HOW WE GET STANDARD TIME.

BY HARLAN T. STETSON.

Although it may be generally known that the determination of time is the work of the astronomer, yet doubtless few people stop to investigate the precise methods employed in the correction and distribution of standard time. It is a system in itself quite indispensable to the success of the industrial world.

The great universal timekeeper is the earth itself. So uniform is the earth's rotation on its axis, that the length of the day according to Newcomb has not altered the 1/100th, and probably not the 1/1000th part of a second since the beginning of the Christian era. The direct effect of this rotation is the apparent revolution of the celestial sphere, or the daily motion of the sun, stars, and planets across the sky. As places on the earth are determined by latitude and longitude, so stars are located by right ascension and declination. Every conspicuous star has its position carefully determined, and from a star catalogue the astronomer knows at once the instant of culmination or meridian passage of any given star. If then with a suitable instrument an observation of a star's transit across the meridian can be obtained, and the time of its occurrence be noted by a clock or chronometer, a comparison with the catalogue will disclose the amount by which the clock or chronometer is fast or slow. Such an operation of finding the clock error is always what astronomers understand by the expression "obtaining time." The instrument used for making these observations is known as the transit instrument, and consists essentially of a telescope so mounted as to be capable of swinging about a horizontal axis in the plane of the meridian. The accompanying illustration shows such an instrument ready for the observation. In the eye-piece of the telescope is placed the reticle, comprising a number of spider webs, of which the attached diagram shows five to be stretched vertically and two horizontally across the field of view. The instrument is so adjusted that the middle one of the vertical threads coincides as nearly as possible with the imaginary circle in the sky called the meridian.

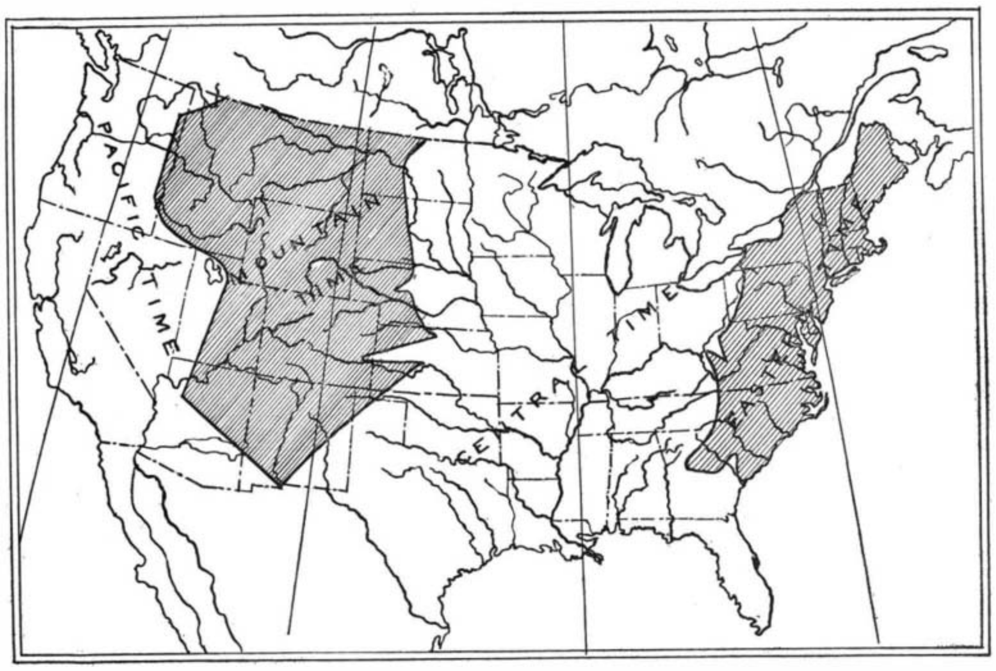
When observations are to be made for determining time, the astronomer first turns to the Ephemeris or some catalogue of stars, and selects a star which is soon to culminate, then from the declination he mentally calculates the altitude at which the star will transit. By means of a reading circle attached to the instrument he sets the telescope at the proper angle, so that the star will pass through the field of view. Either of two methods may now be employed in making the observations. The first and older of the two is known as the "eye and ear" method. This consists of watching the star pass through the field, and while listening to the half-second beats of the chronometer, estimating to the nearest tenth of a second the time at which the star crossed each thread of the reticle. In the "chronographic method," now much used, the mind has less to do, and hence more accurate results can be obtained. Here as before the astronomer watches the passage of the star across the threads of the reticle, but instead of estimating the time of transit, he presses a telegraphic key at the proper instant. The key is in electrical connection with an instrument called a chronograph, and an automatic record is made of each observation. Either method will leave a record for the five threads similar to the following, the Roman numerals designating the number of each thread in order of observation:

I.			16.7
II.			25.5
III.			34.3
IV.			43.0
V.	7h.	9m.	51.7s.
Mean	7h.	9m.	34.24s.

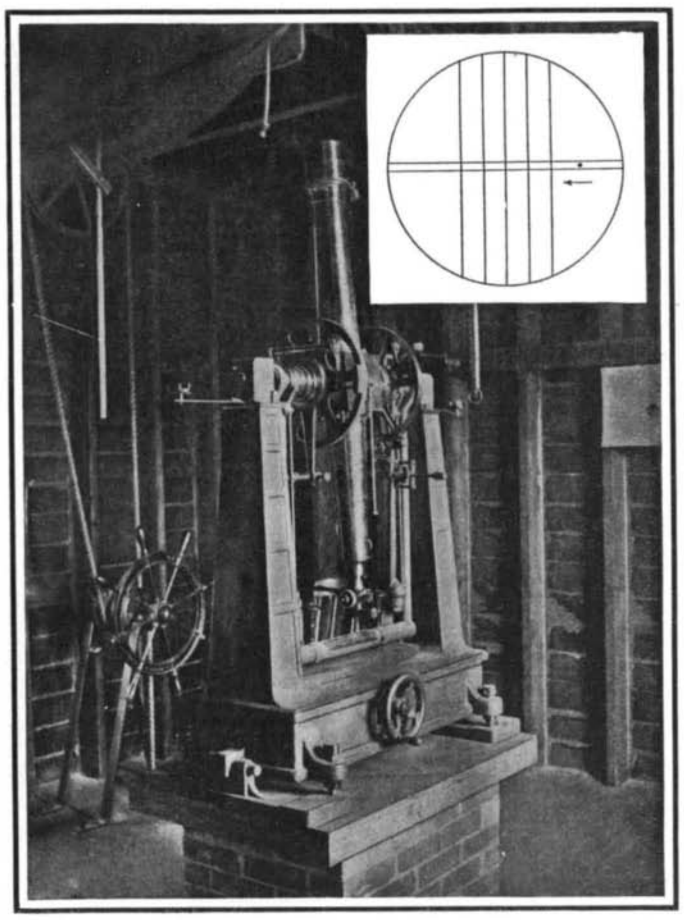
The above is the actual result of a set of observations made by the writer, using the eye and ear method. The figures in the "seconds" column were written immediately after the transit of each thread; the hour and minute were filled in at leisure after the last observation.

The mean of these observations will give a more precise result for the transit over the middle thread than a single observation could afford. The exact right ascension of the star we will suppose to have been known as 6h. 58m. 35.95s., which equaled the correct time of the star's transit. The chronometer, however, recorded the time of transit as 7h. 9m. 34.24s., and was therefore fast by the amount of 10m. 58.29s.

Were the instrument in perfect adjustment, and were there no personal element to enter into the result, such a set of observations would be quite sufficient. As a matter of fact, however, there are always small errors in the instrument, which must be determined and applied as a correction to the final result. The astronomer therefore does not rely wholly upon a single record like the above, but will usually repeat the observation with a number of different stars on the same night. From these numerous records he is able to deduce the necessary corrections, and thus obtain a more accurate value for the chronometer error. Time thus determined, ordinarily correct to within one-tenth of a second, is *sidereal* time; and though very useful to the astronomer, is quite unsuited to the use of the world in general, whose activities are governed by the rising and setting of the sun, and not the stars. Sidereal time must therefore be converted into *solar* time. This is easily effected by a simple calculation constantly employed by the astronomer. Having then obtained solar time, there remains only to distribute it to the outside world.



STANDARD TIME BELTS OF THE UNITED STATES.



AN OBSERVATORY TRANSIT INSTRUMENT FOR DETERMINATION OF STANDARD TIME. DIAGRAM SHOWS RETICLE OF TRANSIT.

Until within the last twenty-five years each community used its own local time, but as travel became more extensive it was found quite inconvenient to alter one's watch and system of time reckoning for every few miles of traveling east or west. Accordingly, in the year 1883 the United States adopted the present system of standard time. The whole country from the Atlantic to the Pacific was divided into time belts of approximately fifteen degrees in width. The "Eastern" belt, extending as far west as Buffalo, uses the time of the 75th meridian, which is very nearly that of Philadelphia, and is five hours slower than Greenwich time. Crossing into the "Central" belt, watches are set one hour earlier, as the time employed is that of the 90th meridian, six hours behind Greenwich time. Similarly, "Mountain" time uses the 105th meridian, seven hours behind; and the "Pacific" belt adopts the 120th meridian time, just eight hours slower than that of Greenwich. Such a system is quite indispensable to railroad lines, and hence standard time is sometimes called "railroad time." At present almost every civilized country is using some system of standard time, usually under the control of its own government.

The chief source for standard time in the United States is the Naval Observatory at Washington, D. C. Here high-grade clocks are carefully regulated by observations of the stars at night, and all necessary corrections applied. For the five minutes preceding noon of each day, eastern time, the Western Union and Postal Telegraphic companies suspend all ordinary business, and throw their lines into connection with the Washington Observatory. It is so arranged that the sounders all over the lines make a stroke each second during the five minutes until noon, except the twenty-ninth of each minute, the last five seconds of each of the first four minutes, and the last ten seconds of the fifth minute; then follows the final stroke at exact noon. This affords many opportunities for the correction and setting of timepieces throughout the country. The Western Union Company also operates a system of some 30,000 clocks, which automatically set themselves by the noon signal each day.

In addition to the Washington signals, many smaller observatories determine and distribute time in a similar way to jewelers and local railroad lines. In most of the larger seaports, time balls are dropped at noon, and give mariners an opportunity to correct their chronometers. Fire-alarm companies aid in the distribution of time in many localities by sounding bells at certain specified times each day, thus affording the public a convenient source of "correct time" with a reasonable degree of accuracy.

The Destruction of Rats with Carbon Disulphide.

M. de Kruyff, of the agricultural bureau of the Dutch Indies at Buitenzorg, Java, has published an interesting article on the destruction of rats. The various contagious diseases which have been recommended for this purpose have been found useless in the tropics and have not always proved effective, even in the temperate zone. Hence De Kruyff's experiments will be of general interest. After working four years with numerous viruses without succeeding in creating an epidemic or even killing a single rat, De Kruyff obtained more encouraging results by employing carbon disulphide in the following manner: All visible ratholes were first stopped with earth for the purpose of ascertaining which holes were inhabited, for the inhabited holes were found reopened on the following day. Half a teaspoonful, or less, of carbon disulphide was poured into each of these holes and, after waiting a few seconds to allow the liquid to evaporate, the mixture of vapor and air was ignited. The result was a small explosion which filled the hole with poisonous gases and killed all the rats almost instantly. A pound of disulphide, costing about 10 cents, is sufficient for more than 200 ratholes; 131 dead rats were found in 43 holes which were opened after the operation. In two cases, 10 rats were found in a single hole.

The process is, therefore, very cheap and its results are immediate and absolutely certain.

It is calculated, states a contemporary, that the United States is producing the following per week for fifty-two weeks in the year for every man, woman, and child of the population of ninety millions: Three-quarters of a pound of wire, more than three-quarters of a pound of rails, half a pound of structural shapes, three-quarters of a pound of plates, one-third of a pound of sheets, three-quarters of a square foot of tin-plate, two and a half pounds of bars, hoops, etc., four pounds of iron castings. These and other finished iron and steel products make a total of twelve to thirteen pounds each week per head.