tioned, the buckled plate decking of Zorès section.

The longitudinal bearers are placed between each of the middle stringers, and are fixed to the secondary girder with angle struts, one on either side, forming chairs; but outside of the third stringer only one longitudinal bearer is laid, since the conduit for the electric street railway itself stiffens the floorwork between the main cross girder and the wood paving.

The whole of the bridge structural work, including the towers, is of Siemens-Martin mild steel, and its total weight is 3,801 tons, besides 2,082 tons for the superstructure of the towers. The steel has a minimum ultimate tensile strength of 7,700 pounds, and a maximum of 9,900 pounds a square centimeter, or 0.155 square inch. The test specimens 8 inches long, with a maximum sectional area of 0.62 square inch, and at the limits named, yielded minimum elongations of 28 per cent and 22 per cent. Perpendicular to the rolled direction, the material yielded elongations of 26 and 20 per cent respectively. All rivets are of the same material, and have a tenacity of 7,700 to 8,800 pounds, with elongations of 32 and 26 per cent respectively.

The maximum unit stresses allowed per square centimeter of sectional area are 2,420 pounds in the main girders, and 2,640 pounds in the towers, the wind bracings, the floor members, and the suspension bars, or hangers, and a shear on the rivets of 1,870 pounds. The stress calculated upon the bearing diameter of the rivets and bolts was 3,960 pounds.

THE MANUFACTURE OF THE EYEBARS.

In the manufacture of the chains, and in fact of other steel parts, the following conditions were imposed: In the preparation of the plates neither punching nor shearing was allowed, and the treatment of the plates in their machining appears to have been such as to render annealing superfluous.

The eyes were required to be geometrically central in the head and on the center line of the plate, and the maximum deviation from templates permitted in the distance between eye centers was 0.12 inch at a temperature of 10 deg. C., 0.02 inch in the eyes themselves, or a total of 1.6 inches in the half-span of the suspended chain.

The plates were assembled, and the complete members for each eyebar were temporarily bolted together at one end, and rigidly clamped up throughout the rest of their length, with their center lines in exact correspondence. The eye at the free end was then reamed accurately at one operation, and as nearly as possible at the same temperature, this process being followed subsequently by the similar boring of the opposite head.

THE ERECTION.

The work of erection was naturally so arranged that it could proceed simultaneously from both shores toward the middle of the bridge.

Following immediately upon the fixture of the anchor thrust blocks or shoes, the lowest links in the lower anchor chains—chain eyes Nos. 1 and 2—were erected upon timber stoolings, with the anchor stop plates threaded between every alternate link, and onto these were screwed the angular filling plates, which, along with the stop plates, take the thrust against the forged steel double anchor beams. The corresponding links of the upper chain were next erected, and this permitted the completion of all the principal work in the anchor chamber.

At least three openings were necessary for the river traffic during the entire period of erection, and consequently more than three fixed falsework bridges could not be erected because of lack of time, but the constructors were obliged to avail themselves of floating scaffoldings.

The operation of mounting the chains was as follows: The single plates, protected against buckling by wooden beams, were placed upon cars by cranes. The cars ran on tracks upon the falsework at a height of 9 meters. That the work might proceed simultaneously at four points, electric cranes of 5.2 horse-power were placed between the panel points 14 and 15. By this means the chain plates were raised to a height of 120 feet and placed on tracks running at right angles to the plates. They were then allowed to slide to the point at which they were to be used, and were built into the structure by means of small hand cranes.

One of our illustrations shows the mounting of the lower chain, the floating falsework being located in the third channel opening, and the erection of the two falsework bridges having not yet begun. We can here clearly see the vast amount of expensive wooden falsework that was used in erecting this bridge. In the proposed Manhattan bridge across the East River, the erection was to have been carried on from a temporary suspended erection platform, similar to that used for the construction of the new suspension bridge.

After the falsework over the channels and the falsework bridges had been removed, the mounting of the channel span was begun by means of the previously-used floating falsework. By this means, the cross girders together with the verticals of the stiffening trusses, the lower chords of the latter, the wind bracing, and the three middle rows of longitudinal girders from joint 18 to the center, were mounted in the following manner:

The falsework, built upon four floats, was first divided into two sections, each of which rested upon two floats. One of each pair had its mounting surface 2 meters lower than the other, so that it could pass under the already erected iron construction. The cross girders were completely riveted and joined to the proper verticals of the stiffening truss before being placed upon the floats. These were so arranged that the above-mentioned cross girders could be drawn up under the hangers. The parts of the cross girders and the verticals of the stiffening truss were placed on a mounting scaffold on the shore and there riveted together. After the cross girders had been hung on the hangers, by means of great screws, the three middle longitudinal girders were built into the structure, and then the cross girders were joined to these longitudinal ones.

The painting of the ironwork proceeded simultaneously with the erection of the same. The magnitude of this operation is evidenced by the fact that the paint used at the working place and in the factory weighed some 216,000 pounds, and was valued at over $11,000.

Correspondence.

An Earthquake Observation.

To the Editor of the SCIENTIFIC AMERICAN:

Having just read in the SCIENTIFIC AMERICAN of August 26 an account of the seismic disturbance recorded at Birmingham, England, July 15 last, it occurred to me that it might be of the same origin as the earthquake felt here at 5.08 A. M. on the same date.

The features of the shock here were two tremendous reports about one second apart, louder than the heaviest crash of thunder I ever heard, followed by a rumbling sound of perhaps 15 seconds' duration. The reports were not instantaneous, like the discharge of a gun, but resembled the grinding roar of the fall of an immense pile of bowlders, and lasted rather more than a second. These loud noises, which seemed like explosions, came without any noticeable warning, and the movement of the earth was slight as far as my personal observation went. The only damage done in this vicinity was the shaking of a few loose bricks from chimneys, but the noise was the most terrific I ever experienced. I had been up about ten minutes and was sitting by an open window, so was in a favorable position to observe these phenomena.

The difference in longitude—68 degrees—between Birmingham and Augusta, Me., would account for four and one-half hours of the difference in time, and the remainder, I presume, would be required for the earth tremors to traverse the intervening distance.

WARREN W. SEAVEY.

Gardiner, Me., August 28, 1905.

A Suggestion for Aeroplane Designers.

To the Editor of the SCIENTIFIC AMERICAN:

I wish to call attention to one fault in all, or nearly all of the aeroplanes and areoplane-supported flying machines thus far described in the SCIENTIFIC AMERICAN. The center of gravity is too near the wing surface. When one sees such a machine with a wing expansion of 20 feet and with the seat or platform and operator and machinery only a foot or two below the center of the wing surface, one may know that it is only a question of time—generally a very short time—till a disaster occurs. The reason is this: while the air at some times and places is calm or has a smooth and regular movement, at other times and places it has as many waves, cross-currents, and eddies as the rapids at Niagara. Now, while in the former case an aeroplane may be so designed as to be practically without ballast and yet maintain a horizontal position, in the latter it is sure to roll and pitch and plunge. To see the difference, take a thistledown, with seed attached, and set it afloat in the air. It will move off evenly and steadily. Now take another exactly like it, detach the seed, and set it afloat. It will dive, plunge, roll over and over, and perform all kinds of antics. It is thus that practically all the aeroplane accidents to date have been caused, including that to Langley's machine and those which caused the deaths of Lilienthal and Maloney (Montgomery's machine). Neither rudders, wings, nor skill of operator is any match for the eccentricities of the wind, and when anything goes wrong with the apparatus a greater accident is sure to occur.

The parachute is the most unscientific of aeroplanes; yet accidents are rare, practically never occurring after the parachute has once opened and the aeroplane principle has come into play, except what may be due to landing in unfavorable places. That this is so is due exclusively to the fact that the ballast and center of gravity are far below the supporting surface, thus always preserving the apparatus in an upright position.

What the writer suggests is this: Place the platform, the engine, the operator, etc., at a distance below the wing surface at least equal to the expansion of said wings—if the wings extend 20 feet from tip to tip, then place the platform, etc., 20 feet below; if 30 feet, then 30 feet below, etc. If what goes to make up the ballast is light in proportion to the wings, the distance should be greater. The propellers, rudders, etc., can be placed at or near the wing surface, as at present, and operated by piano wire or light chain. This will add somewhat to the weight and complication, of course, but will make dives and plunges with their accompanying accidents impossible.

CHARLES S. ADAMS.

Warren, Ohio, August 17, 1905.

The Lunar Rainbow.

To the Editor of the SCIENTIFIC AMERICAN:

As you gave place to articles on lunar rainbows in several issues of late, and in that of the 26th instant, now before me, I infer they are infrequent, and may continue to interest your readers. Charleston, S. C., my home, is so near the Gulf Stream that we have ascribed our notably beautiful sunsets to the atmosphere thereby produced. The same cause may account for the frequency of the solar rainbows, and the not infrequent, but seldom noticed, lunar rainbows. Although my home looked into the Atlantic Ocean, across the fifteen square miles of water forming Charleston's beautiful harbor, therefore I seldom had the western skies under observation at the lunar rainbow (full moon) period of the day, yet I recall many lunar rainbows during the half century since I was an observant boy, and, if memory serves me, one double lunar rainbow. But the most perfect of these bows that I recall I saw on the edge of Darlington, S. C.—a beautiful town in east-middle South Carolina—in 1891. I was in a road leading north, with extensive fields east and west, and hence my opportunity. The full moon had just risen above the tops of the distant woods, and the bow in the west was perfect. The span of the bow was materially less than the span of a sun rainbow, but its depth, or thickness, was proportionally much greater. The rainbow colors were distinct but pale, as if the arch were built of pale mother-of-pearl, and they changed and faded less rapidly than the sun rainbows I have seen. In 1863, when in camp on John's Island, S. C., I saw a brilliant sun rainbow with one foot of the arch so near we could stand on it, or pass behind and in front of it, but we did not "dig for gold." JAMES G. HOLMES.

Macon, Ga., August 28, 1905.

The Current Supplement.

The current SUPPLEMENT, No. 1549, opens with an article on the laboratory for the testing of materials of the Charlottenburg Polytechnic School, which article is supplementary to that on the same subject appearing in this issue of the SCIENTIFIC AMERICAN. Last spring Mr. Dugald Clerk delivered a series of lectures, in which he summarized his views on the value of various kinds of gas for power purposes. His remarks are published in the current SUPPLEMENT. A. S. Mann discusses the subject "Can a Steam Turbine be Started More Quickly than a Reciprocating Engine?" Messrs. R. S. Hutton and J. E. Petavel very thoroughly review the preparation and compression of pure gases for experimental work. "Diamonds and the Diamond Industry" is the title of a contribution which gives many a valuable bit of information. Miss Adele M. Fielde, in a striking article on the sense of smell in ants, summarizes the results of investigations which she has carried out, and which throw a flood of light on the function which the sense of smell plays in ants. Prof. A. Berget discusses the rhythmic movement of the sea from a mechanical standpoint, and arrives at conclusions somewhat at variance with those commonly accepted, conclusions which are based mainly on the mathematical investigations of Laplace. Dr. Conant writes on the beginnings of counting.

Simon Lake to Settle in Berlin.

Simon Lake, the submarine torpedo boat inventor, announces that he will settle permanently in Berlin, although he will still maintain an American office.

The reason for his decision to leave the United States, he said, was because he is unable to get the recognition on this side of the water that is his in Europe.

Mr. Lake said that in the tests made with his type of submarine on the other side of the Atlantic the boat had sunk 138 feet, the greatest depth ever reached by a submarine.

A volcano throwing off molten lava has been discovered in Nevada by McClure, Wheeler, and Somers, cattlemen of Lovelock. The volcano is in Rye Patch, Humboldt County. Although that section has been traversed for years, the crater has just been found. The men were in search of cattle when they came on the stream of lava, and tracing it to its source found the volcano.