ter; all the piers are of such height as to raise the structure 28 feet 8 inches in the clear above water level. The bottom chords consist of latticed channels —12 inches—varying in section according to the strains coming upon them. The upper chords extend upward in a parabolic curve toward the center. All the posts are latticed channel columns, and the diagonals are forged links. The floor beams are plate girders, and are suspended from the lower chord pins by plate hangers, and the foot walk brackets are riveted to the hangers by the same rivets that secure the floor beams.

The drum of the draw, which is entirely rim bearing, is 26 feet in diameter, and is formed of two channels 12 inches deep. The weight of the span is transferred to and distributed over the drum by two longitudinal girders in line with the trusses, two cross girders under the central posts, and short inclined connecting girders. All the hydraulic machinery for operating the wedges and turning the bridge is in a room, the floor of which is carried on girders riveted to the central parts of the trusses at an elevation equal to that of the portals. The bridge rests and turns upon a ring composed of 54 cast iron coned wheels, 16 inches in diameter at the base, which are spaced and held truly radial by two guide rings, one inside and one outside of the wheels. The axle of each wheel is connected by a tension rod to a movable center, to which the guide rings are also braced by struts of angle iron. This resembles a large horizontally placed wheel, the hub being formed by the movable center, the spokes by the tension rods and axles, and the face by the cones. The axes of the wheels are inclined upward, toward the center, at such an angle as to bring the upper bearing lines of the wheels in a horizontal plane. The upper bearing plates are of wrought iron planed flat, and the lower track circle is of cast iron segments bolted together by lugs and firmly anchored to the masonry; its bearing surface is planed to conform to the inclined position of the wheels. The outer guide ring for receiving the operating ropes that turn the draw is supported by cast iron winged nuts projecting from the outer ends of the axles. The movable center turns upon a steel shaft 6 inches in diameter. At each side of the draw is a fixed span, supported upon masonry piers of 95 feet from center to center. The drawbridge was erected upon false work resting upon piles and placed parallel with the river, as shown in the lower engraving.

To properly shift the twenty-nine tracks in the yard so as not to interfere with their use, and at the same time obtain the requisite space in which to place the posts supporting the elevated roads, was a task requiring care and judgment. The difficulty may be understood from the fact that in the completed structure there are no two girders, no two elevations, and no two skews alike. The plate girder spans are of varying lengths to suit the tracks, and vary in depth from 42 to 72 inches, in proportion to length of span. The cross girders are from 30 to 60 inches deep. The columns are 12-inch latticed channels, and vary in section, according to the load brought upon them by the spans. No longitudinal bracing could be put in on account of the lower tracks, the minimum head room being 15 feet. All the work is proportioned to carry heavy Mogul freight loads.

The outgoing suburban track crosses the center ones, which run to the yard, and after leaving the bridge turns to the right and extends parallel with the yard tracks to a point where the descending center tracks permit its crossing. The maximum grade is 65 feet per mile. The incoming track is independent of the others. The center tracks approach the ground by an easy grade.

Mr. S. R. Filley is the president, and Mr. J. J. R. Croes is the chief engineer of the company. All the iron work was designed by Mr. Theodore Cooper, consulting engineer for the company.

Two Thousand Miles on a Bicycle.

The longest bicycle ride ever made has just been completed by Mr. H. R. Goodwin, of the North Manchester Club. Leaving Land's End on June 1, he journeyed to John o' Groat's, having reached which point in 7½ days, he at once turned southward, and again arrived at Land's End on the 16th, the double journey of about 1,750 miles, or from one extremity of England to the other, having occupied less than 16 days. From Land's End he rode to London, which was reached on the 19th, the rider having thus completed a journey of 2,050 miles in exactly 19 days, or an average of 108 miles a day. Mr. Goodwin rode a 40 inch "Facile" safety bicycle, and arrived in London well.

The Deepest Bore Hole in the World.

The deepest boring yet made is at the village of Schladebach, near the line between Leipzig and Corbetha. It has been made by the Prussian government to test for the presence of coal, and was bored with diamond drills. Its depth is 1,390 meters (4,560 feet, its breadth at the bottom 2 inches, and at the top 11 inches. It has occupied 3½ years to bore, and cost a little over £5,000. The temperature at the bottom is 118° Fah.

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(Illustrated articles are marked with an asterisk.)

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THE SCIENTIFIC AMERICAN SUPPLEMENT,

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For the Week Ending August 1, 1885.

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GENERAL GRANT.

At eight minutes after eight on Thursday morning, the 23d of July, 1885, the lingering illness of America's greatest citizen terminated in death. General Grant was no more. Nine months of weary fighting against an incurable disease had brought so much pain and suffering that even those to whom he was most dear could not but feel a sad pleasure that the conflict was finally over and the great hero at rest. With his sickness we are all familiar, and from North to South the whole country has felt but one sentiment, that of profound sympathy for an illustrious sufferer, whose terrible illness experienced but little alleviation and could know no cure. And now that it is all ended, and the sad message has been flashed around the globe that the peace of death has fallen, that the world has lost a hero, the nation which claimed him as her own, and the people who delighted to do him honor, remember their loss and mourn for their illustrious dead. Though the remarkable career of General Grant is known in its outlines to all of us, and though many of us have followed the brilliant life from the time when his name was first heard over the land to the time when death came, yet it is, nevertheless, a pleasure to recall again the history of a man whose destiny was so closely linked with that of the nation, and whose achievements have added so much to her glory.

It seldom occurs that a man who at sixty-three occupied the position accorded to General Grant, is at forty almost totally unknown, yet at the beginning of the Civil War such was the case, and few things seemed then so improbable as that this quiet, self-contained man should ever reach a cosmopolitan fame. It is true that he had distinguished himself in the Mexican War, that at Monterey, Vera Cruz, and before the city of Mexico he had shown those splendid soldier-like qualities which were afterward to be tested in a conflict where the opposing forces were more equally matched; but his services seemed to attract but little attention at the time, and we find him shortly afterward settled quietly on a small farm, bearing the bitter burden of poverty and failure. But with the fall of Fort Sumter his career began anew, and from his obscurity at Galena he passed with wonderful rapidity through those brilliant campaigns which resulted in the capture of Fort Donelson, the carnage of Shilo, and, finally, in the grand triumph at Vicksburg, and placed him in three years' time at the head of the Federal armies.

At that time events closely followed upon each other, and with the Wilderness Campaign, the fall of Richmond, and the welcome termination of an unhappy war, his active military duties ended, and left him, who had been one of the most obscure citizens, the most popular man in the whole republic. His position at this time was certainly unique; no one else, perhaps, has ever been so placed. He was by all odds the man most available as a presidential candidate, and, curiously enough, could have received the nomination of either political party. Nothing redounds more to the credit of this great general, to whom so much honor has been given, than the deep sentiment of respect which has always been felt towards him by those people whom he was forced by circumstances to subdue, and to-day many of the most touching tributes to the memory of the dead hero have come from the South, from the very men who were conquered by his genius. It is indeed a great thing that the central figure of a civil conflict should hold the affection of an entire people, that he is regarded without bitterness, and mourned as the nation's loss.

PETER H. WATSON.

Among the strong, brave men who bore conspicuous parts in the late rebellion, though little known to the general public, was the late Peter H. Watson, who died at his apartments in the Albert, Eleventh street and University Place, this city, July 23, in the 68th year of his age. Mr. Watson was assistant to the late "Iron Secretary of War," Mr. Edwin M. Stanton.

Mr. Watson was literally a self-made man. Commencing his career at Washington City as a solicitor of patents, by indefatigable perseverance and industry rose in his profession to the highest point. When Mr. Stanton was called to the Cabinet of Mr. Lincoln, Mr. Watson abandoned his lucrative profession at the urgent request of Mr. Stanton, and entered the war office as assistant, and during those stirring times rendered important and valuable services in his department, and when the war closed, like the other members of that remarkable administration, returned to private life and the pursuit of science, to which he was inseparably wedded. Notwithstanding Mr. Watson was not prominently before the public, he was nevertheless personally known and highly esteemed by the great men of his time, and not a little singular is the coincidence that he should die on the same day with General Grant, for whom he held the highest admiration, having known the great commander intimately, at the time when truly "men's souls were tried."

In speaking of Mr. Watson, we join all who knew him in expressing our sorrow at his loss personally, and to the scientific world, and accord to him every praise for his faithful and indefatigable services throughout the rebellion, and point to him with admiration as one of our self-made men.

Among the remarkable things that occurred in cabinet councils during the war is that related by Mr. Watson, illustrating the peculiarly modest character of Mr. Lincoln in important measures of which he was the author.

At a special meeting called by President Lincoln, he found himself alone in the chamber while waiting for his cabinet, and commenced to read "*Artemus Ward His Book*," left there by some early visitor. One after another the members came in until all were present, and still Mr. Lincoln read on, and finally began reading aloud some part that seemed to amuse him, upon which Mr. Stanton remonstrated in his peculiarly strong manner, remarking that if he (Mr. Lincoln) had nothing of more importance to communicate, he could continue to read, but that he (Stanton) had something else to do, and was about to withdraw when Mr. Lincoln requested him to remain. Laying down "His Book," and the warm genial face of the President changing from mirth to earnestness and troubled anxiety, he remarked that he had a paper to read to them, and, drawing from his pocket a much crumpled manuscript, slowly smoothed the wrinkled pages, and read to his companions the perhaps most remarkable state document of the nineteenth century, a paper that freed four million human beings from bondage, and startled the remotest corners of the world.

And now, after the lapse of nearly a quarter of a century, the effect of this paper is still felt, and gradually but surely the bonds of the slave are passing away. At that time the members of the cabinet were divided as to the expediency of such an important step; some thought it premature and would incite anarchy, others commended his judgment and deemed the time most fitting and proper.

After patiently listening to the various opinions, and thrumming on the window to which he had withdrawn, as if to permit his pent up soul to find relief in the far off valley of Virginia, quietly turned to his friends, and remarked: "Well, gentlemen, I am going to have this paper published in all the newspapers, and then you can each get a copy." Characteristic of that great man, he little thought of the joy and sorrow that his single signature to this paper would cause, and the ultimate revolution in the social world of a class of humanity toiling in bondage with no hope of release. And now that most of that illustrious band have passed away, we feel that history should record the deeds of all engaged in that memorable struggle, and that none who bore a part should be forgotten.

PANAMA VS. TEHUANTEPEC.

The congress which met in Paris in 1879 to decide on the Panama route and a tide-level canal, under which conditions M. De Lesseps gave his name to the enterprise, put the estimated cost at somewhat more than $200,000,000. Subsequently M. De Lesseps visited the Isthmus with an "international technical commission," and, after eight weeks' surveying—although the work to be done was reported greater than at the commencement—the original estimated cost was actually cut down to about $125,000,000, and on this statement from him the money of French investors began to pour in for the building of the canal. Up to the beginning of this year there had been thus raised $150,000,000, counting also the expense of raising the money, and this had been so far spent in September last as to leave a balance of less than $10,000,000. Later and exact figures are not to be had, but it is continually becoming apparent that the quantity of excavation to be done has enormously increased, the estimates now placing it at least three times as much as was calculated upon at the original congress in Paris. It is to be remembered, also, that the whole work is not yet surveyed, and the problem of disposing of the waters of the Chagres River is yet to be met.

Taking all these items into consideration, and putting off the time of completion at least as far as 1892, the London *Financial News* puts the probable cost of the canal, including discounts, at $530,000,000. Whether M. De Lesseps has any charm by which he can manage to raise all this money among French investors, or whether any one thinks the French Government might eventually seek a controlling interest and complete the work, because the money now represents so many small subscriptions of Frenchmen, are questions we do not seek to pursue.

Any statement as to the Panama Canal, however, necessarily calls up the Tehuantepec project, the Nicaragua scheme seeming for the present out of the question, as one which would possibly cost nearly as much as the Panama, and be quite as long before completion. About $300,000 has so far been spent for an inception of the Tehuantepec scheme, careful instrumental surveys having been made from ocean to ocean, and hydrographic surveys of the harbors and water connections at each end of the line. The length of the route proposed is 134 miles, there will be nowhere any heavy grades, and it is actually demonstrated by the surveys that there can be no exceptionally difficult work in making a railway and suitable harbors. The estimates for cost, therefore, may be made with far more confidence than was the case with the Panama Canal, and Captain Eads places the figures for the whole work at $75,000,000, for a road that will give a tonnage capacity equal to that of the Suez Canal.

While, therefore, the proposed ship railway of Captain Eads has been before the public for many months, the capital has not yet been obtained to build it, although more than is necessary for its completion has been invested in small sums in France for a canal at Panama. The advantages of the more northern route for interoceanic communication, and the exceedingly liberal concessions offered by the Mexican Government in support of the enterprise, have not been sufficient to induce capitalists to make the investment, as yet, in the absence of some positive support by the United States Government, which would certainly have a large interest in any such channel of communication between the Atlantic and Pacific from the moment of its completion. Perhaps a large portion of this apparent want of confidence among investors proceeds from the fact that no such ship railway as this was ever before built. Its practicability and economy have, however, been testified to by the most eminent shipbuilders and engineers in this country and Europe, among whom are included three of the chief constructors of the United States Navy; the present constructor of the British Navy, and his predecessor in office; the Chief Engineer of the Liverpool docks; the present scientific advisor of Lloyd's Register of British Shipping, and his predecessor, now the chief superintendent of the Barrow Ship Building Works; the builder of the Oregon, Alaska, and other famous steamships, and numberless other naval architects and engineers of the very highest standing in their professions.

Mr. Eads, therefore, in the absence of the necessary popular support, asks the government to guarantee that the road shall pay a net revenue of $2,500,000 per year, the Mexican Government having already agreed, with this provision, to guarantee $1,250,000 per year, such guaranty to attach only after the completion of the road. The promoters of the enterprise do not believe the government will be called upon to pay any portion of this guaranteed sum, but Captain Eads, in a letter to Secretary Bayard, expresses the opinion that with such guaranty the necessary capital can be raised, and the road completed in four years.

PRESSURE AT GREAT SEA DEPTHS.

In *Science* for July 17, p. 54, the deep sea fishes secured by the "Challenger" are mentioned as coming from "regions where the water permeating all their bodies is under immense pressure; but the tissues must be loose to admit of such permeation, or they would be crushed and ruined under a weight which shivers solid glass to powder." The statement needs revision, as to both fact and theory. We will see the theory first; the facts may come later.

Obviously the same rules of pressure apply in every instance, be the amount of pressure greater or less, on the surface of the sea (our ordinary status), or at 10,000 fathoms. Action and reaction are equal, and where pressure is fully counterbalanced it becomes actually no pressure. We say that ordinary pressure of the atmosphere is, in round numbers, fifteen pounds to the square inch, and the common air-pump experiment proves it. When we open the stop-cock, the receiver, which had been firmly fixed to the plate, at once becomes loose and free. Why? There is precisely the same amount of pressure on its external surface that existed a moment before, and yet we lift it now easily, and we say truly that it is because the pressure within and without is the same, and that the result is *no pressure*.

In our own personal condition, we move without consciousness of any difficulty whatever, notwithstanding that mythical number of tons that the school books figure out for us as our normal load, by applying the regular fifteen pounds to our superficial inches, and we are every one of us conscious that no such burden has any existence. It is truly a myth and a most absurd one. The simple truth is that each individual microscopic cell of our entire structure, though not in sensible manifestation filled with air, is in direct correlation and connection with the surrounding atmosphere, as completely as though we could show it by microscope and test-tube. The air cells of our lungs are no more truly balanced in air pressure than are the microscopic cells constituting the membranes which form each air cell, and, being thus balanced in all parts, the superincumbent atmosphere is to us no "Old Man of the Sea," and we are as free to move as though it had no weight whatever. This our continued experience shows us, and we feel no wonder at it. But the same thing must necessarily be true under other degrees of pressure, and a fish at 5,000 or 10,000 fathoms doubtless experiences no sense of burden, nor does he find any more difficulty in moving than a trout in his native brook or a gold fish in one of our glass globes. Every cell of his tissues is perfectly balanced in its relations to the surrounding water, and his organs of motion show us beyond question that his movements are as free as ours in the air.

The proposition as given above, that "the tissues must be loose to admit of such permeation," etc., can scarcely be maintained by good argument. No reason is apparent why water at any depth should not balance itself as readily in firm tissues as in those that are loose, and we know, in fact, that it does so. Every one of the deep sea fishes has more or less of parts that are relatively solid, although the muscular fibers may be loosely aggregated. Bones are manifest, and it is plain that every one of these must be subject only to balanced pressure, that is, no pressure. If we suppose even a single fiber to be subjected to "a weight which shivers solid glass to powder" (provided there is an air space in the glass), it is not difficult to see what result must take place. The jaws of a vise or the end of a set screw could not jam it tighter, and every semblance of organization would be obliterated. Such pressure never occurs to any living creatures, or to any of their parts, without their instantaneous destruction.

But having looked now at the theory, a word is due, also, as to the facts concerning ths residents of the deep sea. The looseness of tissue among the fishes generally is not disputed, but the same thing is not true concerning the animals of lower grade. Crustaceans, mollusks, etc., are found in large numbers, and their construction is in wide contrast with that of the fishes; they are reasonably firm and solid, which necessarily could not be were looseness and great depth correlative conditions.

We can now readily understand how incorrect and inconclusive were the experiments of M. Regnard last year on this point. He used a special apparatus by means of which he could bring to bear a pressure of 1,000 atmospheres. He tried it on a "golden cyprin" in water, and at 400 atmospheres the fish was "dead and absolutely rigid;" nor can we wonder, although the curious and inexplicable attempt had been made to save him by exhausting his air-bladder in advance. His tissues were of course adjusted in balance to only our surface pressure, and the artificial and rapid addition first paralyzed him, and then literally squeezed him to death. Solid iron could not have crushed him tighter. Theoretically it would be possible for a fish of the deep sea to change his habitat to the upper waters by making the transit through slow gradations, but that this is ever done practically we have no means of knowing. The specimen of *malacosteus*, the earliest known of these deep sea fishes, was found floating at the surface, but he was nearly dead, and had doubtless come up from some abnormal cause.

W. O. AYRES.

The Jablochkoff Auto-Accumulator.

The battery is composed of a number of cells or shallow trays, 4 inches square and ½ inch deep, of impermeable carbon, in each of which is placed a small quantity of iron turnings or zinc clippings. Over these is placed a covering of thick coarse canvas, saturated with a solution of chloride of calcium, upon which is laid a row of very porous carbon tubes, about 3 inches long and ⅜ inch diameter outside, which are similarly saturated. In this way a cell is formed with three electrodes, one of which oxidizes, a second becomes polarized, and the third forms a positive pole with the second, the first two forming a couple with a constantly closed circuit. For service a number of these cells—nine or ten—are placed within a metallic framing, after the fashion of a voltaic pile, the bottom cell resting on a metal plate forming one of the poles. The top cell is covered with a plate of carbon, to which a terminal is fixed, and this forms the other pole. The auto-accumulator produces alternately a primary and secondary current, the latter only being employed in the external circuit, while the former serves to produce the hydrogen necessary to polarize the electrodes. This action stops as soon as polarization is complete, and is resumed when depolarization takes place, so that short and frequent intervals of rest are necessary for the battery to reform itself for the production of the useful current. In practice, when this current is employed for continuous work, the batteries are coupled in groups with commutators, so that no interruption in the current takes place.—*London Times.*

IN science nothing can be permanently accepted but that which is true, and whatever is accepted as true is challenged again and again. It is an axiom in science that no truth can be so sacred that it may not be questioned. When that which has been accepted as true has the least doubt thrown upon it, scientific men at once re-examine the subject. No opinion is sacred. "It ought to be" is never heard in scientific circles. "It seems to be," and "we think it is," is the modest language of scientific literature. In science all apparently conflicting facts are marshaled, all doubts are weighed, all sources of error are examined, and the most refined determination is given with the "probable error." A guard is set upon the bias of enthusiasm, the bias of previous statement, and the bias of hoped for discovery, that they may not lead astray. So, while scientific research is a training in observation and reasoning, it is also a training in integrity.—*Pop. Sci. Monthly.*