27th Congress, 2d Session. | Doc. No. 28. | Ho. of Reps. Treas. Dept.

COAST SURVEY.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A report of F. R. Hassler, superintendent of the coast survey, showing the progress made therein up to the present time.

JANUARY 3, 1842.
Read, and laid upon the table.

TREASURY DEPARTMENT, *December* 30, 1841.

SIR: I have the honor to transmit, herewith, a report from F. R. Hassler, Esq., superintendent of the coast survey, showing the progress made in the work up to this time.

Though this report of the superintendent is chiefly confined to replies to the inquiries contained in the resolution of the House of Representatives of the 24th of June, yet, as it also exhibits the present condition and the extent to which the survey has been prosecuted, it is thought expedient to lay it before Congress, under the impression that it may supersede the necessity of submitting an annual report on the subject, as heretofore usual at the commencement of each regular session.

All the data in the possession of this Department, for answering the resolution mentioned, has been prepared, but that portion of it which calls for the "indirect expenditure upon the survey by reason of the employment therein of the public vessels and officers," has not yet been received from the appropriate department. It is, therefore, deemed advisable to await the receipt of this information before replying to the resolution. This information is expected in the course of a few days, when all the inquiries contained in the call will be immediately answered.

All which is respectfully submitted.

W. FORWARD,
Secretary of the Treasury.

Hon. JOHN WHITE,
Speaker Ho. of Reps.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast and Geodetic Survey

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STATION YARDS, NEWTOWN SQUARE,
Delaware Co., (Pa.,) December 9, 1841.

SIR: With the present I have the honor to transmit to you the answers to the questions made in Congress upon the state of the survey of the coast under my superintendence, which have been communicated to me by your Department, under date of 2d July, 1841, with the request: that I should answer what in them relates especially to the work.

I hope you will approve of the manner in which I have treated the different subjects; and I have no doubt that the account of the financial part of the questions, which are of the special domain of the Treasury Department, will complete to satisfy Congress upon every point: that may ever have laid in the view of the questions.

It will easily occur, that to render account upon the elementary scientific part of the work would be improper in a public document; the principles of the science, and the manner in which I have applied them to the work, I have published on the occasion of the interruption of the work of the survey in 1818, in full, though under the unavoidable supposition that the reader should possess the necessary mathematical elements, which can in no case constitute part of an account rendered of such a work. I have since introduced further particulars in their proper places in the yearly reports to Congress, and in other documents; the first is in *duplo* in the library of Congress, and the second must be supposed known to every member of Congress.

It is to be hoped that the attention excited by the call in Congress will induce the members of both Houses to visit the establishment for the work, which is so near the Capitol, to inspect personally whatever might be further desired by any one of them in particular, to satisfy himself fully upon the propriety of every part of the work, and the manner in which it is conducted, even if no special inspecting committee, or similar, should be established. By the nature of the work and the extent of the establishment, such a way of informing Congress, upon all, would appear most speedy and appropriate, as well as the most effectual.

In the habitual course always followed for the works of the coast survey, I would about this time have rendered account of the progress of this work since my report of last fall, and added to it the state of the works for the standards of weight and measure. But the intermittent fever, which has taken hold of me at this station, like it had previously in other places attacked several assistants, has hardly allowed me to make the few observations of angles which the very unfavorable weather would admit of. I am, by that circumstance, constrained to request that you will indulge me with the liberty to refer such a report to next spring, when I hope to be enabled to present with it, at the same time, standards of the liquid capacity measures, which I hope to have ready for delivery at that time.

In the answers to the questions of Congress, the actual state of the work at this time is, of course, comprehended, so that it will fully supply the place of any special yearly report that I might be able to make.

Since several years that the organization of the coast survey has been in regular course and progress, the appropriation granted by Congress for the same has been $100,000, which has proved most appropriate, and therefore most economical in its result in the adequate advancement of the work.

I take, therefore, the liberty to suggest that the same amount of $100,000

be requested from Congress for the expenses of the coast survey work for the coming year, and I have no doubt but the insight given into the state of the work and its organization will support the proposition with full weight.

Perhaps you may find proper to join to this report, also, my first letter addressed to the Treasury Department immediately on receiving the direction for the answers to the questions proposed by Congress.

I have the honor to be, with perfect respect, your obedient servant,

F. R. HASSLER.

The Hon. WALTER FORWARD,
Secretary of the Treasury.

Questions of the resolution of Congress of June 24, 1841, relating to the survey of the coast of the United States, with the answers to the same, by F. R. HASSLER.

Ques. 1. "The progress which shall have been made in the survey of the coast."

The works of the survey of the coast cover now upwards of 11,000 square miles, with primary and secondary triangulation, topography, and soundings; from the east end of Rhode Island to the neighborhood of the Chesapeake and Cape May.

This is evidently a great progress for the time that the work has as yet lasted; particularly if it be considered that every thing was to *be created*—even the ability of the assistants, they being at first new in the business. It is actually *much more than has ever been done in any similar work before;* for it must be recorded: that since the first law of 1807, nineteen years were entirely unproductive for the work, by postponement and interruption; five years were used in procuring the necessary instruments, and in preparations, as before that time there was not a single instrument, in this country applicable to such a work. Only ten years were employed in the actual work; of which the two first, 1816 and 1817, were rendered useless, and the expenses made became a bill of loss, by the overthrow of the work in 1818; so that the whole work now producible is the result of hardly about eight years actual work.

The gradual progress, year for year, has always been presented by my reports, once, and often twice, sent in to Congress by the Treasury Department, and printed every year, in which I stated all that was occurring and of interest.

The aim of the coast survey is, and has always been considered to be, by all the successive administrations since its existence, to furnish, with the fullest accuracy possible, all the geographical, topographical, and hydrographical data that may in any way be needed for the navigation and the defence of the coast, in their generality, and to the extent of the country in the rear of the coast, to which the valleys extend: that empty their waters into the Atlantic, and are thus separated from it by some chain of mountains, or what may be called the nearest chains of elevations separating the interior from the coasting countries; and that this work should also furnish the elements to any future map of the country desired, as it is by its nature so extensive, and so situated, as to furnish the elements of maps of all the States. In fact, some States have already united in the work, to extend these elements to the advantage of an accurate map of these States.

Ques. 2. "Number, location, and length of the several base lines measured for the triangulation."

In the works of 1817, two base lines had been measured preliminarily, in order to ascertain within certain limits the accuracy of the unit upon which the detail works, to be enclosed within them, might be grounded. One in English neighborhood, in the State of New Jersey, of 5,87209 miles, and one upon Gravesend beach, on Long island, of 4,81952 miles. Since the re-beginning of the work a base line was measured, in September, 1834, upon Fire-island beach, on Long island, of 8,7396 miles at the level of the sea, with the apparatus thereto destined, with microscopes of double focus, and in all respects so as I have described it in my *papers upon various subjects relating to the survey of the coast.* (Transactions of the American Philosophical Society, vol. 2, new series.) This base line serves now to the work as fully accurate unit; its being within the limits of the tide, dispensed of course to reduce it to the level of the sea. The numerical details and calculations are recorded in several folio volumes, containing some millions of figures, open for inspection to any man, but too long to transcribe here. For nearer accounts, see principal documents of the survey of the coast, vol. 1, page 17, seq.; letter to the Secretary of the Treasury, April, 1818, and report upon the coast survey, May, 1835, printed documents, vol. 2, p. 103.

Ques. 3. "The number of the stations occupied therefor, (namely, the triangulation.")

The stations occupied in 1817 were 11, forming the elements of 124 triangles. At that time I was alone in the work. Since 1833, the primary triangulation has occupied over 20 stations. The secondary triangulation has several hundred stations. In the tertiary and plane-table works the number of stations is much greater. These details can best be inspected, or inquired into, in the office of the coast survey itself.

It is here only proper to remark, that the reducing of the primary triangles to the smallest number is one of the great requisites for the accuracy of such a work. To bring the irregular shape of the country into the most advantageous regular mathematical figures, which is the requisite of an accurate survey, is what makes the strongest call upon the science and ability of the operator; therefore its value and labor cannot be judged by the *quantity*, but by the *quality alone*, which, to judge of, requires the same insight into the mathematical and physical sciences as the execution of the operation itself. The success in all these things depends not only upon the instruments and labor of the observer, but still more upon the perfection of the *methods* devised for the work. In this respect I have the favorable unanimous judgment of the most eminent men of science in Europe, distinctly expressed in publications, (see documents, vol. 1, pp. 55, 59, seq.,) so that in fact the speciality of my *methods* are not only *publicly known*, but even publicly *judged*, and *approved*, long ago.

Ques. 4. "The observations made for and the corections applied to the same, (namely the triangles.")

This would require to copy the journals of the observations which contain the reductions, and those of the results; both exhibit the application of the principles implied, as I have exposed them in the memoirs of the Philosophical Society above quoted; they must evidently be inspected in the office, in the about 180 folio volumes which contain them. It would be very ill-placed to repeat again here mathematical elements already fully ex-

posed; because this paper is official, and the proper authority must be supposed in full possession of the means to judge upon them by their known simple scientific principles, these principles being contained in the elementary works on mathematics.

Ques. 5. "The astronomical observations made for the determination of latitude and longitude."

Upon this question it must be at first observed that the ultimate clause of the renewed coast-survey law of 1832 has cut off the most favorable means by the phrase—"provided, that nothing in this act, or the act hereby revived, shall be construed to authorize the construction or maintenance of a permanent astronomical observatory." This proviso forms an unfortunate limitation of the work. The disadvantage therefrom arising for the acceleration and easing of the accuracy, by the determination of ever-standing points of reference for the whole work, is too evident for men acquainted with its scientific requisites to need being treated here.

That the very object prohibited by this clause must unavoidably, however, once be established in this country, is easily seen, as it is one of the requisite tools for a nation having a navy; if done early enough to let the coast survey enjoy the benefit of it, the expense would be comparatively trifling, and immediately recovered by the advantages arising from it in this *national work* of the survey.

Circumstances have not yet allowed to supply this absence fully, nor is it the time, as yet, nor appropriate, nor *possible* in the state of the work within the present limits of it, to do more than what has been done, namely, the following:

1st In 1833 and 1834, the first years of the new operations in the coast survey, observations for latitude with the sun, and with stars, were made upon every station of the main triangulation, with an astronomical repeating circle of 18 inches diameter, and with 10-inch reflecting circles, upon my own plan of construction, which is such as to compensate all the errors reflecting instruments may be subject to. At several of these stations, also, azimuths were observed with the sun.

2d. A special station was made in 1838 upon Weazel mountain, near Paterson, N. J., for latitudes and azimuths; and a solar eclipse, occurring just at that time, gave occasion for an observation of longitude at the same place.

3d. Every solar eclipse that has occurred during the time the work has as yet lasted, has been observed at some one of the survey stations.

It is well known that all those results are to be united, in due time, with those of future times, into one general result, by means of the primary triangulation; while the results obtained hitherto, being for the immediate use of the geographical works of the survey *only*, must be preserved within it until this union into a regular system is accomplished. It would be highly *improper* to give them to the public earlier, as well according to good principles of science, required in the work, as in obedience to a positive, and very proper prohibition, stipulated by Government in my original contract of 1816, confirmed in 1832.

The results of the coast survey constitute a property of the nation at large, which it acquires by the labor and expense bestowed upon the work; for which compensation will, in proper time, be obtained by the *authentic publication* of the results. All interference of private publications are directly *unjust*, and *derogatory to the lawfully acquired property* of the

nation, and *the ultimate proper utility* of the work. The garbled publications, which would be occasioned by partial communications, would interfere with very unjustly, if not destroy entirely, the advantages of the future authentic publication of the work in its appropriate connexion, turning the public expense into profit for the private pockets of single individuals, having no exclusive claims to its benefit; and the *public* would be *deluded* by being presented with results falsely set up as *authentic*. It is self-evident that none but the maps published by *authority*, as results of such a work, either deserve, or will ever obtain, the confidence which is an indispensable requisite in the estimation of the public. The Government that undertakes such a work takes by that act the *engagement* towards the public to provide such maps as shall deserve full and exclusive confidence; therefore, also, it must *discountenance* all that might have any tendency to occasion *doubts*. These considerations were made by all the Governments of Europe which have executed such works. They have followed, in full, all the principles here exposed. It is a very essential consideration for the public *security*, *aimed at* by the work, to prevent all possible abuse.

The map of New York, now in progress of execution, and engraving, will contain as much of these geographical data as belong to the part of the country which it represents, and so will, successively, every future publication within its limits. Whatever nearer particulars might be desired in this respect must be seen in the journals at the office, as the details would be by far too long for these answers. All this lies in the nature of the subject, and cannot be otherwise.

By a regular triangulation, the latitudes and longitudes of every one of the points of the survey are determined with infinitely more accuracy from a few certain, and expressly made, astronomical stations, by means of the geodetical elements obtained by the triangulation, than by the direct celestial observations, which might be made cursorily at these points themselves; in fact, such results are *not admissible* in the comparison. Therefore, also, this has always been the mode of proceeding, where no permanent observatory could be referred to, as the best principles in fact require.

Ques. 6. "The work done by each corps employed in the service."

The survey works are distributed by myself to the best advantage of the work, according to the time, situation, and capacity of the assistants, at any given period, in proportion and succession as they are wanted, and not according to districts or localities. The works are contained in—

32 folio volumes of my own observations and results;

90 folio volumes and cahiers of the assistants;

30 or 40 cahiers, folio, of calculations, and tables, &c.—and upwards of 100 journals, of all sizes, of naval and tidal observations, soundings, and observations thereto belonging. To this I might be allowed to add—

17 volumes of documents of correspondence, and upon subjects of the administration of the work; and about 20 volumes of journals, calculations, and documents relating to the works for the construction of standards of weights and measures;

140 maps; and

80 charts of original works of the different assistants, upon different scales, from $\frac{1}{5000}$ to $\frac{1}{80000}$;

2 register maps, upon a scale of $\frac{1}{100000}$, keep account of all these works, and serve as guides to select the original maps of any part of the work, of which an abstract, or the execution of a map for publication or otherwise,

may be desired. These two maps exhibit the works done upon the 11,000 square miles collected together; the one has 10 feet length by 4 feet breadth; the other, 5 feet length by 4 feet breadth;

4 sketch maps, showing the present state of the triangulation, and of the topography and soundings; and three or four similar ones, showing the state of the works at each preceding year. A number of triangle sketches, and preliminary reductions of the charts and maps, for the use of the register maps, &c. The map of New York is executed double, in manuscript, besides the engraving.

Regular registers of all the journals and maps keep up, to every time of return from the field work, the account of the whole work; they are constantly open in the office for inspection, as well as the works themselves.

Notwithstanding I am so well aware that also the elevation above the level of the sea of the principal station points should be determined, that in 1817 (when I was quite alone) I had begun it, I have been obliged to omit the prosecution of this interesting subject, because of the more urgent call for the geographical and topographical part of the work, and the augmentation of the expenses which would naturally attach to it. The stations being well secured, so that they can be found in future, and the distances exactly known, this datum of the detail geography of the country can be ascertained at any future time.

Ques. 7. "A description of the charts published, if any."

Whenever a special map has been called for, as extract of the works of the coast survey, it has been immediately given; so have been—

The harbor of Bridgeport and its neighborhood;

The harbor of New Haven and its neighborhood;

The bay of Newark and its neighborhood.

These were presented to Congress, and published in the documents of Congress.

Other extracts have been delivered in manuscript, whenever desired and authorized, to different public offices, and otherwise.

The map of New York is known to be in a state of considerable forwardness; it will contain about 1,170 square miles of the work. The engraving has been begun.

After that map is finished, it will be possible to proceed to a regular succession of publications, east and south of that place, provided the regular order and progress of the work be allowed to proceed *in all respects as it is now organized.*

Ques. 8. "The amount of money expended from time to time since its commencement."

The first appropriation, made in 1807, returned nearly untouched to the *surplus fund.* In a similar manner was the next *following* appropriation *returned*, because, under the expectation of war with England, the actual work was always postponed.

After my plans for the work of the survey had been discussed and approved, only the late Professor Patterson, of Philadelphia, and I, were directed by the President to agree, by correspondence, upon the instruments, &c.

In 1811, I was sent to London to procure the instruments for the survey of the coast, to be constructed upon my plans, previously presented to the Secretary of the Treasury and to the late Professor Patterson, and by them approved. During my stay in London, the appropriation was suffered to expire, and I was left in London two years upon my own private

means, as also for about one year yet after my return, to no small private economical damage.

In 1816, new appropriations were made; of which, however, only about $13,500 were used for the work; besides that, the balances due to me and for the instruments were paid, and the whole remainder, of about $50,600 was transferred to the War Department, to enable it to continue the work; as the amendment of the law in 1818 admitted it; but, no action having taken place upon that, the whole of that sum, with the exception of a few trifling expenses, consequent upon the delivery of the instruments, returned again to the surplus fund. The statement of the Treasury Department, handed in to the Senate at the beginning of 1818, exhibits:

Total amount of appropriation - - - -	$183,725 39
Remaining - - - - - - -	50,595 39
Thence, apparent appropriation - - - -	133,130 00
Of this was returned to the surplus fund - - -	79.004 32
Whence, total expenses for instruments, work, pay, outfits, &c.	54,125 18

By which, and by the statement just made, it is evident that for about $40,000 the instruments and objects of that kind were on hand. The accounts with the Treasury Department and the volumes of printed documents may be consulted for nearer details.

The amendment of the coast survey law of 1818, giving liberty to the Navy or War Department to continue the work, it appears that there was something of that kind attempted by the Navy Department; by what means of appropriation, or otherwise, I cannot say; only the fact is proved by the statement of the report of the Navy Department of 1828, which says: "Nor can such surveys be made without the aid of the means contemplated by the act of 10th February, 1807, to provide for surveying the coast of the United States."

The Treasury Department has applied to the Navy Department for the information upon this point.

The appropriations made for the coast survey, since its being taken up again, are as follows:

In 1832 - - - - -	$20,000
1833 - - - - -	20,000
1834 - - - - -	30,000
1835 - - - - -	30,000
1836 - - - - -	80,000
1837 - - - - -	60,000
1838 - - - - -	90,000
1839 - - - - -	90,000
1840 - - - - -	100,000
1841 - - - - -	100,000
Total - - -	620,000

It must be remarked here: that, in conformity with my original request, always adhered to, the money for expenditures does not pass through my hands, but all expenses are made, and attended to, by an accounting officer appointed upon my proposition, like all other assistants, and selected from among them, who renders account directly to the Treasury Department.

Ques. 9. "What sums have been appropriated for the purchase of instruments and books?"

The original amount expended for instruments procured for the first establishment of the coast survey, as stated in the preceding section, is about $40,000. Since the recommencement of the work, in 1832, various sums have of course been expended, as well to repair the losses which the collection had suffered during the interval, from 1818 to 1832, as for the necessary extensions which the progress of such a work always requires.

On another hand, many instruments have been at different times given off to the Departments of War, Navy, and State, and also to the *State of Massachusetts*, for their use; because they could be got much better and quicker from this collection, and from the workshop which is attached to the coast survey, as an *absolute requisite*, that the work may not be stopped in its progress.

The details of these transactions must be collected from the accounts rendered by the accounting officer of the coast survey to the Treasury Department; they would fit only an accessory document, to be made by the Treasury Department or the accounting officer, as voucher to these assertions.

Regular inventories have at all times been kept of the instruments, books, vessels, and all other property belonging to the coast survey, which can be produced, and inspected in the office at any minute.

It is to be observed that a considerable amount of actual property exists in the coast survey establishment, which forms in fact an unexpended capital; five vessels, numerous boats, instruments, clocks, chronometers, books, tables, chairs, tools, tents, and in general all the implements necessary in the office and in the field, besides the full equipment of the vessels, &c. Some of these latter have been returned to the Treasury Department, and their amount is still due to the coast-survey fund. An abstract of an inventory of the property in hand is joined herewith, the amount of which exceeds, certainly, $120,000.

Ques. 10. "The names of all persons employed upon the coast survey, distinguishing such as may have been of the army or navy, together with their salaries, or other compensation."

The *qualifications* are what is of interest in the work; and these are not attached to any names, or class of men. In some parts of the work, the *personel* must be, by its nature, somewhat variable.

My compensation is fixed at $3,000 per annum, and for the personal expenses which are occasioned by the work $3,000. The compensations of the principal assistants are also calculated with a view to compensating the personal expenses to which their functions subject them; all other persons employed receive their board, or a weekly allowance for the same, according to the greater convenience of the work, additional to their pay.

Every quarterly account rendered by the accounting officer gives, of course, the fullest information in this respect. This part will therefore be answered by the Treasury Department.

Ques. 11. "By whom appointed to the service."

This question has been *decided* from the very beginning until this day, always equally, *by the nature of the subject*, by the law of 1807, and by the *contract* I entered into for the work with the Government.

The nature of the subject and the work dictate distinctly that the chief, or (so called) superintendent, of the work shall have the selection of the proper persons needed for his assistance in any way whatever, he being

the best judge of their *fitness* as to the *qualifications* required in any given case; and that no assistant, or other persons to be employed, can be introduced into the work by any other ways or means. It is, therefore, upon the superintendent's *proposition* that the assistants are appointed.

The original law of 1807 gives the execution of the work directly into the hands of the President of the United States; thence he can give it (what is in parliamentary style called) in commission to whomever he pleases; the renewed law of 1832 confirms this. Upon that principle all successive Presidents have acted. The survey being made in the interest of *commerce* principally, the Presidents have at all times given it in commission to the Secretary of the *Treasury*—this Department being, in fact, the only one fitted for the good success of the work; for many reasons. The attempts made to place the work under the Navy Department proved signal failures, as documents fully show, in which the causes and incidental situations of the subjects relating thereto are sufficiently deduced, and to which I therefore refer.

Upon the proposition of the superintendent for any appointment involving a yearly compensation over 1,000 dollars, the Secretary of the Treasury, to whom the proposition is addressed by the superintendent, refers to the President, who decides finally upon it. Temporary appointments, or such as do not exceed $1,000 annually, are at the free, final disposition of the superintendent.

Ques. 12. "Exhibiting as well the direct appropriations for the survey of the coast, as the indirect expenditures upon it, by reason of the employment thereon of public vessels and officers."

There are no indirect expenditures by the employment of public vessels or such like. All the vessels employed belong to the coast-survey fund, and are kept in repair by the same. Even last winter the Navy Department had the loan of one of them, and returned it without having kept it in proper repair.

As for the employment of officers of the navy, it is proper here to refer simply, and positively, to those officers employed in the coast survey, to state: whether they do not find, from their experience, that the navy is indebted to the coast survey, and not the coast survey to the navy. This was one of the circumstances aimed at, and sufficiently discussed at different times in the documents, to which it is always proper to refer.

These officers receive an additional pay from the coast-survey funds, but from the navy nothing different from any other service in which they might otherwise be engaged. The naval part of the work is of course the smallest division of the work, as the naval operations have nothing to do with the direct determination of any distances. These are furnished by the triangulation and the topographical work, with the latter of which they work simultaneously, as much as circumstances will permit, getting their guiding points from it to apply to the determination of their points of sounding.

Ques. 13. "The probable length of time required to complete the survey."

It would be highly improper to answer this question by *direct numbers*. It was made to me by the President in 1835. I answered it by stating this, and entering into particulars about the state of the coast survey, its variable chances in locality, weather, &c., and upon my methods of proceeding, with the view both to accuracy and celerity, and to the *best forwarding* of the work. The ultimate answer of the President was, "that is right; that will accelerate the work," as stated in its proper place in the

printed documents. That such is the only way of treating this question is evident by nature, and by the scientific principles which must guide the work, if it shall be led to an *honorable* and *permanently useful result*, as is enjoined *by the law*, and by all instructions. Assiduity, patience, and perseverance, will bring the work along and to completion as fast as its nature and the disposable means will admit; and positive numbers are not appropriate to state beforehand.

The above statements are already contained in the printed documents. I beg leave, therefore, to refer to this previous treatment of that subject, and to state the following, with a view to clear up the ideas of any inquirer, viz:

With the advancement of the mathematical and physical sciences, the means of acceleration of any work grounded upon them also increase; but still, without such time as is appropriate to the extent of a work, nothing is possible. The coast of the United States is about 3,000 miles long; with its inward bays, large navigable rivers, &c., it will present at least triple that length; and a certain breadth inland must always be surveyed with it, as the aim of the work dictates. The part of the coast now executed being from east of Rhode Island to about Cape Henlopen and the Chesapeake bay, an approximate judgment might be cast upon the question, from the relative extent of the work now executed to the whole, of which it presents no inconsiderable proportion, provided it would be possible to ascertain beforehand the exact nature of the coast yet to be surveyed, and all possible circumstances, the weather, the impediments, &c. But these things being impossible to be known, the judgment would be more than vague.

Ques. 14. "The probable amount of money required to complete the survey of the coast in the mode heretofore pursued."

This is answered in a great measure by the preceding answer upon the time, as from it depends much of the determination of the expenditure. All that is needed for a full answer is, that the whole work is in every way contrived, and carried on, in all its parts, in the most economical manner possible; and that the proper investigation and inquiry that can be made, *and I should like would be made*, comparatively to any other works, would certainly show that never so much valuable work of that kind has been obtained, in any country, and under any known arrangement, as there has been obtained, in the same time, at a proportionally equal expense, as in this survey of the coast of the United States, under the *present organization and administration of that work.*

The results of the coast survey will furnish, for the future, regular systematic data to ground any detail surveys upon, that might be needed, thereby avoiding the double expenses hitherto so frequently occurring, from the Engineer and Navy Departments acting disconnectedly, thereby, of course, doubling the expense, and, I might say, often even *the doubts.*

The coast survey has far more than paid its expenses up to this time, by the advantages which it has procured to two of the principal ports of the country, New York and Philadelphia, the accurate knowledge of which has made known advantages in their navigation superior to those hitherto known, which no operations of surveying, so frequently carried on in those waters, have been able to determine, because they were not sufficiently well grounded upon systematic principles, and upon properly connected operations.

Ques. 15. "With the suggestion of any other mode of surveying the same."

This does not belong to me to answer by any particular discussion, but that both the mathematical principles which must guide the work positively dictate the mode pursued, and that the experience made between 1818 and 1832 has distinctly proved, in this country, that no other mode, nor even fashion, can lead to a result; notwithstanding that in 1832, and even now again, it has been attempted to speak, and even write, about a (so called) chronometric survey, which the science does not know, as chronometers give only detached determinations, and no *survey*, which latter implies a connected series of operations.

I hope to be dispensed from discussing this question; but I allow myself, instead of it, to present the examples of other countries. The surveys made in Europe, of sufficient note to apply to them the mathematical and physical sciences, which are, in principle, to be applied, and without which *success is directly impossible*, were all begun in the last century upon similar plans of triangulation; varied as they all are in the methods and mode of the detail execution, they all agree in that principle.

Austria began already, after the times of Cassini and Liesganig, (1768,) using the triangles of Liesganig, made for the determination of degrees of the meridian, in Austria and in Hungary, as the primary mathematical elements of her future maps.

Russia began under Catharine II, and has since constantly either taken up at different points or extended the triangulations successively made, with always more perfection of men of science. Now, these triangulations form a fully connected series from north of the arctic circle to south of Dorpat. The work goes now on, with a great abundance of means, as well in persons as money, for the topographical and hydrographical parts, to which the triangles give the foundation, principally around the Baltic.

Sweden has similarly taken advantage of the trigonometrical operations of Svanberg, in Lapland, for a measurement of a degree of the meridian begun in 1801, for its maps and the charts of its coast.

Denmark began, under Bugge, before 1784, for its peninsula; and not many years ago the part of Holstein was triangulated, in conjunction with Hanover.

The kingdom of Hanover has been triangulated by Professor Gauss.

Prussia, having taken advantage of the extension of the French triangulation in Germany over its present Rhenish provinces, has not only extended this triangulation over a great part of its dominions, but has added new measurements of degrees all over, until lately, Mr. Bessel, astronomer royal of Königsberg, joined these works with those of Russia just quoted. All these works have been, and are still, used as elements for the geographical, topographical, and hydrographical surveys of the country.

Swabia was triangulated by my university friend, Professor Bohuenberger, of Tübingen, and I accompanied him, in 1795, in the junction of his triangles with mine in Switzerland.

The operations of the triangulation of Bavaria are well known and fully described.

All the States of Germany have either made triangulations upon their own base lines, independent of the French triangulations, which were constantly carried on in the rear of the French armies, during the whole of their campaigns, from 1791 onwards, or used these very triangulations;

and the different States have grounded upon them the maps of their countries.

The same is the case with Italy, where the triangulations of Boscovich, Beccaria, Zach, Nouet, the joint Austrian, French, and Sardinian commission, and others, from before the French revolution, during the same, and since, have been, and are, constantly used as foundation to any maps or charts that are constructed.

Naples and Sicily proceeded in the same manner; and the whole was executed *without any naval officers* being employed in it.

In 1791 I had already begun myself in Switzerland a similar operation, by the measurement of a base line of about 7½ miles long, upon which some triangles were grounded. The several subsequent revolutions interrupted the work, but it was taken up again repeatedly, by me and others, upon the same plan, and with these *my* very same *first elements*. According to the latest accounts, the topography has now been completed. It was the notice of that work of mine, which came to this country about the time of my arrival, in 1805, which occasioned first the proposition to me to do the same here: thence the law of 1807, and the call for plans of operation, of which mine, now proceeded upon, was selected from among thirteen, by the unanimous vote of a special committee assembled in Philadelphia, and by the President himself. (See the historical part of the printed documents, vol. 1.)

France began its first map, after the triangulation of Cassini, in the early part of the last century. The defects which this work presented in its detail execution, which was not made with the care now used, and the improvements of the sciences that progressed rapidly after those times, produced first in 1786 the triangulation to join the observatories of Paris and Greenwich, under Cassini, the third in France, and General Roy in England. Immediately upon it followed the decision of measuring 12 degrees of the meridian, to serve equally as a base to the establishment of standards of weight and measure, upon an unit of length derived from the quadrant of the meridian of the earth, and by the most accurate principles of natural philosophy, applied to the capacity, measures, and the weights.

Only after these works had passed the ordeal of approbation of the men of science sent from all the continental nations of Europe, assembled in Paris in 1800, (England alone refusing to take a share in a *scientific useful aim*, while it employed its arms and treasures to the destruction of the continent of Europe,) the French, as well as the foreign members of this scientific convention, reporting jointly and unanimously—only then, the accurate elements thus obtained were decided to be applied to the construction of a new map of France and to the charts of its coast.

When all the interior that had been done by the triangulation and the topographical works, which always must form the base of the hydrographic operations, had been executed, the western coast was begun in 1816, and account rendered of it in 1829. The coast of the Mediterranean, as far as hitherto known, is not yet finished; but, during the whole of the wars of the Revolution, the triangulations whose bases laid in the French works were carried on as their armies proceeded.

England grounded the first starting of its survey upon the very base line measured in 1789 by General Roy, on the occasion of the junction of the observatories, mentioned above, and has continued it ever since upon the same plan. Several volumes of the work are extant, but the whole is

not yet completed. About the year 1818, according to English accounts of that time, upon the part of the work in Ireland, "above 600 persons, of different conditions, were and are continually employed," &c. According to later verbal accounts, the work goes on now from Dublin, south, towards Cork.

In the East Indies, the English began already, in 1800, trigonometrical surveys, upon which the topographical and hydrographical details are grounded and carried on, like all the rest, upon the same principles as the survey of this country now is, but with immensely greater expenses, and a *personel* far more numerous. The work is proceeding now always upon the same plans and principles, having been extended many degrees of latitude north in new territories, under Lambdon, Everet, &c.

Europe is covered with well-connected series of triangulations, from the south of Sicily to past the north polar circle; from Ireland, through England, France, Germany, to the interior of Russia; from Bordeaux to the frontier of Turkey, and in all the intermediate parts: so that no map need be, nor actually is, attempted without the elements of these triangulations. The works which I have made in Switzerland are included in this series.

These facts give an idea of the labor required to produce such a work as will stand the test of *public scrutiny*, be honorable and useful to the country in which it is performed, and which therefore shall, as I am ordered to make it, be *permanently useful and honorable* to the country. That any other mode of proceeding would dishonor the country, and foil the aim of usefulness entirely, is too well known to need any discussion.

The mathematical theory, which, it will never be doubted, must be applied to such works, is therefore fully supported by the imperious fact, that all surveys whatever, of any note, were made by triangulations, as the only possible mode of operating, *capable* to lead to a result.

Notwithstanding that in this country the work is to be done with reference to views which in science would be called at least over-precipitate, (that is, the results of maps and charts are to be attended to at the same time as the elements are obtained, upon which they must necessarily be grounded,) this is not to be taken as an authorization to dispense with the principles, without which nothing at all is obtainable in that line, that could be considered as warrantable result; and it *cannot be* supposed that it would be approved by the American nation, if such a work, undertaken in this country, was to remain behind the similar works of all other nations, and to be recorded in history as in arrear of the present state of scientific civilization.

If, therefore, in the state of the country and the nature of the demand upon the work, it cannot begin by the determination of degrees of the earth's surface, upon which all the works of that nature are now habitually grounded, the work would, however, be positively shamed out of the annals of the science, and of such works, unless its results could be used, in future proper time, according to any future desire or exigency, to contribute their proper share to the determination of the figure of the earth *in this country*. This very last result will form one of the principal means for its ultimate proof, and credit for accuracy.

The coast survey, to yield the desired and indispensable accuracy and permanent utility, must partake in full of the character of all the works quoted, and exceed them, where possible, in various points, and in accuracy, as instances could be found in the work, by the approbation which

the means and principles employed have met with in Europe, from the most eminent men of science, who have practised in such works.

By entering into the details of this part of the subject, many interesting scientific remarks might be made, which circumstances evidently prohibit here to touch. I have, in its proper place, in my reports printed by Congress, stated what, in this point of view, refers to the Mason and Dixon meridian line, which has been so unsuccessfully tried to be applied as an element to such scientific determinations.

All this answers certainly, also, the question of the probable time that may be required for the completion of the work so fully as to reduce it to the simple statement, that the more impediments there will be laid in the way of the work, the longer it must last, supposing even that it be not entirely destroyed, and the whole undertaking become what is called "a bill of loss for the nation," by attempting to *prescribe* details and *modes of proceeding unscientific*, or distracting the work from its proper course, as former experience has proved.

Ques. 16. "Which shall have for its object the acquisition of the greatest amount of useful information in the shortest time, and at the least expense."

This object cannot be attained by any other mode than that now employed in the coast survey—in no way whatsoever.

Cases are where the economy of a few hundred dollars claimed, or aimed at, has occasioned the loss of some millions of money, years of time, and has caused many disagreements.

It might apparently be fair to claim for the coast survey work, in its present organization, the habitual advice, "Let well alone."

It is easy, by misapprehended views of a scientific subject, investigated with certain predetermined aims, views, opinions, etc., to draw conclusions directly contrary to truth. Such are the ideas which would pretend to determine, almost instantaneously, the latitudes and longitudes of places with sextants and chronometers, when geographical determinations are to be made with that accuracy, which decides certainty. We have the experience of centuries, and of our days equally, proving what a long series of observations, with means far superior to small sextants and chronometers, have been, and are still, required to obtain accuracy in any way only comparable with what a few triangles will put out of doubt within smaller limits than a man (suppose the observer with his sextant) needs to move upon in his sextant operations; and these few triangles are quicker made, and their accuracy is proved in every step with the fullest certainty. Such illusions are instantly dispelled by the knowledge of the scientific principles implied in such works.

It is known, by my reports, that, in addition to the works of the coast survey, I have, during the very same time, also brought the construction of uniform standards of weight and measure for the whole Union to a considerably advanced state, in far less time than similar works have been obtained in any country whatsoever, of far less extent than the United States.

The two works, requiring similar application of mathematical and physical science, and even similar mechanical means, are assisting each other mutually, and therefore serve as acceleration, the one to the other. It is, besides, well known that in France, also, they were grounded upon the

same principles—so much so, as to call the account of the measurement of the twelve degrees of the meridian, "*the base of the metric system.*"

Whatever would act inimical to the coast survey would act equally inimical to this, so highly important and much desired public work.

F. R. HASSLER.

To the Hon. WALTER FORWARD,
Secretary of the Treasury, Washington.

STATION YARDS IN NEWTOWN SQUARE,
Delaware county, (Pa.,) December 2, 1841.

List of instruments belonging to the United States coast survey.

1 30-inch theodolite. Troughton & Simms.
1 24-inch theodolite. Troughton.
1 18-inch repeating circle, with 2-feet telescope. Troughton.
1 18-inch theodolite. Simms.
1 18-inch theodolite. Made in office.
1 12-inch repeating theodolite, with vertical circle. Troughton.
1 12-inch repeating theodolite. (Lent to the State of Massachusetts.)
1 10-inch theodolite. Richer.
1 9-inch theodolite. Made in office.
1 24-inch vertical circle. Troughton & Simms. Brass stand to the same, made in office.
3 repeating reflecting circles, with brass stands, horizon, and mercury flasks.
1 repeating reflecting circle, without stand.
1 5-feet observatory transit instrument. Troughton.
1 5-feet observatory transit instrument. (Lent to the Navy Department.)
1 small transit instrument and stand. Made in office.
15 sextants.
1 transportable clock of Brookbank.
1 astronomical clock of Hardy.
5 box chronometers.
12 watches.
1 three-hundredth second watch.
4 mounted barometers of F. R. Hassler.
4 mounted barometers. (Lent to the State Department.)
1 mounted barometer. (Lent to the War Department.)
1 reflecting telescope of Troughton.
1 6-feet telescope. Dollond.
1 5-feet telescope. ditto.
1 4 $\frac{8}{2}$-feet telescope. Tully.
1 3½-feet telescope. Dollond.
1 3½-feet telescope. Troughton. (Lent to the War Department.)
4 3½-feet telescopes. Frauenhofer & Utzschneider.
4 2½-feet telescopes. Frauenhofer & Utzschneider.
5 pocket telescopes.
7 large heliotropes, with brass stands.
4 small heliotropes.
14 thermometers.

10 large alhidades.
2 small alhidades.
6 complete plane tables.
3 brass motion works for plane tables.
1 brass rule of Schenck's alhidade, with magnetic needle.
1 large azimuth compass, 1 foot needle, and telescope.
1 compass, with telescope, needle, and stand.
2 compasses, with telescopes.
1 small compass, with prismatic readings.
2 2-arm protractors.
2 3-arm protractors.
1 brass circular protractor.
1 small steel protractor.
1 58-inch German silver beam compass.
1 56-inch brass beam compass.
1 32-inch brass beam compass.
1 32-inch graduated brass beam compass.
21 beam compasses of different sizes and metals.
3 steel rulers of 8 feet length.
9 steel rulers of 5 feet length.
1 brass ruler of 5 feet length.
5 steel rulers of 3½ feet length.
2 steel rulers of 2½ feet length.
12 metre scales of brass and German silver.
11 metre chains.
5 graduated triangles.
12 triangles of different sizes, brass and steel.
1 30-inch dividing plate of Bird.
1 new tracing apparatus. Made in office.
3 parallel brass ruling instruments. Made in office.
12 boxes of mathematical drawing instruments.
1 82-inch scale of Troughton, divided on silver, with microscopic comparateur.
1 scale beam and grain weights of Troughton.
1 brass metre of Lenoir.
1 iron metre of Lenoir.
1 iron toise of Lenoir.
2 subdivided kilogrammes.
2 litres modeles.
4 micrometer microscopes, with reflectors.
1 double wire micrometer of Dollond.
1 level tryer, with micrometer screws.
2 micrometer screws.
2 large artificial horizons.
3 small artificial horizons.
1 box with mounted levels.
1 box with unmounted levels.
1 box with parallel glasses.
1 box with dark glasses, sextant mirrors, lenses, reading glasses, and sets of dark glasses.
1 rectangular level arrangement from Brookbank's clock.

1 vertical circle, telescope, &c., of broken repeating circle, from which an instrument is now being constructed in the office.

The base apparatus consists of—
2 boxes with microscopes.
2 boxes with brass and steel motion works.
2 boxes with iron bars.
1 box with thermometers.
1 box with wooden legs for the microscopes.
1 long wood bar, box, and base plank.
2 large brass sectors with levels.
12 large wooden stands with screws.

There belongs to the coast survey a library of a few hundred volumes of valuable mathematical and astronomical works, a number of which are very rare; all classical in their kind.

The following vessels belong to the coast survey:
Brig Washington, with 4 boats.
Schooner Jersey, with 4 boats.
Schooner Gallatin, with 3 boats.
Schooner Nautilus, with 3 boats.
Schooner Vanderbilt, with 1 boat.
The plane table parties have 5 boats in use.
The different land parties have in use 60 tents of different sizes.
Every party has the necessary carpenter tools.

For the triangulation parties there are—
6 instrument carriages.
1 1-horse wagon.
8 horses.

The instrument maker's shop has—
1 large turning lathe, cast-iron frame, wheels, &c.
1 turning lathe, with cast-iron shears, wheels, &c.
1 small turning lathe, with cast-iron shears, wheels, &c.
1 watch maker's turning bench, with all necessary implements and tools.
The artificer's shop has a carpenter's bench, with all the necessary tools.

In the office rooms there are—
12 drawing tables, of different sizes.
9 writing tables and desk.
5 bookcases.
Stands, chairs, washstands, fenders, shovels and tongs.

27th CONGRESS, 2d Session. | Doc. No. 57. | Ho. of Reps. Treas. Dept.

COAST SURVEY.

REPORT

OF

THE SECRETARY OF THE TREASURY,

IN REPLY

To the resolution of the House of Representatives of 24th June, 1841, respecting the expenditure, &c., for the survey of the coast of the United States.

JANUARY 31, 1842.

Read, and laid upon the table.

TREASURY DEPARTMENT,
January 25, 1842.

SIR: I have the honor to make the following report, in obedience to the resolution of the House of Representatives of the 24th June last, directing "the Secretary of the Treasury" to "communicate to this House, at the commencement of the next session of Congress, a statement of the progress which shall then have been made in the survey of the coast of the United States, including the number, location, and length of the several base lines measured for the triangulations, the stations occupied therefor, the observations made for, and the corrections applied to the same; the astronomical observations made for the determination of the latitude or longitude; the work done by each corps employed in the service, and a descriptive list of the charts published, if any."

"Also, the amount of money expended on the survey of the coast, from time to time, since its commencement, showing what sums have been appropriated for the purchase of instruments and books; the names of all persons employed upon the survey, distinguishing such as may have been of the army or navy, together with their salaries or other compensation, and by whom appointed to the service; exhibiting as well the direct appropriations for the survey of the coast as the indirect expenditure upon it, by reason of the employment therein of the public vessels and officers."

"Also, the probable length of time and amount of money required to complete the survey of the coast, in the mode heretofore pursued, with suggestion of any other mode of surveying the same, which shall have for its object the acquisition of the greatest amount of useful information in the shortest time, and at the least expense."

As the report from the superintendent, submitted by the Department to the House of Representatives on the 30th ultimo, and contained in printed document No. 28 of the present session, gives, probably, as satisfactory information as it is in the power of the Department to furnish, in answer to so much of the resolution as relates to the progress and extent of the work already completed, and other details therein called for, I beg leave respectfully to refer the House to the report before mentioned for an answer to these portions of the resolution.

In addition, I take occasion to remark, in reference "to the probable length of time required to complete the survey," that nothing definite can be given in answer to this inquiry; but perhaps some approximation to the period of time may be reached by comparing the relative extent of the coast yet to be surveyed with that already executed, and the time occupied in the completion of the latter. In instituting the comparison, however, due allowances must be made for many unavoidable delays incident to the commencement and proper organization for such a work, such as procuring instruments and other necessary equipments needed for its successful prosecution. It will be proper, also, in forming a judgment of the time required to complete the work, to bear in mind that many of the results already obtained can be used in subsequent operations; and due consideration, at the same time, should be given to the fact that important practical knowledge and experience have been gained by the principal assistants of the superintendent, and others immediately connected with the survey. These, together with the means already obtained, and the complete organization now existing throughout its various branches, would, all combined, no doubt tend greatly to accelerate the completion of the remaining portion of the work.

A similar comparison of that portion of the work already finished, and the cost of executing the same, with that still to be performed, might, it is believed, furnish a tolerably correct idea of the "probable amount of money required to complete the survey of the coast," provided the same means and facilities be extended to the future operations of the work as have been heretofore and are at present afforded for its prosecution. An augmentation of these means and facilities would doubtless expedite its completion, and probably diminish the expense.

As, however, for the foregoing reasons, the Department could furnish nothing more than conjectural answers to these inquiries, it is deemed most respectful and advisable to refrain from the expression of an opinion based upon such uncertain data, and dependent upon contingencies of the nature referred to.

In regard to the "suggestion of any other mode of surveying the same, which shall have for its object the acquisition of the greatest amount of useful information in the shortest time, and at the least expense," I would remark that this Department is not possessed of the requisite information to enable it to make any satisfactory suggestion on this subject, involving as it does both a theoretic and practical knowledge of a branch of the sciences foreign from its appropriate duties, and to which its attention has not been specially given. But, as stated in the report of the superintendent, before referred to, it would appear that this survey is conducted on the same scientific principles, with the benefit of modern improvements, as similar works undertaken by most of the Governments of Europe. It would seem that no new mode, embracing the same scientific principles and accuracy of results, has, if discovered, been yet adopted by those Governments.

The accompanying statement No. 1, prepared by the Register of the Treasury, exhibits "the amount of money expended on the survey of the coast, from time to time, since its commencement, showing what sums have been appropriated for the purchase of instruments and books, the names of all persons employed upon the survey, distinguishing such as may have been of the army or navy, together with their salaries or other compensation, and by whom appointed to the service."

It is to be observed that the compensations of the superintendent, assistants, and others employed in the work, have been fixed by the President for the time being. The pay from the coast survey appropriation of some of the officers of the navy, as also of the lower grade of persons employed in the field operations, ceases during the winter months.

The communication herewith sent, numbered 2, furnished by the Navy Department, is designed to answer that branch of the resolution calling for "the indirect expenditure upon it, [the survey,] by reason of the employment therein of the public vessels and officers."

On this head, it is deemed proper to remark that, as the laws providing for the survey of the coast authorize the President to employ "such of the public vessels in actual service as he may judge expedient," and "all persons in the land and naval service, and such astronomers and other persons as he shall deem proper," it becomes questionable whether these expenditures ought properly to be considered, to their full extent, as chargeable to the coast survey. These vessels, with their officers and men, would, if not employed in this special duty, have still remained a charge on the service to which they belonged. Their transfer to the survey would doubtless increase the expense in some degree, but it is respectfully suggested whether this entire charge can be fairly thrown upon the expenditures of the work under consideration.

All which is respectfully submitted.

W. FORWARD,
Secretary of the Treasury.

Hon. JOHN WHITE,
Speaker of the House of Representatives.

No. 1.

Statement of money expended, out of direct appropriations by Congress, and accounted for by settlement in the office of the First Auditor of the Treasury, for the survey of the coast of the United States, from its commencement, in 1808, *to* 1818; *in* 1832 *and* 1833, *and from* 1836 *to June* 30, 1841; *showing what sums have been paid for the purchase and repairs of instruments, and for books; the names of all persons employed upon the survey, designating such as have been of the army and navy, together with their salaries or compensation, and by whom appointed.*

Periods.		Expenditures for the purchase of books & instruments and repairs of instruments.	Aggregate amount of expenditures.
(Isaac Briggs)	1808	$715 75	$715 75
From July 27 to November 1,	1811	–	1,105 62
From November 1, 1811 to July 1,	1818	17,531 64	54,869 21
	1832	136 75	3,824 16
	1833	3,844 84	16,485 91
	1836	6,076 35	39,704 95
	1837	785 25	90,702 62
	1838	1,540 14	86,120 69
	1839	738 21	87,023 62
	1840	460 91	67,857 97
First and second quarters of -	1841	147 98	34,031 94
Expenditures by the hydrographic parties from April 22, 1835, to May 17, 1841 -		1,745 23	30,289 24
Total - - - -		33,723 05	512,731 68

Names of persons employed on the survey.	Salaries or compensation.	By whom appointed.
F. R. Hassler -	$6,000 per annum* -	President of the U. States.
James Ferguson -	4,000 do -	Superintend't, with approval of the President.
E. Blunt -	4,000 do -	Do do.
C. M. Eakin -	3,000 do -	Do do.
C. Renard -	3,000 do -	Do do.
W. M. Boyce -	2,000 do -	Do do.
J. J. S. Hassler -	2,000 do -	Do do.
John Farley -	2,000 do -	Do do.
F. H. Gerdes -	1,500 do -	Do do.
H. L. Dickins -	1,500 do -	Do do.
T. W. Werner -	1,500 do -	Do do.
S. Hein -	1,000 pr. an. & board	Superintendent.

* $3,000 for compensation, and $3,000 for his expenses.

STATEMENT No. 1—Continued.

Names of persons employed on the survey.	Salaries or compensation.	By whom appointed.
L. Muller	$800 per annum	Superintendent.
W. Werdeman	800 per ann. & board	Do.
C. Flint	50 per mo. & board	Do.
Thomas McDonnell	600 per ann. & board	Do.
W. Jacobi	2 50 per day	Do.
T. A. M. Craven	750 per annum	Superintend't, with approval of the President.
T. J. Page	500 do	Do do.
T. A. Jenkins	500 do	Do do.
T. R. Gedney	627 do	Do do.
Richard Bache	1 per day	Superintend't, with approval of Secretary of Treasury.
A. A. Holcomb	1 do	Do do.
Mid. Crawford,(dead)	1 do	Do do.
Lt. W. S. Young	1 do	Do do.
Mid. Patterson	1 do	Do do.
Lt. J. B. Dale	1 do	Do do.
Mid. E. Jenkins	1 do	Do do.
Lt. C. W. Morris	1 do	Do do.
W. B. Whiting	1 do	Do do.
Lt. Chandler	1 do	Do do.
J. K. Mitchell	1 do	Do do.
Lt. G. S. Blake	627 per annum	Superintend't, with approval of the President.
D. D. Porter	1 per day	Superintend't, with approval of Secretary of Treasury.
Lt. Todd	1 do	Do do.
S. C. Rowan	1 do	Do do.
Lt. G. M. Bache	1 do	Do do.
Surgeon S. Sharpe	1 do	Do do.
H. C. Flagg	1 do	Do do.
C. W. Chauncey	1 do	Do do.
J. I. Boyle	1 do	Do do.
H. S. Stilwager	1 do	Do do.
D. F. Dulaney	1 do	Do do.
Mid. Lowry	1 do	Secretary of the Treasury.
Mid. Sands	1 do	Do do.
Mid. Ring	1 do	Do do.
W. H. Swift, disbursing officer.	2 50, per comm.	Do do.
B. Gluck	25 per mo. & board	Superintendent.
S. Conrad	44 cents per day	Do.
J. Shiras	25 per mo. & board	Do.
James Campbell	20 do	Do.
James Paul	18 do	Do.
S. Bunce	18 do	Do.

STATEMENT No. 1—Continued.

Names of persons employed on the survey.	Salaries or compensation.	By whom appointed.
G. H. Bishop	$18 per mo. and board	Superintendent.
Joel Griffis	18 do	Do.
Joel Soper	18 do	Do.
H. Stoddart	18 do	Do.
P. V. De Grawe	18 do	Do.
Conrad Hoffman	50 cts. per day do	Do.
H. L. Whiting	25 per mo. and board	Do.
Aaron Vanderbelle	18 do	Do.
M. Risby	18 do	Do.
Z. Scull	18 do	Do.
L. Scull	18 do	Do.
Robert Leeds	18 do	Do.
Enoch Higbee	6 do	Do.
J. T. Smith	18 do	Do.
William Johnson	20 do	Do.
Joseph Lees	18 do	Do.
James Trainer	18 do	Do.
James McKnight	15 do	Do.
Patrick Murlin	18 do	Do.
P. Donohoo	15 do	Do.
A. Smith	18 do	Do.
P. Smidt	25 do	Do.
Gustav's Werdeman	25 do	Do.
Edward Sweeny	18 do	Do.
William Greason	18 do	Do.
E. Krafft	18 do	Do.
T. S. Fillebrown	18 do	Do.
M. O'Brien	18 do	Do.
O. McQuard	18 do	Do.
T. McGurren	18 do	Do.
D. Convoy	18 do	Do.
A. Convoy	18 do	Do.
John Smith	18 do	Do.
Tho. Robinson, pilot	40 do	Do.
Robert Williams	18 do	Do.
Joseph C. Fuller	25 do	Do.
J. Farrell	10 do	Do.
Joseph Milford	16 do	Do.
B. Conway	1 50 cts. per day do	Do.
A. Symington	18 per mo. and board	Do.

TREASURY DEPARTMENT,
Register's Office, January 20, 1842.

T. L. SMITH, *Register.*

No. 2.

NAVY DEPARTMENT, *December* 30, 1841.

SIR: Agreeably to the request contained in the letter of your predecessor, the Hon. Thomas Ewing, of the 30th July last, I have the honor to transmit, in answer to the resolution of the House of Representatives of the 24th June, 1841, (so far as the inquiries therein relate to this Department,) a list of the officers of the navy who have been employed on the survey of the coast of the United States; and, also, to state that the sum indirectly expended upon the coast survey, by the employment of a part of the naval force therein, from the month of September, 1834, to November, 1841, amounts to one hundred and fourteen thousand five hundred and eighty-four dollars, viz:

The difference between the leave of absence pay of the officers employed, and their pay at sea -	$25,725
Amount of officers' rations - - -	9,222
Pay of the crews of the vessels employed -	54,379
Rations of the crews - - - -	25,258
Total - - - - -	114,584

I am, &c., sir, your obedient servant,

A. P. UPSHUR.

Hon. WALTER FORWARD,
Secretary of the Treasury.

List of officers who have been employed on the coast survey, from September, 1834, to November, 1841.

Names.	Names.
Commander T. R. Gedney	Lt. David D. Porter, (as pd. mid.)
Lt. J. T. McLaughlin, (as pd. mid.)	Lt. F. Clinton
Lt. Francis Huger, do	Lt. J. Sterrett
Lt. B. W. Hunter, do	Lt. Richard Bache, do
Lt. A. S. Worth, do	Lt. S. C. Rowan
Lt. T. A. Jenkins, do	Lt. Richard Wainwright, do
Lt. W. J. H. Robertson, do	Lt. George M. Bache
Lt. Joshua Humphreys, (as mid.)	Lt. C. P. Patterson, do
Lt. John Rodgers, (as passed mid.)	Surgeon M. C. Delaney
Lt. George M. Totten, (as mid.)	Lt. Charles W. Chauncey
Lt. John L. Ring, (as passed mid.)	Lt. J. I. Boyle
Lt. Levin Handy, do	Lt. D. F. Dulaney
Lt. Albert Griffith, do	Lt. J. K. Mitchell
Lt. B. F. Sands, do	Lt. William Chandler
Lt. A. A. Holcomb, do	Lt. E. G. Parrott, do
Lt. R. W. Meade, do	Passed Mid. H. H. Lewis
Lt. William A. Ball, do	Midshipman T. H. Stevens

LIST—Continued.

Names.	Names.
Lt. Stephen Johnston	Midshipman Henry Oaks
Lt. John Mooney, (as passed mid.)	Midshipman William E. Newton
Lt. H. S. Steelwagen, do	Passed Mid. John J. Almy
Lt. Henry Moore	Passed Mid. and Lt. W. B. Whiting
Passed Mid. W. A. Bartlett	Passed Mid. John F. Mercer
Surgeon S. Sharp	Passed Mid. and Lt. Wm. S. Young
Lt. Com'g George S. Blake	Passed Mid. O. H. Perry
Passed Mid. J. P. McKinstry	Passed Mid. William C. Lambert
Lt. and Passed Mid. Oliver Tod	Passed Mid. C. C. Barton
Lt. and Passed Mid. B. J. Moeller	Passed Mid. Luther Stoddard
Passed Mid. T. A. Budd	Passed Mid. Francis Lowry
Passed Mid. T. A. M. Craven	Passed Mid. John Hall
Passed Mid. Z. Holland	Passed Mid. T. M. Brasher
Passed Mid. William Blecker	Passed Mid. and Lt. John B. Dale
Midshipman William Craney	Passed Mid. D. R. Crawford
Midshipman A. McLane	Passed Mid. and Lt. Ed. Jenkins
Passed Mid. H. J. Paul	Passed Mid. and Lt. R. C. Cogdell
Lt. and Passed Mid. H. C. Flagg	Passed Mid. S. D. Lavallette
Lt. and Passed Mid. C. W. Morris	Passed Mid. J. N. Barney.

REPORT

FROM

THE SECRETARY OF THE TREASURY,

COMMUNICATING

A report from the Superintendent of the Coast Survey, and of the fabrication of Standard Weights and Measures.

DECEMBER 20, 1842.
Read, and referred to the Committee on Printing.
DECEMBER 21, 1842.
Ordered to be printed.

TREASURY DEPARTMENT, *December* 19, 1842.

SIR: I have the honor to transmit, herewith, a report made to this Department by Professor F. R. Hassler, Superintendent of the Coast Survey, and of the work for the construction of Standard Weights and Measures, showing the progress made during the present year in these works respectively.

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

W. FORWARD,
Secretary of the Treasury.

Hon. WILLIE P. MANGUM,
President pro tem. of the United States Senate.

Report of F. R. Hassler, as Superintendent of the Survey of the Coast, and the construction of standards of Weight and Measure, upon the progress of these works in 1842.

The works of the coast survey have since my report of 2d December of last year, continued in all the different branches with steadiness and assiduity, the same as has always been habitual on the part of every one engaged in the work, notwithstanding the difficulties arising; from the nature of the ground, and other causes, which have required increased attention, and from the intermittent fevers, which have more or less attacked every party of the work at different times. This latter difficulty being local, and well known to increase in proportion as the work proceeds southerly, will in a year or two oblige to change the time of the year to be used for the field works, approaching it always nearer to the winter season; this will, however, make but a slight difference in the general organization of the work, the nature of the changes that may arise from this, or any other accessory circumstances, belonging to the detail administration of the work, are so much less to be de-

Thomas Allen, print.

tailed here, as they are only prospective, therefore as yet undeterminable. The present organization of the work being the same as since many years, is of course fully known, the grounds of it have been deduced in my numerous former propositions for the work, and the series of my yearly reports; it would therefore not be proper to dwell here again upon it.

The tasks executed by the last summer's works in the field are as follows:

For the main triangulation: the extension of a more general scheme of larger triangles southerly, on both sides of the Delaware, over those that have been made with the view to topographical and hydrographical use, and which forms their final element and union.

For the secondary triangulation: to extend preliminary triangles over the upper part of the Chesapeake, which will lead also to the discovery of a proper locality for measuring the second principal base line, and to complete the triangles about both sides of Delaware bay, establish those into the neighborhood of the head of the tides of the Delaware river about and above Philadelphia, &c.

The plain table parties have filled up the greatest part of the ground now intended to be surveyed on both sides of the Delaware, and in other parts of New Jersey.

One of the naval parties has continued the soundings in the Delaware, parallel with the works of the topographical parties on its shores; the other has been extending the soundings out of sight of land, in the quadrangle, which is formed between the coast and the parallels and longitudes of Block island and Cape Henlopen, forming the outer approaches of both the New York harbor and the Delaware bay.

This investigation was carried out till to the Gulf stream, and in soundings till 650 fathoms depth, keeping samples of the nature of the bottom below. The officer operating in this work expressed his full satisfaction with the methods indicated to him, the means he was provided with for that purpose, and the results obtained.

The consideration of the peculiarity of these works can alone make them appreciate the nature of the ground over which they extend, the marshes abounding on both shores of the river, and the great multitude and variability of the channels, shoals, and other impediments, which the Delaware presents, multiply in an equal proportion the works, and the difficulties of them, thence the necessary care, assiduity, and exertions, for both the topographical and the naval parties, in that part of the work.

It was of interest to find out the exact place where the observations of the transit of Venus over the Sun was observed in 1769, at what was then called Cape Henlopen; therefore, on my visit to that neighborhood, I made proper inquiry, and was very kindly shown the place by the oldest inhabitant of Lewiston (Mr. Rodney, formerly Senator for the State of Delaware in Congress), who recollected it, from his having been at the tents of the observers at the time, when he was about five years old. This place was therefore determined by the topographical party operating in the neighborhood, and the results for the astronomical position of the place will become comparable with that which will result in time from the present survey.

In a great part of the early season, the weather was very much averse to the works. The fine weather in the fall, though favorable for the works requiring no distant views, was far less so to the works of the main triangulation than its appearance would have led to expect. The constant dense

fogs, particularly over the Delaware, which the greatest number of the large triangle sides, now in operation, are crossing, caused considerable loss of time.

A great desire having been manifested that the engraving and printing of the map of New York might be accelerated, the necessary measures have been hastened, and in part accomplished, and the work proceeds properly and in the best manner by four engravers, of whom each has his appropriate branch, as the proper organization of such works requires.

The maps resulting will be appropriated to give all the data that may be desired for any improvement in the harbors, or navigation of all the approaches and the neighborhoods of that port, and also to the special simpler wants of the seaman approaching the port, in such form as fits him the best.

A copperplate printing-press has also been procured, which has been employed hitherto, and will also for some time yet be employed, for the necessary intermediate proof-sheets, by which the gradual progress of the work is successively tried and directed. With some improvements which will be added to it, it will then also serve for the ultimate execution of the final printing of the plates.

These operations require just as much the constant attention, and the eye, of the superintendent, as any other part of the works of the survey itself. Therefore the whole is necessarily carried on in the office of the coast survey itself, by an appropriated establishment.

Proper time, care, and an adequate portion of the appropriation, must of course be devoted to it, and much attention and time are required to procure the various materials, as copper plates, paper, and others, of that superior quality which can alone be considered satisfactory for a work of the character which the coast survey shall, also in its outward appearance, present to the public.

When I was in London to procure the first instruments for the coast survey, having seen, about 1812, in Mr. Troughton's workshop, the operations of last finishing and dividing the instruments upon the engine, which necessitated yet the unscrewing of the circles from their axis, in the manner of late Mr. Ramsden's dividing engine, which occasioned always, necessarily, a recentering of the instrument, I suggested to him another manner of constructing the dividing engine, thus:

In the habitual manner of ultimately finishing the axis of motion, and the plane of the circle's limb perpendicular to the same, by turning the instrument upon two points without disturbing it in any way. It is habitual at the same time to draw the circles upon the limb, between which the divisions are intended to be made. These circles become thereby concentric to the motion around the axis. Of this circumstance I proposed to take advantage; to place the instrument concentric to the dividing engine, by constructing the central part of the dividing engine so as to admit the instrument to be divided, with its axis remaining fast to the circle, exactly so as the axis and the plane of the circumference had been adjusted finally upon the lathe, of which centrality the circles traced upon the limb at last form the accurate indicators.

With this view, I proposed that the centre of the dividing engine be made a hollow axis, of such size as would admit within its central opening the axis of any instrument of such diameter as are habitually divided upon engines, when this axis, or any other central part of the circle, is turned

downward, as must always be more or less the case. For the axis, or part of the same, going upward, the habitual distance between the two arms holding the tracing arrangement will generally have room enough to admit its passage upward. The instrument being then placed flat upon the plane of the engine, will present the circles traced upon the limb, which have been made concentric with the axis, so that two compound microscopes can be placed over them in such a manner as to make the views of them constantly tangent to the circles traced upon the limb when turning the engine around the whole circumference. The compound microscopes performing this are attached to a bar crossing over the engine, attached to the bars holding the tracing arrangement, and perpendicular to it. They are adjustable to any diameter.

When, by the moving of the instrument upon the engine, the concentricity of the circles upon the limb with the motion of the engine is obtained, the circle is made fast by any means which its construction most conveniently presents, and it is ready for dividing, in that central position, in the habitual way. The rest of the engine is otherwise similar, in any respect, to that which the late Mr. Troughton has made, and described in the Encyclopedia of Brewster.

When I deduced these ideas to Mr. Troughton he fully approved them, and when, some time after, Mr. Th. Jones, of Charing Cross, London, instrument maker to the King, came to him (in my presence) to ask for advice upon the manner in which he should construct a dividing engine, which he intended to make for himself, Mr. Troughton told him to make it according to my direction, which I then explained to him as above.

When in 1832 the coast survey began again, it was found necessary that an establishment should be in it to enable to keep the instruments required in it always in good repair, not only, but also to construct entirely new ones; for this a dividing engine was evidently required, as the necessity to recur to any mechanician not habituated to the wants of the coast survey work, would never give results well appropriated to our use, and keep the work itself back by delays which would be out of our control and very costly.

Therefore the acquisition of such an engine was immediately authorized by the President, and in consequence it was ordered immediately, and upon my plan of the modified construction, which I have just described.

Mr. Troughton and Mr. Simmons, whom he had in the mean time associated with him, received the order to that effect, but Mr. Troughton died before the engine was finished, and it ultimately arrived here in the course of last summer, after a delay which affords again proof that when a work is to be done requiring mathematical accuracy to a high degree, and to an honorable, useful result, the time to be consumed for it can impossibly be limited—as little as the extreme care and assiduity.

The engine is unique in its kind in this country, and of great value even for the general progress of the art of the mechanicians in this country, besides the services the coast survey will derive from it.

With reference to the appropriation to be proposed to Congress for the coast survey for this session, I take the liberty to suggest the propriety that it shall be again one hundred thousand dollars, which several of the later years have proved to be exactly adequate to the proper and (in proportion to its effect and success in the results), most economical amount of expenditures; though it must be considered that it will have to provide for two springs'

outfits of the going into the field of the surveying parties, and that the expenses are of course increased by the whole amount required for the engraving and printing of the map of New York, &c.; but on another side, the nature of the field work will, it is hoped, allow some reduction in the amount of expenses, and that at the time the appropriation will be made, a small balance of the present appropriation may yet remain disposable.

Upon the standards of weight and measure.

My report of 5th April last upon the liquid capacity measures contains the most essential account of the progress of these works, by presenting again a full finished part of this important work, and such a one as, it is evident, required the most delicate combination of elements of natural philosophy in its organization, and of most careful mechanical skill in its execution.

Since then the works for the balances intended for the State Governments have principally occupied the mechanical part of the establishment. The final adjustment of the dry capacity measures of half bushels will, as I have stated there, be begun as soon as the season will be favorable for it; their mechanical execution is completed.

For any fuller information upon this subject, its history and general bearing, if desired, I take the liberty to refer to the account rendered to the committee to whom that report has been referred in the last session of Congress.

PINEHILL STATION, *New Jersey, Nov.* 17, 1842.

F. R. HASSLER.

COAST SURVEY

APRIL 15, 1842.

Present: Mr. Cushing, Mr. Aycrigg.

James Ferguson examined.

1. Question How long have you been employed in the coast survey?
Answer. Since 10th May, 1833.
2. Question. In what capacity?
Answer. As a principal assistant; one of the three principal assistants.
3. Question. What particular part of the duty do you at present perform?
Answer. Making the secondary triangulation.
4. Question. Who makes the primary?
Answer. Mr. Hassler.
5. Question. Is there any essential difference in the scientific principles of the primary and the secondary triangulation; and if so, what?
Answer. The primary requires an instrument of great power, and of nicer graduation; there is no other difference. There is no difference in the mathematical elements.
6. Question. Cannot any scientific person, who is competent in and well practised in the secondary triangulation, perform the primary?
Answer. The primary requires more mathematical knowledge than the secondary, and greater knowledge of practical means; but to the whole question, I answer, yes.
7. Question. If Mr. Hassler should die, must the survey stop, for want of any person in the survey, or in the country, to take it up and carry it on?
Answer. No.
8. Question. Which has proceeded furthest in advance, the primary or the secondary triangulation?
Answer. The secondary. I add, that the secondary is necessarily imperfect, inasmuch as it depends on the primary for its verification.
9. Question. If the primary had preceded the secondary, might not the latter have been verified as it proceeded?
Answer. Certainly.
10. Question. Why has the primary been allowed to remain in arrears of the secondary triangulation?
Answer. I cannot say.
11. Question. Is not the secondary triangulation sufficiently accurate for all practical purposes in the publication of a map of the work so far as it has gone?
Answer. Yes; for all practical purposes.
12. Question. From what point to what point on the coast have the secondary triangulation and the hydrographical survey been completed?
Answer. The secondary triangulation has been completed from Point Judith, including the sound and both sides of Long Island, to Cape May, covering both shores of New Jersey, and including the whole of the Delaware on both sides; and it also crosses the peninsula to the Chesapeake, where it is now in progress, but not yet completed. I refer to the officers engaged in the hydrographical work for answer as to that part of the question.
13. Question. Do you expect that any perceptible error in the secondary triangulation will be detected by the further progress of the primary?

Answer. I should think the maximum error would not exceed five feet in the whole distance. This I infer from the work already verified, where the error proved to be no greater than this. I refer in this to my own work; but the other may be, for aught I know, more accurate still.

14. Question. Did you use the main triangulation as the basis of your work (the secondary triangulation) when you commenced?

Answer. Yes.

15. Question. Do you not in fact proceed in the secondary triangulation at present in the same manner as in the primary?

Answer. The only difference is the difference of the instruments.

16. Question. You have exhibited to the committee abstracts of the whole work on the coast, from Point Judith to Cape May; what objection is there to the publication of those abstracts?

Answer. The first objection is, that no base of verification has yet been measured; the second is, that we are uncertain as to the difference in any meridian in this country and any in Europe, to a minute and a half in longitude; and the third is, that we have not yet determined the ellipticity of the earth.

17. Question. Is either of those things necessary to give practical utility to the soundings and distances in particular bays or harbors?

Answer. Perhaps not; but the superintendent will of course take care of his character as a man of science.

18. Question. In your opinion, ought the practical use of the work, by its publication, to mariners, to be deferred indefinitely, for the supposed purpose of allowing the superintendent to take care of his character as a man of science?

Answer. No.

19. Question. Has the character of the superintendent as a man of science suffered by the publication of the charts of New Haven and Bridgeport, and Newark bay?

Answer. No.

20. Question. If not, what injury would it do to his character as a man of science to publish a chart of New York harbor?

Answer. None; such a map is now in the engraver's hands, for publication.

21. Question. What injury, by the publication of charts of the whole coast, from Point Judith to the Delaware?

Answer. If it were practicable, none.

22. Question. Do you furnish the points of observation to the sounding parties yourselves?

Answer. They are ascertained by us, reported to Mr. Hassler, and by him furnished to the sounding parties.

23. Question. Do you reduce your own observations?

Answer. Yes, certainly.

24. Question. Have you been engaged in Maryland in 1835?

Answer. No; I came in Maryland in 1839.

25. Question. Was any body else engaged in Maryland in 1835?

Answer. Only Mr. Hassler, with Mr. James H. Alexander, as a mere reconnoissance.

26. Question. Has there been any difficulty in procuring suitable points for observation as far as the main triangulation has proceeded?

Answer. Yes; since we entered the valley of the Delaware.

27. Question. Where first?

Answer. At Mount Rose, near Princeton, in New Jersey; some in opening the line from Newtown; then at Willow Grove and at Stony Hill; some difficulty in connecting Mount Holly with the point below; a good deal at Yards. These obstructions could not have occupied more than five months.

28. Question. When is it you propose to measure a base of verification?

Answer. It is spoken of for this year.

29. Question. Why has it not been done sooner?

Answer. The work has not been sufficiently advanced. It has been thought desirable to obtain such a line on the Chesapeake.

30. Question. What is the present condition of the place of the original base line?

Answer. I have not been there since 1836. Then the beach was considerably washed, but the points were undisturbed. Now, I understand, the beach is changed, and the base in danger; but the elements of it will be preserved by the mountain base, inland from the original base.

31. Question. Will a minute and a half's difference between the European and American meridians show on ordinary maps?

Answer. Yes; it would be about a mile.

32. Question. Why has not this difference, in the course of the ten years since the resumption of the survey, been ascertained?

Answer. I cannot answer that. We have observed eclipses of the sun. We have made no other observations for the longitude.

33. Question. Have the observations thus made been reduced?

Answer. Yes, and calculated. I add, that, if we had considered it a sine qua non to determine the longitude, the time occupied in this way might have retarded the other work.

34. Question. But you have previously said that the want of the determination of this fact was one of the objections to publishing any part of the work.

Answer. I said it was an objection, but I did not mean to be understood as saying that it was an insuperable objection.

35. Question. Is the absence of a base of verification any insuperable objection to the publication of the work along Long Island sound?

Answer. I think not I say no.

36. Question. Is the survey engaged now in measuring an arc of a great circle of the earth, with a view to ascertain its ellipticity?

Answer. That will be one result of the survey, and a very important one, in a scientific point of view.

37. Question. When will that result be reached?

Answer. It should await the measurement of the base of verification.

38. Question. Is it necessary to have measured such an arc, and verified the ellipticity of the earth, before it is possible to publish a map, for practical purposes of navigation, of Long Island sound?

Answer. I think not.

39. Question. Where are the results of the work, so far as completed, now kept?

Answer. In the depot of the survey, at Washington.

40. Question. Are they in duplicate?

Answer. Some; not all. The primary triangulation is all in duplicate. Of the secondary, mine is not. As to the rest, I do not know.

41. Question. Of that which is in duplicate, are both parts kept at the depot?

Answer. Yes.

42. Question. Several of the public buildings at Washington have from time to time been destroyed by fire; is the depot a fire-proof building?

Answer. No; it is not.

43. Question. If the results and other matters in the depot should be destroyed by fire, must not the work be done over again?

Answer. Yes. Precautions have been taken to enable the speedy removal of the papers, if the building take fire, by their being in cases on the ground floor.

44. Question. Of the work in duplicate, why is not one copy deposited for safe keeping in the Treasury Department?

Answer. I do not know.

45. Question. Is all the work in such a state that, if Mr. Hassler should die suddenly, it may be used, and reduced or calculated immediately by others?

Answer. Yes.

FRIDAY EVENING, *April* 15.

Examination of Mr. Ferguson continued.

Present: Mr. Cushing and Mr. Aycrigg.

[NOTE.—To make the evidence more distinct, from question No. 46 to question No. 74, it must be observed, that the statement after No. 74, (marked A,) the statement marked "to be annexed to Mr. Ferguson's evidence," and the statement marked "to be annexed to Mr. Ferguson's testimony," together with the chart of Newark bay, referred to in question No. 48, were presented at the beginning of this meeting; the statements having been previously prepared, in writing, by Mr. Ferguson, in answer to questions put to him by the committee at the previous meeting.]

46. Question. Is there any substantial and adequate reason why the mathematical elements of the work should not be published as parts of it are completed?

Answer. No other but that it will require time to put them in order.

47. Question. At what time in each season do you take the field?

Answer. This is stated in the schedule annexed, and marked A.

48. Question. There is shown by you a published chart of Newark bay, purporting to be an extract from the United States coast survey; is there any meridian on the map? (Annexed, and marked B.)

Answer. No.

49. Question. Is the latitude or longitude of any part of it given?

Answer. No.

50. Question. What is the length of Newark bay, as stated in this map, from Shuter's island to the confluence of the Passaic and Hackensack rivers?

Answer. It is, by the scale of the map, five miles and eighty-two-hundredths. But the scale is an erroneous one, and was not published or verified by the superintendent. The actual distance between the two points specified is five miles and six hundred and twenty-three thousandths, obtained by me by measuring on the original topographical map.

51. Question. Please to inspect the map of Newark bay, which is now shown to you, marked C.

Answer. It appears to be the same map, engraved from the same plate as B; but the scale is different, and is at the same time erroneous. It seems to be written $\frac{1}{20000}$ instead of $\frac{1}{10000}$, or erroneous in the proportion of 2 to 1, or about that.

52. Question. If the chart of New York, or any part of the coast, be

published, do you apprehend any dangerous error would be introduced by map sellers?

Answer. If published without care, there would, undoubtedly.

53. Question. Is it considered judicious to suppress the results of the survey, through fear that, if published, map sellers may make errors in copying the maps for sale?

Answer. No.

54. Question. Is the survey of any practical use, unless published?

Answer. Yes; in the experience acquired by the officers of the navy and others engaged on the survey. I am not aware of any other.

55. Question. Do you understand the proper uses of the survey to be confined to the instruction thus acquired by the officers engaged in it?

Answer. No; the uses are a knowledge of the coast for commerce and navigation, and a communication of it by a publication of the maps.

56. Question. Can the survey be of any practical use to the country at large, without the publication of charts and maps?

Answer. Certainly not.

57. Question. Where are the instruments used by you repaired?

Answer. At different places, but generally at the office of the survey here.

58. Question. Have you had any difficulty in procuring repairs at other places?

Answer. I have scarcely ever had occasion for repairs; I should think not exceeding five dollars in amount since 1833, when I entered the survey. All my instruments are of European manufacture. They are good instruments.

59. Question. What necessity is there of plane-table parties, except near the coast?

Answer. No absolute necessity, except for the secondary triangulation near the coast.

60. Question. How far in from the coast have plane-table parties gone on the survey?

Answer. I cannot say precisely. They are carried on by Mr. Gerdes, Mr. Sands, Mr. Boyd, Mr. Dickens, and Mr. Werner.

61. Question. Do the plane-table parties require much science?

Answer. They require practical skill.

62. Question. When a secondary triangulation precedes the primary, is it not a second without a first?

Answer. Technically, it is.

63. Question. Is it not working wrong end foremost for a secondary to precede a primary triangulation?

Answer. I think not, because the secondary loses none of its accuracy by the primary following it.

64. Question. Can you ascertain what the errors of the secondary are until you have the primary?

Answer. No.

65. Question. How are your distances measured?

Answer. In French metres. It is not the standard of the country, but it is the standard best authenticated, and best known in geodetic operations. Our standard is the English yard. The foot is the most common measure used in this country, both for scientific and practical purposes.

66. Question. Is the metre in common use in this country in any way?

Answer. No.

67. Question. Is it not as easy to convert yard measure into metres as metre measure into yards?

Answer. It is the same thing.

68. Question. In that case, what benefit is there in having the work of the survey in metres?

Answer. None but what I have given before.

69. Question. What is the standard used in the English survey?

Answer. Either the English yard or foot.

70. Question. What is the object of the proposed second base line?

Answer. To verify the work.

71. Question. Cannot the work proceed north and south at the same time?

Answer. Not at present, without a larger appropriation and more persons; at least, that is my opinion.

72. Question. Have you a general knowledge of the configuration of the coast?

Answer. Yes, to Cape Henry.

73. Question. On what part of the coast, north or south, can the work be carried on most easily?

Answer. At the north, by reason of the nature of the coast.

74. Question. Of how many points on the coast has the survey ascertained the latitude and longitude?

Answer. I should think my own points were five hundred; and, altogether, a thousand.

A.

Year.	Time of taking field.	Time of going home.
1833 - -	May 10 - -	December 28.
1834 - -	February 20 - -	December 3.
1835 - -	April 6 - -	January 10, 1836.
1836 - -	May 1 - -	December 9.
1837 - -	April 25 - -	November 25.
1838 - -	May 20 - -	November 19.
1839 - -	April 15 - -	November 29.
1840* - -	June 16 - -	December 22.
1841 - -	February 15 - -	December 12.

It must be understood that these dates are given from recollection, and can only be relied on as accurate within a day or two.

*This year I was detained longer from field work, to calculate triangles necessary for the map of New York.

Number of stations made in each year.

In 1833 - - - - -	24
In 1834 - - - - -	64
In 1835 - - - - -	26
In 1836 - - - - -	28
In 1837 - - - - -	13
In 1838 - - - - -	10
In 1839 - - - - -	15
In 1840 - - - - -	16
In 1841 - - - - -	7
	203

[To be annexed to Mr. Ferguson's evidence.]

To the question of the committee, "What is the distance between Shuter's island and the point at the confluence of the Passaic and Hackensack rivers, and what the mean width of the bay of Newark?" Mr. Ferguson answers:

That the distance between the above points is 5.623 statute miles, and the mean width of the bay of Newark 1.37 mile.

That on a map of the said bay, printed at the request of the collector of Newark, the distance between Shuter's island and the point between the Hackensack and Passaic is 5.82 statute miles; but that this map has an erroneous scale attached to it, and was not published or verified by the superintendent of the survey. The map appears conformable to the original of the survey, but the scale given for it is incorrect.

To the question of the committee, "How many points were determined in 1833 in the main triangulation, and what distance were they apart; what extent of country did they cover; what number in 1834, 1835, 1836, 1837, 1838, 1839, 1840, and 1841; and what extent of country do they cover?" Mr. Ferguson answers:

That the part of the question *as to the distances "apart"* is answered by giving, in the following schedule, the length of the longest and shortest lines of the survey each year; that it is difficult to divide the works of successive years from each other; and that the computations are given in gross in square statute miles, presuming that the committee merely wished an approximate and comparable estimate.

In 1833, length of longest line, miles -	41.3	Square miles covered, 1,350
length of shortest line, miles -	7.2	
In 1834, 1835, and 1836, though other stations were occupied, the primary triangulation did not cover any additional space.		
In 1837, length of longest line, miles -	20.69	Square miles, 318
length of shortest line, miles -	8.73	
In 1838, length of longest line, miles -	38.41	Square miles, 300
length of shortest line, miles -	23.29	
In 1839, length of longest line, miles -	31.00	Square miles, 1,070
length of shortest line, miles -	10.93	
In 1840, length of longest line, miles -	18.51	Square miles, 209
length of shortest line, miles -	12.30	

In 1841, length of longest line, miles -	31.02	Square miles, 330
length of shortest line, miles -	17.07	
Square miles covered by whole primary triangulation -		3,577

It is but fair, and perhaps also necessary, to state to the committee that the effect of the primary triangulation, in the progress of the survey, is not properly estimated by the number of square miles within the polygon which it makes, but by the quantity of secondary triangulation for which it afforded the bases. In this view of the subject, the number of square miles covered in each year would be much increased.

[To be annexed to Mr. Ferguson's testimony.]

1833—Buttermilk.
Round.
Bald.
Tashua.
Mount Carmel.
Ruland.
West Hills.
1834—Base measured.
1835—Reconnoissance in Maryland.
1836—West Hills.
1837—Ruland.
East base.
West base.
Harrow.
1838—Weasel.
Springfield.
1839—Bear on Hill.
Disborough.
Stony Hill.
Mount Rose.
Newtown.
Willow Grove.
1840—Willow Grove.*
Mount Holly.
1841—Yard.

Upon the examination of Mr. Ferguson.

The captious questions 5 till 10, inclusive, could of course not elicit any thing; the answers prove it.

Answer to question 11. Mr. Ferguson mistakes.

The answer to 13 would be best calculated over again, as the result indicated needs verification.

Answer to question 15 enters under the same predicament as from 5 to 10.

Answer to question 16 is very right; but answer to 17 subjects it to a personal modification, which it ought not to do, as the principle in itself is fully decisive; the question itself is badly styled.

Question 18 is grounded upon the bad turn in which question 17 had been placed; thence the 19th and 20th are of no value.

Questions 21 and 33. It is well known: that not all can be done at once; the work has always been carried on with the full celerity which the disposable means allowed.

From all the questions 22 till 27, the committee could in no way expect any valuable information.

Answer to 28. I thought Mr. Ferguson knew better.

Question 30. The care of the base-line monuments is given into specia instruction to the light-house keeper of Fire Island beach, by the collector

* The station of Willow Grove was occupied both in 1839 and 1840.

of New York; when I was there last, only in one place, near two-thirds of the line, the water had washed in, as far as to go across the measured line, at high water, but the line is fully secure.

Answer to 35 is not sufficiently reflected and cleared up, because, for a part of the district in question, work is actually in doing, while it is proper, in good principle, to go on only gradually to further distances.

Question 36 shows again great anxiety, lest the coast survey might lead to an *honorable scientific result;* after this, the questions until up to 42 are evidently useless.

To question 42 an answer might be given, speaking very much for the safety of the coast survey office against fire, which I told to a member of the committee.

The rest of that 1st examination is trashing straw.

Question 46 to 52, inclusive, are void in all possible respects.

Question 53 must be discussed again here, as it seems it is insisted upon by the committee: that the money of the nation shall be spent for the benefit of chart sellers, and the public confidence in the work, therefore the *security of the utility of its results*, be thrown in the wind.

A proper organization of this subject will be proposed in due time, when the state of the work will dictate the regular series of publications, it is of no use to speak now nearer upon it, than to state: that if no regular order and arrangement is made in this respect, the maps which may be given out will be *vilified*.

The questions 54 to 56, inclusive, are miscarried catches.

Questions 57 and 58 appear to have been dictated by an instrument maker out of work, for they cannot serve the work in any way.

Questions 59, 60, 61, 62, 63, 64, 65, 66, and 67, prove that the committee was fatigued in inventing questions, and had thrown itself into a vicious circle, which Mr. Ferguson ultimately solved, in the answer to question 68, by referring back to what he had said before.

The answers to questions 69 till 74 must have been highly instructive for the committee, as they offer much field for speculation without bottom. The discussion upon the Newark bay map, requested so minutely from Mr. Ferguson, shows evidently a high degree of research upon mathematical accuracy, and similar subjects, which exceeds itself again, when it comes to determine the square miles covered by triangles who have but three corners, as well explained at the end of the article.

F. R. HASSLER.

Washington City, *January*, 1843.

Friday Evening, *April* 15, 1842.

Present: Mr. Cushing, Mr. Aycrigg.

Examination of Mr. Blunt.

1. Question. Do you know any sufficient reason why maps and other results of the survey should be withheld from the public knowledge?

Answer. None, when they are in sufficiently complete state to be useful to navigators.

2. Question. Is any part of the survey sufficiently complete for that now?

Answer. Yes.

3. Question. How much?

Answer. New York harbor is being reduced for the engravers. Long Island sound is capable of being reduced from Point Judith to New York. The outer coast is already complete, so far as expressed, from Montauk point to Great Egg Harbor, I believe, with exception of off-shore soundings.

4. Question. How far inland from the coast has any part of the work been carried?

Answer. I am unable to say, except in regard to the secondary triangulation, which I have in part conducted. I am one of the principal assistants.

5. Question. Are you acquainted with hydrographical surveys in England?

Answer. Yes.

6. Question. Do they publish results as soon as ascertained?

Answer. They are published in sheets so soon as completed, to be useful to navigation.

7. Question. Can copies or information be obtained by individuals?

Answer. Yes; I have known copies to be obtained repeatedly for my brother, who is a chart seller; as from the Thunder and from the Blossom.

8. Question. Does the hydrographical office in England derive any profit from the sale of the charts?

Answer. I think £200 or £300 per annum. The charts are published under the direction of the Admiralty, with the seal of the Admiralty to authenticate them.

9. Question. Have you applied at any time, as an individual, to the hydrographic office?

Answer. Captain Beaufort offered to give me personally any information I desired. This was when I was a private individual, before being connected with the survey.

10. Question. In your opinion, could the work be extended north and south at the same time?

Answer. It might, with more force; and with the present force, if the line of verification were not to be measured. We can proceed more rapidly at the north than at the south with the triangulation.

11. Question. In going south, do you apprehend any difficulty in the hydrographical part of the work, as distinct from the topographical? Cannot the mere coast survey be prosecuted without leaving the coast and going inland?

Answer. No.

12. Question. How do you propose to survey the coast of Virginia?

Answer. By carrying a series of triangles down the Chesapeake bay, and by extending them up or down the valleys of the rivers, as circumstances will allow.

13. Question. What natural elevations have you in lower Virginia?

Answer. None of any consequence.

14. Question. What do you propose to use as a substitute?

Answer. Artificial elevations and signals.

15. Question. In what way do you propose to triangulate the region of Dismal Swamp, and similar regions of country?

Answer. I have no knowledge in regard to that region.

16. Question. Are we not greatly deficient in knowledge of soundings in Buzzard's bay, Nantucket shoals, Cape Cod, and Massachusetts bay?

Answer. Yes.

17. Question. Is not a knowledge of those soundings of the greatest importance to navigation?

Answer. Yes; it is more wanted there than any where else. More tonnage passes. Most vessels from Europe, for New York and Philadelphia, come between the Gulf stream and Nantucket shoals, in addition to the navigation north of Cape Cod. Most of the coasting trade comes through the Vineyard.

18. Question. What amount of work or repairs have you had done in the office here to instruments?

Answer. Nothing but the mounting of one telescope, which came from Europe without a stand. I have had no difficulty in obtaining repairs elsewhere, if needed.

19. Question. Should you think it necessary to have a mechanician with you in the field?

Answer. To measure the base line it might be desirable; not otherwise.

20. Question. Was any copper imported for the engraving from Vienna?

Answer. Yes.

21. Question. Was it used?

Answer. No.

22. Question. Why not?

Answer. It was not considered suitable.

23. Question. Can good copper for engraving be procured in this country?

Answer. Yes.

24. Question. Have you had any practice as an engraver?

Answer. Yes.

25. Question. Can impressions be taken from a plate in an unfinished state, to show the progress of the work?

Answer. Yes.

26. Question. Can impressions be taken from the plates now engraving in the survey?

Answer. Yes, without injury to them.

27. Question. How long will it take to furnish the eight plates of the harbor of New York, with the present force, at the rate it now goes on?

Answer. I cannot state by conjecture. I should think about three years.

28. Question. Is it not possible to have the work done accurately and more rapidly than at present, if more hands were put on the work?

Answer. Yes.

29. Question. Is it necessary to have a workshop for the repair of instruments at the office?

Answer. I am not able to say. There are some instruments for which it is convenient.

30. Question. In what time could the New York map be finished?

Answer. There might be an engraver for each plate.

31. Question. Of what use are the plane tables, so far as regards navigation?

Answer. I do not consider it of any use to extend the survey any further back than the slope of the hills at the head of navigation.

32. Question. Are the plane tables further back?

Answer. I do not know how far back. I presume they are.

33. Question. What is the signification of the words "primary triangulation?"

Answer. They signify the main series of triangles on which any work to be surveyed is based, extending as far as possible throughout the work.

34. Question. What is a secondary triangulation?

Answer. It is a series commenced within the primary triangles, extending in whole or in part through the same, and dependent on the primary series.

35. Question. Is it possible for a series of secondary triangles to exist where there are no primary ones?

Answer. No.

36. Question. Is not the use of secondary triangles for plane-table parties to furnish detailed points?

Answer. Yes.

37. Question. If in any work there be but one series of triangles, does any such fact exist as primary and secondary?

Answer. No.

38. Question. When you commenced, was not the secondary triangulation intended to be, as the name imports, secondary to and within a primary triangulation?

Answer. Yes.

39. Question. Is it so now?

Answer. East of New Haven I have extended a main triangulation to Newport, and filled up the same with a secondary series of triangles.

40. Question. Is the main triangulation determined by Mr. Hassler, and ending at Yards and Mount Holly, of the same nature as the main or as the secondary triangulation by you, east of New Haven?

Answer. The same as the main triangulation by me, east of New Haven.

Remarks upon the testimony of Mr. Blunt.

Answer to third question. I should have expected Mr. Blunt better informed upon the scientific requisites, to admit fairly publications of maps of an extent of coast, than he shows, by this answer. The extent of coast cannot *honestly* be published before the system of primary triangulation is positively enclosed between two bases, filled with the main triangulation between them, because this is *absolute requisite of the proper location.*

The individual maps of bays &c., are all that can be given to the public with propriety, upon special call, as has always been done hitherto, in any of the parts of the country actually enclosed in a finished system.

Answer to sixth question. In England they have the *main triangulation before them fully executed, since before the end of last century;* they can therefore work in any place, grounding upon that part which is near to any harbor, bay, &c., and are enabled by that to give it to the public by piecemeal, which is not allowable, where the *triangulation is not* made beforehand. It will, besides, be found: that this piecemeal communication is all, and the full coast map *I wish yet to see!*

Answer to questions seventh and eighth. These show evidently that in England, *as properly due,* the authentic maps of the survey are not delivered over to *chart sellers,* but that they must, *as proper, purchase them from the office,* and that is the only *honest way* of doing. Mr. Blunt, who gives the answer, is the head of the firm of *Edmund & G. W. Blunt,*

chart sellers, in New York. Why he does deny his partnership is for him to answer.

Answer to eleventh question. Is properly answered by a flat: NO.

Questions twelve, thirteen, fourteen, fifteen, sixteen, and seventeen, are useless, being, as prospective, without any principles, and ill placed, as proves all this.

Answer to questions eighteen and twenty-nine. It is evidently not to be asked the partner of a seamens' instruments repairing shop *any question* about a part of the coast survey establishment, so indispensable for a work of the extent of the coast survey, as the establishment to keep the instruments in constant good order, and make such works as I must require for my own use. *No man* can judge upon the full extent of the value of that establishment *but myself.* From a rival who expected to have these works as an accessory, *of right,* to his share, there could be no expectation of an appropriated answer.

Question nineteen. Shows the ignorance of the questioner and answer.

Answer to question twenty-three. It is well known to the person answering, that the copperplates can be *procured in this country,* but that they are *imported from abroad,* the importers often putting their own names upon the plates, as *he offered it to me himself.* The actual state of things I have explained elsewhere; the full truth is withheld.

Answer to question thirty. Shows the ignorance of the man who can say that there could be an engraver to each plate. If he knew the very first principles of the organization of an engraving establishment, he would state that the work must be distributed according to its *kind,* as done in the survey, and each kind of work, of *each plate,* to pass through the competent hand purposely engaged for it, and *not each plate a man,* as little as the same assistant makes the secondary triangulation, the plane table, and the soundings, in the same quarter. How the plates are distributed I have stated elsewhere.

Answer to questions thirty-one and thirty-two. It is expected that, upon such subjects, the direction of the superintendent, who oversees the whole extent of the work, deserves more attention than that of an assistant, who sees, *of course, distinctly only* within his limits.

Answer to question thirty five. The simple *no* says nothing. Mr. Blunt ought to have been suffered to explain, as I doubt not he would be able, that the secondary triangulations are allowable to be extended as well *within* as *without* the main triangulation, to a *certain limit,* with the same certainty, and that, therefore, in both cases, the main triangulation is equally the guide of the secondary.

Answer to questions thirty-six, thirty-seven thirty-eight, thirty-nine, and forty. All this is so asked, and so answered, as to bring out no proper information; it stands slant; as it refers to the further prosecution and organization of the work, it is entirely out of place to enter into any explanation prospectively.

F. R. HASSLER.

WASHINGTON CITY, *January* 1843.

APRIL 30, 1842.

Present; Mr. Cushing, Mr. Aycrigg.

Examination of Captain Swift.

1. Question. Are you employed in the coast survey; and if so, in what capacity, and since what time?

Answer. As an assistant, since 4th April, 1833. I am also the disbursing agent, since about 2d July, in the same year.

2. Question. Will you furnish to the committee an exhibit of the expenditure on the survey for the years 1841 and 1842; say of the appropriation of March, 1841, classifying the same so as to show the amount expended on the maritime, and the amount on the land part of the work; the amount on the primary and secondary triangulation, and on the plane tables; the amount for salaries, and for expenditure at the bureau; and in the same way of any and all other conveniently specified classes of expenditure?

Answer. The answer is annexed in the papers marked A 1 and A 2.

3. Question. Will you furnish to the committee a copy of a printed pamphlet on the coast survey, distributed among the members of the House in February last?

Answer. The pamphlet is annexed, (marked B)

4. Question. Is there any sufficient reason for suppressing or omitting to publish the results of the survey as thus far ascertained, and as the same may continue to be obtained?

Answer. No, I think not.

5. Question. May not maps of specific completed parts of the survey be published, while the work is in progress on other parts of the coast?

Answer. Yes.

6. Question. Of how large a part of the coast is the survey now so far completed that such maps might be published?

Answer. The whole of Long Island sound, including both sides of Long Island, New York harbor, and a portion of the northern part of New Jersey, coast and interior.

7. Question. Might not the soundings, position of headlands, and the like, of all so much of the coast, be now published?

Answer. Yes.

8. Question. Is there any sufficient reason for withholding from Congress the mathematical elements of the survey, so far as completed?

Answer. No.

9. Question. In whose possession are those facts and *data* at this time?

Answer. They are at the office in Washington, so far as completed, and except so far as parts of the work now in progress are in the hands of the assistants.

10. Question. Are there duplicates of the observations, measurements, and other unpublished elements of the survey?

Answer. There are of parts, but I think not of the whole.

11. Question. Are the elements of the base line, and of other primary and essential parts of the work, in such form and situation as to be secure from loss by fire or otherwise, and be capable of being handed over to and understood by any competent successor of Mr. Hassler?

Answer. All this is in duplicate in the office, accessible to the assistants, and susceptible of being understood and used by them. No part of this has been published except the final result of the base measurement. The details have not been published. The papers are subject to the hazard of fire; but not more so, and perhaps less, than in some other buildings in Washington.

12. Question. Is there any objection to depositing one of the duplicates in each case in the safes of the Treasury Department?

Answer. No.

13. Question. Would not this be proper, to guard against accidents?

Answer. It certainly would add to the security.

14. Question. In what way are the principal duties of the survey subdivided between the superintendent and his assistants?

Answer. The duties of Mr. Hassler, in addition to the general supervision of the work, are the main triangulation, while the assistants are employed in the secondary triangulation and detailed surveys.

15. Question. Is the main triangulation in arrears of the secondary; and if so, why?

Answer. It is. I am not aware of the reason, except the illness of Mr. Hassler, and his inability to do it, caused thereby.

16. Question. Cannot that work be performed by one of his assistants?

Answer. Yes.

17. Question. How long has Mr. Hassler been so ill as not to be able to attend to that work?

Answer. It was in October of last year that he became ill. He was also ill the preceding year, in September.

18. Question. What prevented his taking the field and performing the work in the spring and summer of those two years?

Answer. I am unable to say.

19. Question. What sum is allowed to Mr. Hassler, annually, for expenses, exclusive of compensation?

Answer. Salary $3,000, and expenses $3,000.

20. Question. For what expenses is this $3,000 designed? Is it for personal expenses?

Answer. I suppose it is the expenses of living.

21. Question. Is he paid for other expenses when he goes into the field?

Answer. He is furnished with an instrument carriage and horses for the instruments and himself, and a baggage wagon besides, for instruments, at the public expense.

22. Question. Is it the same carriage which he is accustomed to use in Washington?

Answer. Yes.

23. Question. Are horses and men paid at the public expense for the carriage and wagon through the year?

Answer. Yes; four horses, one permanent driver, and one other man, who also assists about the office.

24. Question. Please to specify, in the answer to the 2d question, the whole of the expenditures on these carriages, horses, and men, as are of the classes of expenditures therein referred to.

Answer. It is contained in the paper annexed, and marked A.

25. Question. What are the precise duties performed by Mr. Hassler during the chief part of the year, in which he remains at Washington?

Answer. The weights and measures, and the computation of his own field work, and occasional general computation.

26. Question. Do not the assistants reduce and compute their own work?

Answer. Yes.

SATURDAY, *May* 13.

Present: Mr. Mallory, Mr. Cushing.

Continuation of the examination of Captain Swift.

27. Question. Do you wish to add any explanation to the papers now produced in answer to the 1st question, and marked A 1 and A 2?

Answer. In comparing the accounts in the papers marked A 1 and A 2, and in the printed sheet B, there is a discrepancy in the sums, assigned to the secondary triangulation and plane-table parties, respectively. The manuscript (marked A 1 and A 2) is the later and correct statement, the statement in B being an approximate estimate, made up before the complete settlement of the accounts.

28. Question. Does the whole amount expended pass through your hands, and how is it drawn from the Treasury, and on what vouchers paid?

Answer. All the expenditure for work on shore passes through my hands, also the per diem allowance of the officers on board the vessels, and the extra compensation of the lieutenant commandant; but the other payments, in the hydrographical part of the work, do not pass through my hands, being made by the commander of the vessels. The money expended by me is received by me from the Treasury, on requisition made by me on the Department. All the disbursements, except for salaries, &c., fixed at the Treasury Department, are made under the authority of Mr. Hassler.

29. Question. Who prescribes the number of subordinate persons to be employed, and the amount of miscellaneous expenses to be incurred?

Answer. The assistant in charge of each party, subject to the control of the disbursing officer.

30. Question. Who appoints the persons employed in the survey?

Answer. Mr. Hassler.

31. Question. Who fixes their compensation?

Answer. If below $1,000, Mr. Hassler; if more, it is referred to the Department. Such is the practice, so far as I know.

32. Question. Is it necessary to have an instrument maker's shop in the survey?

Answer. I think it is both economical and convenient. An amount of work was done there the last year fully equal to the cost of maintaining the shop.

33. Question. Cannot some portion of the topography of the survey be dispensed with without detriment to the hydrographic part of the work?

Answer. I conceive that the plane-table survey is useful, but it may not be necessary for any hydrographical object that it should be so far extended.

34. Question. What, then, is it useful for?

Answer. I do not know any thing, except that it contributes to a more exact knowledge of the topography of the country adjacent to the coast.

A 1.

Statement of the expenditures made for the survey of the coast of the United States, and for engraving the chart of the harbor of New York, during the year 1841 *and a part of* 1842.

Amount expended by Captain W. H. Swift, from 1st January, 1841, to 31st December, 1841	$80,639 13	
Amount expended by Commander Thomas R. Gedney, 17th May, 1841, to 31st March, 1842	9,162 42	
Amount expended by Lieut. Commandant Geo. S. Blake, 11th March, 1841, to 28th February, 1842	4,766 77	
		$94,568 32

Details of the expenditures.

For the main triangulation, including the compensation of the superintendent, the heliotropers, and hands employed therein, and all incidental expenses, except horses, wagons, and harness, and repairs of same, and pay and subsistence of driver	$9,289 87	
For horse keeping, (4 horses,) repairs of one instrument carriage, one wagon, harness, and pay and subsistence of driver	1,445 98	
		$10,735 85
For the secondary triangulation, including the compensation of the assistants, heliotropers, and hands employed therein, and all incidental expenses, except horses and wagons, harness, and repairs of ditto	20,656 14	
For horses, horse keeping, repairs of wagons, and harness, pay and subsistence of 2 drivers, (3 wagons and 5 horses)	2,160 74	
		22,816 88
For the plane-table surveys, including the compensation of the assistants and the hands employed therein, and all incidental expenses		17,912 99
For the hydrographic surveys: Amount paid by Capt. Swift to the naval assistants, for the authorized allowance of $627 per annum to the lieut. commandants, and of $1 per day to the lieutenants and passed midshipmen	8,644 94	
For amount paid by Commander T. R. Gedney, from 17th May, 1841, to 31st March, 1842, for repairs of 2 vessels, sails, boats, pilotage, and incidental expenses, (Washington and Jersey)	9,162 42	
For amount paid by Lieut. Com't G. S. Blake, for same from 11th March, 1841, to February 28, 1842, (schooners Gallatin and Nautilus)	4,766 77	
		22,574 13

For expenses of the coast survey office, including rent, fuel, lights, and attendance - - - - - -	1,999 17
For expenses of the instrument maker's shop, including the compensation of the persons employed therein, and the cost of tools and materials purchased for same - -	2,318 11
For compensation and expenses of the persons employed in engraving the chart of the harbor of New York - -	2,011 14
For the *general expenses* of the work, including the compensation of all assistants and others not embraced in the preceding schedule, and all purchases and expenditures not specified in same - - - - - - -	14,900 75
	94,568 32

W. H. SWIFT,
Disbursing Officer Coast Survey.

WASHINGTON, *May* 4, 1842.

To Captain Swift's examination.

To questions 4 and 5, the answer does not enough distinguish between the different state of the different parts of the work. Bays, harbors, &c., single detached parts may be given out, like detailed plans of country, disconnected with the general work of the map; but it is positive destruction of the work to publish extents of the coast before a full system between two bases, and two astronomical main stations, at considerable distance, is completed and joined by the main triangulation.

Questions 6, 7, and 8, are entirely erroneous in their application. The reports contain all that is proper to be published; nothing proper to publish is withheld.

Questions 12 and 13. There is so much of economy spoken, and still in this an expense is proposed, entirely useless, and in many respects improper, on account of bad consequences, that might come from it, without giving *means* to increase the work.

Answer to 14. Forgets entirely that there is a scientific part in the work, which cannot be made without work, and which I attend to; that it is found valuable by men of science, is published by them, and even can be witnessed.

Answer to 15 and 16. Notwithstanding I was sick at yards, *I never missed a single observation possible;* Captain Swift was not then present at the station, (Yards.)

Answer to 18. I was the two years kept from going out by reports asked, standards finishing, &c.

Answer to 33. The question being made only as a catch, it ought to have been remarked: that, without the topography to a certain distance, it would, in many cases, not be possible to determine upon which side of the lines there lies water or land; the distance to which the topography must go cannot otherwise but be left to the operator. It is positive nonsense only to treat that subject; in modern science and surveys it is well known what is meant; only *the sea-charts of the lowest grade* of former times are without topography.

NOTE.—The publication questions should also be answered from the side that all persons engaged in the coast survey are actually employed, and that if more should be published, more men would have to be appointed, or other actual survey work must be neglected for it, as the appropriation is a determined quantity, within which the work is to be done.

It is well known that of all the coast-survey and weight and measure works, *not even the slightest means existed*, and that when attempted in any other way, but *by me*, it always signally *failed*. Now where is the justice and reason to disbelieve my organization, and statements, and to suffer to be guided by imperfect knowledge, but can really any good come out of such a course?

F. R. HASSLER.

WASHINGTON CITY, *January*, 1843.

MAY 2, 1842.

Present: Mr. Cushing, Mr. Aycrigg.

Examination of Captain Thomas R. Gedney.

1. Question. Are you an officer of the navy?

Answer. Yes.

2. Question. Are you now employed in the coast survey; and if so, since what time and in what capacity?

Answer. I have been employed in it since October, 1834, in charge of one of the hydrographical parties.

3. Question. How many of such parties are there?

Answer. Two. The other is commanded by Lieutenant Blake.

4. Question. How many persons, and what vessel or vessels, are employed in your party?

Answer. Last year I had two vessels, the schooner Jersey and the brig Washington, with, I think, fourteen officers, all told; and, I believe, thirty-two seamen and forty-four boys. This amount of force was necessary.

5. Question. What surveys have you made since October, 1834?

Answer. I have been engaged in making soundings. I commenced in Fire Island bay in 1834; then the outer coast of Long Island, in 1835, from Fire island to near New York; then the harbor and bay of New-York, and to Montauk point, along the outer coast of Long Island, in part of 1835 and in 1836 and 1837; in 1838 and 1839, from Fisher's island to Block island and Point Judith; in 1840 and 1841, on the coast of New Jersey, as far as Egg Harbor. These soundings include also all the inland navigation from Fire island to Egg Harbor. In addition to this, in 1841, I performed a piece of detached work between Cape Henlopen and Cape May.

6. Question. Have you completed the soundings along the whole extent of coast from Point Judith to Egg Harbor?

Answer. Yes.

7. Question. Are those soundings, as verified by you, in a condition to be published?

Answer. Yes.

8. Question. Do you make any astronomical or other observations on the coast?

Answer. No, except so far as may be needful to keep my own time.

9. Question. Have any views of the coast been taken by you or from your vessels?

Answer. Yes. Mr. Farley has taken a panoramic view of the whole of Long Island and of all the light-houses wherever I have sounded. We have taken no other views, except of the entrance of the new channel in New York harbor.

10. Question. Is the coast of Long Island an easy or a difficult one?

Answer. I think it an easy one myself.

11. Question. What is the chief occasion of wrecks on Long Island?

Answer. When vessels are running in, and are caught by a heavy south-easter, it is difficult to get out, from the trending of the two coasts of Long Island and of New Jersey, and the current setting from New Jersey coast, by reason of which vessels, being thus embayed, are apt to be driven on shore.

12. Question. Have you sounded Jamaica bay?

Answer. Yes, in 1835.

13. Question. What depth of water did you carry into that bay?

Answer. Six feet at low water, eleven and a half at high water, in common tides. At the present time, the depth at low water is seventeen feet.

14. Question. Would not the knowledge of the actual depth of the water in the channel leading into Jamaica bay be useful to a vessel which was unable to claw off the coast?

Answer. Yes; it might preserve a vessel from being stranded.

15. Question. What amount of repairs of instruments have you had done at the office of the coast survey?

Answer. I cannot say.

16. Question. Have you had other repairs done elsewhere; and if so, by whom, and to what amount?

Answer. I have had repairs done for our, or my, party, the last year, to the amount of forty or fifty dollars, by Mr. Montandon, and by George Blunt, of New York, it having been convenient to have this done on the spot there.

17. Question. How far inland do any of the points extend which you have used, as furnished you by any of the triangulating parties?

Answer. Some of them have been from ten to twelve miles inland. They were used for measuring angles from the vessel and from different points. The points which I occupied for measuring were generally on the coast, within a quarter of a mile of the beach.

18. Question. Please to describe your mode of proceeding in this respect.

Answer. I have three officers on shore, at three different stations, with a sextant and a watch each, and a boy with a spyglass also to each station. I then am anchored or lying to off shore in my vessel. I make a signal in the morning, when I get under way, to commence work, I knowing that the men are at their stations by their hoisting a signal flag for that purpose. I commence by running up a signal; so soon as the signal starts from the mast head, the officers on the shore measure the angle between the brig and one of the stations, and the officers on board the brig, two of them, then measure each of them an angle between the stations on shore,

so as to give in all five angles; each officer, as well on shore as on board, marking the time, to see that they agree. Meanwhile I am taking my soundings, on the change of which the signals are repeated and new angles taken as before. In these observations I consider the vessel as a fixed point. This system of operation I have been able to carry out as far as twelve or fourteen miles seawards, which is the greatest distance I have gone. I can see the land inland about ten or twelve miles from the shore, along that part of the coast sounded by me; but if the land were higher the distance seen would be much greater.

19. Question. Did you sound the new channel, commonly called Gedney's channel?

Answer. Yes.

20. Question. Would you have been able, with the ordinary facilities for sounding, to ascertain that channel, without the previous triangulation of the coast?

Answer. Yes; I could have buoyed it out so far as to make it equally useful to navigation.

21. Question. Is the knowledge of that channel of great importance to the shipping of New York?

Answer. I think it is.

22. Question. Could not a master of a vessel, when employed off the harbor of New York, with such information as a good chart of the harbor would furnish, run his vessel in with tolerable safety by that channel?

Answer. Yes.

23. Question. Do you know any reason why a chart of that channel has not been published?

Answer. I do not know any, unless it be that it was not ready. Mr. Hassler has charge of that; I have not.

24. Question. When did you sound out that channel?

Answer. In 1835.

25. Question. Is not the channel as good now as when you first sounded it?

Answer. Yes; I sounded it again last year, for the purpose of ascertaining the fact, and found it so.

26. Question. Is the line of the coast, where examined by you, fixed or subject to change?

Answer. The beach itself, at the mouth of small inlets, is subject to change, with severe gales of wind.

27. Question. Is the topography of the country within the coast of any importance to navigators?

Answer. It is not, except for four or five miles, or where there is any remarkable eminence or other object inland.

28. Question. Is it customary to lay down the topography of the country on the charts of navigators?

Answer. I have never seen it in any charts except of islands. In charts of the West India and other islands it is sometimes given; but in those cases it is not necessary for purposes of navigation.

29. How long do you continue sounding, one year with another?

Answer. I generally commence in May, and leave off early in November.

30. Question. Are you able to keep up with the triangulation?

Answer. Yes; and I have been in advance of the plane-table parties.

31. Question. Are the plane-table parties necessary to the soundings?

Answer. Yes.

32. Question. If you had occasion to sound at a greater distance from the shore than 12 or 14 miles, how would you proceed?

Answer. I should employ small vessels, anchoring them to serve as fixed points; or it might be done by means of chronometers, starting from some given or known point.

33. Question. What proportion of the year, and of the day in each year, have you been able to make your observations, and carry on the work?

Answer. The answer to this question is annexed in paper marked A.

34. Question. Have not your operations along the coast either corrected errors in printed charts or added many new and more complete soundings to those heretofore published in any chart?

Answer. I believe they have.

35. Question. Do you know any reason why the soundings taken by you should not be published?

Answer. I do not.

Commander Gedney's examination.

To questions 7 and 20, 35. How can soundings be published, without their locations being determined? This location is done by the land operation, therefore the question is captious and futile.

Question 11. These currents are complicated, and variable; they require therefore probably still more investigation.

Question 16. The often-repeated question about the instrument maker's room or shop, in the coast survey office, which is so evidently indispensable, for the daily wants of keeping all instruments in order, and where all the plane table instruments, and similar, are made new, shows rather a propensity to delay, than to advance, the work, which by it gets independent from all waiting for the convenience of extraneous artists, and which so often already has saved importation from Europe.

Questions 23, 24, and 25, are well answered, but it is known publicly that the general map was engraving when the questions were asked, and that two special maps for special purposes had been delivered for the use of public offices.

Questions 27 and 28. Commander Gedney mistakes his answer, as the French atlas in the office proves the contrary, and the works of the coast survey must not be governed by the bad precedent of charts made only for sale.

Question 30. The keeping together of the topographical and hydrographical parties is kept up as much as localities admit, at all events always sufficiently to advance the work; the hydrographer can never go, with any advantage, much ahead of the topography; nor is it proper that he should adventure himself to work without it, to any extent, as it duplicates the labor.

F. R. HASSLER.

WASHINGTON CITY, *January*, 1843.

MONDAY, *May* 2, 1842.

Present: Mr. Cushing, Mr. Aycrigg.

Examination of Lieutenant George Blake.

1. Question. Are you an officer of the navy, employed in the coast survey; and if so, in what capacity, and since what time, and on what part of the coast?

Answer. I am a lieutenant in the navy, and have had charge of a hydrographical party from 1835 to the present time; I have been in Long Island sound and Fisher's Island sound, and in Delaware river and bay.

2. Question. What vessel or vessels, and what number of officers and men, have you under your command?

Answer. My force has varied very much; I had last year the schooners Gallatin and Nautilus, with nine officers and forty-one men.

3. Question. Have you been engaged in the outer or the inner waters?

Answer. The inner altogether.

4. Question. What proportion of instruments have you had made or repaired at the office in Washington?

Answer. I have seldom had any sextants or glasses repaired there; but a large part of the drawing instruments have been made there, to the value or cost of say $500 at any private establishment, that is, during the whole time I have been in the survey.

5. Question. Have any views of rocks, shoals, or other dangerous places, been taken from your vessels?

Answer. No; views have been taken of all the light-houses.

6. Question. Have you, in the examination of Delaware bay, discovered any great errors in the supposed location of any shoals?

Answer. Yes; very great.

7. Question. In what cases?

Answer. In that of Cross ledge, especially; but there is no proper chart of Delaware bay; the only one extant is a mere rude sketch. The error in the case of Cross ledge was four miles, I think.

8. Question. Is it not important that these errors should immediately be made known, and a correct chart of the bay published?

Answer. Yes, undoubtedly.

9. Question. Do you know of any reason for withholding from the public a knowledge of the soundings of Delaware bay, as far as verified by you?

Answer. I know of none.

10. Question. Can a topographical map, so constructed as to give in detail a full and self-explaining picture of the country, that, with the map before the eye, the military operations may be properly judged and guided in the cabinet, be obtained, in carrying on the coast survey, without adding greatly to the expense, and materially delaying the execution of the work?

Answer. No, it cannot.

Upon the examination of Lieutenant Blake.

Question 4. The account asking of the instrument shop occurs again;

these questions together have taken more time than it would have cost the committee to see its propriety by a full visit of it.

Questions 8 and 9. Lead no farther than all such, the under-water part of the work can, of course, not be presented to the public, without the land part to which it belongs, who would without it know where it lies.

By question 10, (the last,) the select committee appears to constitute itself into a council of war.

F. R. HASSLER.

WASHINGTON CITY, *January*, 1843.

MONDAY, *May* 30, 1842.

Present: Mr. Mallory, Mr. Aycrigg.

Mr. W. J. Stone's examination.

1. Question. Map marked exhibit C being shown, witness is asked if he recollects the map.

Answer. Yes.

2. Question. Who engraved the map?

Answer. I did.

3. Question. Is that an exact copy of the original sent to you from the House of Representatives?

Answer. It is.

4. Question. How long did it take you to engrave and print this map?

Answer. In from seven to ten days it was fully executed and delivered to the House.

5. Question. With what person connected with the coast survey did you communicate at the time you engraved this map?

Answer. Mr. Hassler. I called on him, and had a conversation on the subject.

6. Question. Exhibit B being shown and examined, he is asked if that in an impression from the same plate.

Answer. Yes.

7. Question. Will you please to examine exhibit B, and see if there is any difference between this and exhibit C?

Answer. The only difference that I can perceive is, that another scale has been put in the place of the one engraved by myself, which was copied from the original.

8. Question. In what manner was that alteration made?

Answer. By cutting out the engraved scale and inserting one with the pen. The engraved scale on exhibit C is 3 inches to the mile; while the scale inserted with the pen is $\frac{1}{10000}$ th, being, in fact, 6 inches to the mile, instead of 3.

9. Question. Have you the original extract sent to you from the office of the coast survey?

Answer. I have.

10. Question. Are there engravers in the United States competent to execute, faithfully and correctly, any work like that required for the coast survey?

Answer. Yes; as well as it can be done in any part of the world.

11. Question. What is considered a liberal salary for a good workman?

Answer. About $1,200 per annum.

12. Question. Is there any difficulty in getting good copper in the United States for engraving purposes?

Answer. No difficulty whatever.

13. Question. How long will it take to engrave the map of the harbor of New York, and what will it cost?

Answer. I cannot answer without examining the chart.

The chairman then gave Mr. Stone a note to Mr. Hassler, of the following tenor, as near as remembered, viz: requesting Mr. Hassler to permit Mr. Stone to examine the manuscript chart of the harbor of New York.

The committee then adjourned.

THURSDAY, *June* 2, 1842.

Present: Mr. Mallory, Mr. Cushing, Mr. Ayerigg.

William J. Stone in examination.

1. Question. What is your business and residence?

Answer. I reside in Washington, and I am an engraver.

2. Question. How long have you followed that business here?

Answer. From twenty-three to twenty-four years.

3. Question. Have you been accustomed to engrave maps and charts?

Answer. Yes; that has been my chief, and is, at present, my only business; I having abandoned other branches of engraving, to devote myself to that.

4. Question. Is there any difficulty in procuring competent map engravers in the United States?

Answer. None.

5. Question. Do you know of any special superiority of German engravers over those of the United States?

Answer. No; I consider the American workmen better, cleaner, and more rapid.

6. Question. Please to look at the map hereto annexed, and marked A. William J. Stone, and state whether it is the original map sent from the House to you, and from which you engraved the map of Newark bay, as mentioned in the first part of your testimony.

Answer. It is.

7. Question. What is the scale on that manuscript map?

Answer. Of three inches to the mile, as on the map I engraved.

8. Question. Annexed is a map of Cape Cod, (marked B, William J. Stone:) did you engrave that?

Answer. Yes.

9. Question. How long does it take, in your establishment, to engrave such a map?

Answer. About two months.

10. Question. What are the dimensions of that map?

Answer, Thirty inches by thirty-six inches.

11. Question. When were you summoned by the committee to attend and be examined?

Answer. I received Mr. Mallory's letter on Monday, the 30th May, and attended that morning.

12. Question. Was that the first intimation you received on the subject?

Answer. Yes.

13. Question. Have you had previously any conversation with any member of the committee on the subject of the examination?

Answer. Never, of any kind whatever.

14. Question. Had you any knowledge of the purpose for which you were summoned?

Answer. No.

15. Question. Did you, as requested by the committee, call on Mr. Hassler, and present the note of the chairman?

Answer. I did.

16. Question. What occurred?

Answer. The interview was so disagreeable, that I would rather not describe it, unless it be insisted on by the committee.

The chairman therefore propounded to the committee the following question: Shall Mr. Stone be required to state what occurred in his interview with Mr. Hassler? and it was determined in the affirmative—Mr. Mallory, Mr. Aycrigg, and Mr. Cushing, present, and voting.

The question being again propounded to Mr. Stone, he answered as follows:

I went to Mr. Hassler's office, and knocked at the door. A servant showed me into his room, and asked me to sit down, and in a minute or two Mr. Hassler came in. I then handed him Mr. Mallory's letter. Mr. H. read it, and immediately fell into a violent rage, and swore that I should not see the map, neither should the committee have it. After much rudeness and violent language, both towards the committee and me, Mr. Farley came in, and Mr. H. handed him the letter. After some further conversation, Lieutenant Page came in, and Mr. H. showed him the letter, and further conversation ensued. At length Mr. H. permitted me to examine the map, which I did; and on my departure, he handed me a letter for the chairman of the committee, which I delivered to Mr. Aycrigg. This letter is annexed, and marked C, F. Mallory.

17. Question. How long would it take to engrave such a map, and what would it cost?

Answer. It would require about a year, I think. There are eight plates, each of 22½ by 32½ inches, making 5,912 superficial inches, which, at 3 cents per inch, would be $177 36, for the *copper;* the engraving, the sum of $4,132. This estimate is given for the execution of the work in the best and most accurate manner, understanding that the parallels of latitude and longitude, with their subdivisions, are marked in by an officer of the survey, and the engraving is to exactly correspond with the same, which must ensure an accurate chart. I have made a liberal estimate, to enable the engraver to enter minutely into detail, and to do justice to himself and to the Government.

Remarks upon Mr. Stone's examination.

Answer to question 2. Is not the fact; Stone did not engrave it himself, another person did it, in his pay.

Answer to question 4. The time indicated for the work appears very doubtful, unless done coarsely.

Answer to question 5. Is entirely incorrect; Stone came with a map, (perhaps the one quoted,) wanting to show it to me, saying: it is not a fine work, but it will be a good solid work. I refused minding it, and directed him off with it; this was all the conversation, for I had then, as always, the same opinion of him.

Question 6, 7, 8, and 9. Are sufficiently refuted by Commander Gedney, and other facts.

Answer to question 10. The topographical drawing, as used in good style of maps in Europe, has never yet been done in this country. *I challenge positively* the exhibition of one. To make the coast survey maps in the same way as the sea charts, and the work shown under Stone's name, would be a positive disgrace to the work, and the state of the art and science in this country, thence it is not admissible for the work. Stone can only engrave cards, and such like, as I have a man in the weight and measure, works to mark the standards.

Answer to question 11. Mr. Stone is no judge of what is a liberal pay for good work, because, 1st, he never intends to pay work liberally; 2d, he is not able to distinguish between the qualification of the actual art of the topographical work.

Answer to question 12. Upon the getting copper, Mr. Stone's statement is not very close; the difficulty of getting copper ought rather to be referring to the *quality* and *and whence it comes originally from.* He knows as well as I: that he gets his plates from the importers of them, and that there are no other good large plates in the country; he hides this truth.

Answer to question 13. Whether examined or not examined, Stone cannot give a fair estimate of the work of the map of New York, when he was shown it, he could only measure it with a foot rule, and said, "we do not mind these mountains," that is, in other words, acknowledging incapacity for the work.

Stone's 2d interrogatory.

Answer to question 4. To ask a man, so ignorant in his pretended art, as Stone is, an opinion about other country's artists, can of course *not produce* an answer worth any thing.

Questions 6 and 7 are old exploded repetitions.

Answers to 8 and 9 will need certificate; beside, the work is bad.

Question 10. The size of the map is the smaller determining element; the quantity of fine work upon it is the principal criterion. Stone *cannot even have it done.*

Questions and answers 11, 12, 13, 14, 15, are evidently an agreed upon farce between Q. and A.

Answer to question 16. It is positively FALSE that I ever swore he should not see the map, or *touched* any thing *about the committee.* I received and treated him *in words*, as he knew that he deserved it of me; but to the committee I wrote frankly and open what I found, and still find, wrong in the transaction. I told him at the first, *you are not able* to put this map upon copper; he acknowledged instantly "*I know that very well.*" This, for him, unavoidable acknowledgement is the only fair part of this whole transaction of the attack upon me, which I, with full right, declared to ex-

ceed entirely the limits of propriety. The inimicality of Stone to me was well known to the members. I gave direction to show Stone into the upper room, where the map was, which he, in real undertaker's way, measured with a foot rule, in hope to have to order the coffin for it.

Answer to question 17. *Is completely incorrect* in every individual part. Stone is as little able to judge upon the case as to execute it; neither numbers nor statements are *true*.

F. R. HASSLER.

WASHINGTON CITY, *January*, 1843.

BUREAU OF TOPOGRAPHICAL ENGINEERS,
Washington, May 17, 1842.

SIR: I have the honor to acknowledge your direction to report upon certain queries from the select committee on the coast survey. Of the queries on the paper A, the 4th is the only one applicable to the War Department.

The following is the list of army officers who have been employed in this duty:

Major John J. Abert, corps topographical engineers, in 1816.
Major John J. Abert, corps topographical engineers, in 1817.
Major John J. Abert, corps topographical engineers, in 1818.
Lieutenant W. G. McNeill, of the artillery, in 1818.
Lieutenant J. A. Adams, of the artillery, in 1818.
Lieutenant J. R. Vinton, of the artillery, in 1818.
Captain W. H. Swift, corps topographical engineers, in 1832, 1833, 1836, 1837, 1838, 1839, 1840, 1841, and 1842.

Major Abert and Captain Swift were, while so employed, also the disbursing agents of the Treasury Department.

It is not in my power to state either the "army pay and emoluments" or any "additional pay" which these officers received while on this duty, as the accounts in the case do not pass through this office. The Second Auditor will be able to furnish the information in reference to army pay and emoluments, and the First Auditor that in reference to additional pay.

The queries of the paper B are the following:

1st. Whether a part of the topographical corps of the army can be detached for the purpose of the coast survey.

Answer. This can undoubtedly be done; probably from four to six could be detached during the present season; and more, as the various surveys upon which the corps is now engaged are completed, if other duties are not in the mean time assigned to it.

2d. Whether the expense of the service of the coast survey will probably be reduced by detaching a part of the topographical corps.

Answer. There would certainly be a reduction, to the extent of the civil agents, and the amounts of compensations paid to them, who would have their places supplied by officers of the corps.

3d. Whether the expenses of the survey of the coast will probably be reduced by employing other persons than officers of the army and navy to perform the duties they are now employed to perform in the coast survey.

Answer. This is a question of compensations, supposing qualifications to

be equal in each. As officers of the army and navy draw their pay from the army and navy appropriations, it is clear, that, if some of these are employed in the coast survey, the appropriation for that survey will be relieved to the amount of their pay; and equally clear, that, if these officers are not so employed, but others in their places, these others must derive their compensations from the appropriation for the coast survey, and the appropriation be taxed to that extent.

Very respectfully, sir, your obedient servant,

J. J. ABERT,
Col. Corps Topographical Engineers.

Hon. J. C. SPENCER,
Secretary of War.

Remarks upon the letter of Colonel Abert.

The enumeration of the military officers is incomplete. I am obliged by it to enter into a historical statement, why the relation between the coast survey and the army is such as it is.

Two officers are omitted in the statement—*Lieut. A. D. Mackay* and *Lieut. J. V. Bomford.* The latter was present only in 1833. But, in relation to Mr. Mackay, I must state the fact which broke off the employment of military officers, except Captain Swift.

Lieut. Mackay had been, in 1832, with me in the first reconnoitering for the coast survey in Connecticut. He liked it, and I wished very much to retain him; but, during the winter, he was ordered off, to quell the insurrection of the laborers upon the Chesapeake and Ohio canal. When this duty had an end, I applied again for him. Speaking to that effect with the Secretary of War, I was directed to Major General McComb. When I entered his room with him, he pretty loudly said: "No sooner have I ordered an officer somewhere, that there comes a reclamation for another disposition. Can you not get other people to your work?" I answered: "Yes, sir; I can get plenty English, French, Poles, Swiss, &c." To this, he answered immediately: "Then take your d——d Poles, Swiss, Germans, &c., and let my officers alone." At this interview General Wool was present, who, it seemed to me, partook of my propensity to laugh upon the scene. Then I related the circumstance to Colonel Abert, who was rather displeased with the result of my application, as were also several other gentlemen in office.

Lieut. Mackay was ordered to Florida. I attempted again a written application for him, alleging, that any officer without the qualifications which Lieut. Mackay had, could do equally well the service in Florida; but he had left within the proper time of his order, and, on his voyage to Florida, *was drowned,* by the misfortune of the steamboat.

That, upon such a reception from the Commander General of the army, it would have been highly improper: to make any further application for officers, is *palpable.*

The work could not stop for that; and I got very soon opportunity to get able assistants from the civil rank, which, as my contract shows, were, *with most undoubted propriety,* considered as equally appropriated to be appointed to the work; so that very soon all the places in the coast survey were well and ably filled with men, engaged satisfactorily in it till to this day.

More persons than are now employed in the coast survey, it would be *improper to appoint* now, in any way whatever. To change those now employed, would be a great loss to the work in which they are now initiated, and which goes on very well and quietly with them; while introducing any new ones *now* would of course break up the unity in the work, delay and deteriorate it very materially, as it cannot be expected otherwise with new men. The *flagrant injustice* which would be done by such a mutation, would *unavoidably discredit* the employment in this work, as it would show a complete *disregard* to services rendered, to justice and merit in this work; and, in the consequent *disgust*, the officers new engaged would share as much as any other man.

This moment is peculiarly inadequate to make any change in the personal employed, or in any other part. *Results are asked* importunely, *overhastily;* and the men, who could alone help in their acceleration, to be dismissed for new ones, implies the *most direct contradiction.*

It must be observed, that the officers of the Topographical Bureau might be ever so well informed, in the different branches in which they served, still the coast survey work is very different from it. Instead of a work of experienced men, it would again be made a work of beginners. That this would be contrary to all economy, is too evident.

I may be allowed to observe, that the pay of officers and civilians in this case would be *about equal*, and, *to the nation, it is of course equal, whether the money comes out of one appropriation, or out of another.* The result obtained by it is the only important part; and the advantage in this respect lies evidently in the continuance of all the arrangements just as they now are, in the present momentaneous state of the work especially.

Therefore, there is not one consideration in favor of any change at this time, *while delay and danger, even of destruction, is evident in any alteration whatever.*

F. R. HASSLER.

Washington City, *January*, 1843.

SURVEY

OF THE

COAST OF THE UNITED STATES.

SURVEY OF THE COAST OF THE UNITED STATES.

Further rectification of facts alleged in the discussion of Congress, in December, 1842.

1. To avoid the length which the repetition of the allegations would occasion, I shall only here state the facts in their *exact truth*, the comparison with the accounts given in the discussions, or retained from recollection, will be sufficient to find out to which allegations they refer as rectification. I follow the order of date omitting all personal references.

2. The mathematical principles upon which the survey is carried on, and the methods of observation, of my own invention, used, are the full proof of its accuracy, they have been stated as such by the men of the highest standing in that branch of mathematical and physical sciences.

3. It is due only to the accuracy in the principles of acting on land, that it is possible to make any discoveries under water, because this determines the place where the lead is thrown, which the simple sounding operation is incapable of indicating.

4. The make of the land decides how far the topography must go inland, to follow the windings of a creek or river costs much more time and work, therefore, also money, than the sweeping survey of the whole country in which they lie, and all the highlands, &c., that may be seen from the water in any way, must be presented by the chart to the aspect of all seamen.

5. The money spent under my direction in the coast survey, is just about half of what has been stated; that sum, quoted wrongfully, is much nearer to what the Navy spent between 1818–'28, without having any map whatsoever to shew for it—accounts would shew that, if called for.

6. The number of officers and other persons employed at any one time is far less than stated, those named by the Treasury Department's report, are all those ever employed for longer or shorter time in the work; their salaries have never been considered as overrated by the men of science knowing the work to be performed.

7. Arrogance is only when a man pretends to what he is not able, what a man knows, and is able to do, and the standing he has proved himself to fill satisfactorily, he has the right, and, as a man of truth, the duty to state without deserving the reproach of arrogance.

8. What may appear eccentricity to a man standing at a distance from a mass of information, may not be eccentric at all in reality, therefore, eccentricity is entirely only relative between the persons concerned.

9. The business of engraving stands as follows: the maps published in this country hitherto, were all without what is called topographical drawing, in the present conventional, generally accepted by the methods now used, are required to give a miniature likeness of the country, which is evidently not the case in neither the sea charts, nor in the maps of the States, in this country. Therefore, it became necessary, as I stated in proper time to the Treasury Department, that the seed to this part of engraving should be imported as yet. The engraving of real land maps divides itself in various

branches, the numbers, the outlines, the topographical drawings, the lettering, the views, &c., are all to be done by different hands, the work is divided by its kind, not by the plates. It must all be done in the very office in which the drawings and general execution of the maps is done, under the same direction; officers of this country who have visited, for instance, the Irish survey, will be able to give account of the mode of proceeding there.

Without such an organization, *all accuracy is lost, and the principal quality of the work is destroyed*, which of course is *wasting what has cost so much care, labor, and expense.* In this branch the establishment for the coast survey is as yet only begun, there are now four engravers, each in a different branch, at work upon six copper plates, each of them in his special line, two new imported, and two from Philadelphia, they progress of course more rapidly in proportion as they become more habituated and acquainted with the speciality of their work.

10. Of the procuring of the copper plates, the following is the true historical statement in full. The good quality of the copper for large map engraving is a very essential requisite, they ought to be able to bear the largest number of impressions possible, in that lies the main economy, as the expense of engraving is always very great, the more it is extended to a greater number of copies, the more the economy in it is obtained.

It is well known, that no copper mine has yet been found in this country that has encouraged its working. Therefore, copper had at any rate to be obtained from abroad. It is equally well known, that Hungary has the best and most abundant copper mines of different varieties; upon these grounds I consulted with the former Austrian Ambassador, Baron Marechal, and got from him a special recommendation to his friend General * * * * Chief of the Politechnic School in Vienna, to order and procure copper plates of the required dimensions, and of the best quality. The money part of the commission, and the forwarding being cared by Mr. Schwartz, the well known and amicably serviable Consul of the United States at Vienna.

The plates arrived in due time, before the engravers were even ordered or needed. However, when they were tried for use, they proved not good, notwithstanding no man can deny that precautions enough had been taken to procure the best quality. To satisfy the anxiety shewn for the beginning of engraving, I sent immediately the engraver to Philadelphia, where a copper plate planisher, Keim, made two plates, which were somewhat better, but such large plates are specially difficult to get of appropriate sufficiently good quality, it is not the same thing as making small plates for a likeness or such.

These plates were therefore, also not fully satisfactory, and it became necessary to procure real good plates from Paris direct, where my friend Mr. Beautems-Beauprés, Chief of the Bureau of Depot de la Marine, had the kindness to have some constructed for the coast survey, which have now been begun to be used. Thus after trying the nearest, and what had at first been considered the best, without the expected success, I succeeded by the third trial only, but now well.

11. The chart of Newark bay was given to engrave by Congress, before even any idea of engraving for the coast survey in general had been thought of, therefore the engraver from Hamburg now present, had not yet even *been thought of*, and the work was taken away from the office.

12. The letter of Mr. Mallory, requesting me to give the map of New York to Mr. Stone, *to examine* (please consult Johnson's dictionary for the

real meaning of this word) an operation which would require, of course, a good mathematician conversant with the principles and practice of the works of the coast survey; I felt very hard to be subjected to the *examination* of a man whom I know incompetent for that task. I even told him directly "you are not capable to put this map upon copper," he immediately answered "I know that very well."

THE MAP WAS HOWEVER SHEWN TO HIM IMMEDIATELY, in presence of several assistants, and he measured it with a two foot rule, as if to order the coffin for it of proper size. Those of my assistants who were present at the time, were as much displeased with the circumstance as myself, and I found it necessary to state on that occasion, a limit which I had hoped would not be stepped over; Stone himself felt that he had overstepped his limits.

13. My report of last 18th November, and the §9, above, shews the principle, upon which the engraving is to be carried on, if it shall not destroy the work itself, by *its inaccuracy*, for such work only there can be responsibility expected from the Coast Survey Office, for any *work done out of it and given out of it in any other way*, under whatever order it may be, it is *impossible to conceive the slightest responsibility on the part of the office, its chief, or any person in it.*

14. Many years ago, when I was in no way connected with the coast survey or the Government, I tried to join a map of the coast from Northern and Southern State maps, at the request of a friend, but at their junction no coincidence could be obtained; this was a transient subject of conversation only with Mr. Mallory, but in no way whatsoever connected with any thing relating to the coast survey; there was *no result possible to draw*, from the want of coincidence, which I found, thence nothing could even have been published; the idea of the work was abandoned by that friend.

15. Upon the principles of publication of such works as result from the survey of the coast, I have made mention in proper places, and the examples of other countries stand before the public. In all of them the main triangulation had been given by some *preceding scientific work, long before* any map was either thought of, or asked for. I, on the contrary, am requested to give maps before the main triangulation can possibly be finished; this inversion of the order, which *nature*, and *science*, *dictates*, can not otherwise but give to the work a turn, at the same time over laborious and often disappointed.

16. Individual harbors, bays, passes, &c., may be published, as have been delivered constantly, upon every call for them, but the connected map of the coast cannot be given before the chain of triangles, upon which it shall be grounded, is completed between two Cases. To publish other specialities, or communicate scattered data from the work, would be giving it up to spoliation and ultimate disgrace. Any demand of that kind can be guided only by improper private interest, and is not to be gratified. It is for that purposely stipulated in my contract, that no results shall be given otherwise but upon call of the Government; under whom the whole mass of this work constitutes a *property of the whole nation*, in no way claimable by a single individual.

17. What relates to the new channel at the entrance of New York bay, has been communicated to several public offices in manuscript, preliminarily to the full publication of the map of New York, now engraving; the public usefulness of the channel is in full activity, it is buoyed out, so that no delay can be reproached in any way whatever.

18. The case for which a small steamboat is proposed, is not that which can apply to the coast survey, except perhaps in some individual cases for short times. There never have been twenty barges employed in the coast survey, as well known; to save $100,000 annually, out of an appropriation of just that amount, is a problem not yet soluble mathematically.

19. As the money transactions are not of my Department, I cannot be quoted as authority for what balance of appropriation may be on hand; I, myself, ask for this information in the Treasury Department, when I need to know it, for the purpose of regulating my plan of operation according to the means on hand. I never make any disbursements. That the work, and especially my personal party, is conducted with the strictest economy and, at less expense, than has ever been done in any other country, proportionally to the price and mode of living, in this country and in others, would certainly prove itself by any comparison of facts (not one spring-seat sofa will be found in any of the bills.)

20. My age dates from 6th October, 1770. It is with life or age, like with all other things, it lasts the longer and remains the longer effectif; the better it is used and husbanded.

21. It is a direct injustice to reproach to the officers issuing from the Military Academy of West Point, and from the Naval Schools, their not being competent to take the lead in a work which they are not instructed the very first principles of, nor provided with any means for. The thing *is impossible for them*, I must state my own experience. Immediately after President Jefferson had approved my plan of operation for the coast survey in 1807, from among the thirteen plans handed in, and examined, by the Commitee held in Philadelphia, he also decided the postponement of the execution of the work, on account of the warlike appearance of affairs with England.

At the same time the first Professorship of Mathematics and Natural Philosophy of West Point was vacant; Mr. Garnet, a private gentleman of New Brunswick, N. J., well known eminent Mathematician, and Col. Williams, chief of the Engineers and of the Military Academy, proposed me for that Professorship, which I occupied 1807,--'8,--'9, to such satisfaction as letters in my possession, and the opinion of students of those times may show.

I attempted to give to some (then new) Lieutenants just dismissed from the Academy, some practical information, in a direction leading to works of the nature in question. I even wrote upon it, but they found themselves entirely unprepared, I could do only little, and they soon left. During the time I was there, and one of my friends (who afterwards died in Arkansas) there was some teaching in this line of the science, which was ever since interrupted until, as I have just been told, it was again begun last year,—but it requires longer years of instruction and practice to acquire proper proficiency in that branch of science.

In 1808, I made a plan for the studies and organization of the Military Academy, which may still be found in the War Department. What they are not taught in the Academy, the students *cannot be expected to bring out of it*, their future practice alone can put them in the possibility of acquiring it, according to the special duties, they may be placed into, which is entirely a chance of circumstances.

The naval schools are well known to be only for practical seamanship, without sufficiently entering into higher branches of Mathematics, as are required for works similar to the coast survey. I made also for a Naval Academy a plan in 1832, which may perhaps be found in that Department, it is

well known that no change has taken place in this respect, therefore also the *Naval Officers are entirely innocent of the accusation lanced against them.*

22. When in 1834, a Bureau was proprosed to direct the coast survey, a meeting of one half hour proved the inadequacy of it completely.

23. I was in London for the instruments from fall 1811, to fall 1815, under the disagreeable situation of an alien enemy, by the then war with England.

24. The State over whose territory the coast survey has the most extended, is New Jersey, therefore also in that State the most money of the coast survey expenditure has been disbursed.

25. I arrived in the United States in October, 1805, but had been in public business in Switzerland before, since 1786, though there engaged in the archives and as a member of Courts of Justice; always, however, applying to Mathematics and Natural Philosophy as subjects of predilection. In April, 1807, I entered my first appointment in this country at West Point, (as stated above.)

26. A suspension of the work of the survey now, would be attended with very great direct loss, as well in work as in objects on hand for its continuance; and principally because it would most likely not be possible to bring it up again within more than a man's age, as the interval lost between 1818 and 1832, may easily lead to conclude under existing circumstances.

27. It must be evident to any reflecting mind, that a scientific work changing hands, loses the advantages of the experience, and practical skill, acquired by the operators, and loses the character of a systematic work.

28. Since the resolution of 24th June, 1841, so much of my time has been taken up by polemic discourse, pressed upon me first from Congress, which has, of course, other disagreements in its consequence, that actually more than one year of my work was lost, which I would, with immensely more satisfaction, have applied to the forwarding of the interesting and valuable works which I have engaged for with the Government.

F. R. HASSLER.

WASHINGTON CITY, *January* 10, 1842.

REPORT,

UPON THE

CONSTRUCTION OF STANDARDS

OF

WEIGHT AND MEASURE,

TO THE

COMMITTEE OF INVESTIGATION

OF THE

COAST SURVEY,

JUNE 29th, 1842.

[COPY.]

U. S. HOUSE OF REPRESENTATIVES,
JUNE 9, 1842.

F. R. HASSLER, Superintendent of Weights and Measures.

SIR,—The select Committee on the Coast Survey to which was referred your last report on Weights and Measures, request you to report, *forthwith*, to the Committee, a general and concise statement of the progress of the work up to this time; showing the time employed, the separate total expenses for assistants, for workmen, for the foundry, for materials, and the grand total of all the expenses, caused by the work. Also, to specify the number of standards of each description, and of scales thus far made, and an approximate estimate of the cost of each, so that the sum of the items shall equal the total expense. Also, a statement of the number of articles yet remaining to be made; also, the time and expense necessary to complete the whole.

Also, that the Report be made in such form as to give a concise view of the whole matter, *without the necessity of referring to other reports.*

Your obedt. servt.,

(Signed) JNO. B. AYCRIGG.

Honorable FRANCIS MALLORY, Chairman of the Committee of Investigation of the Coast Survey.

SIR,—With these lines, I have the honor to present to you the Report upon the works for Standards of Weight and Measure, requested from me, during your absence, in the name of the Committee upon the Coast Survey. I hope it will be satisfactory, notwithstanding its abridged form.

Washington City, 29th June, 1842.

F. R. HASSLER.

REPORT,

Upon the Works of the Establishment of Uniform Standards of Weight and Measure for the United States, made upon a call from the Select Committee of the House of Representatives, upon the Coast Survey, the 9th of June, 1842.

BY F. R. HASSLER.

With the best disposition to give to the Committee, *forthwith*, a general and concise statement of the progress of the works, performed by me, and under my direction, in the construction of the Standards of Weight and Measure for the United States, I find it a difficult task to bring, hastily, in a small compass, and still intelligible, the account of a work of so high an importance, as the settlement and construction of an accurate, and appropriated, system of uniform Standards of Weight and Measure, for a country so extensive as the United States, present for my task, according to my view of the duty which I have undertaken; a work which requires the discussion, and application to practical utility, of some of the most delicate branches of natural philosophy, and the finest and most tedious operations of mechanical arts, in metal, &c., where such a large number of standards of the same kind are to be made, as were *never before made*, within the required limits of *accuracy*. I can, therefore, hardly expect to render such an account to full satisfaction to persons who may be new in the subject, and unacquainted with its exigencies; every individual part of the execution of the work differs entirely from the similar works in the common transaction and execution of the every day's practice in common life; for which, besides, every means to the aim is to be created, as was the case with this work. To approach the nearest I may be able, to an adequate statement, I must divide your letter in its different parts, and treat each of them as a separate question, to be answered in the shortest manner possible: thus—

A. "Showing the time employed."

1. A joint resolution of both Houses of Congress, of 29th May, 1830, taking up again the subject of the great irregularity in the Weights and Measures in the country, (well averred since 1790,) from the side of its vast inconvenience in the Custom-houses, directed the Treasury Department to cause the Custom-houses to

send in, to the Department, samples or Standards of their Weights, and the Measures of length, and capacity, to be compared there.

2. A short time after, the honorable Secretary of the Treasury, Samuel D. Ingham, committed this task to my charge; I devised means for its execution. These works enabled me to decide numerically, the stipulations of the law of the Senate of the United States of 1793, "*that the Standards should be the mean of those found in the country.*" Upon these works I rendered account, under the 27th January, and 29th June, 1832.

I hope I may be allowed to insert here, the expression of a learned society, certainly impartial, upon this report and the principles which guided me in this work, upon which in fact, *the Standards of this country are grounded,* and upon the results which I obtained by it.

Extract of the Memoirs of the Royal Astronomical Society of London, vol. vi. Report of the Council of the Society of 8th February, 1833, page 232.

"The Council regret that the Standard Scale, mentioned in their last report, has not been finished. It is a work that necessarily takes much time, due attention being requisite to the minutest points which are likely to affect its accuracy. Whilst on this subject, the Council cannot omit noticing a public document, laid on the table of this society at their last ordinary meeting, which contains several new and interesting comparisons of two of the principal European standards of length. This document is a comparison of Weights and Measures, made by our associate, Mr. Hassler, to the Congress of the United States of America, and has arrived very opportunely, prior to the adjustment of the present standard."

As it appears not desired by the Committee, that nearer details of this preparatory work should be entered into, it may be sufficient to state here these ultimate numbers, viz:

The Yard, to be the mean of the yard given by the scale of 82 inches, made by *Troughton, for the Survey of the Coast,* (which has by English authority been declared of the most accurate, and its similars to be selected for the English standards.)

The Troy pound, of the Mint of Philadelphia, to be the Standard for the Weights; the Avoirdupois pound, and its multiples, to be in proportion to it, as 5760 to 7000.

The gallon = 58373,0
The bushel = 543391,8 } grains of the Mint weight of distilled water, at the temperature of its maximum density.

This principle of determination of capacity measure, at the temperature of the maximum density of the water, I communicated in

1796, from my teacher, Professor Trallas, in Bern, to Chevalier de Borda, in Paris; upon which it was introduced in the French system, in lieu of the temperature of melting ice, which had been contemplated before.

3. At that time, I had just again contracted with the Treasury Department for the work of the Coast Survey; this occasioned that the work of constructing the standards upon these data, was added to my task, (without any additional compensation.)

4. There were, of course, many discussions and other incidents, upon the mode of proceeding, procuring of the means for the execution of the work, the selection of a proper locality, and building, &c., which were uncontrolable, as all such things are, at the beginning of any work; they, therefore, required time for their settlement, during which the whole of my works came under the Honorable Secretary of the Treasury, then Levi Woodbury, with whom these subjects were finally settled, under approbation of the President of the United States.

5. Brass, of sufficient good quality, not being obtainable in commerce, and the necessary ingredient in its composition, the zinc, being in commerce of bad quality, mixed with iron, it was decided to take advantage of the blende of Perkiomen, in Pennsylvania, and later also of the ores of the upper Jersey and others, to reduce, (or distil, as it is called,) the pure zinc, for the necessary brass, ourselves, for which a furnace was established in a shed built for the purpose, in the Arsenal.

6. In September, 1835, one of the buildings now occupied for the office of the Coast Survey, and the works for the Weight and Measure Standards, promiscuously, was rented, and the turning lathe and the few tools, which had been prepared by one workman only, were transferred there, from the too small house in 13th street, occupied before for the comparison above stated; then, the further constructions for the necessary tools for the work were begun; for it must be observed, that special tools were required, appropriated to the works, such as are not in common commerce; and this want increased with the advancement of the work, which required tools always more peculiarly adapted to the task to be performed. The inventory of the whole establishment shows them, as well as all other objects belonging to the same, presenting a considerable amount of property.

7. In 1835, September 18th, the furnace for distilling the zinc, was reported complete, and the distillation begun.

8. In November, 1835, the first Report upon the actual beginning of the works upon Standards was made; and the principles of the

arrangement, the wants, and requisites of the establishment, discussed.

9. From thence, the delivery of actual Standards to the Treasury Department continued until to the last liquid capacity measures, in regular succession, as they were executed with the workmen necessary at each epoch of the work, more or less according to the wants; regular reports were made upon these deliveries, which I must here omit to quote, under the positive order of the letter addressed to me.

B—"Showing the progress of the work."

This is evidently not intended by the letter to be done in detail, as the work progressed; the account of which is contained in my successive yearly reports.

It is therefore best, and shortest, to present it here, in form of a *table of the results* in actual Standards, &c., which have been executed in this office, since about the beginning of 1836, when the establishment may be considered as having been ready for that kind of work, until to this time, together with some of the accessory works, which naturally accompany the same. This table follows at the end.

C—"The separate total amount of expenses for assistants, for workmen, for the foundry, for materials, and the grand total of all the expenses caused by the work."

In this work, like in all other, that I agreed for with the government, *I refused distinctly all the money business of it;* I know nothing of the amount expended, neither in the whole, nor in detail. I never touched a dollar, nor a cent, of the money expended. I can only say, that all that was ordered, was calculated before hand, to the closest economy, compatible with the indispensable accuracy of the results, and its certainty; for bad work, not answering the aim, is no economy, but *money lost.* This highly important measure, of establishing uniformity of Standards in Weights and Measures, has cost to this nation, in proportion to the quantity of work produced, its accuracy, and the extensive usefulness, *far less time and money,* than any other nation, as I am well acquainted with it.

It is impossible for the Committee to form any proper judgment upon the establishment without properly visiting it in detail; it has actually been visited by men of science of all civilized nations, from Russia through all Europe, to South America, &c., with the highest approbation; all equally considering the establishment unique, and unequalled in its kind; and as actually highly creditable to the country; in which all the well informed citizens of the country rejoiced.

D—"Also to specify the number of Standards of each description, and of scales thus far made."

The Tabular exposition D. D., joined at the end, shows this in all its details.

E—"And an approximate estimate of the cost of each."

This is *impossible in nature*, as I am entirely ignorant of the sum expended. Upon what relates to the work itself, the question would be to decide, what shall, in the above quoted list, be called a standard; what shall be allowed for the tools and implements, made in the office; for the wear and tear of all the tools; the value of the property on hand, paid by the expenses, which is considerably more than might be expected; besides the value of the Standards themselves, what they would be valued at, &c.; for this, *the inventory* of the establishment would have to be consulted, &c. It cannot fail to strike at once, that all this scrutiny would require more time, than it would be reasonable to bestow upon it, to get the most uncertain and rough guess at a very uncertain result.

The objects produced by the establishment, are of course so different in value, amount of labor, and all other expenses, that a real proportional valuation is entirely out of question. For instance, a set of subdivisions of grains, in decimals, costs in London from 5 to 8 shillings sterling, of those we made many hundreds. A balance, like that made here for weighing of the half bushels, would not be made there under 1600 dollars, notwithstanding the greater ease of workmen and their greater cheapness. The balances for the States already will, and must, be superior by far in accuracy, to any made hitherto in the country, as are those already executed for the use of the office.

To give an idea of the habitual cost of such like works, which are, however, always only copies, grounded upon no scientific principles, as accurate Standards must be, to deserve the name of Standards, I will present here some facts, which may be compared if desired.

Standard copies, procured for the government *at different times, with their cost.*

Lot of old standards, procured by the Ambassador, Richard Rush, from England, in February, 1822, with certificate from the exchequer, enumerated in the comparison of 1832, £103 = $515.

(These are very inaccurate, in spite of the certificate.)

Three scales of yards and ell, by Thomas Jones, London. (Cost not found in the Treasury nor State Department.) These standards seem better made. (See their comparison.)

The pound weight, procured for the Mint, by Mr. Gallatin, 21st March, 1828, *the artist's account only*, £2, 5 = $11 25.

(Captain Kater having adjusted it.)

Four single pounds, procured for verification for the weight and measure establishment, cost 25 guineas = $131 25.

One balance of Troughton, of grain weight, up to 10,000, £26, 5 = $131 25.

(The weights of this collection, though accurate within themselves, are too small, being taken from the London Mint, which Dr. Moll of Utrect found, at the same time with me, too small. The Mint weight of London was therefore changed by act of Parliament, and the coins made before 1828 depreciated proportionally to one and a half grain in the pound.)

The standard of the Virginia University, consisting of, first, a balance and weights up to 5 pound troy, - - - $500.

Second, a scale, upon which is traced a yard and metre, with two microscopes, - - - - - - - - - - $300.

For the standards procured from France, the account of Fortin shows a sum total of 4205 francs, - - - - - $841.

(See copy of account.) These standards are very valuable.

The account of Mr. Pollock, of Boston, for balances and weights, furnished to Mr. Adams for his comparisons in 1820, $642.

(These are not sufficiently satisfactory.)

An adjustment of a pound troy in the Mint of London, costs, according to the statement of Professor Moll of Utrecht, *three guineas*, - - - - - - - - - - - $15 75.

The certificate of the exchequer, for the oldest sets of standards, is quoted upon the indenture £1, 15, and their great inaccuracy shows that they have not any proper comparison, - $8 75.

F. "So that the sum of the items shall equal the expense."

This is evidently impossible by what has been said upon this subject before. The money spent upon such an indispensable and valuable establishment cannot be put in any comparison with the benefit which it bestows upon the society, and the daily intercourse of the citizens. The *economy* of a nation, or government, does not consist in not spending, but in *producing good by the money spent.*

G. "Also a statement of the articles yet remaining to be made."

This is shown by the table of results obtained in the work, which shows the unfinished work as well as what is fully finished. It presents a small quantity of unfinished work, comparatively, with the great mass of work actually executed.

It can only yet be remarked upon this subject that, at the end of

the mechanical work, and the full adjustment of the standards, there should still be added the experiments upon the expansion of the brass employed, by heat, comparatively with other metals; the specific gravity of the same, and their relation to the water: as these are scientific elements, that are to be ascertained to fix the system of the standards, in its scientific relations, which is so desirable for its credit and stability. This I had already mentioned to the Treasury Department, and I had heretofore made some experiments tending towards that aim. It may be yet observed that, in England, even the observations of the seconds pendulum were joined, to give to the work a still more extensive resting place, by the determination of the ratio between yard and pendulum.

H. "Also the time and expense necessary to complete the whole."

It must be observed upon that, that the distribution of the work *must* be made according to the *nature of the work*, without regard to the individual final execution of any single one; so that a work of a certain kind must go through all the individuals of the standards requiring that work; thence, speaking of works done, or not done, falls in *between the different parts* of the works, that are *in the whole to be done*, and determines nothing about the *how many* of each kind are done, or not done; the enumeration is contained in my reports, which I am prohibited to refer to.

As to the time, it must be observed, that for the adjustment of the capacity measure, of which the half bushels form the largest part, that by the finished construction of the balance for this aim, a most essential step is already made, but two favorable winters will, it is supposed, at least be needed to execute these adjustments, which can be made only under such a low temperature as is not obtainable in summer. The balances will, on the contrary, be worked at all the time, with the full assiduity which has always been used in all the works of this office; therefore they will proceed to completion as fast as possible. But it must be observed that an accurate balance, of some size, has a considerable number of component parts, and proportional work, requiring great accuracy.

In respect to the estimation of expenses, it must be observed, that all such prospective estimations are altogether too vague and therefore improper, because they cause expectations, for which it is impossible to assign any reasonable ground.

I. "Also that the report be made in such form as to give a concise view of the whole matter without the necessity of referring to other reports."

To establish an accurate and uniform system of standards of Weight and Measure in any state or country, is an unavoidable

and *distinct duty* of every civilized government, and this system requires even sometimes a renewal or verification.

All European governments, without distinction of their kind, have in modern times made such renewals or verifications, and published the principles of them in their countries.

This establishment is one of the means of promoting peace, and administering justice in all dealings among the citizens. The larger the country, the more essential and important the measure becomes; it is in general considered as indicating the civilization of the nation.

General Washington, well aware of the duties of a government, which he had so essentialiy helped to establish, said in his inaugural speech, 8th January, 1790, to the Senate of the United States:

"Uniformity in currency, weights and measures, of the United States, is an object of great importance, and will, I am persuaded, be duly attended to."

The answer of the Senate of the 11th January, 1790, quotes the measure as a subject that shall be duly attended to.

The 8th December, 1790, General Washington recommends this anew, and the 2d and 25th October, 1791, he said:

"An uniformity in the weights and measures of the country is among the important subjects submitted to you by the *constitution*, and if it can be derived from a standard, at once invariable and universal, must be no less honorable to the public councils than conducive to the public convenience."

A committee was established the 1st November, 1791. April 5th, 1792, a report of the committee presented a full system of weights and measures, upon the principles stated by General Washington.

17th and 18th November, 1792, the report was discussed, and also 20th November and 6th December, a full report was again presented, which was, January 29th, 1793, ordered to be printed. This last report being directed to be based upon the mean of the measures and weights found in the country. The 8th February, 1793, the decision was postponed to the next session of Congress.

From thence no special action on that subject appears on the part of Congress; but many State Legislatures made partial arrangements that had in general no lasting effect. However a number of laws passed, grounded upon the supposition that the uniformity *existed*, thereby increasing the difficulty.

The report, made in conformity to the suggestions of General Washington, became well known and was much approved in Europe. About that time I was engaged in making copies of the toises of Leland's, which had been compared in 1769, with the scale of Bird

in London, to determine the relation of French and English standards, on the occasion of the measurement of the Mason and Dixon lien in this country. One set of these toises is in the country, and was again compared in 1817, as is also the toise of Conivet of 1768, which I bought from the heirs of Dionis du Sejour, in which I standarded the toises with which the base-line of my triangulation in Switzerland was measured: (which was since further continued, &c. &c.)

In 1817, 3d March, a resolution of the Senate referred to the Secretary of State, to present "a statement relative to the regulations and standards for weights and measures, &c." which produced the elaborate report of the Honorable John Q. Adams, upon that subject, of 22d February, 1821, which proved forcibly the very great irregularity in measures of different parts of the country; this occasioned, of course, a new proposition for the so desirable uniformity. For that purpose also a set of English standards had been procured from London, certified by the Exchequer, 8th December, 1820, which however have proved to have very little accuracy, when compared in 1831 and 1842, with the liquid capacity measures, &c.

A Committee was established upon this report, which reported under the 11th March, 1822, proposing the fixation of Standards of Weights and Measures, to what would appear to have been the intention of those found in the country, saying, "To render uniform and stable, the Measures and Weights, which we at present possess," and "Standards to be made for the State Department, and for the States and Territories."

New standard units were then procured from England, and from France, under this resolution, which were deposited in the State Department. But no further action took place upon that; *no Standards of any kind were made*, or even attempted to be made.

The 19th May, 1828. The Troy Pound of the United States Mint in Philadelphia, which had been procured by Mr. Gallatin, verified directly by Captain Kater, who had made the English Standards, was declared by Congress,

"The Standard of Weight for the United States, the other Weights to be according to their legal proportion to the same."

As I was of old acquainted with this subject, and could easily foresee the absolute necessity of a measure to establish uniformity of Standards in this country, I did not lose sight of it, when I was sent to London, to have instruments for the Survey of the Coast constructed, under my direction, in 1812 to 1814; I had need, for that work, of accurate Standards of length, as well of England, as of

France; it was an addition of expense entirely unperceptible, (and actually not observed,) to procure also some Weights and Capacity Measures.

The next action upon the subject, was the Resolution of the Senate of the 29th May, 1830, quoted above. When on that occasion I was called by the Secretary of the Treasury, "to compare the Standards of the Custom-houses," these Standards, brought by me, formed the ground-work, and the means, of the whole establishment, which the Secretary of the Treasury was very glad to find on hand, instead of, as he had intended, yet to procure the means from England; besides, I could direct, to be constructed in this country, by arrangements never before applied in so large a scale, but highly approved by the scientific men in Europe, and in this country equally, balances to weigh till above 130 lbs., to a proportional great accuracy.

Without this circumstance, the whole establishment of the uniformity of Standards in this country would have failed again, by the delay unavoidable in procuring the means from abroad; this is proved in comparing dates with the cotemporaneous circumstances of those times.

The intimate connection of the two works, of the Coast Survey, and the Construction of Standards, shows itself already in that circumstance; my comparisons of length measures made in Newark, New Jersey, 1817, form part equally of Mr. Adams' Report of 1821, and of mine upon the Coast Survey, and equally again in the renewed operations in 1831.

From that time, the statement under A. renders account.

The operations going on successfully, a joint resolution of both Houses of Congress of 14th June, 1836, ordered:

"Full sets of Standards to be made *in this office for all the States*, equal to those made for the Custom-houses;" and in July, 1838, (see Laws of the United States, vol. 9, page 839,) it was ordered: "that also Balances should be constructed for the States, in this office."

The nearer particulars are stated in the preceding articles; it may here only be remarked, that so many Committees established during forty years before 1830, have been without any result, towards the beneficial aim in view; while what was done since 1835, has nearly completed the task, which to interrupt now by *any alteration whatsoever*, would be the entire destruction of the system, and therefore of the benefit which the country expects from it; the frequent calls from various parts of the country, prove fully how the more enlightened part of the nation considers these works.

I must here yet place the abridged comparisons of the time, and result of such works, in different countries, so far as they can interest in this country, that is principally of England, for which I will only refer, by quotation of dates, to the authentic public documents, viz:

1. The Parliamentary Report of	7th July, 1819.
" Commissioners' Report,	18th September, 1820.
" do. do.	31st March, 1821.
Report of the Committee of Lords,	1823.
Letter of the Commissioners,	14th September, 1825.

2. Of the Philosophical Transactions of the Royal Society of London, the following volumes give some account of the parts of the work of Captain Kater, connected with the same. In the year 1818, page 33 contains an account of pendulum observations, preparatory to the linear Standard, as it was first intended to accept it instead of the yard, or at least compare it with the same, so as to make it subservient to find the yard, in case of its loss, by its ratio to the pendulum.

In the same volume, page 103 contains the comparison of the French metre, with the different English scales.

In the year 1819, page 70, Reduction of the Pendulum Observations. In the same volume, page 337, Observations of the Pendulum at several of the Trigonometric Stations of the British Triangulations.

In the year 1821, page 75, Account of the various British Standards of Linear Measure. In the same volume, page 316, Remeasurement of the Cube, Cylinder, and Sphere of Sir George Shuckburgh, for determining Standards of Weights and Measures.

In the year 1826, Part 2d, page 1st, Account of the Construction of Standards of Weights and Measures for Great Britain and Ireland.

There were made:

Troy pounds,	5	Total 24.
Avoirdupois pounds,	5	
6lb. Troy,	2	
Gallons,	4	
Bushels,	4	
Yards,	4	

Only these appear in the account, adjusted simultaneously together, by Captain Kater.

However, the following list of deliveries appears to indicate, that they were afterwards multiplied by the artist, Mr. Bates; of their adjustment I find no account.

The Standards delivered, as stated thus in number, were to the

Exchequer,	24
Guildhall,	10
Dublin,	10
Edinburgh,	10
Total,	54

In the year 1830, page 359, a paper appears by Captain Kater, on the *Errors of his Linear Measures.*

This short indication may suffice here, to guide, if detailed information should be desired, to be followed up farther, by consulting the reports and the volumes of the Philosophical Transactions.

Upon the French Standard Establishment, we have the fullest accounts of all parts by the several quarto volumes of the "Base du Systeme Metrique," though the mode of operating is not applicable to this country's standards.

The different other States, Russia, Prussia, Holland, the many States of Germany and Italy, have all equalized and determined anew their system of weights and measures; their publications are of course in the languages of these countries, and are not much spread in foreign countries. Their collection, together with copies of the standards, is one of the subjects upon which I made a special proposition in writing, at the beginning of my works, to impress the advantage of such a collection, to fix upon good principles the daily reduction of all the foreign standards, which now are practised to the fancy of the calculators in the Custom-houses, no regular guide being given to them by authority.

K.—It is to be supposed that the committee has calculated before hand, the great and harmful delay which this detention, and what consequences the committee may still please to give to it, must have upon my works in the Coast Survey, for which I would some time ago have taken advantage of the season, for my works in the main triangulation in the field, which cannot be executed but in the proper season. I have, in my answers to the committee upon that work, stated the losses already arising from the attack of last year upon that work; I can only add here that if I am not soon relieved, the same loss to the work, of about one season's work, will be again incurred this year.

Similar circumstances have unfortunately happened before to my works, which occasioned, that, instead of being able to pursue my works with that assiduity and courage, which I always should like to bestow upon them, I have been called upon to write polemic reports and answers, and distract my attention from the scientific turn, which has the higher claim upon my attention and time, and which

would give to my works the advantages which belong to them. It is well known that both my works require the application of science, sometimes rather complicated, and that no merely *loose scientific* application can satisfy the exigencies of these works; on the contrary, it would introduce new uncertainties and disorder, leading to disappointment and disgrace.

L.—Having executed these answers to the letter received from Mr. Aycrigg, as speedily as the nature of the subject admitted, I have no doubt it will be satisfactory in relation to the works under my charge, for the Committee which has undertaken the inquiry, as much so as the inspection of the work has been to every visiter of the establishment, who takes any interest in the public good, which is the aim of it; however, I cannot refrain from inviting the Committee, most pressingly, not to omit a visit of the establishment in detail, when it cannot but strike, that the compactness of its different inseparable parts, is one of the greatest means of celerity, economy and accuracy, that its junction with the establishment of the Coast Survey produces a mutual assistance, thence an economy, for both, unobtainable by any other means, not connected under one and the same head and roof, besides the advantage which I had from my old acquaintance with the subjects themselves, and their scientific requirements. The same advantages could not be obtained by a whole society, of different opinions, and different degrees of scientific means, and informations; I might even quote again as proof, the failure of all previous attempts, towards this valuable aim, by Committee's as quoted above.

Now the object is nearly attained, and any change whatsoever that might be attempted to be introduced, would destroy again the whole system, make of the whole a disgraceful failure, and a direct pecuniary loss. All the particulars of the work are known, and spread over this county and Europe, and the approbation which my reports met all over, are sure guarentees of the public disapprobation that would follow any change or interruption.

WASHINGTON CITY, JUNE 20, 1842.

Received, February 13th, 1822, from the Register of the Treasury, the account of Thomas Jones, for Weights and Measures purchased by Richard Rush, for the Department of State, which account (amounting to £103,) has been paid by me, as Agent for paying the contingent expenses of Secretary of State Office.

(Signed) FONTAINE MAURY.

Account of Mr. Fortin, for French Standards.

	French Franks.
Metre a traits of Platinum, with box,	2,600
Kilogram of Platinum, with box,	1,100
Do. in brass, cilindrical,	45
Do. do. subdivided square,	100
Litre Modèle, brass, with box,	50
Brass Metre, subdivided, with box,	85
Box and Baling,	25
Custom House expenses,	10
Charges in Havre, Shipping, Insurance, etc.,	190
	4,205

Mr. Gallatin's account, 21st March, 1828.

Bates' account,	£2, 5

Boston, 13th January, 1820.

The United States,

To Allen Pollock, Dr.

For best Large Balance, with Agate Suspension,	$300.00
Large Glass Case, for do.,	55.00
Set best polished Large Weights,	65.00
Brass bound Mahogany Case, for do.,	15.00
Two Thermometers, for large case,	10.00
Best Small Balance, with Agate Suspension,	120.00
Glass Case, for do.,	25.00
Weights, for do., to one hundredth of a grain,	40.00
Boxes, for small weights,	4.00
Packing Cases, Packing,	8.50
	$642.50

Received above amount of Moses Young.

(Signed) ALLEN POLLOCK.

No. 962.

Moses Young,

Register Office.

From other countries, also, weights and measures were procured, besides these, the accounts of which may be found among the Ambassador's accounts; the whole of the expenses incurred for them will be near about $4000; they are collected, as far as yet on hand, in this office, where they may be seen at any time, and compared with the work produced here.

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.*

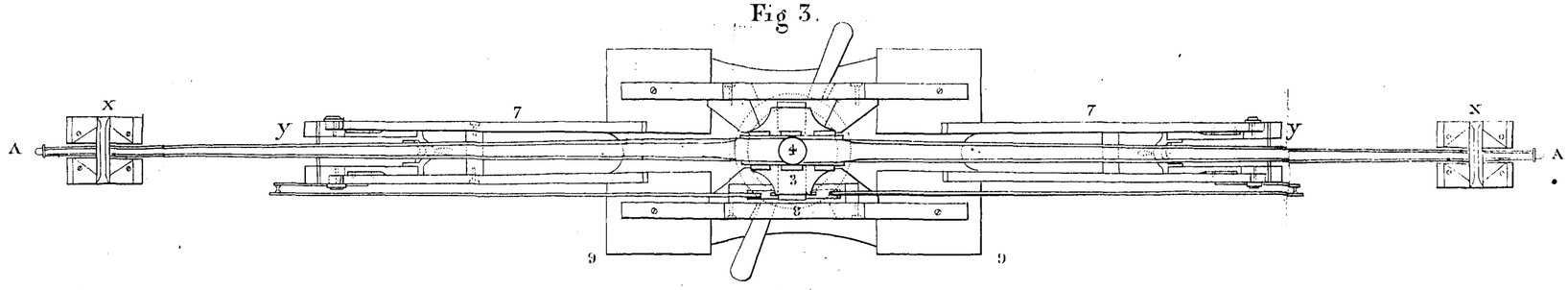
Full sets of Weights from 1*lb. Troy, to* 50*lbs. Avoirdupois.*	Set.	No. in Set.	Pieces.
Delivered to the Treasury Department for the States and the Custom Houses, in two interior boxes each,	200	10	2000
Do. do. do. do. Office,	1	10	10
Do. do. do. do. use of the Sub-Treasury,	2	10	20
Do. do. Patent Office, authorized by the Treasury Department,	1	10	10
Do. do. Old Point Comfort, upon direction of Treasury Department,	1	10	10
Kept in the Office for necessary future comparison,	2	10	20
	207		2070
Set of Ounce Weights.			
Delivered to the Treasury Department for the States, from $\frac{1}{10000}$ to 10 ounces,	29	27	783
Do. do. do. do. Office and the Patent Office,	2	27	54
Do. do. do. do. Office, small box up to 10 ounces and 1lb.,	1	12	12
Do. do. do. do. Sub-Treasury, up to 100 ounces,	1	35	35
Do. do. do. do. do. from 10 ounces down, and subdivided in 3 boxes,	2		40
Do. do. Mint of Philadelphia, boxes from 100 ounces down,	2	25	50
Do. do. do. unadjusted for the Branch Mints,	2	19	38
Do. do. do. unadjusted ounce weights up to 1000 ounces,	4	5	20
Do. do. Office of Sub-Treasury, one ounce set up to 1lb.,	1	8	8
Kept in the Office, my original to guide the work,	1	25	25
Do. do. full sets for future comparison, by combined weighing,	5	19	95
	50		1160
Standard Capacity Measures.			
Just packing for delivery, standards of liquid capacity measures,	54	5	270
Do. do. do. 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
Half bushels, ready for adjustment,			157
Each of the capacity measures has a glass cover, to adjust its fulness,			518
			1036

	Set.	No. in Set.	Pieces.
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 micrometric 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 balances, 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 3 lb. and 2 forks,	1	5	5
Do. do. do. three boxes with single pound weights and forks,	3	2	6
Do. do. Frankford Arsenal near Philadelphia, 1lb. avoirdupois,	1	1	1
Kept in the Office for use in future comparisons, single pound weights,			55
Do. do. the original adjusting weights for my use, above 1lb. weight,			25
Delivered to the Committee of Massachusetts Legislature 1lb. troy, and 1lb. 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	2484
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, Brooklyn, New York,			1
One yard, Lieut. Thomas R. Gedney, U. S. N.,			1
One yard, Capt. W. H. Swift, U. S. Army,			1
One yard, Lieut. Glynn, U. S. N.,			1
One foot measure, Lteut. Glynn, U. S. N.,			1
One yard to the Land Office,			1
			2745

Boxes, with Fittings for the above Standards.	Set.	No. in Set	Pieces.
For 207 sets of large weight standards, 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 office,			151
			1185
Outside Packing Boxes of 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

PLATE III.

Fig 3.



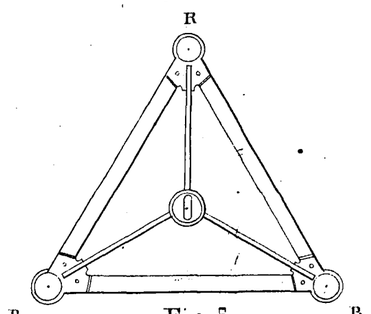
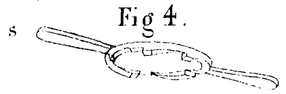


Fig 5.

Fig 4.



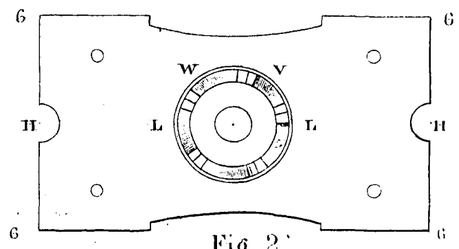


Fig 2.

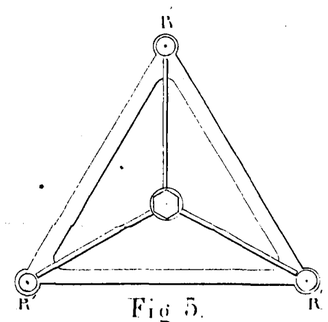


Fig 5.

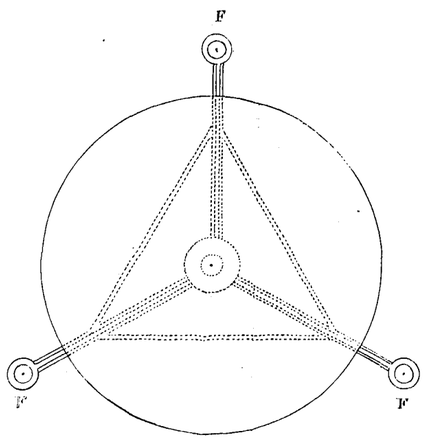


Fig 6.

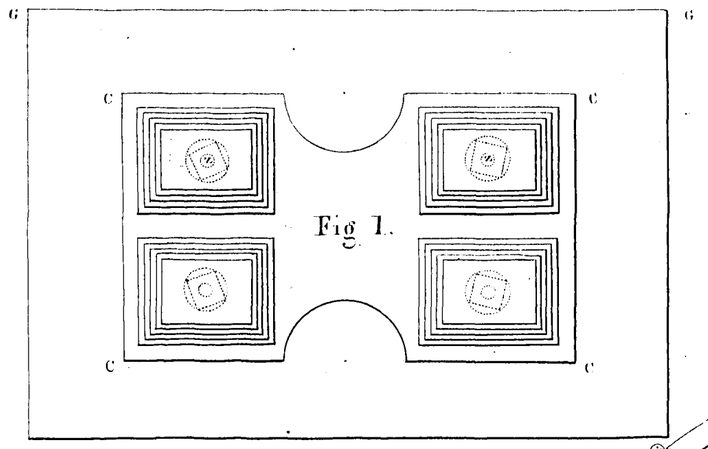


Fig 1.

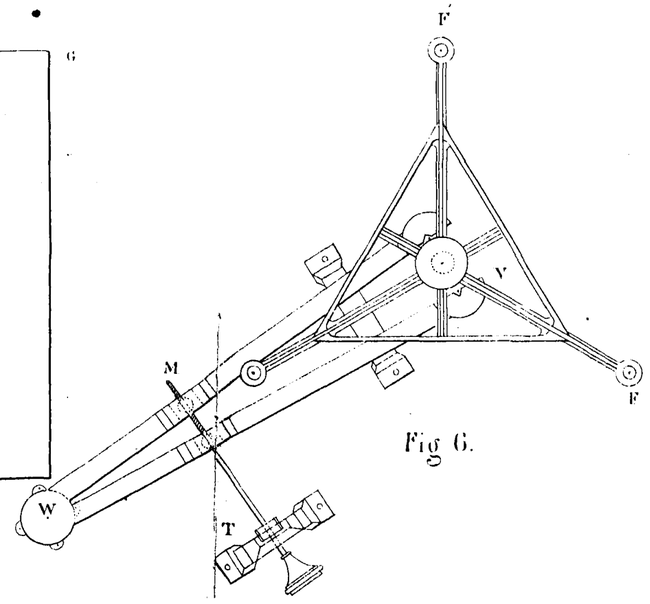
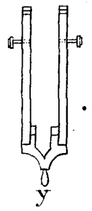
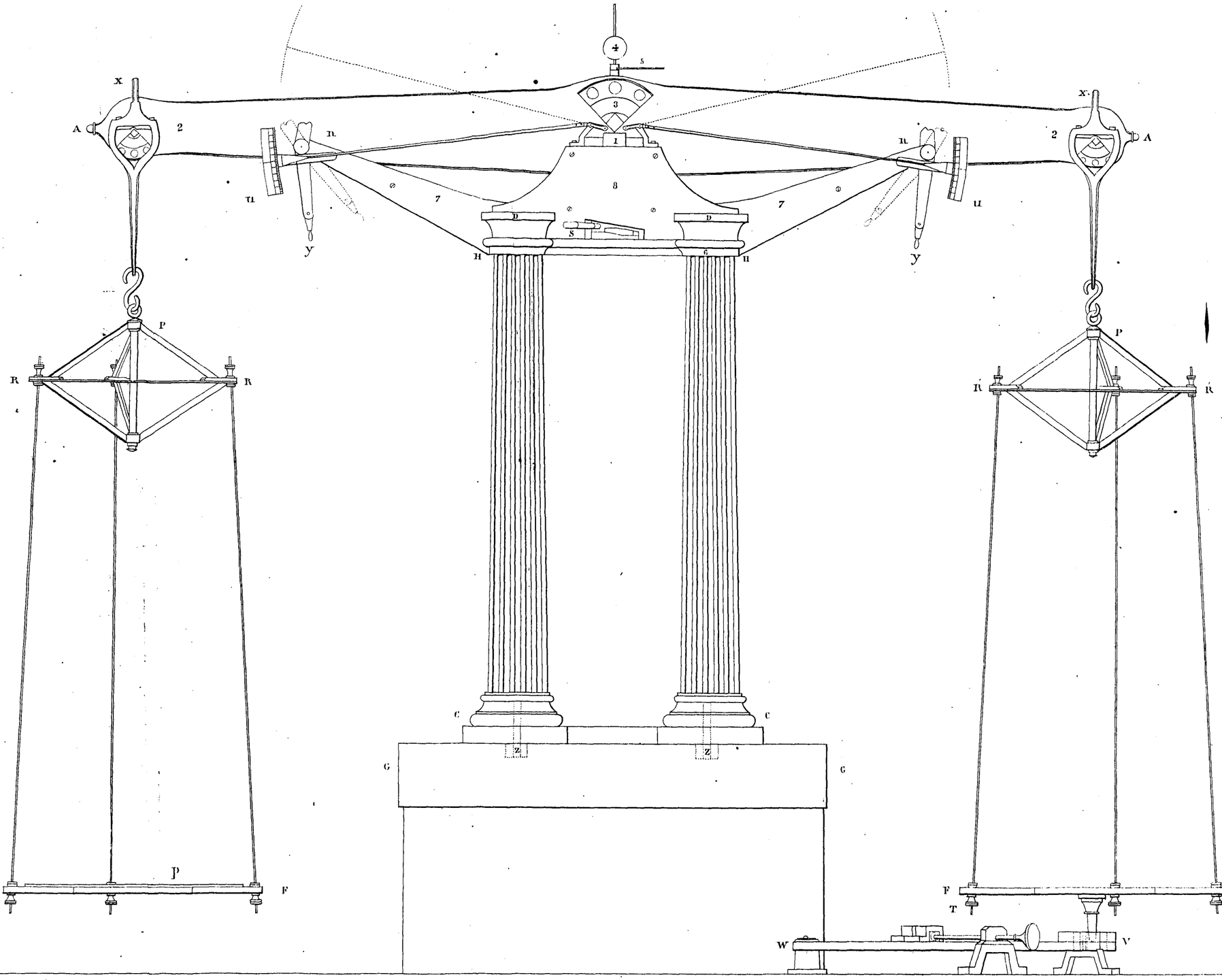


Fig 6.

PLATE II

End View of y.n.n.





End View of Stirrup

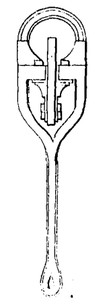
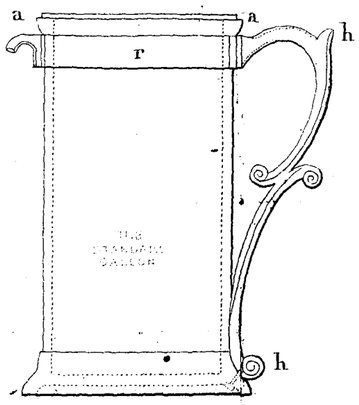
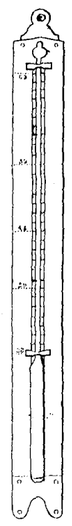


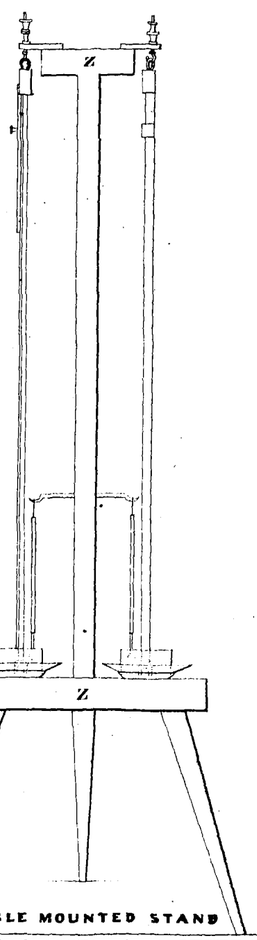
PLATE I.



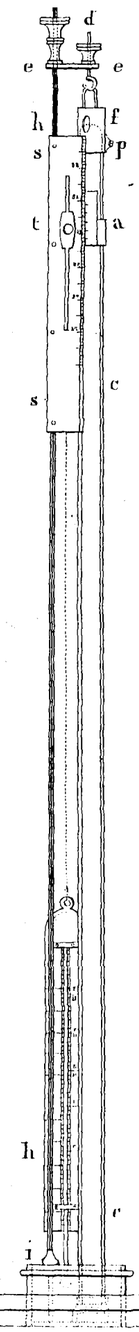
STANDARD GALLON
OF THE U.STATES



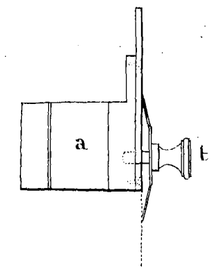
THERMOMETER



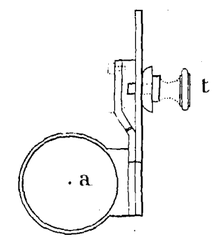
DOUBLE MOUNTED STAND

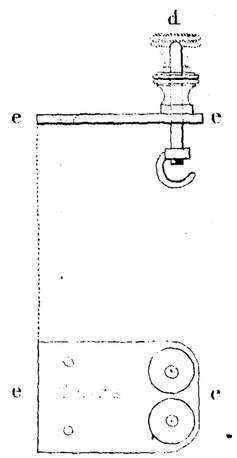


BAROMETER $\frac{1}{4}$ SIZE

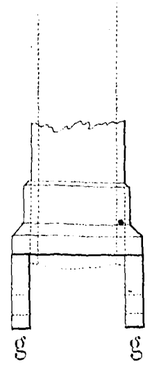


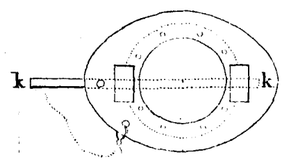
2 VIEWS OF PART a

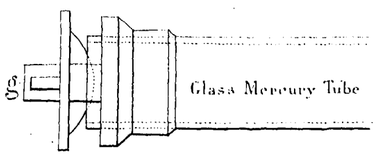


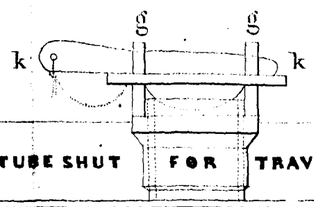


LOWER FERREL
DETAILS IN FULL SIZE









TUBE SHUT FOR TRAVELLING

REPORT

UPON THE

STANDARDS OF THE LIQUID CAPACITY MEASURES

OF

THE SYSTEM OF UNIFORM STANDARDS

FOR

THE UNITED STATES;

WITH A

DESCRIPTION OF A NEW ORIGINAL BAROMETER,

AND

OF THE BALANCE FOR ADJUSTING THE HALF BUSHELS BY THEIR WEIGHT OF DISTILLED WATER.

BY F. R. HASSLER.

WASHINGTON:

GALES AND SEATON, PRINTERS.

1842.

27th Congress, 2d Session. Doc. No. 176. Ho. of Reps. Treas. Dept.

STANDARDS OF LIQUID CAPACITY MEASURES.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A report showing the progress made in the fabrication of standards of liquid capacity measures.

April 8, 1842.
Referred to the Committee on the Coast Survey.

Treasury Department, *April 7*, 1842.

Sir: I have the honor, herewith, to transmit to you a report made to this Department by Professor Hassler, showing the progress made in the fabrication of standards of liquid capacity measures.

I am, very respectfully, your obedient servant,

W. FORWARD,
Secretary of the Treasury.

Hon. John White,
Speaker of the House of Representatives.

Washington City, *April 5*, 1842.

Sir: The letter herewith joined, which circumstances have delayed for some time, contains the report and announcement of the successful execution of one more of the partial tasks, executed for the general aim of introducing uniformity of weights and measures in the United States, namely that of the construction of the standards of the liquid capacity measures. Upon the particulars of the operation, the letter, or report, gives all information.

I take the liberty to request that this report should be communicated to both Houses of Congress, as the previous ones have been, for which purpose I join (like always) two copies.

But the plates it has not been possible, for want of time, to make double. As, however, the whole will be published, they will be multiplied by that means.

I must take the liberty to request, in this respect, that the plates should be returned to this office, for their being lithographed and printed, with the

necessary neatness and accuracy, so much the rather, as the assistant here, who has made the drawings, is in the habit, and able, to execute such works carefully, and that it would be done under my inspection and direction; he being paid by his appointment, the cost will, of course, be diminished for so much.

Instead of the special short instructions which have heretofore been added to the sets of standard weights, &c., upon their use, and the manner of caring them, it will be necessary, in this case, to add to the 54 full sets, containing gallons, and their subdivisions, a full copy of so much of the report as renders account of their construction, &c.; that is, till after the tables, which give their standing towards full accuracy, (or the 48 first articles.)

The descriptive parts of the other articles, as means of the operation for the standards, are not needed for this destination, as they form rather a part of the general account of the whole work.

I cannot omit adding here, again, that it is desirable to make the Governors of the States again attentive to the propriety of their taking the necessary measures to get all the different standards ready, and now accumulating at the Treasury Office, into their intended practical utility, for the benefit of the public.

I have the honor to be, with perfect respect, sir, your obedient servant,

F. R. HASSLER.

Hon. WALTER FORWARD,
Secretary of the Treasury United States.

WASHINGTON CITY, *March*, 1842.

1. SIR: In fulfilment of the promise stated in my letter of 9th December last, I can now have the satisfaction to inform you that 54 full sets of standard liquid capacity measures are completed, all to the outside packing boxes, which are now making in the form of chests, which will serve after for their safe keeping; upon communication by the Treasury Department to me, of the directions to whom, and to which places, they shall be addressed, they will then be immediately delivered.

2. This number of full sets will be sufficient to supply each State with one of them, and to furnish about an equal number of the principal custom-houses.

Each set consists of five pieces, namely:

One gallon.
One half gallon.
One quart.
One pint.
One half pint.

Each of these measures has a ground glass cover, to determine the limit of its fulness, and they are in all respects equal to the two sets delivered, the one to your Department, and the other to the Patent Office, which form part of the above number of 54 full sets. It is proper, nay necessary, that two of these sets shall remain in this office for reference, and possible future necessary use; the rest it is desirable that they should be delivered to your order.

3. To these full sets I am able to add still 71 single gallons, which it is intended that should be given to the other custom-houses; as it was con-

sidered the subdivisions were not absolutely needed for them; this will bring the whole number of gallons to 125, of which, therefore, 123 will be delivered now.

4. The success in the accuracy of adjustment has been above all expectation, their difference from full exactness deviating, in no case, as much as ½ grain of distilled water at its maximum density, as the table inserted hereafter will show.

5. This result proves, as well the accuracy of the physical data from which the elements are deduced, which must serve for the reduction to the point of the barometer, and the degree of temperature, which are selected for standards, and also of the appropriatedness of the means of execution, which I have selected, and the care taken in the execution of the work itself.

6. The principles of the adjustment of capacity measures have been deduced, and discussed, in my report upon the comparison of the weights and measures collected by the Treasury Department, which I rendered in January and June, 1832.

7. Not to repeat the details there gone through, I will here only state the principal facts, as far as they relate to the individual part of the standards herewith presented, viz:

8. The gallon selected as standard for the liquid capacity measures, is the former English wine gallon, of 231 cubic inches in content, which was shown to be intended by the mean of those in use in the country, as was directed by the law of Congress in 1796, to be the principle for all the establishment of standards for the United States.

9. The mechanical determination of this content by measurement, is too rough to present any thing like the accuracy demanded in the determination of standards.

10. The weight of this cubic content of distilled water, at the temperature of the maximum density of it, and at 30 inches height of the barometer, is the physical principle employed in these determinations; it gives for the weight of the gallon, 58,373,0 grains of the troy pound of the United States mint, which has by law been adopted as standard of weight for the Union, supposed to contain 5,760 grains according to ancient habit.

11. The value of the subdivisions of the gallon, which, according to old habit, are by successive halving, follow, of course, the same proportional value.

12. The vessels made to represent these standards, are of the same brass made for the whole of the standards, which is, of course, one of the means of their uniformity; their form is a cylinder, of which the diameter is half its height, nearly. See the figure of them in plate I.

13. The manner in which these capacity measures were made, is the following: Hollow cylinders were cast of the proper capacity for each of the measures, with such a re-enforcement at the upper end, as would serve to give that part more strength, and also more bearing to the glass cover which has to be applied upon it, to indicate the exact fulness. The bottoms were cast in form of a plate, in the inner rim of which the other or lower end of the cylinder was soldered.

14. These cylinders were strongly hammered upon triblets of proper dimensions, by which all inequalities of the castings were avoided, and the metal made more solid, as the case required, without going through the long and costly process of using rolled brass, beat and soldered, and furnishing a far superior quality of metal.

15. This mode of operating is the invention of my son and assistant in the work, Edward T. Hassler, and has been a great means of acceleration and economy in the work; the mechanical part of these constructions having been generally under his care.

16. The vessels are without any ornaments, and avoiding all sharp corners or indentations, where water might find a rest, and escape the careful wiping, which is necessary in the adjustment by weighing.

17. The handle is put on afterwards, separately, and can be taken off, or put on, as it is fastened to a ring that encircles the upper part of the measure under the strengthening part of it, to which the handle is fixed on one side, and a projecting part on the opposite side; the lower part of the handle is held fast by a screw, taking hold of it from below, and passing through the extension of the circular re-enforcement projecting below the bottom part. These handles were never at the measure during the weighings, to prevent their lodging water not easy to wipe off.

18. The first plate presents a figure of the section through the whole gallon and the handle, which will give a full idea of all the measures.

19. The variation of the metal by temperature, as well for the relative buoyancy of the metal as of the water in air, form the elements for the reduction to the standard point. This reduction is, therefore, for all the weighings, compounded of both these influences.

20. Special tables were constructed for these circumstances, grounded upon the physical elements determining them, for the variation as well of the barometer as of the thermometer, adapted to the individuality of the means, the metal and the water employed. I will place them here, together with the enumeration of the elements upon which they are grounded; by their means the whole system will be presented in one view.

21. The following are the elementary numerical data for the determination of the liquid capacity measures of the gallon and its sub-divisions:

A. The legal dimensions of 231 inches cubic of the gallon, presents in grains of the pound troy of the mint, taken at 5,760 grains, the weight of distilled water, which it shall contain, to be = 58373,0 grains, at the temperature of the maximum density of the water, and the barometer at 30 inches.

B. The cubic inch of water at the maximum density is accepted, like in the English determinations, at 252,7453 grains.

C. The cubic expansion of the brass, for 1° of Fahrenheit, according to my own experiments, is = 0,00003154 parts of the whole.

D. The expansion of the brass gallon measure, in capacity for 1° Fahrenheit, near the maximum density of the water, is = 0,0072793 cubic inches.

E. The effect, in the weight of the water at maximum density, of this expansion of the brass, for 1° Fahrenheit, is = 1,8399 grains.

F. The effect of the barometric variation upon the weighing, upon which the reduction to 30 inches barometer is to be grounded, is composed of the specific gravity of air, and of brass, to water, and presents, for 1 inch variation of barometer, the following fraction: $\frac{1}{831} \times \frac{7}{8} \times \frac{1}{10}$, according to the data accepted for the English standard, which it was found proper to use here, because the standard of this country originated first from the English.

G. The effect of this upon the weight of the gallon gives its numerical effect = 2,0488634 grains for one inch variation of the barometer; the tables for smaller variations, and for the subdivisions of the gallon, are too simple

deductions to deserve insertion here, as they present only proportional fractions of this number.

H. The effect of the variation of temperature being compounded of two, the one in arithmetical ratio for the brass, the other in an increasing ratio (explained above) for the water; the table for these reductions of the gallon is here inserted, for the temperatures near the two minima of this effect; remarking only, that the weighings were never made to so great an extent of variation of temperature as the table reaches.

22. *Table of reductions, for the weighing of the gallon to the temperature of maximum density of the water, for a brass gallon, to its absolute value.*

Degree Fahrenheit.	Reduction in grains.	
32,0	+ 19,7142	For the ½ or ¼, &c., gallons, the effect is of course also ½ or ¼, &c.
33,8	+ 13,4068	
35,6	+ 8,0361	
37,4	+ 3,5811	
39,2	— 0,02115	
41,0	— 2,6642	
42,8	— 4,5023	
44,6	— 5,4785	
46,4	— 5,7703	
48,2	— 5,0486	
50,0	— 3,6584	
51,8	— 1,5037	
53,6	+ 1,3929	
55,4	+ 5,0141	
57,2	+ 9,3418	
59,0	+ 14,3605	

23. This necessary limitation in the temperature, without which the proper accuracy would be unattainable, is the cause why these adjustments can be made only in the winter months, when this temperature is obtainable at least for a certain number of hours in the morning; the afternoon hours being employed for the calculation of the reduction of these weighings, and the adjustment of the measures themselves.

24. It will be observed by these tables, that the brass has a particular advantage in these adjustments, namely: while below the maximum density of the water, or about 39.2° Fahrenheit, it continues to contract, while the water expands; from thence to the neighborhood of 52° Fahrenheit, both brass and water expanding, the reduction changes sign from + to —, and passes a maximum at about 45°, from which the two expansions approach again to each other; there the reduction decreases again until to about 52° Fahrenheit they are again equal, thence the reduction becomes = 0 again, after which the increase of the expansion of the water goes on rapidly, while that of the metal increases only in arithmetical proportion. Thus, at the two limits of this change of about 39.2°, and at about 52° Fahrenheit,

there are two points of temperature equally favorable for the adjustment, where namely the variation of the effect of temperature is at its minimum.

25. It is evident that the temperature of 52° is most favorable for the work, and affords a relief in the operation; between the two temperatures, 39° and 52° the reduction never amounts to so much for the about 6½° of variation, as it does after a few degrees of deviation from them, either above or below the two points of minimum variation, or rather of the 0 of variation, for one single degree.

26. By thus organizing the works of such a nature in the practical application of natural philosophy, the greatest accuracy is obtained, which is entirely unobtainable if a point of temperature is selected, where the variations are large, and in the same direction. I have therefore no doubt of this arrangement having been one of the main causes of the extreme accuracy which has been obtained in the present operation, which exceeds all that I have ever found in any similar operation.

27. This mode of proceeding will therefore be so much more approved by the men of science, who have been practically engaged in such works, and are acquainted with the difficulties which these operations have; while on another hand it adds more stability to the system itself, besides that the operation itself is very much easied, and therefore accelerated.

28. The tables of the ultimate results, inserted hereafter, present both the last comparisons, under the temperature by which they were made, and the ultimate results corresponding, when reduced to the temperature of the maximum density of the water, which administers the fullest proof of their accuracy.

29. Weights were made of the same brass employed for all the standards, exactly equal to what the calculations exposed in my report of 1832, indicated for each of the capacity measures; these were used for all equally in the whole operation. Also, in all the weighings, brass was used of the very same proportion of copper and zinc as the standard weights, the length measures, and the capacity measures, were made of; thence all compensation for difference of metal was made by the very organization of the operation, which otherwise would necessitate very complicated reductions, thereby lengthening the work, and, by the increase of the difficulties endangering the accuracy.

30. By thus compensating practically the many accessary influences, which pretend to take share in these delicate operations of natural philosophy, many corrections, and even the reduction to the vacuum, were avoided; thence also, all those possible errors that might arise from insufficiency of the elements which guide these reductions, and complicate so much the operations, were avoided.

31. A special distillery was established to obtain the distilled water employed, always pure and new, which is well known to be the essential quality required; the water employed every day in weighing was never over twenty-four hours old.

32. No more than one-third of the water can be distilled over, to be taken for use, to obtain it pure; the two-thirds remaining become useless for this purpose, and the greatest cleanliness is required in the whole operation, to avoid all extraneous matter in the water employed for that purpose.

33. It may be observed here again in passing, that all weights whatsoever, made in this office, are full; not any hollow parts, nor addition of other metal is allowed, to complete or adjust any weight.

34. In the weighing operation itself, the capacity measure being placed in one basin of the balance, with its glass cover upon, the weight which represents the quantity of distilled water of the measure to be weighed, is placed upon the glass, and the whole is counterbalanced, in the other basin, with brass weights of the same metal as the measure, and the weight in the other basin, so that all the buoyancy of the brass is exactly balanced, which is as well, for accuracy and uniformity, as if all was reduced to the vacuum.

35. The temperature of the measure is ascertained, and that of the water also; then the standard weight is removed, and the measure is filled with the water carefully, so as to occasion the least possible air bubbles; then the temperature of the water is tried again and recorded, when that of the measure is generally found equal with it; the few air bubbles that may be unavoidable, are carefully wiped off, by means of a thin whale bone, with a small rag at the end. The glass cover is again slided over the vessel, and, when near its end for covering, the superfluous water is sucked out by a syringe; the glass fully slided over leaves very little, if any, of the water to be wiped off around the glass cover.

36. Thus the standard measure is ready for weighing by the counterpoises that have been placed in the opposite basin of the balance, and the smaller complementary weights that have been needed, the enumeration of these smaller weights is then made and registered; when the measure is removed the temperature is again observed and recorded; if any difference is found from the first observed temperature, a mean between the two is taken, which was, however, seldom of any amount.

37. Thus was proceeded with every one of the three hundred and forty-one brass vases, here rendered account of, as the standard liquid capacity measures; and there are a number of gallons still under adjustment.

38. This task is the most fatiguing and trying for all faculties of a man in attention and care; it has been executed with the same minute, faithful care and accuracy, as I have described in rendering account of the weights, and the result has rewarded the exertions by its extreme accuracy.

39. It must be evident that these measures cannot be brought to their required accuracy at once; the operation is therefore a successive approach to the truth. The measures are worked out sufficiently large to admit in any case reducing them down, by successive steps, to their proper capacity, their state being successively ascertained, each time, by the weighing.

40. The quantity of reduction in the height, which will correspond to a certain overplus of content of the one or the other kind of measure, is ascertained at first approximately, by pouring the water of one measure, nearly adjusted, in the new vessel, the scale of this reduction is easily deduced from the content of the whole by measurement, compared with its weight. A particular tool has been made to trace within the measure that circle at equal distance from the top, which is considered nearest, but still rather above, the dimension required.

41. Then the measure is brought upon a plate of lead, in the inverted position; upon this it is worked in a kind of epicycloidic revolving motion, with emery upon the plate, by which means the cylindric edge is ground down to the mark made by the guide of the preceding trial, always in an exact perpendicular position.

42. Thus alternately weighing and grinding down, the measure is brought every time nearer to the truth, until it is considered within the limit, which it is found sufficient to allow to abide by, and only to register the ultimate result; it is these last weighings, and their result, which are found in the table hereunto joined.

43. These weighings are of course always made under the existing temperature of the time of weighing, which forms the first column of the table, after the number with which each set is marked; the third column contains the difference found at that temperature; and the fourth column is the final result therefrom arising, for the individual measure, at the temperature of the maximum density of the water, under the direction given by the table presented in section 22; this forms of course the ultimate reduction.

44. It is upon these grounds that I may be allowed to claim, that the determination of standards, made in this office, will stand the test of future times more than could have been expected otherwise.

45. I am, however, unable at this moment, nor is it proper in this special report, to expose the whole philosophical system, its elements and consequences; this belongs more particularly to an ultimate final report upon the whole of the establishment for the uniformity of standards for so extensive a union of country as the United States; the results of which must, by their nature, extend to ages, and of which I understood so well the high importance, in accepting the trust of their execution, at the very beginning.

46. I might yet quote here the result of the reweighing of the English and French standards of liquid capacity measures, which has so strikingly shown the accuracy of the comparison which I have made formerly for the object of my report of 1832, and published therein; but, as this investigation and comparison will be carried on upon the larger scale of embracing also the comparison of the weights, &c., it is much more proper to defer this subject to the final report upon the whole work.

47. But as it may be of interest and importance to make known some of the means employed, the utility of which may extend further to other useful applications, I take the liberty to join here:

1st. The description of the thermometers, constructed purposely for determining the temperature with more accuracy, than the thermometers habitually used give, as it is so essential an assistance in this case.

2d. The description of the kind of barometer of my invention, and of my own construction, which was employed in this work, as well as for all astronomical observations, &c., in the coast survey works.

3d. The description of the balance, constructed in this office, for the next operation of the standard establishment, namely: the adjustment of the bushels and half bushels, which, with a weight of about 130 pounds, to 150 pounds in each basin, will present a sensibility of one-tenth of a grain—an accuracy which I dare assert has never heretofore been obtained, and without which I should consider the results of my works degraded.

F. R. HASSLER.

Hon. WALTER FORWARD,
Secretary of the Treasury.

48. *Tables of the last weighings, and ultimate results of adjustment, of the full sets of capacity measures for liquids.*

I. The Gallons of the full sets.

No.	Last weighing.		Final result.	No.	Last weighing.		Final result.
	Degree F.	Grain.	Grain and decimal		Degree F.	Grain.	Grain and decimal.
1	51,0	— 2,5	+ 0,0214	28	52,4	— 0,6	+ 0,0248
2	45,7	— 5,7	+ 0,0848	29	52,7	— 0,1	+ 0,0101
3	46,2	— 5,8	+ 0,0236	30	52,8	+ 0,05	— 0,0471
4	46,8	— 5,65	+ 0,0887	31	53,0	+ 0,5	— 0,0117
5	47,2	— 5,5	+ 0,0592	32	53,2	+ 0,87	— 0,0917
6	53,8	+ 1,6	— 0,1659	33	53,0	+ 0,5	— 0,0117
7	53,1	+ 0,55	— 0,1867	34	53,2	+ 1,0	+ 0,0383
8	53,0	+ 0,5	— 0,0117	35	53,2	+ 1,0	+ 0,0383
9	54,7	+ 3,5	— 0,1415	36	50,8	— 2,6	+ 0,1928
10	53,8	+ 1,6	— 0,1659	37	49,5	— 3,93	+ 0,1472
11	52,6	— 0,4	— 0,0826	38	50,8	— 2,7	+ 0,0928
12	53,3	+ 0,6	— 0,4470	39	50,5	— 3,1	+ 0,0324
13	53,3	+ 0,7	— 0,3470	40	50,5	— 3,2	— 0,0676
14	50,2	— 3,4	+ 0,0520	41	49,5	— 3,9	+ 0,1772
15	51,5	— 1,8	+ 0,0769	42	50,8	— 2,7	+ 0,0928
16	51,5	— 1,8	+ 0,0769	43	50,6	— 2,97	+ 0,0492
17	51,8	— 1,5	+ 0,0037	44	49,9	— 3,8	— 0,0621
18	52,8	+ 0,05	— 0,0471	45	54,1	+ 2,3	— 0,0344
19	53,0	+ 0,55	+ 0,0383	46	53,7	+ 1,7	— 0,1206
20	52,1	— 1,2	— 0,1249	47	53,8	+ 1,9	+ 0,1341
21	52,2	— 1,0	— 0,0677	48	53,8	+ 1,93	+ 0,1641
22	52,4	— 0,6	+ 0,0248	49	53,8	+ 1,65	— 0,1159
23	51,6	— 1,6	+ 0,1525	50	50,9	— 2,6	+ 0,0571
24	52,5	— 0,4	+ 0,0711	51	50,3	— 3,25	+ 0,0988
25	52,0	— 1,2	+ 0,0180	52	50,2	— 3,3	+ 0,1520
26	52,4	— 0,6	+ 0,0248	53	50,3	— 3,25	+ 0,0988
27	52,4	— 0,65	— 0,0252	54	51,4	— 2,0	+ 0,0012

Last weighings and ultimate results.

2. Half Gallons.

No.	Last weighing.		Final result.	No.	Last weighing.		Final result.
	Degree F.	Grain.	Grain and decimal.		Degree F.	Grain.	Grain and decimal.
1	48,6	— 2,4	+ 0,0036	28	49,1	— 2,25	— 0,0322
2	47,4	— 2,65	+ 0,0723	29	49,1	— 2,2	+ 0,0178
3	53,8	+ 0,8	— 0,0829	30	49,5	— 1,87	+ 0,1686
4	50,0	— 1,85	— 0,0208	31	49,7	— 2,05	— 0,1078
5	54,3	+ 1,3	— 0,0626	32	50,5	— 1,6	— 0,0338
6	52,6	— 0,2	— 0,0413	33	52,8	— 0,05	— 0,0987
7	54,0	+ 1,1	+ 0,0305	34	46,6	— 2,8	+ 0,0536
8	53,0	+ 0,15	— 0,1058	35	46,8	— 2,8	+ 0,0693
9	53,6	+ 0,07	+ 0,0036	36	52,8	— 0,05	— 0,0987
10	53,9	+ 0,08	— 0,1762	37	52,8	0,00	— 0,0485
11	53,3	+ 0,03	— 0,2235	38	52,8	0,00	— 0,0485
12	50,8	— 1,5	— 0,1036	39	52,4	— 0,3	+ 0,0124
13	53,9	+ 0,9	— 0,0762	40	47,6	— 2,7	— 0,0326
14	51,2	— 1,15	— 0,0250	41	48,2	— 2,5	+ 0,0243
15	54,0	+ 1,03	— 0,0369	42	52,5	— 0,17	+ 0,0655
16	50,0	— 1,85	— 0,0208	43	52,9	+ 0,05	— 0,1022
17	50,1	— 1,8	— 0,0224	44	50,8	— 1,4	— 0,0036
18	54,0	+ 1,1	+ 0,0305	45	53,8	+ 0,77	— 0,1129
19	50,6	— 1,4	+ 0,1096	46	52,6	— 0,2	— 0,0413
20	51,1	— 1,15	+ 0,0028	47	52,6	— 0,17	— 0,0113
21	51,9	— 0,07	— 0,0196	48	52,5	— 0,2	+ 0,0355
22	52,2	— 0,43	+ 0,0361	49	52,4	— 0,3	+ 0,0124
23	51,1	— 1,12	— 0,0072	50	46,6	— 2,9	— 0,0464
24	50,4	— 1,53	+ 0,0928	51	52,5	— 0,2	+ 0,0355
25	48,2	— 2,55	— 0,0257	52	52,6	— 0,2	— 0,0413
26	49,0	— 2,2	+ 0,0629	53	47,0	— 2,8	+ 0,0379
27	49,1	— 2,27	— 0,0522	54	45,0	— 2,8	— 0,0155

Last weighings and ultimate results.

3. QUARTS.

No.	Last weighing.		Final result.	No.	Last weighing.		Final result.
	Degree F.	Grain.	Grain and decimal.		Degree F.	Grain.	Grain and decimal.
1	47,4	— 1,3	+ 0,0611	28	53,1	+ 0,1	— 0,0841
2	56,8	+ 1,98	— 0,1097	29	53,0	+ 1,12	— 0,0079
3	56,4	+ 1,78	— 0,1026	30	53,0	+ 1,13	+ 0,0021
4	48,6	— 1,17	+ 0,0318	31	53,0	+ 0,1	— 0,0279
5	53,7	+ 0,37	— 0,0248	32	53,2	+ 0,17	— 0,0701
6	54,5	+ 0,73	— 0,0602	33	52,6	— 0,1	— 0,0207
7	52,3	— 0,1	+ 0,0946	34	52,5	— 0,1	— 0,0177
8	52,0	— 0,25	+ 0,0545	35	52,4	— 0,17	— 0,0138
9	51,7	— 0,4	+ 0,0072	36	52,4	— 0,17	— 0,0138
10	52,0	— 0,3	+ 0,0045	37	52,5	— 0,15	— 0,0123
11	52,2	— 0,15	+ 0,0830	38	52,6	— 0,1	— 0,0207
12	52,2	— 0,2	+ 0,0330	39	52,2	— 0,2	+ 0,0330
13	56,6	+ 1,93	— 0,0561	40	52,4	— 0,15	+ 0,0062
14	53,5	+ 0,2	— 0,1156	41	52,6	— 0,07	+ 0,0093
15	51,7	— 0,35	+ 0,0572	42	46,8	— 1,4	+ 0,0346
16	51,8	— 0,33	+ 0,0459	43	48,8	— 1,17	— 0,0034
17	51,8	— 0,32	+ 0,0559	44	52,9	+ 0,03	— 0,0461
18	51,8	— 0,33	+ 0,0459	45	53,8	+ 0,4	— 0,0414
19	51,7	— 0,33	+ 0,0772	46	53,7	+ 0,37	— 0,0248
20	52,0	— 0,32	+ 0,0155	47	52,8	0,00	0,0000
21	52,1	— 0,3	— 0,0311	48	51,7	— 0,4	+ 0,0072
22	51,7	— 0,35	+ 0,0572	49	52,3	— 0,15	+ 0,0446
23	52,2	— 0,2	+ 0,0330	50	50,2	— 0,87	— 0,0070
24	51,7	— 0,38	+ 0,0272	51	49,4	— 0,97	+ 0,0713
25	51,9	— 0,3	+ 0,0402	52	50,0	— 0,85	+ 0,0646
26	51,9	— 0,37	— 0,0298	53	50,0	— 0,9	+ 0,0146
27	53,4	+ 0,25	— 0,0330	54	50,2	— 0,85	+ 0,0130

Last weighings and ultimate results.

4. Pints.

No.	Last weighing.		Final result.	No.	Last weighing.		Final result.
	Degree F.	Grain.	Grain and decimal.		Degree F.	Grain.	Grain and decimal.
1	53,6	+ 0,15	— 0,0241	28	53,5	+ 0,17	+ 0,0122
2	52,4	— 0,12	— 0,0319	29	53,8	+ 0,2	— 0,0207
3	52,2	— 0,15	— 0,0335	30	53,6	+ 0,2	+ 0,0259
4	53,0	+ 0,05	— 0,0139	31	53,0	+ 0,05	— 0,0139
5	52,0	— 0,15	+ 0,0022	32	53,7	+ 0,2	+ 0,0026
6	51,6	— 0,2	+ 0,0115	33	56,7	+ 1,02	+ 0,0011
7	51,8	— 0,17	+ 0,0179	34	56,8	+ 1,07	+ 0,0251
8	51,5	— 0,25	— 0,0154	35	56,8	+ 1,07	+ 0,0251
9	52,1	— 0,1	+ 0,0343	36	56,6	+ 0,93	— 0,0630
10	51,7	— 0,17	+ 0,0336	37	55,0	+ 0,57	+ 0,0376
11	51,2	— 0,25	+ 0,0312	38	54,8	+ 0,52	+ 0,0348
12	52,8	— 0,07	— 0,0821	39	54,8	+ 0,47	— 0,0152
13	53,3	+ 0,07	— 0,0608	40	55,0	+ 0,57	+ 0,0376
14	54,0	+ 0,23	— 0,0373	41	55,0	+ 0,06	— 0,0676
15	53,5	+ 0,2	+ 0,0422	42	54,9	+ 0,5	— 0,0088
16	53,2	+ 0,12	0,0000	43	53,2	+ 0,05	— 0,0700
17	53,3	+ 0,1	— 0,0308	44	52,9	+ 0,03	— 0,0080
18	53,0	+ 0,07	+ 0,0061	45	52,9	0,00	— 0,0380
19	53,1	+ 0,07	— 0,0220	46	52,6	— 0,07	— 0,0304
20	53,5	+ 0,13	— 0,0278	47	52,6	— 0,07	— 0,0304
21	53,1	+ 0,07	— 0,0220	48	52,6	— 0,05	— 0,0104
22	52,8	— 0,05	— 0,0628	49	53,6	+ 0,17	— 0,0041
23	52,9	+ 0,03	— 0,0080	50	49,7	— 0,47	+ 0,0181
24	52,5	— 0,1	— 0,0412	51	52,7	+ 0,05	+ 0,0637
25	53,2	+ 0,1	— 0,0200	52	52,9	+ 0,07	+ 0,0320
26	53,4	+ 0,15	+ 0,0085	53	53,1	+ 0,07	— 0,0220
27	53,5	+ 0,17	+ 0,0122	54	52,9	+ 0,07	+ 0,0320

Last weighings and ultimate results.

5. Half Pints.

No.	Last weighing.		Final result.	No.	Last weighing.		Final result.
	Degree F.	Grain.	Grain and decimal.		Degree F.	Grain.	Grain and decimal.
1	52,8	— 0,03	— 0,0361	28	50,5	— 0,2	— 0,0043
2	49,5	— 0,3	— 0,0452	29	51,2	— 0,15	— 0,0099
3	49,5	— 0,25	+ 0,0048	30	51,2	— 0,17	+ 0,0045
4	49,5	— 0,27	— 0,0252	31	51,7	— 0,07	+ 0,0318
5	49,8	— 0,27	— 0,0322	32	51,5	— 0,15	— 0,0327
6	50,0	— 0,22	+ 0,0086	33	51,5	— 0,15	— 0,0327
7	50,4	— 0,15	+ 0,0520	34	51,6	— 0,1	+ 0,0057
8	50,6	— 0,17	+ 0,0187	35	51,7	— 0,05	+ 0,0518
9	50,8	— 0,15	+ 0,0245	36	52,2	0,00	+ 0,0582
10	51,0	— 0,17	— 0,0125	37	53,0	+ 0,07	+ 0,0381
11	51,8	— 0,10	— 0,0061	38	52,7	— 0,05	— 0,0431
12	52,3	— 0,10	— 0,0514	39	52,3	— 0,07	— 0,0214
13	53,0	+ 0,03	— 0,0019	40	52,1	— 0,03	+ 0,0371
14	56,8	+ 0,55	+ 0,0276	41	52,5	— 0,03	— 0,0006
15	56,8	+ 0,57	+ 0,0476	42	52,5	— 0,05	— 0,0206
16	56,7	+ 0,55	+ 0,0406	43	52,6	0,00	+ 0,0198
17	56,7	+ 0,5	— 0,0094	44	52,6	0,00	+ 0,0198
18	56,6	+ 0,45	— 0,0465	45	52,7	— 0,03	— 0,0231
19	56,6	+ 0,43	— 0,0665	46	52,7	— 0,05	— 0,0431
20	56,7	+ 0,4	— 0,1094	47	52,8	0,00	— 0,0060
21	56,5	+ 0,4	— 0,0836	48	53,2	+ 0,05	— 0,0100
22	56,4	+ 0,4	— 0,0706	49	53,0	0,00	— 0,0319
23	56,4	+ 0,45	— 0,0206	50	49,8	— 0,2	+ 0,0378
24	52,2	0,00	+ 0,0852	51	53,3	+ 0,1	+ 0,0346
25	52,4	— 0,05	— 0,0110	52	53,2	+ 0,07	+ 0,0100
26	51,0	— 0,13	+ 0,0275	53	53,0	+ 0,03	— 0,0019
27	51,0	— 0,2	— 0,0425	54	53,6	+ 0,1	— 0,0130

49. *Last weighings and ultimate results of the single gallons.*

No.	Last weighing.		Final result.	No.	Last weighing.		Final result.
	Degree F.	Grain.	Grain and decimal.		Degree F.	Grain.	Grain and decimal.
55	51,4	— 2,0	+ 0,0012	91	51,5	— 2,0	— 0,1231
56	51,5	— 1,8	+ 0,0769	92	52,0	— 1,2	+ 0,0180
57	52,2	— 0,93	+ 0,0023	93	51,8	— 1,6	— 0,0963
58	51,1	— 2,35	+ 0,0357	94	52,5	— 0,4	+ 0,0711
59	51,6	— 1,8	— 0,0475	95	51,6	— 1,7	+ 0,0525
60	50,6	— 3,0	+ 0,0192	96	51,6	— 1,7	+ 0,0525
61	51,0	— 2,53	— 0,0086	97	54,0	+ 2,1	— 0,0390
62	51,4	— 2,1	— 0,0988	98	52,0	— 1,2	+ 0,0180
63	51,1	— 2,37	+ 0,0157	99	52,0	— 1,2	+ 0,0180
64	52,9	+ 0,3	— 0,0044	100	51,7	— 1,7	— 0,0713
65	52,4	— 0,65	— 0,0252	101	53,9	+ 2,0	+ 0,0476
66	50,6	— 3,0	+ 0,0192	102	52,2	— 1,0	— 0,0677
67	50,5	— 3,0	+ 0,1324	103	53,9	+ 1,9	— 0,0524
68	50,6	— 3,0	+ 0,0192	104	52,0	— 1,3	— 0,0819
69	54,8	+ 3,9	— 0,0182	105	53,1	+ 0,7	— 0,0367
70	50,5	— 3,1	+ 0,0324	106	53,2	+ 0,9	— 0,0617
71	51,4	— 2,07	— 0,0688	107	52,2	— 1,0	— 0,0677
72	50,5	— 3,0	+ 0,1324	108	50,8	— 2,7	+ 0,0928
73	50,4	— 3,25	— 0,0044	109	52,3	— 0,9	— 0,1214
74	51,4	— 2,0	+ 0,0012	110	54,7	+ 3,6	— 0,0415
75	51,4	— 1,93	+ 0,0612	111	52,0	— 1,2	+ 0,0180
76	51,5	— 1,9	— 0,0231	112	52,9	+ 0,25	— 0,0544
77	51,5	— 1,9	— 0,0231	113	52,4	— 0,6	+ 0,0248
78	51,6	— 1,8	— 0,0475	114	52,0	— 1,1	+ 0,1180
79	54,8	+ 3,8	— 0,0818	115	52,6	— 0,3	+ 0,0174
80	52,4	— 0,6	+ 0,0248	116	53,0	+ 0,5	— 0,0117
81	51,8	— 1,4	+ 0,1037	117	54,6	+ 3,4	— 0,0013
82	51,7	— 1,7	— 0,0713	118	52,0	— 1,2	+ 0,0180
83	51,6	— 1,6	+ 0,1525	119	52,4	— 0,6	+ 0,0248
84	55,1	+ 4,2	— 0,2479	120	52,4	— 0,6	+ 0,0248
85	51,6	— 1,7	+ 0,0525	121	54,5	+ 3,1	— 0,0610
86	55,3	+ 4,6	— 0,2253	122	52,7	— 0,2	— 0,0899
87	51,6	— 1,8	— 0,0475	123	55,9	+ 6,1	— 0,1521
88	50,9	— 2,8	— 0,1429	124	56,1	+ 6,8	+ 0,0864
89	51,6	— 1,7	+ 0,0525	125	52,4	— 0,6	+ 0,0248
90	51,5	— 1,9	— 0,0231				

50. Description of the thermometer.

The whole thermometer is 14 inches long; instead of a bulb, it has a cylinder of 3.1 inches in length, and $\frac{2}{3}$ of an inch diameter, in order that it may take in contact water at different depths in the vessel. It has at the bottom two projecting parts, elevating it away from the bottom, as well because it would otherwise indicate the temperature of this bottom, rather than that of the water, as in order to approach the nearest to the mean of the temperature of the mass of the water, by being placed near the middle of the depth. The scale reaches from 32° Fahrenheit to 62° Fahrenheit, and has 8,1 inches length; thence, each degree is 0,27 of an inch, and is divided in halves, which admits evidently very accurate reading.

51. *Description of a new form of a transportable original barometer, and the method of constructing, and using, the same.*— (See plate I.)

1. The principle upon which the barometer is grounded, is the Torricellian experiment. The more perfect, and the most free from all accessory influences, the experiment can be made, the more perfect the barometer will be.

2. The condition of transportability, added to the requisite of the experiment, constitutes the barometer in use for travelling, &c.: also called mountain barometer. This transportability is aimed at in a variety of ways, of which none is free from objections upon the principles of natural philosophy.

Thence arises the great variety of forms which the barometers are subject to, and the bad habit of establishing or regulating the most barometers by comparison, taking certain individuals as standards, by which to regulate others; for instance, all the barometers made in the same instrument maker's shop, the same observatory barometer, or such like.

3. An inducement to do so arises also from the circumstance: that is often desired to relieve the observer from all reflection upon his work, not to trouble him with actually making the experiment, which a barometric observation should in fact be, and laying most value upon avoiding the inconveniences which barometers may be subject to in travelling. Certainly many observers have felt both the disagreeableness of unsatisfactory results, and the individual inconveniences, of all the habitual constructions of transportable, or mountain, barometers.

4. In the construction which I devised, my aim was, the *undoubted accuracy* of the instrument, the *safety* of transportation, and the easing of *making the actual experiment.*

5. As this appeared to me to constitute the principal difference between an uncertain observation and a real determination of the pressure of the atmosphere, which it is intended to represent, by the counterpoise of the mercury column in the barometer, I considered it was well worth to sacrifice for it some of the mere mechanical conveniences of the habitual constructions, and to suppose, as in fact it should be allowed to do, that the observer will be willing to acquire some habits of care and dexterity in manipulation.

6. The barometer of my construction consists of two principal parts, separated for transportation; first, the tube filled with mercury, and second the scale, to measure the height of the column of mercury, when put in equilibrium with the atmosphere.

7. The scale to measure the actual column of mercury, is placed at the side of the tube, with proper means to adjust the beginning of its counting

to the surface of the mercury in the basin, as such must of course be the beginning point of its measure.

8. An arrangement, marking the top of the mercury column, and referring it to the scale, with verniers for easier reading, is connecting these two parts.

9. By separating the parts in the travelling, and easing the means of uniting them for observation, the actual experiment can be made in such a manner, that security and accuracy are obtained in a much higher degree than habitual. To obtain this, I esteemed of no consideration the trouble and care in putting up for observation the barometer of my form, because it is well repaid by the result.

10. The two main parts are suspended parallel to each other, from a plate of brass, fastened to a stand, or any arrangement as may be easily contrived in the field, when necessary. (See the figures of which the detail parts are in natural size, the main figure in ¼, &c., plate I.)

11. The barometer tube is entirely in view, free, without any longitudinal mounting, and unobstructed when under observation, as seen by the lightly shaded column C, C. The tube is held at the upper end by a brass ferule, *f f*, lightly pressed by the screw, P; the ring at the top of the ferule is hung on a hook attached to the screw, D, which passes through the plate, C, C, and is raised or lowered by the finger screw above the plate; in order that it may not turn in the vertical movement, the screw beam is filed flat at two opposite sides, and the hole in the plate, E, is adapted to that shape. An aperture in the side of the ferule *f* admits a view of the uppermost part of the tube, to ascertain its state of purity, or the close fit of the mercury and glass, which becomes apparent by inclining the tube.

12. By this ferule and hook the tube is suspended freely from the plate, e, e, so as to hang perpendicularly by its own weight, the lower end being immersed in a basin filled with mercury, and reaching nearly to the bottom of it, the basin standing in a plate to receive accidental spillings of the mercury.

13. At the lower or open end of the barometer tube, which has two parts, *g g*, projecting like legs, with slits to receive a wedge, a steel plate, K, with a leather cushion, fitting to the opening of the barometer tube, is applied, when the tube is turned the open end upwards, for the purpose of shutting up the full tube for transportation; the cushion is fastened to its position by the wedge passing over it, pressing the cushion somewhat in the opening of the tube, to shut close; a piece of thin buckskin could yet be added between the tube and the cushion, when this becomes hard by use.

14. In transportation, the tube is carried with this lower end upwards, and well shut by the wedge, (this is, of course, as much as carrying a glass full of water covered, and the open part upwards.) Three such tubes can be easily fitted, as I did, in a block of wood, having longitudinal grooves carved out to fit them, and lined with woollen blanket stuff, the whole block being surrounded by the same stuff, and a sheet-tin tube made to fit over the whole.

15. Parallel to the mercury tube hangs from the same plate, *e e*, the steel rod, *h h*, which is moved vertically by a screw, similar to that for the tube, only, if necessary, sufficiently elevated over it by a ferule to prevent the two finger screws to interfere.

16. This rod plunges below in the basin of mercury, where it bears two marks, one for the beginning of the scale, or the null of the counting, which

is to coincide with the surface of the mercury in the basin; the other is half an inch above it, so as to correspond with the top of the swimmer, *i*, of half an inch height, which moves freely around the steel bar. The swimmer is a light tube with a flat and broader circular base, it is made of ivory, and so very light as to cause no impression in the surface of the mercury. A light file-stroke mark around the rod must be made to coincide with the top of this swimmer, by the screw of the bar above, to place it so as to give proper reading in observation, the coincidence of the surface of the mercury itself never being observable with any degree of accuracy.

17. At a proper distance above the null point of this rod, a divided scale, S, is adapted, of such a length as will serve for all observations intended to be made with the individual barometer: suppose, for instance, from 24 to 32 inches, or lower down when needed. This scale part can be of brass, or any other material, as it is always easy to make a table adapted to the metal used.

18. In a slit of this divided scale slides a piece of brass mounting, *a*, presenting to the tube a very thin ring, about ¾ of an inch high, which encircles the tube, and is cut open vertically, so as to form a light spring, admitting to adapt itself to a light friction upon the tube; in the observation, the lower end of this ring is brought tangent to the convex surface of the mercury, while it presents to the divisions of the scale the vernier, which it equally bears. It is guided by the finger screw, *t*, which presses a light brass spring to the scale, by hand only, and holds its position by friction; it serves to screw also the whole piece fast. It is evident that, if desired, the motion of the piece, *a*, may be put under the guidance of a rack and pinion, if found preferable, like it is often done; but I prefer the simple motion by hand.

19. A thermometer, with the bulb and glass tube projecting about 1¼ inch below the scale, is suspended so as to plunge its bulb in the mercury basin; this may be either hung down from the scale by a string, or from a hook fastened at the side of the vertical bar of the stand, to which the barometer is mounted, as in figure Z.

20. A stand, to bear the whole arrangement, may be made according to the convenience, or the means, of the observer. It requires, of course, a small bench to place the mercury basin upon. The manner in which I generally arranged it, for two barometers, (as I think it a proper precaution to have always several to judge of their state and accuracy,) is represented at Z. The drawing needs no special explanation.

In absence of such a stand, a branch of a tree, near the stem, may be contrived, by a little ingenuity, to answer the same purpose.

21. To place the barometer under operation, the following is the proper manner:

The purity and cleanliness of the mercury in the basin is the first and most essential point to be attended to. It is proper to have for that purpose a flask of distilled mercury, which is best made in the form of which the outline is seen in the plate, I; the cover, X, of which screws over it, holds the stopper pressed in its place when shut, and has, at its rounded top, a projecting tube fitting in the hole of the neck at the top of the flask, Y. Thus the cover, when inverted, serves as a funnel to pour the mercury in the flask.

22. The basin intended to receive the lower end of the barometer is to be filled with mercury, deep enough to immerse the tube above the steel ferule. To have it clean, a funnel is made of writing paper, leaving on the

bottom only a small hole about the size of a pin; through this the mercury is sifted into the basin.

23. The plate *e e* being supposed screwed fast to the projecting top of the stand, and the screw, guiding the hook to suspend the tube from, being in its place, as seen in the figure Z, the piece holding the vernier, and the brass ring, &c., is put over the tube, lightly holding by the spring of the tubular part. The ferule, *f*, is fastened at the hermetically sealed end of the tube (which is yet held lowermost) by means of the screw P, at the side of it. For the easy steadiness of this hold, the glass tube is to be enveloped at that part either with two or three rounds of paper, a small strip of velvet, or other similar stuff.

24. While holding the open part of the barometer tube upwards, the wedge holding the iron plate with the cushion is taken off. Now holding this top near the mercury basin, a little mercury is taken up with a clean small piece of paper, pressed in the shape of a shovel, and put in the top of the tube, causing it to overflow in the basin. What little oxide may have formed itself upon the top will run over in the basin, and clean this part; then place the ball of a finger's end, of sufficient size to cover the opening of the tube exactly over the opening, and press it fast, air tight. A little mercury falling again off in the basin; then this part of the tube is approached to the basin, and, with the finger upon the opening, immersed in it, while, with the other hand, the sealed end of the tube is gradually raised, holding the open part always tight shut up, with the finger under the mercury, until the tube is nearly upright, when the finger is withdrawn from the opening, then nothing but mercury, and no air, can enter the tube. Ultimately it is placed perpendicular. It is now tried, if fully free of air, by causing the mercury column to strike at the top, by means of a somewhat sudden but slight inclination. The sound of the dead stroke will indicate that the operation has succeeded.

This inversion requires, of course, some care and dexterity, which it ought always be allowed to suppose to an observer, or experimentator.

25. The barometer stands now upright in the mercury basin upon the two projecting parts of the steel ferule. By the hook of the screw through the plate *e e*, it is now made to hitch, by the ring at the top of the ferule, to the hook of the screw, which is made turning round like a swivel at the end of the screw. To give it the full, free, perpendicularity, it is screwed up until it is felt that the tube hangs slightly free from the bottom of the mercury basin; so its perpendicularity is secured by its own weight.

26. The measuring rod, with the scale, is now put through its corresponding hole in the plate *e e*, its upper part being pushed through from below, and plunged into the mercury by its lower end; the ivory swimmer being put from below over the rod, will swim freely upon the surface.

27. For the observation, the part of the steel rod, from which the null point of the scale is to be counted, is, of course, first to be adjusted, by moving the screw at the top, so as to make the higher mark upon the steel rod to coincide with the top of the swimmer, for which it is intended, and by which the coincidence of the *o* point of the scale is indicated, to coincide with the top of the mercury.

28. Now, the piece *a*, is placed in its proper place in the scale, in the slit, in which the holding part of it fits; it is clamped by the screw *t*, in such a manner as to admit sliding, and to be held in its position by friction, and this can be moderated by more or less pressure of the screw *t*, so as to al-

low it gently to be moved by hand, because the small plate below the screw forms a spring upon the scale; then the *lower* part of the ring of the piece, *a*, being placed so that the lower edge forms an exact tangent to the convexity of the mercury in the tube, the standing of the mercury is evidently indicated by the scale, and the vernier of the piece *a*, which slides along the scale.

29. This position, and its reading, furnishes the observation of the barometer, to which the indication of the thermometer immersed in the mercury basin, and of another free one, being added, all the desired data of the observation are obtained.

30. Though it is evident that the taking down or dismounting of the barometer must be the inversed operation of the putting it up, as above described, it may not be superflous to state here the regular operation, to prevent any erroneous move, to such persons as may not be used to similar operations.

31. The barometer tube, when in operation, being freely suspended by the hook at the lower end of the screw *d*, and the upper ferule *f*, it is lowered by the screw which guides this hook, so as to touch the bottom of the basin, to stand upon the two projecting pieces *g g*, of the iron ferule below, where it is easy to support it, while it is further lowered, until the ring part of the ferule *f* of the tube can be disengaged from it; then the brass piece *a*, holding the vernier, is loosened, by taking out the screw *t*, and the piece is held in the hand, together with the upper part of the tube. The tube is now inclined gradually, so that it fills itself to the top; by its striking dry to this top, it will prove to be properly free of air. All this time, the lower end of the tube is kept touching the bottom of the mercury basin by the iron legs, *g g*, of the ferule, and the aperture is kept well under the mercury.

32. When the tube is thus well filled again, pass a finger's end in the basin of mercury, between the pieces *g g*, and shut the opening of the tube closely with it, so as to enable to continue turning the sealed end of the tube downwards; and last raise the open lower end, well shut by the finger, out of the mercury, to a perpendicular position, and hold it uppermost; then the finger can be taken off without spilling, and the tube being full, is shut up with the iron plate and cushion by the wedge. Some small drops of mercury which will be about the opening can easily be pushed off in the basin; the tube can now be placed in its proper case for travelling; all the other parts, ferule, scale, basin, &c., are then taken up and cared in such a manner as will be stated in describing the packing for travelling; their manipulation needs no special description.

Manner of constructing the barometer.

33. In respect to the mechanical part to be executed in metal, the above description, showing what is required from that side, will be sufficient to guide the work, as no special instruction is needed for an able mechanician. The operation which is to be described, and which requires care and some delicacy in the operation, is the filling of the tube with mercury, so as to exclude all air.

34. The mercury to be used must be pure, distilled mercury. The tube must be perfectly clean, so much so, that seldom an old tube that has served already, can be made to give a good barometer again; therefore, the new tube, which has been from its making shut up by a stopper, or still

better, hermetically sealed, shall be preferred, or, in fact, is the only one admissible.

35. The tube is cleaned by means of a flock of well washed, long, new, *wool*, deprived of all grease, soap, dust, or other uncleanliness, (not any cotton, because cotton scratches glass;) this is held at the end of a thin piece of whalebone or of metal wire, wrapped around close with linen or woollen thread, so that no metal can touch the glass; this rod or wire has, at its lower end, a smaller part of wire turned in the form of a corkscrew, to guide the flock of wool, which is made to fit somewhat tight in the tube: turn it by a corkscrew motion, and well round at the sealed end; then gradually turn it back out by a screw-like motion, while always holding the sealed part of the tube upwards. For this operation the tube must be warm, as well as the wool and the rod, to prevent all possible dampness; to this effect, I bring always the whole before the fire—tube, mercury, wool, and wire—before the first beginning.

36. The open end is now again lightly stopped with a small paper cone, and is hung before a fire, so as to get equally warm through its whole length, or put in such an inclined position before the fire, that the inside air escapes easily, and admits no vapor to stick to the glass.

37. The mercury is passed through a paper funnel, in a well-wiped glass goblet, with an elevated foot, placed also before the fire, and covered from dust, so that the tube and the mercury get both equally as warm as may be admissible to allow the necessary manipulation of the parts.

38. When in this state, the operator sitting before the fire, in the same dry and warm air, takes the tube, placing the sealed end in his shoe, to be able to guide it by the foot, and holding the tube inclined from perpendicularity, only so much, as will cause the mercury to run, always touching the same side of the tube.

39. With a paper funnel, as before described, in one hand, the goblet with the mercury in the other, he fills the paper funnel held over the open end of the barometer tube, so that the small hole at the bottom of it acts as a strainer; it is best, even here, to let the first few drops of mercury go in another vessel, to get no oxide in the tube; the tube is thus filled until to about one-third of an inch from the top; (here the operator is to be warned to hold fast, in order not to be overtaken by the electric stroke, which will take place, between the mercury in the tube and that in the funnel, when the operation has succeeded the best.)

40. The tube will now show air bubbles in more or less places; these do, however, not adhere, if the operation has otherwise succeeded. They are easily removed by the following operation: Shutting the open end of the tube tight with the finger's end, the sealed end of the tube is gradually elevated, so as to make the air shut in by the finger travel slowly till to the sealed end, revolving a little the tube, so as to make it take up under way, in this course, as much of the air bubbles as can easily be; now turning the tube round, and making, by gradual inclination in slow vertical motion, the sealed end to be again filled exactly, the open end of the tube being always kept exactly closed, is again elevated very slowly, so as to cause the mercury to *empty* itself gradually from the column on the side of the open end, (which in this operation is the higher one,) towards the sealed end of the tube, in a continued *small* stream, until it is all connected in one column, so the tube is in some measure filled again anew, exactly.

41. If, in this manner, a constant, light, uninterrupted, string of mercury is maintained, between the two columns, when the whole has passed, it

will most generally be found that the tube is entirely free of air, to about half an inch of the open side; during this operation the tube has gradually come in a perpendicular position, the open part upwards; and it is now filled entirely by the small necessary addition of mercury, as stated before, with a small paper shovel.

42. If, however, some air bubbles should still adhere, the operation of turning over may be repeated, before the tube is entirely filled. But if the whole of the above process has been done carefully, under a properly elevated state of temperature, therefore of great rarity of the air, and mobility of the mercury, the simple process just described, performed by a steady regular motion, will hardly fail to give a most perfect barometer.

43. It was formerly thought, and is certainly still by many people, that the boiling of the mercury in the tube was the best; the operation is very dangerous, as to breaking the tubes. It is evident that the barometer tube cannot be boiled when full—the pressure of the mercury is too great; the development of the air in the lower part of the column lifts the whole, and bursts the tube. Boiling, therefore, the barometer, with the tube about ¼ or ⅓ full, then half, &c., as habitual, the following is what happens: the mercury vapors, rising, adhere to the inside of the tube, and resist generally, at least the mercury that is poured over, so that no complete freedom is obtained, and this mercury gas, which is created by the operation, adheres to the tube. When the barometer is ultimately put up, it is collected at the top of it, where a *vacuum* should be, and forms a very elastic, though rare, atmosphere; the barometer then becomes phosphorescent, what was considered a good quality, but evidently indicates the presence of a foreign gas, by the first elements of natural philosophy; in proof of it, the barometer does not strike full dry. Of course, also, some barometers made by boiling have succeeded; but by far the greatest number either broke, or were subject to the defects here stated, which has certainly discouraged many, as well as me.

44. *The arrangement of the packing* for travelling is the following, for one single barometer: The tube and the steel rod with the scale are fitted in grooves of a cylindric stick of wood, of 2 inches diameter, lined with thick woollen cloth of blanket stuff or the like, so that the iron ferule of the tube, and the screw at the top of the steel rod, reach above the block, and the tube rests below upon the same woollen stuff; this block is fitted into a tube of sheet tin, with a cover sliding on, which will be filled with some soft stuff, to prevent its moving up, being gently held in its place by the pressure of the cover.

45. The mercury basin is supplied by a quadrangular box of pasteboard, lined and covered with leather, varnished, and with a cover; in travelling, the upper brass ferule of the tube, the vernier part, the swimmer, &c., may be placed in it for transportation. The box is impervious to mercury, and safer against breaking than a glass or earthen ware vessel.

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52. To be enabled to weigh with the same, or at least proportional accuracy, as hitherto done with the other standards, the dry capacity measures of the bushel, or rather half-bushel, which it was found much more proper to adopt, as it is habitually used, and easier managed, it became necessary to construct a balance capable of weighing, with the required degree of accuracy, about 120 to 150 pounds avoirdupois in each ba-

sin—a task never heretofore attempted in a metal balance. It will, therefore, be proper to give here, in advance of the account upon the next part of the standard system, which is to be executed, the description of the balance constructed for that use in the workshop of this office, as follows:

53. *Description of the balance constructed for the adjustment of the standard half bushel.*

1. The balance rests upon a marble plate of about 8 feet long, 2½ feet broad, and 5 inches thick, cemented and levelled upon a brick floor resting upon the ground, in the basement story of the office, where the heavier weighings are habitually made. In the middle of this plate is elevated a massive of marble, of 16 inches high, 31 inches in the direction of the large marble plate, and 21 inches in the direction perpendicular to it. This is cemented to the marble plate first mentioned. Plate II represents a general view of the whole balance.

2. A plate of brass of one inch thickness rests upon this central stone block, and is cemented to it; upon this rest the four fluted quadrangular columns, fastened to it by iron bars, pressing from below that plate, through the middle hollow part of the columns, to the square capitals of the same, D, D, and through the plate H, H, joining the upper part of the four columns. The parts through which these bars pass are therefore held together by the strong pressure of the screws, which have their mothers, Z Z, beneath the lower plate; for these mothers there are excavations made in the stone of the central block, where they are, of course, cemented together with the plate C C C C itself.

3. Upon this upper plate and the capitals D, D, which are *superposed* to it, rest two pieces, 8, 8, one on one side of the scale beam, the other on the opposite side, thence resting each upon two of the columns, and the plate H, H, which joins all four columns, and to which they are screwed fast; these hold up and guide, at their inner side, two dovetailed pieces, sliding perpendicularly, and bearing the steel plate 1, 1, up to the knife edge 3, 3, of the scale beam, which therefore rests upon these steel plates when the balance is in activity; their receding downwards sets the balance at rest by removing this central support, and letting the beam rest upon the two pins O, O, placed for that purpose in the beam at 22,5 inches from the centre, sufficiently above the horizontal middle line of the beam, to secure its steadiness in this suspension; this central support is 43 inches elevated above the brass plate, C C, at the bottom of the columns.

4. The balance beam is 67 inches long between the two points of suspension, A, A, of the basins, which, therefore, are 33,5 inches from the central knife edge; they are quadrangular prisms, passing through the middle of the nearly circular part at each end of the beam, presenting to the suspension of the basins, by their upper edge, knife edges formed by a square prism, exactly similar, but smaller, to that of the central knife edge, while the central quadrangular prism presents a knife edge downwards.

5. On these two opposite knife edges hangs a brass frame, in the form of an inverted stirrup, bearing plates of steel on each side, with a circular, slight excavation, for this the central or most elevated part is marked by a slight line on both sides, to secure its full regularity of adjustment, in the placing of these pieces; the special shape of it is fully seen in the general figure of the balance, plate II, and the figure X, at the side of it. It reaches

down for some distance in order to give it a free motion, and it has on the lower end a loop, which receives a hook in the form of a returned S, of polished cast steel, where namely the two hooks are at right angles to one another, which, of course, breaks off all stiffness of motion that might remain from the arrangement above, and has the effect of making the weight below hang completely free from that point; from which, therefore, the suspension-arrangement for the basins hangs down completely free, (which will be described hereafter.)

6. The two central pieces, 8, 8, resting with their ends upon the two tops, D, D, of the columns, on each side of the balance beam, and between upon the plate H H, are 6,2 inches elevated over the plate H; they have, at their inner side, dovetailed holders, enclosing two strong perpendicular sliding pieces, which carry the steel plates 1, 1, upon which rests the angular edge of the central square prism, which presents the knife edge; to move these supports, they are fastened to a circular plate joining them below, so that, by elevating this plate, they are both simultaneously raised perpendicularly, thus forming only one piece with them, and presenting an arrangement destined to meet the central knife edge, and with it to lift the whole balance into activity, by elevating its centre about half an inch, or to put it back into rest by lowering it.

7. This perpendicular lift is obtained by a peculiar, and entirely new, arrangement, thus: The circular plate of 5¼ inches diameter, upon which the dovetailed perpendicular pieces, carrying the central steel plate, upon which the knife edge shall rest, are fastened, has the form of a cover of a round box, with a steel centre in the middle; excavations in the supporting pieces, 8, admit its free motion up and down, which the supports for the distance required.

8. It receives in the lower excavated part a plate of cast steel, S S, with two handles, projecting diametrically opposite to each other, figure 4, plate III. Near its circumference, for about three-quarters of an inch, it is divided into five parts, or sectors; these quintants are subdivided in five parts, in the following manner: one part is upon a level with the lower plane of this steel plate, then three parts form a continued inclined plane, rising gradually till to half an inch from that surface, there it meets a resting place of again one part, horizontal, and parallel to the first resting plane. This piece revolves around the centre, below the preceding box-cover-shaped one, and is placed in an inverted position, as represented in figure 4, plate III, somewhat in perspective, and its two opposite handles, S, S, project outside, on both sides, till past the excavation of the middle of the plate H H; thereby this plane can be guided from outside, by turning this piece around the centre for one-fifth of the circumference, which is all that is needed to bring the balance from its resting position, in the free suspension needed for its action.

9. A centre piece in the plate H H is of red cast, (that is, copper and tin,) like the cover, above the steel plate with handles, which makes easier motion with the steel, and has, as the drawing shows, exactly the division of its rim, like that of the steel piece, but in an inverted position, so that the deepening of the one receives the projection of the other exactly, when the balance is lowered; and when the piece S S is revolved about its centre in the upper box, the two elevated parts standing upon one another, the balance is elevated for the amount of this elevation, (that is, half an inch,) and the balance rests now upon the lower edge of the quadrangular central prism, oscillating according to the wants of the weighing. In this manner the

revolution of the steel plate, figure 4, performs the office of elevator of the balance beam by a perpendicular lift.

10. Two arms, 7 7, (plate II and plate III, figure 3,) on each side, originating from behind the capitals, D, D, of the columns, above the plate H H, resting upon this end, in part embracing the same, reach up in an inclining elevating direction towards, and till near below the pins, crossing the balance beam at O, O, above mentioned; the two arms reaching towards the same side of the beam's arm, from the front and rear of it, are joined, at some distance from the columns, by a crossing piece; they bear there a piece of brass, n, n, y, drawn separate in plate II, opposite one side of the beam, in the form of an elongated y; these revolve upon two axes, one at each side of the beam, upon which they can revolve to the two positions which are marked in the general figure, plate II, the one in full lines, and the other in dotted lines, in the perpendicular position, these pieces admit the pins O O, passing through the beam of the balance, to pass up and down with the motion of the beam, while the balance is in operation for weighing; when the balance is intended to be rested, the same pieces are moved by means of the lower parts y, which serve as handles; in the position which is marked by the dotted lines; it brings its two y y at the ends n, n, directly under the pins, O, O, of the beam, and arrests its motion.

11. This motion being made with these supports for both arms of the balance simultaneously, the turning towards the right of the handles of the steel piece S S, figure 4, plate III, brings the balance to rest by the pins, O, O, at each of the opposite arms of the beam upon these y, y, at the end of these supporting pieces; the central dovetail pieces, which bear the steel support of the central knife edge, being then lowered, relieves also the knife edge entirely, so that no part of the balance, acting in the weighing, can be subject to unnecessary bearing or action.

12. At the central part of the top of the balance beam is a ball, 4, as usual, for counterpoising; under that a light arm of about two inches long, marked 5, revolves around its stem, and can be brought on either side, so as to compensate the last minute part, that may be needed to establish perfect equilibrium of the whole balance, by the position in which it can be placed, to bring its small weight, more or less, to the one or the other side, or in case the adjustment of the balance is otherwise exact, to keep it balancing itself by its position perpendicular to the beam.

13. The minute reading of the balance is obtained by the index of a light lever, presenting a vernier formed flat piece to a sector of a circle, u u, fixed at the end of the supporting arms, 7, 7, a small support, t, t, fixed to the dovetailed piece, 1, 1, above described, bears the axis of that lever, around which it revolves; the long end reaching to the sector of 21,5 inches long, is made of a light strip of whalebone; the small arm is 1,1 inch long, made of brass, so as to bring a friction roller which is at the end of it, by a light pressure, in contact with the lower inclined side of the central knife edge, by leaving a light overpoise to the longer arm. This arrangement procures a multiplication of the angular movement of the balance in the proportion of the two arms of the lever, and the inclination of the side plane of the central knife to the perpendicular; the very central position at which the friction roller touches the inclined plane of the knife edge, makes that the balance can in no way whatever be affected by it; therefore it takes nothing of its sensibility, while it brings the two readings of the stand of the balance nearer to the operator at the balance, who is, of course, supposed to sit before the middle of it.

14. The half-bushel required a dimension for the basin part of the balance of 20 inches diameter, the perpendicular suspension rods of which should be reaching up to a distance of at least as much, without sensibly narrowing this space; thence the upper corresponding frame, by which the whole arrangement is suspended by the hook P, in the form of a half-turned S, described above, must present supports of complete stiffness at a considerable distance from the centre, at the same time it is very desirable that the balance should not be laden with any superfluous weight; at the end of this distance the connexion between this part, and the lower basin must, therefore, be nearly perpendicular.

15. With the view to these qualifications, the upper frame R R was constructed in the following manner: A brass triangle of the proper dimension, R R, is made, the sides of which lie horizontally, and have circular enlargements at the three angles, perforated in their centre, to admit the passage of steel rods, which connect the lower basin arrangement with it; screws and milled head mothers hold these steel bars in their position to both the upper and lower frame work. (See the general drawing and the details in plate III.)

16. To support this triangle properly, a frame work is made, which has for its centre piece a brass cylinder of about three-quarters of an inch in diameter and 9 inches in length; this bears at its upper part a ring, which is hung to the hook P, of the shape of a turned S; below that, it receives a circular rim, to which three arms, at edge bar to it, inclined towards the horizontal triangle, are fixed, joining the three angular parts of the same. At its lower end it receives a similar centre, and three arms, exactly like the upper ones, reaching from below to the angular part of the horizontal triangle. A strong brass screw and mother, at the lower centre, presses the two inclined triangles together to the horizontal one, and forms a very strong bracing and stiff support to the extremities, where the steel bars pass through, thus uniting the upper and lower triangles together to their support. The bars of all this arrangement are only of about three-quarters of an inch in breadth and one-eighth of an inch in thickness, therefore very light; still the mechanical principle of their combination renders them capable to support a weight certainly more than five times larger than the 150 lbs. which they have to bear in the case of our work. It presents a triangle inscribed in a circle of 16 inches.

17. The lower frame, upon which the bushel or half-bushel is to stand, consists of a triangular frame, the radii of which are 10 inches, going off from a round centre to the extremities F, F, F, (figure 7, plate III,) to meet there again a smaller circular part, perforated to receive the perpendicular steel bars coming from the upper frame, and held to this frame again by screws and mothers from below; it has a strengthening triangle within, connecting the stronger radii from the centre, to which it helps to give stiffness. All these pieces are edge bared, being about one inch high; they are narrower above than below, so as to present a small surface above, and admit in case the water to run off easily from the sides.

18. This side of the balance requires no plate or basin, which would, on the contrary, be in the way. Below the centre of this frame projects downwards a cylinder of about three inches long and half an inch thick, in form of a pin, which admits to be taken hold of by a pincer, V, V, with a rectangular incision in each arm; its centre is at W, at the other end, revolving upon an axis; and it is opened or shut by a steel screw at M, having a

right hand thread in one of the arms, and a left hand one in the other, resting upon a centre piece at its other extremity, and guided by a large milled head handle T; by the motion of this the end of the pincer, V V, is pressing fast, or loosening, the cylinder B, under the centre.

19. As it is essential, in weighing, to keep the balance in full steadiness and quiet equality, this pincer holds the triangular frame fast below while the basin is lading; and when it is laden, the opening of it gives the freedom to the balance which is necessary during the weighing.

20. The other basin, which is intended to receive the weights, has a frame similar to the one described, only somewhat lighter, upon which it holds a plate to receive the weights; the whole is made exactly equal in weight to the frame on the other side, destined to receive the half bushels. It is represented in figure 6, plate III, sufficiently for its full intelligence.

21. It will be understood, as a matter of course, that all the parts of the balance that are connected with the beam for weighing, as suspensions, stirrups, triangle, basins, &c., are made of exactly equal weight, each to each, for both sides of the balance.

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