steel framing the side of the car is in nowise weakened, as the depressed side sill is incorporated into the uninterrupted steel frame. By the slightly increased thickness of the side plates and the additional strength secured in this framing, a great increase in the general structural rigidity of the car is obtained. Notwithstanding that the roof is 9 inches lower than in the previous motor cars, the ventilation is said to be equally good. The square design of the window has been done away with, to allow the substitution of the round portholes, which are air, water, and dust proof. The appearance is similar to that of the porthole of a vessel, and the arrangement successfully gives protection against all the elements, a feature which is almost impossible to attain even with the double sash of the finest Pullman cars. By the use of the round windows, and the elimination of large wooden posts, a gain of 8 inches in the interior lateral dimensions is made.

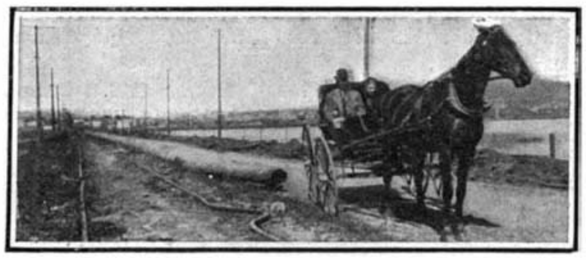
The framework of the car is entirely of steel; the structure is 55 feet long over all, weighs 58,000 pounds, and has a seating capacity of seventy-five. The interior is handsomely finished in English oak with built-up veneered wood seats. The exterior construction has been designed throughout to avoid projections, which are apt to increase the friction of the air against the body, and such projections have been almost entirely eliminated, with the exception, of course, of the necessary ventilators on the roof.

The engine is a six-cylinder, Standard gasoline motor located over the forward trucks, which are of special design to meet this requirement. An improvement in the construction of this car is the cast-steel "skirk," the engine-bed truck frame combination casting, which is a prominent factor in developing the practical side of the motor car for every-day service. The power of the engine is transmitted from the crankshaft by means of chain gearing, cast-steel gears being used for setting the car in motion. There are only two speeds; the first, in which the gears are employed, being up to 10 miles an hour. By means of an "octoroon" clutch, which may be thrown out of mesh, the engine is connected directly with the driving axle. The chain gearing is arranged for the second speed, up to 50 miles per hour. Compressed air is used for starting the engine, for operating the clutch mechanism and the air brake, and for whistle signals. An auxiliary air pump has been provided for emergency in case of shortage of the air, which is ordinarily supplied by a small air pump driven from the main engine crank-shaft. The air tanks, located under the body of the car, are of large capacity and of sufficient size for all ordinary requirements.

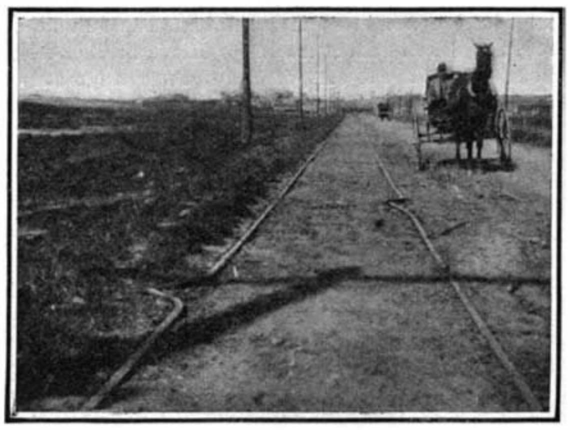
The controlling devices are of simple design, and are largely mechanical in operation. Special effort has been made to do away with the complicated machinery sometimes found necessary for the utilization of gas power in propelling railway motor cars. The equipment includes a powerful acetylene headlight and an acetylene gas system for interior illumination. The lamps for the latter purpose are provided with opalescent panels, which give a powerful light for reading purposes, while the general illumination of the car is subdued and restful to the eye. The accommodations for the passengers in general are simple, but comfortable. By improved engine construction, greater weight of the car, and increased rigidity of the framework, the unpleasant vibration often encountered in motor cars has been largely eliminated. By lengthening the car and providing double trucks the so-called "galloping" has been avoided.

THE EARTHQUAKE AND THE TRACKS OF A TROLLEY LINE.

Whatever seismologists may or may not know about the causes of earthquakes they are at least agreed that such displacements of the earth's crust as San Francisco recently witnessed are due to the sliding, bending, crumpling, and cracking of rocks. The origin of such a disturbance may be best described as a wrench which both compresses and distorts.



Rails Buckled by the Earthquake.



Effect of Longitudinal Compression on Rails.

In the accompanying two illustrations, which were kindly furnished by a subscriber, the effects of the compression are admirably shown in the bending of the rails of a trolley line leading out of San Francisco. Each rail may be said to have been pushed longitudinally from each end, with the result that it bent. Hold one end of a wire in each hand; push your hands together, and a like effect will be produced. If the wire is very long it will buckle at several points. In the case of the railroad the buckling occurred over a distance of about three miles.

The accompanying photographs were taken about eleven miles south of San Francisco, entirely out of the influence of fire.

FIREPROOFING AT SAN FRANCISCO.

In speaking of the effects of the San Francisco disaster on buildings of steel and masonry, and the successful way in which, taken as a whole, they withstood the ordeal, a distinction should be made between the damage wrought by the earthquake and that due to the fire which followed. We have spoken in this journal of the triumphant manner in which such buildings withstood the disaster, and in using that term, we have had in our minds more particularly the earthquake shock, which seems to have had very slight visible effect upon buildings constructed on the skeleton-frame plan. As far as we have been able to learn, the wrenching and twisting did surprisingly little damage to these buildings, most of it being confined to the loosening, and in some cases throwing down, of portions of the tiling, brickwork, or other walling and partition material.

Of the effects of fire upon such buildings, and the way in which the different systems of fireproofing would withstand a fierce conflagration, there was not so much doubt; for when, some two years ago, the great fire at Baltimore swept through several modern skeleton steel buildings from basement to roof, many valuable lessons were learned as to the fire-resisting qualities of these structures. The earliest information received from San Francisco, whether from correspondents or in the form of photographs, showed that none of the steel buildings had been absolutely destroyed, and that most of them were standing apparently intact as to their steel framework. We have recently been favored, however, by Mr. D. W. Terwilliger, an architect of Los Angeles, Cal., with some very instructive photographs, showing the interior of some of the burned buildings, which were taken by him early in May. They prove conclusively that in the presence of a fierce fire, the integrity of the steel columns and floor beams is entirely dependent upon the quality of the so-called fireproofing in which they are incased. Where, as in the case of two of the columns, shown in our illustrations, there was no fireproofing, or the fireproofing was of a faulty character, the heat proved sufficient to reduce the strength of the metal to a point at which it crumpled up under the superimposed load, and the column sank bodily upon itself in its own axial line. That the subsidence of the columns should have taken place in such a true vertical direction is to be attributed to the fact that they were held in vertical line both at top and bottom by the ceiling and floor structure. Had all the columns on these particular floors been denuded of their fireproof material and exposed to the same heat, the whole building must inevitably have collapsed.

In our various articles on the fire we have strongly advocated the use of concrete as being the material which presents the most perfect fire-resisting qualities, and it so happens that in a comparison of two of the photographs sent us by our correspondent, our readers will find a most striking proof of the correctness of this view. We refer to the two views which were taken in the basement of the Ahrensen Building. Photograph No. 1 represents a steel column in this basement, which was supposed to have been rendered fireproof by incasing it in hollow tile. The tiling was stripped off by the heat, or possibly by the shock of the earthquake (although on this point we have no information), and under the weakening action of the fire the column has telescoped on itself for a distance of 10 or 12 inches. Sixteen feet distant from this column is another, which had been fireproofed by incasing it in concrete; but although it must have been exposed to the same shock and the same heat, the concrete is still in place, apparently in perfect condition, and the column within it is presumably uninjured. Just how great a heat it must have endured, may be judged by the condition of the sidewalk lights and beams, the beams being bent down, and the lights being partially melted and hanging from the beams like icicles.

On the first floor of this building was a corner store, which also shows the failure of the hollow tiling,

Fig. 1.—Column Incased in Hollow Tile, Stripped of Its Covering, and Buckled, Sinking 12 Inches.

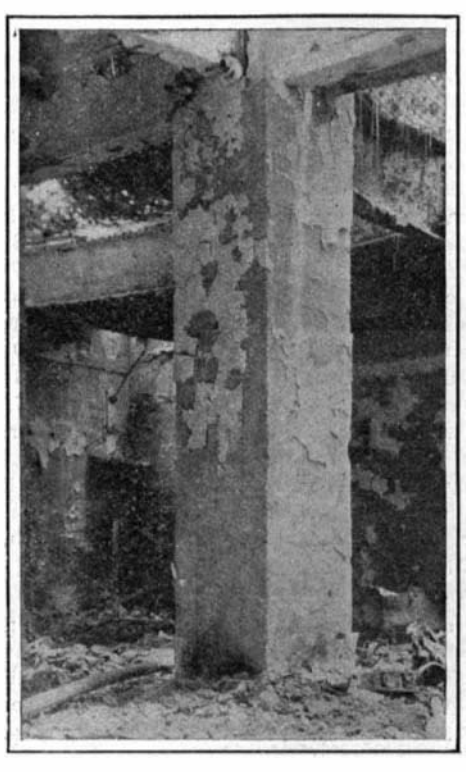


Fig. 2.—Column, 16 Feet from Column in Fig. 1. Incased in Concrete, Was Not Injured.

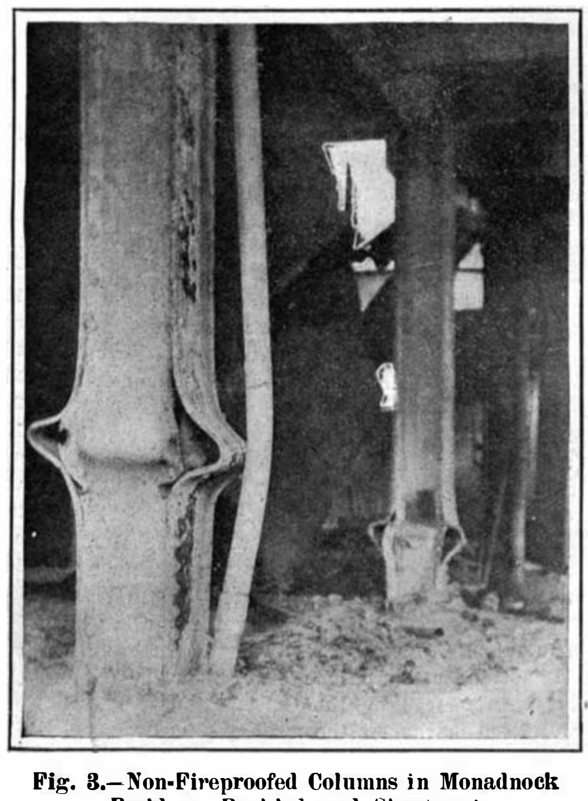


Fig. 3.—Non-Fireproofed Columns in Monadnock Building, Buckled and Shortened 10 Inches.

FIREPROOFING AT SAN FRANCISCO.

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 opportu-