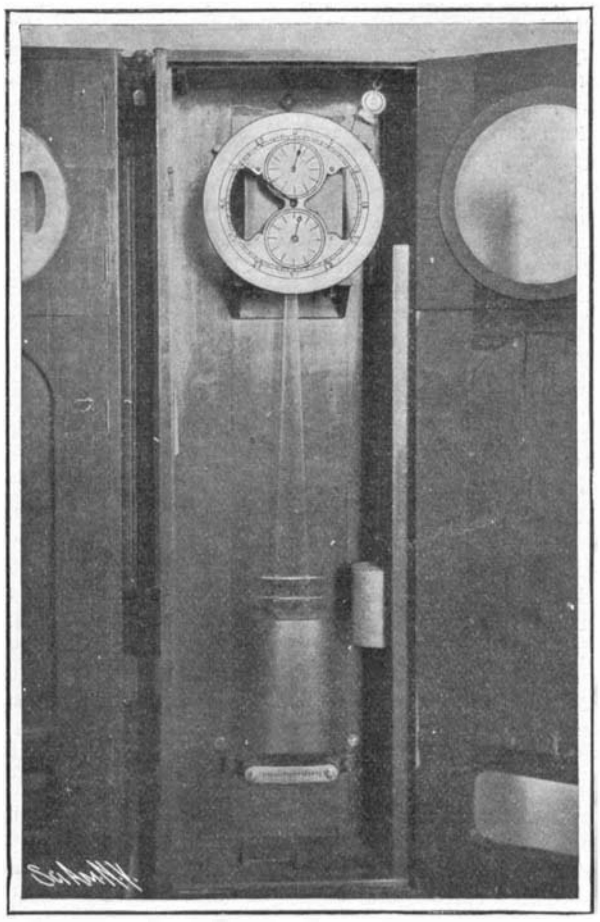
"THE TIME OF DAY."

BY DAY ALLEN WILLEY.

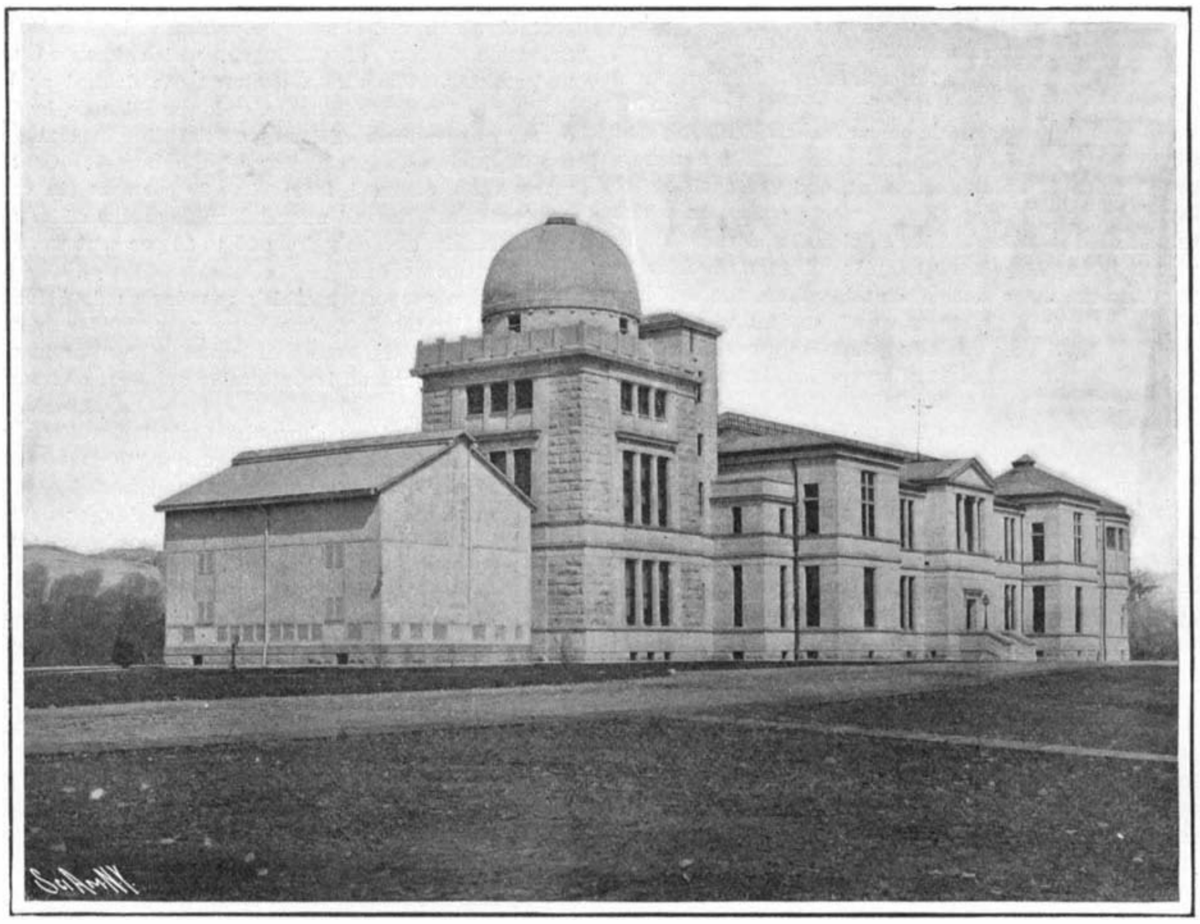
If asked what is the real meaning of the expression "time of day," a person may reply that it is determined by the position of the sun in the heavens. For example, we speak of "noon" as the time when the sun is at the meridian point. The fact is, however, that no longer is the time standard in this country calculated by the sun, but by the stars, and the time signals sent daily throughout the United States from Washington come from star observation.

Americans get their correct time from a little room in the Naval Observatory, located on Georgetown Heights, in the suburbs of Washington. The observatory was originally intended to detect errors in ship chronometers and to regulate them properly. This work constitutes one department at the institution, but perhaps its most important function is that of being hour, minute, and second as determined by the stars are shorter than those of the sun as recorded by the clocks; and consequently the time of the "star clock"—which is corrected directly from the stars by means of the transit—must be translated into solar time, before it is available in the readjustment of ordinary timepieces.

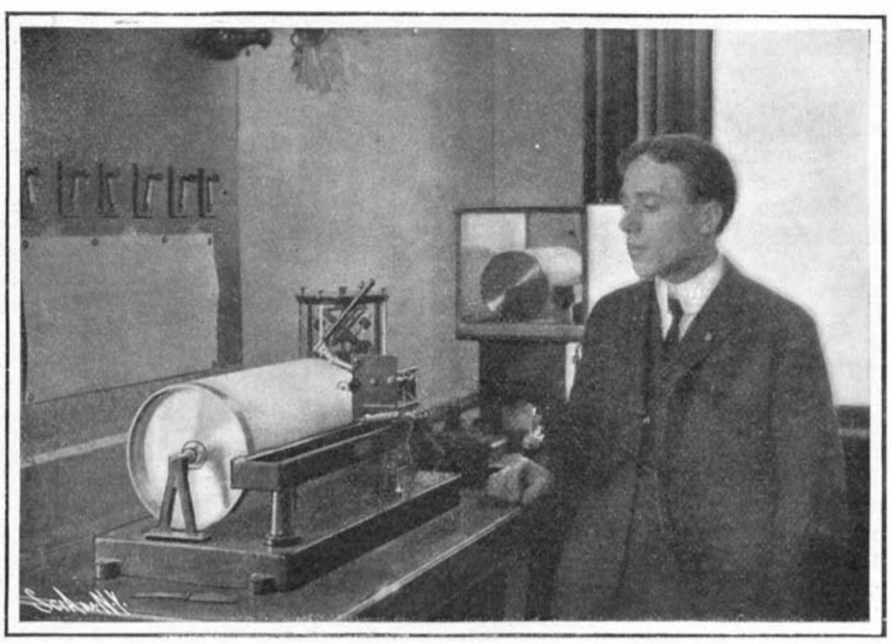
In his observation of the star utilized for a time basis, the astronomer has the aid of the nautical almanac. By consulting the almanac an observer learns just when the star under observation should cross the meridian. Taking his place under the transit, he awaits the scheduled passage of the star. Precisely as the latter crosses the imaginary line, the observer presses a telegraph key, and the exact time of passage is accurately registered by the chronograph. This instrument, which has been described in the Scientific American, furnishes a record of any error in the device is made to revolve at a fixed speed. Behind the dial in each signal clock marking the seconds is a cogged wheel, each cog of which in turn touches a brass spring, thereby closing the circuit of a battery, and by a mechanical arrangement causing the pen above mentioned to make a horizontal mark on the paper enveloping the cylinder. This affords a permanent record of each second. The star clock is also in circuit with the recording pen. A cup of mercury resting in the clock is connected with one pole of the battery. The pendulum is connected with the other. As the latter swings, it touches the mercury in the cup, closing the circuit and sending an electric impulse which causes the pen to do its work. It is comparatively easy to set one of the ordinary clocks within a second of the star clock; but an adjustment of a fraction of a second requires measurements of great nicety. Corrections are made a comparatively short



Master Clock from Which Noon Signal is Sent Throughout the United States.



The Naval Observatory, Where the Nation's Time is Kept.



Chronograph for Noting Any Inaccuracies of Clocks on the Circuit.

Sending the Correct Time to All Clocks and Time Balls at the Hour of Noon.

"THE TIME OF DAY."

the nation's timekeeper as well. Consequently some of the most important instruments installed in the group of buildings comprising the observatory are intended exclusively for this purpose.

Among these are the 9-inch and 6-inch transit instruments by which the position of a star is obtained. The actual elapsed time required for one revolution of the earth on its axis can be accurately determined only by measuring the interval between two passages of a given star across a designated meridian of the earth—intervals which do not vary from century to century. This, then, becomes the basis of time determination. It is, however, a foundation not secured without considerable effort, for the number of revolutions which the earth actually makes on its axis is one greater than the number of so-called solar days in the year, as prescribed by the calendar in common use. Accordingly, the day, time of the star clock by which the latter can be regulated to the minute fraction of a second, for the accuracy of the clock can be calculated by the space between what may be called the observer's second as recorded on the chronograph and the clock second nearest it. By measuring the space with microscopical gages, the correct time can be determined to the minute fraction of a second, and the standard clock set accordingly.

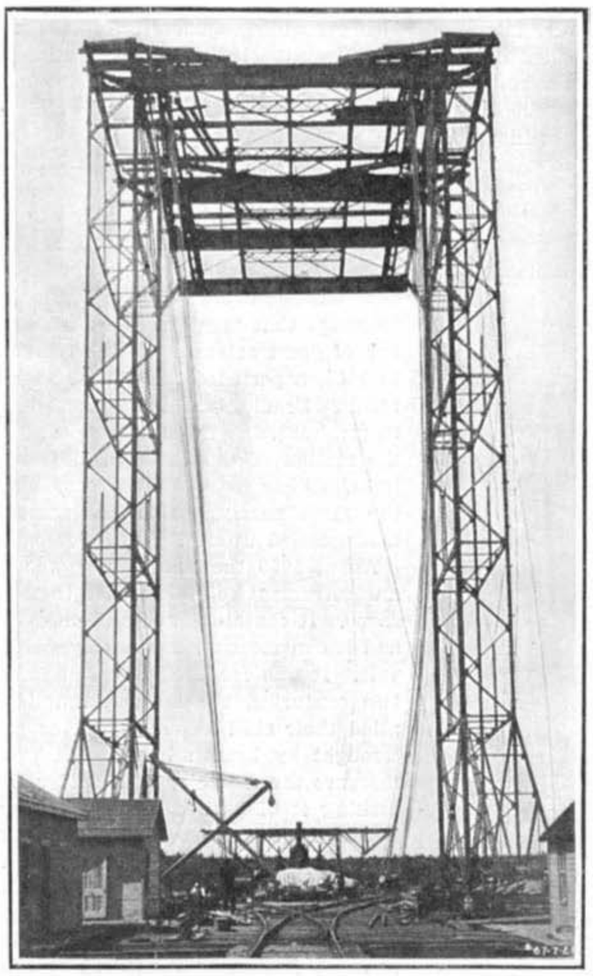
With the star clock adjusted, the next proceeding is to set the signal clock in unison with it. From the signal clock, which is placed in the same room, comes the time announcement, which is sent over the country. There are two signal clocks, one being held in reserve in case of accident. Both are on a circuit with the star clock. When they are to be adjusted by the latter, the paper-covered cylinder of the recording time before noon, so that there will be little opportunity for the clocks to gain or lose before the time at which the all-important signal is transmitted.

At three and a quarter minutes before noon, the signal clock is connected with the telegraph circuit, which covers the entire country; and from that moment until the sending of the signal, all business is suspended throughout the telegraph systems over which it is to be flashed. Warnings of the approach of the time signal precede by short intervals the actual announcement of the noon hour. These warnings are in part sent automatically. The signal clock is fitted with a toothed wheel, which is located directly behind the wheel that marks the seconds, and which is divided into sixty spaces corresponding to the seconds in a minute. At the twenty-ninth second, however, the tooth is missing; also those representing the fifty-fifth to the fifty-ninth second respectively. As the wheel revolves, the teeth come in contact with a spring, which is in connection with the electric current, closing the circuit and causing the sounder to respond. The absence of the twenty-ninth tooth causes the twenty-ninth signal to be omitted, and indicates the approach of a half minute; that of the last five announces the approaching conclusion of the minute. All this takes place in the next to the last minute of the final hour. There is a third warning interval of twenty seconds before the supreme signal; but this is produced not automatically but by the telegraph operator at the observatory, and occurs when he moves the switch key, which throws out of the circuit the wheel marking the seconds, and throws into the circuit the wheel marking the minutes.

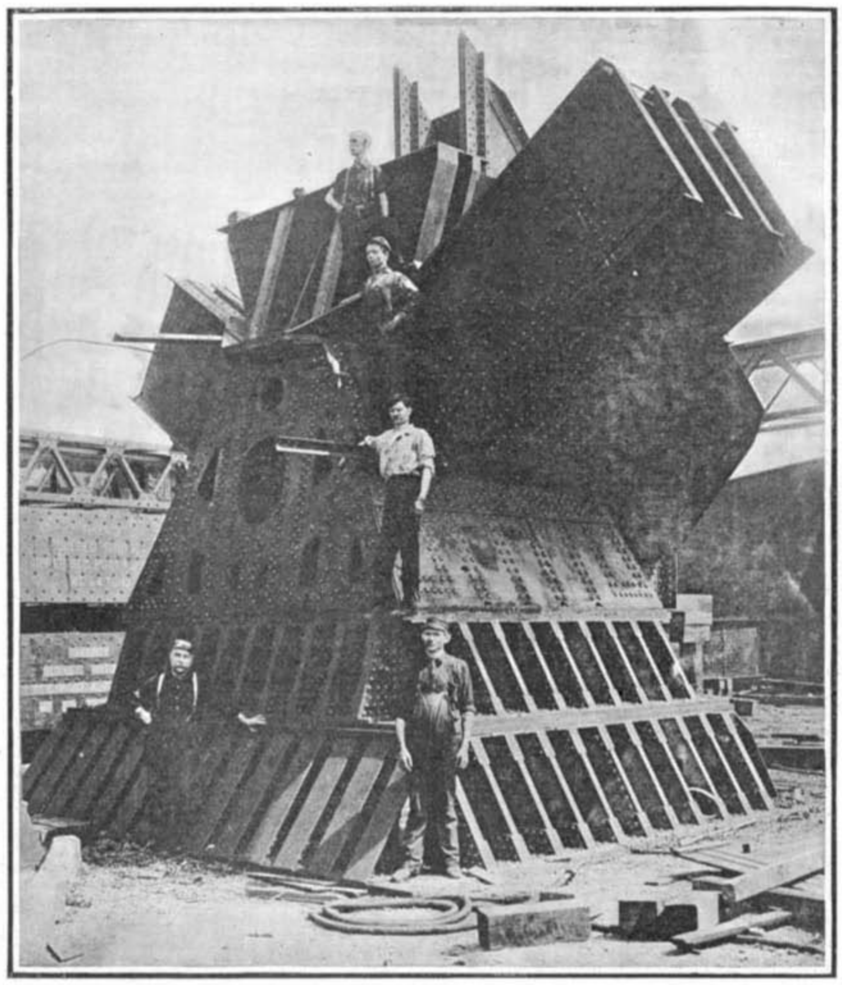
In the final hundredth of the last second of the last hour at Washington, the tooth of the minute wheel touches the spring which closes the circuit. Simultaneously, the announcement is flashed to every part of the country, the flow of the current serving of itself to release the time-balls which have been hoisted to the tops of the staffs in various cities. How rapidly the signal travels may be appreciated from the fact that it is flashed from Washington to San Francisco in one-fifth of a second. Since the time signal is sent out from Washington at noon, or at 12 o'clock standard Eastern time, and there are four different standard times in the United States, determined by geographical locations, the signal from Washington will reach the Central, Mountain, and Pacific time belts at 11 o'clock, 10 o'clock, and 9 o'clock A. M. respectively. On the last night of the year, the time signal—which in this instance marks the advent of the New Year—is sent entirely around the world, traveling over 1,180,000 miles of wire and cables, and making the circuit of the globe in ten seconds.

At present about 75,000 clocks are on the wires connected with the signal clock, but as in some instances one of these is utilized to regulate hundreds of other timepieces, the time standard as computed at the observatory is now depended upon in the principal communities throughout the country.

In addition to the instruments referred to, the Naval Observatory is also notable for the reason that it contains what is considered to be the finest telescope in the United States—with the exception of the Lick, in California, and that in the University of Chicago. It has a 26-inch glass and cost $46,000.



End View of Main Traveler for Erecting the Bridge.
Width, 100 feet. Height, 215 feet. Over-reach, 66 feet.



One of the Four Pedestals and Main Shoes Which Carry the Whole Weight of the Bridge. Weight 278 Tons.

THE ST. LAWRENCE RIVER BRIDGE, QUEBEC.

The noble bridge now under construction at Quebec across the St. Lawrence River will be one of the most notable bridges in the world. In one respect indeed it will rank as the greatest structure of its kind ever constructed; for its main span across the river will have a total length in the clear, between towers, of 1,800 feet, which is exactly 90 feet more than the length in the clear of each of the two cantilever spans of the bridge across the Forth, near Edinburgh, Scotland.

The bridge is being built by the Phœnix Bridge Company for the Quebec Bridge and Railway Company. It will cross the St. Lawrence River at a point about six miles above the city of Quebec, and about 165 miles below the city of Montreal. In the intervening stretch of the St. Lawrence there is no other crossing, and the great width of the river below Quebec renders the bridging of it below that city out of the question. Hence the new thoroughfare will prove of the greatest benefit to the districts lying between Montreal and the sea. Apart from its convenience for foot passenger and vehicular traffic, which must necessarily be local, it will form an invaluable link between the important railway systems on each side of the river. On the north side are the Great Northern Railway of Canada, the Quebec & Lake St. John Railroad, and the Canadian Pacific; on the south side are the Grand Trunk Railroad, the Intercolonial Railroad, and the Quebec Railway; and immediately upon the completion of the bridge a transfer of business between these systems will become possible.

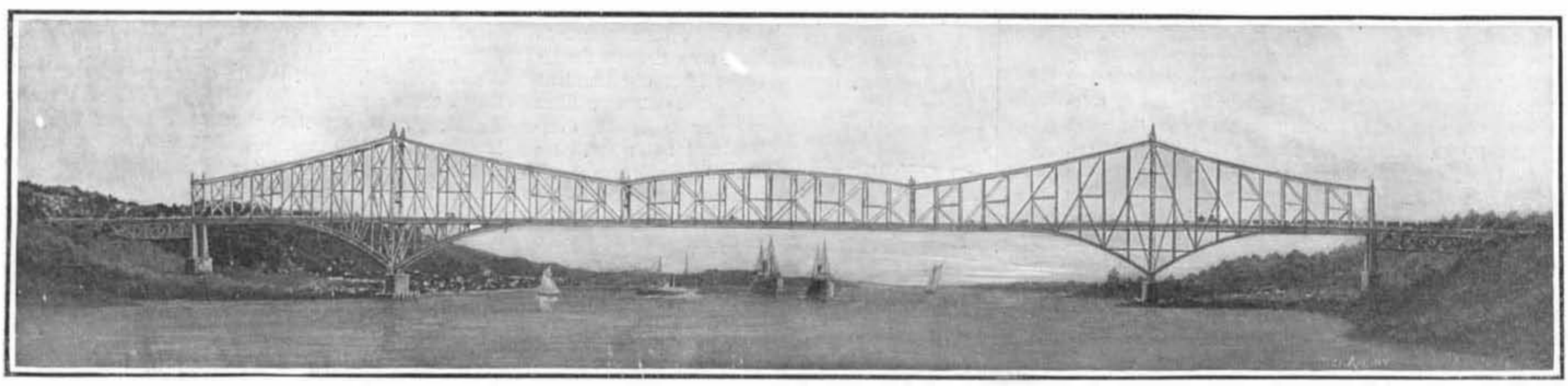
The depth of the river, and the necessity for keeping this great waterway free from obstructions, prevent the use of piers, and call for bridging the channel with a single span. A comparative study of the problem showed that even for a span of this magnitude, a cantilever would be more economical than a suspension bridge, and the plans herewith shown were adopted.

The structure consists essentially of two giant cantilevers, carrying a huge central suspended span. It is approached by two short deck spans. The latter, which are each 214 feet in length, extend from the shore to the two massive anchor piers, to which the anchor arms of the cantilevers are bolted down, and which serve to counterbalance the weight of the central suspended span, and the heavy live load which it will be called upon to carry. The anchor arms are 500 feet long, the river arms 562½ feet long, and the central suspended span is 675 feet long. The height of the cantilevers over the anchor piers is 96 feet 9¾ inches, at the towers 315 feet, and at the portals to the center span, 97 feet 5½ inches.

The bridge has a very large capacity, the floor having a total width, out to out, of 75 feet. It is designed to carry two lines of steam railroad, two trolley lines, two highways, and two sidewalks, the latter being placed outside and the rest of the traffic between the trusses, which are spaced 67 feet between centers. The clear headway above high water is 150 feet.

In a bridge of this magnitude the parts are necessarily of great size, and the huge proportions are well shown in the accompanying illustration of the main shoe and pedestals, which are placed upon the main piers and have to carry the whole load of the bridge. They are of built-up rolled steel girders, not a single casting being used in the completed structure. The weight of each one is 278 tons. As might be expected, the size of the individual members is enormous, the sections of the bottom of the main post being 54 feet in length, 10 feet in width and 4 feet in depth, and the weight of each piece being 70 tons; while the intermediate sections of the main post weigh 24 tons, have a length of 66 feet, and a section measuring 10 feet by 4 feet. The I-bars for the most part are 15 inches and 16 inches in depth, and in a few cases they will be as much as 18 inches in depth. Most of the pins are 12 inches in diameter; but the main lower pins, which will transmit the enormous load from the cantilever to the shoes above mentioned, are 24 inches in diameter. The main chords are 54 inches deep by 68 inches wide, while the main post, over the river pier, is 10 feet wide by 4 feet in depth. The main plate floor beams are 10 feet in depth.

The bridge is being erected by means of the huge main traveler, shown in the accompanying illustration,



River span, 1,800 feet. Two anchor spans, 500 feet each. Two shore spans, 214 feet. Total length, 3,228 feet. Height of towers, 315 feet. Suspended span, 675 feet long by 130 feet deep. Width of bridge, 75 feet.

This Bridge, Now Building at Quebec, Will Have the Longest Single Span in the World.

THE NEW ST. LAWRENCE RIVER BRIDGE.

SCIENTIFIC AMERICAN

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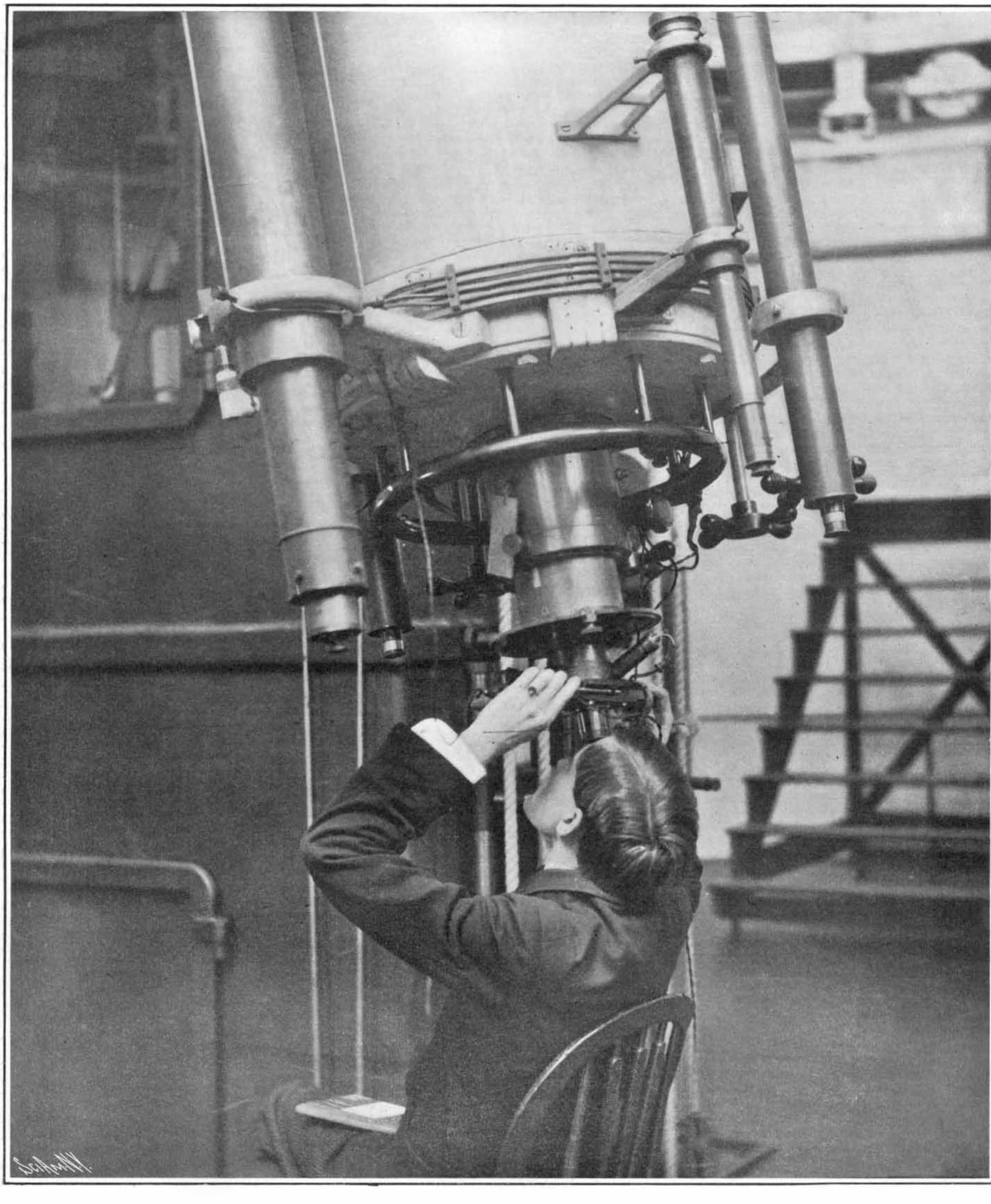

THE TWENTY-SIX-INCH TELESCOPE OF THE UNITED STATES NAVAL OBSERVATORY.—[See page 336.]