

Accurate Time

*by astronomy
by wireless
by Illinois
Springfield
Watchers*



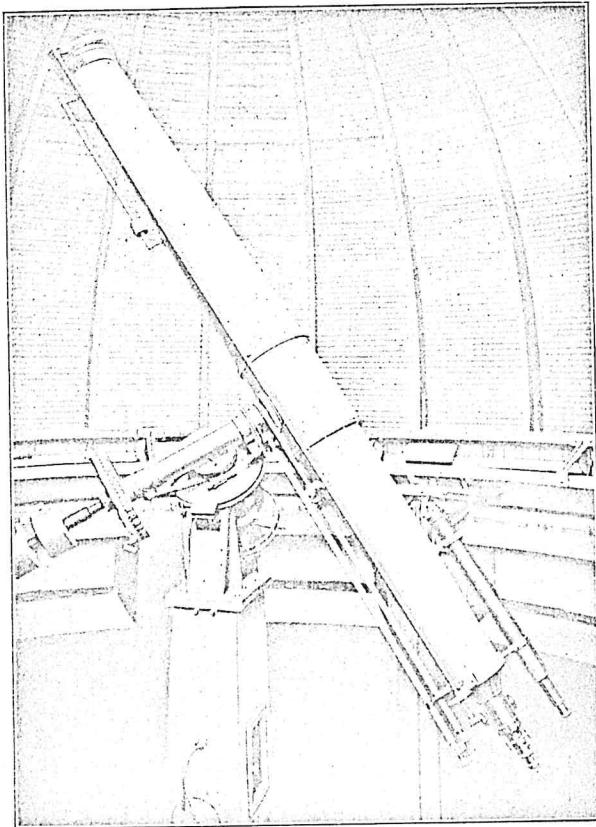
As you enter the grounds of the Illinois Watch Company, Springfield

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"THE old proverb has it that 'Science is measurement,' and of none of the sciences is this so true as that of astronomy. Indeed, the measurement of time by observation of the heavenly bodies was the beginning of astronomy," writes Prof. Maunder of the Royal Observatory at Greenwich.

The three most natural divisions of time are the year, which is the time the earth takes to revolve about the sun; the month, which is based upon the time the moon takes to revolve about the earth; and the day, which is the time it takes the earth to rotate on its axis. From this we see that all our measures of time depend upon astronomy and that the finding and keeping of accurate time as it is done at the Illinois Watch Company's astronomical observatory is one of its most valuable uses.

The ancients found the length of the year by a very simple instrument. This was the obelisk, a pillar with a pointed top set up on a level pavement. Such obelisks were common in Egypt, one of which is now in Central Park, New York City. As the sun moved in the sky, the shadow of the pillar moved on the pavement, and midday, or noon, was marked when the shadow was shortest. The length of the shadow at noon varied from day to day; it was shortest at midsummer, and longest at midwinter.



EQUATORIAL TELESCOPE
Illinois Watch Company's Astronomical Observatory
Springfield, Illinois

This magnificent instrument was designed by the watch factory experts, and all its parts, with the exception of the lenses, were made in the workshops of the company.

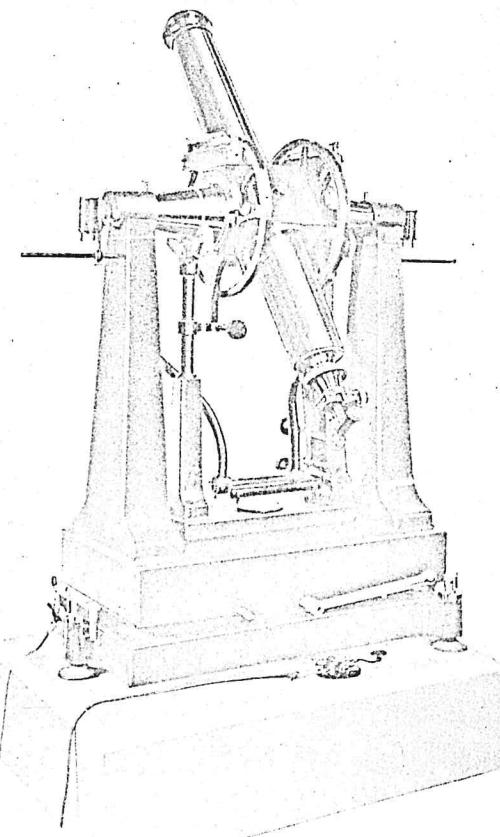
It is conceded a marvel of accuracy and is considered the finest telescope of its size in the country. It has an eight and one-half inch lens with a focal length of twelve feet.

As illustrated above, this telescope is located in the revolving dome of the observatory where, on clear nights, the astronomer in charge cordially welcomes all who wish to see the wonders of the heavens.

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Twice in the year the shadow of the pillar pointed due west at sunrise, and due east at sunset—that is to say, the shadow at the beginning of the day was in the same straight line as at its end. These two days marked the two equinoxes of Spring and Autumn. By counting the days between the shortest shadows—from summer solstice to summer solstice—the ancients found the length of the year. This we find to be 365 days, 5 hours, 48 minutes and 48 seconds. These odd hours and minutes gave the ancients a great deal of trouble and many devices were used by them to make the different seasons come at the same time year after year. This is evident from the fact that Julius Caesar found the Roman calendar very much in error. Their winter months came in Autumn and the first of September came at the summer solstice. With the aid of an Egyptian astronomer he made the ordinary year contain





THE TRANSIT INSTRUMENT

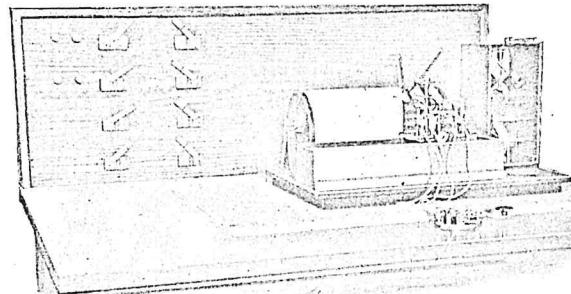
This telescope is set to swing on the meridian of Springfield which is $89^{\circ} 20'$ west, and points exactly north and south. Observations at the Illinois Watch Company's observatory can be taken from the north, the south and directly overhead as there are specially constructed openings for this purpose in the north and south walls as well as a removable shutter across the roof of the transit room. In the eye-piece of the transit instrument is a series of parallel vertical spider lines as well as several horizontal lines. The observer turns the telescope to the point where the particular star should cross at the appointed time and notes the time of passage over each of the vertical spider lines. The average of all these times will be the clock time of passage or sidereal time from which the mean solar time is calculated.

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365 days, but he added one more day to every fourth year, and also made the year begin January 1st. If the year were exactly 365 days and 6 hours long, this arrangement would have been perfect. But because the odd hours and minutes are a little less than one-fourth of a day, the Julian years are a little too long, and the calendar fell back about three days every four hundred years. By the time of Gregory XIII in 1582 it had fallen back 10 days. In 1752, in England, the calendar was 11 days behind but by an act of Parliament the day after September 2nd that year was called September 14th. So great was the opposition to this change among the lower classes, who thought they had been robbed of 11 days, that they ran after the members of Parliament who had secured the passage of the law, and pelted them with stones and mud.

The year measured by the sun is called the tropical year to distinguish it from the sidereal year, which is the time occupied by the sun in passing from a certain star around to that star again. The sidereal year is about 20 minutes longer than the tropical year, or the period of the earth's revolution around the sun.

The month is a very ancient division of time. At first it lasted from one new moon to another, a period of $29\frac{1}{2}$ days, a number inconvenient in itself and not an exact divisor of the year. Finally, at the beginning of the Christian Era, the year was divided into twelve months of varying length, by Augustus, Emperor of Rome.



THE CHRONOGRAPH
Illinois Watch Company's Astronomical Observatory

By means of this instrument, which is connected electrically with the Sidereal and Mean Time Clocks, it is possible to note the slightest variation in either of these master clocks. The record of each is drawn upon a paper record sheet—placed upon a large cylinder—by a fountain pen as the cylinder revolves. As each space represents a sixtieth part of a minute it can readily be seen how a second of time can be divided many times.

The week is not a natural astronomical division of time, although a very ancient one. The names of the seven days were derived as follows: Sunday is the sun's day; Monday, the moon's day; Tuesday, Wednesday, Thursday, Friday and Saturday are derived from the names of five old-English deities.

The day is a true astronomical division of time and is reckoned in several ways. The sidereal day starts from the time a certain fixed star crosses a given meridian until it crosses it again. This is the exact time in which the earth turns on its axis and this time is practically invariable.

In addition to the Sidereal Day there are the Apparent Solar Day and the Mean Solar Day. The Apparent Solar Day is the time it takes the

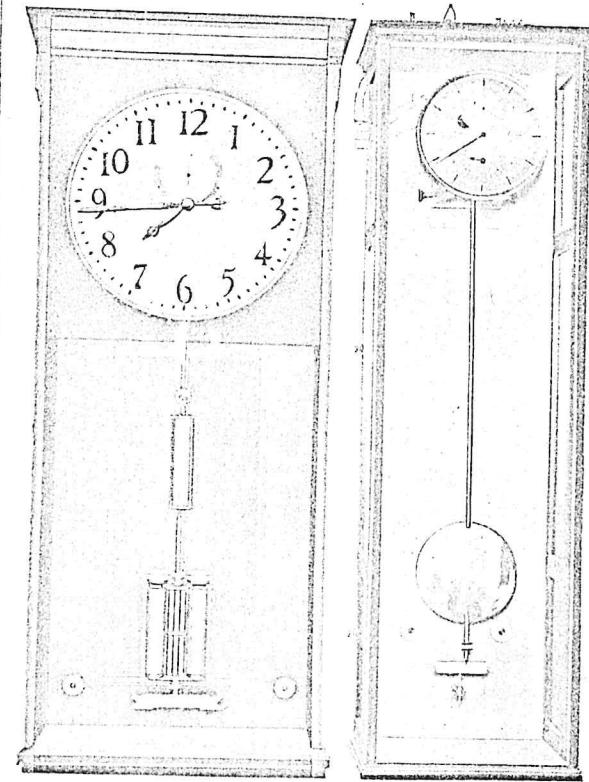
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sun to pass from the meridian of a place around to that meridian again. This time varies during the changing seasons. One cause is due to the fact that the path traveled by the earth is not a circle but an ellipse, as can be seen from any almanac. The most potent cause is the inclination of the earth's axis to the plane of the ecliptic. As the axis points to an approximately fixed point of the celestial sphere, the axis, in the course of the year, is constantly varying in the direction of its inclination in reference to the sun. In the winter the North Pole inclines away from the sun and in summer toward it. This results in a changing path of the sun in the heavens—its extreme altitude in summer being $23\frac{1}{2}^{\circ}$ north of the equator and in the winter an equal distance south.

The Mean Solar Day is the average length of all the Apparent Solar Days of the year. The method of determining this average is simple and interesting. An imaginary sun is supposed to travel at a uniform rate of speed on the equator. The length of the day so measured would be the average length of all the Apparent Solar Days. The difference in time between Apparent and Mean noon is shown approximately in the following table taken from the Nautical Almanac:

February 10th	sun time	is 15 minutes slow
May 14th	" " " 4 "	fast
July 25th	" " " 6 "	slow
November 2nd	" " " 16 "	fast

Remarkable as these variations appear it must be borne in mind that the figures do not



MEAN TIME AND SIDEREAL CLOCKS
Illinois Watch Company's Astronomical Observatory
Springfield, Illinois

The sidereal clock—the one shown to the right—is electrically wound every thirty seconds, thus maintaining absolute and unvarying uniformity in timekeeping quality.

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give the difference in the length of the actual day from noon to noon during the year. These extremes are reached by a gradual shifting of the relative positions of the Real and Imaginary sun during the time mentioned and give an excellent idea why the ancients had so much trouble in calculating their time.

Sidereal time is taken at all observatories by observing the transit of fixed stars over the meridian on which they are located. These observations are made with the transit instrument and the time so found is recorded and kept by a specially constructed Sidereal Clock. This time is practically invariable and is used as the standard to detect errors in the Mean Time Clock.

Both of these clocks at the Illinois Watch Company's observatory are kept in a vault built in the pier which supports the large equatorial telescope. This vault is free from vibration and is so constructed that its temperature does not vary more than a minute fraction of a degree.

A further check upon the accuracy of the Illinois Watch Company's master clocks is the daily wireless signals which it receives from the United States Government's Wireless Station at Arlington, Virginia. That station transmits the accurate *standard* time as it is determined at the National Observatory. It is needless to say, after the difference in longitude is taken into account, the time ascertained at both observatories is exactly the same. Since 1883 there



have been four time centers in the United States. These were established by agreement of the railroad managers as follows: The first on the 75th degree of longitude west of Greenwich, the second on the 90th, the third on the 105th and the fourth on the 120th degree. The time in each locality is therefore taken from that of

the nearest or most convenient of these meridians and accounts for the setting back of one's watch as we travel westward, or, forward as we travel eastward.

From the foregoing it is clear what an important part astronomy plays in the obtaining and keeping of correct time as well as in the

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making of accurate timekeepers at the Illinois Watch Company's factory at Springfield.

For over forty years Illinois - Springfield watches have been famous for their durability and marvelous accuracy. They have not been extensively advertised because the demand for them among the users of high grade watches — especially railroad men, has been so great that the company's daily capacity of over five hundred movements never permitted of a surplus stock being accumulated. The quality of these movements is their best advertising.

ILLINOIS-SPRINGFIELD WATCHES

FOR RAILROAD AND GENERAL SERVICE

Space will not permit of illustrating all of them, but a few of the most popular of these movements are shown on the following pages.

The prices quoted are for the movements only, unless otherwise noted.