

for their morning "tub," and had made use of it accordingly.

A large proportion of the meteorological instruments at Greenwich and other first-class observatories are arranged to be self-recording. It was early felt that it was necessary that the records of the barometer and the thermometer should be as nearly as possible continuous; and at one time, within the memory of the members of the staff still living, it was the duty of the observer to read a certain set of instruments at regular two-hour intervals during the whole of the day and night—a work probably the most monotonous, trying and distasteful of any that the observatory had to show.

The two-hour record was, no doubt, practically equivalent to a continuous one, but it entailed a heavy amount of labor. Automatic registers were therefore introduced whenever they were available. The earliest of these were mechanical and several still make their records in this manner.

On the roof of the octagon room we find besides the two turrets already referred to, a small wooden cabin, built on a platform several feet above the roof level. This cabin and the north-western turret contain the wind registering instruments. Opening the turret door we find ourselves in a tiny room, which is nearly filled by a small table. Upon this table lies a graduated sheet of paper in a metal frame and as we look at it we see that a clock set up close to the table is slowly drawing the paper across it. Three little pencils rest lightly on the face of the paper at different points. One of these, and usually the most restless, is connected with a spindle which comes down into the turret from the roof and which is, in fact, the spindle of the wind vane. The gearing is so contrived that the motion on a pivot of the vane is turned into motion on a straight line at right angles to the direction to which the paper is drawn by the clock. A second pencil is connected with the wind pressure anemometer. The third pencil indicates the amount of rain that has fallen since the last setting, the pencil being moved by a float in the receiver of the rain gauge.

An objection to all the mechanical methods of continuous registration is that, however careful the gearing between the instrument itself and the pencil is contrived, however lightly the pencil moves over the paper, yet some friction enters in and affects the record; this is of no great moment in wind registration, when we are dealing with so powerful an agent as the wind, but it becomes a serious matter when the barometer is considered, since its variations require to be registered with the greatest minuteness. When photography, therefore, was invented, meteorologists were very prompt to take advantage of this new ally. A beam of light passing over the head of the column of mercury in a thermometer or barometer could easily be made to fall upon a drum revolving once in twenty-four hours, and covered with a sheet of photographic paper. In this case, when the sensitive paper is developed, we find its upper half blackened, the lower edge of the blackened part showing an irregular curve as the mercury in the thermometer or barometer rose or fell, and admitted less or more light through the space above it.

Here we have a perfect means of registration; the passage of the light exercises no friction or check on the free motion of the mercury in the tube, or on the turning of the cylinder covered by the sensitive paper, while it is easy to obtain a time scale on the register by cutting off the light for an instant—say at each hour. In this way the wet and dry bulb thermometers in the great shed make their registers.

The supply of material to the meteor-

ological office is not the only use of the Greenwich meteorological observations. Two elements of meteorology, the temperature and the pressure of the atmosphere, have a very direct bearing upon astronomical work. And this in two ways. An instrument is sensible to heat and cold and undergoes changes of form, size or scale, which, however absolutely minute, become with the increased delicacy of modern work, not merely appreciable, but important. So, too, with the density of the atmosphere; the light from a distant star, entering our atmosphere, suffers refraction; and, being thus bent out of its path, the star appears higher in the heavens than it really is. The amount of the bending varies with the density of the layers of air through which the light has to pass. The two great meteorological instruments, the thermometer and the barometer, are therefore astronomical instruments as well.

VICTORY IS GREAT.

With the U. S. Troops Before Santiago de Cuba, July 14, 6 p. m., via Kingston, Jamaica, July 15, 12:15 p. m.—[Copyright, 1898, by the Associated Press.]—The reverse to the Spanish arms in eastern Cuba is complete. Santiago has fallen and with it all the eastern end of the island.

General Toral, the Spanish commander, agreed to the general terms of the surrender at a personal interview with General Shafter this afternoon, at which General Miles was present.

The armies have had a campaign of three weeks of unprecedented hardships for both officers and privates.

The victory of the Americans is greater than expected at first.

The Spanish troops in the Fourth corps, the military division of Santiago province, from a line drawn north from Aseradores, eighteen miles west of Santiago, through Los Palmas, Palmas Sorlan, Alcantaza to Sagua de Tanamo on the north coast and eastward to Cape Maysi, are surrendered, and the territory is abandoned. Between 18,000 and 20,000 Spanish prisoners are taken, about 10,000 of whom are in Santiago. The remainder are at Guantanamo, and others are garrisoned in the towns of eastern Cuba. All these troops are to be embarked and sent back to Spain under parole.

Gen. Shafter bears his honors modestly. To a correspondent of the Associated Press he said: "The enemy has surrendered all the territory and troops east of Santiago. The terms were dictated from Washington. It has been a hard campaign, one of the hardest I ever saw. The difficulties to contend with were very great. Never during our civil war were more difficult problems solved. The character of the country and the roads made it seem almost impossible to advance in the face of the enemy. The transportation problem was hard, but all the difficulties have been successfully surmounted. Our troops have behaved gallantly. They fought like heroes, and I am proud to have command of them. During all the hardships they have suffered they have shown resolution and spirit. They deserve to conquer."

"The resistance of the enemy has been exceedingly stubborn. Gen. Toral has proved himself a foeman worthy of any man's steel. The negotiations which culminated in the surrender of Gen. Toral have been dragging on for ten days with the intermission of Sunday and Monday, when our batteries and fleet bombarded the enemy's position. Throughout these periods of truce Gen. Toral has shrewdly fallen back when hard pressed, upon the statement that

he was simply a subordinate and powerless to agree to the proposals without the sanction of his superiors, except under penalty of being court-martialed. At the same time he seemed to intimate that personally he thought it useless to hold out any longer. But he and his garrison were soldiers, he said, and could die, if necessary, obeying orders."

It was at the personal interview held by Gen. Shafter with Gen. Toral yesterday that the American general made the Spanish commander understand that temporizing must cease and that before noon today a categorical affirmation to his offer must be received, or the bombardment of the city would begin in earnest.

In the meantime all our plans had been perfected. The delay had been utilized to good advantage. Our lines had been extended until Santiago was nearly surrounded and our light batteries had been so posted as to be able to do more effective work.

In addition, arrangements had been made to land troops at Cabanas, west of the entrance of the harbor of Santiago. The Spanish batteries opposite Morro Castle were to be bombarded and stormed, their guns were then to be turned upon the city and Gen. Lawton's division, at the same time, was to fall on the enemy's left flank under the cover of our artillery fire. We could then have enfiladed their lines and have driven them into the city.

Gen. Toral must have realized that he was trapped and that to hold out longer must mean a useless sacrifice of his men, but he made one last effort to gain more time this morning. While nominally yielding to the terms, Gen. Shafter proposed, before 8 o'clock he sent a communication to Gen. Shafter enclosing a copy of a telegram from Captain General Blanco, explaining that the surrender of such an important position as Santiago and the abandonment of eastern Cuba would require the direct sanction of the Madrid government and requiring more time to be heard from Madrid. At the same time Capt. Gen. Blanco authorized Gen. Toral if it was agreeable to the American general to appoint commissioners on each side to arrange the terms of capitulation of the forces under his command, on the condition of their parole and transportation to Spain.

Headquarters Santiago, via Playa, July 15.—Adjutant General, Washington: Sent you several telegrams yesterday as did Gen. Miles in regard to the surrender. Gen. Toral agreed yesterday positively to surrender all the forces under his command in eastern Cuba upon a distinct understanding that they were to be sent to Spain by the United States; this surrender was authorized by Gen. Blanco and that its submission tomorrow was merely formal. The commissioners to arrange details were appointed—Wheeler, Lawton and Miley on the part of the United States. Points were immediately raised by Spanish commissioners. The discussion lasted until 10 o'clock last night. My commissioners think the matter will be settled today and met at 10:30 this morning. There are about 12,000 troops in the city and about as many more in the surrounding districts. 25,000 in all will be transported. Gen. Miles was present and said the surrender was as absolute and complete as possible. It cannot be possible that there will be failure in completing arrangements. Water famine in the city is imminent. Have supply cut; this was told Lieut. Miley by English commissioner. Will wire frequently when negotiations are progressing.

SHAFTER,

Major General, commanding.

If Blanco would only make a sortie in person!