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WEIGHTS AND MEASURES.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A report from Professor A. D. Bache, relative to standard weights, measures, and balances.

February 28, 1845.
Read, and laid upon the table.

Treasury Department,
February 27, 1845.

Sir: I have the honor to transmit, herewith, a report on the progress made in the construction of standard weights, measures, and balances, during the year 1844, under the superintendence of Professor Alexander D. Bache.

All which is respectfully submitted.

GEO. M. BIBB,
Secretary of the Treasury.

Hon. John W. Jones,
Speaker of the House of Representatives.

Report to the Treasury Department, by Professor Alexander D. Bache, on the progress of the work of constructing standards of weights and measures, and balances, in the year 1844.

Office of Weights and Measures,
Washington, February 26, 1845.

Sir: I have the honor to submit to you a report on the progress of the work of making standards of weights and measures, and balances, for the past year.

1. Near the close of December, 1843, I was charged by the Executive with the completion of the work required by the resolutions of Congress, directing the construction of standard weights and measures, and entered upon the duties in January, 1844.

2. The preliminary comparisons of weights and measures, which led to

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Report from the Secretary of the Treasury communicating the report of the Superintendent of the Coast Survey

the distribution of standards, were commenced by Mr. F. R. Hassler, in 1831, under the direction of the Treasury Department, and in compliance with a resolution of the Senate of May 29, 1830. The standards collected from the different departments, the weights and measures obtained from the different custom-houses of the United States, and from other sources, both domestic and foreign, were compared together with minute accuracy, and the results recorded in an elaborate report by Mr. Hassler, dated in January, 1832. The collateral and direct researches relating to this subject, the descriptions of the instruments and methods used, and the details of the operations themselves, the determinations of the forms, materials, and dimensions, and other particulars relating to standards of measure and weight, are set forth with much minuteness in the second part of Mr. Hassler's report, bearing date June 29, 1832. The whole work thus executed is the most extended and laborious ever accomplished in this department of practical science by one individual.

3. The actual construction of standards of weights and measures for the custom-houses of the United States may be considered as having commenced in 1835, when, in consequence of a resolution of Congress, the Treasury Department placed at the disposal of Mr. Hassler such assistance, means, and appliances, as he desired for the execution of the work. A report, dated November 28, 1835, shows the preliminary measures taken for the execution of the work, by preparing or procuring the materials and apparatus for making the standards.

4. During the year 1836, while the construction of the standards for the custom-houses was in progress, the Treasury Department was directed, by a joint resolution of both houses of Congress, approved June 14, to have a set of standards made for each of the States, "to the end that a uniform standard of weights and measures may be established throughout the United States." Six full sets of weights for the custom-houses, including weights from 50 lbs. to 1 lb., (ten pieces,) were completed in July, 1836, and their distribution was directed. Other weights, and some of the measures of length, were ready for final adjustment before the close of the year.

5. In 1837, the weights for the custom houses were cast and finished as far as the condition of adjustment; the balances necessary for adjusting the weights were made; and the approximate adjustment of the weights generally, and the adjustment of the smaller weights, was commenced. Part of the standard yards were brought to an approximate adjustment, and the capacity measures were commenced.

6. In July, 1838, the standard weights for the States were reported as completed and ready for distribution. They consisted of ten weights, from fifty pounds to one pound avoirdupois, and of a troy pound. In addition to this, during the year the work necessary to bring the yard measures to an approximate length was commenced; the intention being to prepare first as many as were wanted for the States and the principal custom houses. The preparation of the large weights for the custom-houses was also continued. The capacity measures for liquids were cast, and twenty made ready for adjustment.

In July of this year (1838) a joint resolution of Congress directed the construction and furnishing of standard balances to the States.

7. During 1839, the sets of weights for the custom-houses were completed and delivered. The adjustment of the number of yard measures required for the States was made, but they were retained for further com-

parisons. The capacity measures for liquids were made ready for adjustment. Part of the half-bushel measures were cast. The weights, except the ounce weights for the States, were completed.

8. In July, 1840, Mr. Hassler reports that forty standards of length (yard measures) had been adjusted and compared, and that the approximate adjustment of the liquid capacity measures had been made. The work of the half bushel measures was reported to be far advanced. A large balance for adjusting the half-bushel measures was in progress. Eighteen of the yard measures were reported in November, 1840, to have been distributed to the custom-houses, and twenty-three to have been packed up ready for delivery to the States, and transmitted with seventy-nine sets of standard weights to the Treasury Department.

9. The ounce weights included in the sets of standard weights for the States were completed (twenty-nine sets) before June, 1841; these include weights from ten ounces to one ten-thousandth of an ounce.

10. In March, 1842, Mr. Hassler reports that fifty-four sets of standard capacity measures for liquids have been completed, each set consisting of one gallon, one half-gallon, one quart, one pint, and one half-pint; and he recommends that one set be sent to each of the States, and one to the principal custom-houses. In the report of this year a description is given of the balance intended to be used in the adjustment of the standard half-bushels, and of the barometer and thermometer used; it contains also tables of the final adjustment of the different measures. The balances for the States occupied the chief attention during the remainder of the year.

11. The report of Mr. Hassler to the select committee of the House of Representatives, made in June, 1842, contains a table exhibiting the progress of the work up to that date. From this it appears that two hundred and seven sets of weights from one to fifty pounds, and fifty sets of one-ounce weights, had been completed, besides one hundred and twenty-two weights for miscellaneous purposes; and that all except the standards retained in the office had been delivered, completing this part of the work. One hundred and twenty five capacity measures are reported as ready for delivery; one hundred and seventy-seven as ready for adjustment and comparison; forty-one standard yards adjusted; one hundred and ten ready for adjustment and comparison; five yard measures and two foot measures, made for different purposes, and four comparing instruments, completed. Six balances for the adjustment of weights and measures in the office, and two for other purposes, had been finished; and twenty required for the States had been begun.

12. On a review of the work thus executed, it appears, that of the researches and operations committed to Mr. Hassler, the laborious preliminary experiments, and the comparisons of standards from the custom-houses, and of certain foreign standards, had been completed, and the form, materials, and mode of construction of standards determined. The preparations of materials, machinery, and apparatus for the construction of the actual standards, had been made. The standard weights for the custom-houses and for the States had been made, adjusted, and delivered. Nearly one-half of the capacity measures had been completed, and the rest were in different stages of progress. Between one-fourth and one-third of the measures of length had been completed, and the others were in progress. The balances for the adjustment of standards, and two others, had been completed, and thirty for the States commenced.

13. The comparisons of hydrometers, or "the ascertaining by experiment the proper hydrometer proofs of liquor," originally committed to Mr. Hassler, in 1830 or 1831, by Secretary Ingham, and the intended comparison of foreign standards of weights and measures with our own standards, for the purpose of introducing uniformity in the reckoning of foreign weights and measures at our custom-houses, do not appear to have been followed up. In reference to the latter, Mr. Hassler issued a circular through the State Department, for the purpose of collecting foreign standards; but the steps taken were not successful.

14. The lamented decease of Mr. Hassler occurred in November, 1843; and in January, 1844, Mr. Edward T. Hassler, who had been appointed assistant to Mr. Hassler in 1835, presented to the Treasury Department a report of the progress which the work of weights and measures and balances had made up to the beginning of 1844. This report not having been published, I have appended it, (appendix A,) with a view to its communication herewith to Congress. The following tables have been compiled from this report:

No. 1, shows the number of standard weights made, and their destination; No. 2, the progress of measures of length; No. 3, the progress of the measures of capacity, liquid and dry measures; No. 4, the progress of the balances. A general recapitulation, showing the number of each kind of standards of weights and measures, finished and unfinished, is given in No. 5.

TABLE No. 1—*Showing the kind and destination of the standard weights, prepared at the office of weights and measures prior to January, 1844.*

No. of sets.	No. in each set.	Character of weights and appliances.	Disposition of the weights, &c.
207	10	1 lb. troy; 1, 2, 3, 4, 5, 10, 20, 25, 50 lbs. avoirdupois. In mahogany boxes, 2 for each set; each pair in stained pine box; each pine box in common packing box; 1 fork and 2 hooks for handling with each set.	1 to England; 2 for independent treasury; 1 for Patent Office; 1 for Old Point Comfort; 3 for office; 99 for custom-houses; 26 for States; 74 for Treasury Department.
35	–	1-10000 oz. to 10 oz. troy. Each set in a mahogany box, lined; 1 pair forceps, 2 pairs tongs, for each set; each box for States in stained pine box.	1 to England; 1 to Patent Office; 4 in office of weights and measures; 29 to Treasury Department, for States.
6	–	1-10 to 100 oz. Packed as above, and with tongs and forceps -	3 to mint and branches; 1 to independent treasury; 1 in office of weights and measures.
1	–	1 to 10 oz. - - - - - - - - -	Patent Office.
1	–	10 oz. to 7 - - - - - - - - -	Independent treasury.
4	–	1-10 to 1,000 oz. Packed as above, and with tongs and forceps, delivered unadjusted - - - - - - - -	Mint.
1	–	1 to 10 oz., and 1 lb. - - - - - - - -	Independent treasury.
3	1	1 lb. 7 In a box, with 2 forks - - - - - - -	Independent treasury.
3	–	1 lb., with small weights, pliers - - - - - - -	Independent treasury.
1	1	1 lb. avoirdupois - - - - - - - -	Frankford arsenal.
1	1	1 lb. avoirdupois. In a bag - - - - - - -	Com. of Legislature of Massachusetts.
1	1	1 lb. troy. In a bag - - - - - - - -	Com. of Legislature of Massachusetts.
3	–	Flat weights, up to 10 lbs.	
3	1	10 lbs. of same forms.	
55	–	1 lb, and various weights - - - - - - -	Office of weights and measures.
4	–	- - - - - - - - - -	Office of weights and measures, for adjusting capacity measures.

TABLE No. 2—*Showing the progress of the standards of length at the beginning of January, 1844.*

No.	Designation.	Progress.	Disposition of the standards.
1	Yard measure "a-trait" (line measures) - - -	Completed - -	Brooklyn, New York.
1	Do do do - - -	Do - -	Lieutenant T. R. Gedney, for coast survey.
1	Do do do - - -	Do - -	Captain W. H. Swift, for coast survey.
1	Do do do - - -	Do - -	Lieutenant Glynn, for survey of Beaufort harbor.
1	Foot measure do do - - -	Do - -	Do do do.
1*	Do do do - - -	Do - -	Frankford arsenal.
41	Yard measures "a-bout" (end measures) and matrices. The yard on the matrix divided into tenths and hundredths -	Do - -	To custom-houses.
3	Yard measures similar to the foregoing - - -	Do - -	1 for Great Britain; 1 for Land Office; 1 for Patent Office.
7	Bars with yard measures, (line measures,) in mahogany boxes - - - - - -	Do	
10	Bars with foot measures, (line measures) - - -	Do	
1	Comparing apparatus, with microscopes, 36 inches laid off from Troughton's scale, and subdivided - - -	Do	
1	Comparing apparatus, four feet in length, and subdivided -	Do	
1	Wide plate, mounted for comparisons with microscopes -	Do	
1	Lever apparatus for adjusting - - - -	Do	
40	Yard measures (line measures) and matrices -	In various stages of approximate and final adjustment. All have boxes and apparatus for making ordinary measures from them.	When completed, to be distributed to the States and custom-houses; 1 for the Treasury Department; 1 for the office of weights and measures.
72	Do do do - -		
3	Strips for tracing yards, (in boxes.)		
18	Bars for yard measures.		
23	Strips for tracing foot measures, (in boxes.)		

* The foregoing measures are packed in mahogany boxes.

TABLE No. 3—*Showing the state of completion of standards of dry and liquid measure up to January*, 1844.

No.	No. in set.	Designation.	Condition.	Destination.
		Dry.		
31	1	Half-bushels, with glass covers. Packed in the same way as the liquid capacity measures.	Completed - -	26 to States; 4 to principal custom-houses; 1 to England.
1	1	Bushel - - - - - - -	Ready for adjustment.	
133	1	Half-bushels - - - - - -	Do.	
72	–	Mahogany packing-boxes for half-bushels - -	Completed.	
18	–	Do do do - - -	Not entirely completed.	
43	–	Do do do - - -	Not lined.	
32	–	Glass covers for half-bushels - - - -	Ready. 11 more required.	
1	1	Half-bushel as a sample - - - - -	Completed - -	In Treasury Department.
1	1	Do do - - - - -	Do - -	In Patent Office.
		Liquid.		
51	5	Complete sets of gallons, half-gallons, quarts, pints, and half-pints. Each in two mahogany boxes; glass covers to measures; pine boxes over the mahogany.	Completed and delivered.	1 to Treasury Department, for each State; 1 to England; 1 to Patent Office; 1 to office of weights and measures; the rest to principal custom-houses.
47	1	Gallon measures. Packed as above - - -	Completed and delivered	Custom-houses.
24	1	Do do - - -	Require one more adjustment.	
31	1	Do do - - -	Require "final touch" and adjustment.	

TABLE No. 4—*Showing the condition of the balances up to January*, 1844.

No.	Designation.	Condition.	Destination.
1	Balance for adjustments of half-bushels, 67 inches between the end knife edges	Completed - - -	Office weights and measures.
2	Balances for adjusting standards, 42 inches beam.	Do - - -	1 to office weights and measures; 1 to independent treasury.
1	Balance of 36 inches beam, for adjusting liquid capacity measures - -	Do - - -	Office weights and measures.
2	Balances 30 inches beam, for adjusting standards -	Do - - -	Office weights and measures.
2	Balances for adjusting standards* - - -	Do - - -	Office weights and measures.
35	Balances of each size, viz: three sizes to the set.	Commenced. Of the larger size, one completed;† one other ready for mounting; five nearly done, require finishing and adjustment; others in "various stages;" one of the second size "far advanced;" the rest in "different stages;" the smallest in less forward state.	† Great Britain.

TABLE No. 5—*Final recapitulation, showing the number of standards of weights and measures, and number of balances, finished and unfinished, up to January*, 1844.

Finished.	Unfinished.	Designation.
328	-	Standard weights.
71	112	Standards of length.
	42	Strips and bars for standards.
101	55	Standards of liquid capacity measures.
31	134	Standards of dry measures.
101	71	Accessories of standards of dry measures.
2	-	Samples of standards of dry measures.
8	96	Balances of different sizes.

15. On the 20th of January, 1844, Mr. Edward Hassler resigned his position; and the papers, of which a detailed list is appended to this report, (marked B,) were handed to me, as the archives of the department of weights and measures. These are the only papers received by me as such.

At the time of the delivery of the property in the office of weights, measures, and balances, to me, as the agent of the Treasury Department, a general inventory was made by Mr. E. Hassler. Subsequently, and with a view to determine the precise progress of the work of the balances, a very particular inventory was made, by my direction, showing the number of pieces in each balance, and the state of each piece, whether merely cast, rough filed,

* The above are mounted on cast-iron tables.

smooth filed, turned, or finished. The castings for the greater part of the work were already done, and I estimated that the balances of the largest size were about half advanced towards completion, those of the second size nearly one-third completed, and those of the third or smallest size more than one-tenth advanced.

16. The inventories were made, preparations for continuing the work of adjusting the standards of capacity measure were completed, and the adjustment of the gallon measures commenced, by the 26th day of January.

17. On the 28th of February, Joseph Saxton, of the United States mint, was appointed assistant and foreman in the construction of weights and measures and balances. Mr. Saxton's practical skill and scientific attainments had placed him in the front rank in this very line of occupation; and the satisfactory manner in which the balances and other work intrusted to him in the mint of the United States had been executed, constituted his best recommendation for this appointment.

18. On the 13th of March, 1844, I was requested by the Secretary of the Treasury, the Hon. John C. Spencer, to undertake the experiments necessary for the comparison of hydrometers, in reference to their use in the collection of the revenue—a subject which appears to have occupied the attention of the department at various times,* in virtue of the authority given by the act of Congress of the 12th of January, 1825.

19. In June last I was further requested to make the investigations required by the act of Congress of the 3d of March, 1843, in relation to sugar, molasses, sirups, &c., and to the saccharine and extractive matters contained in the various kinds of liquors. Although anxious to render any resources which I might possess available to the department, I was satisfied that, to make the important investigations in relation to hydrometers and to sugars would occupy more time than could be spared from the other subjects committed to me, unless the researches should be postponed to a more convenient period. As the alternative was not desirable, I applied for an assistant to obtain the information, and make the researches required under my superintendence; and the department having acceded to my request, nominated Richard S. McCulloh, esq., formerly professor of mathematics, natural philosophy, and chemistry, in Jefferson College, Pennsylvania. The able report of Professor McCulloh has already been presented to the department in a separate communication; it contains the results of much assiduous research into books, and of labor in experiment; and the information is given, as far as the subjects permit, in a popular form. The details in regard to saccharine matters, while they show how difficult it is to obtain strictly accurate results in regard to the complex products of the sugar manufacture, furnish, nevertheless, a safe basis for action by the department, should it deem change advisable in the mode of executing the revenue laws. They also point out the direction in which further experiments are desirable for both sugar-planters and sugar-refiners.

20. Upon the facts brought together in reference to hydrometers, experiments will be founded, which will enable the department to introduce the uniformity so desirable in the different custom-houses of our country, and

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* The letter of the department is appended to my letter transmitting the report of investigations made under my superintendence, by Professor McCulloh, on sugars, hydrometers, &c., February, 1845.

without which the importer or the government, in certain places, must have an advantage not contemplated by the law. If a uniform and simple system of hydrometry were introduced by the government, the States would probably adopt it; and thus uniformity in dealing between the different States would be secured, and individuals would understand better than at present the quality of the articles in which they deal. The system should, for the benefit of trade, include the hydrometry of very various liquids, and the explanation of it should be so full that individuals who desire to manufacture hydrometers may have the information necessary to enable them to do so.

21. On the 5th of October last, a communication was referred to me by the Treasury Department, from the governor of the State of South Carolina, inquiring the best mode of obtaining copies of the standards of weights and measures which had been furnished to the State. A letter of inquiry, in regard to the cost of standards, was also addressed to me directly by the Secretary of the Commonwealth of Pennsylvania. These inquiries show a disposition to action which it is desirable to promote, and by which uniformity of weights and measures may ultimately obtain throughout the Union. The costly nature of the machinery and apparatus required in making and adjusting accurate standards, and the resources of practical science which must be called into action, and without which the attempt would certainly prove a failure, must render attempts on the part of isolated communities expensive, and in some cases precarious. All the apparatus required for the purpose is collected in the office of weights and measures here, and to make the standards, the employment of additional workmen merely would be required. These workmen might be employed at the expense of those for whom the standards were making, and the superintendence of adjusting would remain as now. In fact, while the work ordered by Congress is in the course of execution, it would be an economy to the general government to make standards for the States, since the use of the machinery, of the surplus materials already on hand, and the superintendence, would thus be paid for by the States ordering the standards. If this could be a profitable business to any individual in a State, I would not recommend this course. But the contrary is certainly the case; and few States would probably be willing to encounter the cost of the apparatus and machinery necessary to make and adjust the standards. It is desirable that each State should be supplied with the means of verifying its weights and measures from time to time; and, as far as the weights and smaller capacity measures are concerned, this will have been done when the balances are furnished to them.

22. The matters of which I have just reported the progress are merely incidental. Those which constitute the real business of the year, and of which I now proceed to state the progress, are the standards of weights and measures for the custom-houses and for the States, and the balances for the States. In immediate connexion with these, are the adjustments, made by authority of the Treasury Department, of the liquid capacity measures for the Ordnance Department, and the measurement of the bars of the base apparatus for the survey of the coast.

23. It has been seen, by a previous table of recapitulation, that in January, 1841, all the weights intended for the custom-houses and States had been made and adjusted, and either distributed or deposited in the Treasury Department; that, of the measures of length, seventy-one had been completed, and the rest required comparison with the original standard; that, of the capa-

city measures, one hundred and thirty two had been finished, and one hundred and eighty-nine required adjustment; and that eight balances had been made, and ninety six were in progress.

24. I propose now to give an account of the progress of the different operations of the past year, in their order: 1, of the capacity measures for the custom-houses and Ordnance Department; 2, of the measurement of the base bars for the survey of the coast; and, 3, of the balances.

I. Adjustment of capacity measures.

25 As this must be done near the temperatures when the expansion of water and of the material of the measure is the same, only a small portion of the year can be thus employed. The work was begun on the 26th of January, at a temperature of 47.2° Fahrenheit, and ended on the 15th of March, when the temperature had reached 52.9° Fahrenheit. Seventy-one gallon measures remained unadjusted; and these were completed during the time named, besides adjusting the capacity measures for the Ordnance Department. Having the completion of a work already begun in hand, and not the commencement of a new work, I conformed as nearly as practicable to the mode of adjusting employed by Mr. Hassler, introducing merely such slight modifications as would not affect the uniformity of the standards to be delivered. The same balance was used, and the same workman was employed in the manipulations.

26. Additional precautions were taken in regard to screening the instrument, to observing the weighings from a distance by a small telescope, to ascertaining roughly that the temperature of the measure and of the water used in the adjustment were not very different, to the soldering of the bottom of the measure, and ultimately in using the glass plate belonging to each measure for striking, in adjusting. In other respects, the operations were the same as heretofore*. In reducing the weight of the water contained in the measure, to the weight which the measure would contain if the water had the temperature of maximum density, I used Mr. Hassler's tables. The details of the observations and calculations upon which these are founded have not, however, generally come into my possession, except so far as contained in the published reports. The same reduction to thirty inches of the barometer was used, and the correction made, as was the custom, by placing a weight equivalent to the correction (to the nearest $\frac{1}{100}$ of a grain) in one or other scale pan of the balance.

27. The measures are intended to be rather too large when the adjustment is begun; and it is an operation requiring care and labor to bring them to the condition of standards, or so near to it that the comparisons of their capacity may be registered, to be applied as a small correction in adjusting other measures by them.

It will be recollected that the standard gallon of 231 cubic inches contains, according to Mr. Hassler, 58,373 grains (of the standard troy pound) of water, at the temperature of the maximum density, and at 30 inches of the barometer. The weight previously used as equivalent to 58,373 grains was employed in these comparisons.

28. The handle was removed from the gallon measure in adjusting;

* See Mr. Hassler's report of March, 1812.

it thus presented a cylindrical vessel, with a rim above and below. The bottoms of the measures are fastened to the cylinders with soft solder. To ascertain if these were closely soldered, water was left in each during the night; they were then placed upon a stove moderately heated, so as to force out the water absorbed in the capillary space between the cylinder and bottom, if not effectually closed by the solder. Discrepancies in the different weighings on the same day appear, when the bottom is not perfectly soldered, from the absorption of water; but this test is obtained at the cost of much time.

29. The measures were polished within and without before adjusting, and, as the exterior polish was injured in a degree in the adjusting, a comparison was made after the repolishing. They were handled with buckskin gloves.

30. The balance being in order, the measure, without its handle, but with the glass disk on it, which served to *strike* it, and with a weight upon it equivalent to 58,373 grains, was placed in one scale pan, and a counterpoise in the other. The weight was removed from the cover, and distilled water poured in until the measure was quite full. The air bubbles were removed from the sides by a feather. The glass cover was carefully slid upon the measure, the water heaped up by it being gradually withdrawn by a syringe as the glass plate was moved forward. When the plate nearly covered the measure, a little water was withdrawn by a moist cloth; and as the glass passed upon the metal, the rim was wiped. This is the most difficult part of the manipulation; and, after all, a small portion of water remains between the glass plate and the metal rim, in the part opposite to that where the plate is first applied. This adds but little, however, to the actual weight; and the changes of weight by the small differences in the quantity of this water in separate weighings are quite imperceptible—or at least are merged in other sources of discrepancy of greater amount.

The barometer was observed, and the weight, making the reduction to 30 inches of the scale, placed on one side or other of the balance, as required; the equipoise was now made by additional weights, which showed how much the weight of water in the gallon measure differed from the standard weight.

The measure was removed from the scale pan, the temperature of the water contained in it observed, the water removed, and the temperature of the measure noted. The reduction for the excess or defect of weight at the observed temperatures to that at the maximum density of water was taken from the table before referred to.

31. The water was distilled every day. The still is of copper, with a head lined with tin. The worm is of lead. One-half of the water put into the still was collected in the distillation. It trickled through a wooden plug, the exterior of which was covered by cotton which had been washed in pure water. The water was collected in glass vessels, with paper covers to keep out the dust. The distilled water of one day was used the next. The glass vessel containing it was placed the evening before using it in the inside of a wooden tub, on a bench in the adjusting room, the measures to be adjusted being ranged around the wooden vessel. The measures thus take very nearly the temperature of the water.

32. A little fire was made in the afternoon, in a stove in the middle of the adjusting room. This was allowed to go out at the close of the day. Tin screens were placed, to cut off the radiation of the stove and pipe from

the balance. The temperature of the interior of the measure was taken roughly before and after the weighing, by placing a thermometer with a cylindrical bulb, similar to the one used for ascertaining the temperature of the water, inside the measure. This method was accurate enough for the purpose intended, which was merely to ascertain whether the measure had nearly the same temperature as the water; when this was not the case, the final adjustment was not attempted.

33. When a measure proved to be too large, the lip or rim was ground upon a lead lap (wheel) covered with emery. The same care is not necessary in the weighings intended to bring it to the final adjustment, as in the last comparisons. When making these, the same measure was not weighed more than once on the same day. In general, as many gallon measures as could be weighed once in one day, were under adjustment at the same time; deducting, of course, the time for grinding and other operations connected with the adjustment.

34. The preliminary adjustments require considerable labor, which does not appear in the tables of final comparisons. To give an idea of this by an example, I have placed in the annexed table the number of trials necessary to bring five of the gallon measures (taken at random) to their final adjustment. In the first column of the table is the number of the measure; in the second, the weight, in grains and decimals of a grain, required to be subtracted, (marked —,) or that to be added, (marked +,) in order to bring the measure to the standard, on the days the dates of which are at the head of the several columns.

TABLE No. 6—*Showing the steps towards the final adjustment of the gallon measures, Nos.* 126 *to* 131.

No.	January 26.	January 27.	January 29.	January 30.	January 31.	February 1.
	Grains.	*Grains.*	*Grains.*			
126	— 4.8	— 3.6	+ 0.06	Final.		
127	— 3.7	— 3.1	— 0.56	— 0.06	Final.	
128	— 2.7	— 1.7	— 0.97	— 0.68	+ 0.02	Final.
129	— 9.4	— 6.2	+ 0.02	Final.		
130	— 3.4	— 0.5	— 0.03	Final.		
131	— 2.7	*	— 3.66	— 18.4	— 5.7	— 1.23†

35. As before mentioned, I followed the practice previously introduced into the establishment, of using freshly distilled water, because uniformity was one of the most important of the results sought in the preparation and distribution of the standards. To ascertain, however, if the effect of the absorption of air was perceptible in the adjustments, I had a number of weighings taken on different days of the same measures, with the same water, which, after each weighing, was returned into a glass vessel, and kept covered so as to exclude dust. They are recorded in the following table:

* Bottom badly soldered.

† This measure proved a second time to be badly soldered, and only obtained the final adjustment upon three other finals. This observation suggested to me the precaution before referred to, of ascertaining beforehand that the soldering was perfect.

TABLE No. 7.—*Showing the results of two successive weighings of the same gallon measures, with the same distilled water.*

Number.	February 22.	February 27.
131	— 0.331	+ 0.084
134	+ 0.056	— 0.107
138	+ 0.246	— 0.009
140	— 1.031	+ 0.237
142	+ 0.496	+ 1.281
146	— 0.981	— 0.111
Sum	— 1.545	+ 1.315
Mean	— 0.257	+ 0.221

The results with the separate measures are not regular, but the average difference is nearly six times as great as the same average found by trials of the measures under the same circumstances. On trying a single measure with the same water at different times, nothing satisfactory was elicited.

36. After the measures had been brought to the state of final adjustment, I generally repeated the weighings once, or oftener. The following table contains the results of the final weighings, and the mean of all with each measure. The headings of the columns sufficiently explain the data to be found in them. The adjustment of all the gallon measures is completed by this season's work. When finished, they were marked on the projection at the base of the measure with the letter B, and below it the year —44. The number of the measure was stamped, as heretofore, on the under side of the bottom of the measure. The letters and figures for marking are quite small.

TABLE No. 8.—*Table of final adjustments of the gallon measures.*

No. of standards.	Date.	Barometer.	Temperature of water.	Difference of weight from standard.	Correction for temperature.	Result: — too large, + too small.	Mean.
	1844.	*Inches.*	*Deg. Fahr.*	*Grains.*	*Grains.*	*Grains.*	*Grains.*
126	Jan. 29	30.34	48.6	— 4.75	— 4.807	+ 0.06	
	Feb. 16	29.90	48.8	— 5.10	— 4.666	— 0.43	
	29	30.31	48.8	— 4.05	— 4.666	+ 0.62	
	Mar. 1	30.12	50.7	— 2.95	— 2.906	— 0.04•	+ 0.05
127	Jan. 30	29.90	48.7	— 4.80	— 4.737	— 0.06	
	Feb. 6	29.90	47.8	— 5.60	— 5.225	— 0.37	
	29	30.34	48.8	— 4.90	— 4.666	— 0.23	
	Mar. 1	30.12	50.6	— 2.60	— 3.019	+ 0.42•	
	5	30.46	49.3	— 4.20	— 4.255	+ 0.05	— 0.01
128	Jan. 31	30.21	47.1	— 5.60	— 5.637	+ 0.02	
	Feb. 2	30.05	47.4	— 6.00	— 5.445	— 0.55	
	17	29.94	47.5	— 5.40	— 5.390	— 0.01	
	29	30.31	48.8	— 4.43	— 4.666	+ 0.24	
	Mar. 1	30.12	50.6	— 3.40	— 3.019	— 0.38•	

TABLE No. 8—Continued.

No. of standards.	Date.	Barometer.	Temperature of water	Difference of weight from standard.	Correction for temperature.	Result: — too large, + too small.	Mean.
	1841.	*Inches.*	*Deg. Fahr.*	*Grains.*	*Grains.*	*Grains.*	*Grains.*
128	Mar. 5	30.46	49.3	— 4.00	— 4.255	+ 0.20	—0.05
129	Jan. 29	30.34	47.8	— 5.20	— 5.225	+ 0.02	
	Feb. 2	30.05	47.4	— 5.80	— 5.145	— 0.35	
	29	30.31	48.8	— 5.19	— 4.666	— 0.52	
	Mar. 5	30.16	49.2	— 4.55	— 4.345	— 0.20	— 0.26
130	Jan. 29	30.34	47.7	— 5.30	— 5.280	— 0.02	
	Feb. 16	29.90	48.8	— 4.40	— 4.666	+ 0.27	
	29	30.31	48.8	— 4.35	— 4.666	+ 0.32	
	Mar. 1	30.10	50.5	— 3.10	— 3.132	— 0.27*	+ 0.07
131	Feb. 5	29.96	46.2	— 5.70	— 5.824	+ 0.12	
	6	29.90	47.8	— 5.30	— 5.225	— 0.07	
	20	30.06	47.2	— 6.15	— 5.599	— 0.55	
	21	29.92	48.8	— 4.60	— 4.666	+ 0.07	
	22	29.95	50.6	— 3.35	— 3.019	— 0.33	
	28	30.23	49.3	— 5.70	— 4.255	— 1.44*	— 0.37
132	3	30.26	47.1	— 5.70	— 5.637	— 0.06	
	17	29.91	47.6	— 5.30	— 5.335	+ 0.03	
	29	30.29	48.8	— 4.65	— 4.666	+ 0.02	
	Mar. 1	30.10	50.5	— 3.50	— 3.132	— 0.37*	— 0.09
133	Feb. 1	30.37	47.6	— 5.10	— 5.335	— 0.06	
	29	30.29	48.8	— 5.00	— 4.666	— 0.33	
	Mar. 1	30.07	50.5	— 3.65	— 3.132	— 0.52*	— 0.30
134	Jan. 31	30.27	46.7	— 5.70	— 5.723	+ 0.01	
	Feb. 16	29.90	48.8	— 4.50	— 4.666	+ 0.17	
	20	30.18	47.0	— 5.70	— 5.676	— 0.12	
	21	29.98	49.2	— 4.00	— 4.345	+ 0.31*	
	22	30.00	50.7	— 2.85	— 2.906	+ 0.06	
	28	30.23	49.1	— 5.46	— 4.436	— 1.02*	— 0.09
135	1	30.40	47.8	— 5.10	— 5.225	+ 0.12	
	29	30.28	48.9	— 4.20	— 4.596	+ 0.40	
	Mar. 4	29.96	51.8	+ 4.05	— 3.882	+ 0.17	
	8	30.30	50.0	— 3.47	— 3.658	+ 0.19*	+ 0.22
136	Jan. 31	30.27	46.5	— 5.60	— 5.739	+ 0.14	
	Feb. 29	30.28	48.9	— 4.23	— 4.596	+ 0.37	
	Mar. 4	29.96	51.6	+ 3.33	— 3.351	— 0.02	
	8	30.30	50.0	— 3.40	— 3.658	+ 0.26*	+ 0.19
137	Feb. 3	30.26	47.3	— 5.50	— 5.592	+ 0.09	
	5	29.96	46.2	— 5.60	— 5.824	+ 0.22	
	29	30.28	48.9	— 3.53	— 4.596	+ 1.07	
	Mar. 4	29.96	51.5	+ 3.20	— 3.136	— 0.06	
	8	30.28	49.9	— 3.60	— 3.738	+ 0.10	+ 0.28
138	Feb. 6	29.89	48.6	— 4.70	— 4.807	+ 0.11	
	16	29.90	48.8	— 4.60	— 4.666	+ 0.07	
	20	30.06	47.2	— 5.70	— 5.599	— 0.10	
	21	29.92	48.7	— 4.60	— 4.737	+ 0.14	
	22	29.95	50.4	— 3.00	— 3.246	+ 0.25	
	28	30.23	49.3	— 5.50	— 4.255	— 1.24*	+0.03
139	3	30.26	47.2	— 5.60	— 5.599	— 0.00	
	Mar. 4	29.99	51.3	+ 3.40	— 2.725	+ 0.67	
	5	30.46	50.0	— 3.30	— 3.658	+ 0.36*	+ 0.31
140	Feb. 6	29.89	48.4	— 4.80	— 4.928	+ 0.13	
	7	29.90	47.3	— 5.60	— 5.599	— 0.00	
	8	29.62	48.5	— 5.00	— 4.867	— 0.13	
	20	30.14	47.2	— 5.10	— 5.599	— 0.45	

TABLE No. 8—Continued.

No. of standards.	Date.	Barometer.	Temperature of water.	Difference of weight from standard.	Correction for temperature.	Result: — too large. + too small.	Mean.
	1844.	*Inches.*	*Deg. Fahr.*	*Grains.*	*Grains.*	*Grains.*	*Grains.*
140	Feb. 21	29.98	49.0	— 4.25	— 4.526	+ 0.28	
	22	30.00	50.6	— 4.05	— 3.019	— 1.03	
	28	30.23	49.2	— 5.02	— 4.345	— 0.67*	+ 0.16
141	7	29.91	47.0	— 5.50	— 5.676	+ 0.18	
	Mar. 4	29.99	54.1	+ 2.10	+ 2.334	— 0.23	
	5	30.46	50.0	— 4.00	— 3.658	— 0.31*	— 0.13
142	Feb. 6	29.90	48.2	— 4.90	— 5.049	+ 0.15	
	7	29.90	47.4	— 5.20	— 5.445	+ 0.21	
	17	29.90	47.4	— 5.50	— 5.445	— 0.05	
	20	30.06	47.3	— 4.00	— 5.522	+ 1.52	
	21	29.92	48.7	— 3.60	— 4.737	+ 1.14	
	22	29.95	50.4	— 2.75	— 3.216	+ 0.50	
	28	30.23	49.3	— 4.85	— 4.255	— 0.59*	+ 0.09
143	9	29.94	46.4	— 5.60	— 5.770	+ 0.17	
	Mar. 4	30.03	53.9	+ 1.60	+ 1.952	— 0.35	
	5	30.46	49.9	— 4.20	— 3.738	— 0.46*	— 0.21
144	Feb. 10	30.18	46.8	— 5.70	— 5.739	+ 0.04	
	Mar. 4	30.08	53.6	+ 1.00	+ 1.393	— 0.39	
	5	30.46	49.8	— 4.40	— 3.817	— 0.58*	— 0.21
145	Feb. 9	29.94	46.6	— 5.80	— 5.707	— 0.09	
	10	30.18	46.2	— 5.80	— 5.821	+ 0.02	
	Mar. 4	30.08	53.4	+ 0.90	+ 1.132	— 0.23	
	5	30.46	49.6	— 4.20	— 3.991	— 0.01*	— 0.08
146	Feb. 12	30.22	48.6	— 5.00	— 4.807	— 0.19	
	13	30.20	47.0	— 6.00	— 5.676	— 0.32	
	17	29.90	47.3	— 5.60	— 5.522	— 0.08	
	20	30.12	47.2	— 5.85	— 5.599	— 0.25	
	21	29.98	48.9	— 4.01	— 4.596	+ 0.56	
	22	30.00	50.6	— 4.00	— 3.019	— 0.98*	
	28	30.23	49.2	— 5.13	— 4.345	— 0.78	— 0.30
147	10	30.18	46.6	— 5.70	— 5.707	+ 0.01	
	Mar. 4	30.08	53.4	+ 0.90	+ 1.132	— 0.23	
	5	30.46	49.5	— 4.45	— 4.077	— 0.37*	— 0.20
148	Feb. 9	29.94	46.3	— 5.80	— 5.797	0.00	
	Mar. 4	30.08	53.2	+ 0.73	+ 0.962	— 0.23	
	6	30.48	49.2	— 4.27	— 4.345	— 0.07*	— 0.10
149	Feb. 13	30.30	47.2	— 5.80	— 5.599	— 0.20	
	Mar. 6	30.55	49.9	— 3.35	— 3.738	+ 0.39	
	7	30.50	49.2	— 4.53	— 4.345	— 0.18*	0.00
150	Feb. 13	30.30	46.8	— 5.80	— 5.739	— 0.06	
	17	29.91	47.3	— 6.10	— 5.522	— 0 58	
	Mar. 6	30.55	49.9	— 3.05	— 3.738	+ 0.69	
	7	30.50	49.2	— 3.90	— 4.345	+ 0.41*	+ 0.12
151	Feb. 16	29.90	48.8	— 4.50	— 4.666	+ 0.17	
	Mar. 6	30.55	49.8	— 3.83	— 3.817	— 0.01	
	7	30.50	49.2	— 4.60	— 4.345	— 0.25*	— 0.03
152	Feb. 12	30.28	47.8	— 5.30	— 5.225	— 0.07	
	Mar. 6	30.55	49.7	— 3.80	— 3.904	+ 0.10	
	7	30.50	49.1	— 4.83	— 4.436	— 0.39*	— 0.12
153	Feb. 16	29.90	48.8	— 4.50	— 4.666	+ 0.17	
	Mar. 6	30.55	49.6	— 3.60	— 3.991	+ 0.39	
	7	30.49	49.1	— 4.00	— 4.436	+ 0.43*	+ 0.33
154	Feb. 14	30.21	48.4	— 5.00	— 4.928	— 0.07	
	17	29.94	47.5	— 5.20	— 5.390	+ 0.19	

TABLE No. 8—Continued.

No. of standard.	Date.	Barometer.	Temperature of water.	Difference of weight from standard.	Correction for temperature.	Result: — too large; + too small.	Mean.
	1844.	*Inches.*	*Deg. Fahr.*	*Grains.*	*Grains.*	*Grains.*	*Grains.*
154	Mar. 6	30.55	49.6	— 3.50	— 3.991	+ 0.49	
	7	30.49	49.1	— 4.30	— 4.435	+ 0.13*	+ 0.12
155	Feb. 17	29.90	47.4	— 5.30	— 5.445	+ 0.14	
	Mar. 6	30.55	49.5	— 3.95	— 4.077	+ 0.13	
	7	30.49	49.0	— 4.90	— 4.525	+ 0.37*	— 0.12
156	Feb. 16	29.90	48.8	— 4.70	— 4.666	+ 0.03	
	Mar. 6	30.50	49.4	— 3.70	— 4.165	+ 0.46	
	7	30.44	48.9	— 4.45	— 4.596	+ 0.15*	+ 0.19
104	Feb. 15	30.15	49.1	— 4.50	— 4.436	— 0.06	
	Mar. 6	30.50	49.3	— 4.10	— 4.255	+ 0.15	
	7	30.44	48.9	— 4.70	— 4.596	+ 0.11*	— 0.01
106	Feb. 16	29.90	48.8	— 4.50	— 4.666	+ 0.17	
	Mar. 6	30.50	49.3	— 3.70	— 4.255	+ 0.55	
	7	30.44	48.9	— 4.40	— 4.596	+ 0.20*	+ 0.31
107	Feb. 17	29.90	47.4	— 5.50	— 5.445	+ 0.05	
	Mar. 6	30.50	49.2	— 3.85	— 4.345	+ 0.49	
	7	30.40	48.9	— 4.35	— 4.596	+ 0.25*	+ 0.23

* Using glass plate belonging to each measure.

37. The errors to which the weighings are liable are shown in the following table, No. 9; from which it appears that the mean error in two consecutive weighings of thirty-two measures, without regard to the sign of the differences, was 0.29 of a grain, or $\frac{1}{231}$ of the whole weight. The greatest difference was 0.68 of a grain, or $\frac{1}{98}$ of the whole weight of water in the gallon.

TABLE No. 9—*Showing the difference in consecutive weighings of the gallon measures.*

No. of measure.	Difference of first and second weighings.	No. of measure.	Difference of first and second weighings.	No. of measure.	Difference of first and second weighings.	No. of measure.	Difference of first and second weighings.
	Grains.		*Grains.*		*Grains.*		*Grains.*
104	+ 0.22	132	+ 0.10	141	— 0.06	150	— 0.52
106	+ 0.39	133	— 0.30	142	+ 0.10	151	— 0.18
107	+ 0.55	134	+ 0.15	143	— 0.18	152	+ 0.18
126	— 0.49	135	+ 0.52	144	+ 0.43	153	+ 0.22
127	— 0.31	136	+ 0.21	145	+ 0.12	154	+ 0.26
128	— 0.57	137	+ 0.20	146	— 0.13	155	+ 0.27
129	— 0.38	138	— 0.04	147	— 0.22	156	+ 0.50
130	+ 0.29	139	+ 0.68	148	— 0.23		
131	— 0.20	140	— 0.13	149	+ 0.59		

Mean, without regard to signs, 0.29 grain.

38. The most probable error in any one result, and that of the mean of five or more sets of weighings, are shown in the following table, (No. 10;) by which it appears that a single observation is not likely to be in excess or defect more than from two to four-tenths of a grain, and that the mean of five to seven weighings will be within fifteen-hundredths of a grain of the true weight. This, of course, supposes that constant sources of error do not enter into the methods of experiment.

TABLE No. 10—*Showing the probable error of a single weighing, and of the mean of several weighings.*

Number of means.	Number of observations.	Probable error of one observation.	Probable error of mean.
		Grains.	*Grains.*
128	5	0.21	0.095
131	5	0.19	0.085
138	5	0.21	0.096
140	6	0.35	0.143
146	7	0.34	0.131

II. ADJUSTMENT OF CAPACITY MEASURES FOR THE ORDNANCE DEPARTMENT.

39. The final weighings of the set of capacity measures adjusted for the Ordnance Department, are given in the following table:

TABLE No. 11.—*Table of the adjustments of the single set of capacity measures for the Ordnance Department.*

Name of standard.	Date.	Barometer.	Temperature of water.	Difference of weight from standard.	Correction for temperature.	Result: — too large; + too small.	Mean.
	1844.	*Inches.*	*Deg. Fahr.*	*Grains.*	*Grains.*	*Grains.*	*Grains.*
Gallon -	Mar. 13	29.90	53.7	+ 1.50	+ 1.5594	— 0.06	
	Mar. 14	30.10	53.6	+ 1.05	+ 1.3329	— 0.28	— 0.17
Half-gallon	Mar. 13	29.90	53.8	+ 0.77	+ 0.8892	— 0.12	
	Mar. 14	30.10	53.6	+ 0.55	+ 0.6964	— 0.15	— 0.13
Quart, 1 -	Mar. 12	30.25	52.4	— 0.14	— 0.1562	+ 0.02	
	Mar. 13	29.90	53.9	+ 0.60	+ 0.4881	+ 0.11	+ 0.06
Quart, 2 -	Mar. 15	30.01	53.4	+ 0.30	+ 0.2831	+ 0.02	
	Mar. 15	30.01	52.7	— 0.07	— 0.2750	— 0.01	— 0.01
Pint -	Mar. 15	30.01	52.8	— 0.05	+ 0.0120	— 0.06	
	Mar. 15	30.01	52.7	— 0.05	— 0.0137	— 0.04	— 0.05
Half-pint -	Mar. 12	30.25	52.3	— 0.05	— 0.0480	— 0.00	
	Mar. 13	29.90	54.2	+ 0.13	+ 0.158	— 0.03	— 0.01

III. Comparisons of the measuring bars of the base apparatus for the survey of the coast.

40. These bars were employed in the measurement of the Fire island base line, the base upon which the triangulation for the survey of the coast rests; and it was now intended to use them in measuring two bases of verification for the work—one near the northern, and the other near the southern extremity of the main triangulation, as executed prior to 1844, under the superintendence of Mr. Hassler. The bars are four in number, each one being nearly two metres in length. They were found to have rusted, and were cleaned; care being taken to change their length as little as possible in taking the rust from the ends.

41. They were compared with a standard, before using them to measure the base of verification on Kent island; and subsequent to the measurement, and before and after the measurement of the base of verification on the Providence and Boston railroad. The apparatus used in the comparisons was the lever of contact, made under direction of Professor Bessel, of Königsberg, for the office of weights and measures, by request of Mr. Hassler. A length of two metres was measured in the apparatus, by doubling the length of the metre of Lenoir, belonging to the coast survey, or by combining the metre of Lenoir and the standard metre of the French commission of weights and measures, belonging to the American Philosophical Society of Philadelphia. The length of the metre of Lenoir, as compared with this authentic standard, is known from the experiments of Mr. Hassler, and from repeated comparisons in this apparatus, made during the measurements in question. Each bar was compared, in turn, with the length of two metres; and after the comparison the standard was again measured, and the mean of the first and last readings taken as the length of the two metres. The bars were placed in the apparatus in the position in which they are used in measuring. Their ends are not perfectly square with the sides; but the pieces used to communicate motion to the lever (abutting pieces) touched about the middle of the bar at one end, and rested flat against the opposite end. There is a lever of contact connected with a level at both ends of the machine, and sometimes both levels were used; but more generally a flat abutting piece was firmly screwed against the measure at one end, and the other end pressed by means of another abutting piece, the end of which towards the measure was round, upon the lever of contact. As the standard of comparison and the measuring bars are of the same material, it was only necessary to guard against changes of temperature during the operations. Two thermometers, suitably disposed upon the apparatus, and in contact with it, were read; but the effects of the changes of temperature were masked in the slight errors of observation. Each division of the level attached to the longer arm of the lever is equivalent to $\frac{11}{10000}$ of an inch nearly.

42. The observations were made by Mr. William Wurdeman, Mr. Joseph Saxton, and myself. The results, reduced to English inches, are given in the annexed table. The four bars, A, B, C, D, when arranged in measuring, are longer than eight metres of Lenoir by the quantity in the third column. This is put in English inches, as a more familiar measure than the metre.

TABLE No. 12.—*Comparisons of the bars used for measuring the verification bases of the coast survey.*

When compared.	Number of comparison.	A, B, C, D, longer than eight metres of Lenoir by—	Means from successive sets of measurements.
		Inches.	*Inches.*
Before measurement of the Kent island base - -	1	0.00480	
Do do do - - -	2	0.00480	
Do do do - - -	3	0.00646	
Do do do - - -	4	0.00579	
Do do do - - -	5	0.00337	
Do do do - - -	6	0.00278	
Do do do - - -	7	0.00371	
Do do do - - -	8	0.00508	0.00460
After measurement of the Kent island base - -	9	0.00568	
Do do do - - -	10	0.00592	
Do do do - - -	11	0.00627	
Do do do - - -	12	0.00564	
Do do do - - -	13	0.00581	0.00586
Before measurement of Massachusetts base - -	14	0.00503	
Do do do - - -	15	0.00470	
Do do do - - -	16	0.00547	
Do do do - - -	17	0.00588	0.00527
After measurement of Massachusetts base - -	18	0.00112	
Do do do - - -	19	0.00590	
Do do do - - -	20	0.00131	
Do do do - - -	21	0.00588	
Do do do - - -	22	0.00337	
Do do do - - -	23	0.00386	
Do do do - - -	24	0.00436	0.00455
Final mean - - - -	-	0.00496	

Probable error of the mean, 0.000014 of an inch.

43. The differences between the successive sets obviously result rather from slight differences in the repetition of the observations than from any real change in the bars by use. After the last use of them, the ends appeared to be slightly corroded by rust; but, on removing it by a ground glass plate, the change made in the length was quite imperceptible. The probable error of the mean of these results, deduced from the comparison of the whole by the usual formula, is 0.000141 of an inch in eight metres, which, in a measurement of eleven miles, would make but three tenths of an inch.

44. Though the differences are given in inches, for the sake of indicating their actual amount in an ordinary measure, they were really taken in parts of the metre, and give the length of the four bars compared with eight metres of Lenoir, 8.0001261669; or, compared with the standard of the French committee of weights and measures, by using Mr. Hassler's comparisons, 7.999929261 metres. The possession of this authentic standard, which was at one time Mr. Hassler's private property, probably induced him to adopt the metre as the unit of length in the survey of the coast.

The Troughton scale of 82 inches being merely a copy of the standard of Great Britain, unverified by authentic comparison, could not be assumed as of equal authority. The measures of the survey being in metres, the results could always be compared with those of the principal European works of the same character.

IV. Of the work upon the balances.

45. By direction of the Treasury Department, the chief attention has been given to the completion of the balances of the first and third sizes. The six balances of the first class, nearly completed under the direction of Mr. Hassler, have been finished and adjusted. Cases have been made for them, with sliding doors. They have been packed ready for delivery, and will be distributed, as already directed by the Secretary of the Treasury, on the opening of the season in the spring. A person will be sent to set up these instruments in the places which may be assigned for them, and to illustrate their use to those to whom the executives of the States may assign their safe keeping. Three other balances are very nearly completed.

In the six balances just referred to, very little change has been made from the original designs; and, in general, in all those of the first class, only such changes have been made as appeared indispensable to both Mr. Saxton and myself. The chief alterations consisted in an arrangement for adjusting the knife edges, upon which the scale pans rest, without grinding; in the means of bringing always the same line of the suspension piece, or stirrup of the pan, upon the knife edge; in the steady pins for the scale pans, indispensable to convenience in weighing; and in the cases required for covering the whole instrument, to protect it from currents of air in weighing, and from dust at all times.

46. It is difficult to give a precise idea of the progress of this kind of work. I had prepared detailed tables, in which, under the head of each of the different pieces of the balance, the progress made in that piece, in every set, was indicated by the number cast, rough-filed, smooth-filed, or turned or finished. The technicalities, thus introduced, seemed to me at last rather to perplex than to clear up the subject, to any one not specially conversant with it; and I have now substituted a general abstract for these tables. The different pieces of which each balance is composed were distributed into three classes, according to their size or the difficulty of execution; so that all the largest pieces, or those requiring the most care in making, were classed in the first; the smallest, and those requiring the least care, in the third; and a second or medium class was formed between these two. The amount of progress during the year may be estimated by comparing the number of pieces, of each kind, which have been in progress, with the whole number required.

47. To estimate the progress up to January, 1844, by the same principles, the following table has been prepared. The remarks just made, and the headings of the different columns, sufficiently explain the meaning of the numbers contained in them.

TABLE No. 13—*Showing the progress of the balances up to January*, 1844.

Classification of the pieces.	In the condition of rough castings.	Rough or smooth filed, or turned.	Finished pieces.	Total number of pieces in all the balances.	Per ct. of the whole number of pieces.		
					In the condition of rough castings.	Rough or smooth filed, or turned.	Finished pieces.
First class - - - -	817	432	245	1,796	45	24	13
Second class - - -	1,954	693	306	3,381	58	25	9
Third class - - -	4,758	1,694	3,122	9,237	51	19	34

From the foregoing table, (No. 13,) it would appear that the balances, as commenced by Mr. Hassler, were advanced about one-fourth towards completion at the beginning of 1844. This conclusion is nearly equivalent to the one stated in a former part of this report, which was derived in a different way.

48. It is to be observed, in regard to the table just given, as well as to the one which follows, that the numbers are merely approximate, and that the whole number of pieces required is not the sum of the numbers in the different columns; because, in some cases, all the castings have not been made, and in others more pieces were cast than were absolutely required, to allow for defective castings. No distinction has been taken between the brass and iron parts of the balances, as the only object is to give an approximate idea of the work done.

TABLE No. 14—*Showing the progress of the work on the balances from January*, 1844, *to January*, 1845.

Classification of the pieces.	Castings.	Rough or smooth filed, or turned.	Finished.	Whole number of pieces in all the balances.	Per ct. of the whole number of pieces.		
					Castings.	Rough or smooth filed, or turned.	Finished.
First class - - - -	442	640	393	1,796	25	36	22
Second class - - -	774	628	738	3,381	23	18	22
Third class - - -	767	891	2,149	9,237	8	10	23

49. This table, when taken alone, gives too favorable a view of the year's progress, because the higher grades of finish, in many cases, were an advance upon the lower grades, and not, as in the former table, executed from the casting up to the finished article. Making due allowance for this, it appears that about one-seventh of the whole work originally marked out upon the balances has been executed within the past year, and that on the 1st of January, 1845, it was about two fifths done. A greater proportionate progress may be expected during the present year.

Very respectfully submitted by

ALEXANDER D. BACHE.

GEORGE M. BIBB, *Secretary of the Treasury of the U. S.*

APPENDIX.

A.

Special report, submitted to the Treasury Department by Mr. Edward Hassler, on the progress of the work of constructing standards of weights and measures and balances, to January, 1844.

WASHINGTON CITY, *January* 4, 1844.

SIR: It is with pleasure I report to the department, in answer to the queries in your letter under date of December 27, 1843, respecting the United States weight and measure work.

I shall take them up in the order in your letter.

"1st. State the number and designation of each kind of standard already finished, and of the number which have been delivered.

"2d. The same in regard to the accessories, as boxes, &c."

The standards finished and delivered are 207 full sets of weights, consisting of 1 lb. troy, and 1, 2, 3, 4, 5, 10, 20, 25, and 50 lbs. avoirdupois. Of these—

One set was sent to England.

Two sets were delivered to the Treasury Department, for the use of the independent treasury.

One set was delivered to the Patent Office.

One set to Old Point Comfort.

Three sets remain in this office, for future comparison.

The balance have been delivered to the custom-houses, the respective States for which they were designed, and the Treasury Department.

They are packed in two strong mahogany boxes, filled with yellow pine, in which are bored cavities expressly for receiving each weight, lined with fine cotton velvet, and furnished with one fork, covered with buckskin, for lifting the smaller weights, and two double hooks, covered in the same manner, for the large weights, for the purpose of avoiding touching the standards with the hands, by which they would soon lose their nicety of adjustment.

These two boxes are packed in a pine box, stained red, furnished with handles, lock, and key.

The sets sent away are again packed in common pine boxes, hooped in the ordinary way for forwarding merchandise.

35 sets of troy ounce weights, from $\frac{1}{16000}$ to 10 ounces, intended for the States. Of these—

One set was sent to England.

One set to the Patent Office.

Four sets remain in this office, for future comparisons.

The balance were delivered to the Treasury Department, for forwarding to the States.

These weights are packed in mahogany boxes filled with white pine, lined with fine cotton velvet, each weight fitting its proper cavity; they are furnished with one pair of forceps and two different sized tongs, for their manipulation.

The sets delivered to the department were again packed in stained pine boxes.

Five sets of ounce weights, from $\frac{1}{10}$ to 100 ounces, packed similar to the above, and furnished with forceps and tongs for their manipulation. Of these—

Three sets have been delivered to the mint and its branches.

One set to the independent treasury.

One set is retained in the office, for future use.

One set of ounce weights, from 1 up to 10 ounces, delivered to the Patent Office.

One set of ounce weights, from 10 ounces down, delivered to the independent treasury.

Four sets of ounce weights, from $\frac{1}{10}$ to 1,000 ounces, packed similar to the large weights, sent to the States and custom-houses, furnished with forceps, tongs, and hooks, for their manipulation, delivered unadjusted to the United States mint.

One set of ounce weights, up to 10 ounces, with 1 lb., delivered to the independent treasury.

Three 1 lbs. in one box, with two forks, delivered to the same.

Three 1 lbs. in separate boxes, with forks, delivered to the same; small weights and pliers accompanied the weights delivered to the independent treasury, to assist in the weighings.

One pound avoirdupois, delivered to the Frankford arsenal, Pennsylnia.

One pound avoirdupois delivered to the committee of Massachusetts legislature, put up in a bag.

One pound troy delivered to the same, packed in the same way.

Three sets of flat weights, up to 10 lbs.

Three 10-lb weights of the same form.

Fifty five single pound weights, for the use of the establishment; also, various weights, with or without heads, of different forms and all sizes, for counterpoise in the establishment. Various very small weights, as $\frac{1}{1000}$ to $\frac{1}{10}$ of a grain, for the work.

Four sets of weights for adjusting capacity measures, in mahogany boxes.

One yard delivered to Brooklyn, New York.

One yard delivered to Lieutenant T. R. Gedney, U. S. N., for the coast survey.

One yard delivered to Captain W. H. Swift, for the coast survey.

One yard delivered to Lieutenant Glynn, U. S. N., for his survey of Beaufort harbor, North Carolina.

One foot measure delivered to the same, for the same purpose.

One foot measure delivered to the Frankford arsenal, Pennsylvania.

The above yard and foot measures are measures *a trait*, packed in nicely executed mahogany boxes.

Fifty-four complete sets of liquid capacity measures. Of these—

One set was delivered to the State [Treasury] Department, for each State.

One set sent to England.

One set delivered to the Patent Office.

One set remains in the office, for future use.

The balance were forwarded to the principal custom houses.

They are packed in two mahogany boxes, with various arrangements for the packing and safe transportation of the round flat plate-glass covers that accompany each measure, to secure its exact filling. The sets sent away were *again packed in common pine boxes*, stained red, and hooped with iron.

Forty-seven gallons, with ground plate-glass covers, delivered to the custom-houses, packed similar to the gallons accompanying the full sets of capacity measures.

Thirty-one half-bushels, with ground plate-glass covers. Of these—

Twenty-six have been directed to the respective States.

Four to the principal custom houses.

One was sent to England.

They are packed similar to the liquid capacity measures, with peculiar arrangements for the security of the glass cover, which is packed between the two bottoms of the box; and were again packed in common boxes for transportation.

Forty-one yards *a-bout*, with accompanying matrices, on which are traced a yard in tenth and hundredth parts.

Their boxes are so arranged and furnished with implements, that they serve at the same time as an apparatus for making copies for common use from the subdivided yard *a-trait* on the matrices, without removing or touching the standard itself.

Adjusted and delivered, (one intended for each State, the remainder for the custom-houses)—

One yard and matrix, similar to the above, sent to England.

One yard and matrix, similar to the above, delivered to the Land Office.

One yard and matrix, similar to the above, delivered to the Patent Office.

Seven bars, with yards *a trait* laid off on them, in mahogany boxes.

Ten bars, with feet *a trait* laid off on them, in mahogany boxes.

One microscopic comparateur, with a 4 feet scale, with 36 inches of Troughton's 82-inch scale laid off eleven times.

With one yard divided into $\frac{1}{10}$ and $\frac{1}{100}$;

With one yard divided into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, and $\frac{1}{16}$;

With one yard divided into feet and $\frac{1}{10}$ of inches;

And a plan for laying off a metre *a-trait*, if desired.

One microscopic comparateur, with a 4 feet scale, with 36 inches of Troughton's 82 inch scale laid off ten times; divided the same as above.

One wide plate, like the lever comparateur, mounted for a microscopic comparateur.

One lever comparateur, adapted to adjust yards and matrices.

"3d. The number and designation of each kind of standard *unfinished* (as whether ready for adjustment or not") consist of—

Forty yards and matrices, with a yard *a-trait*, divided into tenth and hundredth parts, traced on the matrices.

Sixty-eight yards and matrices, requiring the yard *a trait* to be traced on the matrices.

One yard and matrix, at the Treasury Department, for showing the manner they are constructed only approximated.

Three yards and matrices for the use of the establishment.

Two bars, forming yards *a bout*, for use in the establishment.

The above yards and matrices are in various stages of approximate and

final adjustment, have boxes, and are furnished with implements for making copies from the subdivided yard *a-trait* for common use, similar to those accompanying the yards and matrices already delivered.

Three strips for tracing yards on, in boxes.

Sixteen bars that will serve for yards or matrices, *a-bout* or *a-trait*, without boxes.

Twenty-three strips for tracing feet on, in boxes.

Fifty-five gallons. Of these—

Twenty four are finished, except one further determination, in mahogany box, in pine boxes, not finally packed.

Thirty-one gallons in mahogany and pine boxes, requiring their final touch, packing, and to be adjusted.

One bushel, mechanically executed, ready for adjustment.

One hundred and thirty-three half-bushels, ready for adjustment.

Seventy-two mahogany boxes, completely prepared, for packing half-bushels.

Eighteen mahogany boxes, completely prepared, for packing half-bushels, except for the want of a little velvet, daily expected.

Forty three mahogany boxes for half-bushels, requiring to be lined, for which there are thirty-two glass covers; making eleven glass covers yet required, for which an order is out.

One half-bushel sent to the Treasury Department, to show the manner they are executed.

One half bushel delivered to the Patent Office, for the same purpose.

In consequence of the dimensions and weight of the bushel surpassing the convenient dimensions for the size, strength, and convenience of those generally requiring them, it was determined to construct half-bushel standards for general use; which admit of nicer adjustment, and are also more convenient for verification with its subdivision in general use.

The bushels and half-bushels are of one casting—a point in which England failed, and had to abandon, on the last establishment of her imperial standard by Captain Kater, after thirteen experiments by her best founders.

The above works require for completion different circumstances, temperatures, means, and methods, for different parts; all will be so arranged and combined as to take the most advantage of the attending circumstances and means, that in the whole the utmost may be accomplished consistent with the indispensable care necessary to the honorable execution required to elicit the confidence of the nation.

"4th. The number of balances completed, the number ready for final adjustment, the number begun, with the approximate stage towards completion, in general terms."

To answer this, I must enter a little into the details of the cause and origin of the law directing the construction of balances for the States.

When it was the question of adjusting the standard weights for the States and custom-houses of the United States, it became requisite to have balances far superior in principle and workmanship to those habitually made for sale; which led to inquiry, that terminated in a decision to construct proper balances, expressly for the purpose, in the establishment itself. Consequently, I designed duplicate balances of three sizes: one to serve for the approximate, the other for the final adjustment. The success and approbation they elicited, caused a desire that the States should be furnished similar means for verifying the standards used by the respective countries with those furnished by the general government, and to decide any case of doubt.

For the purpose of obtaining this object, the following law passed:

"*And be it further enacted*, That the Secretary of the Treasury cause to be made, under the superintendence of Mr. Hassler, one standard balance for each State; and, when completed, that he cause them to be delivered to the respective governments, for the use of the respective States."

The spirit of the above law is, that the States be furnished with means by which they will be enabled to determine any question that may arise, with such a degree of nicety as to be as valuable for all practical purposes as if *absolutely exact*.

This object cannot be secured by any single balance; consequently arises the necessity of seeking the best means of accomplishing the desired object. Experience has proved that it cannot be secured with sufficient accuracy by less than three balances.

It will also be perceived that the above law has the same error or oversight common to the English laws, from which our laws have their origin, and in which our statesmen are schooled, namely: the misnomer "standard balance"—an impossibility in nature and principle.

Consequently, I considered myself justified in carrying out the spirit, and securing to the country the important and so-much-needed object of the law.

Knowing the effect of this work, as well as that of the standards themselves, must last and be felt for centuries, I bestowed much study and mature reflection on the subject, which has enabled me to secure a design for a balance on principles differing materially from those usually employed in delicate determinations, capable of weighing with a degree of accuracy, certainty, convenience, and despatch, also rendering continual and repeated service, that I believe not heretofore obtained.

The plan and method of using those balances is described in my paper (that you have seen) entitled "Directions for mounting and weighing with the balance presented to the British government by the government of the United States," that accompanied the standards and balance sent to England.

Copies of the correspondence between the Earl of Aberdeen, her Majesty's secretary of state, and Mr. Everett, envoy extraordinary and minister plenipotentiary of the United States, relative to the delivery of the standards and balance, are to be found in the archives of the State Department.

In consequence of the possibility of introducing a discrepancy in the material composing the standards, it would have been improper to recast the turnings from the standards, and use them again for making standards.

Instead of permitting their being wasted, they were remelted and refined, and serve, with an addition of copper and tin, to form a very appropriate and beautiful material, of which the balances are constructed.

The balances finished are—

One large balance for adjusting half-bushels, 67 inches between the end knives, capable of weighing with great precision to about 150 pounds in each basin, standing on a marble slab 4 by 8 feet, cemented and levelled on a paved ground floor, with new and peculiar arrangements for noting the differences, and relieving the balance when not in use.

Two balances of 42 inches between the end knives, for adjusting standards from 20 to 50 pounds. The one used for the approximation was delivered to the Treasury Department, for the use of the independent treasury.

One balance, of 36 inches between the end knives, for adjusting the capacity measures.

Two balances, of 30 inches between the end knives, for adjusting standards from 2 to 10 pounds.

Two balances for adjusting standards from 2 pounds down.

The above balances are mounted on cast-iron tables, furnished with adjusting screws, for bringing them to their proper level.

Of the balances for the States, 35 of each size have been commenced, with the view, in case of any defects in their casting being found, or accidents in other parts during the progress of their execution, that there might yet be a sufficiency for the present States, and those Territories that may soon become States, and to admit of being able to meet a few calls that may be made in consequence of experiments that government may direct, similar to those for which the Ordnance Department have already requested standards.

Should there be any balances remaining on hand at the completion of the work, they will be valuable acquisitions to the United States mint and its branches.

Of the larger size—

One balance has been completed, and presented to Great Britain.

One is now completed, and ready for mounting in this office.

Five are in a very advanced stage, requiring their final finishing touches and adjustment.

The balance of this size are in various stages.

One of the second size is far advanced; the rest are in different stages. The smaller size balances are in a less forward state.

As the balances admit of being taken in hand, when the imperative laws of nature will not permit of adjusting of the different standards, more or less application has been given to this branch inversely as nature permitted in the others. Of late, the largest size have received the principal attention.

The results of experiments made with the balances brought to a stage admitted of being tested, are gratifying, on account of demonstrating the correctness of my views on the subject, as well as in consequence of the result surpassing my most sanguine expectations.

On the whole, this branch is in quite an advanced stage, and shortly can furnish repeated results, that I have every reason to believe will be as gratifying to the well-informed citizens calling to see the work, as what the establishment has furnished heretofore, and which is considered as highly creditable, unequalled, and unique in its kind. The completion of the above work will fulfil the laws already passed.

An association of twenty years, of which I have a distinct recollection; a taste for similar pursuits; access to any of my father's well known and varied scientific information, though unattainable from other sources; a free communication of views; detailed imitation in every branch; several years' study and practice, in the details of this work—warrant my assuring the department it need entertain no fears of those changes in the manner of completing this delicate, important, and arduous task, that would be inevitable and injurious under other circumstances, on account of the superintendence having changed, in consequence of the death of my father, to myself.

My earnest wish is, that the requisite application and confinement will not have the effect of producing a change in my already feeble health and crippled limbs, that may frustrate my will for the cause.

Permit me to conclude by expressing the hope that I will receive from

the department those facilities and protections that are indispensable to the proper accomplishment of this invaluable national work.

I remain, sir, most respectfully, yours, &c.,

E. HASSLER.

Hon. JOHN C. SPENCER,
Secretary of the Treasury.

B.

Detailed inventory of the papers received from Mr. Edward Hassler, as the archives of the office of weights and measures, January 22, 1844. (The general titles are those given by Mr. Edward Hassler from the general inventory, and the detailed titles result from an examination of the papers.)

No. 1.—1 roll containing drawings for dry measures, and draughts of bushel and gallon.
1 sheet for projecting curves.
1 small sheet for projecting curves.
1 sheet, with projecting curves, } Expansion of mercury and
1 sheet, with 2 projections of curves, } water.
1 sheet projection and curves for copper bulb.
No. 2.—1 sheet, design for sub treasury balance, front view.
1 sheet of different sections of balance, by Mr. Edward Hassler.
No. 3.—1 sheet, drawing of feeling lever, for yard and matrix.
No. 4.—Complete projection of standards of weights and measures, on two sheets, and of length and capacity.
No. 5.—1 set of complete publications of weights and measures, from 1835.
No. 6.—1 certificate of pound weight procured by William Simms, London.
1 certificate of 8th December, 1820, and copy of the same, standards of State Department.

No. 6 contains the following papers:

I No. 855. De Grave. The government of the United States of North America, dated June 12, 1837. Indenture of one brass weight of one pound imperial troy, one brass weight of one pound avoirdupois—both of spherical shape.

II. Indenture by E. A. De Grave, for copies of every weight and measure at his Majesty's exchequer at the present time, December 2, 1820. Signed by Thomas Jones, London.

No. 7.—Instructions of Mr. Hassler, upon preparation of yards and measures, plans and directions, at the arsenal.

No. 7 contains the following papers:

I. Letter of F. R. Hassler to Colonel Bomford, September 22, 1832, enclosing a statement respecting weights and measures at the arsenal.

II. Plan and dimensions of weights.

III. Instruction upon the preparation of yards and weights, to Mr. Samuel Schmid, 24th September, 1832.

No. 8.—Copy of letters between Lord Aberdeen and Mr. Everett, relating to the presentation of standards to England.

No. 9.—Complete records of weight and measure works, and the delivery of standards.

No. 9 contains the following papers:

I. Four printed copies—remarks of the superintendent, F. R. Hassler, esq., on the construction and adjustment of the standard half-bushel measures, April, 1843; and each copy has, in manuscript, a table of the ultimate result of the adjustment of 31 half-bushels, adjusted in the winter of 1842–'43.

II. Printed blank letter of Treasury Department, May, 1843, to accompany weights and measures; and, in manuscript, table of the ultimate result of the adjustment of 31 half-bushels, adjusted in the winter of 1842–'43.

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

IV. Letter from the Treasury Department, July 1, 1842, about the delivery of liquid capacity measures; and a copy of the same letter.

V. Receipt of John Eaches, Alexandria, July 11, 1842, for 22 boxes, addressed to the collectors of customs.

VI. Letter from the Treasury Department, September 4, 1840, about depositing weights in Treasury Department vaults.

VII. The following 18 boxes of yards are marked for delivery to the collector at Alexandria, as follows: dated September 7, 1840.

VIII. Number of boxes of standard weights delivered to the Treasury Department, September 7, 1840.

IX. Ultimate result of the comparisons of the yards delivered, July, 1840.

X. Receipt of George Brent, collector at Alexandria, March 27, 1839, for 91 boxes, containing standard weights.

XI. Letter from the Treasury Department, July 25, 1842, containing list of the ports to which standard gallons are to be sent.

XII. Copy of letter of Edward Hassler to McClintock Young, esq., acting Secretary of the Treasury, August 3, 1842, containing bill of lading of 48 boxes of standard gallons.

XIII. Memorandum: States not having received standards.

XIV. Memorandum: States whose ounce weights are still in the Treasury vault.

XV. Memorandum: States to which a set of standard weights have been delivered, and States whose governors have not yet applied for the standard weights.

XVI. Memorandum: Standards remaining uncalled for in the Treasury vault, end of year 1842.

XVII. Nine receipts of collectors, &c., for standards.

XVIII. Contents of boxes to be sent to the Hon. Edward Everett, minister of the United States to England.

XIX. Bill of lading for 1 box standard weights; November, 1838.

No. 10.—Tables, data, &c.

No. 10 contains the following papers:

I. Table of brass weights in Troughton's grains.

II. Results of the comparisons of Troughton's scale of the comparateur with itself, and determination of the micrometer screw on each place, &c.

III. Detailed thermometric reduction for temperature.

IV. Table for the reduction of the barometric effect.

V. Effect for water and brass combined.

VI. Effect of temperature.

VII. Table for the adjustment of the half-bushels.

VIII. Two printed copies of remarks of the superintendent, F. R. Hassler, esq, on the construction and adjustment of standard half bushels.

IX. Memoranda of preliminary calculations, and scraps of papers.

X. Pieces of paper, with rough draughts of parts of balances, &c.

No. 11.—Tables of curves of expansion.

No. 12.—Orders for the delivery of standards.

No. 12 contains the following papers:

4 letters of 1836.

1 letter of 1837.

18 letters of 1838.

3 letters of 1839.

No. 13.—Journals of the adjustment of capacity measures, and loose papers appertaining thereto.

No. 13 contains the following papers:

I. Original journal—capacity measures No. 1, contains the adjustment of 54 complete sets of liquid capacity measures, from No. 1 to No. 54, inclusive; and final adjustment of single gallons, from No. 55 to No. 125, inclusive—1841 and 1842.

II. Original journal—capacity measures, half-bushels, January, 1843: contains the final adjustment of 31 half-bushels, and the first reduction of half-bushels, from No. 31 to No. 150, inclusive.

III. Final adjustment of weights for liquid capacity measures (contained in boxes *o*, *p*, *q*, *r*.)

IV. Final adjustment of the flat weights (in box 4.)

V. Comparison of troy pounds (in box *n*.)

VI. Comparison of kilogrammes (in box *n*.)

VII. Scraps of rough calculations.

No. 14.—Accounts of castings of weights and measures, 7 vols.

No. 14 contains the following:

I and II. 2 vols. Castings up to 1839.

III. Castings for 1839.

IV. Castings for 1840.

V. Castings for 1841.

VI. Castings for 1842.

VII. Castings for 1843.

No. 15.—Inventory of property belonging to weights and measures of 1834, left by Mr. Schmid.

Inventory, December 31, 1838, of weight and measure property.

Inventory, January 1, 1840, of weight and measure property, and of castings to date.

Inventory, September 1, 1841, of weights and measures, containing also a copy of Mr. Schmid's list.

1 bound folio volume, Laws and Regulations relative to the French System of Weights and Measures, from 1790 to 1825.

1 bound folio volume, Reports of the Commissioners of Weights and Measures of Great Britain, presented to the United States 1831.

REPORT

FROM

THE SECRETARY OF THE TREASURY,

COMMUNICATING

A report of the Superintendent of the Coast Survey, showing the progress of the work under his charge during the year ending November, 1845.

DECEMBER 16, 1845.

Read, and ordered to be printed, and that 500 copies in addition to the usual number be printed; 250 of which for the use of the Superintendent of the Coast Survey.

TREASURY DEPARTMENT,
December 15, 1845.

SIR: I have the honor to transmit herewith a report made to the department by Professor A. D. Bache, Superintendent of the Coast Survey, showing the progress of said work during the year ending November, 1845. All which is respectfully submitted.

R. J. WALKER,
Secretary of the Treasury.

Hon. GEORGE M. DALLAS,
Vice President of the United States,
and President of the Senate.

Report of the Superintendent of the Coast Survey, showing the progress of the work during the year ending November, 1845.

COAST SURVEY STATION,
Bodies Island, N. C., November 29, 1845.

SIR: I have the honor to present the report of the progress and state of the survey of the coast, required by the regulations, in order that it may be "laid before the President and Congress."

The report contains, 1st, a brief statement of the work executed by the different parties in the field; 2d, of the office work, including the preparation, engraving, and publication of maps and charts resulting from the survey; and 3d, a sketch of the work proposed for the ensuing year, with an estimate of the cost of execution.

In the statement of the work done, I have endeavored to be sufficiently minute, to enable the President and Congress to judge whether the pro-

Ritchie & Heiss, printers.

gress for the past year has been satisfactory, either in reference to that of former years or to the sum appropriated and expended.

In regard to the estimate for the next fiscal year, I would bespeak for it in advance a favorable consideration; it has been made carefully and after due knowledge of the requirements of the different parties, and a careful study of the operations which can be carried on to the greatest advantage in the course of the year.

Any diminution of the sum there asked must involve a decrease in the amount of work which is practicable, and thus, postpone the realizing of the results of the survey on some portion of the coast, and the ultimate completion of the work. Operations are proposed which may certainly be accomplished with the present scientific force, or with a very moderate addition to it. The number of parties which may be employed advantageously in their execution is stated. The actual expenses of such parties are taken as the basis of the estimate—expenses which are limited as far as is consistent with the due progress of the work- so that no party shall consist of more officers or men, or be supplied with more equipage, than is absolutely necessary. The estimates for computing, reducing, drawing, engraving, and printing, are regulated in a similar way. To place these estimates upon a lower scale would be, in the case of field parties, to risk the cessation of operations during the working season, and thus to incur the expense of salaries without corresponding progress in the work.

It is sometimes supposed that salaried officers alone constitute the working parties of the survey. It is true that the scientific chief of each party is the essential person by whom the results are obtained, and who works with his hands as well as his head; but there are also purely manual operations to be performed, requiring in each of the land parties the employment of at least from four to six, and in some cases ten and twelve men. The number of persons therefore necessarily employed in the mechanical operations of the survey is very considerable.

The increase of the appropriation for the year 1845-'46 has enabled me to commence operations effectively in two additional southern sections—one in *North Carolina* and one on the *Gulf of Mexico*. This is a measure of economy, since it gives employment in the field during periods of the year when the parties cannot be employed to the north, and as it advances the work towards completion. It is of public utility, because it must give, at an early day, charts of a portion of our coast but little known and dangerous to the navigator.

Should the estimate which I furnish be adopted, the work will be extended from these centres, and a new southern centre be established in *South Carolina* or *Georgia*, from which in turn to extend the survey to meet the other parts of the work.

The estimate furnishes means for carrying on the survey of the coast effectively in the following named States: *New Hampshire*, *Massachusetts*, *Rhode Island*, *Connecticut*, *New York*, *New Jersey*, *Pennsylvania*, *Delaware*, *Maryland*, *Virginia*, *North Carolina*, *South Carolina* or *Georgia*, *Florida*, *Alabama*, *Mississippi*, and *Louisiana*; in all, sixteen States. In some of them the work is nearly finished, in others far advanced, and in others new centres are to be occupied, from which the survey may be extended until the parts unite.

The southern coast must be surveyed by frequent bases connected

generally by intermediate triangulations. There is no objection to the establishment of these centres, which will finally be connected by a chain of triangles. The results thus procured are of course approximate until the connexions are made, but they are practically useful, and in the absence of more complete ones, (to be finally supplied by the coast survey,) they may save the loss of many valuable lives and of much property. During the past year the survey in *North Carolina*, and in *Alabama*, *Mississippi*, and *Louisiana*, has been actually begun, establishing two new centres, the northern one of which will be connected in three or four years with the chain of triangles down the Chesapeake, and thus with the whole coast survey from Maine to North Carolina. The sum which I ask for field work was repeatedly granted when the survey extended over but one of the five sections in which it is now executing.

The additional sum voted by Congress last year for reducing, engraving, and publishing part of the work of former years, has secured the publication, within the year, of no less than seven engraved sheets, and the preparation, by computations, reductions, and drawings, of others for engraving. Besides these, charts of two harbors surveyed during the past year are engraving, and will probably be finished before next February.

The work promised to be executed within the period embraced in this report has been actually done, and I may, therefore, claim confidence in the promises now made for the ensuing year. The amount of work done in the field and office has been greater in proportion than the increase in the appropriation of last year on that which preceded it. Upon a general review, that increase of work cannot be taken at less than one-third, and the additional means exceeded those of the former year, including a balance of the year next preceding, but one-sixth. If the report were carried to the close of the fiscal year, it would probably present a greater proportionate gain.

The direction of Congress, that officers of the army and navy should as far as practicable be employed upon the work, has been faithfully executed, and an additional number in both services has been asked for within the present year. The frequent changes necessarily occurring in these parties, from the prior claims of professional services upon the officers, put a limit to their advantageous employment, and thus determine their due proportion to the more permanent civil parties.

The following is a summary of the work done since November, 1844, the date of my last report:

In the eastern section.—The primary triangulation has been extended to Cape Ann and across the northern boundary of Massachusetts, one station observed on being in New Hampshire. The verification base, on the Providence and Boston railroad, has been connected with the primary triangulation. The secondary triangulation has been carried to the peninsula of Cape Cod. The topography of the shores of Buzzard's bay, the Elizabeth islands, and Martha's Vineyard has been nearly completed. The hydrography includes Buzzard's bay and part of the Vineyard sound. Additional observations for differences of longitude from Europe have been procured at Cambridge, Portland, and Nantucket. The work of this section has been within the limits of the States of Rhode Island and Massachusetts.

In the middle section.—The primary triangulation of Mr. Hassler has

been connected with the main triangulation in Delaware bay, and carried across the neck between the Delaware and Chesapeake bays. A reconnaissance, for connecting the work on the Delaware with that on the coast of New Jersey, is in progress. Astronomical observations have been made at one of the Delaware stations.

Magnetic observations have been made in the harbors of Long Island sound. The off-shore work has been continued, and the special examination of the Gulf stream has been commenced. Observations for the set and drift of the tides have been made in New York bay and harbor, in the East river, and in Long Island sound. Additional soundings have been made in the East river and in Long Island sound. This work is generally within the limits of Connecticut, New York, New Jersey, Pennsylvania, and Delaware.

Southern Section No. I.—The Kent island base has been connected with the primary triangulation of Mr. Hassler, and the primary triangulation has been carried south of Kent island. A reconnaissance for a triangulation to connect the work on the bay with the capitol and naval observatory, and for verifying the work on the Potomac river, has been completed. Also, additional astronomical and magnetic observations have been made. A secondary triangulation of the streams emptying into the Chesapeake, north of Kent island, and of part of the bay, has been completed. The secondary triangulation of the bay, south of Kent island, has made considerable progress. The topography of the shores of the bay, of the Patapsco river, and of other streams flowing into the Chesapeake, north of Kent island, is more than three-fourths done. The hydrography of the Patapsco and of the approaches to it is completed, and that of the bay north of Kent island is nearly finished. This work is generally in the States of Delaware, Maryland, and Virginia.

Southern section No. II.—The operations connected with the measurement of the base line on Bodies Island, North Carolina, and the triangulation of Albemarle sound, have been commenced.

Southern section No. III.—A reconnaissance of the coast of Alabama, Mississippi, and part of Louisiana has been made, and the triangulation and astronomical observations on Mississippi sound will be commenced as soon as the season permits.

The following maps and charts have been published within the year, or will be ready for publication before the first of February next: a map of New York bay and harbor, on a scale of $\frac{1}{20000}$; two sheets of the large map of New York bay and harbor, scale $\frac{1}{30000}$, completing this map of six sheets; a chart of Fisher's Island sound; one sheet of the entrance of Long Island sound from the eastward; one sheet of Delaware bay and river; New Bedford harbor, surveyed in 1844; Annapolis harbor and the Severn river, surveyed in 1844. The engraving of a sheet of the southern coast of Long island is nearly done.

The engraving of the following is nearly completed. A second sheet of Delaware bay and river, and chart of the harbor of New London.

I now proceed to give a more particular account of the progress of the work, avoiding, however, scientific details as far as practicable.

In accordance with the plan adopted in my last report, the operations of the survey will be classified under the heads of—

1. The primary triangulations and astronomical and other observations connected with them.

2. The secondary triangulations, and others connected with them.
3. The topography.
4. The hydrography.
5. The office work, including—
First. The calculations of the survey.
Second. The drawing of maps and charts.
Third. The engraving, printing, and publishing of the maps and charts.
Fourth. The making and repairs of instruments.

The progress of the field operations will be described in the different geographical sections of the country to which the survey has extended, beginning northward and eastward. These include—

I. The eastern section. From Narragansett bay, eastward and northward, to Massachusetts bay; in the States of Rhode Island and Massachusetts.

II. Middle section. From Narragansett bay to New York bay, and thence to the capes of the Delaware, including, also, Delaware bay and river; in the States of Connecticut, New York, Pennsylvania, New Jersey, and Delaware.

III. Southern section No. I. Chesapeake bay, &c.; in the States of Delaware, Maryland, and Virginia.

IV. Southern section No. II. Coast of North Carolina, in the State of North Carolina.

V. Southern section No. III. Coast of the Gulf of Mexico; in the States of Alabama, Mississippi, and Louisiana.

I. Eastern Section.

From Narragansett bay, eastward and northward, to Massachusetts bay.

If any incentive to exertion had been required in this section of the work during the past season, it must have been found in the accidents occurring within the knowledge of the different parties, from a want of information in regard to the dangers of this part of the coast. In the Vineyard sound a ship prepared for a whaling voyage to the Pacific struck, in good weather and with a fine and fair breeze, upon a shoal off Holmes' Hole, and this vessel had not entirely been released from peril, to be taken into harbor to refit, when a heavily loaded schooner struck near the same spot. The injury to the first of these vessels would have paid for the operations of the survey in this quarter more than twice over. The ship Centurion, lost on Nantucket south shoal during the summer for want of knowledge of the extent of the shoal and of the set and drift of the tides near and upon it, was insured for a sum beyond the whole appropriation for the field work of the year. These are only a part of the accidents which occurred in this region during the summer, the least dangerous portion of the year. There passed through the Vineyard sound within the last three years, (as appears from an interesting letter from William Mitchell, of Nantucket, appended to this report, appendix, No. IV,) four hundred and forty-seven ships, three thousand six hundred and sixty-four brigs, twenty-three thousand two hundred and sixty-two schooners, and nine thousand seven hundred and seven sloops; or a total of thirty-seven thousand and eighty vessels. The sound through which this trade is carried on in these vessels has many dangerous shoals, the limits of which are not defined on the existing charts. The pilots know the chan-

nels, but not the configuration of the bottom generally, and, besides this, a vessel is often without a pilot when danger is nearest. The coast survey will soon be able to supply the want of a good chart in this quarter.

1. *The primary triangulation* in this section has been carried from Narragansett bay eastward across Buzzard's bay, the Vineyard sound, and the sound between Nantucket and Cape Cod; then northward across Cape Cod and Massachusetts bays, where it meets the same work carried northward from Narragansett bay, and stretches to the hills which are near the northern boundary of Massachusetts, and into New Hampshire.

The diagram (sketch A) gives a sufficiently correct idea of the character of the triangulation, and of its connexion with the geographical features of the country. It rests upon the base measured by assistant Blunt, on the Boston and Providence railroad, as shown by the dotted lines in the diagram. It is connected with the main triangulation, and carried eastward, as indicated by the lighter full lines, the line McSparran —Quaker Hill being common to the two triangulations. Passing eastward, it gives a suitable base (Cuttyhunk—Indian hill) for the secondary triangulation; determines an important point (Cuttyhunk) at the entrance of Buzzard's bay and the Vineyard sound, a point on Martha's Vineyard, a point on the island of Nantucket, one on the ridge of Cape Cod, near Barnstable, one near the extremity of Cape Cod, one at Manomet point, near Plymouth; furnishes the base Manomet—Provincetown, for the secondary work; determines a station (Blue hill) overlooking Boston harbor, a point (Thompson's hill) near Cape Ann, and other stations suitable for carrying the work along the coast of New Hampshire and Maine.

The character of the country, in proceeding northward and eastward from Massachusetts, admits of a triangulation with sides of very considerable length, tending to accuracy in the scientific results, and to economy and rapidity in the practical ones. At the same time, by adopting intermediate points, a series of triangles is formed, furnishing, directly or by easy subsidiary operations, frequent bases for the secondary work, in addition to the constant checks presented by the positions of the primary points themselves. Thus, for example, the quadrilateral formed by Blue hill, Wachusett, and Thompson's hill in Massachusetts, and Unkonoonuc mountain in New Hampshire, has sides of from thirty to fifty-eight miles, one of these being immediately in the direction of the coast, and the stations at the other extremities overlooking the whole coast and country adjacent to it, to the northward and eastward, while by the intermediate station of Holt's hill a chain of lesser triangles is carried forward, of which the angular points overlook the adjacent waters and islands. In the case used for illustration, the stations Blue hill and Prospect hill overlook Boston harbor, its islands, and dependencies. The larger triangulation is marked on the diagram by the broader full lines, and the minor one by the narrower lines.

This part of the work will be connected immediately with the observatory at Harvard University, Cambridge, and when completed will render directly available the accurate determinations for the longitude and latitude of that point, which have been the accumulation of many years of the labors of the Cambridge and Boston astronomers, and are especially valuable to the survey in reference to the difference of longitude between this and European observatories. The triangle Blue hill, Prospect hill, Harvard observatory, makes this connexion.

Seven stations, marked 1845 in the sketch, were occupied this year between the 6th of May and the 19th of October, when the party was transferred to North Carolina. Those stations, upon which observations were made without occupying them, are marked (u). The stations at Nantucket and Provincetown were not occupied, because they are not used in carrying the work forward, and the results, with the instrument employed, proved, by the test of summing the angles in the triangles of which all three of the angles were measured, that a due degree of accuracy in the positions of those points was attainable without the necessity for measuring the third angle for verification.

The work especially intended for testing the main triangulation, by joining it with the base of verification through Pocasset station, was shown in the sketch accompanying the report of 1844, and has on that account been omitted in the one now presented.

The number of points observed upon has been as follows: primary stations 41; from the station first occupied 7; from the second 6; from the third 4; from the fourth 5; from the fifth 4; from the sixth 7; from the seventh 8; other stations and objects observed upon from the seven stations, 16. The number of angles measured was 55, and the number of observations used in their measurement was 4,436.

The area of the polygon covered by the season's work is 2,840 square miles. In making this estimate, the area of the triangles, of which two angles only have been measured, has been estimated at two-thirds of its real extent, and those where one angle only has yet been measured at one-third. Work has been prepared for a secondary triangulation party for at least two years.

Astronomical observations were made at four of the stations: Great Meadow hill, between Providence, Rhode Island, and Taunton, Massachusetts; Indian hill on Martha's vineyard; Shootflying hill, near Barnstable; and Blue hill, near Boston. At the first, the eclipse of the sun of May 6th, and the transit of Mercury on May 8th, were observed, the local time being carefully obtained. At the others, observations for latitude and azimuth were made, requiring of course the determination of local time as an auxiliary. The number of observations for time was 1,125; for latitude, 6,362; for azimuth, 937. The azimuths were obtained, as during last year, by the elongations of the pole star.

Vertical angles for the heights of the stations were measured at all the stations upon nearly all of the others in sight, so that reciprocal angles have been measured from most of the stations occupied in 1844 and 1845. One of the heights above the level of the sea was also measured by the barometer.

Magnetic observations were made at five primary stations, and, in addition, at a secondary station near New Bedford, the last named observations being required for the chart of that harbor now preparing for publication. The observations were as follows: of variation or declination, 269; of dip, 264; and of absolute horizontal intensity, 90.

A meteorological journal, recording twice a day the temperature and moisture of the air, the direction and force of the wind, the character of the clouds, and proportion of sky covered, and once a day the pressure of the air, was kept at all the stations but three. The number of observations was, of the thermometer, 154; hygrometer, 154; barometer and attached thermometer, 82; other observations, 451.

The instruments employed were as follows: the Troughton and Simms theodolite of three feet diameter, for measuring the horizontal angles of the triangles and the azimuths; the two feet vertical circle, originally accompanying the theodolite and the six inch Gambey theodolite for the vertical angles; a thirty-two inch transit kindly loaned by Major Graham, of the United States topographical engineers, and a twenty inch transit, for which we are indebted to S. C. Walker, Esq., of Philadelphia, for time; the two feet Troughton and Simms circle, and the six inch Gambey theodolite for latitude; a set of Riddell's portable magnetic instruments by Jones, of London, for variation and horizontal intensity; a dip circle by Patten, of Washington, and Hassler barometers.

The Troughton and Simms two feet repeating circle has not been used in the survey for many years, and the trials made with it in the summer of 1844 showed many important defects in the instrument. Some of these were remedied by Mr. William Würdeman, mechanician in the Coast Survey office, during the summer of 1844, so that on further trial in the autumn the results were sufficiently encouraging to induce further changes, and the construction of a stand (in part of the materials of one formerly used,) expressly for the instrument. Further changes were made last spring and summer, and the instrument has rewarded the labor expended upon it, and promises, with comparatively slight additions, to become available for the work.

The measurements of horizontal angles of the triangles, the observations for azimuth, a small part of the observations for height and for time, and the observations of the eclipse and transit in May, were made by myself personally. The observations for time and for latitude were generally made by Lieutenant Thomas J. Lee, of the United States topographical engineers, assistant in the party; and the vertical angles generally were measured, and a part of the observations for time taken by assistant Charles O. Boutelle. The reconnaissance for the work was made under my immediate direction by assistant C. O. Boutelle, at such times during the season as he could be spared from duties in camp. In September the reconnaissance was carried across the northern part of Massachusetts into New Hampshire, and a range of stations beyond those represented in the sketch selected, carrying forward the triangulation very satisfactorily.

During the early part of the season, astronomical and magnetic observations were made by Lieutenant Lee on the Chesapeake, the notice of which will be found in another part of this report.

The assistants of my party were occupied during the last winter in calculating the observations of the previous season.

The astronomical observations already made in this quarter, at points connected by the triangulation, bring seven neighboring local determinations of latitude and azimuth to bear in establishing the position of any one of the station points, or the direction of the lines joining them, for the map of this part of the coast now in preparation.

In addition, the geographical position of Nantucket will be determined by a continuous series of observations, which will be communicated for the use of the survey. These were commenced this season by Professor Elias Loomis, of the University of New York, who has communicated the results of observations of moon culminations, and for latitude, made during parts of July and August. They will be continued by William Mitchell,

Esq., of Nantucket, who will probably add prime vertical observations for the latitude to those in the meridian, and will observe the occultations computed by R. T. Paine, Esq., of Boston, as well as moon culminations with the almanac stars. The instruments used this summer for this purpose were a two feet transit belonging to Mr. Mitchell, and the West Point Troughton circle, loaned to the coast survey by the engineer department on the recommendation of Professor Bartlett. A transit for use on the prime vertical has been kindly loaned by Professor T. H. Perry, United States navy. Besides the importance of this station in a nautical point of view, it is of high practical and scientific interest, from occupying the southern extremity of an arc of the meridian passing near Portland, in Maine, the determination of the length of which will furnish the essential elements for the final computation of the work in this quarter, and the data for the figure of this portion of the earth's surface.

2. The connexion of the base line measured last year, upon the Boston and Providence railroad, by assistant Edmund Blunt, with the primary triangulation, was this year completed; the *angles at the extremities of the base* having been measured by Mr. Blunt, with the twelve inch Simms theodolite.

The peculiar position of this line, parts of which are in the trough formed by the cuttings of the railroad, rendered the measurement tedious, from the variable and considerable effects of lateral refraction. No pains were spared in rendering it as perfect as possible, and the test by the sum of the angles in the triangles, part of which had been measured by me and part by Mr. Blunt, proved both sets of results to be satisfactory.

3. *The secondary triangulation* in this section of the survey has been carried eastward to include the Vineyard sound and the island of Martha's Vineyard, the sound between Nantucket and the main, (Nantucket sound,) the island of Nantucket, the main between Buzzard's bay and Massachusetts bay, and part of Cape Cod. The most westerly station occupied was Falmouth, near the eastern shore of Buzzard's bay. The most easterly station was Sancoty head, and the most northerly was Hyannis. The stations observed upon extend as far east as Sancoty head, and as far west as Mishaum point. The work was retarded considerably during the months of July and August, in consequence of the long lines included in it, across the shoal water between Nantucket and the main; and the thickly wooded country between Falmouth and Sandwich, on Cape Cod bay, which it was deemed desirable to cross, offered at a later date considerable obstacle to rapid progress. The amount of work has, however, notwithstanding the detentions, been satisfactory. The area embraced in the work is 818 square miles, and the survey of the parts of it immediately adjacent to the coast will occupy two topographical parties more than one season. A diagram of the triangulation is given upon sketch A.

The reconnaissance for this work, and the triangulation itself, have been made by assistant C. M. Eakin, assisted by Mr. James E. Shiras. The party commenced their field operations on the 10th of May, and closed them on the 13th of October. The number of stations occupied was 17; the number of objects observed upon was 244, viz: 177 stations, 26 lighthouses, 30 spires, 6 telegraphs, 3 lightboats, and 2 beacons; and the number of angles measured was 4,392.

Assistant Eakin was occupied during the last winter in the computa-

tion of the work of the previous season, in making duplicates of the calculations, a diagram of the triangulation, descriptions of the stations, and in completing the drawing of a sheet containing a topographical survey formerly made by him.

4. *The topographical work* in this section has included the head of Buzzard's bay, the eastern shore of the bay, the Elizabeth islands, and part of Martha's Vineyard island. It has covered an area of one hundred and seventy-eight square miles, determined one hundred and thirty-two miles of shore line, and one hundred and seventy-one miles of roads. This is a considerable increase on the work of last year in the same quarter.

Two sheets, marked Nos. 2 and 3 on sketch A, have been surveyed by assistant W. M. Boyce, assisted by Lieutenant H. C. Pratt, of the United States army. The area of the two is about ninety-three square miles, and they include more than one hundred and forty miles of shore line, sixty-six miles of roads, and thirty-two miles of shore line of ponds. The coast embraced in them is rugged and broken, with alternations of rocky, sandy, and marshy shores. The face of the country is undulating and irregular, with but little wood upon it, and requiring much labor to represent it accurately. The season has been generally favorable for work, but high winds and fogs have prevailed at times, during which the use of the plane table is difficult; at such times the compass and chain have been used with good effect in advancing the work.

This party was not able to take the field until the beginning of June, owing to circumstances not necessary to be detailed here, but by great diligence the amount of work done has been satisfactory. Through the liberal views taken by the Hon. Secretary of the Navy, in reference to the progress of the coast survey, and under authority of the act of Congress of 1807, the party has had the use of the schooner Wave belonging to the United States navy, and the facility thus afforded must be enumerated among the reasons for the amount of work done. The party was transferred to Neapeague beach, on the eastern end of Long island, for the survey of an unfinished space there, on the 20th of October, and to Philadelphia, for the measurements of the wharves, &c., left unfinished there, about the middle of November.

Assistant Boyce was engaged last winter in the office, in putting in ink the topographical work of the preceding season.

Three sheets, marked No. 1, No. 1½, and No. 4 on sketch A, have been surveyed by assistant H. L. Whiting, aided by Mr. W. E. Greenwell. The area included in these is about eighty-five square miles, and one hundred and five miles in length of roads and one hundred miles of shore line are laid down upon them. The work on the main was done between the 8th of May and the close of September, and about the 1st of October the party was removed to Martha's Vineyard island, remaining in the field until the latter part of November. The face of the country on the main has already been described, and that on the Vineyard upon the immediate shore is similar; the country embraced in the interior of the sheet is, on the contrary, level, and covered with woods of scrub oak, interspersed with pines.

The sickness of Mr. Whiting during one part of the season, and of a number of his party at another, has in a degree retarded the work, but

the progress has, notwithstanding, been satisfactory, and the amount of work done considerably exceeds that of the last year.

During the winter Mr. Whiting was occupied in the office in finishing the drawings of his sheets of the previous season, and in reducing for publication the map of New Bedford harbor, the style of the execution of which was very satisfactory. He also assisted in preparing the projections of the plane table sheets of the season.

It appears that, in general, from the beginning of May to the middle of November may be profitably used in this region for the topographical surveys.

The shore line determined by these parties has been furnished to the hydrographical party working in their vicinity.

5. *The soundings* in Buzzard's bay have been completed, and considerable progress made in those of the Vineyard sound, by the party under the command of Lieutenant commanding George S. Blake, United States navy, in charge of the surveying schooner Gallatin. Some supplementary work off the coast of Rhode Island has also been completed for the chart of the entrance to Long Island sound, now preparing for publication. Other observations have been made in Long Island sound by this party, belonging to the next section of the work. Preparations for the season's work were begun on the 23d of April, and the work itself on the 7th of May, continuing until the close of October.

The limits of the sounding sheets are shown by the dotted lines on sketch A, the sheets being five in number. The work of this season will afford means for the immediate publication of charts of two important harbors of refuge on the Vineyard sound, Tarpaulin Cove on the southeast side of Naushon, and Holmes' Hole on the north side of Martha's Vineyard. Combined with the work of last year, it gives the greater part of the hydrography for a chart extending from Point Judith to Cape Pogue, and embracing the entrances to Narragansett bay, and the whole of Buzzard's bay, and the Vineyard sound. The materials for this chart, from the astronomical and geodetic observations, the topography and hydrography, will be collected immediately so as to commence the chart at the earliest possible date, leaving the remaining part of the hydrography to be completed while the chart is in progress. One of the most interesting parts of this will be the determination of the velocity and set of the tides in the Vineyard sound—a subject of not less practical importance than scientific interest.

The area included in the work is about 350 square miles; but the statement of it hardly gives an idea of the work done, as searching for detached rocks occupied much time, and was of paramount importance. Lieutenant commanding Blake's efforts in this search have been rewarded by the discovery of three rocks, very dangerous while their positions were unknown or unmarked, but which are rendered comparatively harmless when known and marked. The positions of these rocks are thus described in his report:

"A dangerous rock, having but fifteen feet water upon it, was discovered northwesterly a mile and a half from Cuttyhunk light-house, with very deep water in all directions immediately around it. This danger lies very much in the way of ships bound to and from New Bedford, many of which, when loaded, draw from sixteen to eighteen feet. Another very dangerous rock has been discovered about a mile and three-quarters southwest-

erly from Mishaum point, also very near the main channel into New Bedford. The Gallatin draws but 9½ feet, and her larboard bilge struck heavily upon this rock, the lead on the starboard side giving at the time a quarter less four, and deepening immediately to six and seven fathoms. * * * * * At the request of the collector of New Bedford, I have recently indicated the proper position for a buoy near this danger."

"A very dangerous single rock, having but ten feet of water upon it at low water, was found in mid-channel off the harbor of Mattapoisett, a whaling port on Buzzard's bay, second in importance to New Bedford."

"In regard to the rocks off Cuttyhunk and Mishaum, I am informed by experienced Vineyard pilots, that although dangers were generally believed to exist in the vicinities named, the precise situations of them were not known. In regard to the one off Mattapoisett, I am informed that nothing has heretofore been known of it. A very dangerous ledge was found off Ragged Neck, near the head of the bay, a quarter of a mile *within* which is a buoy, and which I am likewise assured was entirely unknown before."

A more technical description of the positions of the rocks off Cuttyhunk and Mishaum point, and of the ledge off Scraggy Neck, will be found in the appendix, (No. I.)

Besides the occasional observations for the tides at different points, for the reduction of the soundings, regular observations for the times of high and low water, and the height of the tide, have been kept up during the whole season at Point Judith and Newport.

The views required for illustrating the sailing directions, and desirable for entering New Bedford harbor, were prepared this season by assistant John Farley, under the advice and with the co-operation of Lieutenant commanding Blake.

During the last winter the unfinished reduction of the work of this party for the previous season, which was, however, small in amount, was completed. It consisted chiefly of the reduction of observations of tides and currents and the copying of journals.

The hydrography of New Bedford harbor was reduced for publication, and a copy made of the original chart on the working scale; a general reduction of the season's work was also made on the publication scale. The sailing directions, and other unfinished parts of the New Bedford chart, have since been supplied, and the work has been put into the hands of the engraver.

My attention has been repeatedly called by Lieutenant commanding Blake to the necessity for thorough repairs to the schooner Gallatin—repairs which are entirely beyond the limits of expenditure permitted by the ordinary appropriation for the coast survey. In his report at the close of the season, he says: "The vessel is nearly thirteen years old, has never received a thorough repair, and is now in such a state that the mere patching, which is constantly needed to preserve her efficiency, is extravagant. Her frame is believed to be sound, though it cannot continue so long if the repairs named in the estimate are not attended to."

As it is impossible, without serious diminution in the quantity of work, to furnish these thorough repairs, I have felt it my duty to call the attention of the Treasury Department to the subject in a separate communication, believing that the vessels belonging to the survey should be put in

thorough order before another season's work, and that a special appropriation should be asked from Congress for that purpose.

Another subject of importance to the progress of the hydrography of the coast survey, referred to in the law for its reorganization, and in regard to which no advance whatever has been made or can be made without aid from Congress, is thus referred to in Lieutenant commanding Blake's report:

"In regard to the use of steam vessels in the survey, upon which you request my views, I would observe, that the employment of such vessels, of *suitable construction and equipment*, would in my opinion conduce very much to accuracy, despatch, and economy. To accuracy, because the rate of running would be more uniform than that of sailing vessels; the lines of soundings could be run with more system, and a vast amount of useless labor thereby be avoided. To despatch, because in light winds and calms, which prevail much upon our coast in summer time, where sailing vessels can do little or nothing, steamers could work with perfect success. They could also work with much more success, under all circumstances, than sailing vessels, being independent, in a great measure, of the direction of the wind and of tides. To economy, because a very much greater amount of work could be performed by a steamer in a given time, than by a sailing vessel, and with fewer men. I am convinced, in short, that steamers are as much to be preferred for surveying as for any other purpose whatever. It is proper to add, that I speak from experience on this subject, steamers having occasionally been attached for short intervals to my command."

6. My attention has been repeatedly called this summer to certain dangerous obstacles to navigation off the coast of Massachusetts, requiring but little time to determine their places. Lieutenant commanding Davis brought these before me particularly, at a time when the surveying brig Washington, under his command, was necessarily waiting the repairs of instruments required for his work. A rough or approximate determination of such dangers is certainly better than none, and public utility sometimes requires that ideas of precision should be sacrificed to secure other objects. The determinations can by no means replace the accurate ones which will be made in the course of the coast survey, but they will be useful to navigators, in the absence of them. I directed, therefore, Lieutenant commanding Davis to make the search suggested by him for a ledge of rocks off Brandt point, Massachusetts bay, and the shoal to the west of George's bank. The rock, or rather ledge, is about three-quarters of a mile E. N. E. of Phillips' ledge, which has a buoy upon it, and has but eight feet of water on two different spots at low water, spring tides. It lies in the track of vessels bound into and having a fair wind for Plymouth and the lower part of Barnstable bay, and of coasting vessels beating in Massachusetts bay. An extract from a letter of Lieutenant commanding Davis in the appendix, (No. II,) gives the approximate position of this ledge, which is known to the fishermen from the adjacent shore as "Howland's ledge." It should undoubtedly have a buoy to mark it, as several vessels are reported to have struck upon it, and the buoy on Phillips' ledge tends to give false assurances of safety to the eastward of it.

The season has not permitted a thorough exploration of the shoal west of George's, known as Clark's bank, but a line of soundings, &c. has been run upon it, and an early opportunity will be taken to examine it further.

Soundings were made by Lieutenant commanding Davis in ten fathoms, upon a bank not laid down upon the charts, in about latitude 41° 17′, longitude 68° 36′, or about sixty miles southeast of Nantucket. This bank, it is believed, was not before known, and the credit of its discovery may be claimed for the coast survey.

7. The work of triangulation conducted by me personally being in this section of the survey, I was enabled at intervals when changing stations to visit the different parties employed in this quarter, in some cases to inspect the results of their work, and in others both the results and operations.

II. Middle Section.

1. *From Narragansett bay to New York bay, and thence to the capes of the Delaware.* 2. *Delaware river and bay, and south of cape Henlopen.*

1. The connexion of the *primary triangulation* of Mr. Hassler at its southern end, with the main triangulation across Delaware bay, by assistant Blunt, was made only by secondary triangles. The bay triangulation is remarkable for the beautiful symmetry of its triangles, while the connecting triangles, however allowable in secondary work, were not suitable for the important purpose of making a junction with a triangulation like that of Delaware bay. This triangulation has, besides, assumed a new degree of importance, since it has been decided to carry the primary triangulation across to the Chesapeake, and not down the Delaware bay. The directions sanctioned by the Treasury Department in the spring of 1844 referred to the importance of a revision of this part of the work, but time was not found during that year to execute it. It was accordingly made the first duty of assistant Blunt on the opening of the present season. The reconnaissance was commenced in May, and was carried through under many obstacles, and a suitable triangulation determined upon and executed by the beginning of September.

The triangulation is shown in sketch B, where the stations are marked B, 1845. They are six in number, three in Delaware and three in New Jersey, with a seventh in New Jersey observed upon but not occupied. The number of angles measured was 17, and the number of observations made 530.

At three of the stations tripods of timber were erected, varying in height from 30 to 45 feet. The instrument was placed upon the top of the tripod, and the observer stood upon a scaffold entirely detached from the tripod. The legs of the tripod were stiffened by braces passing to the ground, forming lesser tripods, and by horizontal ties. It might be supposed that the warping and twisting of the timber of which the tripods were made, under the action of the sun and moisture, would sensibly affect the observations made from them, but this does not appear to have been the case. The probable errors of the separate observations deduced at the stations where the tripods were used, are not quite so great as of those at the other stations. Nor do the triangles containing two of the angles measured from the tripods and one from the ground, compare disadvantageously, in the error of the sum of their angles, with those in which one angle only was measured from the tripod and two from the ground. These facts, if further experience should verify them, will have an im-

portant bearing in facilitating the triangulation in the southern sections of the survey.

The angles of the triangles were measured with the twelve inch theodolite of Simms.

S. V. Talcott, assistant in the party of Mr. Blunt, resigned his position in the coast survey just after the opening of the season, and Mr. J. P. Bolles was temporarily attached to the party to assist Mr. Blunt.

Observations for azimuth and latitude were made by assistant Blunt at one of the Delaware stations, marked Deakyne in the sketch, in the months of October and November. The observations for azimuth were taken by the elongations of the pole star, the Simms theodolite being used for measuring the angles with the elongation mark. The observations for latitude were made with the six inch Gambey theodolite.

2. *The primary triangulation* for connecting Mr. Hassler's work with the base of verification on Kent island was in part in this section, but chiefly in the next, where it will be described.

3. The work of triangulation in this section is nearly complete. The only matter of importance which remains, is the verification of the work on the eastern coast of New Jersey. It is very desirable, if practicable, to connect this work with the primary triangulation which was carried across the State of New Jersey to the river Delaware, and southward to near Delaware bay. *A reconnaissance* to examine the practicability of such a junction was commenced in the early part of September, by Lieut. Henry Prince, of the United States army. The examination is a difficult one, and nothing positive can yet be known as to its results, the intention being, if possible, to set at rest the question under review.

4. *The magnetic observations* in this section, to be communicated for the use of the survey by Professor Renwick, of Columbia college, New York, have been continued. The charts of the harbors on Long Island sound, now in progress, require accurate observations of the variation of the needle, and advantage has been taken of the necessity for procuring these results to obtain at the same time, and without additional expense, others interesting to science. The observations of this season have included the variation (declination) dip, and horizontal intensity at Stonington, Connecticut; Greenport, Long island, New York; Saybrook and Bridgeport, Connecticut; of variation and horizontal intensity at New London and Sachem's head, Connecticut; Drowned meadow and Sand's point, Long island, New York; of variation at New Haven and Milford, Connecticut; and Black rock, New York.

The instruments used were Riddell's portable magnetometer, by Jones, of London, and a dip circle, by Barrow, of London, successor to Robinson. Professor Renwick was assisted by Henry Renwick, Esq.

5. *The topographical work* in this section is nearly completed. An omission on the northeastern extremity of Long island has been supplied by assistant W. M. Boyce; one on the Delaware by assistant J. J. S. Hassler. The local data for the plan of the city of Philadelphia, and especially for the wharves, having been found conflicting, and not accordant in total distances with the determinations of the survey, it was necessary to make the measurements required for the coast survey map, and these were executed, on returning from the field in the eastern section, by assistant W. M. Boyce.

The topography of the coast immediately south of cape Henlopen, the

triangulation for which was made in 1844, was executed by assistant J. J. S. Hassler, between the middle of September and the close of November. The shore line near cape Henlopen, which was reported to have undergone changes, was also resurveyed. The work extends south to Indian river, and completes the data necessary for the chart of the approaches and entrance to Delaware bay, which is now in the course of engraving.

6. *The off-shore work* of this season, which was chiefly in this section, included the commencement of an examination of the gulf stream. A thorough exploration of the gulf stream is necessary to furnish information upon one of the most important parts of the hydrography of the North American coast. To ascertain its limits at and below the surface, the direction and rate of the current, its temperature at the surface and at different depths, the soundings in and near it, the character of the bottom and other important particulars, with the influence of the seasons and prevailing winds, will require much labor and great zeal and intelligence on the part of those charged with the execution of the work. The high temperature at and near the surface of this body of water enables the navigator to recognise his position on reaching it, when bound for the United States, and is one of the important uses made of this stream. Various causes interfere with the constancy of the indications, as belonging to particular positions, and these should be investigated carefully, so as to give certainty in regard to the practical conclusions or rules that must be furnished to the navigator.

This work is not without risk, and was unavoidably delayed by the repairs required by the surveying brig Washington before it could be employed in such service. It was not possible to make these repairs from the remnant of the small appropriation for the survey in 1844-'45; but as soon as the new appropriation was available, the Washington was put in charge of Lieut. Com. Charles H. Davis, U. S. N., and made ready for the service. The preparations were completed and the vessel left New York on the 20th of July. The means of observing were necessarily tentative, experiment being required to test the value of the methods suggested in the instructions; the duties, too, were in a great measure new to the officers. The zeal and ability of Lieut. Com. Davis have supplied the place of experience in the modes of observation; and the methods themselves have been remarkably successful in his hands—having realized at the very first attempt some most interesting results.

This is not the place to discuss those results, and, indeed, it would be premature to ground conclusions upon the few observations already reported; but the obvious utility of the facts developed, connecting, as they do, temperatures and soundings together, and the efficacy of the means employed, as proved by the verification of known laws of the transmission of heat by conduction through a fluid warmed at or near the upper surface, are too remarkable not to give great encouragement in prosecuting the work.

Lieut. Com. Davis returned, for the repairs of certain of his instruments and for essential changes in others, in September, and in the beginning of October again proceeded to the gulf stream, returning at the close of the month. In this second exploration, bottom was reached in 1,300 fathoms, and a specimen brought up. The number of observations for temperature, at and below the surface, made during the season, is 813. The number of soundings, including the work in the sound and off

Brandt point, is 2,354. 95 specimens of bottom, and 26 specimens of water at various depths, have been preserved.

The surveying brig Washington requires considerable repairs and alterations to render her thoroughly effective, and the estimate by her commander will be included in a special report to the Treasury Department.

The views entertained by Lieutenant commanding Davis in regard to the use of steam-vessels in the hydrographic part of the coast survey, are expressed in the following extract from one of his reports to me:

"I believe that the present expense of this purchase would be amply repaid by the greater amount of work they would perform. Their superiority to sailing vessels in sounding, both in rapidity and certainty, makes the argument in favor of their employment to be this—that with them the coast of the United States can be surveyed in one half the time consumed by the present means."

The fact cannot be too often presented, that there is a certain determinate extent of coast to be surveyed. The more rapidly it is surveyed the more economically can the work be done, and the sooner will its fruits be enjoyed.

7. The party of Lieutenant commanding Davis was occupied during part of October in supplementary work of *sounding* at the eastern entrance of Long Island sound. As other duties did not permit the completion of this work, Lieutenant Carlile P. Patterson, of the United States navy, who had been engaged in the reduction of this part of the survey in the office at Washington, was requested to report to Lieutenant commanding Davis for the completion of this work. A small vessel was hired at New London for the purpose, and the work occupied Lieutenant Patterson during the month of October, after which he took charge of the schooner Phenix, loaned to the survey by the Navy Department, to proceed to the Gulf of Mexico.

8. A series of *tidal observations* for the establishment of the port of New London, Connecticut, with observations of the *set and velocity of tides* in Fisher's Island sound, have been made by Lieutenant John N. Maffitt, United States navy, under the immediate direction of Lieutenant commanding George S. Blake. The stations at which the observations were made are marked in sketch C, No. 1. The results will be immediately reduced, and the computations required be made by an officer of this party at the office in Washington. The observations of currents are projected on diagrams, which facilitate the scrutiny of the results, and render practical deductions from them comparatively easy. In a difficult navigation like that of Fisher's Island sound, a chart of which is now publishing, sailing directions must be very imperfect, unless they take into consideration the set and drift of the tide.

Lieutenant commanding Blake in his report acknowledges his obligation to the collector of the port of New London, Charles F. Lester, esq., for the facilities afforded by him for carrying on this work.

9. The unfinished observations of *the tides and currents in New York bay and harbor*, were resumed on the 16th of May, by Lieutenant commanding Davis, then in charge of the surveying schooner Vanderbilt; to these were added observations of the remarkable and dangerous currents at Hell Gate, at the entrance of the East river and Long Island sound. Nothing less thorough than a series of observations, by which the motion of the water should be traced from one end of this passage to

the other seemed admissible; and it was necessary that this should be done at different times of tide, and under different circumstances of wind. This duty was executed by Lieutenant commanding Davis with great ability. Nine stations for the observations of currents (shown in sketch C, No. 2) were occupied in this dangerous passage, and *five* tide stations, two on the East river and three on the Long Island sound, part of the passage. Subsequently, two of the extreme stations were connected by a line of levels run from one to the other by Lieutenant commanding Davis, and simultaneous observations of the rise and fall of the tides made at them by Lieutenant commanding J. R. Goldsborough. The result of these observations is to show clearly upon a chart the direction taken by the water at ebb and flood tide - its rate of motion, not only in the principal current, but in the minor currents; to show how advantage may be taken of the parting of these currents to pass in a particular direction in reference to the dangerous obstacles of this passage, and how to avoid being carried by them in unsafe directions. The examination of the effects of winds, and the connexion of the observations with the figure and dimensions of the passage, remain yet to be made. A chart representing these results will accompany the western sheet of Long Island sound.

The number of stations selected for observations of currents in New York bay and harbor, was twenty-eight; of these, twenty-one were occupied in 1844 by the party under the immediate direction of Lieutenant commanding Davis, and the observations made at them in calm times. The work of this season has been to occupy the remainder of these stations in calms, and to ascertain the effect of the prevalence of particular winds in modifying the observed set and drift of the tides. In connexion with these observations, the rise and fall of the tide were observed at Sandy Hook and at Governor's island, and in addition at or near the localities of the observations of currents. Meteorological observations accompanied those on the tides at the regular stations. The stations are shown in sketch C, No. 2.

The seven stations remaining from 1844 were occupied by Lieutenant commanding J. R. Goldsborough, United States navy, in the surveying schooner Vanderbilt, and under the immediate direction of Lieutenant commanding Davis; and the observations have since been continued by the officer first named, who has availed himself of the prevalence of different winds to advance this part of the work. The observations were continued until about the middle of October, when the Vanderbilt was temporarily required in aid of the arrangements for measuring the base line in North Carolina. Before this time, all the outside stations, thirteen in number, had been occupied after a storm, or long prevailing wind, and the results of ten consecutive tides at the chief stations, and of four at the minor ones, had been obtained and entered in the usual forms, and laid down upon appropriate diagrams. The simultaneous observations of tides in Hell Gate, before referred to, were made by Lieutenant commanding Goldsborough.

The self registering tide gauge, established at Governor's island, was kept up during last winter, and has continued to work moderately well. The mechanical execution of the screw, upon which the working of the machine depends, was not sufficently perfect for this purpose, and has caused some stoppages in the apparatus, especially as the clock had but little power. A self registering gauge, devised by Mr. Saxton, of the office

of weights and measures, seemed so much more perfect than this, that it was determined to make trial of it before causing other gauges to be constructed. There is no doubt but that, with nicer work, the plan at present in use will answer, if Mr. Saxton's gauge does not prove so far superior as to supersede it. This gauge, when replaced by another, will be removed to Boston harbor, where the range of the tide is greater than in New York.

During the last winter the party of Lieutentant commanding Davis was engaged in the office in reducing the tidal observations, made at the chief stations of the survey, entering them in the prescribed forms, determining the corrected establishments, and preparing the materials for a general discussion of the tides of our coast within the limits of the survey. This will be carried as far as may be considered necessary to the hydrography.

10. The chart showing the progressive changes at Sandy Hook, referred to in my last report, was prepared by Mr. B. Glück, draughtsman in the coast survey office, and, by authority of the Treasury Department, was sent to the Hon J. Phillips Phœnix, member of Congress from New York city, to be laid before the chamber of commerce of that city, which has acknowledged, by a very gratifying series of resolutions, the information thus communicated.

Southern Section No. I.

III. *Chesapeake bay, &c.*—1. The *primary triangulation* for connecting the work of Mr. Hassler with the base of verification on Kent island, has been completed during the season by assistant James Ferguson. The whole triangulation is shown in sketch B, where the stations occupied by Mr. Ferguson are marked F, and the year of their occupation is also marked. Those of Mr. Hassler in the same sketch are marked H.

The party reached their first station, at Swan point on the Chesapeake, on the 11th of April, and the work was finished about the close of September, after which the party proceeded to North Carolina to commence the triangulation there. Mr. Ferguson was aided by assistant J. C. Neilson.

The number of stations occupied during the season was six, and one station of last year was reoccupied. The area of the polygon, embraced in the triangulation, is four hundred and eighty square miles. The sides of the triangles embraced in this year's work vary in length from about ten to twenty two miles. The number of primary points observed upon, at the different stations, were as follows: at the first, 3; at the second, 4; at the third, 4; at the fourth, 6; at the fifth, 4; and at the sixth, 4; and at the station of last year reoccupied, 4; making in all 29 points. The number of angles measured was 21; of observations made, 2,376. When the obstacles to the work in this quarter are considered, the progress of the triangulation must be deemed satisfactory. The coincidence in the length of the line, common to Mr. Hassler's and Mr. Ferguson's triangulations, derived by the former from the Fire island base, and by the latter from the Kent island base, is very close. The data are yet insufficient for a final comparison of latitudes and azimuths.

The instrument used was the two-feet Troughton theodolite, which was repaired and improved in many respects in the office of the survey by Mr. William Würdeman, during the last winter, and was redivided on the Troughton dividing engine, which has been rendered automatic by Mr. Joseph Saxton, of the office of weights and measures. Mr. Ferguson

reports that the regraduation has apparently materially reduced the errors in the triangles measured by it, as compared with those measured before the change.

Towards the close of the season, Mr. Ferguson was directed to have a reconnaissance made for ascertaining and reporting the obstacles for connecting two stations in the primary triangulation of Mr. Hassler, near the Delaware, (Bethel and Meeting House hill, see sketch B,) either directly or by using an intermediate station suitably placed. This was executed by Mr. Neilson, whose report on file shows the obstacles which render the connexion impracticable under ordinary conditions.

The party of assistant Ferguson was engaged during the winter in making duplicates of the journals of the summer's work, and in recalculating the astronomical observations made by them.

2. It being desirable to increase the number of *astronomical stations* in this section of the survey, Lieutenant Thos. J. Lee, of the United States Topographical Engineers, assistant in my party, was directed to observe for latitude at Taylor's and Abingdon. (See sketch B.) At the same time, Lieutenant Lee made the *magnetic observations* required for the chart of Annapolis harbor, about to be published, at Taylor's, near Annapolis, and at the south end of the Kent Island base, and similar ones at three other stations. These observations were made between the 8th of May and the 6th of July, when Lieutenant Lee joined me to assist in the observations at the astronomical stations already referred to in the eastern section of the survey, having executed very satisfactorily a considerable amount of work in the brief time allowed him. The number of observations made were as follows: for latitude 2,980, and for time 336. For magnetic variation (declination) 160, for magnetic dip 216, and for total horizontal intensity 108.

The observations for latitude were made with the six-inch Gambey theodolite of the survey, and, for time, with a Hassler reflecting circle; the magnetic observations with the instruments already referred to under the head of the eastern section of the survey.

3. As mentioned in my last report, a *reconnaissance* for a triangulation to connect the coast survey stations, on or near the Chesapeake, with the Capitol, and to verify the triangulation of the Potomac river, was commenced under my immediate direction in 1844, by Lieutenant Henry Prince, of the United States army. The course taken in this laborious reconnaissance, in which Lieutenant Prince has shown much persevering industry, as well as aptitude for the work, was the following.

The country northwest of a line joining Washington and Baltimore was first examined; the Elk, Patuxent, and Montgomery ridges being explored to find intervisible points. This examination proved that the connexion in that direction could only be made by going far into the interior. Lieutenant Prince next examined the route by following heights which skirt the valley of the Potomac as far as Fort Washington, and then crossing to the Chesapeake bay, (at Herring bay), and found obstacles deemed by him very serious, if not insurmountable, by the ordinary modes of triangulating from the ground. The next exploration was in the general direction of a line joining Washington and Annapolis. The practicability of a small triangulation in this quarter was rendered very probable, but it was not of an order desirable for this particular object, and the numerous stations would have made it expensive if executed in a man-

ner suited to the purpose in view. By further examination, and the use of methods common in reconnaissance, Lieutenant Prince finally ascertained that a triangulation is very probably, if not certainly practicable, connecting a line joining two of the Chesapeake bay stations, (one to the north and the other to the south of Annapolis) with the Capitol and naval observatory, by the use of intermediate stations, and furnishing a good base for continuing the triangulation down the Potomac, to meet the work coming from the Chesapeake bay up the river, thus affording a necessary verification.

The work was continued, whenever the weather was favorable, during the last winter and spring, and was completed as far as necessary, in a preliminary reconnaissance, about the close of July.

The very detailed reports, made from time to time in regard to this work, are on file in the coast survey office.

After being temporarily attached for a short period, when the weather was not advantageous for reconnaissance to the plane-table party of assistant Whiting, Lieutenant Prince was directed to proceed with the reconnaissance already described, for connecting the primary triangulation down the Delaware with the coast of New Jersey.

4. The continuation of the *primary triangulation* of the Chesapeake southward from the Kent island base, was assigned to assistant Edmund Blunt. Duties claiming prior attention occupied him until about the 20th of November, when his party was transferred to the Chesapeake. All the progress which the season will permit will no doubt be made, and the work will be resumed as early as the opening of the spring will allow.

5. Two parties have been engaged in the *secondary and tertiary triangulations* of the Chesapeake and waters flowing into it—the one during the whole working season, and the other in a different locality, during part of July and August. The area surveyed includes the Elk, Bohemia, and Sassafras rivers, the bay from Turkey point to Legoe's point, the Gunpowder, Middle, and Back rivers, the Chester nearly to the head of navigation, and part of the bay from Kent island southward.

The secondary triangulation from Kent island south was made by assistant F. H. Gerdes, after his return from the southern reconnaissance, and the completion of his topographical sheet (commenced last year) between the Magothy and Patapsco rivers. The work occupied him from the 13th of July to the 28th of August, between which dates ten stations were occupied. The area of the polygon embraced in the survey is 153 square miles. The sides of the triangles vary from 2½ to 11 mile in length - a main series of triangles for securing the requisite accuracy being carried on, besides the minor series intended specially for the use of the topographical parties. The number of stations and objects observed upon was 23, including stations, spires, windmills, and the cupolas of houses. Assistant Gerdes also filled some tertiary triangles while engaged in the topographical work between the Magothy and the Patapsco.

The angles of the secondary triangles were measured with an eighteen inch theodolite belonging to the survey, and made in the office, the limb having been redivided by Mr. Saxton with the coast survey dividing machine. This theodolite was one of a pair made from another instrument, in order to use the divided circle, but now the strong point of the instrument is considered the weakest; and the Troughton divisions, the supposed excellence of which caused the adaptation of the instrument to the

limb, are erased to give place to a more accurate series, traced in the office on the Troughton dividing engine, as improved by Mr. Saxton.

It being necessary that assistant Gerdes should leave the field to complete the drawing upon his topographical sheet, and the copies of the journal of his reconnaissance in Alabama, Mississippi, and Louisiana, before again proceeding to the Gulf of Mexico, the secondary triangulation was continued by Captain Joseph E. Johnstone, of the United States Topographical Engineers, assisted by Lieutenants R. E. Hammond and Edward Murray, of the United States army.

The *secondary triangulation*, near the head of the bay, and the streams flowing into it, and the *tertiary triangulations* in the streams, have been under the immediate direction of Captain Joseph E. Johnstone, of the United States Topographical Engineers, on coast survey service, assisted by Lieutenants C. Benjamin and J. F. Irons, of the United States army. The precarious state of the health of Captain Johnstone required that two assistants should be assigned to his party, in order to insure due progress in the work. The party took the field on the 3d of June, having been detained by the illness of Capt. Johnstone and other causes, and triangulated the Elk, Bohemia, Sassafras, Gunpowder, Middle, and Back rivers, and the bay from Turkey point to Legoe's point, as shown on sketch B, before the 3d of July, having occupied fifty six points, chiefly tertiary points. The party then proceeded to the Chester river, carrying the triangulation from the mouth towards the head. On the 23d of July, having occupied twelve stations, it was deemed necessary by the officer in charge (Captain Johnstone being absent on account of ill health) to suspend operations on the score of the unhealthiness of the season. In August, Lieutenants Irons and Benjamin were directed by the War Department to rejoin their regiments, there being special need of their professional services.

Captain Johnstone and his assistant, Lieutenant Benjamin, were engaged during the last winter in the office of the survey in making copies of the journals of observations of the preceding season, and duplicate calculations of the work.

5. *The topography* of the shores of the Chesapeake, and of the rivers running into it, as far as the head of navigation of each, has been nearly completed, except that on three sheets, Nos. 6, 7, and 16, of sketch B, from Swan point, on the eastern shore, to the head of the bay, and from Thomas's point, Annapolis harbor, to the head of the bay. The materials for a chart of the Patapsco and Baltimore harbor will, it is confidently expected, be ready for use this winter, and the chart will at once be drawn and put into the hands of the engravers. The topography has been executed by assistants Gerdes, Hassler, Wise, and Cutts.

The unfinished work of last year, on sheets Nos. 1 and 2, at the head of Chesapeake bay and Northeast river, has been completed by assistant J. J. S. Hassler, and the survey of sheet No. 15 commenced and finished by him. The work includes Elk neck, the shores of the Elk and Bohemia rivers, and of Back creek, with a portion of the Delaware and Chesapeake canal, and the roads included within the limits of the sheets. The area surveyed is seventy-six square miles; the extent of shore line, seventy-three miles; of roads, one hundred and eighty miles; and of canal, five miles. The party took the field on the 15th of April, beginning work on the 21st. It was transferred to the neighborhood of Cape Henlopen in September. The country is reported by Mr. Hassler to be difficult to survey, being hilly and thickly wooded, and admitting

of but short sights for the plane table points. The season, too, was remarkable for excessive heat, complained of by nearly all the parties in this region.

Mr. Hassler was engaged during the last winter in drawing in ink the work on sheets Nos. 1 and 2; in supplying an omission in the topographical work on the Delaware river, and in recalculating the positions of some trigonometrical points on the upper part of the Delaware.

The topographical work on sheets Nos. 3, 5, 7, and 13 (sketch B) was assigned for execution to assistant Richard D. Cutts. No. 13, including the eastern shore from Swan point to Worton point, was first completed; then No. 3, near the head of the bay, including part of the Susquehannah river, and the towns of Havre de Grace and Port Deposite. Mr. Cutts was at work upon sheet No. 5, which includes the head of Bush river, when he was taken very ill and obliged to break up his party on the 18th of September. He was enabled to resume work early in October, and completed sheet No. 5, and will probably finish part of No. 7 before the close of the season. The area surveyed up to the 26th of September, was 51 square miles; the extent of shore line 54½ miles, and of roads 40 miles. The party took the field on the 21st of April, and left it finally about the 20th of November.

Mr. Cutts was engaged during the last winter, in part, in revising the work done with assistant Ferguson during the previous season, and in reducing to the publication scale the chart of Annapolis harbor and the Severn river, now nearly ready for publication.

Sheets Nos. 6 and 8 (sketch B) have been completed; and considerable progress has been made in sheet No. 9 by assistant George D. Wise. The last named includes the shores of the Patapsco; No. 8 the city of Baltimore and the adjacent country. Having found it impossible to reconcile the measured distances with a printed plan of the city, Mr. Wise found it necessary to make a detailed survey, especially of the part near the water. This sheet (No. 8) covers an area of 8 square miles, and includes 10 miles of shore line, 5 miles being of wharves, 9 miles of roads, and 48 miles of streets. No. 6 covers an area of 66 square miles, and includes an extent of 102 miles of roads and 48 miles of shore line. The party of assistant Wise is still in the field, completing such parts of sheet No. 9 as are necessary to the commencement of the Patapsco river.

Assistant Wise has had a small vessel during the whole season. His party has again been exempt from sickness, so as to be able to keep the field continuously since last April.

During the last winter, Mr. Wise was occupied in reducing to a more convenient working scale a part of the previous season's work; in drawing his maps in ink, and in assisting in general duties of the office.

The topographical sheet marked No. 10, extending from Sandy point to the Patapsco, commenced by assistant Gerdes in 1844, (designated as No. 3 in the report of that year,) was completed between the 1st and 30th of June. The work done covers about 8 square miles, and includes about 20 miles in length of shore line and 2½ of roads.

6. *The hydrography* in this section has included the soundings of the Patapsco river and the harbor of Baltimore, the approaches to the Patapsco, and part of the bay between Annapolis harbor and Kent island and Poole's island, and observations on the tides and on the direction and velocity of the currents within the same limits in the bay. It has been

executed by the party under the command of Lieutenant commanding George M. Bache, United States navy, in the surveying schooner Nautilus. Materials for the chart of the Patapsco are in readiness. The part of the bay marked as broken ground in Brantz's chart of the Patapsco was thoroughly examined by Lieutenant commanding Bache, but "every new line passed over some knoll that would interfere with the clear progress of large vessels." The work was commenced on the 26th of April, and closed about the beginning of December.

The subordinate officers of this party have generally been changed by the Navy Department during the season, and the two remaining from the former season have been notified that they will be soon detached. The places of the officers detached have been filled as they became vacant.

Views for the chart of Annapolis harbor (now engraving) were taken by assistant Farley, with the advice and co operation of Lieutenant commanding Bache, requiring the use of the surveying vessel a few days in the month of June.

The party was occupied during the winter in copying and reducing the work of the previous season, and in reducing for publication the soundings of Annapolis harbor and the Severn river.

The views of Lieutenant commanding Bache in regard to the use of steam vessels in sounding will be found in the following extract from his report:

"In the deep waters of the Chesapeake bay which have been gone over, the angles as well as soundings have been taken from the vessel. There are many difficulties and delays in working in a vessel under canvass. It is only with a moderate and steady breeze that the work can be laid out to advantage; frequent alterations in the force or direction of the wind are great impediments. Light airs and calms put a stop to all sounding operations, unless the stations are sufficiently near to be distinguished from the boats. On this account, I have long thought that the use of steam vessels on the off shore and bay work would contribute to the accuracy, expedition, and convenience of the work; and, if properly managed, would prove more economical than sailing vessels for the extent of surface surveyed. In a steamer, such lines of soundings could be run as would best display the features of the bottom, without closing upon or partly running over the lines of soundings which had been previously established. This is sometimes unavoidable in working under sail, particularly when distant from the shore stations. During light weather and calms, when the sailing vessel would be comparatively idle, the steamer, going at a moderate and steady rate over smooth water, would be working to the best advantage, and with the greatest accuracy and convenience. It is evident that much more and better work of this kind can be done from a steamer than from a sailing vessel. As regards the comparative economy of the two kinds of vessels, I can only speak in more general terms. The same expenditure for outfits and renewal of sails would not be incurred; on the other hand, the expense of repairs of machinery and cost of fuel would be heavy items; but when the greater amount of work is considered, the cost of it would probably be less ned. As the triangulation progresses down the wide part of the bay, I am confident that, to keep pace with it on the water, either one or more hydrographical parties must be added to the force now here, or that steamers must be speedily introduced."

IV. *The coast of North Carolina.*—The work here has been begun by the employment of two parties as early in the autumn as the weather would permit; the one in preparations for measuring a base line, the other in the primary triangulation of Albemarle sound. The work is fairly begun, and will be followed up as vigorously as the appropriation will admit.

1. As there is no doubt but that, in surveying the southern coast of the United States, the frequent measurement of base lines will necessarily be resorted to, I have been desirous to supply an apparatus more portable than the one formerly used in the work, and combining certain other advantages. Among these are, that the length of the apparatus is invariable at different temperatures; that the bars have equal absorbent powers for heat, and are in one single piece; that they are supported so as to be stiffened laterally as well as horizontally, while capable of free motion; that they are enclosed in a way which prevents sudden changes of temperature, while the covering part of the apparatus gives stiffness; that the apparatus is supported at two points only, and is easily moveable in the different directions required for adjustment in measuring. I expected also to apply Bessel's contact apparatus in measuring, thereby to render the measurement so easy and rapid that its repetition, which is always desirable, might be made without expending too much time; but time has not sufficed for this, and I have employed the microscopes used by Mr. Hassler, with the modifications made last year by Mr. Blunt, and other changes. I have been necessarily, by the same circumstance, limited to the use of one set of bars, instead of two, which I expected to have employed to facilitate the measurement. The general conditions to be fulfilled by the apparatus, and a general description of its construction, were given to Mr. William Würdeman, mechanician to the coast survey, to fill up the details. This was satisfactorily done, and the work commenced in August last. With great effort, the apparatus was prepared for use by the 22d of November. The preliminary trials for the invariable length, and for the comparison of the length of the bars (six metres) with the standard metre of the French committee of weights and measures, were made by me personally, with the assistance of Lieutenant A. A. Humphreys and Mr. Joseph Saxton.

Before the completion of my work at Blue hill station in Massachusetts, assistant Boutelle was sent to reëxamine the site for the base, a reconnaissance for which was made in 1843, by assistant J. C. Neilson, under the direction of assistant Ferguson, to determine definitely its location, to run the line, to make a series of levels so as to determine the best grades for the work, to erect signals at the extremities, to make a preliminary measurement with a chain, and in general to prepare for the final measurement of the base. These operations were nearly completed by the close of November, when I reached the site of the base, to examine the line and fix upon the terminations. The work of Mr. Boutelle had been both diligently and skilfully executed.

The very low state of water in the Dismal Swamp canal, unprecedented at this season of the year, has interposed difficulties and delays in the transmission of the apparatus; but unless the season should prove unusually unpropitious, I expect to proceed at once with the measurement of the base. The only circumstance which can cause the postponement of the

measurement until the close of winter, will be an unusually wet season, covering the sand flats, over which the line passes, with rain water. Should this occur, the triangulation from the ends of the base will be made to precede the measurement.

2. *The primary or main triangulation* of Albemarle sound was commenced early in November by assistant Ferguson, aided by assistant Neilson. A small vessel was hired for the use of the party, in order to facilitate the work. This party will probably be able to keep the field until January, and to recommence work in March; so that considerable progress may be expected within the present year.

There is no part of our coast the peculiar features of which render accurate and minute surveys more necessary than this. The broad sounds are traversed by channels in which alone the requisite draught of water for vessels even of moderate size is to be had, and these are imperfectly explored, out of the ordinary track. Any facilities of navigation which would open more readily the corn-growing region of North Carolina to a market, would add much to the wealth of the country. Accurate charts would thus, directly and indirectly, in their bearing upon the improvements required, be of great advantage to this part of the country.

It is therefore very desirable to follow up the primary work already described by employing a secondary or tertiary triangulation party, and the topographical and hydrographical parties required; and this will be done as far as the means put at our disposal will allow. It would be manifestly improper to cease working on any of the sections of the survey which have been in progress, to take up new sections, for this would prevent the fruits of the work from being soon realized; but I am sincerely anxious to diffuse the benefits of the work over a large extent of our country at a very early day, and this can be done by a small increase of the appropriation. In pressing this, I do so, not that it will benefit those engaged in the work, or will lead to the employment of others; but simply that it may benefit the agriculture, commerce, and navigation of the whole country, in which the whole country is directly interested; and that it may furnish, as fast as possible, means to prevent or diminish the waste of life and property which now annually occurs upon our coast.

Southern Section No. III.

V. *Coast of the Gulf of Mexico*—1. A reconnaissance, preliminary to the survey of this coast, was commenced in January last by assistant F. H. Gerdes, accompanied by Mr. William S. Walker. The coast between New Orleans and Mobile was thoroughly examined, and some progress made in the direction of Pensacola. The reconnaissance included the shores of Lake Pontchartrain east of the meridian of New Orleans, the shores of Lake Borgne and of Mississippi sound, the Chandeleur islands, the islands along the coast of Mississippi and Alabama, Mobile bay, the coast of Alabama from about three to five miles inland, and a part of the interior near Mississippi city and Pearl river. The distance from New Orleans to Mobile is about 160 miles, and as the general breadth of the reconnaissance was from 12 to 30 miles, it comprised an area of more than 3,000 square miles. The conclusions drawn by assistant Gerdes from his reconnaissance are the following:

"1st. That a trigonometrical survey may be extended from New Orleans to Mobile without any great difficulty.

"2d. That the coast is well situated for a series of well shaped triangles.

"3d. That a base line of nearly 7 miles in length may be measured on Dauphin island, which may be connected with the main triangulation by triangles, the sides of which will increase gradually."

A very copious report and journal of this reconnaissance have been deposited in the office, with a scheme of the triangulation, prepared by assistant Gerdes. This includes both a main or primary and a secondary triangulation, which assistant Gerdes proposes to carry on simultaneously, and the execution of which has been assigned to him. He will leave Washington in November for the Gulf of Mexico. If my presence in Washington next spring is not needed, and the state of the coast-survey appropriation will permit, I intend to measure the base line on Dauphin island; and if not, to prepare the apparatus for as early a measurement as circumstances will allow.

Assistant Gerdes acknowledges his indebtedness for information and facilities afforded by collector Minge, of Mobile, J. McCaughan, esq., of Mississippi city; to Col. Totten, chief engineer, for the communication of maps of reconnaissance; also for information derived from the maps and charts of Col. Kearny, U. S. Topographical Engineers, and of Commander Powell and Professor Coffin, of the U. S. navy.

2. In order to facilitate the operations of the triangulating party, and to make a beginning of the hydrography by examining the operations of the tides and currents, which are very complex, Lieut. C. P. Patterson, U. S. navy, on coast-survey service, has been put in charge of the schooner Phenix, loaned to the survey by the Navy Department, and will proceed to this quarter as soon as his duties in Long Island sound are completed.

As showing the necessity for an early commencement of this work in relation to tides and currents, I append (appendix No. III) an extract from an interesting report of assistant Gerdes.

VI. *Determinations of differences of longitude from European observatories.*

The determination of differences of longitude of points on our coast, and of different European observatories required by the plan of re organization of the coast survey, has advanced in the course of the past year by the communication of the following observations for the use of the survey, as well as by calculations which will be referred to in another place.

1. *The solar eclipses of* December 9, 1844, and of May 6, 1845, were observed, by my request, at Portland, Maine, by Lieutenant Charles H. Davis, U. S. navy. The time was obtained by a transit instrument, the use of which was kindly permitted by Mr Senter. On the occasion of the latter eclipse, measurements were made of differences of polar distances of cusps and limbs with a wire micrometer attached to a telescope equatorially mounted, belonging to the coast survey. The internal contacts of the disk of the planet Mercury with the sun's limb, in the transit of May 8th, were also observed by Lieutenant commanding Davis.

2. W. C. Bond, esq., of Cambridge, has communicated, for the use of the coast survey, observations of the eclipse of the sun of December 9, 1844, and of May 6, 1845 In the latter case, differences of declination of the cusps and of the sun's disk were observed. Also, seven occultations

of stars by the moon between the 14th of December, 1844, and the 15th of September, 1845; ninety-five moon culminations and transits of moon culminating stars, between December 16, 1844, and September 17, 1845; and observations of the transit of Mercury of May 8, 1845, including differences of right ascension of the disk of the planet and of the sun's limb.

3. Mr. Bond has also communicated the results of the comparisons of chronometers transported by steamers between Boston and Liverpool, and a special comparison by twelve chronometers between Greenwich and Boston, and Liverpool and Boston. This latter determination gives for the difference of longitude between the observatories of Greenwich, England, and Cambridge, United States, 4 hours 44 minutes 31.69 seconds. Means having been taken to secure the obtaining of the local time at Liverpool from the observatory there, the comparisons by the chronometers of the steam vessels, from their frequency, will, in time, give a body of results of the highest value. The method derives great importance from being, as compared with the determinations by astronomical observations, an independent method.

4. Professor Caswell, of Brown University, has kindly communicated his observations of the solar eclipse of May 6, and the transit of Mercury of May 8th.

5. I have already elsewhere adverted to the observations in progress at Nantucket, which will be communicated for the use of the survey, and also of the observations made by me at Great Meadow station of the eclipse of May 6, and the transit of Mercury of May 8, 1845.

6. The following observations for the longitude of the Philadelphia observatory will be communicated by Professor E. O. Kendall, of the central high school. They were made with the assistance of Professor Thomas H. Perry, United States navy, detailed for the purpose by the Navy Department.

"1st. A series of occultations, embracing, with two or three exceptions, all that could possibly have been observed.

"2d. A series of transits of the moon and moon culminating stars.

"3d. The observations of the transit of Mercury of May 8, consisting of the times of ingress and egress, meridian observations of Mercury, the sun, and several fundamental stars, and micrometric measures of the distances in right ascension and declination between the limbs of Mercury and the sun, amounting to about one hundred in number."

Besides these, advantage has been taken of the fine Ertel circle to make observations for determinations of latitude, which have also been recorded for the use of the coast survey.

7. Professor Perry was detached temporarily from service at Philadelphia, to make observations of occultations and of the transit of Mercury at Finley's station, near Baltimore. Two occultations were observed at Finley's in moon culminations, at Baltimore.

8. The computations made for the survey out of the office will be noticed in another place.

VII. *Office Work.—Calculations, drawing, engraving, instrument making, &c.*

1. The office work of the different field parties during the last winter, consisting of copying journals, calculating observations, drawing, &c.,

has been referred to in connexion with their work of the past season. During the past winter I superintended personally the work of the different parties in the office, and for all official purposes may be considered, according to the regulations of the survey, as present at that central point of the survey at all times; but the immediate charge of the operations going on under my direction is one of the most important duties which can devolve upon an assistant. Upon the efficiency of that officer depends the regular movement of the part of the establishment where the results of the work are collected and put into form to be given to the public. Having felt most forcibly the value of the services to the public, and the relief from responsibility afforded by the ability, method, assiduity, and untiring zeal of the assistant in charge, Lieutenant A. A. Humphreys, of the U. S. Topographical Engineers, I must be excused for warmly and publicly expressing my deep sense of obligation and wishes that his services might meet with the public reward which they deserve.

2. The plan of having duplicate calculations of the work admitting of them made by others than those engaged in executing the work, has been fully carried out; and in cases of disagreement, a third computation has been resorted to. The observations of the last year have nearly all been recomputed, and some of those of the present year have been begun. Assistant Theodore W. Werner, at New Haven, and Eugene Nulty, esq., at Philadelphia, have done the chief work of recomputing, and a portion of work has been referred to Professor Stephen Alexander, of Princeton. The advantages of this system are not only felt directly in the accuracy to which it leads, but in the reaction upon the modes of observations themselves by bringing independent judgments to their scrutiny.

3. The computation of recorded observations for differences of longitude of points upon our coast, and of European observatories, has been continued by Sears C. Walker, esq.

In his report of October 25, 1845, Mr. Walker gives the following summary of the computations added since his last report: "The transit of Mercury of the 8th of May, of which both phases were observed at Philadelphia, enables me to add one to class III of that report. The two partial eclipses of the sun that have occurred in the interval are of no use for purposes of longitude from Europe. Classes IV, V, VI, and VII, have been extended so far as to include all the phenomena of their kind for Philadelphia down to 1842. They have also been made to include the extensive series of observations of eclipses and occultations by Lieutenant Gilliss at the marine observatory at Washington in the years 1838 to 1842, inclusive."

Some idea of the labor of computing the occultations, the observations of which form a considerable part of the materials for Mr. Walker's computations, may be gathered from the fact, that one of the eight classes into which the work has been subdivided for ready reference requires the discussion of not less than one hundred occultations, and that a form prepared for the reduction of one of these occultations occupies four printed pages in folio.

4. In my report of last year, the advantage of publishing every year the results of the work was referred to. I had in view a publication resembling the memorial which contains an account of the operations of the great trigonometrical survey of France. Instead of delaying publication

until the close of the work, I proposed to publish annually the results of observation. I suggested there a difficulty in regard to pecuniary means; and have felt that difficulty so strongly, that the collecting of the work for such a purpose is only in part done. It will not, however, be lost sight of; and possibly, when the volume is presented to the department to be laid before Congress, means may be appropriated for its publication at the office of the survey, or it may be printed as a congressional document.

Drawing, &c.—1. The usual maps of assemblage and record for the work of 1844 generally, which require considerable labor, have been completed. Seventeen sheets were prepared for the plane table parties for the season's work, the meridians and parallels, triangulation points, and sides of triangles being projected upon them.

2. The following maps, charts, and sketches were drawn chiefly on the publication scale:

A map of the harbor of New Bedford, on a scale of $\frac{1}{10000}$, was reduced and drawn by assistant Whiting; the drawing of the hydrography being furnished by Lieutenant commanding George S. Blake.

A chart of Fisher's Island sound, on a scale of $\frac{1}{10000}$, was reduced and drawn by assistant B. Glück.

A map of New Haven harbor, on a scale of $\frac{1}{10000}$, has been nearly completed by assistant Glück.

The hydrography of the eastern sheet of Long Island sound, on a scale of $\frac{1}{10000}$, was reduced under the immediate direction of Lieutenant commanding Blake, by Mr. Glück.

A map showing the progressive changes at Sandy Hook was compiled from different surveys made between 1778 and 1844, and drawn by Mr. Glück. This has been furnished, as before stated, by the direction of the Treasury Department, to the Hon. J. Phillips Phœnix, and has been laid before the chamber of commerce of New York.

The sketches, exhibiting the progress of the survey during the year 1844, were also made by Mr. Glück.

The hydrography of the Delaware, from Fort Mifflin to Trenton, is in part reduced, and the drawing nearly completed by Mr. Glück.

The drawing of the middle sheet of the map of Delaware bay and river has been finished by assistant W. M. Fairfax.

The drawing of the upper sheet of the same map, except the part including the city of Philadelphia, has been finished, and that of the lower sheet, containing the bay and approaches, has been begun by assistant Fairfax.

Scales of shade for representing the slopes of hills, with specimens of hills, and other topographical details, including conventional signs, and for drawings on different scales from $\frac{1}{10000}$, the usual working scale, to $\frac{1}{80000}$, the most common publication scale heretofore used, have been prepared by Mr. Fairfax, under the immediate direction of assistant Humphreys.

The map of the harbor of Annapolis and the Severn river, on a scale of $\frac{1}{20000}$, was reduced by assistant Cutts, and drawn by assistants Glück and Gerdes; the reduction of the hydrography being furnished by Lieutenant commanding George M. Bache.

Additions have been made to sheets Nos. 5 and 6 of New York bay and harbor.

A drawing to exhibit the progress of the coast survey each year since its commencement, designating the different kinds of work and by whom executed, is in progress and nearly completed, by Mr. Morven McClery, who has been also engaged in lettering maps and in miscellaneous duties of the office. Drawings for the projections of the plane table operations for the season were also made by Mr. McClery.

Various tracings and copies of maps have been made for the use of the different parties in the survey.

The verification of the maps published, by comparison with the original surveys, is made by Lieutenant Humphreys personally. This duty has included, within the past year, the verification of the small map of New York bay and harbor, of Nos. 5 and 6 of the large map of New York bay and harbor, of two sheets of the chart of Long Island sound, of one sheet of the Delaware bay and river, of Fisher's Island sound, and of the harbors of New Bedford, New London, and Annapolis.

5. Part of the officers of the party of Commander Gedney, United States navy, have been engaged (latterly under the immediate direction of Lieutenant C. P. Patterson, Commander Gedney being unavoidably absent on account of ill health) in bringing up the office work of the party. The following work has been done in the course of the year:

1. A chart has been made of the off-shore soundings of 1844, from Cape Henlopen to Block island, and southeast to the gulf stream; scale $\frac{1}{400000}$. 2. The off shore work of 1842, within the same limits, has been reprotracted on the same scale, and the soundings transferred to the chart of 1844. 3. The work of the East river and Long Island sound, from Governor's island to Throg's point, has been reprotracted; scale $\frac{1}{10000}$. 4. The work on the south coast of Long island, from inlet East (near Southampton) to Montauk point, has been reprotracted; scale $\frac{1}{40000}$. 5. The work on Great South bay, from Conkley's point (near Fire Island inlet) to Head and Horns, has been reprotracted; scale $\frac{1}{10000}$. 6. The work on the coast of New Jersey, from Sandy Hook to Barnegat inlet, has been reprotracted; scale $\frac{1}{40000}$. 7. A chart has been made of the East river, from Governor's island to Fulton ferry; scale $\frac{1}{5000}$. 8. About one half of the duplicate journals have been compared with the originals and corrected, and the journal of 1844 copied. 9. The charts have been lettered and marked. 10. A register has been made of all the hydrographical notes in the office. 11. Specimens of bottom (3,816 in number) have been put in bottles, marked, and registered.

6. Tracings and drawings have been made of different parts of the work, to answer the calls made for information for public purposes, and under the sanction of the Treasury Department. The archives have been thus rendered useful in cases which could not have been foreseen, but which nevertheless are of value to the public.

Engraving, printing, and publishing.—1. The engraving and drawing have been prosecuted with considerable activity by the aid of the additional appropriation made by Congress at their last session for the publication of the work of former years. The local charts, requiring less finish and uniformity of style than those of the sections of the coast, have been put out of the office for execution, and we shall thus have a fair trial of the contract system in its results as to accuracy, style, cost, and time. It will be found that my pledge, in the

event of this appropriation being made, to carry on the publication of the back work without interfering with that appropriate to the year, has been fully redeemed. Two sheets of the large map of New York bay and harbor, and the map of the same bay on a smaller scale, have been published; a chart of Fisher's Island sound is ready for publication; a sheet of the map of Long Island sound, and of Delaware bay and river, are nearly ready for publication; a chart of New Bedford harbor, and a chart of Annapolis harbor and the Severn river, will be out during the winter; and a second sheet of Delaware bay and river, and a chart of New London harbor, will soon follow. A sheet of the south side of Long Island is engraved as far as the materials in the office permit. The results thus produced will, I trust, induce Congress to continue the additional appropriation for the preparation of the maps and charts, until the whole of the back work has been published.

A more particular account of the several charts in the course of publication or engraving will be found below.

1. The small map of New York bay and harbor, on a scale of $\frac{1}{80000}$, which was nearly finished at the close of 1844, was published in February, 1845.

Copies of it have been distributed under act of Congress and by direction of the Treasury Department, and have been placed for sale with agents at New York, Boston, Philadelphia, Baltimore, and Washington. Arrangements will soon be completed for exposing it for sale at Charleston and New Orleans.

2. The first sheet of the southern shore of Long Island, on the scale of $\frac{1}{20000}$, reported as nearly completed in my last, has been delayed to remedy some essential defects which the verification of the hydrography made apparent.

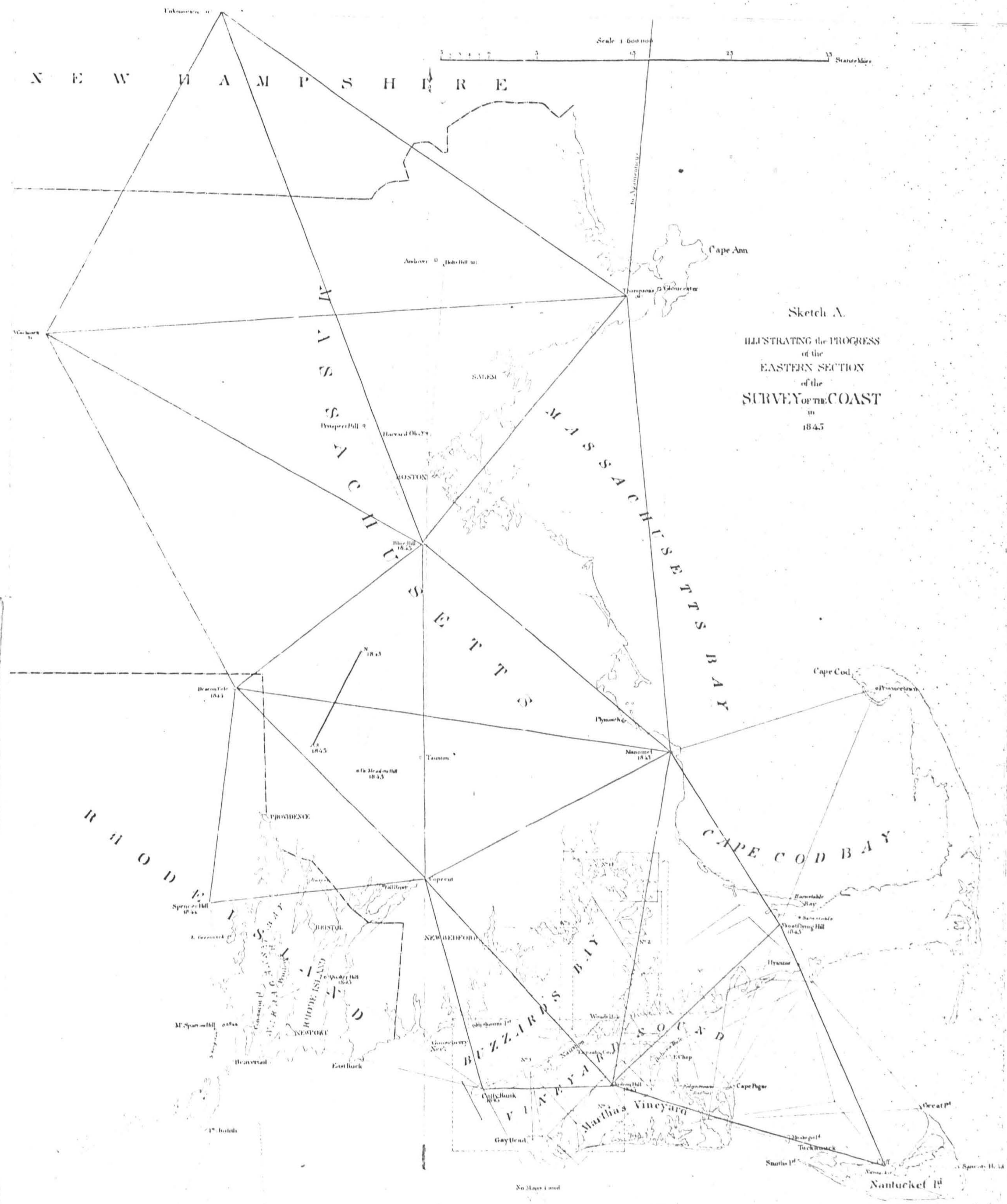
3 and 4. Two sheets (Nos. 5 and 6) of the map of New York bay and harbor, completing the map on the scale of $\frac{1}{50000}$, which were in outline merely at the close of last year, have been completed, printed, and published. The distribution of them must be made through the members of Congress, who apply in behalf of the literary and scientific institutions, and the associations to which by law they are to be sent, the Treasury Department having no longer the privilege of franking them. Copies of these sheets were directed to be placed with the agents of sales in November.

5 and 6. The plate which contains the entrance of the sound from the eastward, and Fisher's island sound, is nearly completed. The elaborate work upon this plate and the two of Delaware bay (numbered below as 7 and 8) renders progress upon them necessarily slow. The middle sheet of the sound is in outline, and the roads and other parts of the topography have been completed. The western sheet, towards New York, is in outline upon the copper.

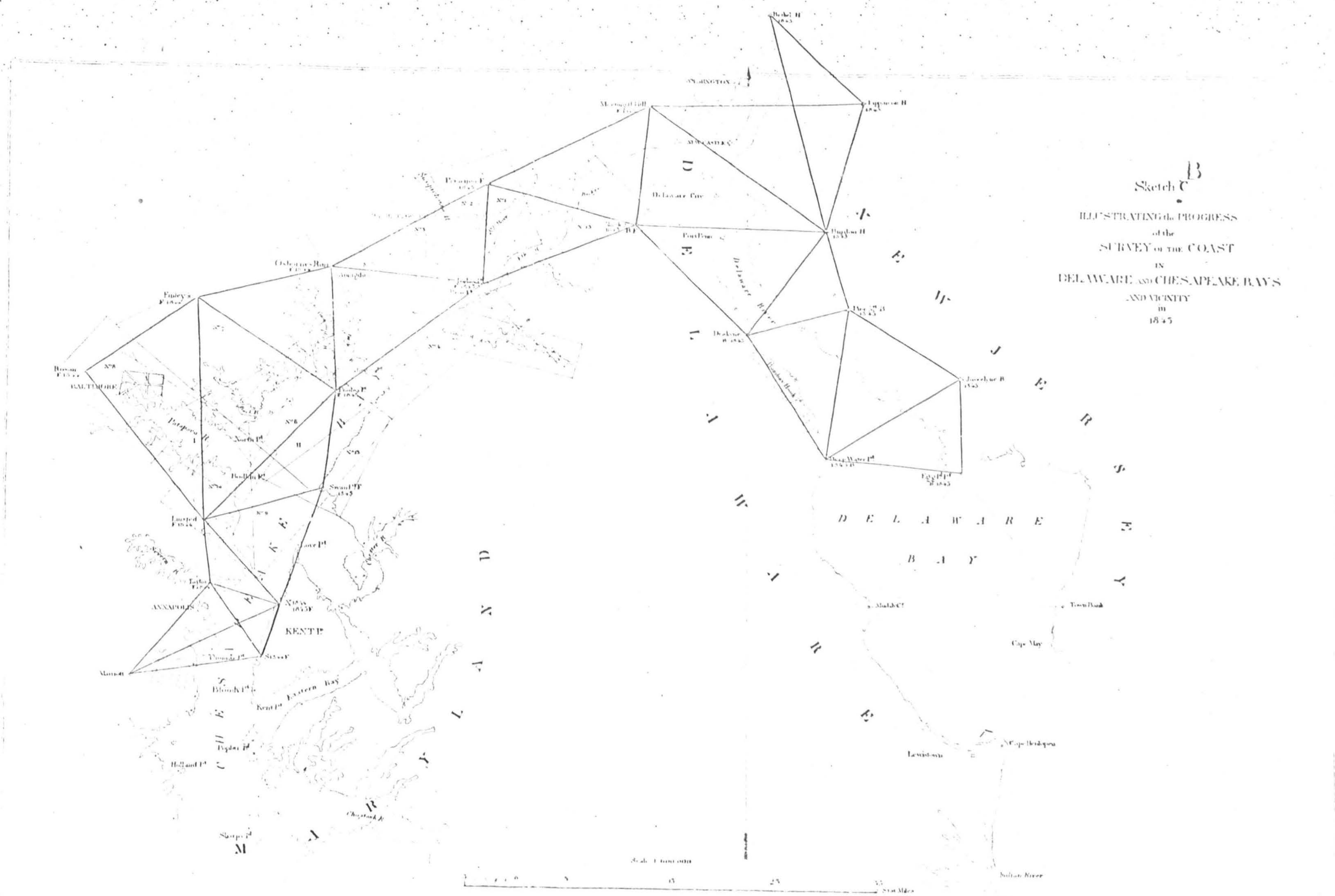
7 and 8. The middle part of Delaware bay and river (No. 2) will be finished by the first of February, and the upper sheet within two months after. The drawing of the lower sheet is nearly ready for the engraver, and the projection upon the copper has been prepared.

9. A chart of New London harbor will probably be engraved before the presentation of this report.

10. A chart of Fisher's island sound, on a scale of $\frac{1}{10000}$, has been en-



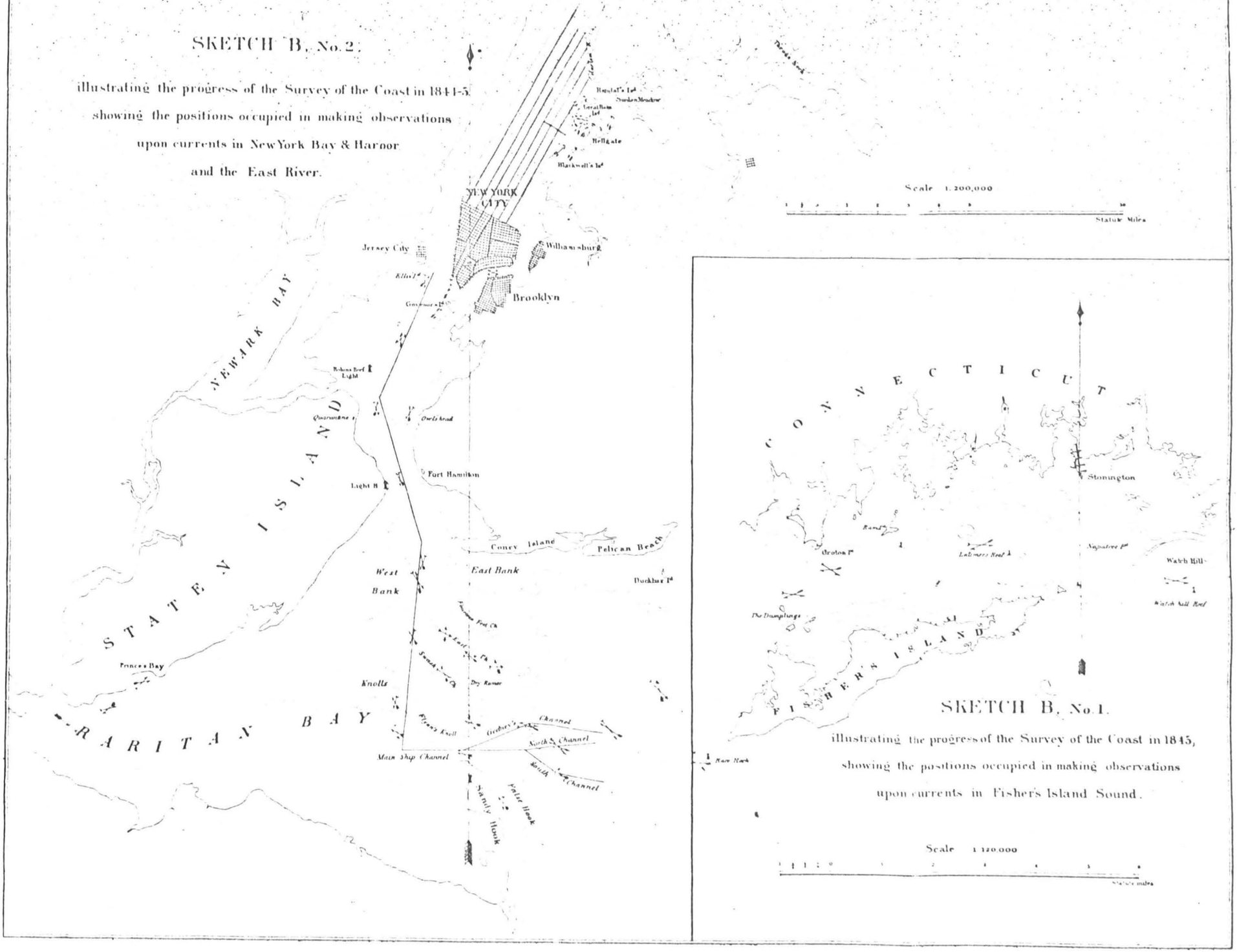
Sketch A.
ILLUSTRATING the PROGRESS
of the
EASTERN SECTION
of the
SURVEY OF THE COAST
in
1843
Scale 1:600000
Statute Miles
NEW HAMPSHIRE
MASSACHUSETTS
MASSACHUSETTS BAY
RHODE ISLAND
CAPE COD BAY
BUZZARDS BAY
VINEYARD SOUND
Cape Ann
Gloucester
Andover
SALEM
Prospect Hill
BOSTON
Blue Hill
1843
Beacon Pole
1843
Taunton
Plymouth
Manomet
1843
Cape Cod
Provincetown
PROVIDENCE
Copecut
Fall River
Spencer Hill
BRISTOL
NEWPORT
NEW BEDFORD
Quaker Hill
1843
Beaver Tail
East Rock
Pt. Judith
Barnstable Bay
Hyannis
Wood's Hole
Cuttyhunk
Gay Head
Martha's Vineyard
Cape Pogue
Tuckernuck
Smiths Pt.
Great Pt.
Nantucket Id.
No Mans Land



B
Sketch C
ILLUSTRATING the PROGRESS
of the
SURVEY OF THE COAST
IN
DELAWARE AND CHESAPEAKE BAYS
AND VICINITY
in
1843
NEW JERSEY
DELAWARE
MARYLAND
DELAWARE BAY
BALTIMORE
ANNAPOLIS
KENT Pt.
Eastern Bay
Cape May
Lewistown
Scale

SKETCH B, No. 2.

illustrating the progress of the Survey of the Coast in 1844-5, showing the positions occupied in making observations upon currents in New York Bay & Harbor and the East River.



SKETCH B, No. 1.

illustrating the progress of the Survey of the Coast in 1845, showing the positions occupied in making observations upon currents in Fishers Island Sound.

graved out of the office, and is nearly ready for publication, requiring the re entering of portions of the topography.

11. A chart of the New Bedford harbor, surveyed in 1844, is in progress out of the office, and the time for its delivery was the first of December. The views and other additions to it will occupy six weeks or two months in engraving, so that it will probably be issued in February next.

12. A chart of Annapolis harbor and the Severn river, surveyed in 1844, is also in progress out of the office to be completed, with the exception of the views, by the first of December. This will speedily be published.

The engraving department has been, during the whole of this year, under the charge of assistant Farley and the general supervision of Lieutenant Humphreys, and monthly reports and proofs of the works have been regularly forwarded to me. It is manifest that great diligence has been shown by the engravers; and, in regard to the style of execution of the two principal parts of the work, the hill topography on the sound, and the woodland upon the Delaware, and sanding in Delaware bay, the style is admirable. The lettering, some of the views, and part of the sanding, approach these in excellence.

2. *Printing and publishing.*—Since the first of December, 1844, 630 copies of Nos. 1, 2, and 3, of the large map of New York bay and harbor, have been printed, and 440 of No. 4. The remaining copies of No. 4 will be printed with No. 6, the sheet which it adjoins; 861 impressions of No. 5 have been printed, and 600 copies of No. 6 will be printed before the close of December, so as to make up 600 complete copies of the six sheets—the whole map; 1,440 impressions of the map of New York bay and harbor on the smaller scale have been printed since February.

Fifty three copies of the four sheets of the large map of New York bay and harbor have been *distributed* this year under act of Congress, including twenty-six to foreign governments; making a total number distributed of two hundred and twenty-two. One hundred and ninety-four copies of the small map of New York bay and harbor have been distributed, including 26 to foreign governments. The agents for the sale of the charts have received 250 copies of the four sheets of the large map, and 630 of the small. Before the 1st of December it is probable that 222 copies of sheets Nos. 5 and 6 of the large map will be directed and ready for distribution, and 250 copies placed with the agents for sale.

I would again respectfully solicit that authority be obtained from Congress to distribute, under the direction of the Treasury Department, an additional number of these charts, at home and abroad, to literary and scientific institutions, and associations connected with navigation, and to supply the depot of charts of the navy with the number which may be required for use by our national vessels. The cost of this distribution will be very trifling, and a great object will be answered by diffusing the information conveyed by the charts as widely as possible.

3. The instruments for nearly all the parties on the work have been cleaned and repaired in the office during the past year. The work done has included the construction of a stand for the two-feet vertical circle, and part of the changes necessary to the instrument itself, which now requires only slight additions to render it available for use. The dividing engine has had various changes made in it. A ruling machine and other tools for the engravers have been made. The three-feet theodolite has

been cleaned, the friction rollers repaired, and the mode of adjustment of the microscopes altered. The two-feet theodolite has been thoroughly repaired and the limb re divided. Two of the theodolites for secondary triangulation have been cleaned, repaired, and the limbs re-divided. The heliotropes have been altered, and an arrangement for heliotroping attached to a two-and-a-half-feet telescope. Theodolites, telescopes, barometers, compasses, and chains, plane tables, and tools for the field parties generally, have been repaired. The parts of six full sets of drawing instruments have been nearly prepared. Four beam compasses, four pairs of proportional dividers, and other drawing tools, have been made. A compensating base apparatus has been made, with the various parts for supporting and adjusting it. This work has been executed by Mr. William Würdeman, assisted during the season generally by one instrument maker, and at pressing times by two others temporarily employed.

When the variety of work thus done is considered, it is obvious that it requires no small share of knowledge, skill, and industry for its execution.

Recently, when it was desirable to employ additional force to furnish the new base apparatus, it was found very difficult to obtain any aid, and several instrument makers, who were applied to, declined undertaking the work at all to be executed by a specified time. These facts must be allowed due weight in estimating the value of the work shop of the coast survey.

It must be obvious from this statement of work done, which exhibits much of constant yearly recurrence, that new instruments can be made, if at all, only occasionally in this work shop. The necessity for more instruments, and of a different kind from those heretofore used in the survey, is very great, and I have asked for a moderate sum in the estimate of next year for their gradual supply.

4. The *disbursements* of each party are made by the chief, and the accounts then pass into the hands of a general disbursing agent, by whom they are first audited under the regulations of the Treasury Department. They then undergo an administrative examination by the superintendent, and if they have passed these two audits, are forwarded by the general disbursing agent to the First Auditor of the Treasury. The appropriation is drawn by the general disbursing agent, who advances the sums required to the chiefs of parties on their requisition, under such restrictions as may be laid by the Department or superintendent. The success of this arrangement of finance depends essentially upon detaching the general disbursing agency from other duty in the survey, and making the officer himself stationary at Washington. The duties of general disbursing agent are performed by Samuel Hein, esq., under whose care entire order and regularity prevail in the supplies to the parties, and in the arrangement and preliminary audit of accounts.

I have thus endeavored to give a view of the work done during the year, extending from November, 1844, to November, 1845, and to assign, as far as practicable, to each one engaged in the direction of any part of it the due share of credit. The amount done proves conclusively that each one in his sphere of labor has been zealously and industriously engaged, that the different branches of the service have harmonized in the execution of their work, and that a good spirit has reigned throughout.

It must, I think, be conceded that (not to go further back than my own superintendence of the work) more has been done during the past year

by each of the parties, with the same or proportional expenditure, than was accomplished the year before, and that thus, in the aggregate, a much greater result is furnished in proportion to the means expended; more has been done, I think, in the aggregate, with the means assigned, than I promised in my report, and perhaps enough to prove that if the appropriation were increased it would go proportionably still further for the public benefit.

In conclusion, I beg leave to present a sketch of the progress which may be made in the next year, and an estimate of the means required to realize that progress.

Two new centres of operation have been added during the past year, one on the coast of North Carolina and the other in the Gulf of Mexico; to these I would add, during the coming year, a third centre on the coast of South Carolina, or Georgia, or Florida, as a reconnaissance may prove most desirable, and I would extend the work efficiently from the two new centres. This can be done without proportionally increasing the appropriation for the survey; for if the means for keeping the parties in the field for a longer period of time each year were provided, we could work to the south during the winter, and to the north during the summer; a system already in part commenced during the past year, and carried as far as the means at my disposal would allow.

Again; the enlightened co-operation of the heads of the War and Navy Departments with the Treasury Department, and the general good feeling towards the survey of the officers of the army and navy, would enable us, under the directions already issued by Congress in regard to the employment of officers of the army and navy, to organize new parties if we had the means to fit them out and supply them with laborers, transportation, vessels, and other appliances for surveying which they require. We should thus be able to make such an impression on the public, by the extension of the work and the speedy publication of its results, as would repay by a rich harvest of popular approbation the fostering care of the Executive and Congress.

The present state of the work in the different sections will admit of the following progress during the next year.

1. *Eastern section.*—The primary triangulation may be extended across the northern line of Massachusetts into New Hampshire, and some progress made upon the coast of New Hampshire. The secondary triangulation may be carried across Cape Cod and Massachusetts bays, and as far north as Plymouth. The topography of Martha's Vineyard and Nantucket may be completed, and that of the main be carried from Wood's Hole eastward to Monomoy point. The hydrography of the Vineyard sound and of the sound between Nantucket and the main (Nantucket sound) may be completed, and the dangerous shoals off Nantucket seaward be examined.

2. *Middle section.*—The triangulation on the coast of New Jersey may be verified, the magnetic observations near New York and on Long Island sound and its vicinity may be completed, and the observations of currents in New York bay, Long Island sound, and Delaware bay may be nearly or quite completed.

The important observations in the gulf stream may be continued, and the off shore soundings be extended southward as well as eastward.

3. *Southern section No. I.*—The triangulation of the peninsula of the

eastern shore of Maryland and Virginia may be completed, and its connexion with the triangulation of the Chesapeake may perhaps be made. The primary triangulation may be extended southward along the Chesapeake, the secondary triangulation reach the Potomac and pass up towards Washington. A main triangulation may be commenced, to cross from Annapolis to Washington, connecting the capitol and naval observatory with the coast, and verifying the triangulation of the Potomac. A tertiary triangulation may be carried up the rivers of the Chesapeake to the head of navigation of each. The topography of the shores of the Chesapeake north of Kent island, the topography of Kent island, and of the shores of the Chester river, may be completed, and that south of Kent island commenced. The hydrography of the bay north of Kent island, and of the rivers flowing into it, may be completed, and that between Kent island and the Potomac be commenced and make considerable progress.

4. *Southern section No. II.*—The triangulation of Albemarle sound and of the rivers emptying into it may be nearly completed, and that of Pamlico sound may perhaps be commenced. The requisite astronomical observations at the Bodies island base and neighboring stations may be made. The topography of the shores of Albemarle sound and the hydrography of Albemarle sound be commenced.

5. *Southern section No. III.*—The measurement of a base on Dauphin island may be made, and the triangulation of Mississippi sound and of Mobile bay be carried on. The requisite astronomical and magnetic observations may be made in this quarter. The survey of the shores may be made from Dauphin island as far west as Mississippi city. The observations of tides and currents may be continued, and the soundings commenced in the same quarter.

6. *Southern section No. IV.*—A reconnaissance for a suitable base line, and to determine the character of the triangulation which is practicable, may be made on the coast of South Carolina, Georgia, and Florida, establishing a new centre of operations.

7. *Office work.*—The office work should consist, 1st, in the copying, reducing, and computing of the observations of the previous season, and in making drawings and projections of past or for future work; the arrangement of the observations of the past year for publication; the verification of calculations made by the field parties. 2d. The preparation of the materials for a map to extend from Point Judith to the east chop of Holmes's Hole, Martha's Vineyard, to include Buzzard's bay and the Vineyard sound, properly so called, and the commencement of the map itself. 3d. The reduction of the chart of the harbors of refuge of Tarpaulin cove and Holmes's Hole, on the Vineyard sound, and the engraving of the charts. 4th. The engraving of the second sheet of Long Island sound, and the drawing and engraving of the harbors of New Haven and Oyster bay. 5th. The preparation of an off-shore chart, to include the work off the coast of Delaware, New Jersey, New York, Connecticut, and Massachusetts; the commencement of the engraving of a sheet of this chart. 6th. The continuation of the drawing of the southern coast of Long Island, with a view to engraving and publication. 7th. The completion of the engraving of the upper sheet of Delaware bay and river, and the progress of the sheet representing the entrance of Delaware bay and the approaches; the drawing and engraving of a chart of Little Egg

Harbor, on the coast of New Jersey. 8th. The preparation of a chart of the Patapsco river and of Baltimore harbor, and the engraving of the chart as far as the materials may be furnished. 9th. The preparation of the materials for the commencement of a map of the upper part of the Chesapeake bay, on the publication scale, with a view to its completion as soon as all the data are furnished by the field parties, and its subsequent immediate publication. 10th. The data for a map of Albemarle sound and of Mississippi sound west of Mobile bay should be collected and arranged, so that the maps may be drawn as fast as the field-work is executed.

If the additional appropriation for preparing maps for publication, and for drawing and engraving, which was made last year, is continued, the new work and the back work, which are spoken of together in the foregoing, may be continued together; if not, one or the other of them must be cut off. That appropriation was made after an estimate had been presented to the Committee of Ways and Means showing the amount required to complete the reduction, drawing, and engraving of the work of former years, and asking for that part of the sum to expend during the past year. It will be observed that no work of this sort has been allowed to accumulate during the past year, but that publication has been made of what was complete in itself. This policy it is desirable to continue, and at the same time to publish the materials which have accumulated in past years so as to bring the publication up to the field-work.

I place the estimate for the field-work under the different sections, that it may be distinctly seen that the cutting off of a part of it involves the cutting off of some one section, or of all proportionately. It should be observed that, if there is a necessity for cutting off new work, or reducing the amount of expenditure upon the work already in progress, economy absolutely requires that the new work be not begun, the proportionate facilities for continuing the new work not being equivalent to those of continuing the old.

The cost of publishing the work of former years is included with that of the new work in the different sections.

General items.—Current repairs of vessels at present in use in the survey, and hire of others for work generally - - - - - - -		$1,350
Purchase of surveying instruments, books, maps, and charts - - - - - - -		5,500
For rent, fuel, postage, stationery, materials for drawing, engraving and printing, and for printing charts		5,000
Eastern section.—To continue the triangulations north into New Hampshire, over Cape Cod and Massachusetts bay to Plymouth; the topography from Wood's Hole to Monomoy point; the hydrography through the Vineyard sound, and to survey the shoals off the island of Nantucket, including observations of tides and currents, will require two triangulation parties, two topographical parties, the whole time of one hydrographical party, and part of the time of another	$18,000	
To reduce and engrave the charts of the harbors of refuge of Holmes's Hole and Tarpaulin cove on the Vineyard sound; to calculate the data for a map from		

Point Judith to the east chop of Holmes's Hole, including the entrances of Narragansett bay and the Vineyard sound proper, will require about - -	$1,300	
		$19,300
Middle section.—To verify the triangulation of the coast of New Jersey; to complete the magnetic observations near New York and in Long Island sound, &c.; to complete the observations of currents and tides in New York harbor, Long Island sound, and Delaware bay; the off shore work off the coast of Delaware, New Jersey, New York, Connecticut, and Massachusetts, will require one triangulation party, one other party for two months, two hydrographical parties—one for the season, the other for five months	8,750	
To complete the engraving of two sheets of Long Island sound, the reduction and engraving of two of Delaware bay, the drawing of the harbor maps of New Haven and Oyster bay, and their engraving, the reduction, drawing, and engraving of the off-shore chart—all belonging to the work of former years - - - - - - -	9,100	
		17,850
Southern section No. 1.—To carry the triangulation from Cape Henlopen and connect it with the Chesapeake bay work; to carry the primary and secondary triangulations down the Chesapeake, the tertiary triangulation along the water courses near it, a triangulation across to Washington and up the Potomac; to finish the topography of the shores of the Chesapeake north of Kent island, and to commence that of the shores south; to complete the hydrography of the upper part of the bay, and to commence that of the bay south of Kent island and of the adjacent rivers, will require three triangulation parties during the season, and one during part of the season; three topographical parties, two hydrographical parties -	21,500	
To make the computations, reductions, and drawings, and to engrave the chart of Patapsco and Baltimore harbor; to make the computations, reductions, and drawings of the chart of the upper part of the Chesapeake, will require - - - - -	3,800	
		25,300
Southern section No. 2.—To commence the triangulations of Albemarle, Roanoke, and Pamlico sounds, and of the rivers emptying into them; to make the necessary astronomical and magnetic observations; to commence the topography of the sound and ocean shores, and the hydrography of the sound, will require one triangulation party during the whole season, one other during part of the season; one astronomical party; one topographical party; one hydrographical party. For each of these parties a vessel must probably be hired - - -	16,100	

The reduction of this work and the computations connected with it, will require - - - - -	$1,500	
		$17,600
Southern section No. 3.—To measure a base line on Dauphin island; to triangulate Mississippi sound and westward; to make the astronomical and magnetic observations required; to begin the topography of the shores and islands; the hydrography, by observing currents and tides, and by soundings; to continue the reconnaissance eastward along the coast of Florida, will require one triangulation party, one astronomical party, one reconnoitring party, and two topographical and one hydrographical party - - - -	17,800	
Calculations and reductions preparatory to map -	400	
		18,200
Southern section No. 4.—Reconnaissance on the coast of South Carolina, Georgia, and Florida commenced		900
Total - - - - - - -		$111,000

The work in four of these sections is actually commenced, and to keep pace in the regular way with its progress will require all that I have asked. The estimates have been made with care, and are approved by the Treasury Department. Should the amount be diminished, the work must necessarily be diminished, and that in a greater proportion than the diminution of the appropriation; because the work is economical just in proportion as the system of division of labor can be more fully applied to it. The only choice will then be between neglecting certain sections altogether, or the wasteful way of working in all with insufficient means. I confess the responsibility of omitting the work projected for any particular part of the country, for either the eastern, middle, or three southern sections, is one which I shrink from, and which I sincerely trust there may be no necessity for taking. If, however, the means asked are not granted, the responsibility for the progress of the survey and for the period of its completion thus passes away from me; for it would be manifestly unjust to refuse the means stated to be necessary to advance the work, and to publish the results, and then to hold those engaged in or directing the work responsible for slow progress and the absence of publication. But I trust a different course will be taken, and that the disposition shown to push the work forward rapidly, to task to the utmost the powers of all concerned, to economize in every way short of destroying the efficiency of the work, and to publish the results as fast as they are obtained, will be responded to by the grant of the amount which, after careful examination, I pledge myself to be necessary to the due progress of the work, and to be that which can be applied to the greatest advantage during the coming fiscal year.

I ought not to close this report without saying that the scale of the survey may be still further expanded, if desired by Congress. In my last report, I showed how this expansion might take place, carrying on the work more rapidly on the coasts of the Atlantic and Gulf of Mexico, at an additional cost of about $47,000. The foregoing estimate is based upon the continuance of the policy heretofore sanctioned by the Treasury De-

partment, and by Congress; but I am very willing to go forward more rapidly, and, if additional means are furnished for the purpose, to commence work at once in our newly acquired coast of Texas.

The extent of the line of coast within the geographical limits of the United States, for the time being, is determined by nature; and the more rapidly it is surveyed, consistently with accuracy, the more economically can the work be done—the sooner will this source of expenditure cease—the sooner will the loss of life and property, caused by ignorance of the dangers of the coast, cease—the sooner will the reproach be removed from us of being dependant almost entirely upon foreign surveys for the little knowledge we possess of our coast and harbors south of the Chesapeake, and east and north of the Vineyard sound.

Very respectfully submitted by

ALEXANDER D. BACHE,
Superintendent United States Coast Survey.

Hon. R. J. WALKER,
Secretary of the Treasury.

APPENDIX NO. I.

Extract from a letter addressed by Lieutenant Commanding Blake, United States navy, coast survey service, to Professor A. D. Bache, Superintendent Coast Survey, containing a description of the position of a rock off Mishaum point, of a rock off Cuttyhunk, and of a ledge off Scraggy Neck, Buzzard's bay.

"Rock off Mishaum point, eight feet at low water. Mishaum point N. 30° E., 1½ *nautical* miles. Highest part of Pune island S. 30° E.—A black spar buoy has been recently placed S. 58° E., a little over one-third of a mile from this rock—in three fathoms at low water. The buoy is upon the eastern extremity of the ledge to which the rock belongs, and is upon the following ranges. Clarke's point light just open to the eastward of the summit of Round hill. West end of Nashawena island just open with the south part of Pune. Vessels bound into Buzzard's bay should, as they draw up with this buoy, be careful to keep to the eastward of it.

"Rock off Cuttyhunk in 15 feet at low water. Cuttyhunk light S. 37° E., 1½ *nautical* miles. Highest part of Pune N. 71° E., 2⅔ *nautical* miles. The only well defined range to this rock is the southwest bluff of Nashawena, just open with the high part of Cuttyhunk, over Copecut beach.

"Entrance of Mattapoiset harbor, a rock in 10 feet at low water. Ned's point light N. 32° W.—Strawberry point just open to the northward of Angelica point.

"A similar ledge, having but six feet water upon it, lies one quarter of a mile *without* southwest buoy off Scraggy Neck, and bearing about SSW. from it."

APPENDIX NO. II.

Extracts from a letter from Lieutenant Commanding Charles H. Davis, United States navy, surveying brig Washington, to Professor A. D. Bache, Superintendent Coast Survey, relating to the determination of Howland's reef, off Brandt point, Massachusetts bay.

"U. S. SURVEYING BRIG WASHINGTON,
"*Provincetown, September* 17, 1845.

"DEAR SIR: Yesterday, on leaving Boston harbor, I searched for the rock off Brandt point, reported to me by one of the bay pilots, and, agreeably to your request, determined its position. On two spots there is eight feet of water only at low spring tides. This small ledge, as it proves to be, is not to be found on the charts, and is, indeed, generally unknown to pilots. * * * * * * * *

"Several packets are reported to have struck upon this reef during the past year. The water deepens rapidly from the shoal part to three and four fathoms (at low water) in all directions. It is situated in the track of vessels bound to Plymouth and the lower part of Barnstable bay, with a fair wind, and of all coasting vessels beating in Massachusetts bay. I waited until this morning and made a more careful determination of the ground, measuring several angles upon topographical points furnished by Mr. Borden's State map. I send a sketch showing the relative place of the ledge, which (by no means intended as an accurate survey) is sufficient to establish its position, and also the claim of the coast survey to its first determination. The following directions will serve to mark its location on the common charts:

"Gurnet lights bearing S. $\frac{1}{4}$° E., distant 4$\frac{1}{4}$ miles.
"Scituate bearing NNW., distant 8$\frac{3}{4}$ miles.
"Captain's hill bearing SW.
"Buoy, Phillip's ledge bearing WNW. $\frac{1}{4}$ W., distant $\frac{3}{4}$ of a mile.
"High Pines ledge bearing S., distant 2$\frac{3}{4}$ miles.

"Its distance from Brandt point is 1$\frac{1}{4}$ mile, and from the shore due west 1$\frac{1}{4}$ mile. The bearings are magnetic. The buoy on Phillip's ledge, $\frac{3}{4}$ mile inshore, is generally supposed to mark the western limit of safety, and this increases the danger of the new ledge, and renders it more important that a buoy should be placed on it."

APPENDIX NO. III.

Extract from a letter addressed by Ferd. H. Gerdes, assistant United States Coast Survey to Prof. A. D. Bache, Superintendent, containing remarks upon the currents in Mississippi sound, and upon the change in the magnetic variation within short distances in the Gulf of Mexico.

"The effects of the prevailing winds, of currents, and of the great differences in the local magnetic variation, have more influence in the navigation of the Gulf of Mexico, between Mobile and the Balize, and in Lakes

Borgne and Pontchartrain, than on other parts of our coast bordering on the Atlantic ocean. The lakes are rather shallow, and only navigable for vessels of a light draught; the tide, therefore, affords frequently a great advantage, or otherwise. But this tide seems to be governed altogether by winds, and at present no system has been developed by which we may form a correct idea or even an approximation to the rise and fall. Under the head "tides and currents," I have mentioned in my report some observations which were made by myself during my presence on the coast, and have also referred to the charts of Mr. Blunt, who derived his information regarding the tides, I presume, from the surveys of Colonel Kearny and Lieutenant Powell. But those observations were necessarily confined to a limited period—Colonel Kearny's register commencing with the 13th of March and ending with the 1st of May, 1822, at Santa Rosa beach, Pensacola, and the notes of Lieutenant Powell, including from the 8th of January to the 2d of February, 1841, at Ship island.

"It appears necessary to investigate, if possible, closely into the causes of the irregularity; to observe for a long time not only the actual rise and fall, but also the direction and strength of the wind, the different formidable currents, their courses and strength, and form an idea of their origin; then I believe we may be able to establish gradually a system of conjectures bordering much nearer on truth than all our present suppositions. To make any observations of this sort, I would provisionally name Mobile point, either Ship island east or the Chandeleur island north, and the Rigolets.

"The strongest and most irregular currents which I observed, were north of the Chandeleur islands and south of Horn island and the Petit Bois. An instance of the strength I have mentioned in the above named paragraph of the report in the filling up of the Pelican channel. This is so extraordinary that it may be compared with the alterations on the Sandy Hook beach, near New York.

"The danger occasioned by this current is very great. On most places the soundings change from a considerable depth suddenly to shallow water, and the velocity of the stream sweeps many a vessel out of her reckoning, and she finds herself without the aid of light-houses, in dark nights, suddenly out of an apparently safe navigation, on bars or amongst breakers, at the mercy of the wild sea.

"Another danger for the navigation on this coast is, the irregular pointing of the needle. In short distances, the variation changes, according to records, materially enough to throw obstacles in the path of the mariner. The following notes were taken from charts:

"St. Joseph's,	Blunt's chart,	1826,	variation	6° 18′	E.
" "	Lieut. Powell,	1841,	"	7° 39′	"
"Mobile bay,	Blunt,	1840,	"	7° 5′	"
"Balize,	Blunt,	1838,	"	10° 15′	"
"Ship island,	Lieut. Powell,	1841,	"	7° 35′	"
" "	J. Wheeler,	1839,	"	7° 41′	"

"The Balize is on the same meridian with Ship island, and differs only 35′ southward in latitude. A difference of nearly 3° in about 40 miles seems to be very large, and, if correct, may form one more objection to the use of the compass in topography.

"These observations belong properly to the hydrographical part of the survey, and were always taken simultaneously or even after the sound-

ings were made. This, however, might in future (without alluding to the past) occasion some delay in engraving the charts, as a much longer period for obtaining results will be required in the Gulf than in our eastern waters; therefore I would propose to take into consideration if we might not begin at once with such observations."

APPENDIX No. IV.

Extract from a letter addressed by William Mitchell, of Nantucket, to Professor A. D. Bache, Superintendent of the Coast Survey, containing an account of the trade through the Vineyard sound for the last three years, and of the Nantucket south shoal.

"My Dear Friend: I have at length obtained the information I desired relative to the number of vessels which annually pass through the sound. Knowing that thou wouldst prefer a modern account, I applied to the captain of the light boat, with whom it has been somewhat difficult to communicate. To his politeness I am indebted for the following particulars:

In 1842 there were	144	ships,	1,295	brigs,	7,551	schooners,	3,616	sloops.
In 1843 there were	151	"	1,194	"	8,228	"	3,525	"
In 1844 there were	152	"	1,175	"	7,483	"	2,566	"
	447	"	3,664	"	23,262	"	9,707	"

and to July, 1845, there were 122 ships, 805 brigs, 4,847 schooners, 1,796 sloops, passed Nantucket light-boat, (an immense amount of property indeed,) and yet there is no chart of this thoroughfare in existence that is worthy of the name.

"My rude angles to the ship Centurion, wrecked on the south shoal, (1845,) resulted in placing her within one hundred rods of the position of the shoal as located by modern observers. The history of this most dangerous and fatal shoal is startling. Situated in mid-ocean; having, in low ebbs, scarcely a foot of water; in a region proverbial for its heavy swell; rising, at times, without a moment's warning; the dread of all mariners, and the grave of thousands; laid down in a position twenty miles in error of latitude, and confided in as late as the year 1821—such is Nantucket south shoal! The honor of giving to this shoal its true locality belongs to Captain Jonathan Colesworthy, of this place, who, on the 24th of June, 1821, made its latitude 41° 3′ 55″, it having, in all former time, been considered to be 40° 44′. In looking over the documents of Captain C., I am entirely satisfied that, in the old location, there are forty fathoms of water. So strong, however, is the impression on the minds of our veteran seamen that the earlier location is the true one, that confidence is still wanting in the survey of Colesworthy, though he has always been distinguished as an accurate observer. Its new and probably true location is precisely in the track of all vessels bound to New York from Europe; and it is remarkable with what apparent recklessness vessels of the largest size (even the Atlantic steamers) dash near its parallel, from an apprehension that it is far south of them. The last

and most authentic account of the ill-fated President (so says rumor) was near Nantucket in a heavy storm, and the idea has always been prevalent here that the south shoal was her burial-ground.

"If we could have the true account of the amount of property and human life that the erroneous location of this single shoal has cost our country, not only prior to 1821, but subsequent to that period, the expense of the whole coast survey would seem a diminutive fraction. The manner in which this survey is conducted will settle this matter forever, by removing all possible doubts."