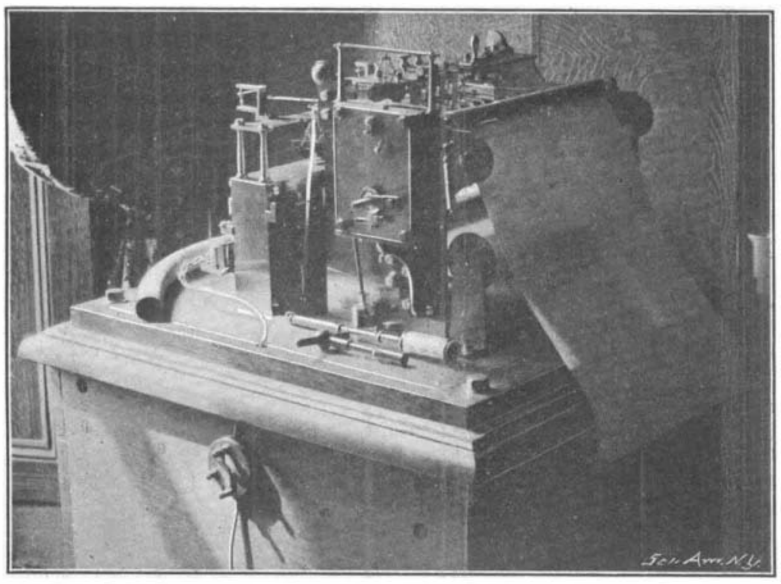
MEASURING THE RAINFALL—THE BRITISH RAINFALL ORGANIZATION AND ITS WORK.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The daily measuring of the rain throughout the British Isles constitutes one of the most important meteorological observations. The Royal Meteorological Society is generally supposed to carry out these surveys, but the records of this organization are neither exhaustive nor complete. The measuring of the rainfall is the sole function of a particular institution known as the British Rainfall Organization, with its headquarters at Camden Town, a northwestern suburb of London. This society was founded in the year 1859, by the late Mr. G. J. Symons, a Fellow of the Meteorological and Royal Societies.



THE BRONTOMETER FOR RECORDING WIND VELOCITY, BAROMETRIC PRESSURE, THUNDER, LIGHTNING, HAIL AND PRECIPITATION.

Although this society performs a valuable national work, it receives no State or public assistance. It is maintained entirely by private resources. When first inaugurated, the founder defrayed the expense of maintaining the institution himself; but as the organization attained larger proportions, several other equally interested gentlemen offered to contribute toward the expense of controlling the same.

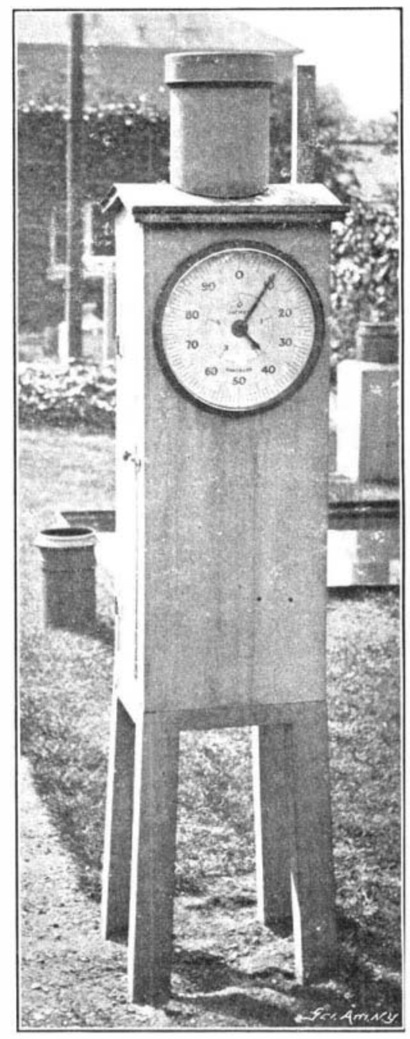
The work is carried out upon a most extensive and exhaustive scale. Scattered over the whole of the British Isles are over 3500 observers, comprising men in all positions of life, the majority performing the work gratuitously, while in some cases, where such complimentary assistance cannot be obtained, remunerated observers are employed. These observers are supplied with printed forms from the London headquarters, which have to be filled in regularly every day, and returned to London for publication in the Society's annual publication and magazine. The major portion of these returns are dispatched to London weekly, in other cases monthly; and in a few instances, owing to the inaccessible places in which the recording instruments are placed, either quarterly or half-yearly. A comprehensive idea of the manner in which this work is undertaken may be adequately realized from the fact that, on the average, there is a rain gage to every twenty square miles in England, one to every thirty square miles in Wales, one to every seventy square miles in Scotland, and one to every one hundred and seventy square miles in Ireland. The reason for the larger disproportion of instruments in Scotland and Ireland, is due to the dearth of observers in the Western Highlands of the former country, and the thinly populated districts in Ireland.

It must be explained that in using the term rainfall, snow, hail, and dew are also incorporated, since the three latter are only various forms of rain, and all tend to nourish and to water the earth.

The instruments employed at the London observing station are both numerous and ingenious for the fulfillment of the various functions for which they are required. The most common type of rain gage consists of a cylinder fitted with a wide-mouthed funnel and terminating in a bottle or other suitable receptacle. In measuring the rainfall, care has to be observed that no loss is incurred by the splashing of the drops, or by evaporation, and the vessels are consequently specially constructed with a view to overcoming these defects. The rain which falls into the bottle within the cylinder is subsequently measured in a graduated glass, and the amount of the rainfall thus obtained.

Although the foregoing constitutes the simplest form of rain gage and is infallible in its working, the institution utilizes one or two types of mechanical registering appliances. The drawback to this description of rain gage, however, is the liability of the instrument to become deranged as a result of the failure of a portion of the mechanism. One of these instruments, known as the Casella rain gage, however, is particularly ingenious. It consists of a large funnel, connected to a small receptacle called the "bucket," placed in the box below. This bucket is suspended upon one end of a lever, to the other end of which is fixed a pencil, which in turn glides over a continuous roll of paper tightly wound upon a drum, making a fine thin line in its progress. As the rain falls through the funnel into the bucket, the latter, owing to its gradually increasing weight, slowly depresses the lever, which movement in turn draws the pencil higher up the paper. The drum containing the paper is slowly forced forward by a clockwork mechanism, so that a pictorial representation of the rainfall similar to that recorded upon the barograph is obtained. This instrument performs its duties very efficiently, and is reliable in its working. Owing to the simplicity of its mechanism and the stoutness with which it is constructed, the possibility of its breaking down is very remote. When the bucket is filled with water it automatically tips over, so that its contents are emptied, and resumes its original position, at the same time returning the pencil to zero. The only attention that the instrument requires is the daily winding up of the clock and the adequate supply of paper upon the drum.

Another type of rain-registering apparatus is the float gage. The principle of this is that the rain falls through the funnel into a cylinder. In this cylinder is placed a float to which is attached a graduated measuring rod, which projects through the mouth of the funnel. As the rain falls into the receptacle below it raises the float, which lifts the measuring rod a height commensurate with the depth of water within the vessel. The snowfall may be recorded in a variety of ways. One process is to melt the snow in a previously ascertained quantity of hot water and then to measure the aggregate, the difference between the latter and the quantity of hot water utilized for melting purposes, representing the amount of the snowfall. The most salient disadvantage of this system is the liability of the observer to forget the amount of hot water that he employed with which to melt the snow. The method employed by the Rainfall Organization is much more satisfactory and infallible. The snow falls into a capacious receptacle, and drops into another vessel below. Round this latter circulates a constant stream of hot water which rapidly transforms the snow to water, and it then drops into a third receiver to be measured.

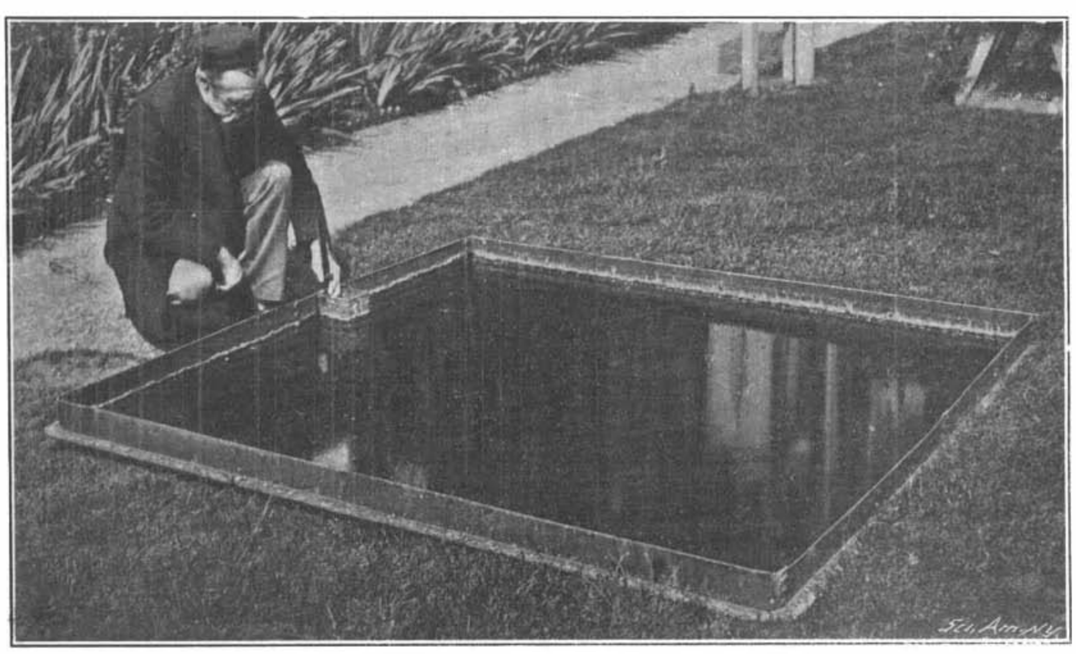


STORM GAGE FOR RECORDING ABNORMAL RAINFALLS.

The storm gage for recording abnormal rainfalls is another ingenious instrument. It consists of an elongated box supported on four legs, to the upper end of which is attached the conventional receiving funnel. Inside this box is a long cylinder equipped with a float, which is connected to the hands of a large dial placed on one side of the external box. As the rain falls through the funnel into the cylinder below, it forces up the float, which in turn actuates the hands of the clock. This dial is inscribed with the inches and tenths of inches, so that the rainfall can be gaged to a nicety.

Probably the most intricate and at the same time most delicate and beautiful machine ever devised for utilization in this ramification of meteorological survey, is that known as the "brontometer." It is the invention of the late Mr. G. J. Symons, the founder of the Rainfall Organization, and is the only one extant. It cost $2,000, and in reality is a combination of various instruments. A wide scroll of paper is wound tightly upon a large drum, which is slowly revolved by clockwork mechanism. Across the roll of paper extends a beam equipped with seven pens, each of which performs a particular function. The first pen is the time indicator. It defines a continuous thin line upon the paper, and at intervals of a minute deviates slightly from its course, so that minute periods are recorded. The second pen is connected by electricity with an anemometer placed on the roof of the building, and the wind velocity is recorded upon the paper. The third pen records the amount of the rain-

COMMON TYPES OF RAIN GAGES.



ASCERTAINING THE AMOUNT OF EVAPORATION.

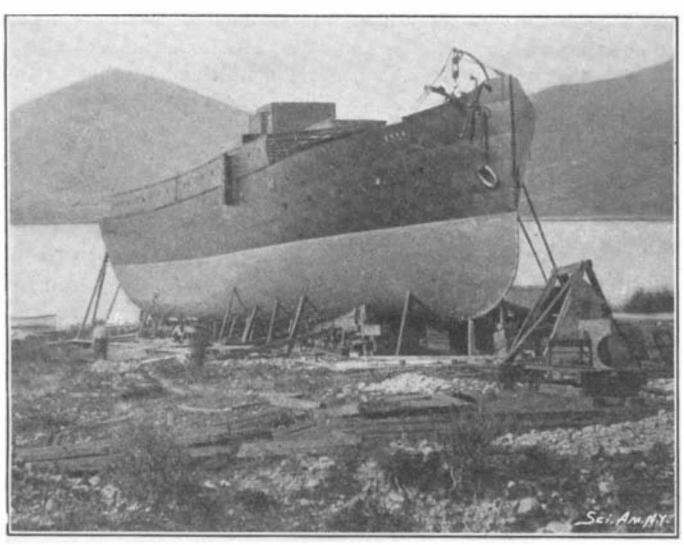
fall; the fourth and fifth pens, lightning and thunder respectively. The observer operates these two last pens by means of two small levers. Directly the lightning flash is observed, the first key is depressed, thus recording the lightning flash. When the thunder is heard, the next key is depressed, and the thunder duly recorded. By simple mathematical deductions between the records of these two keys, and the time indicator of the first pen, the distance of the lightning from the observing station may be gained. The sixth key records the fall of hail, and the seventh key the barometric pressure. The rainfall records from throughout the country are carefully collated at the end of the year, and published in the Society's annual volume, "British Rainfall." It is the standard work on the subject published in the United Kingdom. Through the work of this society a complete record of the daily rainfall in England, extending over a period of approximately forty years, has been gathered. Owing to the annual increment in the number of observers, the work is becoming more thoroughly and exhaustively performed.

These records are of inestimable benefit to the general public. Farmers, by the consultation of these surveys, can deduce the average rainfall within the year at any desired part of the country, and can thus calculate whether the moisture conditions of that section of the kingdom are suitable to the agricultural experiments contemplated. Local authorities who have to combat floods resulting from abnormal rainfalls, are also informed as to the best methods of averting any inconvenience from this source, and to cope with the difficulty when it arises. In view of the many public services thus rendered, the organization, which is the only one of its description in the world, would seem to deserve state assistance.

A REMARKABLE SHIPBUILDING FEAT, 13,000 FEET ABOVE THE SEA LEVEL.

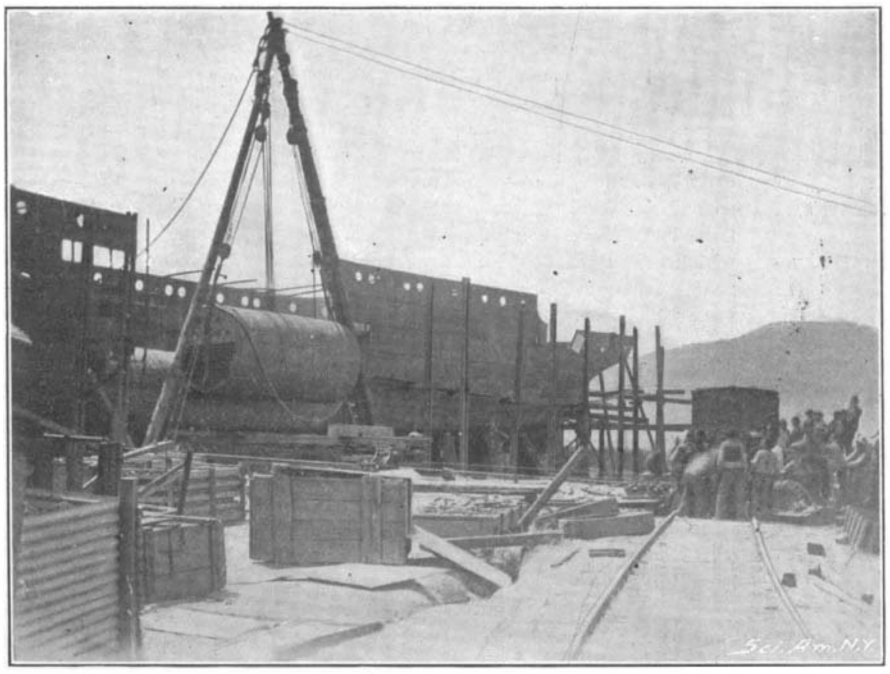
BY OUR ENGLISH CORRESPONDENT.

The Andes of Peru are remarkable on account of the railroad engineering achievements, especially on the section of the iron road stretching from the port of Mollendo on the Pacific coast to Lampa, and Puno on the banks of Lake Titicaca, the highest known sheet of water in the world (13,000 feet above sea level). This inland lake measures 120 miles in length, and varies from 25 to 40 miles in width. For many years communication was desired between the terminus of the railroad at Puno and the terminus of the railroad at Chiliaya in Bolivia on the opposite shore of the lake, some 100 miles away. The traffic between the two termini was maintained by means of the primitive native balsas, constructed out of the totora grass which thrives on the muddy banks of the lake. But the exigencies of the increased traffic necessitated a more expeditious and economical means of communication, and so the Peruvian corporation which controls the railroads resolved to establish a steamship upon the lake to ply between the two ports.



THE "COYA" READY FOR LAUNCHING.

The contract for the steamer was placed with Messrs. Denny Brothers, the celebrated shipbuilders of Dumbarton on the Clyde. The vessel is a twin-screw shallow-draught steamer, 170 feet in length, beam 26 feet, and 550 tons gross, with accommodation for 45 first-class and 30 second-class passengers. Owing to the lake shelving gradually from the shore, it was rendered expedient to have the craft of very shallow draught, in order to approach the landing stage. The vessel, named the "Coya," was temporarily erected upon the Clyde, but not launched. She was then dismembered and shipped at Glasgow to Mollendo. To facilitate transport, the parts of the vessel were made as small as possible. The boilers, however, owing to the great care that has to be exercised in riveting the plates together by hydraulic pressure, so that there can be no possibility of their exploding, were shipped intact, and that constituted the heaviest and most bulky portions of the cargo, since they weighed 15 tons each. The "Coya" was dispatched to Puno under the superintendence of Mr. John Wilson, F. R. G. S., a young engineer who had served his apprenticeship with the builders of the steamer. Considerable difficulty was experienced in disembarking the *materiél* of the "Coya" at the port of Mollendo. This port is the terror of all Pacific navigators, since it is exposed to the full fury of the Pacific Ocean. The surf is so heavy that it is only in the calmest weather that safe landing can be effected. After waiting a few days, the weather moderated sufficiently to permit the plates to be landed, by means of lighters. Apprehensive of the safety of the boilers, which from their unwieldiness and weight were more liable to accident, the engineer proceeded to Islay, a port ten miles north of Mollendo, where there is a magnificent anchorage. They were here transferred to lighters, and towed back to Mollendo. As an extra precaution, the engineer caused the boilers to be plugged, so that in the event of an accident to the lighters, the boilers would float and thus be recovered. The loss of a boiler would have been calamitous, involving several months' delay before it could have been replaced.



THE "COYA" IN COURSE OF CONSTRUCTION.

The cargo was placed on a train of twenty-two freight cars. The boilers were carefully lashed down to obviate oscillation and collision with low bridges.

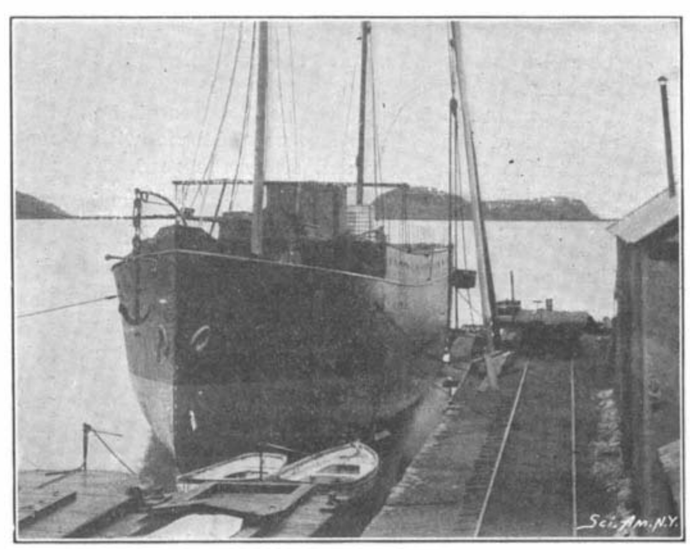
When Puno was reached, a primitive shipbuilding yard was improvised upon the potato patch of a Quichua Indian. Difficulties now confronted the engineer on every side. For some occult reason the railroad authorities at Arequipa had made no preparations for his arrival beyond giving him a pile of disused railway sleepers. Notwithstanding the fact that they had been fully instructed to provide necessary tools, Wilson was not even provided with a hammer. But he remained undaunted by this turn of affairs, and since sending to England for tools would have involved several weeks' delay, he set to work to fashion a few tools from some scrap iron that he discovered. The railway sleepers he cut up and used as keel dogs.

The railroad authorities supplied some riveters from the locomotive shops at Arequipa. The natives who assisted in the work, although slothful, possessed a certain amount of intelligence. Flush riveting was unknown to them, however, and some time elapsed before they became sufficiently expert to render much valuable assistance. Trouble was experienced with the "ne'er-do-wells" of the country, called Gringoes, who hastened to the scene from all parts of the country, not to work, but to see how much material they could appropriate for their own special use. Some idea of the arduous nature of the engineer's task may be gathered from the fact that in the forty laborers he employed, sixteen different nationalities from all parts of the world were represented.

In selecting the shipyard, care had to be exercised to select a suitable spot for launching. Under ordinary conditions the launching ways are laid at low tide, so that at high water the lower ends are sufficiently submerged. In this case, however, he had no assistance from tides. Fortunately, at the time of the year he arrived, the lake was low, so that when the rainy season raged, the water would rise a few feet. But even this would not have supplied a sufficient depth of water at the end of the ways, and they were further submerged by means of heavy weights attached to them. The stocks for the vessel consisted of the timber utilized by the railroad for the erection of their bridges, and they were placed as near the water's edge as possible. The construction of the vessel's hull progressed very rapidly after the laborers had been initiated into the work of flush riveting. The boilers were really the only difficult portion of the "Coya" to handle. As a rule, the machinery is not installed in a vessel until after launching, but this course in this instance was absolutely impracticable, owing to the absence of any kind of lifting appliances. The engineer was unable to obtain a crane, and also could not improvise a derrick, owing to absence of tall trees in that high altitude to furnish sufficiently long lengths of timber. He finally surmounted the difficulty by purchasing the spars from an old sailing vessel in Mollendo port, which the master of the craft only parted with at a high figure, since he had gained news of the engineer's difficulty. The boilers were each about 16 feet in length by about 8 feet in diameter, and were moved 40 yards from the freight cars to the vessel's side by sheer physical labor. The hauling of the boilers into the vessel by the primitive crane was an exacting operation. The condenser weighed five tons. The cylinders and the various parts of the machinery were not installed until after the launch.

Some idea of the rapidity with which the steamer was built may be gained from the fact that within six months of the arrival at Puno the "Coya" was ready for launching. The launch was an anxious operation to the engineer, because even in the best equipped shipyards a certain amount of uncertainty attends this operation. The engineer more than anticipated failure upon the first attempt, notwithstanding the infinite care he had exercised to avoid any hitch.

The launching ceremony was the occasion of great festivities in the city of Puno. About 5000 Indians also witnessed the function. The christening was performed by the Bishop of Puno. After the short religious service, holy water was sprinkled over the bows and a bottle of champagne broken in the conventional style. Immediately this was completed, the engineer pulled the trigger maintaining the cradle in position, and instantly the "Coya" glided with increasing momentum into the water. No launch in the most modern shipyard could have been attended with greater success than the launch of the "Coya."



"COYA" LAUNCHED AND BERTHED BESIDE MOLE AT PUNO.

With the launch of the vessel the most arduous part of the undertaking was completed. The "Coya" was towed to, and berthed alongside the mole at Puno, where the rest of her machinery and cabin fittings were installed. The sight of a steamship floating upon this lake occasioned considerable astonishment among the unsophisticated Indians, many of whom had never seen the sea, and consequently had never seen a steamship.

The trial trip of the steamer was the occasion of a general holiday in the city. The contract speed of the vessel was to be ten knots per hour, and she was to