distant from the proposed clearing; moreover, the distance of this point from each end of the line could not (as in the last case) be found with sufficient accuracy, so observations had to be made from two stations, whose distance apart could be measured. With a theodolite at D (fig. 2), close to the edge of the wood, the angle ADB was twenty times observed; and from its mean value and the approximate distance of D from A and B (as given on the Staff map), the angles φ and ψ were calculated in order to find the direction of the perpendicular DC. This line was then produced to D_1, from which point the angle $A\ D_1B$ was also twenty times observed, the distance $D\ D_1$ being accurately measured. The length of the perpendicular D_1C and its direction were next calculated, and the intermediate point C thus found, at which, by setting off the right angle $D_1\ C\ B$, the direction of the required clearing was laid off toward B and afterward extended toward A. Had the distance of D from A and B been known with sufficient accuracy, the second station D_1 might have been avoided. A special calculation proved that the error in φ and ψ, consequent on $A\ C$ and $B\ C$ being incorrectly known, would average about 22″; and if this clearing was 500 meters long, its far end would lie

$$500 \times \text{sin. } 22'' = 0.055 \text{ meter}$$

out of position, an error quite inappreciable in this case.

The second instance referred to a clearing over the Schneeberg ridges (which were densely covered with pines of fifteen to twenty years' growth), and differed from the first in that the line of sight between Kapellenberg and Ochsenkopf was found, after considerable trouble, to cut the ground about 2 meters below the highest point of this ridge. A very interesting account is given of the difficulties encountered in determining the site of this clearing and in fixing the heghts of the pillars upon the Kapellenberg and Ochsenkopf, in order that the observations might cross 2 meters above the highest point of the Schneeberg ridge. E. H. C.

AN ACCIDENT AT CINCINNATI.

The Cincinnati *Commercial*, of June 30 and July 1, contains accounts of the destruction, at 10:30 p. m. on June 29, of the new steel water tank for the high-service supply on Price's Hill. The tank had been in process of construction for more than three years. It was built on a foundation of solid masonry, and was situated about one-third of a mile northwest of the Price's Hill Inclined Plane. It was only completed so as to be ready for use about two weeks ago, and had never been entirely filled. It was 100 ft. in diameter and 40 ft. in height. Its capacity when full would have been 2,700,000 gallons, and at the time of the break it was estimated that it contained 2,242,000 gallons.

The tank was constructed of half-inch steel at the bottom and one-fourth inch at the top. The bottom was fastened to the solid masonry foundation by Ts or clamps, four in number, These clamps were about three or four inches in length from the angle, the upper portion being riveted in the tank and the lower to the bottom, which in its turn had been fastened to the foundation. It was naturally supposed that until the tank had been completely filled there would not be any considerable pressure. This theory, however, unfortunately proved not to be the cause. With the water less than 8 feet from the top of the tank, the clamps or Ts gave way, and in a second the huge concern was whirling down the embankment, while the water poured in torrents down the ravines, steep hillsides and still steeper roads.

When the tank left its moorings and tumbled over toward Glenway avenue, the water rushed heaviest toward Consodine avenue, and thence by ravines and cuts and roads to the Mt. Hope road, where there seemed to be for a time a miniature "mad" river. Along the Mt. Hope road stones weighing fifty to one hundred pounds were torn from position and thrown up alongside of fences. Small trees were uprooted, and the plank sidewalk for a distance of four or five squares was torn up and carried away.

THE GREAT DAMAGE

seemed to fall on the property on Consadine avenue, to which part of the hill the water seemed to rush first. Another large portion ran toward Glenway avenue, while what was left found its level through other channels.

DAMAGE TO PROPERTY.

One of the first buildings to catch the flood was the residence of P. J. Hogan, formerly a Police Commissioner of Cincinnati. It was a two-story frame, and shaken from its foundations somewhat, but was not damaged so as to require any extensive repairs.

Mr. Hogan happened to be in an outhouse at the time and fell into the vault. His cries brought assistance and he was rescued, more scared than hurt. Superintendent Moore says that the "burst" took place in the middle of the tank facing Consadine avenue, at a point three rings from the bottom, which would be 12 ft. up, and that a hole was torn out 48 ft. long and 24 ft. wide, leaving 12 ft. of the circle above the rupture remaining. This huge mass was thrown 75 ft. from the tank across the ground, carrying in its fall a heap of hammered limestone to be used as a wall around the lot, and thrown into the deep cut of Consadine avenue.

All the rest of the enormous mass was floated north and carried down the steep declivity and deposited in a completely flattened-out shape in Purcell avenue on the west, and Glenway avenue on the north, thus forming an irregular angle in the right angle formed by the intersection of those unfinished streets. All the portions of the tank which are visible present the outer side.

All around the circle of the bottom the thick steel plates were torn off all the way round as if they had been rotten cloth, the ragged edges of the severed metal presenting that sort of a torn appearance.

The tank was constructed after the designs of the late James E. Bell, superintendent of the waterworks. The city built the foundation of masonry, which was supervised by Col. A. L. Anderson, and has not given way. For the superstructure, the specifications were as follows:

The tank to be composed of twelve (12) rings of the best quality of fibrous boiler iron plates of a tensile strength of 60,000 pounds to the square inch.

The annexed tables give the required thickness and weight of iron in pounds per square foot, and also the number, length, width and area for all the plates for the bottom of tank and for each ring in the circumference of the tank.

The length, width and area of the plates given in the before-mentioned tables, includes the width of laps for the different sizes of rivets, to be used for joining the plates.

In the weight of iron given in the table, no variations will be permitted of more than two and one-half (2½) per cent. below standard weight.

All the rivets to be used for joining the plates must be what is termed "rose-head" rivets.

All the vertical joints in the first six (6) rings of plates, from the bottom upward, to be double riveted, known as "staggered" riveting, the remainder of the six (6) vertical joints, as well as the horizontal joints and the joints in the bottom of the tank, to be riveted with a single row of rivets.

The diameter, length and pitch of rivets, corresponding to the thickness of plates and width of laps for joints, are given in the annexed Table No. 3.

A rim of "channel" angle iron, $6 \times 5 \times \frac{3}{4}$ in thickness will have to be riveted to the bottom and side plates, on the outside of the tank, as shown in the working drawing. The same to be double riveted to the bottom and single riveted to the sides plates, with rivets 1 in. in diameter and 2⅞ in. long, spaced 2 in. apart from center to center.

An angle-iron flange, $4 \times 3\frac{1}{2} \times \frac{1}{2}$ in thickness, is to be riveted to the top edge of the uppermost ring inside the tank, with rivets 1 in. in diameter and 1⅞ in. long, spaced 6 in. apart from center to center.

In order to stiffen the tank, T-iron bars, $4 \times 4 \times \frac{1}{2}$ in thickness will have to be riveted vertically, inside to the side of the tank, with rivets 1 in. in diameter, 1⅞ in. long, spaced 6 in. apart from center to center, as shown in the working drawing.

Two angle-iron flanges, $2\frac{1}{2} \times 2\frac{1}{2} \times 5\text{-}16$ in thickness are to be riveted to the center plate and bottom of the tank as shown in the working drawings, with rivets 1 in. diameter and 2⅛ long, spaced 2 in. apart from center to center.

In the bottom of the tank above the chamber, three openings of twenty-two inches in diameter each will have to be made, to pass the pipes through, and in the side of the tank at the lower ring of plates, two manholes of an elliptic shape, and of the usual size (16″x24″) with frames, flanges and caps will be required.

The total estimated weight of iron plates, rivets and angle-iron for the tank amounts to 383,558 pounds, or 192¾ tons of 2,000 pounds.

As the work progresses, the plates to receive a good coat of suitable paint, both inside and out, to protect them from rust, and after the whole tank is completed to receive another good coat of plastic plate paint.

Bids were advertised for, and the following were received:

D. W. Carroll & Co., Pittsburgh	$29,950.00
Tudor Boiler Manufacturing Co., Cincinnati	35,640.00
D. W. C. Carroll (alternative proposition)	35,400.00
Ritter & Conly, Pittsburgh	31,000.00
Motherwell Iron Co., Lancaster, O	23,313.41
C. T. Dumont, Cincinnati	26,800.00
Cincinnati Stationary Engine and Hydraulic Works	31,520.00
Arthur G. Moore, Cincinnati	26,360.00
George Stacey & Co., Cincinnati	25,276.90

Mr. Moore's bid read as follows:

"I will contract to furnish the proposed tank of the dimensions, in the manner and on the conditions required, on the following terms: 6⅞ cents per pound, or to complete the entire tank in accordance with the specifications for the sum of $26,360, and furnish a tensile strength of 65,000 pounds to the square inch if required."

Mr. Moore proposed to use ingot iron or steel plates at a greater tensile strength than the specifications called for, but his bid was thrown out as informal, because it did not happen to include the obligation to furnish a sample and test.

He subsequently sent a communication in to the Board, showing why the award should have been made to him, and he had a lively sort of a wordy "set-to" with Mr. Foote on the subject, but without effect.

On the 22d of January, 1879, Superintendent Bell reported the bids, with the following recommendation:

I have examined the different samples of materials that the various contractors propose to use in the construction of the tank, and would report that the firm of Messrs. George Stacey & Co. furnished the best samples, which are in every respect equal to the quality called for by the specifications. Respectfully yours, JAS. E. BELL.

Before the contract was entered into Messrs. Stacey agreed that in event of the abandonment of the vertical T irons in the tank, they would agree to put in the vertical joints of the side sheets without extra charge.

The above recommendation was approved February 8, 1879, and the contract was entered into accordingly. On the 25th of February the contract and bond of George Stacey & Co. were approved.

DEVIATIONS.

The following notes of deviations from the specifications have been handed in for publication, in justice to the late Superintendent Bell:

First—The specifications provided that the angle iron to which the lower or first ring was riveted should be on the outside, for the obvious and twofold reasons of bracing and staying. Instead of this it was riveted on the inside, which produced one of the causes of rupture.

Second—The specifications required vertical stiffening bars from bottom to top. These were not put in.

Third—The contractors were allowed to use the drift to bring the rivet holes to the proper position, and the evidence of the misuse of this tool, and the principal cause of the disaster, is the numerous fractures it caused.

Fourth—It was Mr. Bell's intention to further strengthen the tank by hog chains radiating from a center plate, riveted to bottom of tank. The plans at the water-works will vouchsafe this statement.

Fifth—By bad inspection a number of the largest rivet-heads were passed when they should have been condemned because they were not "driven home." To cover up the defect the cracks were puttied up.

Sixth—It can be proven that a number of parties of mechanical reputation ridiculed the sizes of iron plates as being too large, and of unnecessary strength, and consequent increased expense, and some of these knowing ones went so far as to protest to the Board; and to satisfy the clamor the factor of safety was kept down to as low a point as was consistent, and if Mr. Bell had been spared to carry out his plans the disaster would not have occurred.

For the benefit of the public it may be stated that Mr. Bell died before the construction of the tank was commenced, the construction being done under Mr. Warden's supervision.

On Nov. 26, 1879, the City Commissioners changed the specifications, and, upon the recommendation of Superintendent Bell, a supplementary contract was made with Stacey & Co. "to change the three upper courses or rings to form the tank at their bid of $1,500."

On the 2d of December, 1879, a supplementary

contract was entered into with Stacey & Co. by the City Commissioners as follows:

First—All iron used must be of a tensile strength of 65,090 pounds to the square inch, and equal in every respect to the sample furnished.

Second—Instead of the T-iron bars, provided in the specifications, the contractors must, without extra charge, butt the vertical joints of the tank with "cover strips" of the same material and thickness as the plates, double riveted in the manner described.

When the Board of Public Works was restored, the present Superintendent of Water-works, Mr. Arthur G. Moore, took the superintendency of the tank construction, and on the 28th of April, 1880, he recommended it as "necessary to girder the upper ring courses of the tank, in order to enable them to properly resist the violent storms," and an agreement was entered into with Stacey & Co. to perform this extra work at their bid of $2255.

The city expended on the tank up to January 1, 1881, a total of $58,603.41, which is itemized as follows: Ground rent on the place, $3,600; property on Glenway avenue, $3,000; improving Consadine place, $12,943.10; foundations for tank, $9,610; Stacy's tank contract, $26,503.32; valves and connections, $1,025.66; new boilers, $820.93.

PERIODICAL MOVEMENTS OF THE GROUND AS INDICATED BY SPIRIT-LEVELS.*

BY M. PLANTAMOUR.

This paper narrates the experiences of a second year's continuous observations from 1st October, 1879, to 30th September, 1880. The levels were arranged as before, but readings were only taken twice a day, at 9 a. m. and 6 p. m., the first a little after the minimum, the second rather before the maximum, diurnal movement; the mean of these represented the bubble-position for that day. The curve-trace was also modified so that it might indicate the ground movements directly in seconds of arc, instead of in millimeters of the bubble-scale.

I. *The Level Placed East and West.*—From the middle of November the east end fell rapidly, and toward the end of that month and up to December 26 in a most marked and unexpected manner, until such depression amounted to —88.71 seconds. It then rose 6.55 seconds up to January 5, to fall again and gradually reach (on January 28) the minimum for the year, viz., —89.95 seconds. After this date it rose slowly, though, as compared with the preceding year, very gradually, following in general the daily rise and fall of the temperature. The total amplitude of the oscillation from October 4, 1879, to January 28, 1880, was 95.80 seconds against only 28.08 seconds the previous year.

Two facts in this curve are most noticeable, as proving that these ground movements are partly due to some other unknown factor than the external temperature. 1st. The extraordinary depression from the end of November to the end of January, which certainly was not caused by any great absolute lowering of the temperature. 2d. The very insignificant elevation during this summer as compared with the previous one, and this in spite of the greater heat of this summer, especially of the last half of July.

II. *The Level Placed in the Meridian.*—This has not been influenced by the exceptional cold of the winter, and its oscillations present a striking resemblance to those of the first year, the total amplitude for the year being 4.56 seconds as against 4.89 seconds in 1878-79. The curve-trace throughout the year has been below the starting-point of 1878, but this arises from the readings having commenced that year on December 23 instead of on October 1. This year's curve repeats the still unexplained fact that the oscillations of the south end act in a *contrary direction* to the temperature from April to October—a fact which does not occur in the case of the level placed east and west.

In reply to criticisms, the author considers that neither of these oscillations can be due to any movements of the outside west wall of the house against which the masonry table is backed, because in the spring and summer of 1878 the levels were placed directly upon the ground in the middle of the cellar, and their indications were then sensibly greater than those observed during the same season in two consecutive years upon the masonry table. E. H. C.

NOTE.—M. Plantamour suggests whether there can be any possible relation between the great depression of the east end and the earthquakes which occurred about that time.

*From the proceedings of the Institution of Civil Engineers.

MINNESOTA SURVEYS.

DEAR SIR: We would ask your co-operation in the organization of a Minnesota Association of Surveyors and Engineers, similar to those at work in other States. We would include in this call all who are engaged or particularly interested in land surveying, as well as those in other branches of engineering, who are interested and in sympathy with our aims and willing to aid us with their counsel. We do not assume to represent the profession of civil engineers and surveyors of the State, but as having the welfare of our profession at heart and desiring to promote its interests and the interests of its patrons. We believe there is urgent need of greater uniformity in our methods of practice, and that through organization and the interchange of ideas which will follow that this result may be attained. We all know that our State law with reference to surveyors is grossly inadequate, and that the office of County Surveyor might as well be abolished as to remain as the statutes now leave it. We believe that legislation is also needed looking to the preserving and perpetuation of the government corners which are rapidly disappearing. Collectively we can determine what we want and what the public good demands in the way of legislation and then do much toward securing this legislation. Singly we can do nothing. The discussions in our legislature the past winter upon the Bookwalter bill—"to provide a better system of land surveys in this State"—has awakened an interest, and while the bill failed by a few votes it had the hearty support of the ablest members

At the next session, we can, if united secure the enactment of such a law as will be just to the surveyor and protect the public from incompetency and criminal carelessness in the practice of surveying. We have vexed questions arising in our practice and in these we can aid each other. We submit whether the decisions of the courts on questions of boundary should not be compiled and in our hands for reference. We believe that united action of the profession is demanded and can but result in benefits to us all, professionally and financially. To that end we invite you to attend with us and take part in a meeting at Minneapolis, at Geo. W. Cooley's office, 411 Nicollet ave., to begin on Wednesday, Sept. 7, 1881, at 2 o'clock p. m. This place and date have been chosen to secure the special railroad rates which will doubtless then be offered on account of the Fair. Business will begin promptly at the hour named and such action taken toward organization as those present may determine.

Parties receiving this circular are urged to notify surveyors and engineers of their acquaintance of this movement, as our list is incomplete. Let us have as full an attendance at our meeting as possible.

GEO. W. COOLEY, Civil Engineer and Surveyor, 411 Nicollet avenue, Minneapolis.
W. G. KELLAR, Civil Engineer, Albert Lea.
A. MOTZFELDT, County Surveyor, Albert Lea.
JOHN ABERCROMBIE, County Sur., Alexandria.
T. W. RUNDLETT, City Engineer, St. Paul.
F. E. PRATT, Civil Engineer, Anoka.
JOHN P. MUMFORD, Civil Engineer, Morris.
J. B. SALISBURY, Civil Engineer, Litchfield.
M. B. HAYNES, City Engineer, Mankato.
JAMES JENKS, County Surveyor, Clearwater.
D. T. WHEATON, County Surveyor, Morris.

MASSACRE OF AMERICAN SURVEYORS.

SANTA FE, N. M., July 6.—No particulars have been received regarding the massacre of thirteen of a party of American surveyors of the Mexican Central Railroad Company, forty miles south of El Paso. The surveying party was under the charge of Locating Engineer C. Mephane, a native of Illinois, and Engineer M. J. Cunningham. Mr. George X. Anthony, General Manager of the Mexico Central Railroad, who is at Paso del Norte, was at once informed, and armed parties were immediately dispatched to the scene of the massacre. So far none of the names of the killed have been learned. It is not positively known whether the raid was made by Indians or Mexicans, but it is supposed some of Victoria's war chiefs and right-hand men, who with about thirty warriors escaped from the Tres Castillos fight, are the perpetrators.

The Cincinnati Southern fairly opened for through business July 1, 1880. Of the freight earnings $692,-998.12 was for through freight, and $754,555.99 was for local. For six months ending July 1, 1881, the total gross earnings aggregated $1,005,318.95, and the gross earnings for 1881 are estimated at $2,400,000.

NOTES.

CLEANING OUT LIME-INCRUSTED WATER PIPES.

One of our correspondents writes: "As a sort of 'shop kink' I give you a curious experiment tried on an engine water-supply pipe that had become choked up with lime incrustation. After hammering it for an hour or two and kindling a fire all over it, without any result, one end was plugged up, and about a pint of refined coal oil was poured in the other end—all it would hold—leaving it stand all night. The next morning the entire mass slid out, a solid lime core. Before trying this we thought of throwing the pipe away as useless, and getting a new one."—*American Machinist.*

HEATING EFFECTS DUE TO COMPRESSION.

On two former occasions we have taken notice of the results of certain experimental investigations instituted by Professor P. G. Tait, of the University of Edinburgh, in regard to the thermometers used in the Challenger expedition, and the alleged effects of compression upon them when immersed to great depths in the sea. Still pursuing the line of inquiry suggested by the experiments made with these thermometers, the learned professor has since made a further series of experiments on the heating effects of compression of a number of liquids and semi-solid liquids, the results of which he laid before the Royal Society of Edinburgh on the evening of Monday, the 16th instant. He mentioned that he had employed a ton pressure upon each of a number of different substances, and had noticed in each case the rise of temperature due to the compression exerted. Marine glue gave a rise of temperature to the extent of 0.9° Fahr.; raw potato, 0.7°; pith, 0.87°; cork, 1.3°; a piece of bar soap, about 1-20°; a piece of liquorice and a piece of cheese, about ¾°; a piece of raw flesh behaved very much like the potato; india-rubber and solid paraffin rose in temperature about 1½°; lithographers' ink and shoemakers' and bees' wax, about 1.4°; lard, about 2°. After mentioning these details, Professor Tait said it was remarkable that potato and raw flesh, with so large a percentage composition of water, had a large comparative amount of independent heat produced, while pith gave no perceptible difference of effect over what would have been produced by water alone. Cork has this peculiarity, namely, that when the pressure was removed the fall of heat was only 0.9° Fahr., as against 1.3° of a rise on the application of the same amount of pressure. That seemed to agree, he said, with what was already known of cork, namely, that on the removal of the pressure it did not spring back to its original form. In these respects india-rubber was opposed to cork, which had this further peculiarity, that, on continued experiment, the amount of heat produced by the pressure gradually fell till it was the same as the amount of cooling which resulted on the relaxation of the pressure. About shoemakers' wax there was the peculiarity that it took a very long time before the heating effect was fully produced. Its chemical composition, also, was of course different from that of bees' wax, which yet had precisely the same amount of heat produced. In concluding his interesting communication, Professor Tait intimated that further research would be necessary before they could get definite facts showing the exact heating effects of compression, which, he added, would form the subject of a future communication.—*Engineering.*

THE ELECTRIC CONDUCTIVITY OF HEATED GASES.

Gases are generally considered incapable of conveying the current from a battery of only a few elements, though the spark from a powerful battery is known to traverse them. In 1853, however, M. Edmund Becquerel discovered that when brought to a red heat a gas would conduct the current of even a single Bunsen element. But he found that the conductivity did not follow the law of Ohm, which holds for solids and apparently for liquids. It depended on the intensity of the current, the number of cells in the battery, and, between two electrodes with unequal surfaces, on the direction of the current. These results have recently been questioned by Herr G. Weidemann, but M. Blondlot has vindicated the accuracy of Becquerel's conclusion by forming a circuit of a single Daniell cell and a Lipmann capillary electrometer, interrupted at one point by two platinum disk electrodes kept nearly ⅛ in. apart in air. When the passive state of the electrometer indicated that no current flowed in the circuit, owing to the breach caused by the non-conducting air, M. Blondlot heated the platinum disks red hot by means of an enameller's blow-pipe, and the electrometer then indicated a strong current in the circuit. Consequently the