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WEIGHTS, MEASURES, AND BALANCES.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A report of F. R. Hassler, relative to weights, measures, balances, &c., &c.

JANUARY 31, 1844.

Read, and referred to the Committee on Commerce.

TREASURY DEPARTMENT,
January 30, 1844.

SIR: I have the honor to transmit, herewith, a report of the late F. R. Hassler, in relation to the weights, measures, and balances which are in the course of construction by the direction of Congress.

It will be seen that Mr. Hassler refers to the fact of a complete set having been sent to the British Government. The instructions and remarks which accompanied them give a better view of the plan and principles of the work than any that have been made public. As well on account of their intrinsic value, as an act of justice to the memory of the distinguished man who originated and continued the work from its commencement, a copy of them is annexed.

The President, in accordance with the sense of Congress, as expressed in their joint resolution, (which, by some accident, did not reach him in time to receive his formal approval, but which met his entire concurrence,) directed that the set of weights and measures, and the standard balance, referred to by Mr. Hassler, should be forwarded to our minister in London, to be presented to the British Government. The accompanying copies of the correspondence on the subject will exhibit the performance of his directions, and the estimation of this courtesy by the British Government.

I also transmit, herewith, a statement exhibiting the number of standard weights and measures delivered to the department by the late superintendent, and showing the disposition that has been made of them.

Very respectfully, your obedient servant,

J. C. SPENCER,
Secretary of the Treasury.

Hon. JOHN W. JONES,
Speaker of the House of Representatives.

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Report of F. R. Hassler, as superintendent of the construction of standards of weight and measure, and of the coast survey, upon the progress of the works in the construction of standards since December, 1842.

The call of the committee of Congress upon the coast survey, and the works upon the standards of weight and measure, of June 9th, 1842, had produced a full report from me upon all the questions put to me upon that subject, including the history as well of former transactions as of the works executed by myself and under my directing, with a full list of all that has been delivered. I expected this full report would be laid up in Congress. This not having been done, I refer here to this report for the nearer details which may be desired. (I can furnish printed copies of it.) I join from it here, at the end of this report, only the final list of the works delivered until then, with the addition of the works delivered since.

In April last there were thirty brass half-bushels, finally adjusted, delivered to the Treasury Department, with their boxes and packing-boxes, which were forwarded to the States, and some custom-houses. An abridged instruction upon their use was published and communicated with each of the standards, stating in each the accurate standing of the half-bushel which it accompanies, which prove them all accurate within imperceptible limits.

The general report handed into the Treasury Department, containing the standing of each half-bushel, might, perhaps, be added to this report, to be printed as a general information for the use of all the States.

Standards of weight and measure form not only a general means for distributive justice in the country; they are equally one of the elements of the mercantile connexions of the nations with one another, by their being the unit upon which all tariffs are grounded—they are an essential determining item of them. Thence most standards have been compared mutually in different countries, in a similar way as I have done by special direction of Congress, and reported upon in 1832, with those samples that I could procure.

A proper collection and an authentic comparison, as I proposed in 1832, would evidently enable to give distinct rules for the reduction of the foreign weights and measures of the invoices presented at the custom-houses; it would be a proper economical measure in the application of the tariff.

The conflagration of the Parliament-house of England having destroyed the original standards of the country, which were deposited there, the presentation to the British Government of a full set of the standards of this country, which have their origin in England, and have lately been carefully executed in the present establishment, according to the communications, from the best origin, procured from England, could be expected to make an agreeable present to the British Government. Therefore a joint resolution of the last session of Congress directed such a set to be forwarded, which was accordingly done; and Mr. Everett, our ambassador in London, has communicated the letter of Lord Aberdeen, British Foreign Secretary, acknowledging, under date of 19th June last, with thanks, the reception of these standards, which were then delivered to the British treasury.

To this sending I have added a full description of the principles that shall guide a systematic establishment of standards, and how this principle has been applied in the construction of the standards of this country

Of the balances for the States, those of the largest size are mostly brought to the state of having the numerous pieces worked out until near adjustment, and six of them are now under full finishing adjustment. Considering the number of pieces which an accurate balance requires, and the extreme nicety of the final adjustment, the necessary equilibration of all the pieces and all its parts, it strikes at once that this operation is as time-consuming as laborious.

All the rest of the half bushels are finished in their mechanical work; their packing-boxes are finished, and they are approached to somewhat above their proper legal size, preparatory to their full adjustment, which will be begun as soon as the somewhat lowered temperature will favor the work.

I understand that the whole of the standards that had been delivered previously, and since some years, have been forwarded to their destination.

The apparatus of Mr. Bessel's construction, from Mr. Baumann, in Berlin, will be used comparatively with the scale of Troughton, belonging to the coast survey, upon a number of yards yet remaining in the office, to deduce from it principles for the future comparison of standards of length by contact, which may prove easier than the microscopic comparison.

The balances made for the use of the establishment will be preserved for comparisons of the standards of weight and capacity measures.

Upon other subjects that are yet proper to be attended to, I have given statements and views in previous papers; it is, therefore, not here the place to repeat anything upon them.

The notices upon the work of establishing this uniformity of standards, and the accounts of the works themselves, being distributed through the numerous papers that have accompanied the deliveries, and my annual reports, it will be proper to make a general report at the final close, presenting the whole system and work in all its bearings, as a guide for its more ready and useful application, and the foundation of the credit and confidence which the whole must enjoy of the public.

A tabular statement of the work executed for the system of uniform standards for the United States, from the beginning of the year 1836 *to June,* 1842, *with their state at that epoch, and the additions made until November,* 1843.

	Sets.	No. in set.	Pieces.
Full sets of weights, from 1 pound troy to 50 pounds avoirdupois.			
Delivered to the Treasury Department, for the States and the custom-houses, in two interior boxes, each - - - - -	200	10	2,000
Delivered to the Treasury Department office -	1	10	10
Delivered to the Treasury Department, for the use of the sub treasury - - - -	2	10	20

STATEMENT—Continued.

	Sets.	No. in set.	Pieces.
Delivered to the Patent Office, authorized by Treasury Department - - - -	1	10	10
Delivered to Old Point Comfort, by direction of Treasury Department - - - -	1	10	10
Kept in the office for future comparison - -	2	10	20
	207	–	2,070
Set of ounce weights.			
Delivered to the Treasury Department, for the States, from $\frac{1}{16000}$ to 10 ounces - -	29	27	783
Delivered to the Treasury Department office and the Patent Office - - - -	2	27	54
Delivered to the Treasury Department office, small box up to 10 ounces and 1 pound - -	1	12	12
Delivered to the Treasury Department, for the sub-treasury, up to 100 ounces - - -	1	35	35
Delivered to the Treasury Department, for the sub-treasury, from 10 ounces down, and subdivided in three boxes - - - - -	2	–	40
Delivered to Mint of Philadelphia, boxes from 100 ounces down - - - - -	2	25	50
Delivered to Mint of Philadelphia, unadjusted, for the branch mint - - - -	2	19	38
Delivered to Mint of Philadelphia, unadjusted ounce weights up to one thousand ounces -	4	5	20
Delivered to the office of the sub-treasury, one ounce set, up to one pound - - -	1	8	8
Kept in the office my original, to guide the work -	1	25	25
Kept in the office full sets for future comparison, by combined weighing - - - -	5	19	95
	50	–	1,160
Standard capacity measures.			
Just packing for delivery, standard of liquid capacity measures - - - - -	54	5	270
Just packing for delivery, standard gallons, besides the above - - - - -	71	1	71
There are, besides, gallons mechanically executed, ready for final adjustment - - -	–	–	19
One whole bushel, to be deposited in the Treasury Department, not yet adjusted - -	–	–	1

STATEMENT—Continued.

	Sets.	No. in set.	Pieces.
Half-bushels ready for adjustment - -	–	–	157
Each of the capacity measures has a glass cover, to adjust its fulness - - - -	–	–	548
			1,036
Standard long measures.			
Yards delivered, fully adjusted, each consisting of yard and matrix - - - -	41	2	82
Yards mechanically executed, ready for the last repeated comparison - - - -	110	2	220
Apparatus for comparing yards with micrometer, microscopes, &c. - - -	4	–	4
	155	–	306
Brass balances.			
Large balances, made for use in the office, of about 40 inches distance of suspensions - -	–	–	4
Largest balance described, for the adjustment of the half-bushels - - - - -	–	–	1
Balance delivered to the sub-treasury - -	–	–	1
Smaller balances, of 13 and 27 inches distance between the knife-edges - - -	–	–	2
Balances begun for the States - - -	–	–	30
One brass balance-beam given to the Mint of Philadelphia - - - - - -	–	–	1
			39
Single weights and measures, and accessories to the standard weight boxes and others.			
Furnished to the sub-treasury, one box with three pounds and two forks - - - -	1	5	5
Furnished to the sub-treasury, three boxes with single pound weights and forks - -	3	2	6
Furnished to the Frankford arsenal, near Philadelphia, one pound avoirdupois - - -	–	–	1
Kept in the office, for future comparison, single pound weights - - - - -	–	–	55
Kept in the office the original adjusting weights for my use, above one pound weight - -	–	–	25

STATEMENT Continued.

	Sets.	No. in set.	Pieces.
Delivered to the committee of Massachusetts Legislature, 1 pound troy and 1 pound avoirdupois	–	–	2
Four sets of weights for adjusting capacity measures - - - - - -	4	6	24
For the gills, which were, however, omitted to be made - - - - - -	4	1	4
Every box of large weights has two separate boxes, each having 2 forks and 4 screw-holders -	207	12	2,484
The ounce-weight boxes have tongs and forceps of different sizes, the full sets each three -	44	3	132
One foot-measure to Frankford arsenal - -	–	–	1
One yard to Brooklyn, New York - -	–	–	1
One yard, Lieut. Thomas R. Gedney, U. S. navy -	–	–	1
One yard, Captain W. H. Swift, U. S. army -	–	–	1
One yard, Lieutenant Glynn, U. S. navy -	–	–	1
One foot measure, Lieut. Glynn, U. S. navy -	–	–	1
One yard to the Land Office - - -	–	–	1
			2,745
Boxes with fittings for the above standards.			
For 207 sets of large weight standard, 3 boxes for each set - - - - - -	207	3	621
For the sets of ounce weights - - -	–	–	49
For the accessory weights given out - -	–	–	9
For the full sets of liquid capacity measures delivered - - - - - -	–	–	108
For the additional gallons delivered - -	–	–	71
For the gallons on hand - - - - -	–	–	19
For the half-bushels - - - - -	–	–	157
For the yards delivered, and those yet in the office	–	–	154
			1,188
Outside packing-boxes for the standards delivered.			
For the large weights delivered - - -	–	–	207
For the ounce weights - - - - -	–	–	29
For the liquid capacity measures - - -	–	–	125
For the yard standards delivered - - -	–	–	41
			402
Dry capacity measures.			
Half-bushels, with glass covers, delivered to the Treasury Department in April, 1843, and distributed to the States and custom-houses - -	30	2	60

STATEMENT—Continued.

	Sets.	No. in set.	Pieces.
Mahogany boxes for the same - - -	–	–	30
Packing-boxes for the same - - -	–	–	30
			120
Objects of standards forwarded to England.			
One standard yard, of brass - - -	1	2	2
One full set of large standard brass weights -	1	10	10
One full set of ounce weights, of brass - -	1	27	27
One full set liquid capacity measures, of brass, with glass plates - - - -	1	10	10
One half-bushel standard, with glass plate -	1	2	2
Mahogany boxes for the same - - -	–	–	7
Balance of the largest size, complete - -	1	many.	1
Packing boxes for all the above, covered with oil-cloth - - - - - -	–	–	9
			68

F. R. HASSLER.

BETHEL STATION, PENN., *November* 12, 1843.

TREASURY DEPARTMENT, *June* 1, 1843.

SIR: I have the honor to inform you that, by direction of the President, in conformity with a resolution which actually passed both Houses of Congress at the last session, although not announced by the Senate to the House, a set of standard weights and measures, and a balance, have been prepared, and forwarded to the collector of New York, with instructions to transmit them to the American minister at London, with the view of being presented to the Government of Great Britain. Accompanying this letter will be found a memoir by F. R. Hassler, esq., under whose superintendence these weights, measures, and balance have been constructed, explaining the principles upon which they are formed, the history of the work, and some directions respecting their use.

The boxes containing these standards are addressed to Mr. Everett at London, and numbered from 1 to 9, inclusive; and their contents are described in the accompanying list.

This communication is made to you, to enable you to apprize the American minister at London of the transmission of the articles, and to

give such instructions as you deem proper relative to their presentation to the British Government.

I have the honor to be, very respectfully, your obedient servant,

J. C. SPENCER,
Secretary of the Treasury.

Hon. H. S. LEGARE,
Secretary of State, ad interim.

DEPARTMENT OF STATE,
Washington, October 10, 1843.

SIR: In accordance with the suggestion contained in your letter to this department of the 7th of June last, I hastened to apprize the minister of the United States at London of the transmission to his address, for presentation to the Government of her Britannic Majesty, of a set of standard weights and measures, and a balance, prepared in pursuance of a joint resolution of Congress, passed at its recent session; and I have now the honor to send you a copy of the correspondence which has since taken place on the subject, between the United States legation in England, the British Foreign Office, and the Admiralty.

I am, sir, with great respect, your obedient servant,

A. P. UPSHUR.

JOHN C. SPENCER, Esq., *&c. &c. &c.*

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46 GROSVENOR SQUARE, *July* 4, 1843.

Mr. Everett presents his compliments to the Earl of Aberdeen, and has the honor to acquaint his lordship that a set of standard weights and measures, and a balance, prepared in pursuance of a joint resolution of the two Houses of Congress, has been sent to Mr. Everett, in the packet-ship Wellington, which has just arrived at this port. Mr. Everett has, at the same time, received instructions from the Department of State, to offer these articles, together with a memoir by Mr. Hassler, under whose superintendence they were constructed, to the acceptance of her Majesty's Government. Mr. Hassler's memoir is herewith enclosed, containing an explanation of the principles on which the articles have been constructed, with directions for their use. Subjoined to this note will be found a list of the articles, as contained in nine boxes addressed to Mr. Everett.

In obeying the above-mentioned instructions, Mr. Everett derives great satisfaction in being able, on behalf of his Government, to make some return, however inadequate, for numerous and highly valuable donations of a scientific and literary character, received by the United States, at different times, from various officers and departments of her Majesty's Government.

Should her Majesty's Government be pleased to accept these articles, it would be a convenience to Mr. Everett if Lord Aberdeen would have the goodness to indicate the place to which they may be sent.

The EARL OF ABERDEEN, *&c. &c. &c.*

FOREIGN OFFICE,
July 19, 1843.

The undersigned, her Majesty's Secretary of State for Foreign Affairs, has the honor to acknowledge the receipt of the note which Mr. Everett, envoy extraordinary and minister plenipotentiary of the United States of America at this court, addressed to him on the 4th instant, stating that he had received instructions from the Department of State to offer for the acceptance of her Majesty Government a set of standard weights and measures, and a balance, prepared in pursuance of a joint resolution of both Houses of Congress, together with a memoir drawn up by Mr. Hassler.

The undersigned has the honor to assure Mr. Everett that her Majesty's Government have great satisfaction in accepting this present, so obligingly offered by the Government of the United States; and the undersigned requests Mr. Everett will have the goodness to convey their acknowledgments to his Government.

In answer to Mr. Everett's question where the set of standard weights, and the other articles mentioned in Mr. Everett's note, should be sent, the undersigned requests Mr. Everett will have the goodness, whenever it may be convenient to him, to forward them to the office of her Majesty's Treasury.

The undersigned requests Mr. Everett to accept the assurance of his high consideration.

ABERDEEN.

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46 GROSVENOR SQUARE, *July* 22, 1843.

Mr. Everett presents his compliments to Sir George Clerk, and has the honor herewith to send to the office of the Treasury, agreeably to the suggestion of the Earl of Aberdeen, nine cases containing a set of standard weights and measures, presented to her Majesty's Government by the Government of the United States.

TREASURY, *July* 24, 1843.

Sir George Clerk presents his compliments to the American minister, and begs leave to acknowledge the receipt of nine cases, containing a set of standard weights and measures, presented to her Majesty's Government by the Government of the United States.

Discussion upon the standards of weight and measure, and their construction in general, as executed for the United States of America, and upon those of the standards sent to the British Government by the Government of the United States.

1. The establishment of a system of standards of weight and measure in a country has a twofold aim, and therefore also needs two main consid-

erations. The *first* is the just regulation of the means by which all dealings in the country are regulated, which relate to material objects; and the *second*, the establishment of a steady rule, in the commercial connexions of different countries with each other; and these connexions have, no doubt, in all countries, exercised some influences upon them.

2. The circumstance that most of the standards were originally agreed upon by a more or less mere accidental decision and connexion, has of course, in time of greater activity, where also more accuracy and reasoning were demanded, shown difficulties, which various attempts have been made, at different times, to overcome; by which the standards were gradually improved. It has not been possible as yet to come farther than to fix, with an accuracy always proportioned to the state of science in this branch, constant relations between the standards existing; all attempts to find in nature an unchangeable material unit of any kind, whether in weight or in length, or capacity measure, have hitherto been fruitless; and even the probability of finding any such object in nature appears to vanish always more by the progress of science.

3. It is evident, from historical facts, that standards were transferred from one country to another, by the mercantile connexions of those countries; thus the troy pound, originating, as its name indicates, from Troyes in Champagne, at a time when that place was a great emporium of commerce, spread over France; outlived the competition with the mark selected for many of the European mints, it stepped with the commercial connexion into Brabant, Holland, England, and America; it appears in every step with some loss, until lately arrested in England, the lightest of all, by bringing the mint weight again up to the new, (now called imperial) weight.

4. So the English mint system dates from Saxony, the eastern invaders of their country, introducing their coins, which from that circumstance were called *Esterlings*, from which the denomination of sterling (value) has remained to our days, to the British *mint system.*

The ell stepped over into England with the Brabant manufactories, as yet in modern recollection. Most likely the migration of the different kinds of bushels and gallons in England might be traced back to their origin by following the commercial connexions of the different parts of the country farther than was done by the comparisons of standards in England about twenty years ago, which have furnished indications towards it.

5. A variation of the mode of establishing uniformity and justice, in the dealings in material objects, is found sometimes in old establishments for the common necessities of life, by taxing their objects at one and the same price for an *equal nominal* unit, and changing the value of *that unit* in proportion inversely to the cost at which they come to stand in different parts of the country; as, for instance, in a country not wine-growing: to diminish the unit of capacity measure of wine, so as to compensate the cost of transportation to the different distances from the place of importation.

6. What may have been the principle upon which feet were divided into *eleven* inches, instead, as more generally, into *twelve*, in some mountain countries of Switzerland and Amsterdam, might be perhaps interesting, but difficult, to find.

7. As soon as the nicer connexions of the society claimed minuter ac-

curacy, the science of natural philosophy, in its mathematical applications, had to be called into assistance for the introduction of a connected *system*, grounded upon steady principles, which might afford the desirable accuracy, and furnish means for future preservation of the same, as well as of the standards themselves.

8. The principal difference, however, between England and the continent of Europe, which existed until the last establishment of the *yard* as a *unit*, was, that any length, desired for a given purpose, was determined by a mean of the distance given by the subdivisions of a scale of equal parts, by the best accredited artists, without regard to the old, indeed too rough bed of the *yard* and the *ell*, which were deposited in the exchequer; from thence of course considerable variety must unavoidably have arisen, proportionably to the want of skill and means for accuracy in straight line dividing, the means to which are rather a more modern improvement; thence it came that they acknowledged in England, lately, that the Troughton scales were the only (it may be said) legitimate family of standards.

The amounts of the surveys made in England, in India, and in other places, by Englishmen of science, bearing witness to this influence, have still more awakened the attention upon this subject.

9. In the last settlement of the imperial standards, a yard was accepted as only a unit, and was taken from Mr. Troughton's scale, of which the most carefully made copy is the scale of 82 inches, made by him personally for the Government of this country, for the coast survey, under my eyes, after a new correction; the particular details have already been extracted from my report of 1832, by the committee established in England for the restoration of the standards lost in the conflagration of the Parliament house.

10. The epoch of scientific improvement dates first from the return of the French academicians from the measurement of the three degrees of a meridian near the equator, on which occasion the double length of the pendulum under the equator was proposed in France as a unit of length-measure, taken from nature; this is traced upon the back of the toise of Canivet, which I brought to this country in 1805, having purchased it in 1793 from the heirs of Dionys du Sejour, member of the committee charged with the plan.

11. But the greatest action in this branch of social arrangements was the scientific operations of the measurement, made by France, of twelve degrees of the meridian, lying equally on both sides of the 45th degree of latitude, and the systematic grounding upon that of a full system of standards of weight and measure, determined upon scientific principles, and with an accuracy previously not attained, taking the ten-millionth part of the earth's meridian for fundamental element of the whole system.

12. The operation that was to be performed in this country could not take any such bold step; it was to be grounded upon only nominal *legal statements*, which were to be made stable, and to which precision could be given only by conditioning them under certain distinct determinations taken from nature, internal qualities and external influences. This was the aim of my arrangements; to which was of course yet to be connected the combination of the best methods to attain the greatest accuracy in each individual kind of work; and it must be observed, that if not the greatest accuracy is aimed at, that degree of it which is indispensable will not even be obtained. This task to execute, for a country of the ex-

tent of the United States, was itself already of great interest in the prospect of the extent of its consequences; and, in the state of the country, the only resource to arrive at an actual practical result.

13. In the habit of the old English system, the material of the different standards was indiscriminately either brass, or (so called) common metal; that is, either an alloy of copper and zinc, or of copper and tin: the first for the standards of length, the second for those of weight; though the difference of expansion between the two is probably not very great, still it is of course more proper to use but one kind of metal. For the standards of the United States I found proper to give the preference to good brass of our own composition, because nicer weights and measures in common use are most generally made of that metal; thereby the difference between habitual measures and the standards was so much diminished in common use.

14. It must, however, be distinctly observed, that only a binary alloy is admissible to obtain the compactness, solidity, and necessary uniformity of the metal, and a proper knowledge of the expansion; thence it follows that also the metals employed in the alloy must be pure in their kind. It was to obtain this condition of purity that I had the zinc used for the standards of the United States, of which those to be sent to the British Government form a part, reduced from zinc ore found in this country, under my own eyes, by a new process, of the invention of Mr. Hitz, a very able metallurgist from Switzerland, established in this country. The proportions used were, 3 parts of copper to 1 part of pure zinc; the solidity of the resulting castings has been proved by sawing in two weights of different sizes, to ascertain this quality. When lead is put in the composition of the brass, (as often done,) the metal gets so bad, that, in attempting to solder it, the brass melts before the solder, and makes a hole in the piece, which spoils the work.

15. It is evident, from the preceding, that the specific gravity of the metal employed must be determined by actual experiments in both states—as simple castings, and in the hammered state; also, the expansion by temperature is to be determined by actual experiments in the two states, if possible. These two data form a very valuable scientific stem in the presentation of a full system; but it must be observed, that hammered metal never returns fully to the same state when it has been exposed to a change of temperature above a certain degree.

16. For the accurate determination of the capacity measures, the necessity—indispensable for accuracy—to determine them by the weight of distilled water, at the temperature of its maximum density, introduces new special requisites; it prescribes a limitation in the operations to wear that temperature, because at that point its variation is the smallest; at greater distance from this point of maximum density of the water, the too rapidly increasing influence of the change of temperature subjects to a liability to errors, entirely inadmissible.

17. The necessity to have the water always fresh distilled, obliges to have an appropriate distillery in constant activity while adjusting; in our operations in this respect, the water was never used over 24 hours old from distillation; longer it does not remain free of air, &c.

18. When Sir George Shuckburgh Evelyn made his experiments for the determination of the actual weight of water, from which all determinations of capacity measures must go off, there was not yet any knowl-

edge of the point of maximum density of the water: thence his determination of 252.422 parliamentary grains weight of the cubic inch of water, which he accepted, (or, as Captain Kater quotes it, 252.458 grains) as a mean of his results at the temperature of 66° Fahr. and 29.74 inch. barometer, lies yet under some doubt. I have not yet been in the case of disposing of the means to make proper experiments upon this subject, as it would be interesting to do; for it is evident that, between that temperature and the temperature of the maximum density, there must be a considerable difference in the accuracy with which that element can be determined.

19. Captain Kater giving to the weight of the cubic inch of water, at the temperature of 62° Fahr., the value 252.7 grains—that is, for 4° change of temperature, an augmentation of about 0.3 grains—the table which he used gives a difference of near 20 grains for the gallon, between these two temperatures; which would give a different result. To clear up these disparities, the experiments of Sir George Shuckburgh should be made anew, with the higher improved means which we possess now, and on a larger and more varied scale, as it is so easily possible in England. They are, besides, of the highest interest for various determinations of importance in natural philosophy. The results, whatever they may be, will therefore well pay for the trouble and expense.

20. It is well known that these elements, and also others entering into consideration in this subject, are differently determined by scientific men of France and the continent of Europe. I have shown deductions referring to this in my report of 1832, upon standard comparisons. But as I was working upon standards of English origin, I gave the preference to English data, not to introduce, by accepting any others, a fractional difference in the result, which might have been inconvenient in comparisons.

21. I may remark that, but a few years ago, Mr. Dalton stated, yet in an English periodical, the maximum density of the water at about 42° Fahr., which is the point of temperature (nearly) at which a *glass* vessel contained the *greatest quantity* of water, where, of course, the state of expansion of the glass is implicated in the result. This is very well proved by experiments upon my water-balances, reported upon in 1832. Three bulbs of different sizes gave the coinciding results of 41°.6; 41°.6; 41°.55; 41°.7—a coincidence more than satisfactory; the curve of this expansion, in my report of 1832, shows these variations strikingly. The copper bulb gives 44°.6 for the maximum contents, owing to the greater expansion of the metal over the glass. I had not yet the opportunity to try the brass, which I intended, and which would apply directly to the experiment of Sir George.

22. The actual maximum, determined independently of the *vessel*, is 39°.6 as determined by the motion of the water within itself from the *change of its specific gravity*, by the *change* of temperature above—thus: placing a deep glass jar with cold water in a warm room, with a thermometer below, and one above, the gradual increase of the temperature of the water will cause the motion of its particles, with the change of their gravity, occasioned by the change of temperature; and the upper and lower thermometer will meet the same temperature only at the point of maximum density. This experiment will be repeated in the inverse order, by placing a jar of warm water into a low atmospheric temperature.

23. Notwithstanding that, in any operation of adjustment of standards,

it is proper to ascertain and calculate exactly all physical influences concerned in the operation; it is, for the accuracy of the results in practice, by far the best to apply the means of compensation of these influences.

24. With these views, I have for the yard selected a breadth nearly, and a thickness of the metal *exactly equal* to that of the Troughton scale, with which they were to be compared; this had, besides, the advantage to bring both in the same focus of the microscopes; and, by the equal thickness, the movement of the temperature (if I can call it so) became equal, thence the comparisons more accurate; for it will be easily observed, in practice, that scales of unequal thickness do not keep together in temperature, particularly when (as always) the observer is nearer to the one than to the other scale. To avoid the influence of the heat of the body of the observer, it is necessary to take a paper screen between him and the scales. It is also indispensable that the scales be supported, in their full length, upon a solid plank-stand, exactly planed and smooth, with an over-sufficient breadth; no substitute for that, by any proportional support, will ever do.

25. For all the weighings, the counterpoises were of the same metal as the main weights, being taken from such as had become accidentally too small, and the weighing was always made by what is called substitution; namely, placing the original weight, and the one to be adjusted, alternately in the same basin, and always well centrally in it. By this method, the reduction to the vacuum is of course not necessary for the practical purpose; still, should it be desired, the observations for that purpose are not excluded.

26. I would, in all cases of comparisons and weighing where it may be applicable by the means on hand, recommend the combinatory method, as I have used it in the comparison of metres, and in the adjustment of the smaller weights. Some dexterity and closer attention, which are required, may soon be acquired. It is evidently the best mode of varying the observations. Both these applications I have described in proper places of my reports.

27. Upon the selection of units of standards, some remarks are to be made. In regard to the magnitude, the two small units, as well as the two large ones, are equally to be avoided. So, for instance, the foot, as the length measure, and the ounce, as the unit of weight, are too small. They require too much multiplication in their application. Thence all possible errors are also too often repeated; while rods, perches, or, in fact, any measure above eight feet, are too long to be kept in equal temperature and equal support in the whole extent, which is an absolute requisite of accuracy. Any weight above two pounds—or, suppose a kilogramme—is too fatiguing for an appropriate balance giving the desired accuracy, or requires a balance too mighty to be properly sensible. In the capacity-measure, the same reasoning, besides the greater ease of manuplication, and consequently habitual measure for grain and similar, dictated to make half bushels for the standards, and not whole bushels. For the liquid capacity-measure, the form and the weight are to be considered as the weighing determines it.

28. The variations of the temperature exercising the greatest influence in the determination of length and capacity-measure, it would appear desirable to have for both one same state of temperature, that could be considered as fixed by nature, and which would be general for all kinds of

standards. Such a degree of temperature is given by the maximum density of the water. [NOTE.—I may be allowed to state here a fact. The Commission des Poids et Mésures in France had first proposed the temperature of melting ice for that of the determination of the unity of weights and capacity-measures. When, in 1796, I was in Paris, my professor of mathematics, Mr. J. G. Tralles, in Berne, wrote to me to propose to substitute for it the temperature of the maximum density of the water; which I did, to Chevalier de Borda, the most active member of the commission of my acquaintance; upon whose proposition it was then adopted.] The advantage of selecting for the capacity-measures the temperature of the maximum density (that is, 39°.6 Fahr.) of the water, has been deduced above; and it does not appear that there can be any difficulty to adopt it for the standards of length and others, to introduce more unity.

29. To the mechanical construction of the standards there are peculiar principles to be followed, for each kind, in order to secure success; particularly in the casting, which is always the most difficult, and in which the operations of this office have been peculiarly successful, as the products show—very few castings ever having failed since the foundry was organized. This is peculiarly due to the purity of the metals used in the combination of the brass, to be certain of having a pure binary compound of proper proportion. To ascertain this last part, different proportions were tried. The best was selected and used.

30. The smaller weights must be cast full, with the knob on, and otherwise cylindrical, having a rim projecting downwards below, upon which the weight stands, and which serves for the final adjustment of the weights, by filing and rubbing it down, by grinding either upon a sandstone, or ultimately upon a dry Missouri stone, even at last only with leather. I preferred, for the cylindric part, the proportion of equal diameter and altitude approximately. The greatest difficulty is in the fullness of the neck of the knob; but it can be overcome by sufficient fullness of the metal in the smaller weights—suppose up to 5 lbs. But in the larger ones, it is necessary to cast full cylinders, and then knobs, separate, with a screw that will fill up, as exactly as possible, the hole made for it, by boring in the middle of the cylinder, which the screw fills up entirely again.

31. In no case it is allowable to leave a hollow part in a weight, to place pieces of any other metal into it, to obtain the equilibrium, as the galvanic effect of the different metals changes the weights very materially. This has been strikingly proved in the collection of the standards of the State Department, in the set of mark-weights made in the mint of Copenhagen, which presented the greatest variation and disparity, by being adjusted by leaden shot put in the circular cavity, practised in them, and shut up very tightly by a strong screw.

32. The yards were hammered, as, in that case, more hardness in the metal is required. The casting of them is more difficult than another shape, on account of the quick cooling of the thinner mass coming immediately so much in contact with the form, and tending to chill the metal. The form given to them is adapted to both modes of comparison, by the microscope, and by contact or feeling-lever. In the first case, the fine line, formed by the contact of the carefully worked butting pieces, serves under the microscrope, as well as a line drawn upon a brass bar; and when the yard and its matrix are taken separate, they apply both equally to a proper feeling-lever contact.

33. The liquid capacity-measures are formed of cast cylinders, hammered, and the bottom soldered to them. Their proportions being two diameters for the height, appeared the best adapted to accuracy, and to the proper working of them. The handles were added afterwards, and can be removed by the loosening of a few screws. It is not proper that they should be on, in the accurate comparisons by weight.

34. The half bushels were cast in the manner of bells, bottom upwards, and have a rim or ring all round the outside, at about one-third of the height below the top. Their proportion between diameter depth, is the depth half the diameter; which gives a very good proportion, and, in case of heaped measure, a regular proportion. It is also more appropriated to measuring of grains and similar dry objects.

35. In the weighing of the capacity-measures with water, they are always covered with a plate-glass, the one side of which is unpolished, and this side is to be placed to the water—that is, the lower upon the measure; the water adapts to that part, without getting any air attached to the plate, because the grinding of the glass occasions for the water a capillarity along its surface, which lets the air escape, and attracts the water.

36. *Special account of the standards of weight and measure sent to the Government of Great Britain.*

These standards are in all respects similar to those made in the office for constructing standards of weight and measure for the different States of the United States, and consist in the following, viz:

1. Two boxes of solid brass weights, being No. 1. <> of the sets made, and containing in the first box—

One 1 lb. troy weight.		One 4 lb. avoirdupois weight.	
One 1 lb. avoirdupois weight.		One 5 lb.	do.
One 2 lb.	do.	One 10 lb.	do.
One 3 lb.	do.	One 20 lb.	do.

In the second box—

One 25 lb. avoirdupois weight.	One 50 lb. avoirdupois weight.

In my report to the Treasury Department of 28th July, 1836, they are nearer described.

The single pound weights were ultimately compared by combinatory weighings, (which I have described in my report of 18th November, 1837,) made upon the adjustment of the ounce weights for the mint; and so were other weights until 5 lbs.; but the higher weights were determined singly. There were several hundred such weights made, which were gradually approached to final adjustment, carried on until no steady ascertainable difference could be found. There was not any detailed individual register kept of their ultimate standing. There was also no need of keeping account of the barometer or the temperature, as the counterpoises were always of the very same solid brass as the weights compared, and the principal standards, and even the balances.

2d. One box containing weights of ounces troy, the highest being 10 *ounces*, and thence down to 6, 5, 4, 3, 2, 1, and decimal subdivisions to the ten-thousandth of the ounce. These were all adjusted, as mentioned in my report, upon the principles of combined weighing. The number of the weights and their distribution made it again here unnecessary to keep special account of the ultimate results which they presented by calculation. It appeared, like in the case of the large weights, sufficient to bring

them to indeterminable differences. The set sent is No. 33 of that part of the work.

For all the weights, it is proper to state that they bear no marks, except a small eagle, very shallow and without sharp edges, *stamped*, so as not to admit any dust or soiling. Any engraving (though often done) is evidently improper, because it admits from the hand, or otherwise, dust, rust, or similar, which cannot be cleaned without altering the weight; for it must be observed that the commonly considered harmless cleaning of the weight with an oiled leather, takes considerable weight away. We have often used that means to approach a weight to the fullest nicety.

3. The yards (the form and construction of which are well known by my reports upon the delivery of some) required, of course, longer and more tedious operations for their final adjustment, by gradual approaching. The yard and its matrix were both to be adjusted, and compared while adjusting. This operation was done first by a feeling-lever, expressly constructed, and after under the microscopes of the 82-inch scale, with butting pieces of the same size and metal, so closely worked as to form, by their contact, mere small lines, which were observed, as has been described in my reports, and already in my papers upon the coast survey. In that case, engraving did not hurt; therefore they are all equally furnished with an engraved eagle and numbers, by which they are registered.

The number of the yard selected for this sending is No. 7, and its standing in the last comparison gave—0.0000493 inch upon the 82-inch scale of Troughton, all being at equal temperature. The yards are made of exactly equal thickness with the scale, and the yard and matrix joined together are very nearly of the same breadth as that scale; so that the motion of the temperature keeps equal path in both, and the observations were always made only when both were of equal temperature, as I consider the equalizing of this condition much more accurate than the accounting for the difference that might be between the two.

4. Of the liquid capacity-measure, the set selected from among those remaining undistributed among the States is that distinguished by No. 2. The state of ultimate adjustment, resulting from the last weighing of each individual of these measures, has been registered in my report of April 5, 1842, so that at any time they can be compared together. As will be seen there, the result for this No. 2 stands thus:

Last final result when reduced to the maximum density of water.

	Degr. temp. Fahr.	Grains.	Grains at maximum density of the water.
The gallon -	45.7	— 2.5	+ 0.0214
The half-gallon -	47.4	— 2.63	+ 0.0723
The quart - -	56.8	+ 1.93	— 0.1097
The pint - -	52.4	— 0.12	— 0.0319
The half-pint -	49.5	— 0.30	— 0.0452

N. B. It is evident that the smaller decimals of the ultimate results are given by the reductions. The signs are used so that, when applied to the measure, their algebraic sum presents the accurate standard. The reduction for the barometer to 30 inches is included in the weighing itself.

5. The half-bushel has been selected separate, after the 30 that were numbered were adjusted. The relation of it towards them will appear in the report which is just now made upon the adjustment of the half-bushels in general.

The ultimate weighing was repeated several times, and resulted as follows:

Temp. Fahr.	Barometer.	Weighing.	Result at max. density.	
Degr.	Inches.	Grains.	Grains.	
49.2	29.84	— 20.8	— 0.557	mean — 0.377
47.7	29.68	— 25.0	— 0.431	
47.5	29.90	— 25.0	+ 0.070	
47.7	30.14	— 25.2	— 0.591	

The signs are here again, like in the liquid capacity-measures, applied so that their algebraic sum shall represent the actual standard unit of weight of distilled water, at the maximum density, which the half-bushel shall hold.

It is proper to join to this sending a whole series of the documents relating to the subject of constructing the standards, and to the previous comparison of the old weights and measures. They are contained, for the greatest part, in the documents of the coast survey; of which, therefore, some are necessarily going with it. I have packed such a set in one of the boxes of the balance.

F. R. HASSLER.

WASHINGTON CITY, *June* 3, 1843.

Comparison of the results of the weighings of the liquid capacity-measures, as obtained in the two weighings of 1832 *and* 1842, *of the English smaller measures and the French liters, in grains of distilled water, at its maximum density.*

Denomination.	In 1832, (A.)	In 1842, (C.)	A — C = Difference between the two weighings.
Liter of the State Departments - - -	15401.33	15400.4824	+ 0.8476
Liter of the coast survey, No. 1 - -	15405.08	15402.7824	+ 1.957*
Liter of the coast survey, No. 2 - -		15403.4636	
English wine gallon -	58460.2	58458.5366	+ 1.6634
English Winchester gallon	68571.0	68563.7366	+ 7.2634
English Winchester quart	17684.21	17686.3581	— 2.1481
English Winchester pint -	8811.21	8811.6163	— 0.4063

* These liters were found, in 1832, differing = 0.6 grain; and again, in 1842, 0.68 grain.

		Difference from the actual gallon.
The quadruple quart gives the gallon -	= 70745.4324.	2181.6954
The eight-fold pint - - - -	= 70492.9304.	1929.1938
Difference - - - - - - -		252.502

This last difference between the small measure reduction is already equal to one cubic inch. These differences, in general, are entirely inexcusable in the English standards furnished with exchequer certificates. It will be observed, on another hand, that the difference between the weighings of 1832 and 1842, with means in every respect different, may be considered minute, particularly when it is considered that the stamps upon the edges of the English vessels weighed are a great impediment to accuracy. In 1832, the water-balances were used; in 1842, the new equal-armed lever-balances.

F. R. HASSLER.

Remarks of the superintendent, F. R. Hassler, esq., on the construction and adjustment of the standard half-bushel measures.

The weight of the half-bushel of distilled water, at the temperature of the maximum density, contained in a brass half-bushel, in its state of expansion at that temperature, has been determined, by my report of 1832, to be 38.8137 lbs. avoirdupois, or = 271695.9 grains troy.

In the same manner as in my report upon the liquid capacity-measures, I have stated the individual numerical reductions adapted to the sizes of the different measures; so I shall here give the result for the size of the half-bushels, or dry capacity-measures.

The stand of the barometer, to which the standard determination refers, is here again 30 inches, as in the liquid measures. The variation for another stand brings for the half-bushel = 9.54653 grains for every inch variation, additive above, subtractive below the 30 inches; which furnishes the following small table for other smaller differences:

	Inch.	Grains.		Inch.	Grains.
For - -	1.0	= 9.54653	For - - -	0.3	= 2.864
For - -	0.5	= 4.77326	For - - -	0.2	= 1.909
For - -	0.4	= 3.819	For - - -	0.1	= 0.955

which will suffice to calculate this reduction.

For the calculation of the effect of temperature, and the consequent reduction of any weighing to what it would present at the stand of 30-inch barometer, and the temperature of the maximum density of the water, it is necessary, like in the liquid measures, to keep account of the expansion of the brass as well as of the water; the brass giving a regular equal progression, while that of the water goes in an accelerating progression.

Upon the combination of these two series, a table was calculated for so much extent on both sides of the maximum as it is proper to extend the adjustment; higher temperatures being too liable to errors, on account of the too great variation for one degree of the thermometer. The inspection of the table shows already within its limits, at the two extremes, the propriety of this precaution.

The barometer and thermometer used in these adjustments were the same as I described in the report upon the liquid capacity-measures, and

the balance used in the weighings is that constructed upon my plan and direction, in the office of the weight and measure establishment, and described in the same report.

Table for the reduction of the half-bushel to the temperature of the maximum density of the water.

Degrees Fahr.	Reduction of grains.	Degrees Fahr.	Reduction of grains.
32.0	+ 91.7609	46.4	— 26.3933
33.8	+ 62.403	48.2	— 23.4985
35.6	+ 37.403	50.0	— 17.0297
37.4	+ 16.669	51.8	— 6.9987
39.2	— 0.0984	53.6	+ 6.4814
41.0	— 12.4006	55.4	+ 23.3357
42.8	— 20.9215	57.2	+ 43.480
44.6	— 25.5557	59.0	+ 66.838

The adjustments were all made by the weight of distilled water, renewed every day. The half-bushel of brass, with its plate-glass cover upon, is first equilibrated by counterpoise of the same kind of brass, as all weights and measures, even the balance purposely made, are constructed of in this office; then a weight, exactly of the proper weight of the distilled water, or 38.8137 lbs. avoirdupois, of the same brass, is placed in the half-bushel, and the balance is again equilibrated. This weight being removed, the half-bushel is filled with distilled water, the temperature of which is ascertained both before it is put in the measure and when in it, when both are left to get to equal temperature. The filling of the measure is done from a vessel standing somewhat higher, by means of a syphon; and if any air-bladders attach yet to the sides, they are removed by passing a small brush over them; then the plate-glass cover is placed upon the half-bushel, by sliding upon the rim of the measure, when just properly filled with water, the *mat* ground side of the glass being turned to the water, as it adapts to it without air-bladders; then the half-bushel is properly wiped dry, that no water may remain adherent outside.

The half-bushels are packed in their boxes, so that the glass cover is hid under a double bottom of the box. When the measure is to be used, it is of course taken out of the box, and the double-bottom board can be taken out when the standard is ready for use, exactly in the same manner as its adjustment has been described in the making of them.

If wooden measures are to be adjusted, it is necessary to select a round uniform seed, as either mustard-seed or millet; which latter is the more uniform. A proper arrangement is of course to be made for that purpose, in a fixed manner, to occasion a regular slow run in filling the half-bushel to be adjusted.

☞ The ultimate result of the half-bushel measure is herewith sent.

F. R. HASSLER.

WASHINGTON CITY, *April*, 1843.

Table of the ultimate result of the adjustment of thirty-one half-bushels adjusted in the winter of 1842 –'3, *at the weight and measure office in Washington city.*

No.	Barometer.	Thermometer Fahrenheit.	Weight.	Result at maximum density.	
	Inches.	Degrees.	Grains.	Grains.	
1	29.30	53.4	+ 4.7	— 0.411	State of Maryland.
2	29.90	53.0	+ 2.0	— 0.378	Maine.
3	30.14	51.5	— 7.4	+ 1.335	Michigan.
4	29.62	51.9	— 6.2	+ 0.128	New Hampshire.
5	29.50	51.1	— 12.0	— 0.931	Vermont.
6	30.14	50.6	— 14.4	— 0.419	Massachusetts.
7	29.50	50.0	— 17.8	— 0.771	Connecticut.
8	29.50	50.1	— 15.7	+ 0.848	Rhode Island.
9	30.20	52.0	— 6.2	— 0.541	New York.
10	30.20	50.6	— 13.5	+ 0.381	New Jersey.
11	29.95	50.1	— 16.4	+ 0.148	Pennsylvania.
12	29.95	49.5	— 19.4	— 0.407	Delaware.
13	29.95	51.6	— 8.8	— 0.644	Virginia.
14	30.36	48.2	— 24.0	— 0.502	North Carolina.
15	30.30	49.2	— 20.4	— 0.177	South Carolina.
16	30.36	50.0	— 16.7	+ 0.392	Georgia.
17	30.07	49.0	— 21.8	— 0.739	Alabama.
18	30.25	48.1	— 23.9	— 0.197	Mississippi.
19	30.12	47.8	— 23.5	+ 0.819	Arkansas.
20	30.00	48.7	— 21.8	+ 0.242	Louisiana.
21	30.15	48.0	— 24.5	— 0.592	Tennessee.
22	30.12	47.3	— 26.0	— 0.406	Kentucky.
23	30.12	47.3	— 25.7	— 0.106	Missouri.
24	29.54	48.9	— 20.8	+ 0.588	Illinois.
25	29.60	48.4	— 22.5	+ 0.434	Indiana.
26	29.60	48.4	— 22.0	+ 0.934	Ohio.
27	29.60	48.4	— 22.6	+ 0.334	Collector of Baltimore.
28	29.59	48.9	— 21.5	— 0.112	Philadelphia.
29	29.95	47.0	— 26.5	— 0.087	New York.
30	29.84	49.5	— 18.5	+ 0.493	Boston.
For England	29.84	49.2	— 20.8	— 0.557	mean = — 0.377.
	29.68	47.7	— 25.0	— 0.431	
	29.90	47.5	— 25.0	+ 0.070	
	30.14	47.7	— 25.2	— 0.591	

Directions for mounting and weighing with the balances presented to the British Government by the Government of the United States.

1. Figure 1 presents a general view of the balance, mounted and loaded, with a standard (S) and its counterpoise (P) prepared to make a perfect equilibrium, and the required comparison.

2. Figure 2 presents the cast-iron table with six legs furnished with adjusting screws, and standing on the stone slab.

3. Figure 3 presents as noticed above, with the centre and end columns.

4. Figure 4 presents head and centre column and lifting apparatus.

5. Figure 5 presents as noticed above, with the long iron bolt for the centre column.

6. Figure 6 presents the cast-iron table with centre end columns, and lifting apparatus prepared for receiving the beam.

7. Figure 7 presents an end view of the end columns.

8. Figure 8 presents an end view of head of centre column and centre knife.

9. Figure 9 presents an end view of the end knives.

10. Figure 10 presents an end view of the stirrups.

11. Figure 11 presents an end view of the lyre shaped checks.

12. Figure 12 presents an end view of the perpendicular lifting apparatus.

13. Figure 13 presents a horizontal view of perpendicular lifting apparatus.

14. Figure 14 presents a horizontal view of the dishes for receiving the weights, showing the rings for directing the proper position of the weights.

15. Figure 15 presents a vertical view of the dish and clamp.

16. Figure 16 presents a horizontal view of the clamp shut.

17. Figure 17 presents a horizontal view of the clamp open.

18. Figure 18 presents a frontal view of the end column, with the divided card turned back.

19. The plates accompanying this paper are too small to admit of presenting the spread eagle, the thirteen stars, and the inscription engraved on the arch and head of the centre column.

20. To present properly the apparatus that acts on the conical points, would require a full-sized draught, showing in detail the different sections of the different parts.

21. It will be found that the weighings executed with the most despatch will prove the best.

22. The operator should not remain nearer one end of the beam than the other; thereby avoiding increasing the temperature of either end of the beam.

23. The operator should use gloves when mounting the balance, and carefully wipe off and dust every piece before putting it up.

24. The beam measures 40 inches between the end knives; height of centre column, 37 inches; and the height of end column, 54 inches; standing on a cast-iron table 64 by 16 inches, standing on a stone slab 66 by 18 inches, and from 2 to 4 inches thick.

25. The firmest foundation at command should be selected for its position.

26. A slab of marble or some other stone, 66 inches long, 18 inches wide,

2 to 4 inches thick, should be procured, to serve as a foundation for the balance to stand upon.

27. It should be so placed, that the light may strike it from above, directly in front, so as to fall upon the back of the observer.

28. If a fire is permitted in the apartment, where weighing, it should be as distant as possible, and so placed as to affect both ends of the beam as equally as possible.

29. No current of air should be permitted in the apartment when weighing.

30. Place the stone firm and level in a position as stated above.

31. Place the cast-iron table with six feet on the stone, as presented in figure 2.

32. Level the table by the adjusting screws at the foot of the legs.

33. Place the centre and end columns as presented, (fig. 3,) taking care to place each column as indicated by the marks made on the columns and table for directing their position.

34. To the head of the centre column cross bars and perpendicular lifting apparatus, (which will be found in the box, all connected as presented by fig. 4) screw the long iron bolt as presented in fig. 5.

35. Great precaution will be required in lifting the parts represented in figure 5, and letting the long iron bolt pass down through the centre of the centre column, and the centre hole of the cast-iron table; taking great care, at the same time, that the extreme ends of the cross bars are exactly received in their proper positions by the top part of the end columns, which will be indicated by the coincidence of the holes in the end of the bars, and top of the end columns, by which the cross bars are firmly secured to the same, so that all will be as represented in figure 6.

36. Screw the ends of the cross bars to the head of the end columns.

37. Now, the washers and nuts belonging to the end columns, and the long iron bolt of the centre column, can be placed in their position, and screwed up lightly, but not firmly home.

38. Place the lyre-shaped checks on the cross bars, as represented by the dotted lines, (figure 1.)

39. The two small brass rods that match with the rod between the boxes of the perpendicular lifters, are now to be passed through the round holes in the top of the end columns; the rings attached to the lyre-shaped checks, and slid in the short tubes that are connected with the boxes of the perpendicular lifters; the small holes that serve to connect these parts by the steel pins, will indicate the position in which these rods are to enter the short tubes; then, insert with care each pin in the same hole it was removed from, to admit of inserting the rods in the short tubes.

40. If all is apparently in proper order, the small crank (made of red metal) can be placed on one of the ends of the small brass rods, (the end the observer may find most convenient,) as represented in figure 6, by turning the crank to the right or left; the perpendicular lifters may be made to ascend or descend at pleasure, which will be performed very nice and smooth if all parts are mounted exactly in their proper position. Should the contrary be the case, the cause will have to be investigated; it will not probably be found in the want of sufficient care in mounting the different parts, which can be easily rectified, and the nuts of the centre and end columns brought firmly home.

41. It would be well here again to try, with a spirit level, if the steel

plates on which the centre knife rests, and the cross bars, are sufficiently nicely level; and if not, to bring them to their proper positions by the adjusting screws to the legs of the cast-iron table.

42. All being found to work properly, the points of the lifting apparatus must be made to ascend to the full extent of their motion.

43. Turn back the divided disks as presented in figure 18, to give more freedom in placing the beam on the conical points.

44. Take the beam with two cloths, or fine dressed skins, with both hands, a little out or inside of the conical holes, fitting the conical points; lift it out of the box, place the beam gently over, and let it descend and rest on the conical points, noting that the heads of the bolts that clamp the red metal braces of the knives are in front.

45. The clamp presented in the general view (figure 1) must now be mounted, by putting it in its proper position, shutting the clamp on the steel pin (I) as shown in figure 16, screwing up the nut of the bolt (B) that passes through the cast-iron table, and the screwing to the table the part (P) that holds the double screw.

46. The clamp opens and shuts by turning the red metal handle (H) that guides the right and left hand screws (S) which work in the two balls, (O.)

47. Put a little clean oil on the screw, and working parts of the clamp, and where the round rod of the lifting apparatus passes the different holes.

48. The stirrup is mounted over the end knives by inserting the small lever made for the purpose in one of the holes in the enlarged parts of one of the arms, (shown in figure 10,) and unscrewing it by turning the arms once or twice around; this will relieve the cast-steel plate, and admit of its being removed to the centre of the round opening on the side of the stirrup, when the steel plates and the brass arms can be drawn through the holes, and from the stirrup, which can now be placed over the end knife a little above the position required when in use, that the steel plate and arms may be again passed through the round holes in the side of the stirrup from which it was drawn, at the same time it passes the opening in the end of the beam. Now the plate can again be slid in its groove and original position. All being now well placed, the arm that was loosened for the purpose of removing the plate can be screwed up to its original position, and the stirrup permitted to rest on the end knife, as presented in the general view, (figure 1.)

49. To the end of the stirrup, suspend the hook connected with the ring, (or, as I call it, independent hook,) interposed between the lower end of the stirrup, and the hook attached to the top part of the frame of the dish, with the view of more effectually preventing whatever motion or jar that may be given to the dishes below, from affecting the position of the steel plates on the knives, or unnecessarily scraping, grinding, or otherwise injuring the knives. The other stirrup is to be mounted in the same way.

50. In mounting the dishes, great care is requisite in adjusting the length of the brass rods connecting the dishes to the part that accompanies the hooks, so that when freely suspended, the dishes will be perfectly horizontal; this is indispensable in the left-hand dish bearing the stem the clamp acts on. The rods should be so nicely adjusted, and the clamp so exactly placed, that the action of the clamp on the dish cannot be perceived.

51. Place the checks close to the boxes of the perpendicular lifters.

52. Permit the beam to descend (the clamp being open) so that the centre knife rests on the steel plates forming the keystone of the arch of the head

of the centre column, and the conical points are withdrawn from the beam; it will be found close to, and almost to rest on, the two checks; so that when the beam may incline the least to one side or the other, it will rest on one of the checks, and the other will be relieved just enough to admit of its being slid back, which will leave the beam free to move in the opposite direction, when the other check can be moved back, and the balance be perfectly free. Should the beam not move of itself sufficiently (after removing the first check) to admit of the second check being slid back, it can be made to move as required, by simply touching the dish required to descend, with the nippers for lifting the small weights, or by placing small weights on the dish itself.

53. The balance is now to be brought to perfect equilibrium and final adjustment by means of the small lever that revolves on the stem of the screw immediately over the centre of the beam; with the use of which, as also that of the ball that works on the same screw, the observer is supposed to be familiar.

54. At first, probably, this balance will be found to work best with the ball removed from the screw over the centre of the balance.

55. This completes the mounting of the balance, so that the clamp being opened, the perpendicular lift set in operation, the balance can be relieved until required for use.

56. To illustrate the manner of using this balance, it will be supposed that it is in the same position as last stated—the position in which it should always be put after being used.

57. Place the two checks in contact with the boxes of the lifting apparatus; open the clamp; lower the beam, by making the conical points descend the full extent of their limits of motion, (or until the points are entirely clear of the beam;) make the beam incline so as to rest on the right-hand check; clamp the stem of the left-hand dish with the clamp; place the standard on the left, and the counterpoise on the right-hand dish; take care to make a small excess in the right-hand dish; unclamp the left-hand dish; then the beam will rest on the right-hand check, and admit of the left-hand check being slid back, as presented by the dotted lines in the general view, (fig. 1;) remove gradually the excess from the right-hand dish, until the beam just commences to turn to the left; slide back the right-hand check as far as convenience may suggest, and complete the equilibrium with all possible nicety. This will be the first equilibrium of the standard. Now the right-hand check must be brought up, the beam made to rest on it; clamp the left hand dish; remove the standard, and place the weight to be compared in its stead; open the clamp, and relieve the balance. Whatever may now be required to be added to either dish to make the exact equilibrium, will be the excess or defect of the weight compared. For greater certainty, the standard can again be replaced, as above described; then, if the equilibrium comes again exact, it will be what is called a perfect verification, and prove that nothing has taken place during the operation to affect the result. If the result of the verification should come a little out of the way, it might yet pass; and the result of the comparison (if desired) corrected for one-half of the difference shown in the verification; but if much difference is shown, the whole operation should be rejected, and commenced again.

58. The operation of weighing by combination is the same, as far as the manipulation of the balance is concerned, but does not admit of using the

error of verification to correct the result, which, even in simple weighing, is very doubtful in itself—so much so, that I would rarely use it myself.

59. The dishes have central rings for placing the ten, twenty, twenty-five, and fifty pounds, when weighing by simple weighing; and eccentric rings for placing the ten, twenty, and twenty-five pounds, when weighing by binary combination. These being the weights for which the balance was contemplated to serve. (Figure 14 shows the rings.)

60. When it is desired to discontinue weighing, both checks must be brought in contact with the boxes of the lifting apparatus, the left-hand dish clamped, and the weights removed; the clamp again opened, and the centre knife relieved, by making the conical points ascend as before described.

61. When it is expected the balance may remain some time out of use, I would recommend that the stirrups be taken by the two arms, between the thumbs and fore fingers, carefully removed from the knives, and placed to rest between the side of the steel prisms and the opening in the end of the balance.

62. I would recommend that a very light frame, (the shape of a tent, or an inverted V,) with suitable light covering, be suspended from the ceiling by means of pulleys, so that it can be raised or lowered at will, to cover or uncover the balance, as may be desired. This I think preferable to a case of any kind, on account of being entirely out of the way when not in use.

63. The lifting apparatus is not intended to be used when the balance is loaded; it is only intended to relieve the centre knife when not in use, and keep the beam in its proper position. The want of mechanical arrangement for relieving the end knives at the same time, and being obliged to dismount the plate from the stirrup when anything may require to be done to the end knives, are defects and inconveniences not so desirable; but it is hoped a compensation for these defects will be seen in advantages not to be found in the best balances constructed heretofore.

64. This balance, I fear, will be subject to a very important defect, namely: that of having a tendency, when long in use without being relieved, to move from its proper position to the right hand. This defect probably results from the method of weighing with the checks and clamps; its effect on the weighing is not so important, but it is to be dreaded on account of the lifting apparatus sliding the beam into its proper position before relieving the knives, by which the centre knife is unnecessarily injured by sliding over the centre plates. This may not occur sufficiently to be easily perceived, except after so many weighings that the observer will be as willing to relieve himself as the balance. This defect could (if desired) be remedied by applying to the lyre shaped checks an arrangement by which a screw would raise a roller, so as to relieve the centre knife before the perpendicular lifters are made to act on the beam for replacing and relieving it, or by simply (when the beam has moved from its place) lifting the beam with the hand, and a cloth, just sufficiently to admit of a card being inserted between one of the checks and the beam, which will relieve the centre knife, and permit the beam to be brought to its proper position, without forcing the centre knife to slide over or scrape the centre plates. This defect in the lifting apparatus is common to all the balances for nice weighing that I have seen, having arrangements for relieving the knives and placing the beam.

65. I have in view a design combining simultaneous action of the conical points for relieving the centre and end knifes, and placing of the beam in

one operation; or, relieving the centre knife, placing and supporting the beam only; admitting, in both cases, of relieving the knife before placing the beam, and of using the checks and clamps in either case—thus correcting the defects noted in paragraphs 63 and 64. At the same time, it secures the advantages noted in paragraph 71, but objectionable on account of being more complicated, delicate, expensive, liable to injury, and requiring more skill in its management.

66. The principal reason for adopting the plan here described, for the balances for the United States, is its permanency of adjustment, and its security against injury—qualities not to be overlooked in instruments which will often fall in the hands of those unaccustomed to their use.

67. The metal of which this balance is constructed, although apparently brass, is a much stronger material, being cast from turnings of the standard weights and measures, with an addition of tin and copper, to make a stronger, tougher material, of a closer grain and richer color. The beam was carefully forged before working, to make the metal more stiff, great care being taken that the arms were equally affected by the forging; all other parts were also forged before working, with a view of increasing their strength.

68. Adopting square prisms for knives has proved in all respects as satisfactory as was anticipated when the idea first suggested itself; experience with the balances made for adjusting the standard weights for the States and customs of the United States, have proved the angle of 90° well adapted for the purpose: when one edge has rendered all admissible service, the position of the prism can be changed, and the three remaining edges used the same as the first; thus obtaining four times the amount of service obtainable by knives made in the usual way. They are the most convenient form for mechanical execution, and admit of being made with the greatest accuracy. When finally worn out, they can the most easily be replaced; this will not be soon, for the protection given the knives, by the use of the checks and clamp, admits of their rendering much service. When the case may occur, I would suggest substituting the hardest jewels for the cast steel. The balances constructed on the same principle, and used in the same manner for adjusting 200 sets of standard weights for the United States, after being once well in order, were not perceptibly impaired at the completion of the work.

69. The greatest objection to adopting cast steel for forming the knife edges, is its liability to rust.

70. Using the checks and clamp has also proved very advantageous, in consequence of the protection given to the knives when loading and unloading the balance, and more particularly so when it is requisite to place the weights in the eccentric rings for combined weighing; also, in checking the balance when it gets what I call *wild;* that is, when it has been disturbed by some cause, the impetus of which would cause the beam to oscillate for a long time, uselessly wearing the knives, wasting time, and greatly annoying the observer. This is effectually and immediately prevented by clamping the stem of the left hand dish just as the index passes the centre division of the divided disk; after which, the beam can be gently relieved, and the equilibrium much sooner accomplished.

71. I believe the method of weighing by counterpoise substitution, combination, using the checks and clamp, not permitting any changes in the position of the knives and plates, from making the first equilibrium to the completion of the verification, secures an accuracy, certainty, despatch,

and convenience of manipulation not to be obtained by the means and methods commonly made use of for securing accurate results in weighing.

72. In large balances, it becomes impracticable to preserve extremely delicate edges to the knives. The approximation is governed by the strength of the materials forming the knives, the weight to be supported, and the care taken in weighing; beyond which, it is useless to pass. In fact, the knives must be finally formed by actual use of the balance itself, which will crush the most prominent irregularities, burs, and rawness of the new sharp edges, and force the knives to assume at their final extremities an almost imperceptible circular form.

73. After passing the above process, the edges of the knives will probably require a slight dressing up; which is to be performed without removing the knives, by the means usually resorted to for the preparing a delicate edge. This delicate operation will require more skill and care than anything connected with the balance. In fact, the balance should be used some time, and passed through this process, before being sent away.

74. This paper being intended for assisting in mounting and weighing with the balance only, and not for constructing a similar one, many things admit of being passed unnoticed, which would otherwise have to be discussed in detail.

WASHINGTON CITY, D. C., *April* 10, 1843.

E. HASSLER.

A statement showing the number and sets of standard weights and measures delivered at the Treasury Department by F. R. Hassler, esq., late superintendent of that work, and the disposition which has been made of them.

How disposed of.	Sets of large weights.	Sets of ounce weights.	Yard measure.	Sets of liquid measures.	Half bushel measure.	Scales.
Quantity delivered by Mr. Hassler	203	41	50	133	–	1
Disposed of as follows:						
Deposited in the office of the Secretary of the Treasury	1	1	1	1	1	
Applied to the use of the sub-treasury	2	2				
Deposited in the Patent Office	1	1	1	1	1	
Deposited in the War Department	1					
Mint at Philadelphia	–	2				
Branch mints, (delivered to the mint at Philadelphia)	–	6				
Navy-yard at Brooklyn, New York	–	–	1			
Use of coast survey	–	–	2			
Use of General Land Office	–	–	1			
Delivered to Mr. Hassler, to be sent to England	1	1	1	1	1	1
Delivered to the different States, viz:						
1. Maine	1	1	1	1	1	
*2. New Hampshire	1	1	1			
*3. Massachusetts	1	1	1			
4. Vermont	1	1	1	1	1	
5. Connecticut	1	1	1	1	1	
6. Pennsylvania	1	1	1	1	1	
7. Delaware	1	1	1	1		
8. Maryland	1	1	1	1	1	
9. Virginia	1	1	1	1	1	
10. North Carolina	1	1	1	1	1	
11. South Carolina	1	1	1	1	1	
12. Georgia	1	1	1	1	1	
13 Alabama	1	1	1	1	1	
14. Michigan	1	1	1	1	1	
*15. Ohio	1					
16. Kentucky	1	1	1	1	1	
*17. Illinois	1	1	1			
*18. Indiana	1					
*19. Missouri	1	1	1			
20. Arkansas	1	1	1	1	1	
*21. Tennessee	1	1	1			
*22. Mississippi	1					
*23. Louisiana	1	–	1			
24. Rhode Island	1	1	1	1	1	
*25. New York	1					
26. New Jersey	1	1	1	1	1	
Delivered to collectors of ports as follows:						
1. Collector at Eastport, Maine	1	–	–	1		
2. Do. Machias, do	1	–	–	1		
3. Do. Castine, do	1	–	–	1		
4. Do. Bath, do	1	–	–	1		
5. Do. Saco, do	1	–	–	1		
6. Do. York, do	1	–	–	1		
7. Do. Ellsworth, do	1	–	–	1		
8. Do. Waldoborough, do	1	–	–	1		
9. Do. Wiscasset, do	1	–	–	1		
10. Do. Kennebunk, do	1	–	–	1		
11. Do. Portland, do	1	–	1	†1		
12. Do. Belfast, do	1	–	–	1		

STATEMENT—Continued.

How disposed of.	Sets of large weights.	Sets of ounce weights.	Yard measure.	Sets of liquid measures.	Half bushel measure.	Scales.
Delivered to collectors of ports, as follows:						
13. Collector at Portsmouth, New Hampshire	1	–	1	1		
14. Do. Burlington, Vermont - -	1	–	–	1		
15. Do. Newburyport, Massachusetts -	1	–	–	†1		
16. Do. Salem, do -	1	–	1	†1		
17. Do. Ipswich, do -	1	–	–	1		
18. Do. Fall River, do -	1	–	–	1		
19. Do. New Bedford, do -	1	–	1	†1		
20. Do. Gloucester, do -	1	–	–	1		
21. Do. Marblehead, do -	1	–	–	1		
22. Do. Plymouth, do -	1	–	–	1		
23. Do. Barnstable, do -	1	–	–	1		
24. Do. Edgartown, do -	1	–	–	1		
25. Do. Nantucket, do -	1	–	–	1		
26. Do. Boston, do -	1	–	1	†1		
27. Do. Providence, Rhode Island -	1	–	1	†1		
28. Do. Bristol, do -	1	–	–	1		
29. Do. Newport, do -	1	–	–	1		
30. Do. Middletown, Connecticut -	1	–	–	1		
31. Do. New London do -	1	–	1	1		
32. Do. New Haven, do -	1	–	–	†1		
33. Do. Fairfield, do -	1	–	–	1		
34. Do. New York, New York -	1	–	1	†1		
35. Do. Sackett's Harbor, do -	1	–	–	1		
36. Do. Oswego, do -	1	–	–	1		
37. Do. Buffalo, do -	1	–	–	1		
38. Do. Sag Harbor, do -	1	–	–	1		
39. Do. Rochester, (Genesee) do -	1	–	–	1		
40. Do. Niagara, do -	1	–	–	1		
41. Do. Oswegatchie, (Ogdensburg,) do -	1	–	–	1		
42. Do. Plattsburg, (Champlain,) do -	1	–	–	1		
43. Do. Cape Vincent, do -	1	–	–	1		
44. Do. Jersey City, New Jersey -	–	–	–	1		
45. Do. Perth Amboy, do -	1	–	–	1		
46. Do. Newark, do -	1	–	–	†1		
47. Do. Tuckerton, do -	1	–	–	1		
48. Do. Bridgetown, do -	1	–	–	1		
49. Do. Burlington, do -	1	–	–	1		
50. Do. Great Egg Harbor, do -	1	–	–	1		
51. Do. Erie, Pennsylvania -	1	–	–	1		
52. Do. Philadelphia, do -	1	–	1	†1		
53. Do. Wilmington, Delaware -	1	–	1	†1		
54. Do. Baltimore, Maryland -	1	–	1	†1		
55. Do. Annapolis, do -	1	–	–	1		
56. Do. Oxford, do -	1	–	–	1		
57. Do. Snow Hill, do -	1	–	–	1		
58. Do. Vienna, do -	1	–	–	1		
59. Do. Saint Mary's, do -	1	–	–	1		
60. Do. Alexandria, D. C. - -	1	–	–	†1		
61. Do. Georgetown, D. C. - -	1	–	–	1		
62. Do. Richmond, Virginia -	1	–	1	†1		
63. Do. Norfolk, do -	1	–	1	†1		
64. Do. Yorktown, do -	1	–	–	1		
65. Do. East River, do -	1	–	–	1		
66. Do. Tappahannock, do -	1	–	–	1		
67. Do. Petersburg, do -	1	–	–	1		
68. Do. Folly Landing, do -	1	–	–	1		

STATEMENT—Continued.

How disposed of.	Sets of large weights.	Sets of ounce weights.	Yard measure.	Sets of liquid measures.	Half bushel measure.	Scales.
Delivered to collectors of ports, as follows:						
69. Collector at Cherrystone, Virginia -	1	-	-	1		
70. Collector at Elizabeth City, (Camden,) North Carolina - - - -	1	-	-	1		
71. Collector at Ocracoke, North Carolina -	-	-	-	1		
72. Do. Plymouth, do -	1	-	-	1		
73. Do. Newbern, do -	1	-	1	1		
74. Do. Edenton, do -	1	-	-	1		
75. Do. Washington, do -	1	-	-	1		
76. Do. Beaufort, do -	1	-	-	1		
77. Do. Wilmington, do -	1	-	-	†1		
78. Do. Charleston, South Carolina -	1	-	1	†1		
79. Do. Beaufort, do -	1	-	-	1		
80. Do. Georgetown, do -	1	-	-	1		
81. Do. Savannah, Georgia -	1	-	1	†1		
82. Do. Saint Mary's, do -	1	-	-	1		
83. Do. Sunbury, do -	1	-	-	1		
84. Do. Hardwicke, do -	1	-	-	1		
85. Do. Brunswick, (Darien,) do -	1	-	-	1		
86. Do. Maumee, (Miami,) Ohio -	1	-	-	1		
87 Do. Sandusky, do -	1	-	-	1		
88. Do. Cleveland, do -	1	-	-	1		
89. Do. Detroit, Michigan -	1	-	-	1		
90. Do. Michilimackinac, do -	1	-	-	1		
91. Do. New Orleans, Louisiana -	1	-	1	†1		
92. Do. Teche, do -	1	-	-	1		
93. Do. Pensacola, Florida -	1	-	-	1		
94. Do. St. Augustine, do -	1	-	-	1		
95. Do. Key West, do -	1	-	-	†1		
96. Do. St. John's, do -	1	-	-	1		
97. Do. Apalachicola, do -	1	-	-	†1		
98. Do. St. Mark's, do -	1	-	-	1		
99. Do. Mobile, Alabama - -	1	-	1	†1		
100. Do. Vicksburg, Mississippi -	-	-	-	1		
101. Do. Natchez, do -	1	-	-	1		
102. Do. Pearl River, do -	1	-	-	1		
	131	34	47	121	18	1

NOTE.—The States with this (*) mark affixed have not received the full complement of standards, which are ready for delivery whenever the Executives of said States shall indicate the mode of transmitting them, as requested in a circular from the department, under date of the 15th of May last.

This (†) mark, in the column for liquid measures, indicates that custom-house to have received full sets of gallons and parts thereof; the other custom-houses have only been supplied with gallon measures.

TREASURY DEPARTMENT,
January 30, 1844.

STATEMENT—Continued.

How disposed of.	Stamps to uses.	Stamps to boxes.	Stamps sent by mail.	Stamps returned to Dept.	Stamps unaccounted for.	Remarks.
Delivered to collectors of ports, as follows:						
69. Collector at Cherrystone, Virginia	1			1		
70. Collector at Elizabeth City, (Camden,) North Carolina	1			1		
71. Collector at Correcke, North Carolina	1			1		
72. Do. Plymouth, do	1			1		
73. Do. Newbern, do	1		1	1		
74. Do. Beaufort, do	1			1		
75. Do. Washington, do	1			1		
76. Do. Beaufort, do	1			1		
77. Do. Wilmington, do	1			11		
78. Do. Charleston, South Carolina	1		1	11		
79. Do. Beaufort, do	1			1		
80. Do. Georgetown, do	1			1		
81. Do. Savannah, Georgia	1		1	11		
82. Do. Saint Mary's, do	1			1		
83. Do. Sunbury, do	1			1		
84. Do. Hardwicke, do	1			1		
85. Do. Brunswick, (Da rien,) do	1			1		
86. Do. Maumee, (Miami,) Ohio	1			1		
87. Do. Sandusky, do	1			1		
88. Do. Cleveland, do	1			1		
89. Do. Detroit, Michigan	1			1		
90. Do. Michilimacinac, do	1			1		
91. Do. New Orleans, Louisiana	1		1	11		
92. Do. Teche, do	1			1		
93. Do. Pensacola, Florida	1			1		
94. Do. St. Augustine, do	1			1		
95. Do. Key West, do	1			11		
96. Do. St. Johns, do	1			1		
97. Do. Apalachicola, do	1			11		
98. Do. St. Marks, do	1			1		
99. Do. Mobile, Alabama	1		1	11		
100. Do. Vicksburg, Mississippi				1		
101. Do. Natchez, do	1			1		
102. Do. Pearl River, do	1			1		
	121	34	17	121	16	1

NOTE.—The Stamps with this (*) mark affixed have not received the full complement of stamps, which are ready for delivery whenever the Executives of said States shall indicate the mode of transmitting them, as requested in a circular from the department, under date of the 15th of May last.

This (†) mark, in the column for illegal issuances, indicates that custom-houses to have received full sets of collects and ports thereof; the other custom-houses have only been supplied with gallon measures.

TREASURY DEPARTMENT,
January 30, 1844.

Fig. 1

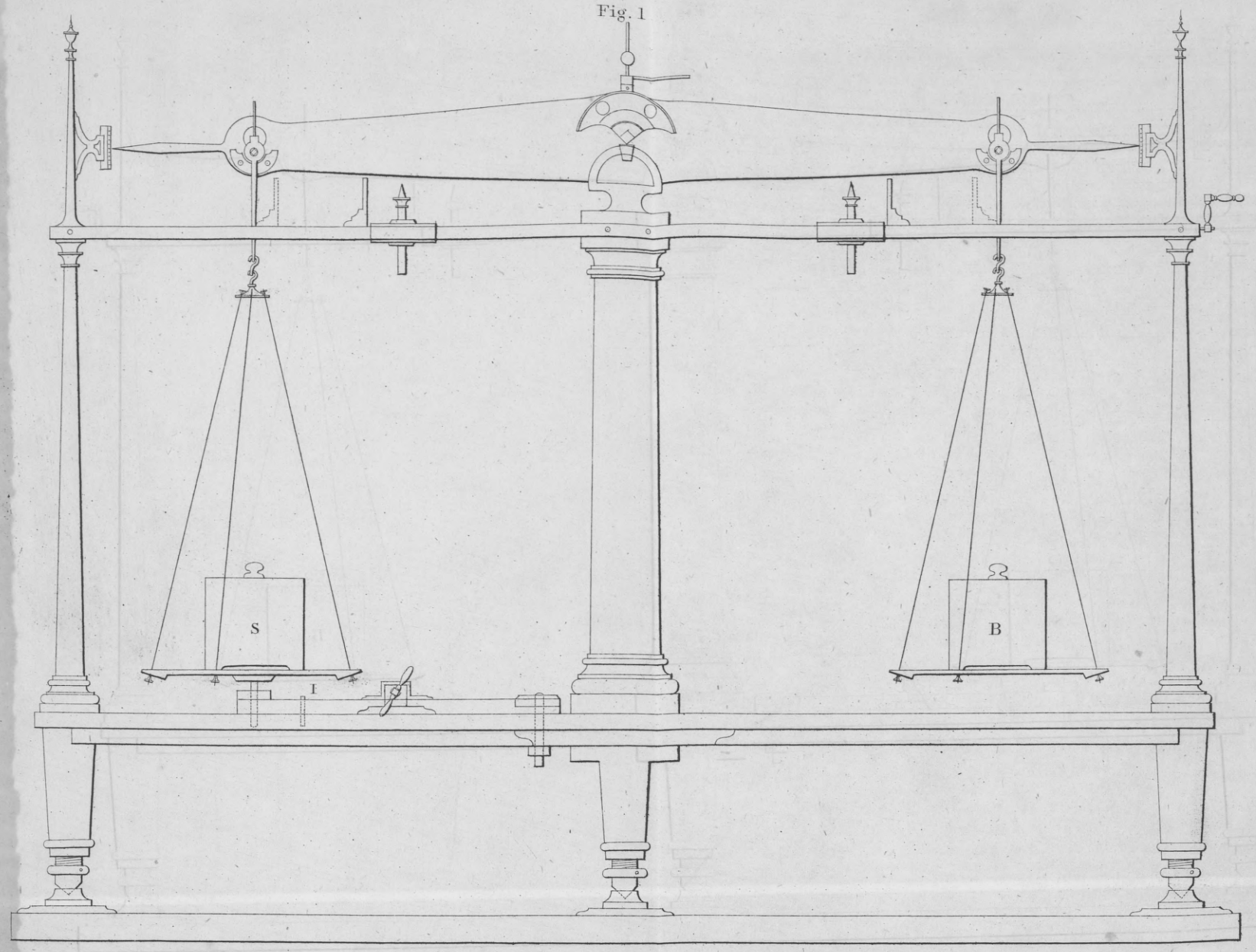


Fig. 3

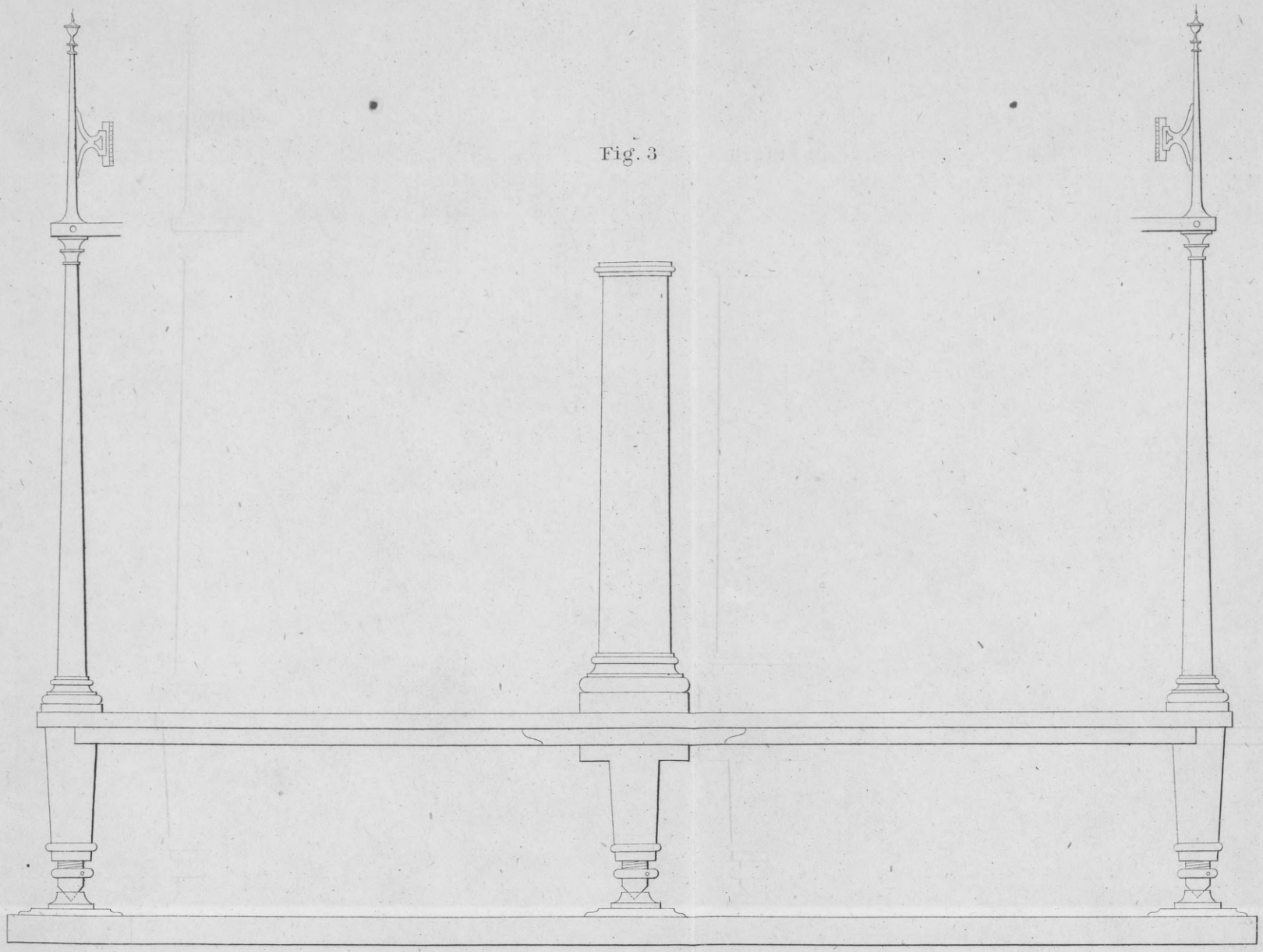


Fig. 4

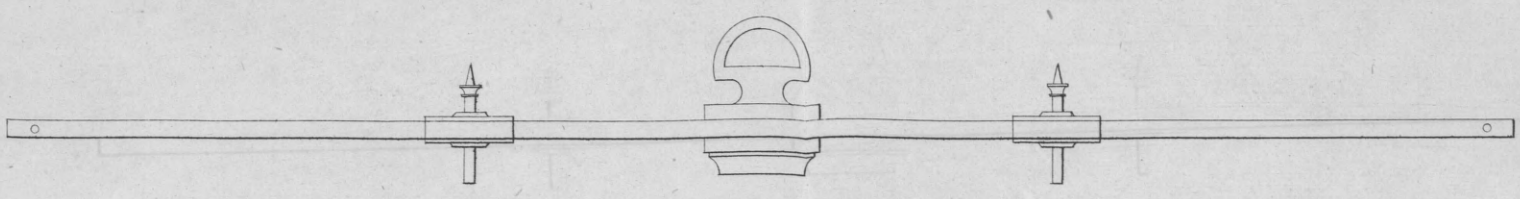


Fig. 16

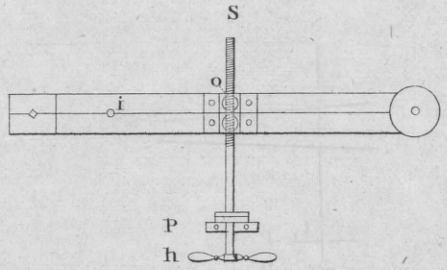


Fig. 14

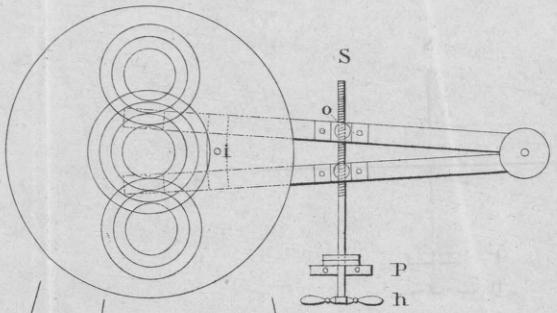


Fig. 17

Fig. 15

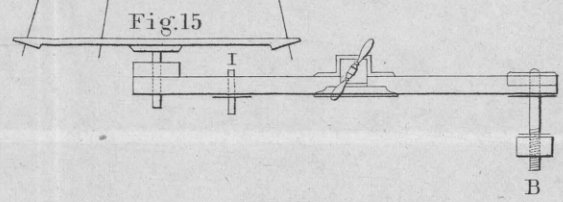


Fig. 5

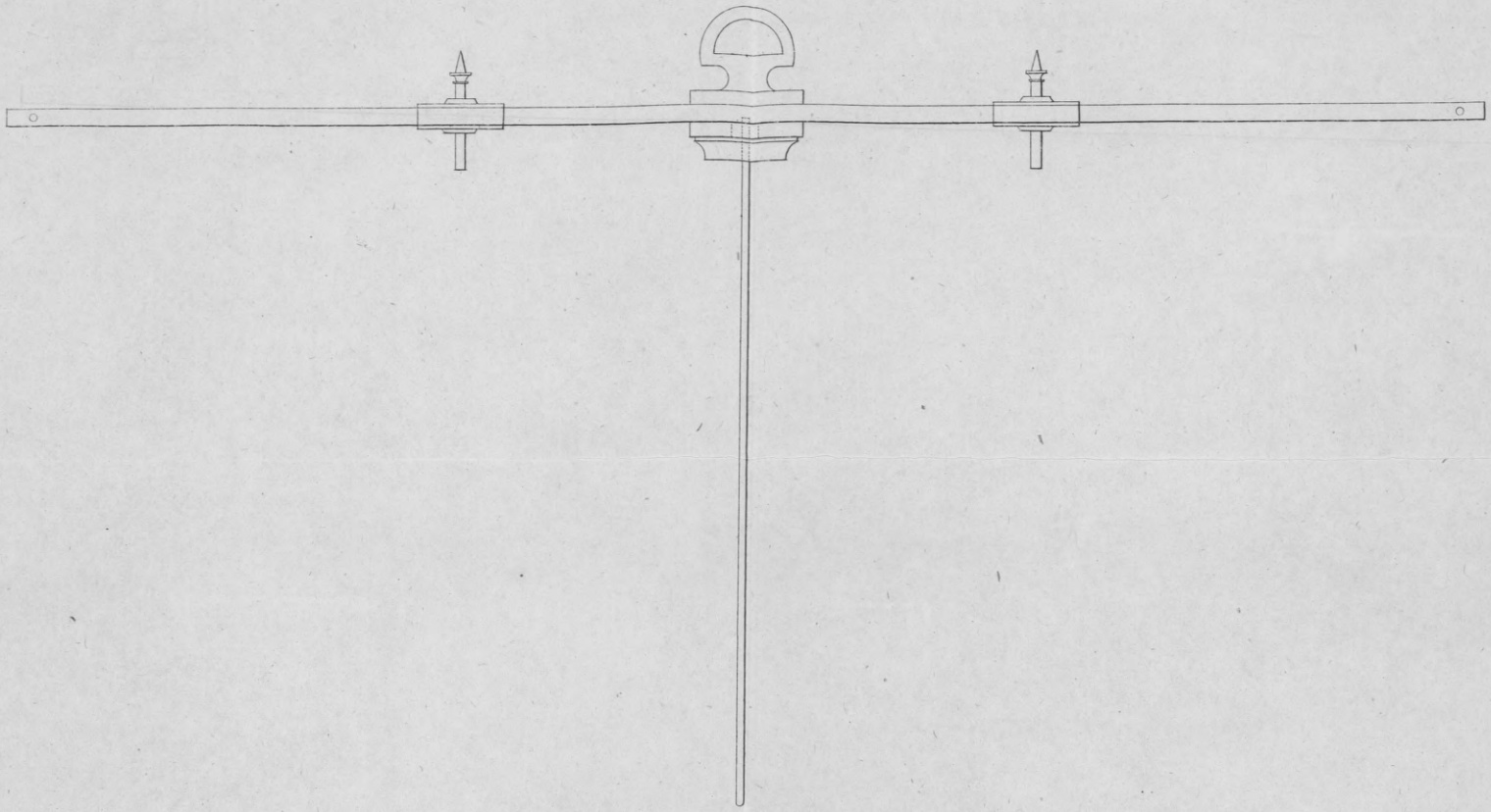


Fig.13

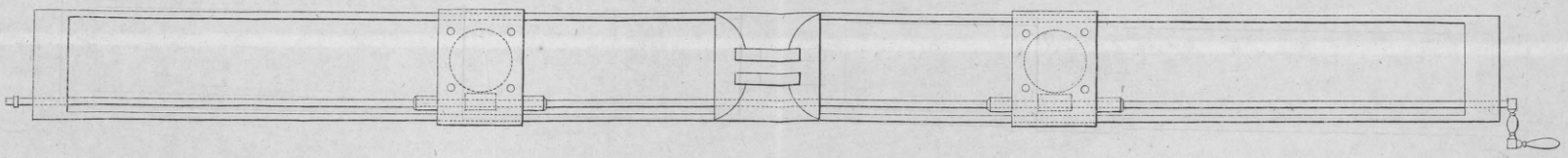


Fig. 6

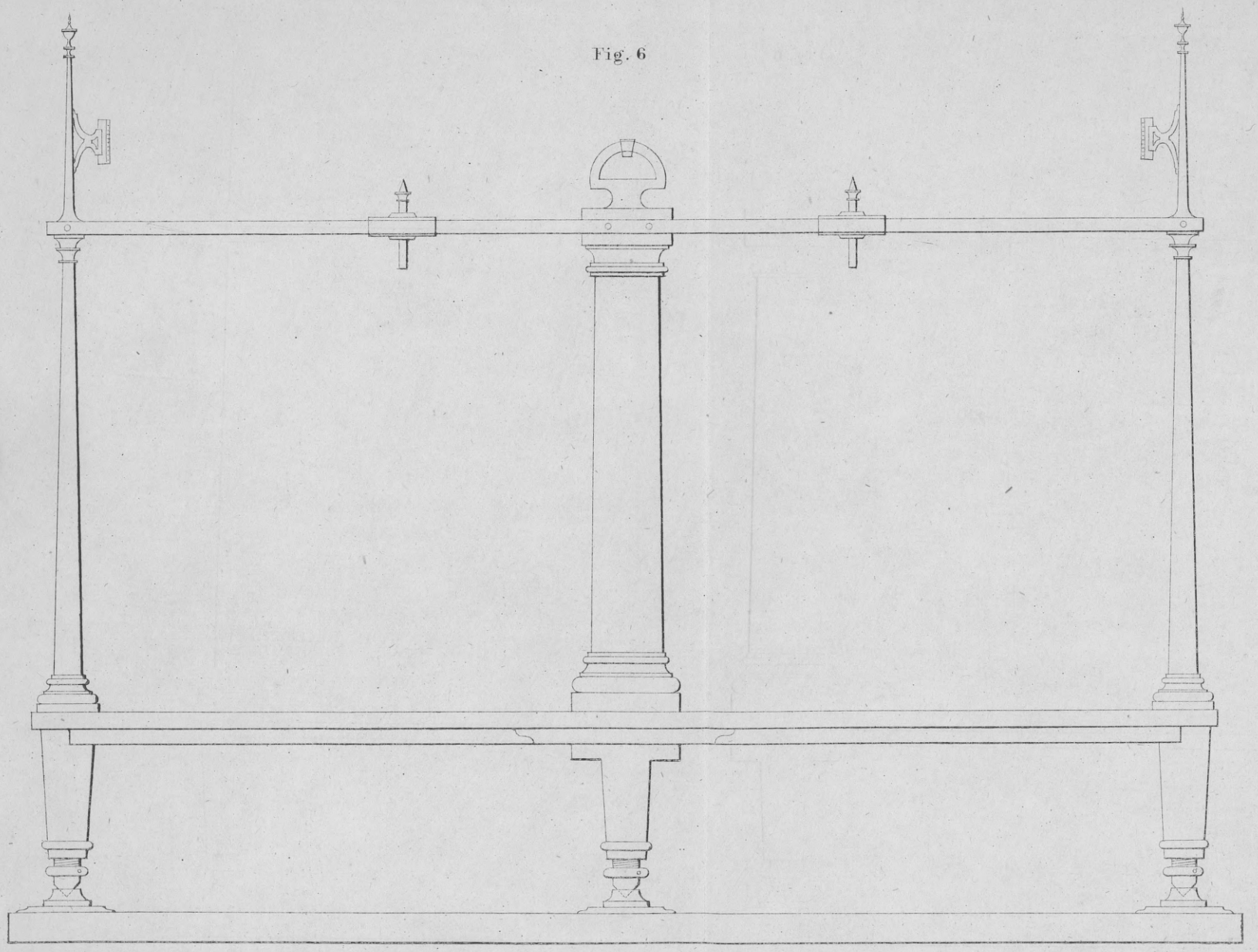
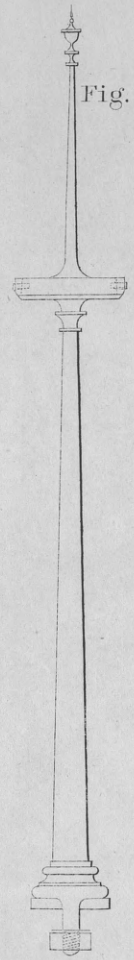


Fig. 7



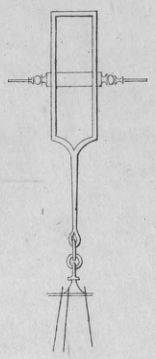


Fig. 11

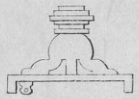


Fig. 8

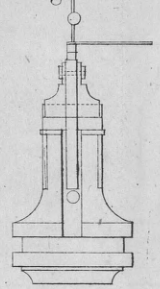


Fig. 12

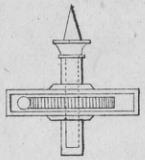


Fig. 9

Fig. 18

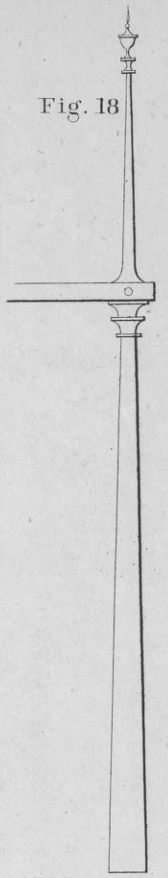
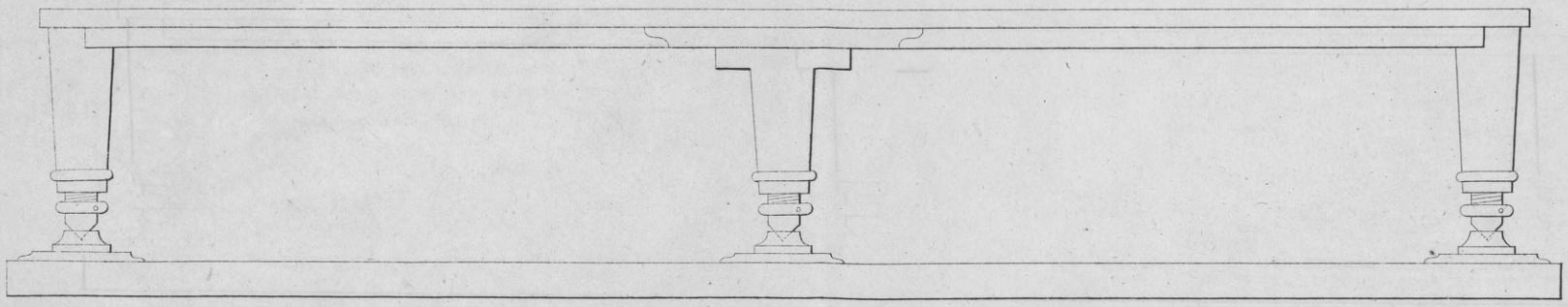



Fig. 2