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had developed the existence of several dangerous shoals between Shovelful light-vessel and Pollock Rip light-vessel, in Monomoy Passage.

No. 46 (May 27, 1884) contained notes on dangers in Neva and Peril Straits, and on anchorages in Fish Bay, Southeastern Alaska.

No. 47 (May 28, 1884) gave notice of dangerous ledges in Fisher's Island Sound.

No. 48 (May 31, 1884) warned navigators of a dangerous pinnacle rock in East River, N. Y., on the prolongation of Twentieth street. A danger buoy has since been placed on this rock.

No. 49 (June 1, 1884) reported the existence of a dangerous ledge in Englishman's Bay, near the eastern entrance of Moos-a-bec Reach, coast of Maine.

No. 50 (June 10, 1884) described the location of ledges off Minot's Ledge light-house, Massachusetts Bay.

No. 51 (June 30, 1884) gave notice of important changes, produced by the inroads of the sea, at and near Cape Henlopen, and of changes proposed by works of improvement in that vicinity.

The hydrographic examinations and surveys which developed the dangers and obstructions to navigation above enumerated were made by officers of the Navy on Coast Survey service, and are referred to again in Part II of this report in the detailed notices of work in their several localities.

IV.—SPECIAL SCIENTIFIC WORK.

INTERNATIONAL GEODESIC ASSOCIATION.

The importance of the questions to be discussed at the seventh annual conference of the International Geodesic Association, held at Rome in October, 1883, and the desirability of continuing the intimate relations heretofore existing between the Coast and Geodetic Survey and similar organizations in Europe, led to the detail of an officer of the Survey, under authority from the Secretary of the Treasury, as a delegate to that Conference.

The letter of convocation of the Conference having indicated as one of its leading objects the consideration of the question of the unification of longitude by the adoption of a universal prime meridian, and of the unification of time by the adoption of a universal time, the delegate on the part of the Survey was instructed to express the opinions entertained by scientific and practical men in the United States in relation to the same. He was instructed also to take occasion to urge upon the Conference the desirability of expressing an opinion in favor of the several Governments participating in a Diplomatic Conference at Washington, as proposed by this Government, for arriving at a settlement of the questions mentioned.

After due deliberation, the conclusions of the conference, representing fifteen separate nationalities, were formulated in a series of resolutions, to be brought to the knowledge of the several Governments, and recommended to their favorable consideration. This action led to the meeting of the Diplomatic Conference held at Washington in October, 1884.

Special report has been made by the delegate of the Coast and Geodetic Survey in regard to the part taken by him in the discussions.

DETERMINATIONS OF GRAVITY AND COMPARISONS OF STANDARDS.

Reference was made in my last annual report to the detail of an Assistant in the Survey for the purpose of obtaining in Europe certain observations necessary to complete the connection of the American and European initial gravity stations. This duty involved the measurement of the flexure of the Repsold pendulum tripod at the observatories at Kew, England, and Geneva, Switzerland; the charge of the construction of new pendulums and of apparatus for gravity investigations, and special inquiries respecting matters discussed at the Gravity Conference. Papers relating to the method adopted for the measurement of flexure, and to the effect of flexure of a pendulum upon its time of oscillation appear as Appendices 15 and 16 to this report.

Advantage was also taken of this detail to have made comparisons of the iron yard No. 57, belonging to the United States Bureau of Weights and Measures, with its mate, No. 58, deposited in the ordnance office at Southampton, and with the bronze yard No. 6, known as the "generator," and kept at the British Standards Office. The Arago platinum kilogram of the United Statse

Weights and Measures Bureau was transported to the International Standards Bureau at Breteuil, for comparison.

The valuable series of comparative determinations of gravity by means of the Kater pendulums was completed at Washington early in the fiscal year by the Assistant in whose charge they had been placed to be swung at the Transit of Venus station of 1882, at Auckland, New Zealand, at stations in New South Wales, British India, and Japan, and at a station in San Francisco. A full report of these observations appears in Appendix No. 14. At Washington, the station occupied was the one at the Smithsonian Institution, at which these pendulums had been swung by Lieutenant-Colonel Herschel, R. E.

PROJECTION TABLES, AND FORMULÆ AND FACTORS FOR LATITUDE, LONGITUDE, AND AZIMUTH COMPUTATIONS, BASED ON THE CLARKE SPHEROID.

In February, 1880, the Clarke spheroid of 1866 was adopted by direction of the Superintendent as the basis of development of the area covered by the entire operations of the Coast and Geodetic Survey. It superseded the Bessel spheroid, which had been in use since 1844, and its adoption made desirable the preparation of new editions of the Projection Tables, and of the auxiliary tables for the computation of geodetic latitudes, longitudes, and azimuths.

The new Projection Tables appear in Appendix No. 6. They have been computed under the direction of the Assistant in charge of the office, and cover the entire distance from the equator to the pole. Some changes and additions in the body of the tables will, it is hoped, make them more convenient for use. They have been prepared for the polyconic projection,* so long in use upon the survey, but answer equally well for all kinds of conic projections.

In Appendix No. 7 is given a third edition of the Tables of Formulæ and Factors for the computation of geographical positions. The first edition appeared in the Report for 1860, Appendix No. 36, and the second in the Report for 1875, Appendix No. 19. The present edition has been carefully revised by the Assistant in charge of the Computing Division, under whose direction it has been prepared.

THE RUN OF THE MICROMETER.

In Appendix No. 8 is given an investigation of the facts and conditions which should guide an observer in determining for the different fractional arcs measured on the graduation of a theodolite the due apportionment of the run of the micrometer, or the quantity by which the micrometer measures more or less than the prescribed number of the seconds of the graduation.

This investigation is followed by examples showing the forms of record and reduction as employed in actual field-work, and also methods of forming tables of run-corrections by means of which these corrections can be readily applied during the progress of the observations.

Tables of this character, in manuscript form, have long been in use by observers and in the Computing Division of this office.

BOUNDARY LINES BETWEEN THE STATES OF PENNSYLVANIA AND WEST VIRGINIA.

Reference was made in my last annual report to a request from the Joint Commission of the States of Pennsylvania and West Virginia for the detail of officers of the Coast and Geodetic Survey to execute the work of tracing out the boundary line between Pennsylvania and the "Pan Handle" of West Virginia. The two Assistants assigned to this duty completed the survey and marking of the boundary early in the fiscal year, the line adopted by the Joint Commissioners being a straight line through the southwest corner of Pennsylvania and the first stone south of the Ohio River, which had been placed in the meridian of the large granite monument marking the south end of the boundary line between the States of Pennsylvania and Ohio.

Subsequently, with my approval, a further request from the Joint Commission was acceded to—the tracing out of a portion of the boundary between Pennsylvania and West Virginia run-

* See Appendix No. 15, Report of 1880, for an account of this and other projections.