LXIX. *An Enquiry into the Meaſure of the* Roman *Foot*; *by* Matthew Raper, *Eſq*; *F. R. S.*

Read May 15, 22, and June 5, 1760.

THE methods that have hitherto been taken to diſcover the meaſure of the Roman foot, will, upon examination, be found ſo unſatisfactory, that it is no wonder the learned are not yet agreed in that point.

The antient foot-rules now remaining; the repreſentations of the foot in ſculpture; and the meaſure of it, derived from the congius, differ ſo much among themſelves, and from each other, as to be inſufficient evidences ſeparately: and the great diſagreement of the foot from the congius, with the reſt, has not hitherto been ſatisfactorily accounted for.

The foot-rules found in old ruins at Rome, are of various lengths; and the age of none of them being certainly known, no preciſe meaſure can be determined from them, otherwiſe than by taking a mean from ſuch as appear to be moſt perfect. But though this may have been the foot in uſe at ſome time or other, yet as theſe rules are probably of different ages, both the greateſt and the leaſt of them may have anſwered to the ſtandards of their times.

For though we have no account of any alteration ever made in the ſtandard of the Roman foot, yet the wear of a ſtandard meaſure by uſe, and the making new to replace the old ones, muſt, in all probability, create a difference; eſpecially, as the Romans had not thoſe inducements to ſo preciſe an accuracy

accuracy in theſe matters, as the later diſcoveries in natural philoſophy (particularly the invention of the pendulum) have introduced among the moderns. Add to this, that the different ſtate of Europe, which has, for ſome ages, been divided into many conſiderable kingdoms and ſovereign ſtates, independent on each other, equally civilized, and carrying on a more conſtant and regular mercantile commerce with each other, than was known to the Romans, muſt neceſſarily introduce more frequent enquiries into the weights and meaſures of the different ſtates, and a more careful examination of the reſpective ſtandards of each, than the Romans could have any occaſion for: and uſe in theſe matters, is the parent of accuracy.

We can arrive at no greater certainty from the marbles, than from the foot-rules. Theſe, indeed, do not differ ſo widely from each other, as the rules; which ſeems to be the reaſon why moſt of the writers on this ſubject have given them the preference: but of the four that are extant, no two agree in the ſame meaſure; nor is the age of any one of them known: and as they were intended for repreſentations only, and not for uſe, their accuracy may reaſonably be doubted.

Feſtus, Frontinus, and Rhemnius Fannius, ſay, the ſide of the quadrantal (which contained 8 congii) was a Roman foot (1). A ſtandard congius of Veſpaſian

(1) Quadrantal vocabant antiqui quam ex Græco ἀμφορέα dicunt, quod vas pedis quadrati octo et quadraginta capit ſextarios. Feſtus in v. Quadrantal. Pes quadratus concavus capit amphora trimodia

Veſpaſian is ſtill in being, and has been meaſured by ſeveral learned men; but the foot derived from it exceeds thoſe on the marbles, and the greateſt number of the foot-rules, ſo much, that Mr. Greaves could find no better way of accounting for ſo great a difference, than by ſuppoſing what Feſtus and Fannius ſay (for he does not quote Frontinus), to be a vulgar error (2): whereas the name of this ſtandard ſhews its figure to have been a cube (3); which adds probability to their teſtimony, that its ſide was intended for the meaſure of the foot.

The meaſures of public roads in the itineraries, can be of little uſe in this enquiry; for they omit fractions, and we do not know whether the diſtances of the towns are reckoned from the market-places or from the gates; but a difference of half a mile in ſixty, is equivalent to the tenth part of an inch in the foot: therefore, no exact meaſure is to be expected from thence, even though the modern menſurations of Caſſini, Riccioli, and others, were more unexceptionable than they really are.

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trimodia [read, amphoram trimodiam]. Frontinus, in Expoſitione Formarum. Though the paſſage is corrupt, there can be no doubt of the meaning.

Pes longo ſpatio latoque notetur in anglo,
Angulus ut par ſit quem claudit linea triplex;
Quattuor ex quadris medium cingatur inane,
Amphora fit cubus: quem ne violare liceret,
Sacravere Jovi, Tarpeio in monte, Quirites.
Rh. Fannius, de Pond. et Menſ.

(2) See Dr. Birch's edition of Greaves's Works, p. 228.

(3) Quæ illi κύβους, nos quadrantalia dicimus. A. Gellius, l. i. c. 20.

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The diſtances between the antient mile-ſtones are not liable to theſe objections; and if a ſufficient number of ſuch as ſtand neareſt to Rome were carefully meaſured, their authority would be conſiderable. But I do not find that any are now ſtanding within thirty miles of that city, nor that any of theſe have been meaſured, or even any in Italy; and provincial meaſures are not of equal authority.

There is ſtill another method, whereby we may diſcover the meaſure of the Roman foot; which is, from the remains of the antient buildings now ſtanding at Rome: and though many have made uſe of ſome ſingle parts of them for this purpoſe, yet no one hath hitherto compared the meaſures of the principal parts of any one of them with each other, which is the only way to diſcover the meaſure whereby a building was conſtructed.

With this view, therefore, I ſhall carefully examine the meaſures of the buildings contained in that ineſtimable treaſury of antient Roman architecture, intituled, Les Edifices antiques de Rome, and publiſhed at Paris, by Monſ. Deſgodetz, in the year 1682.

In order to this, it will firſt be neceſſary to aſcertain the proportion of the Paris foot (the meaſure uſed by this author) to ſome known Engliſh ſtandard.

The Paris foot is one ſixth part of the toiſe in the Chatelet; which was renewed in the year 1668 (4), and the new ſtandard has continued in uſe ever ſince.

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(4) See De la Hire's Diſſertation on the Roman Foot, in the Memoirs of the Academy of Sciences for the year 1714, where he gives an account of this renewal of the ſtandard in the Chatelet.

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In the year 1742 (5), the Royal Academy of Sciences at Paris, at the requeſt of the Royal Society of London, ſent over a meaſure of half the toiſe of the Chatelet; from which Mr. Graham determined the proportion of the Paris foot to that of London, to be as 1065,41⅔ to 1000. Monſ. Le Monnier, of the Royal Academy of Sciences, from the ſame originals, found their proportion as 864 to 811, or as 1065,351 to 1000. The difference is inconſiderable, and we may, without injuſtice to Mr. Graham's known ſkill and accuracy in theſe matters, ſuppoſe their true proportion to be as 1065,4 to 1000.

Mr. Graham's meaſure of the London yard, together with that of half the toiſe of the Chatelet, are depoſited in the archives of the Royal Society at London, and of the Royal Academy of Sciences at Paris; and whenever I ſhall mention the London foot, without ſpecifying any particular ſtandard of it, I would be underſtood to mean this meaſure.

In this enquiry, we are to ſeek a common meaſure to the ſeveral parts of each building, that ſhall not differ very widely from ſome aſſumed magnitude of the Roman foot: and though we might take this aſſumption from any of the antient foot-rules now remaining, yet the nearer it is taken to the truth, the better guide it will be to us, and the more it will facilitate our enquiry. Now, as a mean meaſure, derived from theſe rules, will, probably, be nearer the truth, than either the greateſt or the leaſt of them, ſo one that ſhall include ſuch other remains of antiquity, as have hitherto been made of to diſcover

(5) See Philoſ. Tranſ. N° 465.

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the meaſure of the Roman foot, will be ſtill more unexceptionable, as the writers on this ſubject are not agreed, which of the different authorities is to be preferred.

The repreſentations of this foot in ſculpture, are four in number; one on the ſepulchral monument of Coſſutius, formerly in the Colotian gardens at Rome; another on that of Statilius, in the Belvedere; a third on that of M. Ebutius, in the Villa Mattei (6); and the fourth on a marble, without inſcription, dug up of late years in the Via Aurelia, which, being in the poſſeſſion of the Marquis Capponi, is called, by P. Revillas, the Capponian foot.

Moſt of the early writers on this ſubject have expreſſed their meaſure of the Roman foot by a diagram; and Snellius (7) obſerving, that the paper contracted in drying, after the impreſſion was taken off, endeavoured to make a proper allowance for it. But Greaves, finding the meaſures of theſe figures to differ in different copies of the ſame impreſſion, took another method; and ſeems to have been the firſt that compared the original figures on the monuments of Coſſutius and Statilius with a modern ſtandard. This he did with ſuch care and diligence, that his meaſures deſerve a particular examination.

The London foot, which he uſed upon this occaſion, was taken from the iron ſtandard of 3 feet in

(6) Picard and Auzout (in a paper called De Menſuris, hereafter quoted) have given the meaſure of the foot on this monument of Ebutius for the Colotian foot.

(7) See his Diſſertation on the Roman Foot, in the 3d vol. of Saggi di Diſſertazioni Academiche di Cortona.

the Guild-hall, London (8); which having been long ſince loſt, or deſtroyed, we have nothing left whereby to diſcover its true magnitude, but the meaſures others have taken of it, and thoſe which have ſince been taken of ſuch magnitudes as Greaves had compared with his copy of it.

Snellius, from a meaſure ſent him of this iron ſtandard (9), determined the proportion of the Rhynland to the London foot, as 1000 to 968. The Rhynland foot, according to Picard (1), contains 696 ſuch parts as the Paris foot contains 720: whence the proportion of the latter to this meaſure from the iron ſtandard, is as 1065,4 to 997 nearly. Eiſenſchmid found the Rhynland foot to contain 1391,3 ſuch parts as the Paris foot contains 1440 (2); which gives 1065,4 to leſs than 996½, for the proportion of the Paris foot to that of the iron ſtandard. Huyghens makes the Paris to the Rhynland foot as 144 to 139 (3); whence the proportion of the former to Snellius's London foot, will be nearly as 1065,4 to 995½. But there is reaſon to believe, that Huyghens's meaſure of the Rhynland foot was too ſmall (4).

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(8) Greaves, p. 223.

(9) Eratoſthenes Batavus, p. 125. 141.

(1) See a paper intituled De Menſuris, in Divers Ouvrages de Mathematique et de Phyſique, par Meſſrs. de l'Academie Royale des Sciences, Paris 1693, in folio, and afterwards printed in the 4th vol. of Ouvrages adoptez.

(2) Eiſenſchmid de Pond. et Menſ. vett. p. 94.

(3) Horolog. Oſcill. part iv. prop. 25.

(4) Picard, in his Voyage d'Uranibourg, p. 64. edit. Amſt. ſays, " Paſſant par Holland je pris l'occaſion de verifier la proportion

By theſe compariſons it appears, that Snellius's meaſure of the London foot, from this iron ſtandard, was at leaſt 3 parts in 1000 ſhorter than Graham's London foot.

Our countryman Norwood, in the year 1635, meaſured the diſtance between London and York, in order to determine the length of a degree on the meridian; which he found to contain 367196 London feet of this iron ſtandard (5). The French found the meaſure of a degree, in the latitude 66° 20′, to be 57438 toiſes, and at the equator 56783. Hence the meaſure of a degree in 52° 44′ (the middle latitude between London and York) will be found to be 57276 toiſes, or 343656 Paris feet. Theſe numbers give the proportion of the Paris foot to that of the iron ſtandard, as 1065,4 to 997,1 —, wanting ſomewhat leſs than 3 parts in 1000 of Graham's London foot.

Picard's paper De Menſuris, quoted above, and another on the ſame ſubject by Auzout, printed with it, contain ſome meaſures, which Greaves had before compared with his London foot. Both theſe papers were written after the renewal of the ſtandard of the Chatelet, in 1668. The former is ſo full of inaccuracies and miſtakes, that little uſe can be made of it; but Auzout's meaſures appear to be accurate; and as he ſeems to have taken his Paris foot from the

portion du pied de Paris à celui du Rhin, dont l'original eſt à Leyde; laquelle proportion me parut eſtre exactement comme 720 à 696, au lieu de 720 à 695, que j'avois ſuppoſée dans la meſure de la terre." This latter is Huyghens's proportion.

(5) See Norwood's Seaman's Practice.

toiſe in the Chatelet for this purpoſe, it was probably a correct meaſure of that ſtandard.

Such of his meaſures as anſwer to Greaves's, are here reduced to thouſandth parts of the London foot, reckoning his Paris foot to contain 1065,4 ſuch parts.

	Greaves.	Auzout.	Diff.	Diff. *per* foot.
The Statilian foot	972.	969,96	— 2,04	2,1
The braccio of Florence	1913.	1908,84	— 4,16	2,18
The braccio of Siena	1974.	1973,21	— 0,79	0,4
Pætus's palm	732.	731,35	— 0,65	0,89

All theſe differences fall the ſame way, and ſhew, that Greaves's London foot bore a leſs proportion to Auzout's Paris foot, than that of 1000 to 1065,4. The Statilian foot, and the braccio of Florence, give the greateſt differences; one is carved in relievo, and the other is a rod; ſo that both are ſubject to diminution, by time and uſe. The palm is engraved; and Auzout, from the deviation of Pætus's Greek and Roman foot, from the common received proportion of 25 to 24, ſuſpected, that the latter was lengthened by wear; if ſo, the like muſt have happened to the palm. How their meaſures of the braccio of Siena come to differ ſo little, I cannot account for. But we can draw no certain concluſion from this compariſon, till we know whether any, and what, allowance is to be made for the diminution or increaſe of theſe magnitudes, in the interval between Greaves's and Auzout's meaſuring them.

For this purpoſe, I ſhall compare Auzout's meaſures, with thoſe taken by P. Revillas, with a correct

rect London foot (6), between fifty and ſixty years after. Theſe he has converted into Paris meaſure, by the proportion of 864 to 811; and I have reduced them back again, according to the ſame proportion.

	Auzout.	Revillas.	Diff.	Diff. *per* foot.
The Statilian foot	969,96	969,79	— 0,17	0,18 —
The Ebutian foot	972,91	972,22	— 0,69	0,71 —
Pætus's palm	731,35	732,65	+ 1,3	1,78
Pætus's foot	966,26	968,74	+ 2,48	2,57
	or 967 —		or 1,75	1,81

Hence the carvings appear to have ſuffered very little diminution in this interval; but Pætus's meaſures, which are engraved, and in conſtant uſe as public ſtandards, have been conſiderably lengthened. Therefore, allowing for both theſe circumſtances, we may conclude, that Greaves's London foot wanted 2 parts in 1000, to be to Auzout's Paris foot, in the proportion of 1000 to 1065,4.

Greaves's meaſure of the door-caſe of the Pantheon, 9 inches within the jambs, is 19,602 of his London feet and decimal parts (7). Deſgodetz found the meaſure of the ſame on the inſide 18 feet $4\frac{7}{8}$ inches Paris meaſure, and on the outſide 18 feet $4\frac{1}{3}$ inches, their difference is $\frac{1}{24}$ of a Paris inch; the depth of the jambs is 4 feet $10\frac{3}{4}$ inches Paris meaſure; and

(6) Eſattiſſimo piede Ingleſe. See Saggi di Diſſertazioni Academiche di Cortona, vol. iii. p. 113. I have been credibly informed, that this London foot was given him by the late Martin Folkes, Eſq; and that it was made by Siſſon, according to Graham's meaſure.

(7) Greaves, p. 348.

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9 London inches are equal to 8,447 Paris inches and decimals. Hence the meaſure of this door-caſe 9 London inches within the jambs, ſhould, according to Deſgodetz, be 18,3676 Paris feet and decimals. But 19,602 is to this number, as 1065,4 to 998,3; and Greaves's London foot wanted $1\frac{7}{10}$ to be to Deſgodetz's Paris foot, in the proportion of 1000 to 1065,4.

Greaves ſays, moſt of the white marble ſtones on the pavement of the Pantheon contained exactly 3 of thoſe Roman feet on Coſſutius's monument (8). Their Paris meaſure, according to Deſgodetz, is 2 feet $8\frac{1}{2}$ inches, which is equal to 2885,46 London parts. This number divided by 3, gives but 961,82 ſuch parts; whereas Greaves's meaſure of the Coſſutian foot was 967 parts of his London foot; which muſt therefore have wanted above 5 parts in 1000 of the proportion before-mentioned. But it is probable they meaſured different ranges of theſe ſtones.

The meaſure of the Paris foot, which Greaves received from Monſ. Hardy, was taken from the old ſtandard in the Chatelet (9), and contained 1068 ſuch parts as his London foot contained 1000. Theſe numbers are in the proportion of 1065,4 to 997,57; therefore, if the new ſtandard did not differ from this old one (and no ſuch difference appears to have been intended), Greaves's London foot muſt have been 2,43 parts in 1000 ſhorter than Graham's.

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(8) Greaves, p. 211.

(9) See Monſ. Hardy's Letter, in Greaves's Works, p. 447. The meaſure he ſent was only half the Paris foot; but he tells Greaves, it was taken from the ſtandard, under his own inſpection, with great care.

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All theſe compariſons ſhew Greaves's meaſure of the London foot to have been ſhorter than Graham's. But they are not all of equal authority. The meaſures of Snellius depend upon the correctneſs of three ſeveral ſeet; that is to ſay, his copy of the iron ſtandard, the Rhynland, and the Paris foot; whereas the reſt (except Norwood's) depend only on the Paris foot, applied to the ſame magnitudes that Greaves himſelf had meaſured. Norwood's meaſure is rather to be wondered at, that, notwithſtanding all the difficulties he had to encounter, it ſhould come ſo near to the true magnitude of a degree, than to be depended on for the exact meaſure of the iron ſtandard; and is an inſtance of what the diligence and ſagacity of a private and obſcure man, unaſſiſted by the public purſe, or the contributions of friends, could accompliſh; whoſe labours may, perhaps, be forgotten, when the meaſures of the French, taken under a royal commiſſion, ſhall be known to the lateſt poſterity.

The three more immediate compariſons of Greaves's meaſure with the Paris foot, are by the meaſures of Auzout, Deſgodetz, and Hardy, which afford as clear a proof as can well be expected in this matter, that his meaſure of the iron ſtandard was about 2 parts in 1000 deficient of Graham's London foot.

Mr. Greaves found the foot on the monument of Statilius to contain 972 ſuch parts as his London foot contained 1000; and that on the monument of Coſſutius 967 (1). Theſe meaſures reduced to Graham's foot, are 970, and 965.

(1) Greaves, p. 208, 209.

Auzout's

Auzout's meaſure of the foot on the monument of M. Ebutius, is nearly equal to 973 London parts. Revillas makes this 972¼, and the Capponian foot 968¾.

The mean of theſe meaſures of the Roman foot on the marbles, is nearly 969 thouſandth parts of the London foot.

Philander, in his notes on Vitruvius (2), ſays, the foot from a porphyry column, inſcribed ΠΟΔ. Θ. exceeded the Coſſutian foot by the ninth part of an inch; therefore it contained nearly 974 London parts. This column ſeems to have been a more authentic meaſure of the Roman foot, than the figures on the monuments; ſince the inſcription ſhews it was intended for ſuch, whereas they were only repreſentations of it. And notwithſtanding the inſcription was Greek, the foot muſt have been Roman; for Philander's meaſure of it exceeds the mean meaſure of thoſe on the marbles, by leſs than the ſixteenth part of a London inch, and is leſs than ſome of the antient foot-rules, hereafter mentioned; whereas it wants above the third part of an inch to be equal to the Greek foot. It might, perhaps, be uſed by ſome Greek maſon at Rome, to adjuſt his workmens rules by; for when the Romans began to be expenſive in their buildings, they had moſt of their maſons from Greece. And though this column is not now to be found, and the accuracy of Philander's meaſure of it may be doubted, it is ſtill a proof, that, at one time or other, the meaſure of the Roman foot was ſenſibly greater than that on the monument of Coſſutius.

(2) P. 117. of the Lyons edit. 1552.

Lucas

Lucas Pætus compared five antient foot-rules with the marbles; he ſeems not to have been a perſon of great accuracy; for though in one place he allows there was ſome ſmall difference between the Statilian foot and that on the monument of Coſſutius (3), yet he every-where elſe ſpeaks of them as equal, and has given but one figure for the meaſure of both. His compariſons ſeem to have been made only with the latter, the meaſure of which he had before ſet up in the Capitol, as the true Roman foot (4). Three of theſe rules, which, he ſays, were exactly equal to each other, were ſhorter than the Coſſutian foot by one ſeventh part of a Coſſutian inch; they muſt then have been nearly 953$\frac{1}{2}$ London parts. Of the other two, one appears to have been 958, and the other 974, equal to that from Philander's column. He decides in favour of the three ſhorteſt, to which perhaps he was induced, partly by their agreement with each other, and partly by his opinion, that the Roman foot had been continually increaſing; whence it muſt follow, that the ſhorteſt meaſure of it was the moſt antient.

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(3) Cum quo ſane convenit modico diſcrimine hic Statilianus. Pætus de Menſ. et Pond. lib. i.

(4) Greaves, p. 209. ſays, the Roman foot engraved by Pætus in the Capitol, agreed exactly with that on the monument of Coſſutius. Pætus therefore ſeems at that time to have acquieſced in the opinion of Portius, which, he ſays, was generally received. (Leonardus Portius Vicentinus, vir ſane doctus, primus omnium noſtræ ætatis qui de hac re ſcripſerit, menſuram Colotiani pedis pro vera tradidit.—Quem juniores quoque ſecuti ſunt.) But he changed his opinion when he wrote his book, which was after he had ſet up the meaſures in the Capitol.

Greaves ſays, the Coſſutian foot exactly agreed with ſome very antient and perfect Roman feet in braſs; and from his compariſon of two that differed from it (which ſeem to be the greateſt and leaſt he had met with), one of them appears to contain nearly 972¾ London parts, and the other 962⅗ (5).

P. Revillas has given the meaſures of three foot-rules of an uncommon length; one of which contains 972 London parts, another 976, and the third 983 (6).

There are many more of theſe rules in being, that we have no account of; for moſt of the writers on this ſubject, preferring the authority of the marbles, have been negligent in their accounts of the foot-rules; therefore I think a mean meaſure from theſe above-mentioned of no great authority, eſpecially as ſome of them have been produced only on account of their difference from the more common meaſure of the reſt.

If a cubic Roman foot contained a quadrantal of wine, the cube of half a foot muſt have contained a congius, which was the eighth part of the quadrantal. Pætus, Villalpandus, and Auzout meaſured the ſtandard congius of Veſpaſian with water; and have

(5) Greaves, p. 222. But, p. 227. he ſays, there is not one of ten meaſures of the Roman foot (beſides thoſe on the monuments), that arrive to the proportion of that deduced by Villalpandus from the congius, by 27 parts in 2000; whereas the greater of the two here mentioned contained 974¼ parts of his London foot, and he makes the foot from the congius of Villalpandus, but 986 ſuch parts; their difference is but 23 two thouſandth parts of the latter.

(6) Saggi di Diſſ. Academ. di Cortona, vol. iii.

given

given the weight of its contents. The two firſt differ from each other by almoſt 5½ modern Roman ounces, which is nearly the one-and-twentieth part of the whole weight, though they both meaſured up to the ſame part of the neck. The weight of water given by Pætus, is deficient of the mean weight of Auzout's meaſures by 3 Troy ounces; and that given by Villalpandus exceeds the ſame by 2; therefore they muſt both have uſed bad ballances.

Auzout meaſured this veſſel twice, with the water of Trevi. His greater weight of the water is 63024 Paris grains, his leſſer 62760 (7).

Picard found a cubic Paris foot of ſpring water to weigh 641326 Paris grains (8); and that foot containing 2089,69 cubic London inches, Auzout's greater weight will give 205,36 ſuch inches for the ſolid content of the congius, his leſſer 204½.

According to Picard's experiment, a cubic London inch of ſpring water ſhould weigh but 251½ Troy grains; whereas, according to Snellius, it ſhould weigh above 254 (9).

Our countryman Wybard made many experiments to diſcover the weight of water (1), from which the weight of a cubic inch of rain water ſhould be 253 Troy grains. His experiments ſeem to have been made with great attention, and his inch muſt have been that of the iron ſtandard, which I have already

(7) See the paper De Menſuris, above quoted, p. 366. 371. of the folio edit. where Picard gives theſe weights as Auzout's, without any farther account of them.

(8) Ibidem.

(9) Snellius, in Eratoſthene Batavo, p. 155.

(1) See Wybard's Tactometria, from p. 269 to p. 287.

ſhewn to be leſs than Graham's; therefore, I think a cubic inch of Graham's meaſure of the water of Trevi, cannot weigh leſs than 253 Troy grains. This will reduce Auzout's two meaſures of the congius to 204,35 and 203,49 cubic London inches; which give 981,7 and 980,3 for the meaſure of the Roman foot.

Greaves meaſured the congius with millet ſeed (2), and comparing it with our meaſures of capacity, found it to contain $7\frac{1}{8}$ pints wine meaſure, and $6\frac{1}{6}$ pints corn meaſure. When he wrote, the wine gallon was univerſally allowed to contain 231 cubic inches (3); and the dimenſions of the buſhel were publiſhed yearly, by the Lord Mayor of London, to be 19 inches in diameter, and $7\frac{1}{2}$ in depth (4). But Greaves's inches were according to the iron ſtandard in the Guildhall, and were 2 parts in 1000 ſhorter than Graham's. Therefore reducing theſe meaſures in that proportion, the wine gallon will be found to contain 229,62 cubic London inches, and the corn gallon 264,22. Hence by the wine meaſure, the congius contained 204,5 cubic London inches, and by the corn meaſure 203,7; which give 981,9 and 980,6 for the meaſure of the Roman foot.

Theſe meaſures agree ſo well with thoſe of Auzout, that I think a mean between them muſt be very near the truth, and that we may reckon the

(2) Greaves, note f. p. 303.

(3) See Wybard's Tactometria, p. 264. Oughtred's Circles of Proportion, p. 57. who quotes Gunter and Briggs for the ſame opinion.

(4) Wybard's Tactometria, p. 282.

foot,

foot from the congius to contain about 981 London parts.

Greaves took likewiſe another meaſure of this congius, by the cube of his Coſſutian foot, which he found to contain 7 congii, and about an half, of millet (5). Now, the quadrantal ſhould contain 8; hence the ſide of the quadrantal to this congius will contain 988 parts of the iron ſtandard: for 988 is to 967 (Greaves's meaſure of the Coſſutian foot) in the ſubtriplicate proportion of 8 to $7\frac{1}{2}$. But this is a greater meaſure than even that of Villalpandus, and was probably owing to an erroneous cube of the Coſſutian foot; for the joiners at Rome might be as bad workmen as the ſcalemakers; and Greaves ſays, he could not get a ballance there, fit to examine the congius by weight (6).

Monſ. Aſtruc, in his Natural Hiſtory of Languedoc, ſays, he had cauſed the diſtance between the ninth and tenth mile-ſtones on the road from Niſmes to Beaucaire to be meaſured, and that it was found to be 754 Paris toiſes. They were both ſet up by Tiberius, and the road lies in a ſtrait line between them. This meaſure gives a Roman foot of 964 London parts. He does not ſay he took this meaſure himſelf (7), nor has he given any account how it was taken. Perhaps by a provincial meaſure, and

(5) Greaves, p. 225.

(6) Ibid. note f.

(7) Memoires pour l'Hiſtoire Naturelle de Languedoc, p. 225. His expreſſion is, "J'ai fait meſurer la diſtance de l'un à l'autre, et elle s'eſt trouvée de 754 toiſes de Paris." Where he ſpeaks of the Marquis Maffæi, he ſays, "Il à meſuré;" but, in the ſame paragraph, ſpeaking of himſelf, he again ſays, "J'ai fait meſurer."

after-

afterwards reduced to Paris toiſes; or by a wheel, which is liable to great errors: therefore we cannot allow much authority to it, unleſs we were better aſſured of its accuracy. He quotes the Marquis Maffei for a meaſure of 756 toiſes between two other mile-ſtones on the ſame road; but obſerves, that they were ſet up by different emperors, Auguſtus and Tiberius, and that the road formerly made an elbow between them, whoſe poſition is now not certainly known. Therefore this meaſure, which gives a foot of 966⅔ London parts, is likewiſe of ſmall authority.

All that can be determined from ſuch uncertain and diſcordant data, as I have here collected, is a meaſure that ſhall probably be neither the greateſt nor the leaſt magnitude of the Roman foot. And for this, I ſhall take a mean from all the meaſures above recited, which is nearly 968 thouſandth parts of the London foot.

Before I enter upon the examination of the antient buildings, it may be proper to ſay ſomething concerning the nature of the evidence to be expected from them.

All buildings are planned and executed by ſome meaſure of the country where they are built. At Rome this meaſure was the foot, which was divided by the workmen into 4 palms, and each palm into 4 digits (8).

If

(8) Vitruvius, lib. iii. c. 1. Frontinus de Agrorum Qualit. Both theſe authors are technical writers, and give this as the diviſion uſed by workmen; and the antient foot-rules are ſo divided. They

If the Roman buildings were correctly executed, and we had the true dimenſions of their ſeveral parts in any known meaſure, ſome diviſors conſiſting of Roman feet, and parts of thoſe feet, applied to theſe meaſures, muſt, in the ſame building, give the ſame quotient to all; and this quotient will be the meaſure of the foot, by which that building was conſtructed, in parts of the known meaſure. Therefore, where a range of ſimple diviſors, applied to the principal parts of any building, give as nearly the ſame quotient as can be expected from the common inaccuracies of workmanſhip, we may reaſonably conclude, that theſe diviſors were the architects numbers; and the foot derived from them, that by which the building was conſtructed.

As an architect cannot be ſuppoſed to be limited to a few digits in the extent of the front, or of the depth of large buildings, it is probable ſuch meaſures conſiſted of whole feet. Theſe, and the diameters of circular buildings, I call prime meaſures.

In all large prime meaſures, the preference is to be given to a round number for the diviſor; as it is more probable a building ſhould be deſigned for 100 feet in front, than for 99 or 101: and becauſe the paſſus was 5 feet, I reckon any multiple of 5 a round number.

The diameters of columns are of leſs authority than any other horizontal meaſures; not only on account of the difficulty of meaſuring them correctly,

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They both mention the duodecimal diviſion, which ſeems to have been uſed by the vulgar; for the Romans divided every integer into 12 unciæ.

but

but becauſe errors of workmanſhip, to which they are more liable than ſquare members, more ſenſibly affect the magnitude of the foot in ſmall meaſures, than in large ones.

Uprights, of any conſiderable height, are of leſs authority than horizontal meaſures, from the difficulty of taking them correctly; and being deſigned by modules, few of them anſwer well to the foot meaſure. But here we muſt except ſuch ſhafts of columns as are of one block of marble; which ſeem to be as good authority as any part of a building: for the neceſſity of making them all exactly of the ſame length, muſt produce accuracy; and the doing this was no difficult piece of workmanſhip. Being likewiſe commonly (if not always) wrought at the quarry, to ſave expence in the carriage, they were probably beſpoke to ſome ſimple meaſure; and we ſhall find all ſuch ſhafts anſwer to ſome number of whole palms.

In the following enquiry, I ſuppoſe that Deſgodetz's Paris foot contained 1065,4 ſuch parts, as our London foot contains 1000: ſince it appears, from the compariſon of his meaſure of the door-caſe of the Pantheon with Greaves's, that if Greaves's London foot was not above 2 parts in 1000 ſhorter than Graham's, Deſgodetz's Paris foot was but $\frac{3}{10000}$ of the London foot ſhorter than that in the archives of the Royal Scociety. This difference (if ſuch there was) does not amount to the 277th part of an inch; which is much nearer than we can expect to find the meaſure of the Roman foot, from all the remains of antiquity now in being.

The

The temple of Fortuna virilis.

When this temple was built, is not known; but it is commonly thought, from the poorneſs of the materials, and the ſtyle of the architecture, to be one of the moſt antient buildings now remaining in Rome. The great ſimplicity of its parts, and their near agreement with each other, afford ſo clear an evidence of the meaſure by which it was conſtructed, that I have choſen to begin with it, as an introduction to the reſt.

It has four Ionic columns in front, and ſeven in depth.

The depth, taken between the centers of the angular columns, is 54 feet $8\frac{1}{4}$ inches Paris meaſure, equal to 58264,06 thouſandth parts of the London foot; which contain juſt 60 Roman feet of 971 + ſuch parts each.

The diſtance between the centers of the columns in this range, is 9 feet $1\frac{3}{8}$ inches, equal to 9710,6 London parts; containing 10 Roman feet of the ſame meaſure with the former.

The extent of the front, taken between the centers of the angular columns, is 28 feet $8\frac{1}{6}$ inches, = 30556,25; which contain $31\frac{1}{2}$ Roman feet of 970 + London parts each.

The diſtance between the centers of the angular columns, and thoſe on each ſide the entrance, is exactly equal to the diſtance between the centers of the columns on the ſides; being 10 Roman feet of 971 + parts each.

There remain therefore $11\frac{1}{2}$ Roman feet, for the diſtance between the centers of the columns on each

ſide the entrance. This meaſures 10 feet $5\frac{5}{12}$ inches (9), equal to 11134,9; which, divided by $11\frac{1}{2}$, gives $968\frac{1}{4}$ for the Roman foot.

This diſagreement between the meaſures in the front, cannot be reconciled by any probable diviſors; therefore it muſt be owing to an error in workmanſhip. And if the diſtance between the centers of the middle columns were but a little more than $\frac{3}{8}$ of a London inch greater, both that, and the whole extent of the front, would anſwer to the ſame meaſure of the foot with the ſides. Now, as the middle intercolumniation was intended to be greater than the reſt, the workman might be leſs exact in laying out the front, than the ſides, where they were all to be equal; for the front intercolumniations next the angles being kept equal to thoſe on the ſides, the ſymmetry of the building would be preſerved, and the whole error fall on the middle intercolumniation, where it could not be diſcovered.

Or if, on the other hand, we ſuppoſe the meaſure of the extent in front to have been correct, and the error to have lain in the ſides, the workman muſt ſtill have made the intercolumniations on the ſides equal to each other, and thoſe in the front next the angles, equal to them: and, in this caſe, 970 would be the true meaſure of the foot, inſtead of 971.

Therefore, I think, it cannot be doubted, that one or the other of them was the meaſure by which this building was conſtructed.

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(9) Deſgodetz has figured this 10 feet $5\frac{1}{12}$ inches; which will be found to be a miſtake, by comparing the correſpondent numbers, and by his meaſure of this interval in modules.

The

The temple of Veſta, at Rome.

This building is remarkable for the ſtyle of its architecture, and the elegance of its workmanſhip. The pointed abacus ſhews the architecture to be Greek; which is a ſtrong preſumption in favour of its antiquity, as it is the only example of the kind now remaining at Rome (1).

None of the diameters will anſwer to the ſame meaſure of the foot with the other parts, by probable diviſors. This was likely enough to be the caſe, if the circles of the plan were deſcribed by a cord, whoſe ſtretching might increaſe their diameters beyond the intended meaſures. But the reſt of the meaſures agree pretty nearly with each other, by as ſimple diviſors as can be expected in ſo ſmall a building.

At the door-caſe, the arch of the wall is diſcontinued, and the groundſil is ſtrait. The width between the jambs is 9 feet $1\frac{2}{3}$ inches, equal to 9736,6; which, divided by 10, gives a foot of 973,7 London parts.

From the wall to the centers of the columns, is 8 feet $8\frac{1}{8}$ inches, = 9244,6; which, divided by $9\frac{1}{2}$, gives a foot of 973,1 parts.

From the wall to the extremity of the baſement, is 10 feet 6 inches, = 11186,7; which, divided by $11\frac{1}{2}$, gives 972,7.

(1) That is to ſay, it is probably older than the Pantheon; for, according to Pliny, in his thirty-ſixth book, there ſeems to have been no marble temple in Rome above ſixty years older than that building. And his hiſtory of marble is confirmed by the ſaying of Auguſtus, "That he found Rome brick, and left it marble." Sueton. in Aug. c. 28.

From the top of the ſurbaſe within, to the pavement of the cell, is 7 feet $9\frac{1}{6}$ inches, = 8271,65; which, divided by $8\frac{1}{2}$, gives 973,1.

From the top of the ſurbaſe without, to the outer pavement, is 9 feet $1\frac{5}{6}$ inches, = 9751,4; which, divided by 10, gives 975,1.

The ſhafts of the columns are 27 feet 5 inches, = 29209,8; which, divided by 30, gives 973,7.

The columns, with their baſes and capitals, are 32 feet 0 inch, = 34092,8; which, divided by 35, gives a foot of 974 London parts.

The mean meaſure of the foot from this building, is 973,6; which agrees nearly with the foot of Philander's porphyry column above-mentioned, and with one derived from Greaves's meaſure of the monument of Ceſtius, whoſe ſide within the city (as he ſays in p. 151 of his works) is completely 78 feet Engliſh; which, reduced to Graham's meaſure, is 77,84, and contains 80 Roman feet of 973 London parts each.

The temple of Veſta, at Tivoli.

The meaſures of the parts of this building diſagree ſo much with each other, by any probable diviſors, that I ſhall only mention the width of the door-way between the jambs, which is 7 feet $3\frac{3}{4}$ inches, = 7790,7, and anſwers to 8 Roman feet of 973,8 parts each.

The Pantheon.

This is a circular building, with a portico before the entrance; which, having been added after the body of the work was finiſhed (2), has induced many

(2) See Deſgodetz, p. 3. & p. 14.

to

to think the temple was more antient, and that Agrippa only adorned it with marble, and added the portico. But the inſcription on the freze, " M. " Agrippa L. F. Coſ. tertium fecit," ſeems to refer to the whole. And Pliny, enumerating the moſt magnificent buildings in Rome, ſays, " Pantheon " Jovi ultori ab Agrippa factum; cum Theatrum " ante texerit Romæ Valerius Oſtienſis architectus, " ludis Libonis (3)." If the latter part of this paſſage alludes to the dome of the Pantheon (as it ſeems to do), it will imply, that Agrippa built it. In another place (4), Pliny calls this building Agrippa's Pantheum. Now, temples of this form were uſually peripteres; that is to ſay, encompaſſed with columns (5), as the two temples of Veſta; but ſuch a colonnade to this building (ſuppoſing the entablature to reach up to the top of the wall) could not conſiſt of fewer than twenty-ſix columns of 9 London feet in diameter; which, with their entablature, muſt have coſt much more than the whole building, as it now ſtands. Therefore, it ſeems as if no columns were at firſt intended on the outſide, and that the portico was an after-thought.

This temple is ſaid to have been burnt in that great conflagration, which happened in the reign of Titus (6); and again by lightning, in the thirteenth year of Trajan (7), and to have been reſtored by

(3) Pliny, lib. xxxvi. c. 15.
(4) Ibid. c. 5.
(5) Vitruvius, lib. iv. c. 7.
(6) Xiphilin. in Tito. Suetonius likewiſe mentions this fire; but does not ſay what buildings were burnt by it. Titus, c. 8.
(7) Euſebius in Chronico.

Adrian

Adrian (8). But it does not ſeem to have been totally deſtroyed either time; for the inſcription of Severus ſays, it was "vetuſtate corruptum;" which could hardly be true, if it was entirely rebuilt by Adrian, who began his reign but ſeventy-ſix years before Severus; but is very applicable to a building that had ſtood above 200 years, and been twice damaged by fire. Neither does it ſeem poſſible, that a building of this ſize and ſolidity, without any timber in it, except the roofing of the portico, ſhould be totally conſumed by the fire of the neighbouring buildings. Therefore, we may ſuppoſe the meaſures of the principal parts of it to be according to the foot of the Auguſtan age.

If the execution of this noble building had been anſwerable to the beauty of the deſign; the multiplicity of its parts, and the accuracy with which Deſgodetz has meaſured them, would have afforded ample materials for the diſcovery of the foot by which it was conſtructed: but the dimenſions of ſuch parts of it as ſhould be equal to each other, differ ſo widely, that ſcarce any but the prime meaſures are to be depended on.

Theſe were, probably, the diameter of the circle paſſing through the centers of the columns within; for on this, the diameter of the cupola depended; and the diameter of the whole building, from out to out.

Deſgodetz has given twelve meaſures of the diameter within the ſhafts of the columns. The mean from them all, is 133 feet $2\frac{3}{7}$ inches Paris meaſure:

(8) Spartianus in Adriano.

to

to this, add the mean diameter of the columns, 3 feet $4\frac{4}{7}$ inches, their ſum, 136 feet $7\frac{1}{7}$ inches, equal to 145533,6 London parts, is the diameter of the circle paſſing through the centers of the columns; which, divided by 150 (as round a number as can be deſired), gives 970,2 ſuch parts for the meaſure of the Roman foot.

The mean depth of the four long chapels, between the ſhafts of the columns and the wall, is 9 feet $1\frac{47}{48}$ inch, = 9764,3; which, divided by 10, gives a foot of 976,4 London parts; but by $10\frac{1}{4}$, one of 952,6; which is certainly too ſmall. And if this was an arbitrary meaſure, we cannot admit the fraction of a palm in it. Therefore, we may ſuppoſe theſe chapels were intended to be 10 Roman feet deep in the clear between the columns and the wall.

The mean diameter of the columns, 3 feet $4\frac{4}{7}$ inches, = 3622,36 London parts, divided by $3\frac{3}{4}$, gives a foot of 966 parts. The ſhafts of theſe columns meaſure 27 feet $1\frac{1}{3}$ inches, whoſe eighth part (reckoning the ſhaft at 16 modules) is 3 feet $4\frac{2}{3}$ inches; which is ſomewhat leſs than the mean of their diameters. Yet even this meaſure (which is equal to 3610,5 London parts) does not want half a Roman digit of $3\frac{3}{4}$ feet of 970,2 parts each; which the architect might ſafely neglect, and allow $3\frac{3}{4}$ feet for theſe diameters, in his general plan.

Now, if to twice the depth of theſe chapels, or 20 Roman feet, we add twice the ſemidiameter of the columns, or $3\frac{3}{4}$ ſuch feet; and to their ſum, the diameter of the circle paſſing through the centers of the columns, 150 feet; we ſhall have $173\frac{3}{4}$ Roman feet

feet for the diameter from wall to wall of the oppoſite chapels.

Deſgodetz has given four meaſures of this diameter, whoſe mean, 158 feet $2\frac{2}{3}$ inches, is equal to 168570 London parts, which, divided by $173\frac{3}{4}$, give 970,2 —, for the meaſure of the Roman foot; agreeing with that found from the diameter of the circle paſſing through the centers of the columns.

Or if, inſtead of taking a mean of the four diameters from wall to wall, we add twice the mean depth of theſe chapels, and twice the mean ſemidiameter of the columns, to the mean diameter of the circle paſſing through their centers, we ſhall have 158 feet 4 inches for the diameter from wall to wall, equal to 168688 London parts; which, divided by $173\frac{3}{4}$, give 970,9, for the meaſure of the foot.

But if this diameter from wall to wall was a prime meaſure, as well as that of the circle paſſing through the centers of the columns, the depth of theſe chapels muſt have been a reſiduary meaſure, and might be more or leſs than 10 Roman feet. And if we divide the diameter laſt mentioned by 174 (which being compoſed of 150, and twice 12, may here be reckoned a round number), it will give a foot of $969\frac{1}{2}$ London parts. But if, inſtead of twice the mean depth of theſe chapels, we take twice the greateſt depth, 18 feet 6 inches, for part of this diameter, the ſame diviſor will give a foot of $970\frac{1}{2}$ ſuch parts.

The meaſure of the diameter from out to out cannot be ſo well determined as either of the former; for Deſgodetz has given but one meaſure of the outer wall, which is 5 feet $4\frac{1}{2}$ inches; to this we muſt add 1 foot $10\frac{1}{3}$ inches, for the mean depth of the niches

in

in the long chapels; and twice their ſum, 14 feet $5\frac{2}{3}$ inches, added to 158 feet $2\frac{2}{3}$ inches, the inſide diameter between the walls of theſe chapels, will give 172 feet $8\frac{1}{3}$ inches for the diameter from out to out. This is equal to 183988,6 London parts; which anſwer to 190 Roman feet, of 968,4 ſuch parts each. But this diameter being got by the addition of many ſmall parts, one of which is a ſingle meaſure, is of ſmall authority. Though if the outer wall is 5 feet $4\frac{1}{2}$ inches thick in brick-work, and the backs of the niches in the long chapels are incruſted with marble (as I ſuppoſe they are), a proper allowance for the incruſtation will make this diameter anſwer to a foot of 970 London parts.

The principal parts of the circular range within, are too unequal to anſwer to any regular diviſion into compartments; and the two largeſt meaſures in it ſufficiently evince, how little uſe is to be made of the reſt: for the width of the grand chapel oppoſite the entrance, and the width of the entrance between the pilaſters in the range, will not anſwer to the ſame meaſure of the foot, by any probable diviſors.

But the inequality of the faces of the pilaſters, that terminate the ſolids in this range, affords the cleareſt proof, that no certain meaſure of the foot is to be obtained from the leſſer parts of this building: for two of them, at the extremities of the ſame ſolid, differ in breadth by a Paris inch and three quarters. One of the two on each ſide the grand chapel exceeds the other in breadth, by a Paris inch and a quarter; and it exceeds the leaſt in the circular range, by no leſs than $4\frac{1}{4}$ ſuch inches, though the diameter of the column before it is leſs than that of ſome in the range.

The diameter of the circular light at top is 27 feet 5 inches, equal to 29209,7; which, divided by 30, gives 973⅔ for the Roman foot. Whether Deſgodetz took more meaſures than one of this diameter, does not appear, nor how he took it. It is probable, that 30 Roman feet was the meaſure here intended, being a round number, and one fifth of the diameter between the centers of the columns: but the making this light a true circle, preciſely anſwering to a given meaſure, was a difficult piece of workmanſhip. Therefore, this meaſure is of ſmall authority.

The ſquare compartments on the pavement meaſure 9 feet 0⅔ inch, or 9647,79 London parts; which, divided by 10, give a foot of 964,8 parts. But Deſgodetz obſerves (9), that this is not the original pavement: and this meaſure of the foot anſwers to the age of S. Severus, as I ſhall ſhew hereafter.

This pavement being conſiderably raiſed above the old one, no meaſures of uprights taken from it are of any authority.

The height of the attic, above the cornice it ſtands upon, is 27 feet 2¾ inches, equal to 29010; which, divided by 30, gives a foot of 967 parts. But the walls of this building being brick, this meaſure may have been diminiſhed by their ſettling, as the whole error occaſioned by it might be made to fall on this part, rather than on the order below.

The length of the ſhafts of the columns in the circular range, is 27 feet 1⅓ inches, = 28884,18; which anſwers to 29¾ feet, of 970,9 parts each.

(9) Deſgodetz, p. 41.

The

The width of the door-caſe, between the jambs, has been ſuppoſed, by Picard, De la Hire, Eiſenſchmid, and others, to have been a meaſure of whole feet; for this reaſon, becauſe they thought it an arbitrary one, and therefore not likely to contain a fraction (1). But in this, I think, they were miſtaken; for it appears to have been determined by the width of the paſſage within, of which it takes up juſt three fourths. The proportion is too ſimple, and too exactly executed, to be accidental; and it is highly improbable, that the width of this paſſage, which is a principal part of the plan of the inſide, ſhould be determined by that of the door-caſe. The width of the paſſage, is 24 feet $5\frac{2}{2}\frac{3}{4}$ inches, = 26098,6; that of the door-way, next the paſſage, is 18 feet $4\frac{7}{8}$ inches, = 19610; next the portico, 18 feet $4\frac{1}{3}$ inches, = 19561,9; none of which will give a meaſure of the foot, anſwering to the reſt of the building, by whole diviſors. The width of the door-way next the portico (which has been ſuppoſed to be juſt 20 Roman feet), divided by 20, gives 978. But the diameters of the temple (taking either the greateſt or the leaſt, inſtead of a mean), will not anſwer to a foot of this meaſure, by probable diviſors.

The principal meaſures in the portico are, its extent in front and depth, and the ſhafts of the columns.

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(1) Mr. Greaves ſays, this door-caſe is one entire marble ſtone. See p. 348. and p. 494. And Ficoroni (a late writer), in his Veſtigia di Roma antica, p. 132. ſpeaking of this door-caſe, ſays, "Eſſendo amendue i lati, col di ſopra, e il di ſotto di un ſolo pezzo di marmo." But Deſgodetz, p. 18. ſays, that each ſide of the architrave conſiſts of two ſtones, and the top, of one; and corrects Serlio, for ſaying the whole was of one piece.

The extent in front, taken between the centers of the angular columns, is 98 feet $4\frac{3}{8}$ inches, equal to 104797,6; which contain 108 Roman feet of 970,3 parts each. Its depth on the right-hand ſide of the entrance (2), from the center of the angular column to the center of the pilaſter, is 41 feet $5\frac{1}{8}$ inches, = 44136,4, and contains $45\frac{1}{2}$ feet of 970 + parts. The ſhafts of the columns, which are each of one ſingle ſtone, meaſure 36 feet $7\frac{7}{8}$ inches (3), equal to 39053,6; which anſwer to $40\frac{1}{4}$ Roman feet of 970,3 London parts.

I can find no meaſures in this building of equal authority with the diameters, the ſhafts of the columns in the circular range, and theſe meaſures in the portico. All of which give the meaſure of the Roman foot greater than 970 ſuch parts as the London foot contains 1000.

In the reſt of the buildings, where the meaſures do not require a particular explanation, I ſhall firſt give Deſgodetz's meaſures, with their reductions to thouſandth parts of the London foot, and then ſet down the diviſors and quotients with two hooks between them; the diviſor on the left-hand, expreſſing

(2) By ſome expreſſions of Deſgodetz, his plans ſeem to be inverted, as gravings commonly are. I ſpeak according to the plan, ſuppoſing the reader to view it in front.

(3) Deſgodetz, p. 19. has figured the ſhafts of the pilaſters in the portico 36 feet $7\frac{1}{3}$ inches, and in modules 16 mod. $8\frac{1}{4}$ parts; which is ſomewhat too great for his foot meaſure, his module being 27 Paris inches. But p. 16. he has figured the ſhafts of theſe columns 16 mod. $8\frac{3}{4}$ parts, which is 36 feet $7\frac{7}{8}$ inches. And that this is no miſtake, appears from his meaſures of the capitals of each.

a num-

a number of Roman feet; and the quotient on the right, their magnitude in parts of the London foot.

The temple of Peace.

The length on one ſide within the walls, including the pronaus or porch, is 269 feet $8\frac{1}{2}$ inches, = 287347,26 ——— ———	296) ... (970,8 —
The width of the nave 77 feet $5\frac{1}{2}$ inches, = 82524,1 (twice) ———	85) ... (970,9 —
The width of the ſide-building 48 feet 0 inch, = 51139,2 (thrice) ———	$52\frac{3}{4}$) ... (969,5 —
The length of the firſt diviſion of the ſide 71 feet 5 inches, = 76087,3	$78\frac{1}{2}$) ... (969,3 —
The length of the ſecond diviſion 71 feet 8 inches, = 76353,87	$78\frac{3}{4}$) ... (969,6 —
The length of the third 70 feet $3\frac{1}{2}$ inches, = 74888,75 ———	$77\frac{1}{4}$) ... (969,4
The width of two of the paſſages in the croſs walls, is 22 feet 4 inches, = 23793,9 ——— ———	$24\frac{1}{2}$) ... (971,2 —
The width of the exedra in the middle diviſion of the ſide 53 feet 11 inches, = 57442,82 ———	$59\frac{1}{4}$) ... (969,5
Its depth is equal to the width of the paſſages in the croſs walls.	
The two middle entrances through the porch, 15 feet 3 inches, = 16247,35 ——— ——— ———	$16\frac{3}{4}$) ... (970 —
The ſide entrances 14 feet $4\frac{1}{2}$ inches, = 15315,13 ——— ———	$15\frac{3}{4}$) ... (972,4 —

The entrance into the porch on the right-hand 14 feet 4 inches, = 15270,74	———	$15\frac{3}{4}$) . . . (969,5
The ſhaft of the column (of one ſtone) 49 feet 3 inches, = 52470,9	———	54) . . . (971,7 —
The diameter of the column 5 feet $8\frac{1}{4}$ inches, = 6058,47	———	$6\frac{1}{4}$) . . . (969,4 —
The height of the order 71 feet $0\frac{1}{2}$ inch, = 75687,79	———	78) . . . (970,4

A mean from theſe twenty-one meaſures gives a Roman foot of 970,3 parts. But the meaſures in this building ſeem to be very incorrectly executed.

The temples of Bacchus, and of Faunus.

I ſhall not particularly recite the meaſures of theſe buildings, becauſe they ſeem to be the works of a much later age than any of the reſt. By the different workmanſhip of the ſhafts of the columns in the temple of Bacchus (4), it ſeems to have been compiled out of the ruins of other buildings. In the temple of Faunus, moſt of the columns are of granate, but ſome of them of white marble; the croſs wall was evidently deſigned to ſupport a flat roof, the outer wall being too weak to bear a cupola (5); and the windows (which I take to be as old as the reſt of the building) are in the Gothic ſtyle: all which are marks of a late age. Therefore both theſe temples ſeem to be more modern than they are commonly thought to be. The temple of Bacchus

(4) See Deſgodetz, p. 68.
(5) Ibid. p. 79.

anſwers

anſwers to a foot of 968 parts, that of Faunus to one leſs than 967.

The amphitheatre of Veſpaſian.

The plan of this building is elliptical; and the area in the middle being allotted to the exhibition of the ſhews, ſeems to be the part on which the magnitude of the whole depended. Therefore one of its axes muſt be the prime meaſure.

The greater axis meaſures 263 feet 11 inches, = 281176,8 London parts; the leſſer 165 feet 1 inch, = 175879,7. Theſe numbers are ſo nearly in the proportion of 8 to 5, that there is little reaſon to doubt their being intended for it.

The only two whole numbers in this proportion that will anſwer our purpoſe are 288 and 180, by which the greater axis will give 976,3 London parts for the meaſure of the foot; the leſſer, 977,1.

Either the diſtance from the inner to the outer wall, or that from the inner wall to the extremity of the upper ſtep, was probably a prime meaſure too. The former is 155 feet $5\frac{1}{3}$ inches, = 165610,5; which, divided by 170, gives 974,2. The latter is 158 feet $0\frac{1}{12}$ inch, = 168340,6; which, divided by 172, gives 978,7.

But the axes will admit of other diviſors, which are in my opinion as probable at leaſt, as thoſe above-mentioned. For if we ſuppoſe the greater axis to have been the prime meaſure from which the leſſer was determined in the proportion of 5 to 8, and aſſume 290 Roman feet for it (which is a more probable meaſure than 288), the leſſer axis muſt then be $181\frac{1}{4}$ ſuch feet. And the meaſure of the foot by the

the greater axis will be 969,6 parts; by the leſſer 970,3.

The diſtance from the inner to the outer wall will not anſwer to this meaſure of the foot by any whole diviſor. And that from the inner wall to the extremity of the upper ſtep, divided by 174, gives but 967½. But this diſagreement will not appear extraordinary, when we conſider that theſe diſtances are not ſingle meaſures, but the ſums of nine or ten ſmaller ones (6), and may therefore be liable to an error of ſome inches.

The leſſer parts are ſo incorrectly executed, that no uſe can be made of them. And the heights of the four orders, and of their parts, are ſo irregular as not eaſily to be accounted for.

The amphitheatre at Verona.

The principal meaſures in this building anſwer to the Greek foot; which is not the ſubject of the preſent inquiry.

The arch of Titus.

This edifice is ſo ruined, that we have not the meaſure of the extent of its front.

The depth of the ſolid is 14 feet 7 inches, = 15537,1 —	— 16)...(971,1 —
The width of the entrance, 16 feet 4 inches, = 17401,5	— 18)...(966,7
The ſhafts of the columns, 16 feet 2 inches, = 17223,97	— 17¾)...(970,9

(6) See the ſection, Pl. 3.

The

The arch of Conſtantine.

The meaſures of this elegant deſign are ſo incorrectly executed, that I can make no uſe of them. The fronts of the two outermoſt ſolids differ by a Paris inch and one third; the ſide entrances by $1\frac{2}{3}$; the diſtances of the columns from the pilaſters (a meaſure of little more than 18 inches) differ an inch and $\frac{1}{12}$; and the depth of the ſolid at one end, exceeds that at the other end by no leſs than $7\frac{1}{4}$ Paris inches.

The temple of Antonine and Fauſtina.

Deſgodetz has given the meaſure of no part of this building in feet and inches, but the diameters of the columns; which he ſays do not differ from each other, as in many of the reſt.

The diameter of the columns is 4 feet $6\frac{7}{12}$ inches, $= 4846{,}09$ ———	$5)\ldots(969{,}2$
The extent of the portico taken between the centers of the angular columns, 25 mod. $16\frac{5}{6}$ parts, $=$ $61935{,}7$ ——— ——— ———	$64)\ldots(967{,}7$
The ſhafts of the columns, 15 mod. 28 parts, $= 38607{,}2$ ———	$40)\ldots(965{,}2$

Theſe ſhafts were probably intended for 16 modules, and their meaſure is more to be relied on than that of the diameters, both on account of its ſize, and becauſe the correct execution of it was not only more eaſy, but more neceſſary. Therefore, though theſe meaſures are too few, and too unequal to determine the exact magnitude of the foot uſed in the con-

ſtruction of this building, yet it ſeems to have been leſs than any we have hitherto met with.

The arch of Septimius Severus.

This building deſerves our particular attention, both on account of the correctneſs of the workmanſhip, and becauſe it exhibits a different meaſure of the Roman foot from any of the preceding. It is all of white marble. The ſtones are laid without mortar, and faſtened together with cramps. And the ſhafts of the colums are each of one ſtone.

The whole extent in front, is 71 feet $5\frac{5}{6}$ inches, = 76161,3 ———	79) . . . (964,1
The depth at one end, is 21 feet $8\frac{3}{4}$ inches, = 23150,3 ———	24) . . . (964,6
The depth at the other end, 21 feet $8\frac{5}{6}$ inches, = 23157,6 ———	24) . . . (964,9
The width of the middle entrance, 20 feet 10 inches, = 22195,8	23) . . . (965
The width of the ſide entrances, 9 feet 2 inches, = 9766,17 ———	$10\frac{1}{8}$) . . . (964,5
From the middle entrance to the extremity of the outer ſolid, on one ſide, is 25 feet $3\frac{3}{4}$ inches, = 26967,9 ——— ———	28) . . . (963,1
The like on the other ſide, 25 feet $4\frac{1}{12}$ inches, = 26997,5 ———	28) . . . (964,2
The diſtance between the ſhafts of the outermoſt columns, is 60 feet $7\frac{5}{6}$ inches, = 64619,5 — (7)	67) . . . (964,5

The

(7) This and the two following meaſures are inſerted only to ſhew the probability, that the diameters of the columns were deſigned

The diſtance between their centers,
63 feet $4\frac{1}{3}$ inches, = 67504,9 ——— 70)...(964,4
The diſtance including their ſhafts,
66 feet $0\frac{5}{6}$ inch, = 70390,4 ——— 73)...(964,3
The diameter of the columns, 2 feet
$8\frac{1}{2}$ inches, = 2885,46 ——— 3)...(961,8

The uprights will not anſwer to any one meaſure of the foot by whole diviſors; nor will they agree with each other by broken ones, ſo nearly as the horizontal meaſures do, which may partly be owing to the difficulty of taking them correctly.

The ſhafts of the columns meaſure
21 feet $8\frac{1}{4}$ inches, = 23105,9 ——— 24)...(962,7
The pedeſtals, 12 feet $3\frac{5}{12}$ inches,
= 13088,14 ——— ——— $13\frac{1}{2}$)...(969,5
The whole order, 33 feet $4\frac{1}{4}$ inches,
= 35535,53 ——— ——— 37)...(960,4
The attic, 15 feet $5\frac{1}{3}$ inches, =
16454,51 ——— ——— ——— 17)...(967,9
The blocking, 1 foot $9\frac{3}{8}$ inches, =
1923,64 ——— ——— ——— 2)...(961,8
The whole height, 62 feet $10\frac{2}{3}$ inches,
= 67001,8 ——— ——— $69\frac{1}{2}$)...(964,1 —

I have produced theſe uprights, rather as an inſtance how little ſuch meaſures are to be depended on, even in buildings correctly executed, than as of any authority for the meaſure of the foot. For they cannot be reconciled to a common meaſure without

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ſigned to be three Roman feet, and not as of any authority in the determination of the meaſure of the foot.

fractions of the digit in the diviſors, by which means any meaſure of the foot might be derived from any building.

A mean from the ſeven firſt horizontal meaſures gives a Roman foot of 964,3 parts. A mean from the uprights one of 964,4.

But the depth of the ſolid, and the widths of the entrances are moſt to be depended on, and theſe give a foot of $964\frac{3}{4}$ London parts; which will be found to be the greateſt meaſure this building will anſwer to by probable diviſors.

For though the extent of the front, or the width of the middle entrance, muſt probably have been the prime meaſure in a building of this kind; yet no part ſeems more likely to conſiſt of ſome number of whole feet (or at leaſt whole palms) than the depth of the ſolid; ſince there appears no reaſon why the architect ſhould uſe odd digits in the meaſure of it. Now if we ſuppoſe the extent of the front to have been $78\frac{1}{2}$ Roman feet, they will contain 970 parts each; but to make the depth agree with this meaſure, it muſt have been $23\frac{7}{8}$ ſuch feet, which does not ſeem probable, for the reaſon above-mentioned. The middle entrance muſt then have been $22\frac{7}{8}$, inſtead of 23 whole feet, and the extent on each ſide $27\frac{15}{16}$, inſtead of 28. And there will not be one whole meaſure in the plan of this building; which is improbable. Neither do theſe broken meaſures ſerve for the ſubdiviſion of the ſides better, or even ſo well as the whole ones.

The ſhafts of the columns are ſo nearly 16 modules, that they ſeem to have been deſigned for that proportion; and $\frac{1}{32}$ of a Paris inch added to the diameters

meters would make them ſo. But this is not ſufficient to make thoſe diameters anſwer to 3 feet of $964\frac{3}{4}$ parts, of which they want almoſt $\frac{1}{10}$ of a Paris inch. This may be partly an error in the workmanſhip, and partly in Deſgodetz's meaſure; but if this quantity were added to them, they would not only anſwer to the ſame foot with the reſt of the building, but all the parts in which their meaſure is included, would agree better with the depth of the ſolid, and the widths of the entrances.

The height of the blocking was probably intended for 2 Roman feet, though it anſwers to no greater meaſure of that foot than the diameters of the columns do. But meaſures of 2, 3, and 4 feet, ſeldom agree with the larger ones in any of the buildings; for a ſmall error, either in the workmanſhip, or in the meaſuring, makes a very ſenſible difference in the length of the foot derived from ſuch intervals. And this blocking does not want the $\frac{1}{13}$ part of a London inch, of 2 feet of 965 parts each.

The bankers arch, and the portico of Severus, are contemporary buildings with this, and ſeem to agree with it in the meaſure of the foot. The former is a very ſmall building, and its parts will not anſwer to any one common meaſure by diviſors of whole digits. However, the depth of the ſolid (which, as I have before obſerved, is moſt likely to be a whole meaſure) taken at three different parts, is 6 feet 4 inches, which anſwer to 7 Roman feet of 963,93 London parts.

There are but few meaſures in the portico of Severus. Thoſe moſt to be depended on are, the whole extent in front, and the ſhafts of the columns, which

are

are each of one block. The former meaſures 56 feet $11\frac{78}{100}$ inches, = 60708,3 —, which contain 63 Roman feet of 961,6 parts each. The latter meaſures 26 feet $11\frac{1}{4}$ inches, = 28699,22, which contain $29\frac{3}{4}$ ſuch feet of 964,7 parts. The whole column, with the baſe and capital, meaſures 32 feet $6\frac{1}{2}$ inches, = 34669,9 London parts, which contain 36 Roman feet of 963 parts each.

It appears by the inſcription on the architrave of the portico of the Pantheon (8), that Severus repaired that temple; and Deſgodetz obſerves, that the pavement is not ſo old as the building. That it was laid by Severus is probable, from the correctneſs of its meaſures, which is a remarkable characteriſtic of the workmanſhip of that age. The ſquare compartments on this pavement anſwer to 10 Roman feet, of 964,78 parts, agreeing with a mean from the depth of the ſolid of this arch, and the widths of the entrances, which are the moſt unexceptionable meaſures in it. The breadth of the ſtrait bands between theſe compartments, is equal to the meaſure Deſgodetz has given of the diameters of the columns of this arch, and anſwers to 3 feeet of 961,8 parts. But theſe bands might be purpoſely made ſomewhat ſhort of the full meaſure, to leave room for one of the ſame breadth with the reſt between the outermoſt compartments and the circular range; for notwithſtanding this, the workmen found themſelves obliged to diminiſh both the outermoſt compartment, and the band beyond it.

(8) Imp. Cæſ. Septimius Severus——et Imp. Cæſ. M. Aurelius Antoninus——Pantheum vetuſtate corruptum cum omni cultu reſtituerunt.

The

The concurring teſtimonies of theſe contemporary works, though not of ſufficient authority to eſtabliſh any meaſure of the foot by themſelves, are yet very ſtrong evidence in favour of the meaſure above derived from this arch. And we ſhall find a farther confirmation of it in Diocletian's baths.

The baths of Diocletian.

The whole length of this building is 439 feet 3 inches, = 467977	485)...(964,8
The length of the great hall, 180 feet $8\frac{1}{6}$ inches, = 192497 +	200)...(962,5
The breadth at one end, 74 feet $3\frac{5}{6}$ inches, = 79179,9	82)...(965,6
Its breadth at the other end, 74 feet $5\frac{1}{2}$ inches, = 79327,9	82)...(967
The diſtance between the middle ſolids on the ſide, 49 feet $8\frac{1}{4}$ inches, = 52937 +	55)...(962,5
The depth of the receſs out of the great hall between theſe ſolids, is 33 feet $6\frac{1}{6}$ inches, = 35705,7	37)...(965
The diſtance between one of theſe ſolids and the neareſt angular ſolid, 32 feet $11\frac{5}{8}$ inches, = 35124,9	$36\frac{1}{2}$)...(962,3
The diſtance between the other of them and the other angular ſolid, 33 feet $1\frac{1}{3}$ inch, = 35276,57	$36\frac{1}{2}$)...(966,4
Entrance at one end of the hall, 36 feet $2\frac{1}{6}$ inches, = 38546,8	40)...(963,7
Entrance at the other end, 36 feet $1\frac{1}{4}$ inch, = 38465,4 — (twice)	40)...(961,6

Paſſage

Paſſage from the circular veſtibule, 30 feet $9\frac{1}{4}$ inches, = 32783,2 (twice) —— —— ——	34)...(964
Side entrance into the veſtibule, 20 feet $9\frac{2}{3}$ inches, = 22166,2 ——	23)...(963,7
A meaſure from 4 feet 6 inches to 4 feet $6\frac{1}{2}$ inches, repeated 12 times, the mean from all of them is 4 feet $6\frac{77}{288}$ inches, = 4818,03 ——	5)...(963,6
A meaſure from 5 feet 5 inches to 5 feet $5\frac{1}{4}$ inches, repeated 11 times, the mean from all is 5 feet $5\frac{2}{11}$ inches, = 5787,05 —— ——	6)...(964,5
A meaſure from 2 feet $8\frac{1}{2}$ inches to 2 feet $8\frac{5}{6}$ inches, repeated 4 times, the mean from all is 2 feet $8\frac{7}{12}$ inches, = 2892,86 —— ——	3)...(964,3
A multiple of 6 feet on the wall, where this meaſure of 3 feet is thrice repeated, is 43 feet $5\frac{1}{8}$ inches, = 46267,2 —— ——	48)...(963,9

The diameter of the circular veſtibule is too principal a part to be neglected. It anſwers to 65 Roman feet of 969,1 parts, which the other meaſures in this building will not come up to by probable diviſors. It anſwers likewiſe to $65\frac{1}{4}$ feet of 965,4 parts; but an odd palm in ſo large a meaſure is not probable. Therefore it ſeems to have been incorrectly executed, and perhaps this circle was deſcribed by a cord.

The

The ſhafts of the columns, each of one block, meaſure 35 feet $11\frac{5}{12}$ inches, = 38302,6 —— —— $39\frac{3}{4}$)...(963,6

The whole column is 43 feet $6\frac{1}{6}$ inches, = 46359,7 —— —— 48)...(965,8

Theſe are the principal meaſures in this building, and a mean taken from all of them, except the diameter of the veſtibule, gives a foot of 964,1 London parts.

But the three ſmall meaſures, of 5, 6, and 3 Roman feet (the firſt of which is the paſſus) are alone ſufficient to diſcover the meaſure of the foot by which this building was conſtructed. For, being ſo often repeated with ſo little variation, they muſt afford a mean very near the truth, if their diviſors be rightly aſſumed; and that theſe are ſo, can hardly be doubted. For, were the two largeſt to be encreaſed but by a ſingle digit, they would give different meaſures of the foot from each other; and that from the paſſus ſo encreaſed, would fall ſhort of 952 London parts; which is leſs than the leaſt of the antient foot-rules. On the other hand, were they diminiſhed by the ſame quantity, they would not agree together ſo nearly in the meaſure of the foot as they now do, nor give ſuch a meaſure of it as the reſt of the building will anſwer to by probable diviſors. Beſides, I have here reckoned only ſuch of theſe meaſures as Deſgodetz has figured on his plan; whereas they are much oftener repeated, and that not in the diameters of columns, or the members of an order, but in breaks, projections, and thickneſſes of walls, where a digit or two more or leſs could make no viſible

difference, provided the correſpondent parts were made to anſwer to each other: and it is highly improbable that ſuch odd meaſures as the paſſus wanting a digit, 6 feet wanting the ſame, and 3 feet wanting half a digit, ſhould be ſo often repeated in ſo large a building, and in places that do not ſeem to require any ſuch preciſe exactneſs. Therefore theſe meaſures muſt have been whole feet, and the diviſors are rightly aſſumed.

Their mean is 964,1 London parts, which exactly agrees with that found above from all the meaſures taken together.

The other remains of antiquity contained in this work are ſuch fragments as can be be of little uſe in the preſent enquiry.

CONCLUSION.

It appears from the meaſures of theſe buildings, that the Roman foot before the reign of Titus exceeded 970 parts in 1000 of the London foot, and in the reigns of Severus and Diocletian fell ſhort of 965.

Whether this difference proceeded from any alteration in the ſtandard, or from a falſe meaſure of it being got into common uſe, either before the reign of Titus or after, is uncertain.

We have no account of any alteration made by law in the Roman ſtandards after the Plebiſcitum Silianum, quoted by Feſtus (9); but as great a difference as this might ariſe from their having been loſt or deſtroyed.

(9) Under the words Publica pondera.

They were kept in the Capitol (1), and Rigaltius, from a paſſage in Hyginus, obſerves that the ſtandard of the foot was depoſited in the temple of Juno Moneta (2). Now the Capitol was burnt no leſs than three times; firſt in the civil war of Sylla (3); then again when Sabinus was beſieged in it by the troops of Vitellius (4); and the third time in that dreadful conflagration which happened in the reign of Titus (5). Whether the ſtandards were deſtroyed in the firſt of theſe fires is uncertain; but they could hardly eſcape the fury and confuſion of the ſecond, when, according to Pliny, the temple of Juno Moneta ſeems to have been burnt to the ground (6). And, if we may credit Xiphilin (whoſe account of the third is in ſome meaſure confirmed by Spartian), not only the temple of Jupiter Capitolinus, but thoſe adjoining to it, were burnt down in the laſt (7).

Veſpaſian

(1) This appears from the inſcription on Veſpaſian's congius, and from R. Fannius. And Jul. Capitolinus in Maximinis, mentions the amphora Capitolina.

(2) Hyginus de Limit. conſtituend. near the end, diſtinguiſhes the Roman foot by the name of Pes Monetalis. That this temple was in the Capitol, appears from Livy, lib. vii. c. 28. Cicero de Divin. lib. i. and Pliny, lib. xxxiv. cap. 7. Suidas (v. Μονητὰ) tells us the mint was kept here.

(3) Taciti Hiſt. lib. iii. This fire is likewiſe mentioned by Plutarch and Appian.

(4) Tacitus, ibid.

(5) Xiphilin in Tito. Sueton. in Domit. c. 5.

(6) Pliny, lib. xxxiv. c. 7. ſays, "Ætas noſtra vidit in Capitolio, priuſquam id noviſſime conflagravit, à Vitellianis incenſum, in cella Junonis canem ex ære, &c." And if the donatives were deſtroyed, it is not likely the ſtandards ſhould be ſaved in a ſcene of ſuch confuſion.

(7) Τόν τε νεὼν τῦ Διὸς τῦ Καπιτωλίυ, μετὰ τῶν συνναόων αὐτῷ, κατέκαυσεν. Xiphilin in Tito. Spartian, enumerating the public

Veſpaſian rebuilt the Capitol after the ſecond conflagration, and reſtored the antient records from copies of them that were got abroad (8), and probably the ſtandards at the ſame time. The congius was reſtored by weight, according to the Plebiſcitum Silianum, as the inſcription on it teſtifies. The quadrantal was too cumberſome a veſſel for common uſe, to which the congius (like our gallon) was well adapted; ſo that I do not ſee what other purpoſe it could ſerve, but to adjuſt the congius to its capacity, and the foot to its ſide: but here we ſee the congius adjuſted by weight, and it is not very likely that a new quadrantal ſhould be made for no other end but to adjuſt the foot by, when ſo many copies of the old ſtandard were extant.

Therefore it is not improbable, that the ſtandard of the foot was at this time reſtored, without any regard to its relation to the quadrantal.

But as to the difference between the foot derived from the congius, and that found from other authorities, I muſt farther obſerve, that the correct adjuſtment of weights to meaſures, is a very difficult matter, even in this age, and in this kingdom, where workmanſhip is arrived at a high pitch of accuracy. And what errors rude workmanſhip is liable to, ſufficiently appears from the weights Pætus and Villalpandus have given of the congius. Therefore I ſee no reaſon to reject the teſtimonies of thoſe authors,

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buildings reſtored by Adrian, mentions moſt of thoſe that Xiphilin ſays were burnt in this fire. Domitian rebuilt the Capitol. Suet. in Domit. c. 5.

(8) Sueton. in Veſpaſ. c. 8.

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who ſay that the cubic foot contained a quadrantal of wine; and as little to believe that theſe two ſtandards were ever truly adjuſted to each other.

But had the original ſtandard of the Roman foot been truly adjuſted to the quadrantal, and continued invariable from the time of its firſt eſtabliſhment, yet a falſe meaſure of it might at one time or other have got into common uſe at Rome, as well as a falſe meaſure of the French foot did at Paris; where in the year 1668, the maſon's foot was found to exceed the foot of the Chatelet by $\frac{5}{72}$ of a Paris inch (9), which is above $\frac{1}{14}$ of a London inch: and the unaccountable negligence which appears in the Roman coinage, gives ſufficient ground to ſuſpect they were not more accurate in their meaſures.

LXX. *A Deſcription of a metalline Thermometer*; *by* Keane Fitzgerald, *Eſq*; *F. R. S. Communicated by the Right Hon.* George *Earl of* Macclesfield, *Preſident of the Royal Society.*

Read May 22, 1760.

IT is univerſally allowed, that all bodies, whether ſolid or fluid, are expanded and contracted by heat and cold; and, as far as experiments of this kind have yet reached, it appears, that ſcarce any two bodies of different natures, or even of the ſame, are expanded, or contracted equally by the ſame degrees.

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(9) Picard, in the paper De Menſuris, quoted above.

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