which was stripped from the columns and left the fire free to attack the columns. They telescoped in the same way as the columns in the basement, although in this case the collapse took place near the ceiling. An interesting fact brought out in this building is, that although the columns in some cases failed, the floors, the beams of which are incased in concrete, are apparently intact. Photograph No. 3 shows a similar failure of the so-called fireproofing on the columns in the basement of the ten-story Monadnock Building. Our correspondent also draws attention to the fact that in some of the buildings the rivets connecting the girders to the columns have apparently sheared off. The lesson of this last defect is that special attention should be paid to these connections, and extra heavy reinforcements, in the form of gussets and knee braces, should be worked in.

These views may be taken as a strong indorsement of the system of reinforced concrete, which, because of its homogeneous and monolithic character, presents ideal conditions of resistance both to the wrenching of an earthquake and the fierce ordeal of such a conflagration as destroyed San Francisco.

Return of Halley's Comet in 1910.

BY MARY PROCTOR.

Some interesting calculations have been made concerning the expected return of Halley's comet in the near future, by David Smart, F.R.A.S., and published in a late number of the Journal of the British Astronomical Society. Halley's comet is the first ascertained to move in an elliptical orbit, and it has a period of about seventy-six years, its periodicity having been discovered by Halley in 1681. It has since been observed in 1759, and again in 1835, and according to the calculations above referred to, which are founded on the best authority, will reach perihelion May 23, 1910.

The orbit of the comet in its outer part occupies a great circle as seen from the sun, passing 10 deg. south of Spica, then near Delta Corvi through Crater and Sextans, north of Alpha Hydræ, and close to Procyon, then north of Orion and Aldebaran to Delta Arietis. The greater part of the orbit is then south of the ecliptic, the ascending node being just outside Mars before reaching perihelion, and the descending node just inside the earth's orbit, after perihelion passage.

The speed at which the comet travels in its orbit varies tremendously from time to time, as the radius vector sweeps over equal areas in equal times, and the ellipse is a very elongated one. At aphelion the comet moves at 39 miles a minute, which is far more than we mentally associate with an "aphelion crawl."

Between aphelion and the orbit of Neptune the speed increases to 65 miles per minute, and between Neptune and the orbit of Uranus the speed equals 171 miles per minute. The comet is now about halfway between the orbits of Uranus and Saturn in a direction two degrees south of Epsilon Geminorum, its speed at present being 320 miles per minute. After it leaves the neighborhood of Saturn the comet will rush forward at the rate of 520 miles per minute until it passes the orbit of Jupiter and begins to approach Mars, when its speed will have increased to 783 miles per minute. Woe to any small asteroid it may encounter on its way, but worse still for the comet did it approach too near Jupiter, the great disturber of comets. However, on the comet's return journey, in 1909 it will not approach much within five times the earth's mean distance.

None of the other large planets comes anywhere near the comet on this trip, and in the case of Neptune this is fortunate, for when the elements of the 1910 orbit were computed, Neptune had not been discovered. (Date of the discovery of Neptune, September 23, 1846). Before perihelion the comet will be fairly near Mars.

At Mars's mean distance the speed will be 1,234 miles per minute, and at the earth's mean distance 1,548; while at perihelion the speed reaches its greatest value, namely, 1,878 miles per minute. Were this speed increased by about 17 miles per minute the orbit would become parabolic, and the comet would leave our solar system forever.

On May 22, 1910, or one day before perihelion, the comet and Venus will pass each other, on opposite tacks, at a distance of 0.245 unit. The comet will, as seen from Venus, pass within two degrees of the Pole Star. On June 12, 1910, the comet will make almost as close an approach to the earth, passing within five to ten million miles of the earth's orbit.

It is impossible to say anything as yet, regarding its position in the sky, as observable from the earth, until certain important computations have been made. A prize has been offered by the German Astronomical Society of 1,000 marks for the most exact calculation of the next appearance of Halley's comet. The paper may be written in English and need not be presented until the year 1908. When the orbit is computed we shall know exactly where to look for the comet. As seen from the sun its position at perihelion will be about four or five degrees from Theta Aquilæ, a distance equivalent to that separating the Pointers.

As to the appearance of the comet on its return, it depends entirely upon its position with regard to the earth and sun. If the earth is at a remote part of its orbit while the comet is passing the sun, it may be seen only with great difficulty, or even become quite invisible. On the other hand, if the earth happens to be near the comet about the time of its perihelion passage, when the comet's light is necessarily greatest and its train most extended, then a most favorable opportunity will be afforded for witnessing its physical appearance.

At its appearance in 1759, the comet had a train 50 degrees in length, and was best seen in the southern hemisphere. At its next return in 1835, it did not present the appearance of an extremely brilliant comet, but was reasonably conspicuous with a tail about 15 degrees in length. How it will look at its next return, it is impossible to conjecture.

At aphelion the comet reaches the immense distance of 35.2 units from the sun, and spends nearly half its time outside the orbit of Neptune. The sun as seen from aphelion is about a minute of arc in diameter, or about the apparent size of Venus at inferior conjunction. By viewing part of the sun's disk through a hole one-hundredth of an inch in diameter in a screen held three feet from the eye, we can get a good idea of how the sun looks from the comet at its greatest distance. According to Mr. Smart "the comet would be a grand place, as far as its orbit is concerned, for observing stellar parallax, but climatic conditions would not be favorable to observing. Only one year would be spent in each 75 in anything like sunshine, and near perihelion the telescope would probably appear as a bright line spectrum, and the observer as a hydro-carbon band."

The Current Supplement.

A new British, four-cylinder, balanced, compound "Atlantic" locomotive is described and illustrated in the opening article of the current SUPPLEMENT, No. 1588. It is only in recent years that diametrical and circular pitches have come into serious collision in the machine shop. For that reason an excellent discussion of the subject in the current SUPPLEMENT will be found of interest. Mr. Edwin C. Eckel's analysis of the cement materials and industry of the United States is continued. Mr. M. C. Miller tells in a very instructive way how the time tables of our great railroads are constructed. In an article entitled "Mechanics of Luminosity," the views of the modern English school of physicists are set forth. The physiological effect of life in the Alps is discussed. Mr. Friedrick Knauer presents many a bit of curious information on the ways of the ant. The astronomer and geologist ask but cannot decisively answer the question "How Old is the Earth?" That question Mr. Warren Upham has taken for the subject of his article, "Geological Time." The importance of oxygen is increasing so rapidly, that a paper on the commercial production of oxygen by the liquid air process, in which the work of Georges Claude is discussed at length, will be found of value. Mr. Maginnis's paper on Reservoir, Fountain, and Stylographic Pens is continued. For the average person the proper cooking of cereals is quite as important as the proportion of different nutrients which they contain. Hence an article on the subject which appears in the current SUPPLEMENT should be read.

Official Meteorological Summary, New York, N. Y., May, 1906.

Atmospheric pressure: Highest, 30.49; date, 15th; lowest, 29.55; date, 3d; mean, 29.97. Temperature: Highest, 86; date, 18th; lowest, 40; date, 11th; mean of warmest day, 76; date, 18th; coldest day, 45; date, 10th; mean of maximum for the month, 70.3; mean of minimum, 53.3; absolute mean, 61.8; normal, 59.9; average daily excess compared with mean of 36 years, +1.9. Warmest mean temperature for May, 65, in 1880; coldest mean, 54, in 1882. Absolute maximum and minimum for this month for 36 years, 95, and 34. Precipitation: 4.67; greatest in 24 hours, 2.50; date, 27th and 28th; average for this month for 36 years, 3.15; excess, +1.52; greatest precipitation, 7.01, in 1901; least, 0.33, in 1903. Wind: Prevailing direction, south; total movement, 8,805 miles; average hourly velocity, 11.8 miles; maximum velocity, 48 miles per hour. Weather: Clear days, 15; partly cloudy, 7; cloudy, 9. Thunderstorms: Date, 2d, 5th, 11th, 17th, 18th, 27th. Frost: Light; date, 11th.

One of the most remarkable features in connection with gas engines for driving electrical generators is the great increase in alternating-current machines, and such increase is still rapidly continuing. To some extent this change has been unfortunate for gas-engine makers, owing to the greater difficulties in constructing suitable engines. As, however, in most instances such engines are required to be of considerable power, more than one cylinder would be required, for this reason, as well as to give greater regularity.

Correspondence.

The World's Iron Supply.

To the Editor of the SCIENTIFIC AMERICAN:

My attention has been attracted to an article in your issue of March 24, entitled "The Impending Exhaustion of the World's Iron Supply."

Allow me, through your columns, to inform those who are unnecessarily worrying themselves over this matter, that the already known iron deposits of Mexico, many of which are close to the sea, are ample in themselves to supply the iron furnaces of the world for at least the next half century, at the present rate of consumption. Moreover, our neighbor's mineral resources are as yet scarcely looked over, vast areas being unknown in detail to white men. I have spent the bulk of the last twelve months traveling in Mexico, from the Rio Grande to the Isthmus of Tehuantepec, and in that time have seen enough of available deposits of iron of excellent quality to calm all fears as to a possible scarcity of cheap ores of the metal.

THEO F. VAN WAGENEN.

Denver, Col., May 19, 1906.

The Earthquake at Napa, Cal.

To the Editor of the SCIENTIFIC AMERICAN:

In an article entitled "Earthquake Observations," published in the SCIENTIFIC AMERICAN of May 19, 1906, I notice the statement that Napa, Cal., was destroyed in the great earthquake of April 18. You will be conferring a favor on some of your readers if you will kindly publish the statement that *Napa was almost uninjured*. Several brick walls fell into the street, some stones fell from the face of one large building, many chimney tops came off, and some plastering fell from the walls. That is the extent of the damage here. Only two wooden buildings were moved. Their foundations were decayed and gave way, allowing them to drop down a couple of feet without hurting the people inside them. No one was killed here, and only one man hurt by falling bricks. In nearly seventy years of American settlement here no person has ever been killed by an earthquake, nor has any building ever been destroyed. Napa is forty-seven miles from San Francisco, and has felt every shock that has been recorded in the city, yet without damage except as above noted. Compare that with the loss by lightning in any town in the Eastern States. Factories were running here two hours after the shake, with no damage to repair. In a few hours after the earthquake Napa was starting three steamers loaded with supplies for the sufferers from fire in San Francisco.

Napa, Cal., May 23, 1906. HERBERT H. SAWYER.

The San Francisco Earthquake Felt in China.

To the Editor of the SCIENTIFIC AMERICAN:

The great San Francisco earthquake has been registered by the seismograph of the Zi-ka-wei Observatory. The perturbation has been even rather strong, and the commotions propagated through the terrestrial crust lasted a little over 1 hour and 34 minutes. The pointer of the self-registering apparatus (ratio of multiplication = 15) has traced undulations of 66 millimeters. The first preliminary tremors, transmitted through the mass of the globe, began at 9 h. 31 m. 0 s. P. M., China coast time. The first big waves, coming on the crust, along an arc of great circle, were felt at 9 h. 11 m. 14 s. The last waves of decreasing amplitude left their trace at 10 h. 31 m. 31 s. P. M. and the last slight fluctuations of the ground died away at 11 h. 9 m. 44 s. P. M., April 18.

That phenomenon will help some day to calculate the velocity of propagation of the seismic undulations, when the exact minute and second of the occurrence at San Francisco is known. Meanwhile, adopting the means found from preceding quakes, by Prof. Dr. F. Omori, of Tokyo, for the transmission of the tremors on one hand, and of the superficial waves on the other, we find for the time of the disaster, the epicenter of which must not be far from the city of San Francisco, 5 h. 21m. on the 18th morning (Pacific zone time) by one method, and 5 h. 20 m. A. M. by the other, the figure being of course a mere approximation.

San Francisco has the official time of the Pacific zone, exactly 16 hours after the China coast (Shanghai) time. L. F.

Observatory of Zi-ka-wei, near Shanghai, China, April 18, 1906.

A Set of the Scientific Americans Wanted.

To the Editor of the SCIENTIFIC AMERICAN:

In the calamity of April 18 we lost everything—residence, church, and college. Our losses would approximate $800,000. Not least among them is our splendid library of some 35,000 volumes, which fire destroyed totally, and which some endeavor must now be made to restore. To that end we confidently seek some measure of your co-operation. While librarian of the St. Louis University in 1872, too many opportunities were given me to judge how keenly alive our people are to the importance of your publication, not eagerly to covet, in their totality, the files of the SCIENTIFIC AMERICAN. They form a work of reference which St. Ignatius College can ill afford to be deprived of. We can hardly consent to be without it, and so become an exception among all our houses in the United States and Canada. On the other hand, our present financial plight makes payment quasi-impossible. Just now we have too many other financial problems pressing for a speedy solution. Ultimately, however, a favorable answer to our plea could hardly entail any loss on your part.

J. A. FRIEDEN, S. J., Super. Miss. Col.

St. Ignatius College Library, San Francisco, Cal., May 25, 1906.

[Unfortunately, the publishers have no sets of the SCIENTIFIC AMERICAN that they could furnish the college library above mentioned, or they would gladly do so. The earlier issues of the paper are out of print. It is possible, however, that some of our readers may have, or may know of, sets, even if they are not entirely complete, that they would be glad to donate to the above institution, which has been such a heavy sufferer from the earthquake.—ED.]

Fire-Resisting Qualities of Redwood.

To the Editor of the SCIENTIFIC AMERICAN:

I have always read your valued publication with great credence, but your correspondent in issue of May 12 at San Francisco, describing the conflagration after the great earthquake, seems to place great stress upon the very inflammable character of redwood as a building material and speaks slurringly of its virtues. He seems to be unaware of the fact that at no time was there more than an average of 30 per cent of redwood used in building construction in San Francisco, and for the past several years less than 20 per cent of the construction timber has been redwood.

Redwood contains no resin or turpentine of any kind, and, owing to its great resistant qualities of severe climatic conditions, is free from cracking or decay, where cinders might lodge and start fires. When burning it is easily extinguished with a small quantity of water and has the appearance of burned cork and is harder to ignite a second time than at first. When the famous Baldwin Hotel of San Francisco was burned five or six years ago, in the most densely populated part of the city, the firemen confined the flames to the building only; and while the heat in the interior of the building was sufficient to melt cast iron, the weather boarding (which was of redwood), by applying the hose to the outside walls, remained almost intact when the fire had been extinguished within after it had burned fiercely for five hours.

Redwood forests are practically unharmed by forest fires, and it is common practice for the lumbermen to fell the trees and peel the bark from them and, when the dry season is on, set fire to the felled timber and burn the branches and bark and other wreckage without practical injury to the saw logs, which procedure would mean disaster to any other wood. Owing to the cheapness of lumber and the great cost of other building materials at San Francisco it must necessarily be mostly reconstructed of wood. Where wooden buildings are well constructed on balloon frames, they are equal to A1 steel construction in resisting earthquake shocks; and if the city should be quartered by some wide avenues with auxiliary fireproof pumping stations connected with some of the power plants near the bay shore in each quarter, and three or four auxiliary reservoirs on high points in the interior of the city in case of a repetition of the past circumstance, fires could be easily confined to small areas, as it is considered by many that the fire could have been confined to the district south of Market Street if any water could have been had to keep it from crossing that broad thoroughfare.

The Southern Pacific Railroad Company saved their depot and yards south of Townsend Street with their own employes and private fire-fighting facilities, thereby saving the great lumber yard district along both sides of Channel Street.

If you would care to test the relative merits of redwood as a fire resistant, will furnish you samples of wood, as it is a very interesting subject to the whole Pacific Coast at present.

F. A. MCKEE.

Thorn, Cal., May 19, 1906.

Flying Machines and Wind Resistance.

To the Editor of the SCIENTIFIC AMERICAN:

As I am following the sport of gas ballooning, and have made ascensions of more or less importance myself (holding the American record for an endurance flight) I wish to correct a statement which is always to be seen with an article upon aerial navigation—that of "wind resistance." Often I hear (or read) of the resistance offered by the wind to an airship, aeroplane, or bird, and even a balloon, when in fact *there is no wind* to a body poised in the air. Wind (or air-currents) is a relative movement and is observed only when a body is resisting it. If an airship pitches more when running to the wind than when running away from it, it must be because of the fact (do not know the authority) that the wind is in waves, still this should be felt just as well when going with the wind.

An aeroplane cannot get help from the wind as is often stated, as it has only its own speed ahead to create it, and will get the same whether going with or away from the point of the wind.

A bird, aeroplane, or airship (so called) may and can go in any direction at equal speed in relation to the air in which it rests, but would not be able, of course, to do so in relation to the ground. A bird is able to fly to the wind and gain even in a high wind, simply because he has speed enough to fly faster than the current is moving away from his point of alighting. He will meet the same resistance if he flies with the same speed in the opposite direction. So, of course, with an aeroplane or dirigible balloon.

Mr. Walter Wellman states that he does not care for speed in his new airship. Speed is all that makes an airship. On a lake (or in still air) two boats would arrive at a given point even if one could make twenty miles an hour and the other but four miles an hour. But with the airship the ground advantage gained would be the difference between the speed of the ship through the air and the movement of the air in relation to the ground (assuming, of course, the ship is moving against this current) and would find the slow airship going backward much of the time, in relation to the ground.

The ship would make its speed in any event and meet no more resistance of the air than if it turned and moved with it, the ground speed being all the change it would undergo and that having nothing to do with the resistance offered to its progress through the air.

GEORGE T. TOMLINSON.

Syracuse, N. Y., April 10, 1906.

A Miner's Theory of Earthquakes.

To the Editor of the SCIENTIFIC AMERICAN:

I have read very attentively the article in your issue of April 28 regarding the late disastrous earthquake here in California, and the views of scientists as to the causes thereof, the consensus of opinion attributing it to the slipping or breaking of the strata due to the strain caused by the shrinking of the earth's crust. In a local newspaper the other day Prof. Buckhalter, of the Chabot Observatory in Oakland, expressed his belief that it was owing to the settling of the adjacent Coast Range of mountains.

Now I am not what is called a scientist, but for forty years I have been a miner in earthquake as well as in other countries and—of course in a small way—am familiar with rock movements. While I think that the foregoing ideas are correct as to the initiative force, I am satisfied from my own experience that they do not go far enough.

I cannot conceive how the breaking or slipping of the strata for a short distance or even the settling of a mountain range—otherwise than indirectly—could have occasioned the continuous eccentric movement of the earth's surface which was witnessed here. Therefore I venture to suggest another explanation of the destructive motion in the wake of the settling or slipping of the crust as follows: I use crust in the common as well as the geological sense as a word signifying a hard substance superincumbent over a vacancy or resting on softer matter beneath. The geologists sometimes term it the sensitive crust.

Judging from the quantity of matter ejected from volcanoes in our own times, besides the enormous masses of lava lying in many places on the superficies of the earth, not the least of which are to be found here in California, we may surely infer that there are very extensive hollow spaces below the surface. The contraction toward the center of the globe would also have a tendency to originate them.

With what are these cavities filled? "Nature abhors a vacuum." The answer might be either air or gas, or a mixture of both, elastic and highly compressed by the attraction of gravity. Must it not have been a whiff of this gas, expanded and fired in its escape through the volcano Pelee, which destroyed St. Pierre, in a moment snuffing out thirty thousand lives?

As the jar from a heavy blast in a mine often throws down portions of the roof, particularly where the veins have but a slight inclination from the horizontal, so it seems feasible that shifting, settling, or breaking of the strata of the crust of the earth would cause a vibration which would dislodge and throw down parts of the overhanging roof of the cavities. The concussion produced by the precipitation of countless billions of tons, of incalculable masses of solid rock, into the gaseous medium to unknown depths below would assuredly cause it to impinge on the unstable vaultlike roof, the sensitive crust on which we dwell. No other hypothesis would as fully account for the undulatory, wavelike motions on the surface, which besides opening seams do the greatest damage, and gradually dying away as the distance from the fall increased, like the effect of dropping a pebble into a pond. The impact of these waves on the more solid boundaries of the cavern, the ribs of the globe, would transmit the shock through the seismic zone which encircles our planet. If instead of a gaseous body the roof is superincumbent on molten or liquid matter or any plastic material, the result would be the same. What is termed a twin earthquake would come from two great masses falling at short intervals. The subsequent minor shocks—which almost invariably succeed the greater—would ensue from the falling of smaller bodies jarred and loosened by the first heavy fall.

In a mine, after a cave of what was supposed to be solid rock or stable roof, the skillful, experienced miner is very careful, if work is being carried on in the vicinity, to examine it, look for and throw down parts which he expects have been left and are all but ready to drop. As it always happens that solid rock is broken in falling, it is calculated to take up fifty per cent more space than before. Hence the falling rock itself finally makes a new support for the roof. This would take place as the result of an earthquake in the way I have set forth, until the base from whatever cause became unstable. Unless the excavations in a mine are very extensive and very near the surface, it never caves to the top, even when abandoned. I have witnessed old mines pumped out which began to cave below as soon as they were free from the water pressure which sustained them.

In my own time I have had several experiences of air concussion. One in particular I have reason to remember well. The walls of a nearly vertical vein gave way from the jar of a heavy blast of dynamite, setting free the timbers supporting some hundred tons of waste rock, which fell about forty feet through an empty stope to the drive on which I was standing. So great was the rush of air, that I was only saved from being blown into the shaft by the cage being at the landing. A Cornish miner who was on the other side of the fall was knocked down and had his shirt torn off. Prof. Buckhalter in the article above mentioned is quoted as saying that there was no preliminary shock. I certainly noticed one, and I know my earthquakes. I was awake in bed when the tremor commenced in the southeast corner of the room which I occupied on the upper—the second—story. I had plenty of time to think, to put it in words—"Hello! this is a temblor"—before the big shock came. Our house is a small wooden building, a mere box, and although I felt in the big shock as if a dog had it in his mouth and was shaking it, growling horribly the while, beyond the fall of the top of the chimney it sustained no damage whatever. Our next-door neighbor was not so fortunate. His house—only one story—was higher above the ground, supported by slender timbers, mere stilts, fell over and leaned against ours. The preliminary tremor which I observed I would call the shifting, settling, or breaking of the strata, the great shock the fall of a mighty mass as set forth above. To return again to the mine for a comparison, the watchful workman is often warned by a slight noise and dropping that a heavy fall is impending, and is thus given time, but not always, to jump to a spot which he has foreseen is secure.

Would not the foregoing theory account for the tremendous earthquake and tidal wave which followed the blowing up or explosion of Krakatoa in 1883, brought about, it is supposed, by the irruption of water into that volcano? Also for the behavior of Ihalco, a volcano near Acajutla on the coast of Salvador, which I have often watched? Every forty minutes or so it throws out red-hot stones and lava, supposedly from the slow infiltration and accumulation of gas from the adjacent home of the volcanoes and earthquakes. San Salvador, the capital close by, is nicknamed the swinging or rocking hammock from the frequent earthquakes there.

In connection with the foregoing there is one thing which I am free to acknowledge I do not understand, and cannot fully account for. For nearly three years I mined in Honduras within as many miles of the frontier. Fifteen miles away in Salvador rises a volcano called San Miguel. Sometimes it smoked without eruption; again it was quiet. It was always the predominating feature in the landscape, seemingly so close that I always considered, so to speak, that it was in my front yard. There were frequent slight earthquake tremors, but they were always imperceptible in the mine. I think it was in 1889 that I was employed in El Callao Mine in the Guiana of Venezuela, east of British Guiana on the Yuruari River, between the Orinoco and the Amazon. There we had an earthquake, which although not very severe lasted fully three minutes, and as we afterward learned was felt all over the West Indies. I was on the surface, and our first thought was what had happened in the mine, where there were great open spaces and upward of two hundred men at work. On going down we found that the trembling had passed unnoticed below.

E. D. GUILBERT.

274 West Santa Clara Street, San José, Cal.