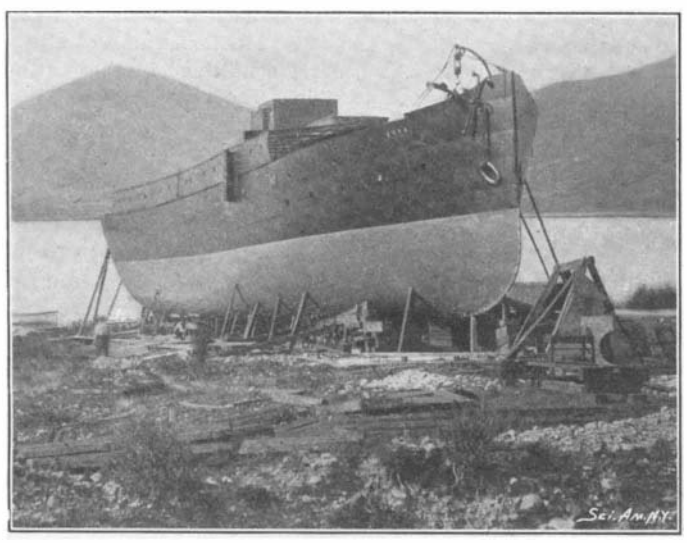
fall; the fourth and fifth pens, lightning and thunder respectively. The observer operates these two last pens by means of two small levers. Directly the lightning flash is observed, the first key is depressed, thus recording the lightning flash. When the thunder is heard, the next key is depressed, 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.

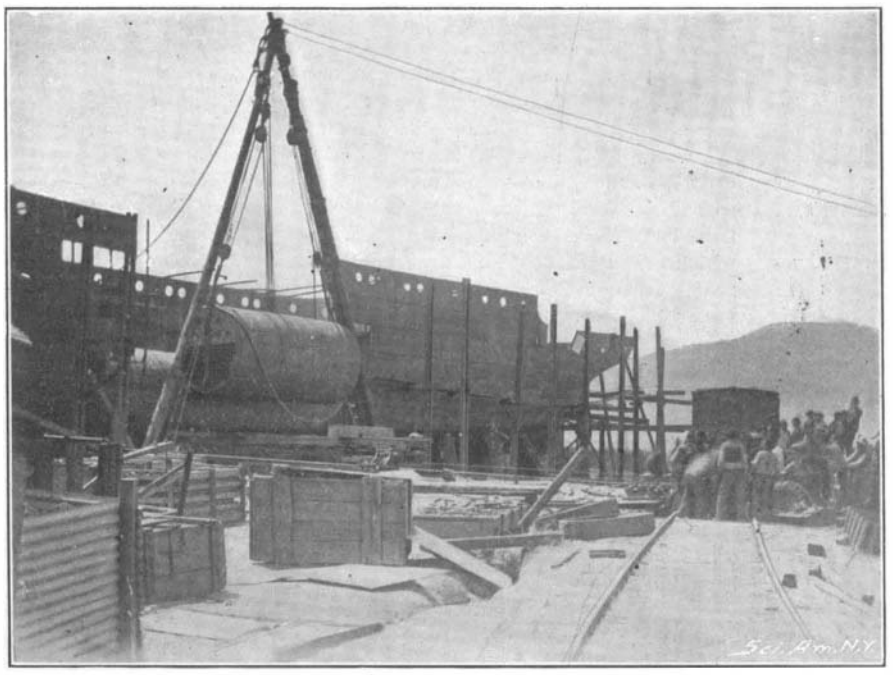
BY OUR ENGLISH CORRESPONDENT.

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 *material* 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.

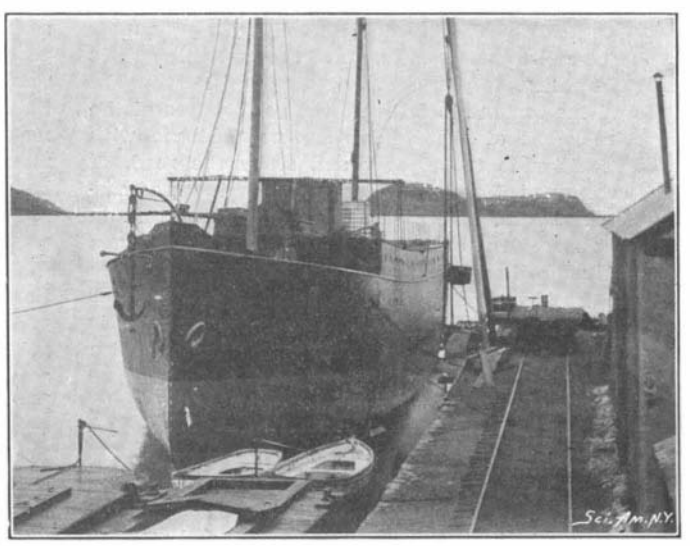
The railroad authorities supplied some riveters from the locomotive shops at Arequipa. The natives who assisted in the work, although slothful, possessed a certain amount of intelligence. Flush riveting was unknown to them, however, and some time elapsed before they became sufficiently expert to render 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."

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.



"COYA" LAUNCHED AND BERTHED BESIDE MOLE AT PUNO.

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

cover the journey between Puno and Chiliaya in ten hours. The vessel was captained by a Peruvian, who had to be initiated into the work of the telegraph apparatus connecting the bridge with the engine room, while Mr. Wilson accompanied the vessel as engineer. One difficulty that was experienced was in connection with the stoking of the furnaces. Owing to the rarefaction of the atmosphere at this high altitude, there was a decreased supply of oxygen, which necessitated stoking the furnaces in small quantities, or else the fires were smothered. This required continual labor, which was exceedingly fatiguing. Forced draught was of course applied, but this did not alleviate the difficulty to any appreciable extent. The steamer was also supplied with the apparatus necessary for petroleum fuel. The engineer described the experience of traveling at such an altitude as peculiar. The air was extremely clear, with the clouds rolling thousands of feet below, while the throbs of the piston rods of the engines rang out clearly and distinctly upon the rarefied air.

The engineer suffered many privations as the result of working at such a high altitude. The blood would rush to his head and his eyes protrude from their sockets with painful results. He was also seized with one of the epidemical diseases indigenous to that region, and was troubled at times with soroche, the prevalent complaint. By conceiving a severe attack of *mal-de-mer* combined with a splitting headache, a quasi-asphyxiation, and land sickness, a tolerable idea may be obtained of the painfulness of this malady.

By the terms of the contract, the "Coya" was to be constructed and delivered over to the railroad authorities within twelve months from the signing of the document. The contract was fulfilled within the specified time by two days. The construction of a vessel of the dimensions of the "Coya" in such an isolated spot as the shores of Lake Titicaca is an engineering triumph. When one recollects the insuperable obstacles the engineer had to surmount, the absence of any of those appliances with which the modern shipyards are provided to facilitate work, the employment of unskilled labor, then some idea of the magnitude of the task may be gained.

THE FAMOUS OROYA RAILROAD OF PERU WHICH CLIMBS HIGHER THAN ANY OTHER ON THE GLOBE.

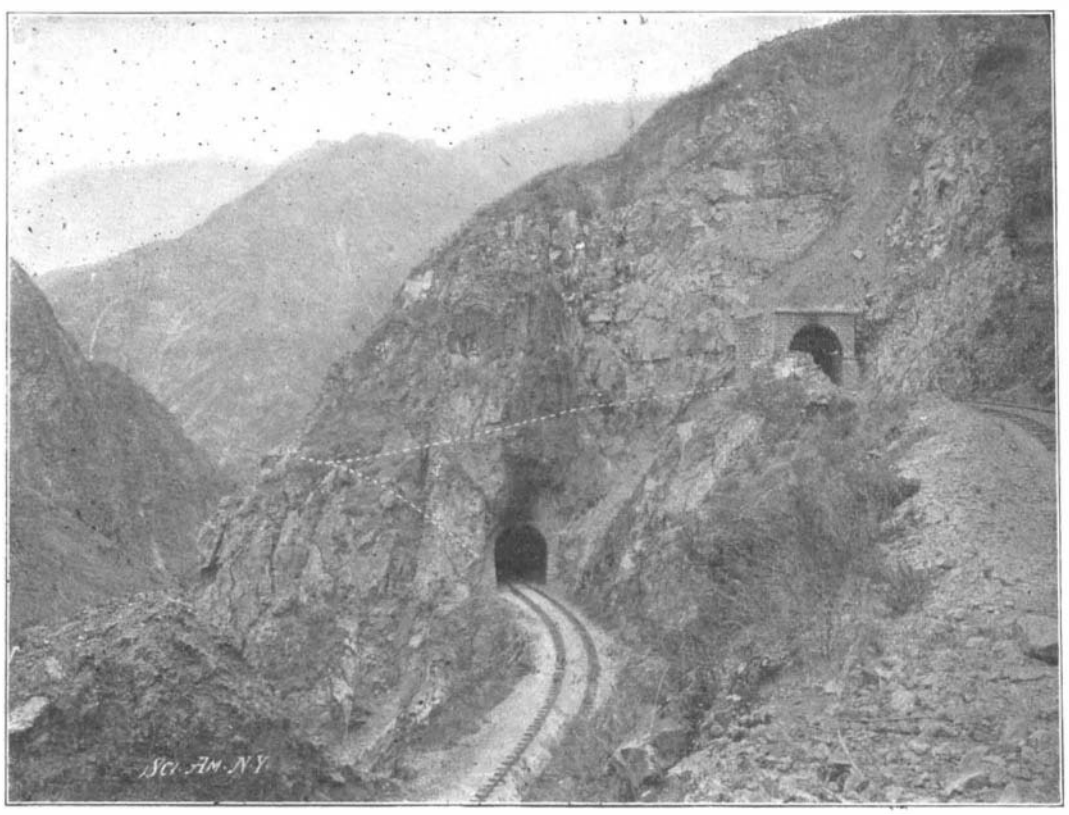
BY E. C. ROST.

To ride in American cars, drawn by an American locomotive, over an American-built railroad of standard gage, to an altitude of 1445 feet higher than the summit of Pike's Peak in Colorado, is a feat than can be accomplished only on the Oroya Railroad, or Ferrocarril Central del Peru. Messrs. Meiggs and Thorndike, the famous American railroad magnates, constructed and completed the line at a total cost of $43,000,000, which places it among the most costly of railroads per mile, since the entire length is only 138 miles.

I had the fortune to fall into the good graces of the superintendent of the line, who furnished me with every facility to travel over and study the road. I was accompanied on my various trips by the roadmaster, an American, who, by the way, lost an arm and an eye in an accident on this line. Our start was made from Lima, although the road runs to the very shores of the Pacific at Callao. The road is of four per cent grade, the running time, including stops, is about fifteen miles per hour. It was therefore with some misgivings that I started on the trip, because we ascended so rapidly from sea level into the rarefied air, and in nearly every instance the passenger suffers intensely from the effects of this sudden change.

As Lima, the queen city of the Pacific, fades into the distance, we see naught but low hills and scant vegetation, which confine themselves more and more to the banks of the Rio Remac, and after a few miles we see no sign of vegetation, not even a scraggy cactus. These low hills are only the foothills of the Andes. A 33-mile run brings us to Chosica, 2800 feet altitude, where are several side tracks to permit trains to pass; for the Oroya is a single-track road. Here are some fine mansions, occupied by wealthy citizens of Lima, and we find a good hotel. Fourteen miles more brings us to San Bartolome, 4959 feet altitude, another point where trains pass.

From San Bartolomé we begin our zigzag journey over the famous switch system, here introduced by Henry Meiggs, called the "V switch," and known by us as the "switchback." This system saves cost of construction, difficult development round the mountains, wear and tear of rolling stock, etc. Four miles farther on, and at an altitude of 5839 feet, we cross the world-famous Agua de Verrugas bridge (built in Philadelphia), the loftiest viaduct on the globe, which spans the valley of like name. Many lives were lost during the construction of this wonderful bridge, from the dread and always fatal disease, also called the Verrugas, which is due to the mineral gases and dust peculiar to this locality. It is claimed that one American died from this malady, having crossed this bridge but once. It may be proper to state here that the Andes present a mass of various kinds of minerals, and to remind the reader that the word Andes means mountains of copper, so named by the Indians. After passing an unimportant station, having traveled 12 miles more, we arrive at Matucana, which is loftier than the summit of Mount Washington, in New Hampshire, or 7708 feet above sea level. This is a resort patronized by those afflicted with pulmonary troubles. Here commences the wonderful scenery, which is one of the celebrated features of the road. Nowhere else are such weird, rugged mountain vistas to be found. As we proceed, now forward, now backward, over the zigzag V-system (for the locomotive pulls the cars over one section, then runs onto a switch and backs the cars over the next), as we pass through dark tunnels and over substantial iron and steel bridges, now crawl along the flank of a mountain whose perpendicular walls reach above the clouds, the effect is awe-inspiring. No brush or pen can describe the grandeur of nature as created here. Our own Rocky Mountains are grand, nay sublime, and have been more or less described; but the Andes must be seen to be appreciated. After leaving Matucana, we pass over three more important bridges, and arrive at Tamboraque, where in one view we see five sections of the line below us, over which we have passed in making the ascent. Here are extensive works for the manufacture of carbide for acetylene gas purposes, lime being found in very large quantities. Next we come to Aruri, 76 miles from Callao and 10,094 feet altitude, where we find another of the remarkable engineering difficulties for which this road is celebrated, the famous double tunnels, where the train passes into the lower tunnel, drawn by the engine, and is backed out of the upper tunnel almost exactly above. Two miles from here we come to San Mateo, an old mining town, just beyond which is another of the engineering features of the Oroya, combined with scenic wonders—the Infiernillo bridge and tunnels, where a substantial steel bridge hangs suspended between the mouths of two tunnels, with the mad torrents of the Remac rushing far below.



SWITCH-BACK TUNNELS ON THE OROYA RAILROAD, 10,094 FEET ABOVE THE SEA LEVEL.

At 88 miles from the shores of the Pacific we find ourselves at Chicla, which is 12,697 feet above old ocean. This is another mining town of some importance. Fifteen miles more, and we arrive at Casapalca, of 13,606 feet altitude, where are located the silver-smelting works of an American company, and here it is that the soroche, the dread disease feared so much, and rightly, by the mountain climber has taken a firm hold on all but a very few. If your courage permits—and it takes considerable—you proceed on the upward journey; for we have still a hard climb ahead to reach the summit. Otherwise, avail yourself of the hotel, a very poor one, or the kind hospitality of the superintendent of the smelting works, and return to a lower level.

From Casapalca we have 11 miles more to Galera tunnel, the highest point of the road and the highest point in the world ever reached by any railroad; in fact, the highest point at which the piston rod was ever used. This tunnel is one and one-half miles in length, and when half way through it we are on the very highest point of the road, for the waters running from the eastern mouth of the tunnel find their way into the Atlantic, while those running out of the western mouth run into the Pacific Ocean.

At the tunnel we are 15,665 feet in height above our starting point, or 1445 feet higher than the summit of Pike's Peak in Colorado. Here we are in the region of everlasting snow and ice. From this point there are still 32 miles more of road to Oroya, the terminus, over a down grade, for Oroya itself is only 12,178 feet above sea level. This latter section is not so interesting, although there are considerable mining interests which, with produce from the eastern slopes of the Andes, provide a good, paying profit.

From Oroya travel is continued on donkey to Cerro de Pasco, some 80 miles away and some 6000 feet higher up, where extensive mining is carried on, and to which point a railroad has been surveyed and a concession granted for the construction of the same. On my return to Galera tunnel I found a handcar in waiting, owing to the kindness, as already mentioned, of the superintendent, in which we traveled to the shores of the Pacific. The handcar travels down the four per cent grade by its own momentum for 106 miles to Callao.

Arsenical Beer and Rats.

When the arsenical poisoning from beer caused such a sensation in Manchester a few months ago, the British government appointed a Royal Commission to investigate the subject. One of the most interesting outcomes of this investigation has been the experiments by Prof. Delepine, of Manchester, to ascertain the action of arsenical beer and other arsenical solutions administered in large quantities to rats. According to the scientist who carried out the researches, he selected these rodents, since they are specially suitable for the experiments, and because they take beer and weak watery solutions of alcohol and arsenious acid very readily, and can adapt themselves to considerable variations in their diet. They are less affected by arsenic than man and many other mammals, and to estimate the probable effects of certain quantities of arsenical beer upon man, solutions containing at least four times more arsenic than had been found in the most contaminated beers examined during the outbreak were administered to a certain number of rats. The experiments were conducted in sets. In each set a certain number of rats were placed under conditions absolutely identical, and care was taken to make the general conditions in the various sets as similar as possible. The stoppage of the arsenical beer to the rats was followed by marked disorder of health, manifested by a marked disinclination to take food and drink, which had been well taken up to then, and a marked loss of weight. This was after beer sampled from one of the districts in which the scare had occurred had been administered, diluted or undiluted, arsenical beer being less injurious when undiluted than when diluted with water. Those rats which were well fed were less seriously affected than those which had not been well fed. The result of the second set of experiments apparently proved that arsenical beer containing only a trace of arsenic, even in presence of an amount of alcohol above the average, was not injurious to health so long as a large amount of food was taken; and the presence of a large amount of arsenic was clearly injurious, whether the amount of alcohol was small or large, but the presence of a large amount of alcohol seemed to precipitate a fatal issue. The other experiments showed that it mattered little whether arsenical glucose or arsenious acid were used in making beer, but laboratory beer was more deadly than brewers' beer. One experiment showed that beer brewed at a low temperature was more wholesome than beer brewed at a high temperature.

Frank Linde, a wealthy resident of Bridgeport, Conn., has been sued by a local lumber firm for supplies furnished to Gustave Whitehead, the alleged inventor of a flying machine, who had secured the interest of Mr. Linde in his work.