cdot \frac{7000}{5760}$. Troy and avoirdupois together.
280.	282 Gallon, supposed of Henry VII. 280 Eliz. quart of 1601 278.4 do. pints 1601-2	Wine gallon = $216 \cdot \frac{16}{15}$. Bushel = $8 \cdot 230.4 \cdot \frac{7000}{5760}$.
283.5	282 Treasury Ale-gallon?	Bushel = $8 \cdot 230.4 \cdot \frac{15}{12} \cdot \frac{63}{64}$.
280.73	282 do. do. 1688	Bushel = $8 \cdot 231 \cdot \frac{7000}{5760}$.
282.	282 for Ale	*Period of Confusion.* Standards all independent. Ale-gallon copied from Hen. VII.'s bush. combined with Irish gallon, thus—$\frac{2124}{8} \cdot \frac{231}{217.6} = 281.85$?
277.27	277.3 Imperial gallon.	*Uniformity of Proportion abolished.* Capacity determined by weight of distilled water at 62° F. 30 B.

I have been thus copious upon the subject of the English capacity-measures, because of its intrinsic interest and the acknowledged extrinsic difficulties besetting it. When I read, in the latest legislative report upon it, such passages as this—that "the gallon of England was originally identical for all uses, and that variations have arisen, in some cases from accident, in others from fraud;" or this—that "the wine-gallon is supposed to have gone on shrinking, until its progress was arrested by a fiscal definition at 231 inches," and saw how then these last explorers threw away their torches in despair,—I could not but be irresistibly attracted to ruins which are inscribed in dignified and now venerable statutes as having once contained wisdom-treasure "of old time," and in which I think I find the traces of the most beautiful and uniform system that ever regulated commerce between man and man.

In calling the Saxon system *uniform*, I do so intentionally and upon reflection. The term *uniformity* can only be predicated of an assemblage of elements or individuals; a single individual, uncontrasted, has nothing to be uniform with. A unit, in weight or measure, may be repeated or multiplied or subdivided in different parts of the system; and such repetitions are to be called *identical*, and the system itself *unitary;* but as long as our language remains true to its radicals, it can hardly be said to be *uniform*. Besides this, there is another consideration necessary to complete the idea of uniformity in this regard; and this is the correspondence between the weights or measures (which are but the indices or representatives for articles of commerce,

grown or manufactured,) and the articles themselves, so indicated or represented. In both these aspects the early English system, prior to the fourteenth century, is more fully uniform than any modern establishment. By it, the properties of numbers, extension, gravity, and content all conspired to one result; and, wherever applied, reached their results in one way. An arithmetical harmony governed in the subdivision of linear measures, and fixed the number of pounds to the gallon of wine as well as the number of grains in the bushel of wheat; linear extension, defined on a positive standard, measured the content of the gallon and weighed (as it were, in the balance of the sea) the ton; between gravity and content, no more terse and suggestive description of uniformity could be devised than the phrase of the Great Charter which says, 'of weights it shall be as of measures;' and finally, there can be no fuller correspondence between an index and the things indicated, than was manifested while the respective measures of liquid and dry substances reciprocally served to weigh each other, and the coins, the necessary implements of commerce, weighed both. In this system, uniformity not only co-existed *with*, but existed *because* of, the several unitary elements of which it was composed.

If modern establishments lay claim to a similar or paramount uniformity, it must be upon the same principle; but a calm examination might shew, I think, that this has not always been attended to, and that people, as Mr. Adams has already remarked, have sometimes taken *uniformity* to be nothing else but *identity*. For such an examination there is here no occasion, and I

shall, therefore, not contrast the weight and measure system which we have been contemplating, with (for instance) the newer metrology of France,—where occur two different units, neither derived from nor in any physical correspondence with commercial substances, and where the principal uniformity is in the harmony of decimal progression; nor again with the present establishment of Great Britain,—where there are also two units, and one of them entirely local, and not, in the present state of science, perfectly referable anywhere else,—where articles so dissimilar as wine and wheat, coal and potatoes, are rated by one measure, and that not founded upon the weight of any one of them, but upon the space occupied by an even (but neither a square nor a cubic) number of pounds of water. I shall rather proceed to a brief account of the steps which led to the establishment of the system in the United States.

The commercial dependence of the American provinces upon Great Britain, notwithstanding the actual differences in colonial origin of some of them, would naturally tend to a sort of identity with the English standards of weight and measure. We have already seen what was the case in Maryland; and in point of fact, at the establishment of the American Confederacy, all the thirteen States had legalized the measures of England. Five of them had named the Winchester measures in their laws; of the rest, all but one had, under the epithets *Exchequer* or *London*, accepted either the Winchester bushel, or one, derived from a gallon of Henry VII., of 2177.78 inches. The single exception was Connecticut, which had

taken a gallon of 224 inches for wine, and one of 282 inches for ale: this last was intended to be the eighth part in volume of the bushel.

When the States became independent, a zeal for repudiating all old connections possibly augmented the stimulus which at the time, as I have already said, was pervading many parts of the civilized world, towards the research after uniformity and an absolute indelible measure. At all events, as early as August, 1785, the Board of Treasury was directed to "report an ordinance fixing the standards of weight and measure throughout the United States." But the still revolutionary character of the period, and a coming crisis plainly marked, were unpropitious to any immediate result; and at the adoption of the present Constitution, the matter stood as it had done for years before.

The second session of the First Congress under the Union was held in New York on 4 Jan. 1790, and five days afterwards President Washington, in his speech, called the attention of the Legislature particularly to the subject. A suitable reply, promising "early attention," was made in the Senate, and in the House of Representatives an order was passed calling upon the Secretary of State (then Mr. Jefferson) to prepare and report a proper plan or plans for establishing uniformity in the currency, weights, and measures of the United States. Six months later the report was received by the House where the call had originated; and it was communicated to the Senate on 23 Dec. of the same year, after a fresh special invocation by the President's address upon the subject of which it treated.

This document was quite characteristic of the eminent person by whom it was prepared. An admirer of the French philosophy, he took as the basis of the new system what had been almost simultaneously proposed publicly to the National Assembly of France by Talleyrand, and in the earlier discussions with regard to which, Mr. Jefferson very probably himself assisted during his residences in Paris. This basis was the seconds-pendulum, in the parallel of 45° N. latitude. But the report was made before Borda and his colleagues in France had shewn the inferiority of what may be called a *dynamical* to a *statical* standard, and the other pursuits of its author had not allowed him to attain sufficient acquaintance with practical science to be entirely aware of the mechanical difficulties which the plan he proposed would have to encounter, or the uncertainties it must submit to. I believe that not many, at the time or since, have considered as a misfortune that neither of the propositions it contained was adopted.

The report comprehended two distinct plans: 1°. to render uniform and stable the existing system—by comparing and fixing the unit of length with the pendulum, to which also superficial measures would be referable; by abolishing the distinction between liquid and dry capacity-measure, and fixing the unit of the latter (now to become the unit for both) at some medium term likewise defined by the measure of length, viz. 1.25 cubic feet; by retaining the more known denominations and proportions of the two systems of weight, and referring them (reduced to one series) to a definite volume of some substance, viz. rain-water, the specific gravity of

which never changes; and finally, by expressing the quantity of pure silver for the money-unit in terms of the weight so defined: or 2°. to attain uniformity by new units, a decimal division, and a partially new nomenclature. These plans were called alternatives,—they might have been termed opposites.

It is not necessary, nor even proper, to enter here farther into the details of the two propositions. The whole report may be regarded as an original document, of illustrious emanation, and worthy to be consulted by the curious in such subjects. Even its most valuable suggestion, that of the reciprocity between weights and coin, I consider as in some sense original too; for there is no evidence in any of its phrases that such reciprocity was known at the time to have been anciently inherent in the old Saxon system, upon the *débris* of which our own was working. In other particulars, too, there appears to have been no superfluous research into that early system; only some of the most palpable, modern, or accidental coincidences are indicated. The gallon for wine, of whatever calibre, is "altogether disregarded, as concerning principally the mercantile and wealthy;" and the wine-gallon of 231 inches, the habitual one in the country, is stated as resting "on the authority of very long usage, before the 5th of Anne, the origin and foundation of which are unknown." In January, 1791, a supplemental report corrected a slight arithmetical error which had been committed, and added some developments in regard to the superficial measures under the second plan.

In the House of Representatives, I am not aware that

any immediate order was taken; in the Senate, the report and postscript were referred to a committee, who, on 1 March, 1791, reported in substance that, regard being had to the steps in progress both in France and England, "it would not be eligible at present to introduce any alteration in the measures and weights which are now used in the United States." This report was adopted.

The Second Congress met at Philadelphia on 24 Oct. 1791, and on the next day received an emphatic stimulus upon this subject in the address of General Washington. Accordingly, in carving out the business of the session, "the fixing the standard" was made the second in order among the topics to be treated by the Senate, and a committee raised for the purpose. The report of this committee, made on 5 April, 1792, was, as nearly as might be, a transcript of the second plan of Mr. Jefferson. Its consideration was postponed until the next session of Congress.

At that next session it was taken up, but the question between the new system it recommended, and the existing one, was not easily settled, and gave occasion to long debates and repeated postponements. Two substitutes, having in view the conservation of the old system, (one of them identical with the first plan of Mr. Jefferson,) and a third, combining in an ingenious manner the existing units with a decimal subdivision, and thus melting as it were the two propositions into one, were successively discussed; and, after a month, the whole matter was referred to a new committee. The report of this last, made on 29 Jan. 1793, has eluded my search; but

ten days after, the entire subject was formally postponed until the next session.

Apparently, the difficulties experienced in settlement overcame the attractiveness of the subject; the first session of the Third Congress passed over without reference to it, and the only notice of it during a second session was the transmission to the Senate, on 8 Jan. 1795, of a communication from the French Envoy, Fauchet, accompanying copies of the provisional standards according to the metrical system, which had been directed to the American Government by the Committee of Public Safety. The Senate ordered the printing of the communication, but took no further action.

In the House of Representatives it served as a motive for a committee to report both upon it and upon the plans which had been submitted by the Secretary of State five years before, and which hitherto seem to have been left in courtesy to the charge of the Senate. On 12 April, 1796, this committee reported. They wisely confined themselves to the enunciation of only the most indisputable principles; and, by the aspect of their conclusions, rather increased the doubts, both as to the elements of the question, and the attainment of an advantageous result from any change. They preferred the old units, but, if possible, the decimal division; and they desired to do away with the objections to positive (or, as the report terms them, *assumed*) standards, by a reference to some uniform principle in nature—"if it can be made to appear that reference may be had to such a measure, with sufficient certainty of uniformity in the result of different experiments, and without much

time, trouble, or expense, in making them." By way of trial only, they proposed the following experiments to ascertain—1°. the length of the seconds-pendulum in existing feet and inches; 2°. the weight of the thousandth part of the cubic foot of water; and 3°. the respective weights of four different divisions, which they refer to, of the pound and ounce. Nothing actually followed these propositions; and it is curious that contemporaneously, a private gentleman in England, upon his own means, was undertaking and successfully achieving substantially the same research at which the American Congress, with all the *éclat* of national effort, aimed and failed.

The subject slumbered now, until the beginning of a new century. On 28 Feb. 1800, the Senate referred to the Secretary of the Treasury (then Mr. Wolcott), "to prepare and report to this House a plan for establishing uniformity in the weights and measures of the United States." Such a report was, I believe, never returned; from time to time occasional memorials and motions, as I have before said, were made to and in Congress; but the breaking out of the war of 1812 repressed even these.

Upon the return of peace, President Madison, in his last Message of 3 Dec. 1816, reminded Congress that no adequate provision had been made for the uniformity of weights and measures; and he coupled it with a recommendation of the decimal subdivisions, which his predecessors had hitherto abstained from doing, and which seems to me to have been precisely the chief obstacle to the admission of any reformation. The

decimal computation seems to have been no part of the inheritance of the Saxon family.

Three months later, 3 March, 1817, a resolution reported by the committee to whom this part of the Message had been given in charge, referred to the Secretary of State, (who was, two days afterwards, Mr. J. Q. Adams,) to prepare and report to the Senate a statement relative to the existing standards in the States of the Union, as well as to what had been done in foreign countries towards the aim of uniformity, and what would be proper to be done here. A resolution of the same purport was afterwards, on 14 Dec. 1819, adopted by the other House. Before these orders were complied with, (for the field which they authorized was large, and the points to be connected, distant,) a committee-report upon the subject was offered in the House of Representatives, collateral to what had been the main subject of inquiry, viz. the propriety of altering the laws in regard to domestic or foreign coins. It was on 25 Jan. 1819, that this report was presented. Its conclusions are, in its own words, "that little should be done; that standards conformed to those in most common use among us should be accurately made, and carefully preserved, at the seat of government; that correct models should be placed in different districts of the country; and that the proportions and relations between these should be ascertained."

This report is a model of calmness and conservatism: too much learning had not confused, nor too wearied reflection led astray. It is easy to see, too, from its tone, as well as that of the Senate-resolution just

quoted, how the public mind was settling down in aversion to a violent change; what had been found hard of acceptance in 1790, among a people of less than four millions, was now, with a population not far short of ten millions, grown to be nearly impossible.

At length, on 22 Feb. 1821, the report of the Secretary of State was communicated to the Senate. If the report of the former Secretary was characteristic of its author, this was equally so. A combination of acute perception, discriminating judgment, learning varied and rarely at fault, and brilliant diction, renders it attractive beyond its destined sphere. It answered the call and more. In general, its conclusions were what might have been expected. It recommended two distinct things, capable of being carried on simultaneously or separately, — one tending to present improvement, the other looking to future perfection. These were, "1°. to fix the standard with the partial uniformity of which it is susceptible, for the present excluding all innovation; and 2°. to consult with foreign nations for the future and ultimate establishment of universal and permanent uniformity."

The first recommendation has been subsequently in substance realized; it is to be regretted that the second was, at a propitious moment, lost sight of. The report itself exercised a strong influence, in various ways, in bringing about the realization I have spoken of. Deprecating innovation on the ground of both principle and expediency, it attacks from a third position, technically; and it argues, from the literal phrase of the powers conceded to Congress, very fairly, (though I

doubt if the distinction was in the mind of the framers of the Constitution at the time,) that an authority to "*fix* the standard" does not convey one to *unfix:* Congress could repair, but might not subvert,—it might reform, but ought not to revolutionize. I believe, too, that most persons rose from the perusal of the document better content with what we had, and disposed to find in the aptitude and fecundity once characteristic of the ancient system, and capable of being in a degree restored, a compensation for the dazzling but cheerless sameness imparted by a new metrology which, like that of France, would plant the extremes of its primordial unit of length on either frozen Pole, and test its unit of weight by a mass of hardly melting ice.

Such appears to have been the effect upon the House of Representatives, if we may judge by a brief committee-report upon this document, on 11 March, 1822, from the same pen which furnished the report of 1819 to the same body. The committee thought "it scarcely necessary to do more than submit the resolutions" which were expedient to be passed at the time. They acquiesced in the view of simply rendering "uniform and stable the measures and weights which we at present possess." The troy pound they considered as already virtually disused in the community; and they proposed to have but one unit of weight—the avoirdupois pound, —of which the habitual mint-grain should be the one-seven-thousandth part. Contrary to the Secretary's opinion, they desired the standard of length and weight to be made of platina; those of capacity, they supposed, would be best formed of copper or brass. Finally, they

proposed a joint resolution, by which copies were to be procured on platina, of the Exchequer yard of Queen Elizabeth, and of the English avoirdupois pound *in vacuo;* and in any other material, at the discretion of the President, of the standard English wine-gallon, and of the Winchester bushel. These, when made, "if satisfactory to Congress, should be declared the standard yard, bushel, liquid-gallon, and pound of the United States." The President was besides to have constructed, for distribution among the several states and territories, models of these standards, and of certain subdivisions for each, which are indicated in the resolution: and the system so published was to be left to the good sense and good feeling of the nation for acceptance, uninfluenced by any sovereign requisition or special penalties. But Mr. Adams' proposition for concert with foreign nations was not mentioned; and as it came to be known shortly after, that Great Britain was about reforming her standards upon principles and elements in some regards the opposite of what would have found favour here,—partly for that reason, and partly for some others wholly unconnected with the matter, the resolutions do not appear to have been pressed, and the whole question before Congress was for the present dropped. The steps which had been recently taken were not lost, however; and though they did not reach to the fixing of the standard, they served to fix our ideas about it, and became a *point d'appui*, on which subsequent measures rested.

Copies of the Exchequer-standards, of the classes recommended by the committee, had been procured by the State Department before or about the time of the Secre-

tary's report: there was added to them subsequently, in 1822, a copy of the Elizabethan yard of 1601, not on platina, but on brass. This turned out very well accordant, upon a subsequent comparison with other standards; as did also the weights of the former invoice: but the wine-gallon was found to be of 235.4 inches, instead of 231, the corn-gallon of 274.325 instead of 268.8, and the so-called Winchester bushel of 2124.1 instead of 2150.42 cubic inches. It is easy to see, however, that these two last were not inaccuracies in the workmanship, but a mistake in the standard selected to be copied. They had taken the corn-gallon of George III., and the small bushel of Henry VII., instead of the Winchester bushel and its appropriate gallon. The coal-bushel of Queen Anne, which should have contained 2217.62 inches, gave only 2211.26 inches. The other suggestions of the Committee, to employ such standards in the making of authentic models for distribution, were not acted upon.

In 1828, after the new British standards had been executed, a copy of the imperial troy pound, made under direction of, and standarded by, Captain Kater, was procured for the Mint, and was declared by Congress, on 19 May, 1848, to be "the standard of weight for the United States; the other weights to be according to their legal proportion to the same." This is, I believe, the only case of express legalization of any specific unit, as yet. Upon comparison shortly after, this pound was found to differ very materially (2.5 grains nearly) from an authentic and carefully made set of grain-weights of Troughton. Such a discrepancy created some surprise

at the time, but is capable of receiving a very distinct explanation. The United States mint-pound was copied from, and is identical with, the troy pound of the Parliamentary committee of 1758. That Parliamentary pound, made (as I have said) under the direction of the assay-master of the English Mint, was identical with the mint-pound of the same era. But the former, after its construction, did not see the light again for forty years; while the latter was in habitual use for the same term, and gradually lost weight. The grains of Mr. Troughton were derived from the latter, evidently; because there was no other accessible authentic source. So when Sir George Shuckburgh, in 1798, compared the Parliamentary pound with Troughton's grain-weights—he was in fact comparing the mint-pound of 1758 with the mint-pound of 1798, though the experiment was not received in that sense, and he found the last too small. The same result, of course, was shewn with the Troughton weights of Mr. Hassler, which were made not long after, and were intended to be identical with those of Shuckburgh. The comparison of Dr. Moll, of Utrecht, made about this time, shews the same thing—the elements being reversed. He weighed two English mint-pounds of 1818, copied from the gradually diminishing standard in use, against grain-weights made by the artist Robinson (who furnished the balances for the new English standards of 1824, and whose grains are, therefore, parts of the pound of 1758,) and also against a copy of the imperial pound by the artist Bate, who had made the original. Finally, the English Mint itself recognized the difference; and by a notice in July, 1833, indicated the deduction (of

1.5 grains to the pound) to be made upon all monies coined prior to 1 Jan. 1826, when, by the Act of 5 Geo. IV., the old weight was directed to be restored. For greater distinctness, I put all these different recognitions together in the table on the side.

Taking, as I do, Troughton's grain-weights to represent the weights at the Mint about 1798, the line of differences shews the variations which have occurred there during about a century. In a popular sense, it shews a certain consistency; but scientifically, it is not creditable to the arts applied. For after all the acknowledged deviations are allowed, there still remains a possible unappreciated error of 0.0624 grains in every copy. It is curious that this is just the minimum possible error which, as Schumacher has shewn, still affects the imperial standards of weight, in consequence of the omission to ascertain the specific gravity of the metal composing them; and this error may be still farther multiplied by the other omission to observe the barometric heights at the time of comparison. I leave this subject, however, to be considered more in detail hereafter.

Brit. Mint, 1833.	Grains.
Since 1826	5760.0
Before ,,	5761.5
	1.5

Moll, 1830.	Grains.	Bate's Copy	Grains.
Robinson's Copy .	5760.000	Mint .	5760.00
Mint, 1818	5761.515		5761.45
	1.515		1.45

Hassler, 1830.	Grains.	Kater's Copy for U. S., 1828	Grains.
Troughton's gr.	5762.41	Troughton's gr.	5760.00
	2.41		

Shuckburgh, 1798.	Grains.
Bird's Parliam't 1 lb., 1758 .	5760.000
Troughton's gr.	5763.745
Differences .	3.745

A resolution of the Senate, on 29 March, 1830, directed the Secretary of the Treasury to cause a comparison to be made of the weights and measures used at the

different Customhouses, in view, I believe, of allowing that Department to correct any variations which such a comparison might detect, and thus to introduce a desirable and long-sought uniformity at least in those transactions to which the Government was a party. Under this resolution, the Department engaged the late Mr. Hassler, a person singularly qualified in intellect and experience for the task, to make the necessary examination. In March, 1831, the progress in it was communicated to the Senate by a report from the Treasury; and the next year two other reports from the same Department, dated 20 and 30 June, 1832, respectively, covered an elaborate account, by Mr. Hassler, of the general results of the comparison, and of the detailed methods for their ascertainment and verification.

The terms employed as standards in this comparison were ample and authentic, many of them having been brought to this country on the previous selection of Mr. Hassler himself, either for himself or in behalf of the Survey of the coast,—to procure the apparatus for which he had, in 1809, revisited Europe. Of the last kind, among the length-measures, was a scale of 82 inches divided to tenths, by Mr. Troughton, and in all regards (except length) a facsimile of Sir George Shuckburgh's scale; of the former—a scale likewise by Troughton, of 52 inches, having the distance 51.2 inches laid off by the same artist from the actual Shuckburgh scale, which thus connected the operation fully with the English determinations concerning the pendulum and yard—an original iron metre from the French Committee of Weights and Measures of 1799, and a toise of Canivet used in the

French comparisons of 1791, which thus connected as well with the determinations of the arc of the meridian as with the older system of France. Of course I do not mention various others, such as the standards in the State department, all of more or less interest. For the weights, there was the mint-pound which had been legalized by act of Congress as the standard, and a set of grain-weights from $\frac{1}{100}$ to 10,000 grains, made originally by Mr. Troughton for Mr. Hassler before 1805, and re-verified by the same artist in 1814, which served to unite with the English system; and an original brass kilogramme of the Committee, which lent the assistance and guarantee of all the physical experiments that had been made for the establishment of the weights of France.

The variations in the measures of length used by the Custom-houses, from the mean of 36 inches on Troughton's 82-inch scale, were found to extend between 35.76 and 36.165 inches; presenting an extreme error of very nearly $\frac{1}{90}$ of the yard. The weights, which were all avoirdupois, varied from 6830.95 to 7075.52 grains of the mint-pound; thus shewing a discrepancy of 244.57 grains, or of nearly $\frac{1}{28}$ of the unitary weight. The liquid capacity-measures gave for the wine-gallon (although its nominal value, almost universally, was 231 cubic inches) 219.5 and 226.5 inches, as the extremes; the smallest deviating 11.5 cubic inches or very nearly $\frac{1}{20}$ from the true unitary capacity. The bushel-measures—the mean of more than fifty of which, guaged by Mr. Adams' direction in 1820, had been shewn to be 2153 inches, or very little more than 2 inches over

the Winchester bushel of William III.—ranged between 2056.29 and 2165.2 cubic inches; giving room for an error likewise nearly $\frac{1}{20}$ of the true capacity.

Upon these results, which shewed reason enough for the interference of the Government, it was not difficult to adopt the principles that would in future reconcile them. The weight of the Mint was the already-settled standard in that regard; the scale of Troughton, sufficiently authenticated to afford the unit of length; and the desire, which has been shewn to have existed from the beginning, for preserving the mean of the habitual measures of the country, was to be gratified by restoring to the units of liquid and dry capacity the dimensions expressed or implied in many of the Colonial and State Laws. Therefore the Secretary, in his Report of 20 June, 1832, expressing the opinion that "the Department has full authority to correct the evil, by causing authentic standards to be supplied to all the Customhouses," announced in substance the adoption of the Troughton scale aforesaid as the standard of all linear and cubic dimension; an avoirdupois pound raised from the unitary mint-pound in the proportion of 7000 to 5760, as the standard of commercial weight; and a wine-gallon of 231 and a Winchester bushel of 2150.42 cubic inches, as the standards for liquid and dry capacity, respectively. These last were understood to be determinable from the weight of distilled water they would contain (viz. 8.339 and 77.6274 avoirdupois pounds, respectively) at the temperature of its maximum density, say 39°.8 of Fahrenheit's thermometer; in this particular differing from the English method, where the temperature is taken

at 62° of the same scale. In both, the barometer-stand is 30 inches. Mr. Hassler had wished to adopt the point of maximum density as a standard temperature of comparison, throughout; actually, however, it has been applied no farther than to the capacity-measures. It was understood, also, that the material of which the standards should be constructed—a condition evidently not without influence—would be *brass*.

The same Report also announced that the fabrication of the standards was actually in progress at the Arsenal in Washington. Diplomatically speaking, such was the fact; practically, the matter had gone no farther than the opening of an extensive correspondence for supplying the requisite materials for the artistical part of the establishment. Among other things, Mr. Hassler (to whom its superintendence was confided) was very desirous to execute the recommendations of Mr. Adams in extending the comparison to authentic weights and measures of foreign countries;—a step both of high interest in itself, and absolutely essential (one would think) to a due administration of the commercial regulations of the country. It is to be regretted that his efforts in this regard met with less encouragement and success than they deserved.

The artistical commencement of the work is to be dated in March 1836; after a confirmation and stimulus to the acts of the Department had been given in the passage of a resolution by the House of Representatives, declaring it "highly expedient that the Treasury Department should complete, with as little delay as practicable, the fabrication of standards of weight and measure for

the supply of the different Customhouses," upon the principles already set forth. A joint resolution of 14 June, 1836, directed "a complete set of all the weights and measures adopted as standards, to be delivered to the Governor of each State in the Union, or such person as he may appoint, for the use of the States respectively;" and on 7 July, 1838, a section in the Act for the support of the Military Academy authorized the construction of standard-balances for the several States.

Further particulars touching the fabrication of these standards have just been made public in an official document, proceeding from the establishment where they have been made, and from which I could only quote from memory. It is enough, here, to say that at this moment, in a new continent, over three millions of square miles, and among a population of thirty millions of souls, is now introduced and active, with entire recognition and uniformity, that English system whose origin, correlations, and symmetry it has been the object of the preceding investigation to inquire into and set forth.

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