

SCIENCE, *i. e.*, by the mechanical action of frost on sandstones exhibiting a tendency to conchoidal fracture.

These natural bridges occur in the strip of very rough country formed by the outcrop of the Basal Coal Measure Conglomerate, where it is underlaid first by shale and then by lower Carboniferous limestone and shaly sandstone. This strip is a part of a deeply multi-dissected plateau, known farther south as the Cumberland Plateau. The tributary streams, deeply buried below the old plateau level, have along the margins of the strip cut down into the underlying shale, limestone and shaly sandstone. They have extended their ramifications up the steep slopes to the base of the Conglomerate, where they have hollowed out their virtual sources in the shale, undermined the Conglomerate cliffs and thus formed vast amphitheaters, or 'rock-houses.' The extent of these is often seemingly out of all proportion to the size of the stream leading away from them. These streams sometimes find continuation above the cliffs as wet-weather streamlets and during the times of their flow plunge over the escarpments in picturesque waterfalls. More commonly, however, there is no gathering ground above. By the recession of sources the watersheds have been reduced to the narrowest ridges, which are often quite inaccessible. In a number of instances two streams in their recession have met in the shales under the Conglomerate. Two 'rock-houses' have met back to back and formed a 'Natural Bridge.' There are three of these bridges in Kentucky that are beginning to have something more than a local celebrity. One of these is in Pulaski, one in Wolfe and one in Powell county. Views of the Powell county bridge accompany this sketch. Perhaps a tendency to conchoidal fracture in the coarse sandstone has favored the hollowing-out process that has resulted in these natural arches, but in the main they

are due to the mechanical action of water causing a recession of sources in the way above indicated.

ARTHUR M. MILLER.

STATE COLLEGE, LEXINGTON, KY.

THE INTERNATIONAL AËRONAUTICAL CONFERENCE AT STRASSBURG.

THE meeting, ten weeks ago, of the International Aëronautical Committee appointed by the Paris Meteorological Conference of 1896 was noteworthy in two respects. First, it marked the beginning of a new era in meteorological investigation, as shown by an organized effort to cut loose from observatories on the earth and to study the conditions of the free air; and, second, by the assembling at Strassburg of French and Germans, political questions were held to be subservient to the conquest of the high atmosphere and the extension of the common realm of science. Official and private hospitality was abundant and the utmost good fellowship prevailed among the members of the Committee and the other meteorologists, physicists and aëronauts who were present by invitation. It was regretted, although hardly a surprise, that there was no one from Great Britain, where, since Glaisher's remarkable balloon ascension, little has been done to explore the free air. The following named members of the Committee were in attendance: Professor Hergesell, the President, of Strassburg; MM. de Fonvielle, the Secretary, Cailletet and Besançon, of Paris; Drs. Assmann and Berson, of Berlin; Professor Erk, of Munich; General-Major Rykatcheff and Colonel Kowanko, of St. Petersburg; Mr. Rotch, of Boston, United States.

The methods discussed for obtaining observations in the free air were balloons with aëronauts; *ballons-sondes*, or unmanned balloons to carry self-recording instruments to the height of ten miles or more; and,

for observations within a mile or two of the earth, the captive kite-balloon and kites with self-recording instruments. Aside from technical details, the most important decisions concerning balloons related to the measurements of their height and of the air temperature around them. Although, for the determination of height, from observations in the balloon, the mercurial barometer must be considered as the standard, yet its indications are only accurate when the balloon has no vertical velocity. If aneroids are used they should be compared frequently with the standard and, so far as possible, under actual conditions. It was decided that for the calculation of height the barometric observations should be reduced everywhere by the same method, whatever that might be ultimately. M. Cailletet described his apparatus for photographing automatically, at fixed intervals of time, a barometer in the balloon and the ground vertically below, so that the barometric heights can be calculated and from a map the true heights and the route of the balloon may be determined. This apparatus was recommended for use with both manned and unmanned balloons. On account of the rapid changes of temperature, it was recognized that very sensitive thermometers must be employed in *ballons-sondes* and that their artificial ventilation is essential. M. Cailletet exhibited a thermometer having a spiral silver tube for its bulb soldered to a glass tube, both being filled with the liquid toluene. This thermometer is extremely sensitive. M. Teisserenc de Bort showed a very sensitive self-recording thermometer which is at the same time almost insensible to shocks. It is composed of a blade of German silver set in a frame of invariable steel, and can be ventilated in a *ballon-sonde* by a fan turned by a weight attached to a long wire. For the determination of the temperature of the air around manned balloons the

proper instrument to employ is Assmann's aspiration thermometer, hung at least 5 feet outside the basket, but simultaneous comparisons with the sling thermometer were advised. The self-recording instruments carried in manned and unmanned balloons should be verified in pneumatic and refrigerating cabinets under such changes of pressure and temperature as might occur in the atmosphere.

Drs. Hergesell and Berson urged the importance of simultaneous balloon ascents in the different countries when there was a barometric depression over the European continent. From a meteorological standpoint the manned ascents have an importance which the *ballons-sondes* do not possess, because the temperature of the highest atmosphere has no influence on the meteorological elements near the surface of the earth. M. de Fonvielle, however, called attention to the interest which thermometric measurements at a very high altitude would offer for the determination of the temperature of planetary space. These measures might enable us to choose between the kinetic theory of gases, which assumes the temperature of 273° Centigrade below zero, and Fourier's hypothesis that the temperature of space is near that of the minima observed in the polar regions of the earth.

It was agreed that the fifth international ascent of *ballons-sondes* should take place early in June, and manned or unmanned ascents were promised in Austria, Belgium and Italy, in addition to those in Germany, France and Russia, which countries had already cooperated. On the day designated, observations at the mountain stations, as well as with kites and captive balloons, will serve for the simultaneous study of the lower air.

Mr. Rotch read a report, which he had been asked to prepare, on the use of kites for meteorological observations, based on the experiments carried on at Blue Hill Ob-

servatory for several years past. The advantages which kites have over balloons up to a height of at least 10,000 feet, whenever there is wind, were pointed out. It was reported that, besides their use in the United States, kites were being employed to obtain meteorological records at St. Petersburg and near Paris. M. Tacchini proposes to try them on Mounts Cimone and Etna, and Professor Hann hopes to obtain data in this way above the Sonnblick, the highest permanently occupied observatory in Europe. The Conference recommended kites as being of great value to meteorology, and desired that they should be used at the chief observatories, together with the kite-balloon (described hereafter) for continuous observations. The Committee was enlarged by the addition of the following persons: M. Teisserenc de Bort and Prince Roland Bonaparte, of Paris; Professor Hildebrandsson, of Upsala; Professor Pernter and Lieutenant Hinterstoisser, of Vienna; Captain Moedebeck, of Strassburg, and Lieutenant von Siegsfeld, of Berlin. The next meeting will be at Paris in 1900.

During the Conference there were two trials of the kite-balloon—a captive balloon which, unlike the ordinary spherical one, is not driven down or carried away by strong winds. It is the invention of Lieutenants von Parseval and von Siegsfeld, of the German army, where it is used for reconnoitering, but the smaller Strassburg balloon, constructed by Mr. Riedinger, of Augsburg, for Professor Hergesell and Captain Moedebeck, is the first to lift self-recording meteorological instruments. It consists essentially of a cylinder of varnished linen, having a volume of 7,770 cubic feet, so attached to the cable that its upper end is inclined towards the wind, which thus tends to raise the balloon. The cylindrical form is preserved, notwithstanding leakage of gas, by admitting wind into an auxiliary envelope at the rear end, which also serves

as a rudder, stability about the axis being secured by lateral wings. The instruments are contained in a basket, with open ends, hung far below the balloon. The azimuth, angular altitude and traction of the cable are recorded continuously by an ingenious dynamometer. In spite of unfavorable weather and gas of insufficient lifting power, the experiments were fairly successful, and previously the balloon had been maintained during several days above the city.

The Committee also witnessed an ascent of the *ballon-sonde* 'Langenburg,' carrying self-recording instruments. This silk balloon, when inflated with 14,000 cubic feet of coal gas, had an initial lifting force of 440 pounds in excess of its load. Owing to a premature start, the ballast was left behind, and the sudden plunge upward not only emptied some of the gas, but stopped the clock movements of the thermographs. The ascent was made in the late afternoon, and the balloon, which soon disappeared in the clouds, was found the next day about sixty miles southeast of Strassburg, having risen more than six miles, as was determined from its barometric record.

A. LAWRENCE ROTCH.

THE FIELD COLUMBIAN MUSEUM.

THE Field Columbian Museum is making fast progress and doing effective work in the various departments. The Zoological Department is busy with the rich collection brought back by Professor Elliot's expedition to Somaliland. Two notable groups have been installed in the West Court, viz.: the lesser koodoo (*Strepsiceros imberbis*) and Waller's gazelle (*Lithocranius walleri*). The first is said to be the largest and most complete of its kind in the world, and in fact the only one in existence giving a full representation of this beautiful spe-