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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

GUARD RAILS IN THE SUBWAY.

The contemplation of what would happen if a train of cars were to jump the track in the Subway and strike the wall of columns which supports the roof, has led a correspondent to forward to this office a sketch of a section of the Subway, showing two continuous lines of guard rails riveted horizontally to the vertical columns, one line being at the level of the floor of the car, and the other at about the height at which the side of the car rounds off into the roof. The object of the guard rails is to prevent a derailed car from striking, end-on, one of the columns, and so precipitating a serious wreck.

The question as to how far the supporting columns would be endangered in the event of a derailment is not a new one, and, indeed, it was given consideration by the engineers when they were working out the plans of the Subway. It was found that the clearance between the sides of the car and the columns is so small, and the cars are so long, being over 51 feet between the bumpers, that a derailed car could not become slewed around very far from its normal position parallel to the tunnel. Moreover, the columns are spaced so closely, being only five feet apart, that when a derailed car had become slewed around as far as it could go, it would be impossible for the forward end of it to strike a square blow against any particular column. The car, it is believed, would slide along the inner face of the columns as though they presented a continuous wall.

It has been suggested that in case of a derailment, especially of an express train, two or three of the columns might be carried entirely away, and thus permit the street above to fall in upon the cars. The engineers of the Subway, however, do not anticipate that the posts would be knocked out, or, if they were, that the roof would come down. The great power of resistance afforded by these columns, riveted as they are at top and bottom to the tunnel roof, and floor, was shown on one occasion during construction, when a train of cars laden with rock ran away down an incline, and crashed into a line of columns. In spite of the fact that the rock train was running at very high speed, only one of the posts was bent and none was carried away. Moreover, during the course of construction a large mass of rock torn loose in blasting operations would occasionally hit the columns and bend them out of plumb; but in no case was a column entirely carried away.

Although the above facts are not to be disputed, it must be remembered that the columns have never been subjected to an impact that would be comparable to that of an eight-car express train weighing about 350 tons, and moving at a speed of 40 miles an hour; and although on tangents it might be difficult for a derailed car to get a "bite" on any particular column, on curves and turn-outs the offsetting of the successive columns would bring them into a position more favorable to receive an end-on blow. The Scientific American is of the opinion that on such curves as those at the Grand Central Station and Times Square; and at all turn-outs, such as that at Spring Street, which are liable to be taken by express trains at high speed, it would be advisable to attach some form of guard rail to the line of posts on the outer side of the curve. A still better provision would be to use the protection which the Subway engineers have already installed at points where there is a crossover and the continuity of the line of columns is broken. Here they have incased the lower half of the columns in a wall of concrete, with the result that if a derailed train should hit the end column the blow would be resisted by the united strength and inertia of the wall and the columns that it included. It is particularly desirable that lateral guard-rail protection should be given wherever the Subway tracks pass between the foundation columns of tall buildings, such as the Times Building and the Belmont Hotel, and we understand that such protection is being put in place.

AN ALL-DAY RACE BETWEEN BATTLESHIPS.

Shortly before the opening of the recent war, the British government, it will be remembered, purchased from a South American republic that was retrenching its naval expenditures, two battleships which had recently been constructed in English yards. One of these, now known as the "Swiftsure," was built at Elswick, and the other, now named the "Triumph," at the Vickers yard. Both of these battleships, which are of the very moderate displacement of 11,800 tons, carry an armament practically as heavy and, as some experts think, heavier than that carried by the government-designed battleships of the "Duncan" class, which are of 14,000 tons displacement. Therefore, they are excellent representatives of the Elswick school of design, which, like that of our own navy, seems to be able to secure very heavy gun power in proportion to the displacement. Sir William White, the designer of the "Duncan" class, has been criticised for not securing greater offensive and defensive elements on the large displacements which he has given to his ships; but he has always contended, and we think with reason, that what his ships have lost in gun power, they have gained in endurance and reliability. The "Swiftsure" and the "Triumph" had shown, in the course of trials held in 1904, a speed under full power of over 20 knots an hour as against the designed speed of 19 knots. The "Duncan" had developed on trial a speed of 19.1 knots, and the average speed of the rest of the class was about the same. It should be mentioned that the armament of the 14,000-ton "Duncan" is four 12-inch and twelve 6-inch guns; while that of the "Swiftsure" is four 10-inch and fourteen 7.5-inch.

Naturally, the introduction of the Elswick-built ships into the British navy led to keen rivalry between them and the fast "Duncan" class, and this culminated in a twenty-four-hour race (carried out under the recent Admiralty provision for a quarterly full-power trial of all ships of the navy) which recently took place between the "Duncan" and the "Swiftsure." The battleships started on their all-day race on even terms. They were driven at full power for the whole twenty-four hours, and at the end of that time the "Duncan" was 30 miles ahead of the "Swiftsure," having put to her credit the remarkable performance, for a battleship, of maintaining for a whole day an average speed of 20.1 knots an hour. An average speed of 19.6 knots an hour was sustained by the "Swiftsure." That a 14,000-ton battleship could be able to steam for 482½ knots at an average speed of over 20 knots an hour, constitutes a record that will probably stand for some time to come.

To enable our readers to form an intelligent estimate of the relative performances of the two ships, we may mention that the "Swiftsure" is 436 feet in length, by 71 feet beam, and 24 2-3 feet in draft, and that on her official trial she made 20 knots an hour with 14,018 indicated horse-power; whereas the "Duncan" is 405 feet in length, by 75½ feet beam, and 27¼ feet draft, and on her official trial made 19.1 knots with an indicated horse-power of 18,232.

THE GROWTH OF OUR RAILROAD SYSTEM.

A sure indication of the advancement of a people is the extent and quality of the provision which it makes for transportation, and there is a pretty close relation between the growth of that system and the advancement of the people it serves. The rapidity with which the network of railroads that now covers the United States has been woven over the entire face of the land, is a subject of justifiable pride on the part of those who clearly appreciate what the upbuilding of that system has really involved in time, labor, and money. For the most part, its growth has been a healthy one, although there have been periods of wild-cat speculation, such as that of 1882, when over 11,000 miles was constructed in a single year, and again that in 1887, when nearly 13,000 miles was built. In each case these years of extravagance were followed by others of comparative stagnation, as, for instance, in the period from 1894 to 1897, when an average of only 1,700 miles was built per annum. These years of limited construction were marked by a steady increase in the freight and passenger business over the roads already constructed, and the low record of new construction simply proved that the roads were waiting for the traffic to catch up with the over-rapid construction of previous years. According to the figures which have just come to hand in Poor's "Manual of Railroads" for the fiscal year 1904, there has been a decided increase in the amount of new construction over the five years preceding, the amount of new road constructed having increased from 4,397 miles in 1903 to 5,014 miles in 1904, the total number of miles of railroad now in operation being 212,349. This vast system represents total liabilities of over $15,000,000,000, of which six and a quarter billions represent capital stock, and six and three-quarter billions the bonded debt. Among the assets, the cost of the railroads and their equipment represents over eleven and a quarter billion dollars. During the year 715,654,951 passengers were carried, and the total number of tons of freight moved reached the enormous figure of 1,275,321,607 tons. The passenger earnings amounted to $455,067,129, the freight earnings were $1,367,119,507. Other sources of income brought up the total traffic revenue for the year to just under two billion dollars. The net earnings for the year were $640,000,000, and other receipts raised the total available revenue to $721,000,000.

THE HEAVENS IN DECEMBER.

The magnificent group of constellations which adorns the winter sky is now fairly visible in the east and southeast. Orion, the finest of them all, is also the best one to use as a pointer to help us to find the others. At 9 o'clock in the evening in the middle of December, it is almost due southeast, and about one-third of the way from the horizon to the zenith. Its two brightest stars, Betelgeuse and Rigel, lie to the left and right of the line of three which form Orion's belt. Two others, not quite so bright, complete a quadrilateral which incloses the belt and also the smaller group on the right, known as the sword. The middle one of these last three stars is perhaps the most remarkable object in the heavens. A field-glass will show it double, and a small telescope resolves the brighter of the three stars seen with the field-glass into four components, to which a powerful instrument adds two more.

The whole system is surrounded by an enormous nebula, familiar to all students of astronomical literature. Part of it can be seen even with the naked eye, and more with the telescope, but it requires photographs of long exposure, made with large lenses of short focus, to bring out its faint extensions. They reveal it as a huge mass of nebulosity connected with one of the bright stars in the belt, and extending over almost the whole constellation.

The line of Orion's belt points downward to Sirius, which even at its present low altitude is easily the brightest star in the sky, and upward to Aldebaran, and beyond it to Jupiter, near which to the northward are the Pleiades.

The very bright star in the Milky Way, north of Aldebaran, is Capella, in the constellation Auriga. Below this is Gemini, marked by the twin stars Castor and Pollux, from each of which a line of fainter stars runs toward Orion. Below these again is Canis Minor, with the bright star Procyon.

The southern and southwestern sky is less interesting. Next to Orion is Eridanus, a very large constellation consisting of a crooked line of faint stars which begins close to Rigel, runs westward, then south, then southeast, and then southwest to the horizon, terminating in a bright star, Achernar, invisible in our latitude. West of this again is Cetus, which contains one pretty bright star, which stands alone about two hours west of the meridian at an altitude of about 25 deg.

The great square of Pegasus is well up in the west. Aquarius is below it. Saturn, Mars, and the bright star Fomalhaut are all in this part of the sky, but now they are just setting, and to see them we must look earlier in the evening.

Cygnus is low in the northwest, and Lyra is still lower, Vega being near setting. Cepheus, Cassiopeia, and Perseus lie in the Milky Way between Cygnus and Auriga, and Andromeda and Aries are south of them, almost overhead. Ursa Major, Ursa Minor, and Draco lie below the Pole, and so are not conspicuous.

THE PLANETS.

Mercury is evening star until the 15th, when he passes through inferior conjunction and becomes a morning star. However, he is so near the sun and so far south that he will not be visible to the naked eye this month.

Venus is morning star in Scorpio and Sagittarius, but she is also inconspicuous, rising only about an hour before the sun.

Mars is evening star in Aquarius and Capricornus, and sets at about 9 P. M. on the 15th. On the evening of Christmas day he is in conjunction with Saturn. The two planets are only half a degree from one another, and they are easily observable, as they do not set till about 8:30 P. M. They appear about equally bright, but it does not follow that viewed telescopically they would look equally large. Mars presents a very small disk, only 5½ seconds of arc in diameter, so small that it would be hidden by a silver dollar a mile distant, while the diameter of the disk of Saturn is nearly three times as great, to say nothing of his rings, which nearly double his apparent area. So if Mars and Saturn looked equally bright, *area for area*, the latter planet would appear to the eye about fifteen times as bright as the former. But they both shine by reflected sunlight, and, since Saturn is at present about seven times as far from the sun as Mars is, a square mile of Saturn's surface receives only about one-fiftieth as much sunlight as a square mile of surface on Mars.

Hence, if the two planets reflected the same proportion of the incident light, Mars ought to look three times as bright as Saturn. But as a matter of fact, Mars is very little the brighter of the two. It follows that Saturn must reflect between two and three times as large a proportion as Mars does of the light which falls on it, and this is one of the reasons which lead us to believe that the visible surface of Saturn consists of clouds, as no surface of land and water could be expected to be such a good reflector.

Jupiter is in Taurus, and is visible all night long. The phenomena of his satellites are visible with a small telescope, and very interesting to watch. There are several favorable evenings this month. On the 7th the second satellite crosses the disk of the planet, entering on it at 8:40 P. M., followed by its shadow three-quarters of an hour later, and before these leave the planet the first satellite and its shadow also come on, at 10:33 and 10:55 respectively. The same thing happens again on the 14th, about two hours later in the evening. The 16th, the 23d, and the 30th are also remarkable occasions, especially the last two, when for some time (between 8:30 and 9 on the 23d, and between 11 and 12:30 on the 30th) Jupiter seems to have only one satellite, as the first and third are in front of the planet, and the second behind it.

Saturn is evening star in Capricornus, and sets about 9 P. M. in the middle of the month.

Uranus is in conjunction with the sun on the 26th, and is invisible throughout the month.

Neptune is in opposition on the 31st. He is then in Gemini, in R. A. 6 h. 39 m. 30 s., dec. 22 deg. 10 min. north, and is moving northwestward at the rate of one minute of time in R. A. and one minute of arc in declination, every eight days.

THE MOON.

First quarter occurs at 2 P. M. on the 3d, full moon at 6 P. M. on the 11th, last quarter at 7 A. M. on the 19th, and new moon at 11 P. M. on the 25th.

The moon is nearest us on the 23d, and most remote on the 7th. She is in conjunction with Mars on the 1st, Saturn on the 2d, Jupiter on the 10th, Mercury on the 24th, Venus on the 25th, Saturn again on the 29th, and Mars on the 30th. The last two conjunctions are close, and occultations of the two planets will be visible from points in the Pacific Ocean and in Asia.

At 7 A. M. on December 22 the sun reaches its greatest southern declination, and enters the sign of Capricornus—though not that constellation—and, in almanac parlance, "winter commences."

COMET B 1905.

A bright telescopic comet was discovered on November 17 by Schaer, of Geneva. At the time of discovery it was close to the north pole, but it has been moving very rapidly, and on November 21 was on the borders of Cassiopeia and Andromeda, in about 54 deg. north declination. It is of about the seventh magnitude, and is visible in a field-glass as a hazy spot of light. Its orbit, the elements of which have just come to hand, shows that at the time of discovery it was already retreating from the sun, but very near the earth. It is now moving rapidly away from both, and becoming much fainter. On December 2 it was in R. A. 23 h. 31 m., dec. 4 deg. 34 min. north, and only one-sixth as bright as at discovery. Within a week or so more it will be so faint and so far south that it will hardly be observable. HENRY NORRIS RUSSELL, Ph.D.

Princeton, N. J.

THE MYSTERIES OF THE OCEAN BED.

The disaster which happened to the French vessel "Sully" not so very long ago, when it went to the bottom not far from Saigon, has afforded the divers intrusted with examination of the submerged ship opportunities for making exhaustive and important explorations of the bottom of the sea. In these fields of sub-aqueous exploration special distinction has been won by a young naval engineer named De Plury, who, by the aid of an apparatus of his own invention, succeeded in reaching a depth of even more than 336 feet— a depth which had never before been attained.

De Plury has invented a kind of metal armor which affords him every protection, while by means of a special chemical combination, respiration is automatically provided for. Thanks to this, he has already made over 115 most daring descents with perfect safety. He has thus been able to discover a most marvelous world, hitherto seen by no eye but his; the sea bed is a scene of marvels combined with no small amount of tragic horrors.

"The first sensation experienced," said this intrepid diver at a recent interview with an Italian journalist, "is something like that which is felt on descending into a mine, but you soon get accustomed to it. At a depth of about nine feet medusæ began to be found in large quantities. Seen through the water, everything appears magnified, and they are apparently of enormous proportions. All recollection of the protection afforded by the glass front of the helmet is forgotten, and the first impression is that these masses of horrid flaccid and slimy medusæ will adhere to your face.

"Just a little lower down, and a scintillating multitudinous shoal of small fishes is encountered, shimmering like so many strips of shining copper, or other metal, in a state of continuous vibration.

"At a depth of about 162 feet thick masses of seaweed are traversed; some of these are hair-like vegetable growths, with arms from 20 to 30 yards in length, which, with a kind of horrid vitality, wrap themselves round every part of the body. These algæ constitute a grave danger, as they can easily paralyze the diver's movements and, by rising up above and around him, can weigh him down with a weight amounting to several hundredweight—sufficient to break a rope or lifeline when hauled on. Below 162 feet there are small snake-like fishes of about three feet in length, and also other denizens of the deep resembling dolphins. These latter hurl themselves violently against the diver. If, as already remarked, he is somewhat young at the game, and has forgotten the protection afforded by his helmet, he is still filled with a mortal dread lest they should succeed in smashing the glass front of the helmet despite its four inches of thickness. Of course, should that occur, death would be almost instantaneous.

"Still other and worse monsters are the polypi or devil fish, who wrap their slimy tentacles round the bold explorer; but although repugnant, these monsters are cowardly, and immediately renounce their attack on coming in contact with the unfamiliar feel of the metal armor plating of my diving dress. There are also equally horrible, and much more intrepid, giant crabs. Some of those I have seen have measured as much as three feet in diameter. Due to their strong shells and formidable claws, they constitute a continual menace to the safety of the diver, which is by no means to be despised. This is about all that can be said on the score of the deep-sea fauna. The deformation of fish is not very noticeable at such a small depth; by deformation I mean not only change of form, but also of character. This takes place at a depth of about 1,094 yards; here their nature changes entirely, and they assume the forms and constitutional modifications necessary to enable them to bear the enormous pressure to which they are subjected at the depth where they move and have their being.

"Hitherto it has been quite impossible to obtain living specimens of these submarine creatures, as they reached the surface with their volume quadrupled, due to the reduction of pressure. All these creatures are carnivorous, and their capacious maws not unfrequently serve as the tombs of unfortunate sailors whose ship has gone to the bottom, and their bodies gradually sink deeper and deeper, while the formidable pressure to which they are subjected in an increasing intensity soon smashes all their bones, and finally crushes the corpses quite flat. But enough; suffice it to say that this awful spectacle is scarcely visible after a depth of 30 feet.

"One curious fact attending these submarine explorations is afforded by the light, which forms a strange blend of green and violet light, the color being a little similar to that of the caverns which are to be seen in icebergs. At a depth of 32 yards the light begins to get more and more diffused, and the sun viewed through the mass of superincumbent water appears like a reddish opaque globe; but—and this is somewhat strange—when sheltered from the rays of the sun (behind a rock, for instance) the stars become visible even at midday.

"One day, just about noon, I saw a never-to-be-forgotten sight at a depth of 129 feet. The sun was right at the zenith. The bottom upon which I stood consisted of fine white sand, and the reflection of the light upon the snowy carpet gave me the impression of standing upon a plain of molten gold. At a depth of 226 feet the obscurity is complete; at 327 feet the darkness is impenetrable, and it is necessary to have recourse to electricity for purposes of vision. I use electric lamps of 10,000 candle-power, but even these cannot diffuse their light beyond a radius of 90 feet. A most tragic spectacle is then presented by sunken vessels, broken boats, splintered hulls, gaping decks, and broken masts."

No scenes of horror can be surpassed by the awful panoramas of death and disaster which have been witnessed by Engineer de Plury in the course of his professional experience as a diver.

"In the vicinity of Ostend," he relates, "I was requested once to examine the wreck of a vessel which had sunk not long ago. This was the occasion upon which I was assailed by a veritable horde of those giant crabs of which I have already spoken. They were at the time busy devouring the corpses of the dead sailors. One of these monsters seized me by the leg, which would have been crushed, as if squeezed by a jaw of steel, had it not been protected by the powerful armoring of my diving dress. I had a kind of sword in my hand, with which I succeeded in killing two of these monsters, the shells of which I still possess. All objects at the bottom of the sea are covered with a kind of curious powder, and a terrible gloom and silence prevails. What a scene of melancholy! The floor of the ocean is strewn with bones, not a few of them of human origin! A very singular fact which I have observed is that the sea, for a certain period of time, keeps bodies in a perfect state of preservation. I once visited the hull of a vessel which had gone down with all hands. The crew were mostly asleep at the moment when the disaster occurred, and had thus passed practically instantaneously from sleep to death. So far they had not been bitten or gnawed by any fish, as most of the hatchways were closed. The men still appeared as if asleep. There they lay, wrapped in a calm and mysterious slumber. I approached, and, climbing down to the hatchways, touched one of the corpses with my hand; the flesh seemed to dissolve and vanish under my hand, leaving nothing but a grinning skeleton!

"And the treasures of the seas! Millions alone are engulfed not far from Vigo. Personally, I have never been there, but one of my men once went down there clad in the old diving dress. This was before I had invented my present dress. The unhappy man died almost directly he reached the surface again; but he had had time to see several galleons lying at the bottom, with the masts still standing, and the timberwork still sound. These, of course, were some of the famous treasure ships; but I do not think it would be possible to recover them. All metals would have been destroyed by rust by now, as they have been below water ever since 1707.

"I have seen personally the vessel which, about 1808, was conveying Napoleon's treasures to Holland, but it was wrecked *en route* and sank with one hundred millions of gold on board; of these, fifty-six millions have been recovered, but the remainder, as I have said, is still in the bosom of the ocean. The Prince of Monaco states that he has found near Cyprus a galley still full of objects of art at the botttom of the sea. This is where submarine boats will have such a great future before them, as, by their aid, we shall one day be able to explore unknown deep sea grottoes, rich in unknown forms of life, vaults full of untold wealth, and the tomb of many a poor sailor."

SCIENCE NOTES.

Among the minerals which contain a considerable proportion of radium we may mention a natural phosphate of uranium known as autunite, named for the town of Autun, in France, near which it has been found. This mineral has been known for a long time past, and owing to the uranium it contains has been used for some purposes. The beds of this mineral which are found at Saint Symphorien de Marmagne, in the Seine-et-Loire district, were worked by M. de Fontenay, the director of the great Baccarat glass factories, owing to the special color which some of the crystals were found to give to the glass. The discovery of radium drew attention again to this mineral, and a new search was made to find the beds of it which had been lost. The search has been successful owing to the recent work of M. H. Marlot, and at a depth of 6 feet below ground in a special kind of marl, they found plates of autunite which reached over an inch in thickness. This mineral was found to contain a large amount of radium salts, and it acted strongly upon the photographic plate, showing that it is quite powerful in its actions. We thus have another radium-bearing mineral to add to the list.

The recently-published report of the British government dealing with the fishery and hydrographical investigations in the North Sea during the years 1902-3 contains much interesting data concerning the fecundity of fish. According to the report, the turbot is one of the most prolific of sea fishes. The number of eggs in five specimens examined varied from over five millions to more than ten millions. The heaviest of these specimens weighed only 21 pounds, and the fact is expressed that large specimens are still more fertile. There is, however, but limited information extant concerning the rate of growth of turbot, but a specimen marked and put back in the sea on May 27, 1891, had grown from six to eight inches when caught again on August 31 of the same year. Unlike some round fishes, the flat species keep to the bottom of the sea and move along it, traveling great distances. Records have been obtained showing that plaice have traveled eighty-eight miles in twenty-eight days, or an average of not less than three miles a day. Experiments in the large spawning pond of the Fishery Board's laboratory at Aberdeen showed that this fish could cover more than a mile in an hour. Apparently the brill is not so fertile as the turbot. A brill weighing only 5½ pounds had the comparatively trifling number of 825,000 eggs. The halibut takes second place as to quantity, and third as to value among all the flat fishes. In a specimen weighing 91 pounds no less than 1,327,000 eggs were found.