ing at sea were transmitted daily to the Weather Bureau office at San Francisco. These were carefully plotted from day to day and were utilized with good results by the forecast official.

The Commercial Pacific Cable Company is now (June, 1903) laying nearly 10,000 nautical miles of cable across the Pacific Ocean. The cable is laid in sections running from San Francisco to Honolulu, from Honolulu to Midway, Midway to Guam, Guam to Manila, and from Manila to Shanghai. This will not be the first cable across the Pacific, making complete the circuit of the world for cabling purposes. The British Pacific cable running from Victoria to Fanning Island, to Fiji, to Norfolk, to Southport and to Doubtless Bay, was completed October 31, 1902. The line was opened for commercial business during the first decade of December, 1902. The length of the British Pacific cable is 7900 nautical miles. A detailed description of the laying of the American transpacific cable is given by the writer in the Journal of Electricity, Power, and Gas, San Francisco, Cal., January, 1903.

Through the courtesy of Mr. Clarence H. Mackay and Mr. Geo. H. Ward the Weather Bureau office at San Francisco was enabled to test the value of weather reports from the Pacific Ocean. The following table gives the daily run of the ship and her position at noon, ship's time, when weather reports were cabled:

Date.	Position.				Total cable laid.	Soundings.	
	Lat. N.		Long. W.				
1902.	°	′	°	′	*Miles.*	*Fathoms.*	
December 15	37	8	123	47	77	1,800	Mud.
16	35	50	126	44	259	2,550	Yellow ooze.
17	34	36	129	59	455	2,700	Brown ooze.
18	33	14	133	30	662	2,685	Do.
19	31	39	136	46	865	2,550	Do.
20	30	18	139	38	1,054	2,480	Do.
21	28	44	143	2	1,269	2,725	Do.
22	27	7	146	16	1,480	2,820	Do.
23	25	39	149	8	1,677	2,880	Do.
24	23	57	151	20	1,894	3,016	Do.
25	22	22	155	23	2,109	2,426	Do.
26	21	18	157	50	2,238	450	Do.
	Honolulu *						

Connections at Honolulu, 38 miles; in all, 2276.317 nautical miles.

* Hawaiian standard time is based on standard meridian, 157° 30′, or ten hours and thirty minutes west of Greenwich. Honolulu local mean time is ten hours and thirty-one minutes slow of Greenwich. San Francisco local mean time is three hours and ten minutes slow of Washington.

NOTE.—The United States Coast and Geodetic Survey is now sending a series of time signals over the cable for determining longitude of Honolulu. The exact time difference has doubtless been determined to a fraction of a second.

While the cable was being laid communication with the shore was restricted to one hour in every twenty-four, as a rule the hour beginning with the ship's noon. Insulation tests of the cable were made every five minutes. The first report from the *Silvertown* was received on December 15, when the vessel was about ninety miles off shore. An interesting fact is that the steamer was experiencing strong southeast winds with rain, while at San Francisco, ninety miles to the northwest,[1] the wind was northwest and weather cloudy. At Point Reyes Light, however, thirty-five miles northwest of San Francisco, the wind was southeast. The wind was also from the southeast at Mount Tamalpais. It appears then that at San Francisco there still existed a stream of air flowing near the surface of the earth from the great valley to the sea, while within comparatively short distances, both horizontally and vertically, air currents were moving at an angle of 90° with this. The wind at sea was southeast.[2] The second message received from the *Silvertown* indicated the existence of a disturbance off the coast of southern California, with strong northwest winds prevailing at sea. The pressure conditions shown on the forecast map a few hours later indicated the probable approach of a storm which would reach the coast south of Point Conception and move eastward across southern California and Arizona. Forecasts of *rain* for southern California and of *fair* weather for northern California were issued. By the morning of December 17 the rainfall at Los Angeles amounted to 1.34 inches; at San Diego, 1.72 inches. In northern California no rain fell.

The third message received from the steamer, December 17, while in 34° 36′ north and 129° 59′ west, indicated the passing of the disturbance at sea; terrific seas had prevailed all night of the 16th, followed by a heavy swell on the 17th, with partly cloudy weather. Conditions were still favorable for rain along the Mexican boundary, and forecasts were made in accordance therewith. All succeeding reports indicated fair weather for California.

We now know that at Honolulu the lowest pressure, 29.73 inches, occurred on December 10, and that a disturbance was then passing eastward over the Hawaiian Islands. It is also noticed that Mauna Kea and Mauna Loa were heavily covered with snow in the storm of the 11th to 13th. It may be inferred that the disturbance from the Hawaiian Islands moved slowly northeastward across the Pacific in six days, the average velocity being about fifteen miles an hour. It is of further interest to note that this disturbance apparently preserved its identity in crossing the United States. In the MONTHLY WEATHER REVIEW for December, 1902, on Chart II, "low" area marked "No. V" is doubtless the same disturbance which reached the Pacific coast near San Diego on December 16, 8 p. m. This disturbance is charted as leaving the United States near the mouth of the St. Lawrence on December 22. It would be interesting to know the further history of the disturbance.

[1] Northeast. (?)

[2] In the opinion of the district forecaster, the wind directions at San Francisco are largely influenced by the peculiar topography of the district.

THE EARTHQUAKE OF JUNE 2, 1903, AT WASHINGTON, D. C.

By C. F. MARVIN, Professor of Meteorology.

At $8^h\ 27^m\ 0^s$, June 2, 1903, the new Omori seismograph at the Central Office of the Weather Bureau began the registration of an earthquake which is the second one recorded since the apparatus was set up in February of this year. The disturbance was inappreciable to ordinary sensations, but it is evident from the record that at its origin it was undoubtedly of very considerable severity. It is also seen that the movement of the earth had traveled a long distance before reaching Washington.

The reader is referred to section *C* of fig. 1, page 126, of the March REVIEW for an illustration of an earthquake record by the Omori instrument. The present record, which is not reproduced, is very much longer and shows much more complex movements of the earth than in the earthquake of March 15. The following table gives the times of occurrence of the principal features of the record:

June 2, 1903, (75th meridian time).

	H.	*m.*	*s.*
First preliminary tremor	8	26	32
Second preliminary tremor	8	33	8
Principal portion began	8	43	2
Principal portion ended	8	48	49
Duration of the end portion	0	43	28
End of earthquake	9	32	16
Total duration	1	5	46

Maximum double amplitude of strong waves in the principal portion, 0.22 millimeter.

Period of the pendulum, 26 seconds.

Magnification of record, 10.

AUTUMNAL COLORATION OF FOLIAGE.[1]

By Mr. A. F. WOOD, Pathologist and Physiologist, Bureau Plant Industry, U. S. Department of Agriculture.

The production of color in autumn foliage is, as is well known, due in part to the gradual destruction of the chlorophyll when the leaves have reached maturity and approach the

[1] Advance copy from an article on Autumnal Coloration in the Encyclopedia of Horticulture.—ED.

period of death, and in part to the action of acids on anthocyanin as described below. Many of the destructive changes which take place in the chlorophyll are oxidation processes, the same as occur in the cells of highly colored variegated plants, and physiologically they are not very different from the changes occurring in calathea, caladium, codiæum, etc. The approach of maturity in the leaf, and the coming on of cool weather in autumn, stimulate the production of oxidizing ferments, and the action of these and the acids of the cell sap upon the chromogen, or color contents of the leaves, especially the chlorophyll and anthocyanin, causes many of the brilliant colors of autumn foliage. There is a popular belief that these colors are due to cold weather or frosts; but while frosts, if they are light, hasten the solution and destruction of the chlorophyll, they can not be looked upon as more than hastening changes, which would occur in time without them. Even in the Tropics, some foliage before it matures becomes highly colored, and on the Japanese maples the writer has observed beautiful autumnal colorations in July in the region of Washington.

In practically all deciduous trees, bushes, etc., before the maturing and falling of the leaves, all of the valuable food materials, such as sugars, albuminoids, etc., pass from the leaves through the vascular bundles into the twigs and branches, so that they are not lost to the plant. When the leaves finally fall they are therefore nothing but mere skeletons, containing waste materials. In the passage, especially of albuminoid matters from the leaves to the stems, it is necessary that the materials be protected from the strong action of light, and it is believed that part of the coloration of maturing leaves serves the purpose.

A coloring material, or chromogen, known as anthocyanin, is always present in such cases, and develops beautiful reds when the cell sap is acid, blue when no acids are present, and violet when there is only slight acidity. This, in connection with the disorganizing chlorophyll, causes the various mixtures of yellow, brown, violet, red, orange, etc., of autumnal coloration as described above. In very young leaves of many plants, such as *Ailanthus glandulosa*, *Juglans regia*, *Vitis*, *Cissus*, and many other plants, this same anthocyanin is developed as a protection to the albuminoid materials traveling to the young cells. Such protective colorations have to be distinctly separated from variegations. In evergreen leaves, during the winter, the chlorophyll granules are protected by the development of anthocyanin, forming a brownish or reddish tinge in the cell sap. This is especially prominent in many conifers.

While, as stated above, these protective and in some cases transitory colorations should be clearly distinguished from variegation, it is an interesting fact that they develop when the conditions for active nutrition are unfavorable, and may, in many cases, be produced in maturing leaves by starving the plants or permitting them to become sufficiently dry to check growth.

THE WEATHER BUREAU SEISMOGRAPH.

By Prof. C. F. MARVIN, dated July 1, 1903.

It has always been the policy of the Weather Bureau to require its observers to take careful note of earthquake phenomena of sufficient intensity to be felt at stations, but no specific effort has been made to provide generally the instrumental means by which such phenomena could be automatically recorded and measured. The Central Office at Washington has, however, maintained a simple form of seismograph in operation ever since December, 1892, and recently has greatly improved its equipment by the installation of one of the large horizontal pendulums made by J. & A. Bosch, of Strassburg, and designed after the models described by Omori.[1]

[1] Publications of the Earthquake Investigation Committee in Foreign Languages. No. 5. Tokio, 1902.

The older form of the Weather Bureau seismograph was described by the writer in the MONTHLY WEATHER REVIEW for July, 1895, Vol. XXIII, p. 250.

The new instrument is of a very superior type and gives an accurate record of the movement of the earth at the pendulum in the horizontal plane. At the present time but one of the two pendulums constituting the set has been installed and this produces a record of the north and south component of horizontal motion.

The mechanical principles involved in the construction of a seismograph of this type were first developed and applied to the measurement of earthquakes in the latter part of 1880 by James A. Ewing, then Professor of Mechanical Engineering at the University of Tokio, but now Professor of Mechanism and Applied Mechanics at the University of Cambridge, England. Numerous modifications have since been incorporated in the instrument by Gray, Omori, and others, and in its present form it is well adapted to measure and record all kinds of earthquakes, except, perhaps, the most destructive, and is especially suited to register the feeble, unfelt earthquakes, which frequently occur in all parts of the world.

The instrument as set up to photograph is shown in fig. 1. As actually installed in a small basement room of the Weather Bureau, the separate castings are secured to thick blocks of stone cemented firmly into the concrete floor of the building and projecting but a few inches above the floor level. The heavy casting *A* forms the support for the so-called horizontal pendulum *B C D*. *C* is a massive lead weight, rigidly attached to the conical tubular rod *B*, the end of which, at *B*, terminates in a hardened steel plug, hollowed out cup-wise and highly polished. At this point the pendulum is supported upon a sharp, conical pointed stud of hardened steel fixed to the casting *A*. The remaining support for the pendulum consists of a pair of steel wires, faintly seen at *w w* in the picture. At the weight end these are attached to eyes with a knife-formed inside edge and there engage two studs that project laterally from the mass *C*. At *D* the wires are united to a stirrup, which at the point opposite the wires is provided with a bit of hardened steel formed with a cup-shaped recess and highly polished. Here the stirrup is supported on a sharp, hardened steel cone attached to the carrier *E* forming the summit of the casting *A*. The carrier *E* is provided with several adjusting screws; thus, *a* serves to raise or lower the weight *C* and thus adjust it to a horizontal position, while *b* causes the point at *D* to move away from or nearer to the top of the column, and, finally, a pair of screws, one of which is seen at *c*, gives *D* a lateral motion in the horizontal plane. In short, the pendulum *B C D* is supported at *B* and *D* on sharp steel points and swings, therefore, with great freedom of motion. If the points *B* and *D* are rigorously in a vertical line, the pendulum is in neutral equilibrium and the mass *C* will then remain at rest in any position. For practical work, however, a small degree of stability must be imparted to the mass *C*, otherwise minute changes of temperature and other influences which it is impossible to control will cause the mass *C* to wander about from one position of rest to another. The desired degree of stability is given to the pendulum by means of the screw *b* and the azimuth of the point of rest is adjusted by the screws *c*. The degree of stability is determined by noting the time of vibration of the mass *C*, which can be adjusted to swing as slowly as one complete vibration in thirty or forty seconds. A period of twenty-five to thirty seconds seems to contribute a sufficient stability for practical work.

The whole object sought in this construction is to secure a "steady mass," as it is called; that is, a mass that shall remain quite at rest during an earthquake, notwithstanding that the earth and the supports for the mass are undergoing appreciable vibratory displacements. The kinetic property of bodies utilized in this connection is that which gives rise to the so-