

Weights and Measures (Metric System).

SCHEDULE TO WHICH THIS ACT REFERS.

Schedule of Tables of the Values of the principal Denominations of Measures and Weights on the Metric System expressed by the Means of the legalized Denominations of Measures and Weights in Great Britain and Ireland.

MEASURES OF LENGTH.						
Metric Denomination.				Equivalent in British Denominations.		
		Metres.		Miles.	Yards.	Fect. Inches. Decimals.
Myriametre ...	...	10,000	{ or	6 ³	376 ³	0 ⁷ 11 ⁹
Kilometre ...	...	1,000			10,936 ³	0 ⁷ 11 ⁹
Hectometre ...	...	100			1093 ³	1 ⁰ 10 ⁷ 9
Dekametre ...	...	10			109 ³	1 ⁰ 79
Metre ...	...	1			10 ³	9 ⁷ 079
Decimetre ...	...	$\frac{1}{10}$			1 ⁰	3 ³ 708
Centimetre ...	...	$\frac{1}{100}$				3 ³ 71
Millimetre ...	...	$\frac{1}{1000}$				0 ³ 937
						0 ³ 94

MEASURES OF SURFACE.				
Metric Denomination.			Equivalent in British Denominations.	
		Square Metres.	Acres.	Square Yards. Decimals.
Hectare ...	...	10,000	{ or	2 ² 2280 ³ 3326
Dekare ...	...	1,000		11,960 ³ 3326
Are ...	...	100		1196 ³ 0333
Centiare ...	...	1		119 ³ 6033
				1 ⁰ 1960

MEASURES OF CAPACITY.							
Metric Denomination.			Equivalent in British Denominations.				
		Cubic Metres.	Quarters.	Bushels.	Pecks.	Gallons.	Quarts. Pints. Decimals.
Kilolitre ...	...	1	3 ³	3 ³	2 ³	0 ⁷	0 ⁷ 77
Hectolitre ...	...	$\frac{1}{10}$		2 ³	3 ³	0 ⁷	0 ⁷ 77
Dekalitre ...	...	$\frac{1}{100}$			1 ⁰	0 ⁷	1 ⁰ 6077
Litre ...	...	$\frac{1}{1000}$					1 ⁰ 6077
Decilitre ...	...	$\frac{1}{10000}$					0 ¹ 76077
Centilitre ...	...	$\frac{1}{100000}$					0 ¹ 76077

WEIGHTS.							
Metric Denominations.			Equivalent in British Denominations.				
		Grams.	Cwts.	Stones.	Pounds.	Ounces.	Drams. Decimals.
Millier ...	...	1,000,000	19 ³	5 ³	6 ³	9 ³	15 ⁰ 4
Quintal ...	...	100,000	1 ⁰	7 ³	10 ³	7 ³	6 ³ 301
Myriagram ...	...	10,000		1 ⁰	8 ³	0 ⁷	11 ⁰ 801
Kilogram ...	...	1,000	{ or 15432.3498 grains)		2 ³	3 ³	4 ³ 3830
Hectogram ...	...	100				3 ³	8 ³ 4383
Dekagram ...	...	10					5 ³ 6438
Gram ...	...	1					0 ⁵ 6438
Decigram ...	...	$\frac{1}{10}$					0 ⁵ 6438
Centigram ...	...	$\frac{1}{100}$					0 ⁰ 056438
Milligram ...	...	$\frac{1}{1000}$					0 ⁰ 0056438

DECIMAL SYSTEM OF MEASURES, &c.

FURTHER RETURN to an Order of the Honorable The House of Commons, dated 2nd May 1864;—for,

COPY "of a LETTER to the Lords of the Treasury, in reply to,—1, The REPORT of Mr. Chisholm, Chief Clerk in the Office of the Comptroller General of the Exchequer; 2, NOTES by the Astronomer Royal: by James Yates, Esquire, M. A., F. R. S., Vice-President of the International Association for obtaining a UNIFORM DECIMAL SYSTEM of MEASURES, WEIGHTS and COINS."

Treasury Chambers,
7th June 1864.

F. PEEL.

FURTHER RETURN on Mr. Yates's Letter (Parliamentary Paper, 265), in Reply to,—1, The REPORT of Mr. Chisholm; 2, The NOTES of the Astronomer Royal.

1.—TYPOGRAPHICAL ERRORS in Mr. Yates's Reply to the Report of Mr. Chisholm:

- Page 2, lines 28, 33; 34, 36, for "grain," read "gramme."
- " line 50, for "gentlemen, more especially," read "gentlemen more especially."
- " lines 51, 52, for "Committees," read "Committee."

2.—CORRESPONDENCE relative to Mr. Yates's Observations on the Notes of the Astronomer Royal (Return, p. 4—6.)

(A.)

G. B. Airy, Esquire, Astronomer Royal, on receiving the Parliamentary Paper, No. 265, to James Yates, Esquire.

Royal Observatory, Greenwich, S. E.,
14th May 1864.

DEAR SIR,

I AM much obliged for the copy of your Parliamentary Paper, and also for the copy of your List of Coins, which I had seen before (I believe by your kindness).

But I think it necessary to write immediately, to beg your correction of the very remarkable error regarding myself. I must have written very strangely indeed to have made my meaning so totally misunderstood. I will refer to a few of the passages in which I am so exceedingly misrepresented.

Page 4, line 4 from bottom.—"He approves of the decimal scale universally in ascending to multiples, &c.; but what havoc would this make, &c."

Page 5, line 3.—"Hence, in order to decimalize in going upwards, it would be necessary to abolish," &c. (instances given by you).

Page 5, line 8.—"Mr. Airy proposes that, while the multiples are decimal, the divisions should be binary."

Page 5, line 18.—"Mr. Airy's proposal."
All this is most purely imaginary.

Weights and Measures
(Metric System).

BILL

[AS AMENDED IN COMMITTEE]

To render permissive the Use of the
Metric System of Weights and Measures
in this Country.

(Prepared and brought in by
Mr. William Ewart, Mr. Alderley, Mr. Colclough,
and Mr. Fintlay)

Ordered by The House of Commons to be printed,
22nd June 1864.

10.11.1864
10.11.1864
10.11.1864

PAPERS RELATING TO A DECIMAL SYSTEM

Do me the kindness to read my Notes again, and you will see that I have not "approved" or "proposed" any thing whatever. I have never proposed that the multiples should be decimal. I have never proposed that the divisions should be binary. I have never proposed (in my Notes) any thing whatever, except to leave things alone, in which case there would be scarcely any decimal multiples.

I have said (Note 56) what is "the practice of mankind." And in Note 58, I have expressly said,—"These subdivisions are taken without any regard to their coincidence or non-coincidence with inferior measures."

If a philosopher describes the length of the mètre as 39.37079 inches, he adopts the unit as standard, does not convert the 39 into feet and inches, and so reads the number. And if a carpenter reads the same, he calls it "thirty-nine inches and three-eighths;" he adopts the inch as standard, and does not convert 39 inches into feet and inches, but expresses it by decimal scale as thirty-ninè. And this is the way in which, as far as I can see, every measure is in practice expressed. An engineer, for instance, has told me that the diameter of a cylinder is "seventy-nine inches and a half," not using the equivalent in feet and inches, but using a decimal-scale expression for the number of inches, the inch being his standard.

I rely on you for making public the correction of the error regarding my published opinions and proposals.

I am, &c.,
(Signed) G. B. Airy.

(B.)

James Yates, Esquire, to G. B. Airy, Esquire, Astronomer Royal.

Lauderdale House, Highgate, N.,
16th May 1864.

DEAR SIR,

I THANK you very sincerely for the frankness and explicitness of your communication.

I have already sent a letter to the Printer to the House of Commons, requesting him not to print or circulate any more copies of my "Letter to the Lords of the Treasury," until further instructions. I have also again read with great attention your "Notes," and conclude, that in using the terms "approves" and "proposes," I intended, without quoting your very words, to express what appeared to me to be the sense clearly implied in them. In writing that letter, I referred to your evidence before the Committee of the House of Commons, in which you refer to these "Notes" (Qu. 1969. 1973.); I thought that the paper of "Notes," and your evidence before the Committee, ought to be taken together, the one being regarded as a commentary upon the other. For example, I take the following Questions and Answers as parallel to Nos. 56—61, in your "Notes:"

"2009. Chairman.] What do you think with regard to the general practice respecting the selection of the scale of multiples and divisors? I think the testimony of practice is without variation; namely, that in the different application of weights or measures something is adopted by the mind as a unit, and that unit is multiplied, and then its multiples are expressed by decimal multiples; but the sub-division is not expressed by decimals, but by halves and quarters."

2010. Do you extend that observation generally to different trades and callings? I think, on examination, it will be found to apply to everything. The largest measure, in practice, people have to use is the league, and they divide that by halves and quarters. Next to that is the mile, and in common practice people divide that by halves and quarters down to the furlong. It is very rare that the reference to the number of yards comes into play. Then, in like manner, the fathom, which is merely used for sounding, is so divided. The yard is also so divided, down to the nail. The inch is so sub-divided, and so it is with weights."

On reviewing the matter, I really cannot see that I did you much injustice. However, every man is the best judge of his own meaning, and,

OF MEASURES, WEIGHTS, AND COINS.

therefore, I shall endeavour without delay to adopt some method of appending this correspondence to my "Letter to the Lords of the Treasury."

I remain, &c.,

(Signed) James Yates.

P. S.—Before publishing the above, I think it desirable to submit it to Mr. Wm. Ewart, and to the Council of the International Decimal Association, on whose behalf the "Letter to the Treasury" was written. If you wish to substitute any other statement of your views in place of the preceding, I see no difficulty in inserting it.

(C.)

G. B. Airy, Esquire, to James Yates, Esquire.

Royal Observatory, Greenwich, S. E.,
17th May 1864.

DEAR SIR,

I shall not readily forget the fairness and courtesy of your letter of the 16th. I will now endeavour to explain my meaning, which seems to have been most oddly misunderstood.

You have correctly quoted the passages of my evidence which correctly represent my views, and I will take one for comment:—

"Something is adopted by the mind as a unit, and that unit is multiplied, and then its multiples are expressed by decimal multiples."

First.—You will observe that I do not *approve*, *propose*, or *recommend* anything. I speak as witness to a matter of fact.

Second.—You will remark that I do not speak of any *decimal scale of denominations* (indeed, in speaking to a fact, I could not, because no such thing exists in Britain). I speak of decimal multiples as expressed in ordinary numeration (shall I call it Arabic numeration), which proceeds by decimal scale.

Instance 1.—I speak of a 42-inch telescope with 3 $\frac{1}{4}$ inch aperture. No optician, since telescopes began, ever expressed that 42 inches as "3 feet 6 inches," or as "one yard 6 inches;" he takes the inch as his unit, and calls it "forty-two inches." Neither does he call it "four of an [innominate] upper decimal denomination and two inches," as I understand you to attribute to me.

Instance 2.—I see in the newspaper an advertisement of a frontage of 75 feet. The surveyor does not call it "25 yards," or "a chain and 9 feet;" he has, for frontages, adopted the foot as his unit, and he calls it "seventy-five feet." Neither he nor I should call it "seven of an [innominate] upper decimal denomination and five feet."

Instance 3.—In a series of rifle experiments the distance of 1,200 yards is mentioned. The recorder does not speak of "five furlongs four chains, and twelve yards;" the yard is his unit, and he describes the distance in decimal numeration as "one thousand two hundred yards," or "twelve hundred yards." But he does not allude to one thousand yards, or one hundred yards, as matter for special denomination; neither do I.

I hope that I have now made my meaning understood; and if so, I think you will see how marvellously it is misrepresented in the printed letter.

I think that, on consideration of instances like those which I have cited (which are the correct type of ordinary modes of expressing measures of every kind), you will find that nearly all the supposed inconvenience of our existing scales is without foundation.

I shall be glad if you think this sufficiently important to be placed before Mr. Ewart. And, if any amplification of my views (as expressed in my Notes and my Evidence) is made, I would request that it may be done in conformity with the explanations which I have now given.

I am, &c.,
(Signed) G. B. Airy.

A REPORT

TO THE

COMPTROLLER-GENERAL OF THE EXCHEQUER,

ON THE

EXCHEQUER STANDARDS OF WEIGHT AND MEASURE.

BY H. W. CHISHOLM,

CHIEF CLERK IN THE OFFICE OF THE COMPTROLLER-GENERAL OF THE EXCHEQUER.



RE-PRINTED BY A. DODD, ROYAL SECRETARIAT PRESS.

Deco-2563/64

DECIMAL SYSTEM OF MEASURES, &c.

FURTHER RETURN.

COPY of a LETTER to the Lords of the Treasury, in reply to,—1, The Report of Mr. Chisholm, Chief Clerk in the Office of the Comptroller-General of the Exchequer; 2, Notes by the Astronomer Royal: by James Yates, Esquire, M. A., F. R. S., Vice-President of the International Association for obtaining a Uniform DECIMAL SYSTEM of MEASURES, WEIGHTS, and COINS.

(Mr. William Lwart.)

Ordered by The House of Commons, to be Printed, 17th June 1864.

Deco-2563/64
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REPORT.

Exchequer, 27th April 1863.

MY LORD,

IN obedience to your Lordship's directions, I beg to lay before you the following Report upon the Exchequer Standards of Weights and Measures, in which I have endeavoured to collect together from the several Statutes, Reports, and other Documents, as well as from the Records of this department, such information relating to the subject as appeared deserving of mention. I have been aided by Mr. Bowen, the Superintendent of Weights and Measures, and by Mr. Chaney, his Assistant, to whose department the subject more immediately belongs.

Before entering upon the subject of the standards now in use, some account may be given of the ancient standards now remaining in deposit at the Exchequer. They are as follows:—

An ancient bushel, marked "Henricus Septimus," with a rose.

A ditto ditto.

An ancient gallon, marked "Henricus Septimus."

A case containing the following troy weights:—

One each of 256, 128, 64, 32, 16, 8, 4, 2, 1, $\frac{1}{2}$, $\frac{1}{4}$ oz., and two of $\frac{1}{8}$ oz., all marked "1588, ER., 30th year of reign."

An iron box containing the following weights, avoirdupois, bell-shaped:—

A 56 lbs., 28 lbs., 14 lbs., marked "1582, Elizabetha Regina," a 7 lbs., 4 lbs., 2 lbs., and 1 lb. marked "1588, ER."

A case containing the following avoirdupois weights, flat:—

One each of 8 lbs., 4 lbs., 2 lbs., 1 lb.; 8, 4, 2, 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$ oz., all marked "1588, ER., 30th year of reign."

The following avoirdupois weights, 23 lbs., 14 lbs., 7 lbs., 2 lbs., marked with a rose:—

A bushel marked ER., 1601.

A gallon ditto.

Ditto ditto.

An iron box containing—

A bushel marked ER., 1601.

A quart ditto.

A pint ditto.

Ditto, marked ER., 1602.

A wine gallon, marked 1707 wine gallon.

An iron case containing a coal bushel, marked 4 Geo. II.

An octagon yard rod, with divisions of 1, 2, 3, 4, 12, and 18 inches, marked H., supposed to be of the time of Henry VII.

A bed of bell metal marked E., with a crown, and having the following attached:—

A yard marked E., with a crown, with divisions of 2 inches (has been mended with a dovetail joint).

An ell ($1\frac{1}{4}$ yards, or 45 inches), marked E., with a crown.

All these standards were formerly in the custody of the Chamberlains of the Exchequer. They were transferred to the custody of the Auditor of the Exchequer, upon the abolition of the office of Chamberlain in 1826, under the operation of Mr. Burke's Act, 23 Geo. III., C. 82., passed in 1783, and which provided that, upon the death or removal of the two Chamberlains of the Exchequer, their duties, including the custody of the standard weights and measures, should be committed to the Auditor of the Exchequer. The custody of the standard weights and measures, and all the duties relating to

the standards, were transferred to the Comptroller General of the Exchequer on 11th October 1834, in pursuance of Section 7 of the Exchequer Act, 4 and 5 Will. VI., C. 15.

There was formerly in the Exchequer a standard of 712lbs. In 1841 it was stated to be "in the possession of Sir Francis Palgrave, of the Record Office. How it came there is not known." It is described by Sir F. Palgrave in the Introduction to his *Kalendars and Inventories of Her Majesty's Exchequer*, Vol. I., p. 115.

There are also the following ancient weights, removed in 1842 from the Pyx Chamber in the Cloister of Westminster Abbey, formerly one of the Treasuries of the receipt of Exchequer. Although they cannot strictly be called standards, they are curious from their antiquity, and appear to deserve mention. They are described in a Report to your Lordship, dated 8th August 1842, by Mr. Black, then one of the Assistant Keepers of the Public Records, as follows:—

1. "An ancient pound weight of brass, bell-shaped, less than the standard troy weight of the Exchequer by 15 dwts. 9 grs., apparently a moneyer's pound.

"It appears by Kelly's *Cambist* (1835, 4to, p. 21), that the moneyer's pound, which was abolished or disused in 18 Hen. VIII. (1526), weighed 5,400 grains, or less by 360 grains than the troy weight which was substituted for it.

"As this weight is 369 grains less than the standard, and consequently differs only 9 grains from that statement, there can be no doubt that it is a genuine specimen of the moneyer's pound, and perhaps the only one now in existence.

2. "A nest of five weights, being $\frac{1}{4}$ lb., 2 oz., 1 oz., $\frac{1}{2}$ oz., and $\frac{1}{4}$ oz., apparently made of latoun or bell metal, whereof the largest weighs 3 oz., 14 dwts., 8 grs., of the standard troy weight.

"The pound of this weight must have been equal to 7,136 grains, exceeding the present standard avoirdupois pound by 136 grains.

3. "An old nest weight, 17 grains less than the half ounce in No. 2, apparently made of latoun or bell metal.

4. "An ancient box of elegant shape, like an urn, turned in boxwood. Its side is inscribed with ink in handwriting of the time of Henry III. or Edward I. thus, '*Grana pro auro*.' It contains only one small circular weight, of copper, marked with two dots, as if serving for two grains, but it weighs less by almost a quarter of a grain than two grains of the present standard."

There are also several small weights, rudely made of lead, of various shapes and sizes, which are more particularly described in Mr. Black's Report.

The moneyer's pound, or the money pound of the Anglo-Saxons, continued to be in use as the tower pound for some centuries after the Conquest. It contained 12 ounces of 450 grains each, or 5,400 grains, being $\frac{1}{16}$ less than the troy pound, and this weight of silver coins was a pound sterling. The mark was $\frac{2}{3}$ of the pound, the Anglo-Saxon shilling was $\frac{1}{2}$ of an ounce, the Anglo-Norman shilling $\frac{1}{20}$ of a pound. The penny was $\frac{1}{20}$ of an ounce, or $\frac{1}{240}$ of a pound, both before and after the Conquest.

Until the introduction of the troy weight, which appears to have been first used in this Kingdom about the time of Henry IV., although it was not established by Statute till the reign of Henry VII., the moneyer's, or goldsmith's, or tower weight, by all of which names it was called, consisting of pounds, shillings, and pence, was used for weighing precious metals and medicines. The following examples are taken from many similar entries in Sir F. Palgrave's *Kalendars and Inventories of the Exchequer*.

17 Edward II., Poot d'or, du pois LXXII s. i d.

31 Edward III., II. bacynes t LXII. esqueles d'argent, poisantz p le poise d'orefevre XVIII l. II s. VI d.

Ancient weights.

Published in the Journal of the Archaeological Association, Vol. I. p. 131.

Ancient moneyer's pound.

Appendix to First Report of Royal Commission, 1819.

Kalendars, &c. of the Exchequer, Vol. III., p. 123.

p. 230.

33 Edward III. Vessel d'argent, la quiele vessel poisoit de poys della to' en tote cIII l. XVIII s. VIII d.

Vol. I., p. 197.

36 Edward III. Una coupa argent deaurat cu una aquer ejusd, secte ponde LXIII s. VIII d. p ponde aurifabr.

There was another pound, called the merchant's pound, which contained 25 shillings, or 15 ounces, equal to 6,750 troy grains, and which was used for all other commodities. Both the moneyer's pound and the merchant's pound appear to be referred to in an Act of Edward I., passed in 1302, the one as applicable to the precious metals and medicines, and the other to all other articles. It is enacted in the "*Tractatus de ponderibus et mensuris*," 31 Edward I. "Sciend. quod quelibet libra de denariis et speciebus, utpote in electuariis, consistit selummmodo ex pondere xxs. Libra vero omnium aliarum rerum consistit ex viginti quinq. solidis. Uncia vero in electuariis consistit ex viginti denariis. Et libra continet XII. uncias."

But neither the merchant's pound nor the moneyer's pound is mentioned in the Act 12 Henry VII., C. 5., passed in 1496, which legalized the troy weight. Practically the merchant's pound was superseded in general use by the avoirdupois pound, although no record remains of the change, in the same way that the moneyer's pound was practically superseded at the Mint by the troy pound in 1526, the 18 Henry VIII.

The troy weight is said to have derived its name from the town of Troyes in France, where a celebrated Fair was held. Although not legalized by Statute until the reign of Henry VII., it appears to have been generally used at a much earlier date. It is first noticed in the Statutes in the 2 Henry V., Stat. 2. C. 4., thus, "that all the goldsmiths of England take for a pound troy of silver gilt but 48s. 8d. at the most." Sir F. Palgrave mentions the record in the 6 Henry IV. of a jewel of a certain weight "pois de troye;" and from the beginning of the reign of Henry V. all the recorded weights are troy weights.

The Statute of 12 Henry VII., by which the troy weight was established by law, confirms the old regulation, that the pennyweight should consist of 32 corns of wheat. It does not appear when or by what authority the troy grain, of which 24 went to the pennyweight, was first introduced. It was probably taken from the old French system of silver coinage, in which 24 grains went to the denier. The troy grain with its multiples, was amongst the Exchequer standards authorized by Queen Elizabeth in 1588. But it is supposed that the original standards of weight namely, wheat corns, were, soon after their establishment by law in 1266, represented by metallic grains of the same weight as the troy grains. These were probably used in the operations of the Mint, such as are referred to in the earliest Mint Indenture of the year 1272, where no greater deviation than one grain, more or less, from the right weight of a silver penny was allowed. ("Li fors ne pusse peser plus de un grain den droit dener, ne li plus febles ne pusse peser mains de un grain den droit dener.") The small weight inclosed in an ancient box marked *grana pro auro*, as described by Mr. Black, which was taken from the Pyx Chamber, is in all probability an unique specimen of these ancient metallic grains.

The earliest mention of the term avoirdupois occurs in a Charter of 1 Feb. 1303, 31 Edward I., as applicable to commodities; in which sense it is also used in the Statute 27 Edward III., Stat. 2. C. 10., anno 1353. This Statute enacts that there shall be but one weight, measure, and yard throughout the "realm, et que leins et tut maner de avoir du pois soient poises par balaunces." The first Statute that applies these words to describe a weight is the 24 Henry VIII., C. 3. (anno 1532). The words of this Statute are as follows: "Beef, pork, mutton, and veal shall be sold by weight called *Haver-dupois*. No person shall take for a pound of beef or pork above ob. (a halfpenny), nor for a pound of mutton or veal above ob. q. (three farthings), and less in those countries where they be sold for less."

Origin of avoirdupois weight.

From the importance of weights and measures, their adjustments must have been amongst the first regulations of civil society. Standards of weights and measures were generally held sacred by the ancients, and were therefore deposited in the sanctuary of the Jews, the temples of the heathens, and the Churches of the primitive Christians. Ancient standards were generally adjusted by the dimensions of some durable buildings, and thus the base of the largest pyramid in Egypt was applied, being the 500th part of a degree of the meridian, which had been previously measured for that purpose. Many of the neighbouring countries of Asia and Europe took their measures from the Egyptians; and throughout the Roman Empire uniform standards were established from the archetype kept in the Capitol at Rome.

The original standards of English weights and measures, like those of most other countries, are extremely vague and uncertain. The earliest standard recorded in the history of this country was originally kept at Winchester. Nearly a century before the Conquest, King Edgar is said to have decreed, with the consent of his wifes or council, "that the measure of Winchester should be the standard." By a Statute of William the Conqueror it was ordained "that the measures and weights should be true and stamped in all parts of the country," as had before been established by law. The standard for long measure is said to have been fixed in 1101 by Henry I., who commanded that the ancient ulna or arm, which answers to the modern yard, should be made of the exact length of his own arm. Under King Richard I., in his Parliament holden at Westminster, A. D. 1197, it was ordained that there should be only one weight and one measure throughout the kingdom. There was a provision for enforcing this Ordinance in the Great Charters of King John and his son. These original standards were called *Pondus Regis* and *Mensura Domini Regis*, and were directed by a variety of subsequent Statutes to be kept at the Exchequer, and all weights and measures were to be made conformable thereto.

The earliest Statutes for the determination of the standards are mentioned in the Appendix to the First Report of the Royal Commission of Weights and Measures in 1819.

"The original magnitude of the measures of England seems to have been ascertained in a manner not very capable of affording a correct duplicate, in case that it should be necessary to have recourse to it a second time. In the reign of Henry III., by the consent of the whole realm of England, the measure of our Lord the King was made, that is to say, that an English penny, called a sterling, round and without any clipping, shall weigh 32 wheatcorns in the midst of the ear; and 20 pence do make an ounce, and 12 ounces a pound; and eight pounds do make a gallon of wine, and eight gallons of wine do make a London bushel, which is the eighth part of a quarter. This definition is repeated in the Tractatus de Ponderibus at Mensuris, which stands as a Statute of Edward I." It may be remarked that in this last-mentioned statute the standard pound of 12 ounces is called the London pound. ("Duodecim uncie faciunt Libram, London.")

"Another standard, still less precise in its magnitude for the immediate determination of standards, is found in a Statute of Edward II. It is ordained that three barleycorns, round and dry, make an inch, 12 inches a foot, three feet a yard (ulnam), 5½ yards a perch, and 40 perches in length and four in breadth an acre. An acre had been more minutely described for the convenience of a more illiterate age by a statute of the preceding reign, declaring the breadth of land that constituted it for different lengths, from 10 perches upwards, so as always to make 160 square perches.

"In the reign of Henry VII. a new standard bushel seems to have been actually determined according to the method prescribed by the Statute of Henry III. It was to contain eight gallons, each of eight pounds troy of wheat, each of 12 ounces, each of 20 sterlings or pennyweights, each of the weight of 32 corns of wheat that grew in the middle of the ear, according to the old laws of the land.

Importance and sacred character of standards in ancient time.
Kelly's Universal Cambist (from Pausan's Metrologia.)

Original standards of English weights and measures.
Blackstone, Vol. I. p. 274.
First Report of Royal Commission, 1819.

Determination of standards.

Anno 1266, 51 Henry III., Stat. 1.
Assiza Panis.

Anno 1313, 31 Edward I.

Anno 1324, 17 Edward II.

Anno 1305, 33 Edward I.

Anno 1496, 12 Henry VII.

This statute proceeds, "that it pleaseth the King's highness to make a standard of a bushel and a gallon, after the said assize, to remain in his Treasury for ever." The standards of all the countries, cities, &c., were to be replaced by the new bushel and gallon, and all other bushels and gallons of brass remaining in the Treasury and in all other places in England were to be before the feast of Christmas next coming, damned and broken upon pain of 20 pounds to be levied upon every city, &c., that shall keep any other bushel or gallon unbroken and not damned, of brass than is ordained to be made by the present Act."

This standard bushel still remains deposited in the Exchequer, and appears to be the oldest standard now in existence in this country.

The Exchequer standards made in the reign of Queen Elizabeth were not authorized by any statute. These standards were ordered by the Royal authority, as appears from a roll of Michaelmas term in the 29th Elizabeth, preserved in the Queen's Remembrancer's Office, containing the Royal proclamation. A copy of this roll is appended to the First Report of the Committee of the House of Commons upon the original standards of Weights and Measures, appointed in 1758, and it is described in the Report as being to the following effect:—

"In the 16th Elizabeth (anno 1554) complaints had been made to the Treasurer and Barons of the Exchequer that the weights throughout the kingdom were uncertain, and that no true or just standards were then extant for sizing of true weights. Whereupon a jury of nine merchants and goldsmiths of London were impanelled to size upon their oaths one certain standard, as well of troy weight as of avoirdupois. Which jury had performed their office, and by their verdict in writing established the several poizes of the said standard. But in the 25th Elizabeth (anno 1583) objection had been made to those standards, as not agreeable to the ancient one and the laws of the realm. And 11 goldsmiths of London upon their oath did inquire whether the said standards newly sized were agreeable to the ancient standard and the laws of the land; who, upon consideration of the matter and hearing the former jury, gave their verdict that the said standards and weights newly sized were not agreeable to the ancient standards and the laws of the realm; but they do now of new size two several standards, one of troy weight, which doth agree with the true proportion at Goldsmith's Hall, which hath been of ancient use, and the other avoirdupois which doth agree with the true proportion of one ancient standard of 56 pounds remaining in the Exchequer, as it seemed since the time of Edward III. to size all other weights by, and was in use. Queen Elizabeth therefore gave orders, by the advice of her Privy Council, that the first verdict, and standards sized and presented with the same, should be frustrated, and of no force, and the standards should be broken and destroyed; but that the last presentment and the standards sized and then presented by the jury should continue to be used, allowed, and accepted as lawful, good and true; the standards to be laid up and safely kept in the Court of Exchequer, and like weights and standards were to be made and sent to the cities and towns mentioned in the statute of 11, Henry VII., &c. The proclamation specifies the weights and measures to be kept as standards at the Exchequer. The list of these standards agrees with those of that date now remaining, with the exception of the following smaller weights specified in the proclamation, of which nothing is now known, viz:—

1 oz.	= 20 dwts.
$\frac{1}{2}$ "	= 10 "
$\frac{1}{4}$ "	= 5 "
$\frac{1}{8}$ "	= 4 "
3	"
2	"
1	= 24 grns.
$\frac{1}{2}$ "	= 12 "
$\frac{1}{4}$ "	= 6 "
4	"
3	"
2	"
1	= 13 pieces in all.

There is also a record in the roll of the delivery, on 18th June 1588, of the standards to the hands of Thomas Pierson, the Usher of the Exchequer.

It may be remarked that although this authority directs two standards of weight, one troy and the other Avoirdupois, no single weight of one pound troy was specified, or appears to have been included amongst the standards made and deposited at the Exchequer by order of Queen Elizabeth. The troy weights consisted of ounce weights only, and their parts and multiples. The pound troy, the unit of weight, like the pound sterling, the unit of value, appears to have been the unit of account only, and not to have existed as an actual standard.

The wine gallon, marked 1707, was constructed in pursuance of the Act 5 Anne, C. 27, S. 17. In 1700 there was a dispute as to the contents of the wine gallon, and the amount of duty payable thereon, and the matter was tried before the Court of Exchequer. The result of the trial was that a juror was withdrawn, and in 1703 the Attorney-General, Sir E. Northy, having perused all the laws relative to the subject, advised that as the contents of the wine gallon were uncertain, being to be fixed by wheat corns, an application should be made to Parliament to have a standard of a gallon made. These proceedings caused the provision in the Act of 5 Anne, whereby the wine gallon in the receipt of the Exchequer was made the wine measure and the standard. It was enacted "that any round vessel, commonly called a cylinder, having an even bottom, and being seven inches diameter throughout and six inches deep from the top of the inside to the bottom, or any vessel containing 231 cubical inches, and no more, shall be deemed and taken to be a lawful wine gallon."

63 gallons were to constitute a hogshead.

126 " " a butt or pipe.

252 " " a tun of wine.

This standard wine gallon was examined by the Royal Commissioners in 1819, and found to contain 230.9 cubical inches. It was abolished in 1825 by 5 Geo. IV., C. 74.

The standard gallon of Queen Elizabeth contained 271 cubic inches, the ancient corn gallon 272 cubic inches, and the ale gallon 282 cubic inches. These measures have been all altered to the imperial gallon, which contains 277.274 cubic inches, its capacity being ascertained by a fixed weight of 10 pounds of distilled water contained in it.

The coal bushel, marked 4 Geo. II., was constructed in pursuance of S. 11 of the Act 12 Anne, Stat. 2., C. 17., which enacted that "in accordance with the practice and usage in the port of London for many years past, the coal bushel shall be made round, and with a plain and even bottom, and be 19½ inches from outside to outside, and to contain one Winchester bushel and one quart of water, according to the standard for the Winchester bushel, per 13 and 14 Will. III., C. 5." All sea coals and culm are directed to be "measured by the chalders, containing 36 of such bushels, heaped up, and no other, and so on in proportion for any greater or less quantity."

Section 12 directs the Treasury to cause an exact bushel of brass to be made accordingly, and kept in Her Majesty's Exchequer as a standard. This standard was received at the Exchequer under the authority of a Treasury Warrant dated 20th August 1730, to which is appended a certificate, signed Edmond Halley James Hodgson, and I. The Desaguiliors, and dated 13th August 1730, declaring that they "had examined and proved the contents and dimensions of the new-made coal bushel, and found the same strictly to answer the contents prescribed by the Act of Parliament in that behalf."

This standard coal bushel was abolished in 1825 by the Act 5 Geo. IV., C. 74, and coal was directed to be measured by the imperial bushel, heaped measure. In 1835, by the Act 5 and 6 Will. IV., C. 63, which abolished the heaped measure, coal was directed to be sold by weight, and not by measure.

All the ancient standards now in the Exchequer are noticed in the First Report of the Committee of the House of Commons appointed in 1758 to inquire into the original standards of

weights and measures, of which Committee Lord Carysfort was Chairman. This Report was presented to the House on 26th May 1758, and the resolutions of the Committee were agreed to by the House on 2nd June. In the following Session the Committee was re-appointed, and made

a Second Report on 11th April 1759, when the resolutions of the Committee were also agreed to. A Bill embodying these resolutions was brought in, and was read a first and second time in the next Session of 1760. The Bill was amended in Committee, and printed on 8th May. Parliament, however, was prorogued on 25th May, and the Bill was not further proceeded with.

The resolutions thus agreed to are printed at length in the Commons' Journals. Amongst other recommendations the Committee recommended that a new standard yard and a new troy pound, constructed under their directions, should be made the legal standards of length and weight, and that measures of capacity should be ascertained according to the number of cubical inches therein contained.

That these legal standards should be deposited at the Exchequer, to be kept under the seals of specified officers, and models of these standards and of the several weights and measures mentioned in the Report should be made and used for the verification of the secondary local standards.

That the genuine standards should be deposited in the same manner and kept in the same place as the trial pieces for the coin, used on trials of the pyx, are preserved at the Exchequer.

That the genuine standards should be only at certain times and before certain officers produced in order to try and rectify the copies made use of to ascertain the weights and measures issued to the subject.

The two Reports of Lord Carysfort's Committee contain much interesting information on the subject of the Exchequer standards. The First Report recites at length the several provisions of the ancient Ordinances and Statutes relating to the standards of weights and measures. It contains a list of the standards then remaining in the receipt of the Exchequer, which list agrees with the list of ancient standards now remaining, as shown in page 3. These standards were compared with each other, under directions of the Committee, by Mr. Harris, the Assay Master of the Mint, on 14th April 1758, and the results of these comparisons are shown in detail in the Report. The results were as follows, and they deserve notice as showing the defects in the standards then in use at the Exchequer, after they had been used for verifying the local standards during a period of 170 years, from 1588 to 1758.

Exchequer Standards compared, 14th April 1758.

Troy weights, 13 pieces.	2 of ½ oz.	one heavier than the other by ½ grain.
	1 of ¼ oz.	lighter than the two ½ oz. by ½ grain.
	½ oz.	three preceding by ½ grain.
	1 oz.	four " "
	2 oz.	five " "
	4 oz.	agreeing very nearly with the six preceding.
	8 oz.	seven " "
	16 oz.	eight " "
	32 oz.	lighter than the nine preceding by 2 grains.
	64 oz.	agreeing very nearly with the ten preceding.
Avoirdupois weights, 11.	128 oz.	heavier than the eleven preceding by 15 grains.
	256 oz.	heavier than the twelve preceding by 24 grains.
	1 lb.	an exact counterpoise to this was made.
	½ lb.	heavier than the two preceding by ¼ grain.
	¼ lb.	agreeing very nearly with the preceding three.
	1 oz.	heavier than the preceding four by ¼ grain.
	1 oz.	heavier than the preceding five by ¼ grain.
	2 oz.	lighter than the preceding six by ¼ grain.
	4 oz.	agreeing very nearly with the preceding seven.
	8 oz.	agreeing very nearly with the preceding eight.
	1 lb.	agreeing very nearly with the preceding nine.

Avoirdupois weights,
bell shaped.

- 2 lb. heavier than the preceding ten by 2 grains.
- 4 lb. heavier than the preceding eleven by 8 grains.
- 8 lb. agreeing exactly with the preceding twelve.
- 1 lb. heavier than the flat weight by $3\frac{1}{2}$ grains.
- 2 lb. lighter than the flat weight by 4 grains.
- 4 lb. agreeing exactly with the flat weight.
- 7 lb. lighter than the preceding three weights by 4 grains.
- 14 lb. lighter than the preceding four weights by 24 grains.
- 28 lb. lighter than the preceding five weights by 20 grains.

Measures of capacity.

- 56 lb. agreeing very nearly with the six preceding.
- A bushel, time of Henry VII., with a copper rim; holding nearly three pints of water more than the other three bushels.

One bushel without a rim. These three bushels agree. The standard bushel holds less than 8 standard gallons by about $\frac{1}{2}$ pint.

One bushel, dated 1601-1091, not used (date of 1601 reversed.)

One bushel dated 1601, used as a standard.

A coal bushel, marked 4 George II.

One gallon, temp. Henry VII., contains less than the standard by two spoonfuls.

A gallon, 1601, with two E's and crowns, contains less than the standard by two spoonfuls.

A gallon, 1601, with E. and a crown, used as a standard; holds less than four standard quarts by $\frac{1}{2}$ pint.

One quart, with two E's and a crown, the two pints not quite filling this quart.

One pint with two E's and a crown.

One pint with E. and a crown, used as a standard. } These 2 pints agree.

Measures of length.

One ell } marked E. with a crown; standards. } Very coarsely made, the divisions of them not equal. The rods bent, and very bad standards. Supposed of the time of Henry VII.; not used.

One yard }

One other yard marked H.

The report of the Committee states that in 1742 several members of the

Construction of New Standards.

Standard yard, 1758.

Royal Society had been at great pains in taking an exact measure of the standard of length, by very curious instruments, prepared by the late ingenious Mr. Graham, and that the Royal Society had a brass rod made pursuant to these experiments. The Committee had two brass rods made, according to a plan of Mr. Harris, by Mr. Bird, who was described as one of the best artists in London. These brass rods were 38 or 39 inches long, with two gold studs, on which points were made to ascertain the length of the yard. They were compared with the Royal Society's rod and with the Exchequer standards, and found to agree as nearly as possible. The Committee recommended one of these to be by law made the proper standard, and to be marked "Standard Yard, 1758."

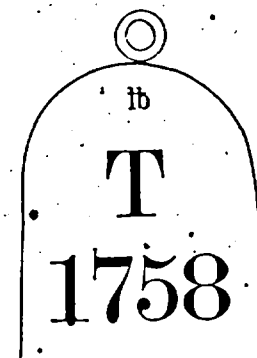
Upon the advice of Mr. Harris, the Committee recommended the pound of a convenient size for the unit of weight, and that the troy pound should be the standard. Mr. Harris's reasons were as follows:—

- That it is the weight best known to the law.
- That by which our own coins are measured.
- That which is best known to the rest of the world.
- That to which our learned countrymen have referred, and compared ancient and foreign weights.
- The weight which hath been divided into the smallest parts.
- That the avoirdupois weight is of doubtful authority.

The Committee in order to discover, as nearly as possible, what was the genuine weight of the troy pound according to the standard, made experiments at the Mint, first upon the weights which were the legal standards of the Exchequer. They used an exact pair of scales belonging to Mr. Harris, and the scales used at the Mint for weighing gold. By comparing the Exchequer standard troy weights with each other, they found the average lightness of 12 ounces or the pound troy to be $1\frac{1}{2}$ grain. They then compared the 8 ounce and 4 ounce Exchequer standards with the Mint troy pound and with other Mint 8 ounce and 4 ounce weights, and in order to ascertain the medium difference between those weights and the weights in general use among the public, they also tried the standard weights by which the scale makers made their weights for sale. The result of the second experiments was to show an average lightness of one grain in the Exchequer standards representing the pound troy. The Committee considered that the medium difference of these experiments, $1\frac{1}{2}$ grain, should be added to the weight of the Exchequer standard weights of 8 and 4 ounces to show the proper weight of the pound troy.

The Committee endeavoured to compare the troy weights with the original standards at Goldsmith's Hall, from which the Exchequer weights were made in the time of Queen Elizabeth. But they were informed that no such weight was to be found there, the goldsmiths having no weight older than the Exchequer.

The Committee ordered three pound weights to be made in accordance with the result of their experiments. These were made by Mr. Bird and adjusted by Mr. Harris. One of these weights was delivered to the House of Commons, together with the first report of the Committee, and recommended as the standard of weight. It is represented as being in the annexed form.



It appears from the Commons Journals that when the Committee was re-appointed in the session 1758-9, this pattern troy weight, which had remained in the custody of the Clerk of the House, was re-delivered to the Committee. The final delivery to the House of these standards was on the 21st May 1760, when the following entry was made in the journals: "Lord Carysfort reported from the Committee, 31st March 1760, who were appointed to adjust copies of the standard yard, standard pound, and its multiples, and they delivered the following weights in, examined by Mr. Harris's apparatus. 11b. to 32lbs. troy, two copies of each, and a measure of a yard, the troy standard pound being made of fine gold." These weights and measures were locked up by the Clerk of the House.

It may here be remarked that the troy standard pound thus deposited with the Clerk of the House of Commons, and stated as being made of fine gold, is described as a piece of fine copper in the bill brought in by Lord Carysfort to give effect to the recommendation of the Committee of which he was chairman. But in the Act 5 Geo. IV. C. 74. this standard pound, then also in the custody of the Clerk of the House of Commons and declared to be the imperial standard troy pound, is described as a brass weight. It is now impossible to reconcile these discrepancies and to ascertain the actual fact, this standard pound having been destroyed in the burning of the Houses of Parliament in 1834. In the Report of the Commissioners for the Restoration of the Standards, dated 21st December 1841 (paragraphs 5-6,) after describing the injured states of the other standards, viz., the two standard yards, and the multiples of the troy pounds from 2 lbs. to 32 lbs., "apparently of brass or

copper," which were recovered from the ruins of the House of Commons, the Commissioners add "the legal standard of one troy pound is missing."

After 1760 the subject of weights and measures was not taken up in Parliament until 1790, when a Committee was appointed, but no record remains of their proceedings.

Committee, 1790.

In 1774 an Act was passed by which analogous duties to those performed by the officers of the Exchequer, in relation to the standard weights and measures generally, were imposed upon the officers of the Mint, in relation to the weights of the gold and silver coin of the realm. By the Act 14 Geo. III., C. 92, it was enacted that the officers of the Mint should make weights of a guinea and a shilling, according to the standard of the Mint, together with other weights being parts and multiples of the guinea and shilling weights, and when approved of by His Majesty in Council, these weights were to be reputed and accepted in law to be standard weights of the gold and silver coin of the realm, and to be deposited in the custody of the officers of the Mint.

Exact duplicates of these standard weights for coin were directed to be made and delivered to an officer, to be specially appointed under Royal Sign Manual, with an annual salary of 250*l.*, to be paid out of the coinage duties. Once or oftener in every year this officer was to attend at the Mint with the duplicate standards, with which he was to compare and examine the standard weights for coin. After 31st December 1774 all weights used for coin were to be examined and compared with the duplicate standards by the officer so appointed, who was to stamp them. This duty was to be performed without fee or reward, and without wilful delay. No other weights than those so stamped were to be accepted in law as true or of any effect for determining the weight of the gold or silver coin of the realm.

By an Act of the following session, 15 Geo. III., C. 30, the officer so appointed, John Whitehurst, was empowered to receive one penny for every twelve weights so stamped.

Under Section 3 of the Act 57 Geo. III. C. 67, the salary of 250*l.* per annum allowed by the 14 Geo. III. C. 92 to the officer for stamping the money weights, was abolished upon the termination of the existing interest in that office.

It appears from evidence given before the Royal Mint Commission in 1848, by James Hill, the stamper of money weights at the Mint, that as the Act of 1774 applies only to weights of gold coin, being a guinea or parts or multiples of a guinea, and as the sovereign is no part or multiple of a guinea, the scale-makers who sell sovereign weights are not compelled to have them verified at the Mint, and that in fact no money weight had been stamped at the Mint at the two previous years.*

In 1814 a Committee of the House of Commons was appointed, of which Sir George Clerk was chairman, to inquire into the original standards of weights and measures, and to whom the reports of Lord Carysfort's Committee were referred. The minutes of evidence of three witnesses, Professor Playfair, Dr. Hyde Wollaston, Secretary to the Royal Society, and of Mr. Warner, a maker of weights and measures, are appended to their report. Professor Playfair and Dr. Wollaston both gave their opinions that the best standard of measure was the pendulum

* Note.—3rd June 1863.

The following Memorandum shows the present practice at the Mint with respect to the verification of money weights:—

MEMORANDUM on the issue from the Mint of Weights for testing the Current Weight of Coin. Blank weights for testing the gold coin current in the United Kingdom, one for the sovereign and another for the half sovereign, continue to be brought by the public to the office of the stamper of money weights in the Mint, to be stamped by him under the provisions of the Act 14 Geo. III. C. 92.

There is no demand for silver weights, probably in consequence of the silver coins having become tokens and not circulating by weight.

The larger weights of 100, 50, 40, 20, &c. sovereigns, often used by bankers and others, are unofficial, not being verified here.

The number of weights stamped at the Mint was 542, or 45 dozen and two in 1861; and 466 or 39 dozen and ten in 1862.

Royal Mint, June 2, 1863.

THOMAS GRAHAM,
Master of the Mint.

vibrating in a given time and place, that the unit of weight should be ascertained from that of a given number of cubic inches of distilled water at a given temperature, and the unit of capacity should be a vessel containing a given weight of distilled water. The Committee recommended, in accordance with the opinion of these witnesses, that the standard of length should be kept invariable by means of the pendulum; the standard of weight by the standard of length; and the standard of capacity by that of weight. They were of opinion that although the troy pound was the only weight established by law, yet the avoirdupois pound was so much more generally known and used that they could not hesitate to recommend it in preference to the troy pound, except for gold and silver and for apothecaries' medicines. The Committee resolved that the length of a pendulum vibrating seconds in the latitude of London had been ascertained to be 39.13047 inches, of which the standard yard contains 36; and they stated that the standard metre which was adopted by the French Government, being the 10,000,000th part of a quadrant of the meridian, had been ascertained to exceed the yard at a temperature of 55° by 3.3828 inches, being thus equal to 39.3828 inches.

290—1814.

Their Report was ordered to be printed 1st July 1814, and a Bill founded upon it was brought in during the following session. The Bill was printed as introduced and as amended on recommendation. It was proposed to enact that the pound avoirdupois should be the only standard of weight, to be equal in weight to 27.648 cubic inches of pure water at 56½ Fahrenheit, and that all measures of weight should be parts or multiples of the avoirdupois pound, thus abolishing the troy weight. The pound was to be divided into 16 ounces—

256 drams at 16 to the ounce;
768 scruples at 3 to the dram;
7,680 grains at 10 grains to the scruple.

The Bill was not further proceeded with in that session, and a similar fate attended another Bill in the following session, after it had been printed and amended by the Committee.

83—1816.

In 1819 a Royal Commission made their first Report upon the subject of weights and measures, dated 24th June 1819, and signed by Sir J. Banks, Sir G. Clerk, D. Gilbert, Dr. Wollaston, Dr. T. Young, and Captain Kater.

First Report of Royal
Commission, 1819.
565—1819.

Second Report of
Royal Commission, 1820.
314—1820.

The Commissioners made a second Report dated 13th July 1820, to which the same names are signed, except Sir J. Banks.

The opinions and recommendations of the Commissioners, respecting the standard of length, will be found detailed in these two Reports. They proposed no change in the existing primary standards, and recommended that all the multiples and subdivisions of the standards to be adopted should retain the same relative proportions to each other as those which were then in general use. They considered these to be more convenient for practical purposes than the decimal scale. An index of terms relating to weights and measures, both in their legal and provincial acceptance, is appended to the second Report.

The third Report of the Commissioners, dated 31st March 1821, bears the same signatures as the second Report. The Commissioners state that it has been found by computation that the weight of a cubic inch of distilled water at 62° Fahrenheit is 252.72 grains of the Parliamentary standard pound of 1758, supposing it to be weighed in vacuo. They recommend—

1st.—That the Parliamentary standard yard made by Bird in 1760 be henceforward considered as the authentic legal standard of the British Empire, and that it be identified by declaring that 39.1393 inches of the standard at the temperature of 62° Fahrenheit have been found equal to the length of a pendulum supposed to vibrate seconds at London on the level of the sea, and in a vacuum.

2nd.—That the Parliamentary standard pound troy, according to the two-pound weight made in 1758, remain unaltered, and that 7,000 troy grains be declared to constitute an avoirdupois pound.

In the session of 1821 a Select Committee of the House of Commons was appointed to consider the several Reports relating to weights and measures, and the proceedings for determining the length of the pendulum vibrating seconds. In their Report, dated 25th May 1821, the Committee agree with the recommendation of the Royal Commissioners in their third Report.

And they advert to the extraordinary knowledge and ingenuity, and to the indefatigable industry, displayed by Captain Kater, by whom all the experiments have been gratuitously conducted for ascertaining the various standards, &c.

In the session of 1822 a Bill founded on these Reports was introduced into the House of Commons, and was printed as amended in Committee, and again on recommitment.

In 1823 the Bill was again printed as amended by the Committee in that session.

In 1824 the Act 5 Geo. IV. C. 74 was passed, founded on the Reports of the Royal Commissioners. The Bill was brought in 25th February 1824, by Sir G. Clerk and Mr. D. Gilbert, two of the Commissioners, and seems to have passed both Houses without discussion or opposition.

Hansard.
Its enactments.

By Sections 1 and 4 of this Act the only "original and genuine standards" were declared to be—

1. Standard of Extension.—"The straight line or distance between the centres of the two points in the gold studs in the straight brass rod now in the custody of the Clerk of the House of Commons, whereon the words and figures 'Standard Yard, 1760,' are engraved, the brass being at the temperature of 62° Fahrenheit, to be denominated the 'Imperial Standard Yard.'"

2. Standard of Weight.—"The standard brass weight of one pound troy, made in the year 1758, now in the custody of the Clerk of the House of Commons, to be denominated the 'Imperial Standard Troy Pound.'"

All other weights and measures were to be derived from these standards.

From the imperial yard were to be derived:—1st. The lineal measures of length, being parts or multiples of the yard, viz.:

Foot	= $\frac{1}{3}$ of yard.
Inch	= $\frac{1}{36}$ of foot.
Pole or Perch	= $5\frac{1}{2}$ yards.
Furlong	= 220 yards.
Mile	= 1,760 yards.

2nd.—The superficial measures of length, viz.:

Rood = 1,210 square yards.
Acre = 4,840 square yards.

From the imperial troy pound were to be derived:—1. The following parts, viz.:

Ounce Troy = $\frac{1}{12}$ of troy pound.
Pennyweight = $\frac{1}{20}$ of " ounce.
Grain = $\frac{1}{24}$ of troy pennyweight, so that 5,760 grains were = a troy pound.

2. The pound avoirdupois = 7,000 grains troy.

Ounce " = $\frac{1}{16}$ of pound avoirdupois.
Dram " = $\frac{1}{16}$ of ounce "

3. Standard gallon "containing 10lbs. avoirdupois weight of distilled water weighed in air at the temperature of 62° Fahrenheit, the barometer "being at 30 inches," the same being in bulk equal to 277.274 cubic inches. A measure was directed to be made forthwith of brass of such contents as aforesaid, under directions of the Treasury, and declared to be the *Imperial Standard Gallon*, and the *Unit and only Standard Measure of Capacity*, from which all other measures of capacity should be derived.

These measures of capacity, being parts or multiples of the imperial gallon, were declared to be as follows: 1. Measures not heaped:

Quart = $\frac{1}{4}$ of imperial gallon.

Pint = $\frac{1}{2}$ of " "

Peck = 2 gallons.

Bushel = 8 " "

Quarter of corn or other dry goods = 8 bushels.

2. Heaped measures.—The *Standard Measure of Capacity for Heaped Measure* was declared to be the *Imperial Bushel* containing 80lbs. avoirdupois weight of water as aforesaid, and made round with a plain and even bottom, being 19 $\frac{1}{2}$ inches round, outside diameter. The heaped cone to be at least 6 inches high. The sack = 3 bushels; chaldron = 12 sacks. This regulation was altered by an Act of the following year, 6 Geo. IV., C. 12, and all heaped measures were directed to be made cylindrical, the diameter to be at least double the depth, and the height of the cone to be equal to $\frac{3}{4}$ of the depth, the outside of the measure being the base of the cone. The heaped measure was abolished in 1835 by S. 7. of 5 & 6 Will. IV., C. 63.

It thus appears that in addition to the *two original standards or units of extension and weight*, viz. :—1. The imperial yard; and 2, the troy pound, *two other derivative standards or units of capacity* were established by the Act 5, Geo. IV., C. 74, viz. :—3. standard gallon of capacity; 4, standard bushel for heaped measures. Sections 3 and 5 of the Act contained provisions for the restoration of the standards, if lost, injured, or destroyed. The standard yard was to be restored by comparison with the length of a pendulum vibrating seconds, and the standard troy pound by comparison with the weight of a cubic inch of water, in accordance with the recommendation of the Commissioners.

By Section 2 of the Act, "copies and models of each of the said

"Standard yard,

"Standard pound,

"Standard gallon, and

"Standard for heaped measure,

"and of such parts or multiples thereof respectively," as the Treasury should judge expedient, were directed to be made, and verified under the directions of the Treasury, and deposited at the Exchequer and copies thereof, verified as aforesaid under the direction of the Treasury, were to be sent to the Lord Mayor of London, to Edinburgh, Dublin, &c.

The Act then provides for the making of secondary or local standards for the several counties, cities, &c., and their comparison and verification with the standards at the Exchequer.

By Sections 15 and 19, all contracts and dealings in the United Kingdom are to be ascertained by the standards established by the Act. No weights or measures are to be made, except in conformity with the standards, but existing weights and measures may be used, being marked so as to show the proportions they bear to the standards. Tables of equalization are to be made, and published under the authority of the Treasury, showing the proportions between the weights and measures heretofore in use in England, Scotland, and Ireland respectively, and the standards.

And Section 22 recites and repeals former Statutes and Ordinances relating to weights and measures.

The Exchequer standards of weights and measures now in use for the verification of the local secondary standards were prepared in pursuance of the Act 5 Geo. IV., C. 74. It may be convenient here to mark the distinction between these *Exchequer standards*, of which there is one for every legal weight and measure, and the original *Parliamentary standards* or units, so declared by Parliament, from which the other standards are derived.

At the request of the Lords of the Treasury these Exchequer standards were constructed under the superintendence of Captain Kater. An account of their construction was read before the Royal Society, 24th November 1825, and was published in the *Philosophical Transactions* of that year.

Their Construction.
Description by Captain
Kater.

The standards of weight and capacity were constructed by Mr. Bate. Those of linear measure by Mr. Dolland. Brass being peculiarly liable to decomposition in the atmosphere of London, it was found, after some trials by Mr. Bate, that the best proportions of metals for the standards were—

576 parts of copper.
59 „ tin.
48 „ brass.

This metal was used for the standards of capacity; the standard weights were made of brass. Five copies of the imperial troy pound in the custody of the Clerk of the House of Commons were first made by Mr. Bate, and accurately verified. The pound avoirdupois was next constructed, being derived from the troy pound and some of its aliquot parts. The imperial gallon and imperial bushel were then constructed, and verified by ascertaining that they exactly held the due weight of distilled water at the temperature of 62°. Five copies of each of these standards, and of their necessary parts and multiples, were constructed by Mr. Bate.

Four copies of the standard yard were constructed by Mr. Dolland, from the standard yard in the custody of the Clerk of the House of Commons. They were made of brass, one inch square. To their extremities were firmly screwed rectangular pieces of steel of the same width as the bar, and projecting above its surface. The distance between the interior faces of the steel terminations was intended to be equal to the length of the imperial yard.

These standards were intended for the purpose of verifying others. Four accurate copies of the standard yard were also constructed for the purpose of being referred to upon extraordinary occasions. They were made of brass, $1\frac{1}{4}$ in. wide, $\frac{1}{2}$ in. thick, about three inches longer than the yard, with gold studs let into the bar showing the exact distance of 36 inches between lines marked upon them.

The several steps in the construction and verification of these standards is recorded by Captain Kater in his published account. He also gives a list of the whole, with an account of the places where they were deposited, viz:—

The Exchequer, Westminster,
Guildhall, London.
Edinburgh, and
Dublin.

These standards were finally completed and delivered at the Treasury by 2nd August 1825. It appears by the Treasury Minutes of 28th June, and 2nd August 1825, that Sir G. Clerk, Dr. Wollaston, Dr. Young, and Captain Kater, four of the Commissioners appointed to inquire into the subject of weights and measures, attended at the Treasury Board, and stated that the weights and measures had been subjected to the several tests, and had been found, some of them quite free from error, and the others having only such extremely minute variations as an elaborate philosophical experiment could detect, but such as must be wholly imperceptible to any ordinary test, and absolutely immaterial for any practical purpose. They therefore considered them as being fit standards for the trial of any weights and measures sent to the Exchequer for comparison in pursuance of the provisions of the Act.

On 5th August 1825, the following set of standard weights and measures was transmitted to the Exchequer from the Treasury, together with a Treasury letter, with a Schedule of the standards annexed. These standards were directed to be deposited at the Exchequer for the purposes mentioned in the Acts 5 Geo. IV., C. 74 and 6 Geo. IV., C. 12. A copy of some instructions prepared by Captain Kater, together with some observations, was also transmitted for the guidance and assistance of the Officers of the Exchequer in the use of the standards, and in the verification of any weights and measures which might be brought to the Exchequer for comparison.

List of new Exchequer Standards deposited at the Exchequer, 5th August 1825.

1 imperial troy pound.
1 imperial gallon, } Conical shape.
1 quart, }
1 pint, }
1 bushel, with two projecting hoops.
1 weight of imperial gallon of water.

1 standard yard with steel terminations.
1 set of 15 troy weights, from 1 lb. to 1 grain.
1 set of 16 avoirdupois weights, from 56 lbs. to $\frac{1}{2}$ drachm, with counterpoises for each troy and avoirdupois weight.

1 bushel, }
1 half bushel, }
1 peck, }
1 gallon, } Cylindrical
1 half gallon, }
1 quart, }
1 pint, }
1 half pint, }
1 gill, }
1 half gill, }

These standards have never been used at the Exchequer, with the exception of the troy pound, which has been once used in the comparison and verification of a set of troy weights for the Russian Government on 11th August 1833.

For common use. There is a duplicate standard weight of $\frac{1}{2}$ drachm.

In his account, Captain Kater states that the following standards were also deposited at the Exchequer:—

1 imperial standard yard, with gold points.
1 avoirdupois pound, No. 1.
1 ditto No. 5, in a box with smaller weights.
1 imperial gallon, No. 3.
1 pint.

This is not the fact. They were probably intended to be so deposited, and were sent to the Treasury for that purpose, but with the exception of the avoirdupois pound No. 5, in a box with smaller weights, of which nothing is known at the Exchequer; all these standards still remain deposited at the Treasury, together with the three other imperial standard yards with gold points, stated by Captain Kater to have been deposited at the Guildhall, London, at Edinburgh and Dublin. A report of this fact, that these standards remained at the Treasury, was made by Mr. Bowen to your Lordship on 3rd August 1849, and was on the same day transmitted to the Treasury by your Lordship, but nothing more was done in the matter.

It subsequently appeared that the cylindrical standards of capacity, from the bushel to the half gill, so deposited at the Exchequer, were considered by Mr. Bate as not sufficiently finished for the purpose; and on the 23rd October 1834, he delivered at the Exchequer what he stated to be a proper set in completion of the order given him from the Treasury. This set of standard measures of capacity was most carefully compared and verified with those which had been in temporary use at the Exchequer, and which were then returned to Mr. Bate. A report of the circumstance was transmitted to the Treasury by the Assistant-Comptroller on 10th November 1834.

The standard yard and standard weights deposited in the Exchequer in 1825, and the standard measures of capacity deposited in 1834, have since been in continual use at the Exchequer.

In 1834 the subject of the uniformity of weights and measures was brought before the House of Commons by Lord Ebrington, and was referred to a Select Committee. The minutes of evidence taken before the Committee were printed, and these proceedings led to the passing of the Act 4 and 5 Will. IV., C. 49, to amend the two preceding Acts of 5

Select Committee,
1834.
464—1834.
Act 4 and 5, Will.
IV., C. 49.

Geo. IV., C. 74, and 6 Geo. IV., C. 12. The object of this Act was to enforce uniformity of weights and measures in use throughout the kingdom, and the Act did not refer to the Exchequer standards further than by Section 4 to abolish the heaped measure, and to require by Section 19, that all copies of the standards which may have been worn by time, or mended in consequence of any wear or accident, should be forthwith sent to the Exchequer to be again compared and verified.

In 1835 a Select Committee, of which Lord Ebrington was also Chairman, was again appointed to examine further into the subject. Their report and the minutes of evidence taken before them were printed, and the 5 and 6 Will. IV., C. 63, to repeal the Act 4 and 5 Will. IV., C. 74, and to make other provisions in lieu thereof, was passed to carry out their recommendations. The Act 5 and 6 Will. IV., C. 63, applies to weights and measures in general use, and contains no further regulation affecting the Exchequer standards, except a provision for comparing and verifying at the Exchequer copies of the standards, although they should not be exact models and copies in shape and form of the respective Exchequer standards, as had been prescribed by the Act 5 Geo. IV., C. 74.

In the meantime, by the burning of the Houses of Parliament on 16th October 1834, the standard yard of 1760, and the troy pound of 1758, declared by the Act 5 Geo. IV., C. 74, to be the only original and genuine standards, were destroyed.

On 11th May 1838, the following gentlemen were appointed by the Treasury Commissioners to consider the steps to be taken for the restoration of the standards of weight and measure:—

Professor Airy, Astronomer Royal.

F. Baily, Esq., V. P. R. S., and R. A. S.

J. E. D. Bethune, Esq.

Davies Gilbert, Esq., V. P. R. S.

J. G. S. Lefevre, Esq.

J. W. Lubbock, V. P. R. S.

Rev. Geo. Peacock, D. D., F. R. S., Dean of Ely, and Lowdian Professor of Astronomy.

Rev. R. Sheepshanks, F. R. S., and F. R. A. S.

Sir J. F. H. Herschell, Bart.

Their report, signed by all the Commissioners except Mr. D. Gilbert, who died in the meantime, and which was dated 21st December 1841, deserves especial notice, as containing the recorded opinion of so many distinguished persons upon the subject of the imperial standards, in which opinions they appear to have been unanimous, with the exception of Mr. Bethune, upon one point, as will be shown hereafter, and as containing many highly important recommendations. The Commissioners were of opinion "that the definition in the Act of 5 Geo. IV., by which the standard yard and pound are declared to be respectively a certain brass rod, and a certain brass weight therein specified, is the best which is possible to adopt;" that accurate restoration of the standard of length by means of the length of a pendulum vibrating seconds, or of the standard of weight by that of a cubic inch of water, as directed by the Act of 5 Geo. IV., had since been found to be doubtful; and they were fully persuaded that, with reasonable precautions, it would always be possible to provide for the accurate restoration of standards by means of material copies which had been carefully compared with them.

They recommended "that no change be made in the values of the primary units of the weights and measures of this kingdom, or in the meaning of the names by which they are commonly denoted."

That the construction of the standards be entrusted to a Committee of scientific men, under certain instructions specified in the Report, and by comparison with the most carefully verified existing specimens.

That the Parliamentary standard of length be one yard, there appearing no sufficient reason for departing from the length hitherto adopted for the standard.

That the avoirdupois pound be adopted instead of the troy pound as the Parliamentary standard of weight, the avoirdupois pound being invariably known and generally used, and the troy pound being wholly unknown to the great mass of the British population, and comparatively useless.

That no standard of capacity be constructed, the gallon being defined by its containing 10 pounds weight of distilled water as specified by the Act 5 Geo. IV., C. 74.

That four sets of copies of the Parliamentary standards of length and weight; the yard and pound avoirdupois, in all respects similar and as nearly as possible equivalent to them, be also constructed and preserved in different places.

All these recommendations relating to the original standards of weight and measure were carried out, as will be shown hereafter, by the appointment of a Committee to superintend the construction of the new standards, and by the passing of the Act 18 and 19 Vict., C. 72, for legalizing and preserving the standards so restored.

Many other important recommendations of the Commissioners should be mentioned relating to the Exchequer standards, which are the only standards used in the verification and legalizing of local standards.

In order to decide upon the selection of secondary standards which they could recommend for the adoption of the Government, the Commissioners state that they found it necessary to institute inquiries as to the weights and measures most extensively used, and as to the practicable changes which with the least present inconvenience might add most to the simplicity and uniformity of the scales of weights and measures, and might ultimately tend to the general convenience.

They first recommended a decimal system of coinage, "because no circumstance whatever would contribute so much to the introduction of the decimal scale in weights and measures in those respects in which it is really useful, as the establishment of a decimal coinage."

They thought it "undesirable to enforce the decimal system exclusively in all parts of the various scales of weight and measure, even were the attempt likely to be attended with fewer difficulties than would be experienced in this country;" but they strongly called the attention of the Government to the importance of encouraging the use of the decimal scale, and especially of sanctioning its use where custom had already adopted it. They recommended a modified adoption of the decimal scale, both in measures of length and in weights, and a complete revision of the Exchequer standards of troy weight and avoirdupois weight, having in view the ultimate removal of the troy scale.

They recommended that the troy pound, the avoirdupois weights above 10lbs., and the avoirdupois drams ought to be removed, and other weights in the ascending decimal scale of troy ounces and avoirdupois pounds, and in the descending decimal scale from the avoirdupois pound, ought to be substituted; an addition to the standards of capacity now in the Exchequer; and the increase of the number of Exchequer standards of length, being parts and multiples of the standard yard.

The Exchequer standards recommended by them were as follows:—

Troy weight, 1 ounce	} and several multiples of each, but no weight of 12 troy ounces.
10 ounces	
100 "	
1,000 "	
1 dwt. and several multiples.	
1 grain	} and several multiples of each.
10 grains	
100 "	
1,000 "	
10,000 "	

Avoirdupois weight :—

1 lb. and several multiples not exceeding 10 lbs.
 10 lbs. ditto ditto 100 "

100 " } and several multiples of each.
 $\frac{1}{10}$ " }
 $\frac{1}{100}$ " }
 $\frac{1}{1000}$ " }

Measures of capacity :—

$\frac{1}{8}$ gallon, as a measure of the wine bottle.

$\frac{3}{4}$ "

$\frac{5}{8}$ "

9 " in addition to the existing Exchequer standards.

Measures of length :—

Measures and beds of 1 foot... the bed having divisions into inches, 10th of inches, and 10ths and 100ths of feet.

" " 2 feet... the beds similarly divided.

" " 1 yard... the bed divided into halves, quarters, eighths, and sixteenths, and also into tenths and hundredths.

" " 10 feet... the bed divided into feet and tenths of feet.

" " 22 yards (the chain) divided into links.

Also an Exchequer standard of one yard, in which the yard should be defined by two lines upon its surface, and which should be furnished with a microscopic apparatus for accurate comparison.

They further recommended "that other Exchequer standards, representing other divisions and multiples of the principal weights and measures included in the decimal scale should be added from time to time as the Treasury should direct."

"That once in every five years the Exchequer standards of the yard and the pound be compared with the Parliamentary standards, and all the Exchequer standards be compared amongst themselves and repaired if found incorrect."

That, in the comparison at the Exchequer of standards of weight no greater error than $\frac{1}{20,000}$ th of the quantity weighed be tolerated; of measures of length, no greater error than $\frac{1}{20,000}$ th of the whole, except as to the chain of 22 yards, of which no error exceeding $\frac{1}{20}$ th of an inch should be tolerated; and of measures of capacity, no greater error than $\frac{1}{20,000}$ th of the whole.

That the local standards be compared and reverified at the Exchequer once at least in every five years.

That Colonial local standards be authorized and used, and be compared and reverified once every 10 years by means of a set of itinerant standards, which also should be returned to England, to be compared with the Exchequer standards every 10 years.

The Committee add,— "The method of comparing at the Exchequer the weights and measures of capacity brought for comparison with the Exchequer standards appears to us unexceptionable. The method of comparing measures of length does not appear sufficiently good, as it gives no means of determining the amount of error of the measure compared."

Several other recommendations were made by the Commissioners in their Report, relating to weights and measures in use throughout the country, which do not appear to require further notice here.

Much condensed and valuable information is contained in an Appendix to the Report under the following heads of subjects, which refer not only to this country but to other foreign countries :—

- A. Basis of the System of Standards.
- B. Construction of Primary Standards.
- C. Means of restoring Standards.

- D. Preservation of one Standard unaltered.
- E. Change of Scale of Weights and Measures.
- F. Alteration of the Land Chain and Mile.
- G. Abolition of Troy Weight.
- H. Introduction of Decimal Scale.
- I. Assimilation to Scales of other Countries.
- K. Construction of Secondary Standards.
- L. Construction and Use of Local Standards.
- M. Powers of Inspectors.
- N. Manufacture of Tradesmen's Weight.
- O. Miscellaneous, principally relating to the Extension of the Laws of Weights and Measures.

The point upon which Mr. Bethune differed in opinion from the other Commissioners is explained by him in a letter to the Chancellor of the Exchequer, dated 21st February 1841. He thought it desirable to make some alteration in the standards of weight and capacity, so as to simplify the relation between them; and also to make some alteration in the value of the coins of the realm, in order that the commercial weights might bear a similar relation to them. His proposal was negatived almost unanimously by the Commissioners, and was not further pressed by him.

Of all these recommendations of the Commissioners, two only have been carried into effect, the establishment of Bullion Standards, being decimal parts and multiples of the troy ounce, by the Act 16 Vict., C. 29 in 1853, and the compulsory comparison and re-verification of the local standards of weight every five years, and of the local standards of measure every 10 years, under 22 and 23 Vict., C. 56 applicable to Great Britain, and 23 and 24 Vict., C. 119 applicable to Ireland.

The Committee to superintend the construction of the new Parliamentary Standards of length and weight was appointed by Treasury Minute, dated 20th June 1843. The following names appear in the list of the Committee, in addition to those of the Royal Commissioners :—Marquis of Northampton, P. R. S., Lord Wrottesley, and Professor Miller. On the death of the Marquis of Northampton in 1851, the name of the Earl of Rosse, his successor as President of the Royal Society, was added.

Their Report, dated the 28th March 1854, is signed by every surviving member of the Committee. It states that the direct superintendence of the standard of length was entrusted to Mr. Bailey, and after his death to Mr. Sheepshanks; that of the standard of weight was undertaken by Professor Miller.

In the construction of the standard of length the following decisions were made by the Committee :—

1. The length of one yard to be the standard of length.
2. After considering whether the measure of length should be defined by the whole length of a bar, or by the distance between two points or lines upon it, a *line standard* was adopted, in preference to an *end standard*.
3. For the material of the standard of length, gun metal composed of—

Copper,	16 parts.
Tin,	2 $\frac{1}{2}$ "
Zinc,	1 "

 was adopted after a series of experiments.
4. The form of the standard adopted was a solid square bar, 38 inches long and 1 inch square in transverse section; the measure of length to be shown by the distance between two fine lines transverse to the axis of the bar marked upon two small gold plugs.
5. For the reproduction of the standard, it was decided that no scales ought to be used for restoration of the standard except those which

had been *directly* compared with the imperial standard; and after elaborate experiments, that the only admissible scales were, the Royal Society's brass scale No. 46, and the 3-feet iron bars of the Ordnance Department. It does not appear that any direct comparison was made with the Exchequer standard yard, or with any of the copies constructed under Captain Kater's superintendence in 1825, amongst which were the four standard yards with gold points remaining deposited at the Treasury.

6. As to the details of the mode of verification, the Reports refers to a promised memoir to be given by Mr. Sheepshanks to the Royal Society. It appears that, during the comparison, the bars were floated in a trough of quicksilver, which itself floated in a trough of water supported upon a foundation of masonry. This masonry also carried the comparing microscopes. It was established in the cellar beneath the apartments of the Royal Astronomical Society at Somerset House. In the experiments it was necessary to ascertain the temperature with the greatest accuracy. It was found that the effect of a change of the hundredth part of a degree of Fahrenheit is sensible in the measure of the length of a bar. No thermometer in England at the time of commencing these experiments could be trusted to such a nicety. New thermometers were, therefore, constructed for the purpose, and the relation between the adopted authorities and the Imperial standard was ascertained with all the accuracy possible.

After the construction of the new standard, numerous bars were constructed and compared with it, and five bars were selected for their nearest approach to the lost Imperial standard, and as well adapted to be taken as Parliamentary standards and Parliamentary copies.

It was proposed by the Committee that—

- No. 1 be adopted as the PARLIAMENTARY STANDARD OF A YARD.
- Nos. 2, 3, 4, 5, as Parliamentary copies.

No. 6 to be retained by an Officer of the Government for comparison with other yard measures.

During the experiments an extensive series of new observations was made by numerous observers. The discussion of these observations showed clearly, as had been suspected before, that there is a difference among the results of different observers far exceeding the uncertainty inferred by the theory of probable errors from the observations of each observer taken separately. In other words, that each person has a personal equation in the microscopic observations of the engraved lines. The means of the first results of the different observers were therefore taken, giving equal weight to each.

The following points were decided by the Committee for the construction of the standard of weight, the future standard being the avoirdupois pound, or pound weight of 7,000 grains, as recommended by the Committee, and understood by them to be adopted by the Government:—

1. For the material, platinum.
2. For the form, a cylinder, nearly 1.35 inch in height and 1.15 inch in diameter, with a groove a little below the top, that it might be lifted with an ivory fork.
3. For the comparison of the weights a balance of the utmost delicacy was provided by Professor Miller from Mr. Barrow. This instrument was mounted in a cellar beneath the Mineralogical Museum at Cambridge.
4. For ascertaining the exact weight of the lost standard troy pound, by which the weight of the new standard pound avoirdupois was to be derived, the following weights, which had been compared with the lost standard, were examined:

The brass troy pound Exchequer standard.

The three do., for the cities of London, Edinburgh, and Dublin.

The platinum troy pound, and the two brass pounds, then in the custody of Professor Schumacher.

The platinum troy pound of the Royal Society, 1843.

After comparing these weights with each other, it was found that the brass weights had gained in weight, whilst the platinum weights retained precisely the same relation as before. There appeared to be no doubt that the increase of weight of the brass pounds arose from oxidation. It was decided, therefore, to base the restoration of the standard on the platinum pounds only.

To the weight of the troy pound of 5,760 grains, thus determined, was added the weight of 1,240 grains accurately ascertained, and thus was formed the new standard avoirdupois pound weight of 7,000 grains.

Five platinum pounds were prepared by Professor Miller, marked as follows:—

	P. S. (Parliamentary standard.)
No. 1.	P. C. (Parliamentary copy.)
" 2.	P. C.
" 3.	P. C.
" 4.	P. C.

The Committee recommended that the two Parliamentary standards of one yard and one pound be deposited at the Exchequer.

P. C. yard No. 2, and pound No. 1 at the Royal Mint.

" 3,	" 2 with the Royal Society.
" 4,	" 3 in the Royal Observatory at Greenwich.
" 5,	" 4 be immersed in the sill of the recess on the east side of the lower waiting hall in the New Palace of Westminster.

The Report states that under sanction of the Treasury, dated 23rd June 1853, the standards and the several copies had been so deposited by them.

The proceedings and recommendations of the Committee for the restoration of the standards are recited and legalized by the Act 18 and 19 Vict., C. 72, passed 30th July 1855, for legalizing and preserving the restored standards of weights and measures.

In addition to these recommendations since so carried into effect, the Committee referred to the other recommendations of the Report of 1841, which had not since been acted on, and stated that they adopted in their utmost extent the whole of those recommendations; and, after alluding to a proposal in Lord Carysfort's Bill of 1760 for appointing Commissioners with an adequate establishment for maintaining the standard department in a perfectly efficient and reputable state, the Committee further recommended that a permanent scientific Officer be appointed with adequate salary, to keep a constant watch on the state of the standards, and the law generally as applying to them, and who should call the attention of the Government to any points connected with them; as occasions might arise.

The Committee also called attention to the unfitness of the apartments of the Exchequer for the execution of the duties connected with the standards, the improvements pressingly required in the length standards, the antiquated and inaccurate balances requiring to be replaced by balances of a more accurate construction, and the fact of the Exchequer standards not having been verified for many years.

An appendix to the Report contains three letters to the Chancellor of the Exchequer from the Commissioners, strongly advocating the advantages of a decimal system of coinage, and proposing a new schedule of customs duties to be levied on a decimal scale of weights, in substitution for the existing weights.

Under the sanction of the Treasury letter, dated 23rd June 1853, the Parliamentary standards of length and weight were deposited at the Exchequer, 3, Whitehall Yard, on 17th September 1853, by the Astronomer Royal, Chairman of the Standard Committee, and Sir J. W. Herschell, Bart., a member of the Committee.

The following schedule, describing the standard yard measure and standard pound avoirdupois weight, accompanied these standards:—

"The standard yard measure is defined by the interval between two lines upon a bar of gun metal. The bar is about 38 inches long and 1 inch square. It is supported in a horizontal position upon eight brass rollers, which are carried by levers so arranged that the pressures upon the eight rollers are necessarily equal. The lever frame with the bar resting upon it is placed in a box of mahogany wood. The bar is prevented from moving endways by weak brass springs attached inside to the end of the box; and it is prevented from moving upwards by wedges of paper placed under the inverted stirrups. Near to the end of each bar a cylindrical hole is sunk from the upper surface of the bar to the depth of half an inch, and at the bottom of each cylindrical hole is inserted a gold pin; upon which are cut three fine lines in the direction transversal to the bar, and two fine lines parallel to the axis of the bar. The limiting points of the yard measure are those points of the middle transversal lines which are midway between the longitudinal lines. Upon the upper surface of the bar the following inscription is inscribed:—

"Copper, 16 ounces.
"Tin, 2½"
"Zinc, 1"

"Mr. Bailey's Metal No. 1. Standard Yard at 62° 00 Fahrenheit. Cast in 1845. Troughton and Simms, London."

"Upon the lid of the mahogany box is cut and painted the following inscription:—

"The standard pound weight is a weight of platinum representing, when weighed *in vacuo* against the lost standard troy pound, 6,999-99845 grains, of which the lost standard pound contained 5,760. The form of the weight is a cylinder, with a groove surrounding it a little above the middle of its height, for the insertion of the fork which is used in lifting it. Upon the upper end of the cylinder is engraved the following inscription (the sharp edges of the engraving having been rubbed off):—

"P. S. 1844.
"1 lb."

"The box is mahogany, and when its portions are screwed together, the weight is fixed immovable. This mahogany box is placed in a second mahogany box whose lid bears the inscription—

"Standard Pound, 1853."

"The mahogany boxes of the yard and pound are enclosed in an oak box upon whose lid is cut and painted the inscription:—

"British Standards of Length and Weight, 1853."

On 1st December 1853 these standards were placed in a stone case, like one of the ancient Celtic coffins, which, under the directions of the Astronomer Royal, had been prepared for them, in the vaulted Strong-room of the Exchequer.

In 1855, during the passing through Parliament of the Bill for legalizing the new standards, it was referred to a Select Committee of the House of Lords appointed to consider it. Their Report bears date 8th June 1855. They recommended that, whilst retaining for the primary standard of length the method of line measure, secondary standards of end measure should be made and legalized for general purposes; which measures should represent a standard yard, a standard foot, a standard inch, or other measures being multiples thereof, and that means should be taken for the distribution,

Report of Select Committee of House of Lords, 1855.

Lords Papers (133) 1855.

"conservation, ready comparison, and occasional verification of such measures in the principal provincial towns."

The evidence of the Astronomer Royal and of Mr. Whitworth, who were the only witnesses examined by the Committee, is contained in the Appendix to the Report. Mr. Whitworth stated his objection to the proposed standard line measure, and advocated an end measure as far preferable. He produced a standard inch measure, being an end measure, and declared that by means of an apparatus which he employed he could take the length of this standard and compare it with any other similar standard, and could ascertain any difference there might be in their length to the millionth of an inch. He added that it would be of the highest importance to all engaged in the mechanical arts to have a standard foot and a standard inch, indeed of far greater importance, than to have a standard yard.

The Astronomer Royal allowed that for common use the end measure was most convenient, but he stated the several reasons which had determined the Commissioners, after long and careful consideration, to decide upon adopting a line standard for the Parliamentary standard of length. He said that Mr. Sheepshanks was then engaged in forming an end measure to be derived from the line measure, and to be used as a secondary standard. They proposed to adopt for the ends spherical curves, the centre of the curves being the centre of the bar, so that the ends would be portions of a sphere three feet in diameter.

This recommendation of the Committee was the cause of the insertion in the Bill on its third reading of the following clause, which appears as S. 6 of the Act 18 and 19 Vict., C. 72.

18 & 19 Vict. C. 72.
S. 6., authorizing additions to Exchequer standards by Orders in Council.

"All weights and measures which shall be hereafter verified and authenticated by comparison with the said Imperial standards of weight and measure, in such manner as Her Majesty shall by any Orders in Council from time to time direct and appoint, shall be deemed and taken to be legal secondary weights and measures."

This clause was proposed by Lord Wrottesley, who was a member of the Royal Commission of the Standard Committee, and of the Select Committee, and was approved on the part of the Government, as rendering the further intervention of the Legislature unnecessary for adding to the number of the secondary standards. Lord Wrottesley added that the secondary standards of the Exchequer were in a state unworthy of the nation, and that the whole subject required to be carefully looked into, and that proper measures should be adopted for correcting the evil. I may be allowed to remind your Lordship of your reply that those who had charge of these measures were always ready to listen to any suggestion for their improvement.

On 26th June 1857 the Astronomer Royal transmitted to the Exchequer the following standards, and apparatus relating to them. Those which relate to the measures of length were constructed under the superintendence partly of Mr. Sheepshanks, and partly of the Astronomer Royal; those which relate to weight under the superintendence of Professor Miller.

Other standards of length, &c., deposited at Exchequer.

Box 38. A three feet line standard of gun metal, No. 30.

A three feet scale of brass, divided into nails, one foot divided into ½ inch, one foot divided into ⅓ inch, and one foot divided into ¼ inch.

Box 45. A three feet end standard of gun metal, No. 45.

Box 46. A three feet end standard of iron, No. 70.

Box — A 12-inch standard of gun metal, No. 76.

A 6 " " " No. 79.

A 3 " " " No. 81.

Box — A 1 lb. avoirdupois weight of gilt gun metal, No. 31.

A do. " " " No. 34.

Box — An apparatus for comparing three feet end bars with the three feet end standards, Nos. 70 and 45.

The three feet standard bear inscriptions describing (among other particulars) the temperature at which they represent the exact measure of a yard, from which they may practically be accepted as representing, without discoverable error, the exact yard at any ordinary temperature.

The weight No. 31 is stated by Professor Miller to be too heavy by 0.00088 of a grain, and the weight No. 34 to be too light by 0.00088 of a grain. As these quantities are so small as to be discoverable only by the most careful use of the most delicate balances, the two weights may be accepted in practice as sensibly exact.

In 1853 the Act 16 Vict., C. 29, for regulating the weights used in the sales of bullion was passed. The Act recited that "the weights now ordinarily used in sales of gold and silver are the troy ounce and other weights being multiples or decimal parts of such ounce," and enacted that for such purposes such weights should be legal, and such troy ounce taken to be the standard or unit of weight. It was also enacted that models of such multiple and decimal parts of the ounce as the Treasury should from time to time direct should be carefully made, and verified and deposited at the Exchequer, and all the provisions of the Act 5 and 6 Will. IV. C. 33, were made applicable to these bullion standards.

A Treasury letter dated 18th July 1853 authorized your Lordship to verify multiples and decimal parts of the troy ounce, and to incur any expense that might be indispensably necessary for that purpose. Your Lordship was at the same time informed "that the models of these weights should, in their Lordships' opinion, be considered supplementary to the Standards at present in the Exchequer."

At the request of the Astronomer Royal, and with your Lordship's concurrence, the bullion standards were constructed under the superintendence of Professor Miller, and were accurately verified by him. The whole of them were deposited at the Exchequer by 21st August 1855, being as follows:—

Oz. .001, .002, .003, .004, .005 of platinum wire.

.01, .02, .025, .03, .04, .05, .1, .2, .3, .4, .5, 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500 of brass, electro gilt.

There are duplicates of all these bullion standards, not gilt.

A 10 lb. avoirdupois weight, or the weight of 1 gallon of water and a killogramme, as a specimen of French weight, were at the same time deposited at the Exchequer.

On 22nd and 23rd August Professor Miller reported the minute errors of each bullion weight in decimals of a grain, and gave instructions for the mode of verifying copies of these bullion standards in the most accurate manner. In reply to some questions to Mr. Bowen, he gave some further instructions on 31st August, and added,—"the amount of error, or allowable error, in a weight ought to be determined by law."

These bullion standards were constructed by Messrs. Ladd and Streatfield. Under the advice of Professor Miller, a duplicate set of working weights was ordered from them on 25th August 1853, and was duly furnished. The total amount of their bill for these bullion standards was 275l. 5s.

The subject of the balances for comparing standards at the Exchequer was brought to the notice of the Treasury by your Lordship on 6th December 1853. The opinion of the Astronomer Royal, the Master of the Mint (Sir J. Herschel), and Professor Miller was referred to, that the existing balances were imperfect and insufficient, and your Lordship suggested the necessity of procuring without delay three new balances of different sizes for the purpose of testing the new bullion weights. By letter dated 15th December 1853, the Treasury authorized the necessary steps to be taken for procuring these balances. The attention of the Treasury was at the same time drawn by your Lordship to the apartment in which the balances were then placed, as being by no means in a condition to ensure the accuracy required; and it was recommended that the aid of the Astronomer Royal, Sir J. Herschel, and Professor Miller should be obtained to judge what ought to be done. The

Treasury concurred in this recommendation, and these gentlemen attended at the Exchequer, 3, Whitehall Yard, on 21st March 1854, and made their report on the same day. They were of opinion that the rooms were utterly unfit for the purpose of the business relating to the standards, and that it was impossible by any practicable alteration to make them efficient, and that it was absolutely necessary to transfer the Standard Department to some other locality. The requisites were, in their judgment, a series of at least four or five fire-proof rooms, of ample size and height, in a dry situation on the ground floor, at a considerable distance from frequented streets. They referred to the necessity for providing not only for the operations of the existing system, but also for an extensive series of standards of length, for some of which different circumstances of window light would be required. They stated that the balances then in the Standard Office were by no means fit for their purpose, being of an antiquated construction, and essentially inaccurate. That it was absolutely necessary to replace them by entirely new balances, in order to give confidence in the result of their comparisons. They considered that at least four, if not five, balances of different dimensions would be necessary, and proposed that Messrs. Ladd and Streatfield should be entrusted with the construction of the larger balances, and Messrs. Oertling with the smaller.

This report was forwarded to the Treasury on 29th March 1854 by your Lordship, and you expressed your entire concurrence in their recommendations. No record appears of any reply or further instructions having been given by the Treasury, and eventually Messrs. Ladd and Streatfield, in consequence of having already too much work on their hands, declined the construction of the larger balances, and recommended Mr. Oertling as the most efficient person to construct them. Your Lordship on 20th April 1855 directed Mr. Oertling to furnish the following balances:—

No. 1.	For comparing bullion weights from 500 oz. to 200 oz., or avoirdupois 56lb.	
No. 2.	" " " 100 oz. to 200 oz., " 7lb.	
No. 3.	" " " 10 oz. to 2 oz., " 1lb.	
No. 4.	" " " 1 oz. to .001 oz.	

with suitable instruments and apparatus. The balances to have a scale opposite to the left hand extremity of the beam, which should carry an index. The scale to have close divisions numbered from 0 at one end to the other end.

These balances were delivered at the Exchequer by Mr. Oertling on 21st July 1855. Their cost was 173l. They are finely poised upon agate bearings, and are enclosed in plate glass cases. The smallest of these balances, No. 4, after being exactly in equilibrio, will indicate a difference of three degrees of the scale, with the addition of the weight of one thousandth part of a grain placed on one side of the beam. This is effected by placing, by means of a mechanical contrivance, a small piece of very fine bent wire of the weight of $\frac{1}{1000}$ of a grain, upon the graduated beam, one-tenth of the distance from the central bearing to the point of suspension of the pan.

On 4th February 1858, the Exchequer Office was removed from No. 3, Whitehall Yard, to No. 6 and 7, Old Palace Yard, where the balances and other apparatus required for the comparison, and verification of copies of the standard weights and measures were fixed in a large and more suitable room on the ground floor of the building, and where the working standards were also deposited. On 11th February the Imperial standards were removed from the vaulted strong room in the old building and deposited in the strong room of the present building, where they now remain. These instruments are the Parliamentary standard yard and pound. The standards and apparatus transmitted by the Astronomer Royal on the 26th June 1857 were also deposited in the strong room. No directions have been received from the Treasury or other constituted authority for making any use of, or reference to, the Imperial standards, or the secondary standards so furnished by the Astronomer Royal. Under these circumstances, since their deposit in the strong room, by direction of your Lordship, they have remained undisturbed in their cases up to the present time.

But in October 1858 the attention of Sir Edward Ryan, the Assistant Comptroller, having been called to the two comparing instruments, he desired Messrs. Troughton and Simms to give an explanation of them. This explanation was as follows:—"First, with respect to the apparatus for comparing yards. This must be fixed to the wall in a vertical position by means of three Lewis's and screws, care being taken to leave sufficient space in front of the apparatus to admit the insertion of the bar to be compared, thus—
 "There must be an open space of seven feet in front of this comparateur."

"Next, the horizontal comparateur will be fixed to projections standing out from the wall by means of eight Lewis's and screws. Sufficient space must be left between the horizontal surface and the wall to allow for the adjustment of the divider scale to its proper position. This scale will be screwed to a beam, which has been previously fixed to the wall."

(Signed) JAMES SIMMS.

Mr. Simms subsequently attended to this office, together with an officer of the Board of Works, with the view of fixing this comparing apparatus. But as no convenient place could be found for it, and as no authoritative instructions had been received respecting it, any idea of fixing and using it was at that time necessarily abandoned.

Towards the close of the year 1859, some communications passed between the Astronomer Royal, and Mr. Walpole, then Home Secretary, and your Lordship, with reference to a complaint of Mr. J. Hayman of the defective state of the local standards. These communications led to an important Report upon the whole subject of the standards by the Astronomer Royal, dated 1st February 1859, which was transmitted to the Home Secretary, together with observations upon it, by your Lordship, in a letter, dated 9th February 1859. These two papers were laid before Parliament and printed. The points contained in them, which may be here noticed, are as follows. The Astronomer Royal refers:—

1. To the number of local standards tested at the Exchequer since 1824, being 29,699, compared with the number re-tested, being 9,969 only, and to the number of re-verifications, barely exceeding one-third of the number of standards, as evidence of the probable deterioration of the local standards which may tend to serious consequences.
2. To the want of public standards, as recommended by the standard Commission of 1841. He mentions the erection on 30th January, upon the external wall of the Observatory at Greenwich, of mural standards of length (3 feet, 2 feet, 1 foot, 6 inches, 3 inches).
3. To the presumed error in the general theory of British legislation on the subject of standards and to the mode of correcting it. He is led to the conclusion that there is an entire apathy on the part of the Government with respect to the standards, and that the Government acts only when pressed by popular demands. He thinks that the spirit of our legislation on standards ought to be entirely changed, and that it ought to be the duty of a department of the Executive to undertake as of its own authority (not supplanted by others) the necessary steps for furnishing to every part of the realm the apparatus necessary for ensuring accuracy in all transactions of measure or sale.
4. To the presumed error in the practice of the British Executive on the subject of standards, and of the mode of correcting it. The general error

in the practice of the Standard Office he considers to be that it is absolutely passive, only responding to demands. He would correct it by appointing an active chief of the Standard Department, who should be invested with ample powers for inspecting and maintaining in efficiency all the local standards, and for supervising the general use of such standards in verifying weights and measures for common use. He should be the responsible officer (under the Comptroller-General of Exchequer or other officer of State) for all matters connected with the Exchequer standards.

In your Lordship's observations on this Report of the Astronomer Royal you fully concur in his general view of the errors of the existing law and practice, the principle of which appears to be to depend, as far as possible, upon the voluntary action of private persons, and to limit the interference of the State to its minimum. But you express some doubt how far the error might be corrected by the more active interposition of the Executive Government, by taking upon themselves the responsibility of maintaining the accuracy of the local standards of weights and measures in the same manner as they are now responsible for the integrity of the coinage of the realm. You express your opinion that a stringent and effective system of inspection and comparison by public officers of the local standards should be established, and you recommend to the serious attention of Her Majesty's Government the establishment of a special office in conformity with the Report of the Astronomer Royal. You remark upon the advantage that would result by extending the application of the decimal system, now adopted in the troy weights for bullion, to avoirdupois weights in lieu of the present complicated system, and express your astonishment that so many important recommendations contained in the Report of the Commissioners of 1841, made by the most distinguished scientific men of our time, should not have attracted the notice of the successive Governments and of the Legislature.

After referring to the length of time the Exchequer standards have been in use without verification and adjustment, and to the obvious necessity that these standards should be in a perfect condition; you express your opinion that measures should be adopted for periodical re-adjustment of these standards, under high scientific responsibility and supervision; that the interposition of the Legislature is required for this purpose; and that no legislative interposition can satisfactorily take place, except under the guidance and advice of the responsible Ministers of the Crown.

In 1859 the Act 22 and 23 Vict., C. 66, for regulating measures used in sales of gas, was passed. Under this Act a new legal standard or unit of measure for the sale of gas, was established, being the cubic foot containing 62 321 pounds avoirdupois weight of distilled water, weighed in air at 62° Fahrenheit, the barometer being at 30 inches. Other gas standards, being multiples or decimal parts, were directed to be made under the authority of the Lords of the Treasury, as they should judge expedient, with proper balances, indices, and apparatus, and deposited at the Exchequer for comparing and verifying copies as local standards.

The construction of the gas standards required by the Act was entrusted by the Treasury to the Astronomer Royal. In his report How carried out. to the Secretary of the Treasury, dated 5th November 1859, the Astronomer Royal expressed his distinct opinion that no standards, being multiples and decimal parts of the cubic foot, were required; that gas-holders containing multiples of a cubic foot are supplied by repetitions of one cubic foot; and that decimal and other sub-divisions of the cubic foot are never used.

In making arrangements for fixing the apparatus that would be required for comparing and verifying copies of the gas standards, it was found necessary that increased accommodation should be provided at the Exchequer, and an additional room was accordingly built on the ground-floor of No. 7, Old Palace Yard, under the immediate direction of the Astronomer Royal, with all the necessary appliances.

On 15th November 1859, the following gas standards were compared and verified at the Exchequer by the Astronomer Royal, assisted by Professor Miller, and were declared by them to be sensibly correct:

A weight of 62·321 lbs., being the weight of a cubic foot of water.

A copper bottle or vessel, containing the capacity of one cubic foot of water:—

A cubic foot gas-holder, or

Transferer, by which successive cubic feet can be discharged into another vessel.

In a letter from the Treasury to your Lordship, dated 13th December 1859, the Lords Commissioners refer to the gas standards, with the balances, apparatus, &c., then deposited and duly verified, and state that the requirements of the Act have in this respect been duly complied with.

A further Report of the Astronomer Royal, dated 11th February 1860, recapitulates the several steps taken in the construction and deposit of these gas standards, and recommends that an allowance of half a cubic inch or $\frac{1}{3458}$ of the whole may with propriety be adopted as the amount of error to be tolerated in each cubic foot gas-holder.

In this Report the Astronomer Royal refers to the gas meters in common use, to be tested by the local standard gas-holders or gas measurers. These gas meters are not, like the Exchequer gas-measuring standards, vessels merely for measuring with accuracy a cubic foot or other definite measure of gas. They purport to record and to indicate the number of cubic feet of gas successively passing through the meter. This result is endeavoured to be effected by means of a succession of wheels, pinions and indexes. But no provision was stated to be contained in the Act. 22 & 23 Vict. C. 66, for compelling any examination of the mechanical construction of gas meters. The Astronomer Royal states, and supports his statement by the evidence of facts, that gas meters are from their mechanical construction open to any amount of error or fraud, and that therefore the Act of 22 & 23 Vict., C. 66, was practically nugatory or useless unless amended.

In your Lordship's observations on this Report, dated 17th February 1860, you express your apprehensions, in concurrence with the Astronomer Royal, that the mechanism of gas meters was seriously imperfect, and not only ineffectual against intentional fraud, but even against inaccuracy or mistake, and that without some effectual amendment of the law, the whole operation would be little more than a delusion; at the same time you ask whether it is not a matter of grave doubt how far that Act can be safely adopted for the regulation of a great trade, and how far it is justifiable to give it effect without forewarning buyers and sellers of the imperfections of its enactments. These two letters were laid before Parliament, and printed in 1860, (Commons Paper 100, 1860); all the further correspondence relating to the gas standards was also laid before Parliament the same session, and printed. (See Commons Papers 293, 339, and 547, 1860).

In the Treasury Minute of 24th February 1860, my Lords sanctioned the tolerance of one-half of a cubic inch in excess or in defect in the cubic foot measurers or gas-holders, as recommended by the Astronomer Royal. This allowance was subsequently extended by Treasury letter of 24th April 1861, on the further recommendation of the Astronomer Royal, to $\frac{1}{100}$ part or $\frac{1}{2}$ per cent. over or under in the gas measurer under comparison.

In the Treasury Minute of 1st March 1860, with reference to the admitted imperfection of the Gas Act of 1859, the Lords of the Treasury stated that it was a question whether it would not be expedient to repeal the Act, with a view to a careful and deliberate consideration of the whole subject; and they had considerable doubts whether it would not be preferable to leave the detection of fraud to the acuteness of individuals interested, rather than endeavour to guard against fraud by legislation in matters of such minute detail. They stated that the functions imposed upon the Treasury by the Act of 1859 were unsuitable to a Central Controlling Department, and that the Treasury possessed in itself no means of

effectually carrying out the provisions of the Act; and they referred the subject to the Board of Trade for their opinion.

The opinion of the Lords of the Committee of Privy Council for Trade was given on 16th March 1860. They had in the meantime conferred upon the subject with the Astronomer Royal, and with a deputation of gentlemen engaged in the manufacture of gas and of gas meters. They thought it was desirable that the sale of gas should be guarded by a legal standard, and that the Act should be allowed to come into operation in its present form, in order that the sufficiency of its provisions might be tried. This course would not exclude the adoption of any proceedings to affect the objects for which the Astronomer Royal recommended further legislation.

In the meantime, in a letter to the Treasury, dated 12th March 1860, written after his conference with the gas meter manufacturers, the Astronomer Royal stated that it had been contended that the provisions of Section 12 of the Gas Measuring Act did sufficiently authorize the local inspectors to examine the mechanical construction of gas meters; and he recommended, upon further consideration, that gas-measuring standards of convenient capacities of 1 foot, 5 feet, and 10 feet should be constructed.

In the Treasury Minute of 24th March 1860, their Lordships acted on the opinion so given by the Board of Trade. They invited the attention of manufacturers of gas meters to the devising of arrangements for facilitating the examination of the counting apparatus, and they left to the local authorities and inspectors the responsibility of exercising their powers of preventing fraud or irregularity in the sale of gas, or, if necessary, of bringing the subject before the Secretary of State for the Home Department, for the purpose of obtaining further powers for effecting this object.

The Treasury at the same time, in accordance with the recommendations of the Astronomer Royal, directed that gas-holders of the respective capacities of 1, 5, and 10 cubic feet respectively should be provided for the Exchequer as gas-measuring standards. These standards were accordingly provided, and were verified by the Astronomer Royal, at the Exchequer on 10th December 1860, and reported, to all intents and purposes, perfect. The Astronomer Royal, at the same time, expressed his conviction that the instruments applying to the measure of gas now furnished to the Exchequer were entirely fitted to maintain the character of our national standards.

Instructions for the mode of verification of copies of the gas-measuring standards were given by the Astronomer Royal on 25th January 1861 and 24th April 1861.

The several gas standards and necessary apparatus were constructed and furnished to the Exchequer by Messrs. Donkin and Co., acting under the directions of the Astronomer Royal. Copies of these gas standards were also furnished for the metropolitan cities of London, Edinburgh, and Dublin, as directed by the Act, and were verified at the Exchequer. At the recommendation of the Astronomer Royal, the Treasury, by letter, dated 2nd February 1851, sanctioned the temporary employment at the Exchequer of Mr. Tomkins, an engineer in the employment of Messrs. Donkin, and who was stated to have actually made all the comparisons and verifications in the construction of the gas standards. Mr. Tomkins was accordingly so employed from 7th February 1861 to 18th June 1862, when his services were discontinued, by directions from the Treasury, your Lordship having, by letter dated 16th June 1862, reported that Mr. Tomkins' services might be then safely dispensed with.

In 1862 a Select Committee of the House of Commons was appointed "to consider the practicability of adopting a simple and uniform system of weights and measures, with a view not only to the benefit of our internal trade, but to facilitate our trade and intercourse with foreign countries." The Committee consisted of the following members:—Mr. W. Ewart, Mr. Sotherton Estcourt, Mr. Cobden, Mr. Adderley, Mr. Baines, Colonel Wilson Patten, Mr. J. B. Smith, Mr. Hume,

Report of Select Committee on Weights and Measures, 1862.

Mr. St. Aubyn, Mr. Hennessy, Colonel Sykes, Mr. Mackinnon, Mr. Findlay, Mr. Greenall, Mr. Pollard Urquhart. The Report of the Committee, dated 15th July 1862, bears no signatures of the members. From the reported proceedings, the following members were present when the Report was agreed to:—Mr. Ewart (in the chair), Mr. Adderley, Mr. J. B. Smith, Mr. Cobden, Mr. Baines, Mr. Hume, Mr. Greenall, Colonel Sykes, and Mr. St. Aubyn.

The Committee enumerate the anomalies of our present system of weights and measures, and state that they have sought for advocates of this system, but have found it difficult to discover them. They invite attention to the French metric system as the most simple, convenient, and scientific system of weights and measures in existence, as homogeneous in all its parts, and perfectly decimal in its multiples and divisors, and as becoming more and more an international system.

The French metric system is based upon the *Mètre*, or the ten millionth part of the distance from the equator to the pole, as the unit of length. The *litre*, the unity of capacity, is derived from the tenth part of a *mètre* (the *decimètre*) by cubing it. The *gramme*, the unit of weight, is derived from the hundredth part of the *mètre* (the *centimètre*) by cubing it also, and filling it with water of a given temperature. The multiples of the several units are expressed by Greek numerals, the divisors by Latin numerals. The French coinage is based on the unit of weight, the *gramme*, the *franc* being equal to five grammes. Thus the whole system, not only of weights and measures, but of coins also, is connected and rests upon the *mètre*.

The Committee arrived at an unanimous conclusion that the best course to adopt is cautiously and steadily to introduce the metric system into this country, and to adopt its nomenclature also.

Their principal recommendations are, that "the use of the metric system be rendered legal. No compulsory measures should be resorted to until they have been sanctioned by the general conviction of the public."

"That a department of weights and measures should be established in connexion with the Board of Trade for executing the several duties relating to the standards, and for promoting the use and knowledge of the metric system." This department to be subordinate to the Government and responsible to Parliament, and to make an annual report to Parliament.

That Government should sanction the use of the metric system (together with the present one) in levying Customs Duties; and should in other ways promote its use.

The Committee add their conviction that a decimal system of money should, as nearly as possible, accompany a decimal system of weights and measures. The evidence before them tended to show that the *maximum* of advantage cannot be obtained without a combination of the two.

The evidence of a considerable number of witnesses is appended to the Report. Copies of your Lordship's letter of 9th February 1859, and of the Astronomer Royal's Report of 1st February 1859, on the subject of weights and measures, are also appended.

The recommendations of the Committee may be classed under three general heads:—

1. The addition to our present system of weights and measures of other units of length, weight, and capacity based on the metric system, of multiples and parts of these units on the decimal scale; the adoption of the French system of nomenclature for the new metric weights and measures.
2. The establishment of a special department of weights and measures.
3. The adoption of a decimal coinage.

Remarks on proposed metric system.

1. The metric system is proposed to be legalized; to be made permissive, not compulsory, at least at any definite period.

No direct recommendation of the establishment of Exchequer standard weights and measures, and of local standards on the metric system, in addition to those of the existing system, is made by the Committee, although the

legalizing of the metric system may perhaps be considered to involve, as a necessary consequence, the construction and use of metric standards.

From the earliest times the object of our laws, and of the several Commissions and Committees appointed to consider the subject, has been to create and enforce uniformity of our weights and measures. This object has never yet been attained. The Committee enumerate 10 distinct systems now used, in this kingdom, besides various other diversities of weights and measures, leading to "mazes of numerical confusion." It certainly does seem that to superadd to this complicated number of systems a new system of weights and measures, based on new primary units, and not capable of easy or exact comparison with those of the present system, would greatly tend to increase and make more complicated the confusion which already exists, however desirable the metric system may be in itself, and from its facilitating transactions with other countries where it has been adopted.

But the Committee recommend the introduction of the metric system into this country cautiously and gradually, that when sanctioned by the gradual conviction of the public it may be made compulsory. It would then altogether supersede the present complicated system, and thus the long-attempted uniformity of weights and measures might be ultimately established. This result is certainly much to be desired, but the important question to be asked is, whether its attainment is practicable in this kingdom? Does past experience warrant the reasonable expectation that either by the general conviction of the public, or by compulsory legislation, any uniform system of weights and measures, and more particularly an entirely new system in substitution for the existing system, can be practically established? It is to be feared that the question can receive only a negative answer.

The Report of Lord Carysfort's Committee of 1758 states, as "a matter deserving attention, that for no less than 415 years, from the great Charter to 16 Charles II., the Statute Book abounds with Acts of Parliament, enacting, declaring, repeating that there should be but one uniform weight and measure throughout the kingdom, yet every Statute complains that the preceding Statutes were ineffectual and the laws disobeyed."

The Committee of 1862 confess in their Report, "the silent influence of usage has baffled the decrees of legislation, and we are still distant from uniformity at which we have so often, yet so vainly, aimed." Mr. Henley, a gentleman of great authority and experience, who has been President of the Board of Trade, and who was examined before the Committee, states, with respect to the Weights and Measures Act of 1835 (Q. 2991),—"The present law, so far as I recollect it, is that there is a 40s. penalty on every man who sells, a 5l. penalty on every man who uses, and every contract is void that is not carried on under the existing Weights and Measures Act of some 30 years ago, but so far as my experience goes that Act is an absolute dead letter. It does not occur to me how you can make a law more stringent." Indeed, it is a notorious fact that up to the present time the laws enforcing uniformity of weights and measures in this kingdom are wholly inoperative for this object, and that in fact no attempts are made to enforce uniformity.

The Committee felt the difficulty arising from this remissness, and rely upon a comprehensive and exact system of inspection, and the establishment of an efficient central department to give force and unity to local action. But unless there is a reasonable expectation that far more stringent exertions will be made to enforce obedience to the laws relating to weights and measures, and that even if so made these exertions will prove effectual, the expediency of sanctioning the addition of the metric system to our present system, with the view of its ultimate and exclusive adoption being made compulsory, appears doubtful.

I may call your Lordship's attention to the recorded opinion of the Royal Commissioners of 1819, and to that of the Select Committee of the House of Commons in 1821, as bearing upon the metric system.

The attention of the Standard Commissioners was also specially directed to the metric system; their expressed opinion will be found in their Report of 21st December 1841.

At the present time among the Notices of Motions in the House of Commons, a notice appears for the 12th of May of the introduction of a Bill by Mr. W. Ewart, the Chairman of the Committee of last Session, "to legalize the permissive use of the metric system of weights and measures in this country and its dependencies." Under these circumstances it remains for the Government and the Legislature to decide how far they are disposed to sanction the introduction of the metric system as recommended by the Committee of 1862.

2. The establishment of a special department of weights and measures was first recommended by Lord Carysfort's Committee of 1758. In the Bill to carry out the recommendations of the Committee, which passed through a Committee of the House of Commons in 1760, but was not further proceeded with, provision was contained for the appointment of four Commissioners, with an establishment of eight clerks and a sufficient number of workmen, for executing all business relating to the standards. These recommendations are quoted in the Report of the Standard Committee in 1854, (paragraph 16). The Committee, after stating that "they were very strongly impressed with the inadequacy of the present arrangements," add, "we see no remedy for this unsatisfactory state of things except in the appointment of a permanent scientific officer, whose business it shall be to keep a constant watch on the state of the primary standards, the secondary Exchequer standards, the local standards, the equipment of the Standard Office, the relation of British and Foreign standards, and the state of the law generally as applying to standards; and to memorialize the Government from time to time, as occasion may arise, on any of these points." "We, therefore, recommend that a permanent scientific officer be appointed, with adequate salary, to undertake these duties."

In the Report of the Astronomer Royal to your Lordship, of 1st February 1859, the importance of the appointment of a chief of the standard department is also urged, and his duties more particularly explained. This portion of the Astronomer Royal's Report is recommended in your Lordship's letter to the Treasury of 9th February 1859, to the serious attention of Her Majesty's Government, and as meriting very serious consideration. You add your opinion, that "in this manner it seems to me that many of the imperfections complained of might be remedied, and a better security obtained for the impartial execution of the law against delinquents."

The Committee of 1862 recommend that the department of weights and measures be established *in connexion with the Board of Trade*. The custody of the standards and the duties connected with them has, from the earliest periods, been entrusted to officers of the Exchequer. In ancient times many other analogous duties were executed by them as servants of the Sovereign, of all which other duties one only, that of the custody of the trial pieces of the gold and silver coin used in trials of the pyx, now remains, and in this duty the Treasury is jointly responsible. Your Lordship has on more than one occasion expressed a doubt whether the Exchequer was now the fittest department for the performance of the duties relating to weights and measures, and when examined before the Committee on Miscellaneous Estimates in 1848, suggested the Royal Mint as a more effective department for this purpose. The Master of the Mint assigned reasons, which were held to be sufficient, for not undertaking these duties.

The expediency of the transfer to the Board of Trade of the duties imposed upon the Treasury by the Act of 1859, relating to the gas-measuring standards, was suggested by your Lordship in your letter to the Treasury of the 17th February 1860. The Lords of the Treasury, in their Minute of 1st March 1860, concurred with this suggestion, and requested the opinion of the Lords of the Committee of Privy Council for Trade on the subject. This opinion was given on 16th March 1860. The Lords of the Board of Trade considered that the several duties imposed by the Act of 1859 relating to the gas-measuring standards, both upon the Treasury and upon the Exchequer, closely resembled the duties cast upon these departments relating to the other standards of weights and

measures; and that the most important of those duties imposed upon the Treasury relating to the gas-measuring standards had already been executed under their directions. They add,—"My Lords, therefore, can but think that so long as the care of the standards and the verification of official copies of the standards of weights and measures are entrusted to the Exchequer Office, the like functions with respect to the standards for gas measurement will properly be executed by that office; and it appears to their Lordships that the Board of Trade, or any other public department that might undertake the functions now under consideration, would have to be strengthened in order to possess a competent staff for the purpose, to the same extent to which it may be necessary to add to the strength of the Exchequer Office, if it performed the duties imposed upon it by the Act of 1859, and stated in detail in the Report of the Astronomer Royal."

3. The Committee recommend a decimal system of coinage in connexion with a decimal scale of weights and measures. There is so obvious a connexion between the decimalization of weights and measures and of coins, that the consideration of one has naturally and usually led to that of the other.

In the year 1824, on the same day on which the Weights and Measures Act 5 Geo. IV., C. 74., was brought as a Bill into the House of Commons, the subject of a decimal coinage was discussed there on a motion of Sir John Wrottesley for an address to His Majesty to direct inquiries to be made for ascertaining the best mode of adapting the coinage of the realm to a decimal scale. He proposed that the coinage should consist of pounds, double shillings, and of farthings altered 4 per cent. in value, in order to bring them to a decimal calculation; and that the penny should be retained, also altered in value 4 per cent. The motion was opposed by Mr. Wallace, the Master of the Mint, on the ground that the inconveniences that would inevitably follow the change would be very great, and of a character that the expected benefits would not compensate. The proposal seems to have met with no support in the House, and was negatived.

The Standard Commissioners in their Report of 21st December 1841 (p. 5) advert to the advantage and facility of establishing in this country a decimal system of coinage, "because no circumstance whatever would contribute so much to the introduction of a decimal scale in weights and measures, in those respects in which it is really useful, as the establishment of a decimal coinage."

The Standard Committee, whilst preparing a Report on the subject of standards, addressed a letter to the Chancellor of the Exchequer, dated 26th March 1853, representing that they were strongly impressed with the advantages of a decimal system of coinage, and urgently requested the careful consideration of the subject by Her Majesty's Government at that period, when an immediate coinage of copper to a large amount was in contemplation. In their Report upon the construction of new standards they proposed with the utmost confidence that these recommendations should be immediately carried out, and stated their opinion that the introduction of a decimal system would be very easy.

These and other proceedings relating to a proposed decimal coinage are mentioned in the preliminary Report of the Decimal Coinage Commission, dated 4th April 1857, of which your Lordship was chairman.

Upon this subject it may be sufficient if I remind your Lordship of the following paragraph in the preliminary Report.

"The questions of the decimalization of weights and measures and of international coinage were early forced on our notice. These are questions of great importance, and upon which probably much difference will exist. But they are not, we conceive, necessarily involved in the subject of our inquiry; and it appears to us that the terms of the Commission under which we act restrict our investigations to the practicability and expediency of introducing the decimal principle into the coinage of this country, without contemplating any change in our present system of weights and measures, and without considering the possibility or advantage of an international system of coinage."

• The final Report made after your Lordship's withdrawal from the Commission by the two remaining Members, Lord Overstone and Mr. Hubbard, and dated 5th April 1859, was not favourable to the introduction of a decimal coinage, and contained the following paragraph:—

“ It does not appear desirable; under existing circumstances, while our
“ weights and measures remain as at present, and so long as the principle on
“ which their simplification ought to be founded is undetermined, to disturb
“ the established habits of the people with regard to the coins now in use by a
“ partial attempt to introduce any new principle into the coinage alone.”

Present establishment of
Weights and Measures
Department.

The present establishment of the Department of Weights and Measures is as follows:—

	Length of Service at 31st March 1863	Scale of Salaries.			Present Salary.
		Minimum.	Annual Increase.	Maximum.	
Superintendent Mr. J. Bowen	36 $\frac{1}{2}$ years.	£. 300	£. 10	£. 400	£. 450*
Assistant Mr. H. J. Chaney	2 $\frac{1}{2}$ "	100	10	300	120
Mechanic D. Porter	1 "	78	...	78	78
					648

The number of local standards of weights and measures verified and re-verified at the Exchequer in each year from 1825 to 1838 is stated in the Appendix to the Report of the Standard Commissioners, page 69. A further return was made in 1857, showing in detail the number verified since 1825, and the dates when verified and re-verified. The total number verified and re-verified up to the year 1859 has already been referred to, as stated by the Astronomer Royal in his letter of 1st February 1859 (see p. 24). The total number up to the present time is appended to this Report.

The following fees are paid at the Exchequer for verification or re-verification of a full set of copies of the standards, in addition to the stamp duty of 3*l.* 10*s.* on the indenture, which accompanies every set of copies of the standards, except gas standards, verified at the Exchequer :—

Exchequer fees for verifying copies of the standards,

For a set of troy weights	...	...	£	s.	d.
„ avoirdupois	...	...	1	14	0
„ measures of capacity and length	...	...	1	0	0
			0	14	0
			<hr/>		
			3	8	0
			<hr/>		
For each gas standard	...	...	1	0	0

The ancient fees, for verifying copies of the standards, which were payable to the Chamberlains of the Exchequer, were continued by S. 12 of the Act 5 Geo. IV., C. 74. After the abolition of the office of Chamberlains in 1826, and the transfer of their duties, first to the Auditor and subsequently to the Comptroller-General in 1834, the fees so continued became payable to the Consolidated Fund. Formerly the same fee was paid upon the verification of a single weight or measure as upon a whole set. In 1835, at the suggestion of the Comptroller-General, the Lords of the Treasury, by letter dated 17th

* Specially increased by Treasury Minute, 22nd October 1858.

March 1835, sanctioned the following scale of fees for verifying single weights and measures:—

	<i>s.</i>	<i>d.</i>
56 lbs. avoirdupois weight	7	0
28 " "	3	6
14 " "	2	0
Bushel measure	9	6
Half bushel	5	0
Peck	2	6
Gallon	1	6
Yard	2	6
Each smaller weight or measure	1	0

Under S. 5 of the Act 5 and 6 Will. IV., C. 63., every re-verification of copies of the standards is to be endorsed upon the original indenture, and such weights and measures are to be charged the fees of verification only.

The amount of the stamp duty and of fees received at the Exchequer in the year ended 31st March 1863 is as follows:—

	£	s.	d.	£	s.	d.
Stamps on indentures				122	10	0
Exchequer fees, viz., on weights and measures	98	15	6			
Gas-holders	37	0	0			
Total fees				135	15	6
				<hr/>		
				258	5	6

The whole amount of fees, 135*l.* 15*s.* 6*d.*, has been duly paid to the Consolidated Fund.

The abolition of the stamp duty and the reduction of the Exchequer fees, for verifying copies of the standards, were recommended by the Commissioners for Restoration of the Standards (Report, S. 69) by the Committee for Constructing new Standards (Report, S. 67), and by the Astronomer Royal in his letter of 1st February 1859, (S. 14). In your Lordship's letter of 9th February 1859, in reply to the Astronomer Royal, you entirely concur with him in condemning these charges as "impolitic, inexpedient, and as a tax charged on the subject which ought not to be continued."

Having thus laid before your Lordship a detailed statement of the laws affecting the standards of weights and measures, and of the mode in which these laws have been carried into effect, as well as of the various measures recommended and adopted for the improvement of these laws, and their practical operation, I will, with your Lordship's permission, make some concluding practical remarks on those points which appear to require attention, and which have already been referred to as recommended by the Standard Commissioners and by your Lordship.

These are—

1. The re-verification of the Exchequer secondary or working standards.
2. The addition of other multiples and part of the standards and units, particularly of the standard of length.
3. The improvement of the mode of verifying measures of length.
4. The authorizing the greatest error to be tolerated in the comparison of standards.

1. It has been stated that the Exchequer secondary standards of length, Re-verification of Ex- weight, and capacity were constructed under the directions chequer Standards. of the Treasury in pursuance of Section 11 of the Act 5 Geo. IV., C. 74. That the standards of length and weight have been in use since 1825, and the standards of capacity since 1834. That no comparison or re-verification of these standards has since been made; that no legal provision has been made for such re-verification; but that the necessity for the periodical re-verification of the standards has been urgently recommended by the Standard Commissioners, as well as by your Lordship, your opinion being that the interposition of the Legislature is required for this purpose, under

the responsibility of the Executive Government. This opinion was given on 9th February 1859 to the Secretary of State for the Home Department; since this period, no steps have been taken to authorize the comparison and re-verification of these standards.* It is obvious that these instruments ought to be maintained in the highest state of accuracy, they being the standards for ascertaining the accuracy of all the weights and measures in this kingdom, and the longer their re-verification is delayed, the greater is the risk of increased imperfections in these standards, and of consequent public inconvenience.

I beg to call your Lordship's attention to the fact that since the construction and deposit at the Exchequer of the new primary standards of length and weight in 1853, no comparison whatever has been authorized or made between the Exchequer secondary standards and these primary standards. The Exchequer secondary standard weights are made of brass. On the one hand there is a risk of these weights becoming light from use and friction, and, on the other hand, there is a risk of their becoming too heavy by oxidation. In the construction of the new standard avoirdupois pound, six brass troy pounds, which had been compared with the lost troy standard, amongst which was the Exchequer secondary standard pound troy, were rejected as models by the Standard Committee (see p. 19), as having gained in weight from oxidation.

Revision of, and addition to, the existing Exchequer standards.

2. The revision of the standards of weight, capacity, and length, as recommended by the Standard Commissioners, may be considered under two heads:—

I. The substitution of a decimal scale for the present scale of troy and avoirdupois weights.

II. The addition to the measures of capacity and of length.

It has been already stated that the decimal scale of troy weights has already been established (see p. 22). This applies only to weights used in sales of bullion. The Commissioners recommended no alteration in the troy and other weights used by apothecaries in the combination of drugs, and that they might "for the present be tolerated as leading to no ambiguity." The troy weights thus used are the grain, ounce, and pound; there are also the apothecaries' weights of the scruple = 20 grains, and the drachm = 3 scruples, 8 drachms being equal to an ounce. But neither the scruple nor the apothecaries' drachm appears to be directly authorized by law, nor is either amongst the Exchequer standards. The apothecaries' or troy ounce weighs 480 grains, the apothecaries' drachm, being $\frac{1}{8}$ of an ounce, weighs 60 grains. The avoirdupois ounce weighs $437\frac{1}{2}$ grains, and the avoirdupois drachm, $\frac{1}{16}$ of an ounce, weighs only $27\frac{1}{2}$ grains.

Under Section 4 of "The Medical Act," 21 and 22 Vict., C. 90, the Medical Council established by that Act were authorized to publish a book containing a list of medicines and compounds, and the manner of using them, "together with the true weights and measures by which they are to be prepared and mixed." This book was to be called "British Pharmacopœia," and the Council were empowered to alter, amend, and republish such Pharmacopœia as often as they shall deem it necessary.

I have been informed, upon what I believe to be good authority, that the Medical Council have lately prepared a British Pharmacopœia, the use of which is compulsory on druggists in the United Kingdom. They had a difficulty in settling the question of weights. It is well known that wholesale druggists have been in the habit of using the pound avoirdupois instead of the apothecaries' pound, as directed in former Pharmacopœia. To obviate the difficulty the Council at first proposed to abolish the apothecaries' pound and ounce, and substitute for it the avoirdupois pound and ounce; and in order to retain the old divisions of the ounce into eight drachms of

* In answer to a question upon this subject on 29th July 1862, in the House of Commons, Sir G. Grey is reported to have said (see Hansard) that "the standards had been examined, some adjustment was found necessary, and measures would be taken to have them verified." It is probable that the answer of the Home Secretary was imperfectly heard or misapprehended, as no examination, comparison, or adjustment whatever of the Exchequer standards has been made.

60 grains each, they proposed to diminish the grain, so that 480 apothecaries' grains should be equal to $437\frac{1}{2}$ avoirdupois grains. The alteration was thought to be objectionable on account of the confusion that would arise in changing old grains into new. The Council have now determined to limit the terms of the apothecaries' weight to grains, scruples, and drachms; the higher weights will be the avoirdupois ounce of $437\frac{1}{2}$ grains, and the avoirdupois pound being 16 of such ounces.

Although there is no authority for the use of the decimal scale of apothecaries' weights and measures, it is occasionally used in medical and chemical investigations.

The mode in which the Standard Commissioners proposed to substitute a decimal scale of avoirdupois weights is stated at length in their Report (Section 9, p. 13). Their proposed new decimal weights have been stated in page 28 of this Report.

II. The proposed additions to the standard measures of capacity and of length have also been stated in page 17. Amongst these new measures of capacity, there is now, in consequence of the largely increased sale of wine since the reduction of the duty, a far more urgent want for a standard wine bottle than when it was recommended by the Commissioners in 1841. It appears to be doubtful whether it is practicable to make wine bottles of an uniform size of one-sixth of a gallon; the evidence adduced before the Standard Commissioners tending to prove that it was not then practicable according to the existing system of manufacture. But it is to be hoped that the difficulty may now be overcome, and that amongst the other improvements in the manufacture of glass since the abolition of the duty, which was the cause of the imposition of so many restrictions, means may be found for making wine bottles of a more exact and uniform size. Bottles containing an imperial quart and an imperial pint, either of wine or malt liquor, are now commonly sold, and these are capable of being measured by the imperial standards. But there is no standard whatever for the ordinary wine bottle. This test at least may be afforded for the security of the public.

There is now only one standard measure of length, the standard yard. The addition of other standards of length, being parts and multiples of the standard yard, is more imperiously called for. It seems hardly credible that with the advanced state of mechanical and scientific acquirement in this kingdom, no other standard measure of length than the yard should be established by law. Mr. Whitworth's evidence upon this subject has been already referred to, (see page 21). There are now other modes of accurately measuring the minutest distances besides Mr. Whitworth's apparatus. Measurements may be made by the aid of a microscope, to the $\frac{1}{100,000}$ th part of an inch, by means either of Ramsden's cobweb micrometer, acting by the movement of micrometer screws, or of Mr. G. Jackson's eye-piece micrometer, in which is inserted a transparent scale ruled upon glass in very minute divisions. Using in a powerful microscope one of these transparent scales with line divisions each of $\frac{1}{10,000}$ th of an inch, one of these divisions being subdivided into seven parts, I have myself had no difficulty in distinctly measuring lines on the shell of one of the *Diatomaceæ* found in the mud of the River Thames, and ascertaining them to be very nearly $\frac{1}{10,000}$ th of an inch distant from each other.

Instead of advancing, we have actually retrograded in our standards of length. The standard yard measure of Henry VII., now in the Exchequer, has divisions of 1, 2, 3, 4, 12, and 15 inches; and Queen Elizabeth's standard yard and ell, which were in use at the Exchequer up to the year 1825, have subdivisions marked upon each of them. It has been shown that several standard yards, with various subdivisions, have been constructed under the directions of the Astronomer Royal, and are now deposited at the Exchequer.

See p. 21.

These subdivisions, as well as any other additions to the standards that may be decided upon for adoption, require only to be authorized by Orders in Council, in pursuance of Section 6 of 13 and 19 Vict., C. 72, in order to be legalized as Exchequer secondary standards.

3. The improvement of the mode of verifying measures of length, by using a line standard in place of an end standard, must necessarily accompany any authorized additions to the Exchequer standard of length, being line subdivisions of the imperial yard. For this purpose the necessary authority may be given, and the comparing apparatus furnished under the Astronomer Royal's directions by Messrs. Troughton and Simms, may be fixed, proper directions for its use being supplied to the officers of the department. The same difficulty as to a convenient place for fixing it does not now exist which prevented the fixing of this apparatus in 1858, (*see p. 23.*) There appears to be ample space in the new room for the gas-measuring standards where it may be conveniently fixed, and where there is a good light for its use.

4. The Royal Commissioners have recommended that no greater error be tolerated in verifying copies of the standards than the amounts stated by them, (*see p. 17.*) Under the existing regulations the department is not authorized to tolerate any, even the slightest, *deficiency* in any copy of the standards under 5 Geo. IV., C. 74, and, in fact, the slightest deficient copy is at once rejected. The tendency of this practice is therefore to cause all copies brought to the Exchequer for comparison to be slightly in excess of the standard. There is a practice in the department, for which no authority can be found, of tolerating an *excess* of not more than one cubic inch in a copy of the standard bushel, and so in proportion in the smaller vessels of capacity. There is more strictness enforced in regard to any excess in the copies of the other standards under 5 Geo. IV., C. 74. The necessity of determining by law the amount of error to be tolerated in the bullion standards has been stated as the opinion of Professor Miller, (*see p. 22.*) The amount of error to be tolerated in the copies of gas standards, viz., one $\frac{1}{300}$ th part or $\frac{1}{2}$ per cent., in excess or in defect in the gas measurer compared, has been already authorized by the Treasury at the recommendation of the Astronomer Royal. It cannot but be expedient that the amount of error to be tolerated in the comparison and verification of any copies of the Exchequer standards should be duly fixed by authority.

The Comptroller-General of the Exchequer,
&c., &c., &c.

I have, &c.,
H. W. CHISHOLM,
Chief Clerk.

APPENDIX.

Appendix 1.

A List of the Standards now in use at Her Majesty's Exchequer.

Weights.			Measures.		Gas Standards.	
Avoir- du-pois.	Troy.		Of Extension.	Of Capacity.	22 & 23 Vict., C. 66.	
	5 Geo. IV., C. 74.	16 Vict., C. 29, Bullion.			Weight.	Measures.
56 lbs.	1 lb.	500 oz.	Yard.	Bushel.	62,321 lbs. weight of cubic foot of distilled water at 62°	Cubic foot bottle.
28 "	6 oz.	400 "		$\frac{1}{2}$ Peck.		10 ft. gas-holder.
14 "	3 "	300 "		Gallon		5 "
7 "	2 "	200 "		$\frac{1}{2}$ Quart.		1 "
4 "	1 "	100 "		Pint.		
2 "	10 dwts.	50 "		$\frac{1}{2}$ Gill.		
1 "	5 "	40 "		$\frac{1}{4}$ "		
8 oz.	3 "	30 "				
4 "	2 "	20 "				
2 "	1 "	10 "				
1 "	12 grains	5 "				
8 drms.	6 "	4 "				
4 "	3 "	3 "				
2 "	2 "	2 "				
1 "	1 "	1 "				
$\frac{1}{2}$ "		$\frac{1}{2}$ "				
		$\frac{1}{4}$ "				
		$\frac{1}{8}$ "				
		$\frac{1}{16}$ "				
		$\frac{1}{32}$ "				
		$\frac{1}{64}$ "				
		$\frac{1}{128}$ "				
		$\frac{1}{256}$ "				
		$\frac{1}{512}$ "				
		$\frac{1}{1024}$ "				

Appendix 2.

THE SECRETARY OF THE TREASURY TO THE CHAMBERLAINS OF H. M. EXCHEQUER OR THEIR DEPUTIES.

Treasury Chambers, 5th August 1825.

MY LORD AND SIR,

THE Lords Commissioners of His Majesty's Treasury having had under their consideration the Acts 5 Geo. IV., C. 74, and 6 Geo. IV., C. 12, relating to the establishment of new Weights and Measures, I am commanded by their Lordships to refer you to those Acts, and to transmit to you to be deposited in your office, according to the provisions thereof and for the purposes therein mentioned, a set of standard Weights and Measures (according to a Schedule hereunto annexed*) which my Lords have caused to be prepared in conformity with the said Acts. I am further directed in sending these Weights and Measures to you to transmit to you for the guidance and assistance of your Officers in the use of them, and in the verification of any weights and measures which may be brought to you for adjustment by the new standard, a copy of some instructions prepared by Captain Kater, one of the Commissioners, of Weights and Measures for that purpose, together with some observations accompanying them.

The Chamberlains of H. M. Exchequer
or their Deputies.

I am, &c.,
(Signed) J. C. HERRIES.

* Already delivered at the Exchequer.

DIRECTIONS FOR USING THE STANDARD WEIGHTS AND MEASURES.

The principal standards of weight and measure about to be deposited at the Exchequer, Guildhall, Edinburgh and Dublin, have been made with every minute attention to ensure accuracy which the present state of science admits.

They are therefore to be considered as models to be very carefully preserved, in order to be referred to only on extraordinary occasions.

These standards consist of—

- The Imperial Standard Yard.
- The Imperial Standard Troy Pound.
- The Avoirdupoise Pound.
- The weight of the Imperial Gallon of distilled water.
- The Imperial Gallon.
- " Bushel.
- " Quart, and
- " Pint.

For all ordinary purposes of comparison copies of the standards of weights and of those of capacity (in cases where such may be more convenient) should be employed, with the exception of that of the standard bushel, the absence of which may be advantageously supplied by the use of the gallon.

It must, however, be recollected that the spirit of the Act for "ascertaining and establishing uniformity of Weights and Measures," as well as one of the most important advantages it presents, consists in the definition of the measure of capacity by the weight of distilled water which it shall contain. This is by far the most accurate, and will perhaps be found in practice to be the most ready method of determining such measures.

For this purpose the measure to be examined is to be placed in one of the pans of the balance, together with the weight of the water it is to contain, and also a piece of plane glass of a size sufficient to cover it having a small orifice in the centre, and the whole is to be counterpoised with brass. The weight is then to be removed and the vessel filled with water, carefully detaching air bubbles should any be formed. The temperature of the water and the height of the barometer are then to be taken, and the number of grains due to such temperature and pressure found in the annexed tables is to be added to the counterpoise or placed in the other scale according as the sign is + or —. The glass is then to be slid upon the top of the vessel, adding a little water if necessary through the small aperture.

If the capacity of the vessel is correct, the whole will now be in equilibrium. This is the most accurate mode of proceeding, but for all the usual purposes of comparison the allowance of temperature and pressure may be neglected.

On those occasions of rare occurrence, where it may be necessary to adopt the less precise mode of appealing to the original standard measures of capacity, the following method should be pursued:—

The imperial standard is to be slowly filled with water by means of a syphon of small bore, adding afterwards a few drops, until the water appears elevated a very little above the mouth of the standards.

The glass which accompanies the standard is then to be slid with its plane surface upon the mouth of the vessel, taking care to remove the water which may be driven before it, or which may have passed through its small hole in its centre.

The vessel, the capacity of which is to be compared with that of the standard, is to be filled with water and then emptied and drained.

The water contained in the standard is now to be transferred to the vessel to be compared with it, the standard being held inverted to allow as much water to drain from it as possible.

It would then be desirable to examine whether the vessel is quite full, or otherwise, by placing a plane glass upon it, as before described. No allowance is necessary for temperature, it being presumed that all the copies will be made of brass.

The imperial standard weights are never on any account to be wiped or touched with the hand, a wooden fork, which accompanies the weights, is to be used for taking them out, and replacing them in their cases. An attention to this caution is most important to their preservation and accuracy.

Should it be necessary to compare other weights, with either of the imperial standards, the following method is to be pursued:—

The standard weight being carefully taken from its case with the wooden fork, and placed in the balance, it is to be counterpoised with brass, when the equilibrium is perfect, the standard weight is to be removed by means of its wooden fork, and replaced by the weight about to be tried, the difference of which from the standard may be then ascertained by putting small weights in one or other of the pans of the balance.

It may not, however, be unnecessary to repeat that the original standards of weight, as well as those of capacity, are never to be used except on very rare occasions. For common purposes of comparison the copies are to be employed, the same care and precautions being taken in their use as is recommended for originals.

The imperial standard yard, with steel terminations, is intended for common use, no particular care being necessary, except to keep the steel from rust, by occasionally applying a little oil.

York Gate, Regent's Park.
2nd July 1825.

(Signed) HENRY KATER.

CORRECTIONS for TEMPERATURE on the GALLON			CORRECTIONS for the BAROMETER.			
Temperature of the Water.	Correction in Grains.	Difference for one Degree.	Barometer.	Correction in Grains.	Barometer.	Correction in Grains.
			In.		In.	
50°	+ 35.45	—	29.0	+ 2.50	30.0	0.00
51°	+ 33.97	1.48	29.1	+ 2.21	30.1	— 0.25
52°	+ 32.51	1.46	29.2	+ 1.97	30.2	— 0.49
53°	+ 31.08	1.43	29.3	+ 1.73	30.3	— 0.74
54°	+ 29.68	1.40	29.4	+ 1.48	30.4	— 0.98
55°	+ 28.30	1.37	29.5	+ 1.20	30.5	— 1.23
56°	+ 26.95	1.35	29.6	+ 0.98	30.6	— 1.48
57°	+ 25.63	1.32	29.7	+ 0.74	30.7	— 1.73
58°	+ 24.33	1.30	29.8	+ 0.49	30.8	— 1.97
59°	+ 23.06	1.27	29.9	+ 0.25	30.9	— 2.21
60°	+ 21.82	1.24	30.0	0.00	31.0	— 2.50
61°	+ 20.61	1.21				
62°	+ 19.43	1.18				
63°	+ 18.28	1.15				
64°	+ 17.15	1.13				
65°	+ 16.05	1.10				
66°	+ 14.97	1.08				
67°	+ 13.92	1.05				
68°	+ 12.89	1.03				
69°	+ 11.89	1.00				
70°	+ 10.91	0.97				

H. KATER, Esq., to J. C. HERRIES, Esq., M.P.

York Gate, Regent's Park, 5th July 1825.

SIR,

In addition to the directions for using the new standards which I have had the honor to communicate, I trust the Lords Commissioners of His Majesty's Treasury will not deem the following remarks obtrusive.

The definition of the gallon by the weight of distilled water it contains, appear to be the most important advantage presented by the late Act for "ascertaining and establishing uniformity of weights and measures." By means of this, every individual possessing weights has it in his power to verify at pleasure, measures of capacity, and the facility thus afforded, must, it is presumed, powerfully tend to produce that uniformity contemplated by the Legislature, by causing the standard gallon to be speedily adopted as the most convenient unit of capacity throughout the kingdom.

The principle thereof of determining the measure of capacity by the weight of water it should contain, cannot be too strongly urged, and I would submit that the Exchequer, &c., be directed to examine all measures of capacity in this manner, in order that the principle may the sooner become generally known.

An idea seems to prevail that the standards of weight and of lineal measure have been changed by the late Act, but the fact is that they remain the same as heretofore, the Commissioners of Weights and Measures having constantly kept in view the expediency of making no alteration, but such as appears to them to be absolutely necessary to obviate confusion, so far indeed from having made any such change they have been careful to provide for the preservation of the existing standards by multiplying accurate copies of them, and have defined the avoirdupois pound, which had never before been recognized by the Legislature.

Such being the fact, it becomes a question whether there exists any necessity for counties, &c., to provide themselves with new standards of weight or of lineal measure, but it may nevertheless be desirable that their standard weights, now in use, should be re-examined in order to ascertain that they have sustained no injury by wear.

Copies of the weight of the imperial gallon, distilled water might, however, be provided in order to facilitate, as far as may be, the determination of the measure of capacity by a method, the general adoption of which appears so very desirable.

J. C. Herries, Esquire, M. P.,
&c., &c., &c.

I have, &c.,
(Signed) HENRY KATER.

Rev-2563/64

Appendix 3.

Number of Standards tested for the first time at the Exchequer, and number of Standards re-verified since the passing of the Act 5 Geo. IV., C. 74, and under the Acts 16 Vict., C. 29. (Bullion), and 22 and 23 Vict., C. 66 (Gas).

For use in	NUMBER OF STANDARDS TESTED FOR THE FIRST TIME.					NUMBER OF RE-VERIFICATIONS.					
	Length.	Weight.	Capacity.	P. Bullion.	Gas-holders.	Length.	Weight.	Capacity.	Bullion Weights.	Gas-holders.	
England	617	16,612	6,557	472	96	27	4	324	9,733	4,250	56
Wales	33	1,051	374	...	...	...	...	20	386	229	...
Scotland	94	1,970	790	...	8	12	...	40	630	323	...
Ireland	97	1,903	867	...	4	2	...	26	346	283	...
Private use	7	505	99	...	...	...	...	...	52	...	...
British Isles of Man and Jersey	2	17	11	...	...	...	...	...	...	...	...
Colonies and Foreign	63	1,140	696	...	...	...	...	...	...	...	...
Total	913	23,198	9,394	472	108	41	4	470	11,152	5,085	56

MEMORANDUM.—The above stated Weights and Measures have been verified and certified in 1,355 Indentures. The increased proportion of the number of re-verifications, as compared with the Return dated January, 1859, has been caused by the operation of Sect. 1 of the 22 and 23 Vict., C. 56, which enacts that no copies of the standard weights shall be legal unless compared or re-verified every five years, and copies of the Standard Measures every ten years.

No just idea can be formed from the above Return of the number of local standards actually re-verified, as compared with the number required by law to be re-verified as in many instances new weights and measures have been substituted for the old weights and measures requiring re-verification, and have been certified under the old indenture, and these new standards have not yet required re-verification under the terms of the 22 and 23 Vict., C. 56. Indeed it is a common practice with regard to the smaller weights, to substitute new weights for such as require re-adjustment and re-verification.

It has also frequently happened that sets of Weights and Measures have been verified at the Exchequer for the use of towns and parishes, and that subsequently, these sets have fallen into disuse, those of the county or district having been used in their stead. These disused sets have, therefore, not required re-verification.

From *N. 2302*
J. C. Bayley Esq
 Secretary to the Govt of India
 To *J. D. Sini Esq*
 Secretary to the Govt of Fort St. George
 Dated Simla the 29th August 1864

Home Dept

Sir
 I am directed to transmit for the information of the Madras Committee on Weights and Measures, the accompanying copy of a Report upon the Exchequer Standards of Weight and Measure by Mr. W. W. Chisholm, Chief Clerk in the Office of the Comptroller General of the Exchequer.

Have the honor to be
 Sir
 Your most obedient servant
J. C. Bayley
 Secy to the Govt of India

7/13

*Post Office
 1219
 10155-155*

Commenced to the
Madras Committee on Weights and
Measures -

30.6.16 ✓

N^o 455 & 456.

From Mr. George
30th Sept 1864

3 To the Madras Committee on Weights and Measures, S.D. 5000

Perinne 1864. Oct.
No. of Govt. for Sept
N^o 2563.

From the Secy to the
Govts of India

Dated 29th Aug. 1864.
Received 29th Sept.

N^o 2302.

C-3.

Transmitting for the
information of the Madras Committee
on Weights & Measures a report
from the Enchequer Standards of
Weight & Measure.

N^o 1809 - 30th Sept.

W. H. B. D. O.

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