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PLUMBING OF THE TAMARACK SHAFTS

The Two Plumb Lines, Each 4,250 Feet Long, Give Some Decidedly Queer Results.

At the Tamarack mine there has recently been conducted an experiment of the deepest interest to the engineering world. To the test made there was nothing new in principle, but the actual facts are such as to make it unique. In fact, it stands alone as an undertaking in mining engineering that may lead to certain new conclusions as to the laws of gravitation. Though to the mining engineer the result was not just what was expected, discoveries were made that to the scientific world in general may prove of value.

A plumb line dropped a distance of 4,250 feet is certainly something unusual, and a pendulum swinging to and from 4,250 feet from the stationary point is out of the ordinary. Indeed, never but once has it been attempted to make use of a plumb line over 4,000 feet in length and never but once has a pendulum with a rod over 4,000 feet in length been experimented with. This once was at the Tamarack mine and but a short time ago, and the history of the experiment, together with the results obtained, is extremely interesting.

From the new No. 5 shaft, the deepest perpendicular shaft in the world, it was desired to crosscut a distance of 800 feet at the twenty-ninth level, or 4,250 feet from the surface, over to the lode. Already from the twenty-ninth level of No. 2 shaft, which is 3,220 feet at the surface from No. 5, there was a crosscut of 2,200 feet to the lode and a drift on the lode, from this crosscut, 460 feet in length. In order to facilitate the work of reaching the lode from the new shaft, it was desired to begin working away from the shaft and toward it from the farthest point of the drift from No. 2 shaft; in other words, the engineers desired to solve the old tunneling problem--that of beginning work at either end and meeting somewhere near the centre.

In order to do this it was necessary to give the men working from the No. 2 shaft drift the proper direction. Already they had at the mine office a survey from which it would have been possible to have begun work, but it was desired to verify it. It was made years ago, and the engineers thought that the opportunity of satisfying themselves as to its accuracy was at hand. The dropping of the plumb line was the first step.

Chief Engineer J. B. Watson and his assistants went to work to use the method that had been tried many times. It had been tried at the Tamarack mine before and had been a complete success. At the vertical shaft of the Calumet & Hecla, known as the Whiting or Red Jacket shaft, plumb lines had been dropped by the engineers, and at other mines where vertical shafts are in use it had been successfully tried. In principle it was nothing new, but it was practically new, as never before had it been necessary to deal with a shaft close to 5,000 feet deep.

The idea was to drop two plumb lines down the shaft to the twenty- ninth level, then to take observations both at the surface and down in the mine, taking the same data. After this had been done at the new shaft it would be necessary to repeat the operations again at the old shaft, when it would be possible for the engineers to give the miners, working away from the old shaft and toward the new one, the proper directions to enable them to meet the men working in the opposite direction. The idea was a simple one and one that is known to all mining men.

It was realized that a line of unusual strength was to be experimented with, so the engineers began to make tests in order to settle upon what sort of a wire should be used. No. 24 piano wire was finally settled upon, but thorough tests were made before the real work was begun. The wire selected was of steel and possessed a tensile strength of 350,000 pounds to the square inch. A piece 30 feet long was taken for the test. It was suspended and weights gradually added until it parted after 154 pounds had been fastened on it. This was quite satisfactory to the engineers, and the preparations for dropping two lines of No. 24 wire down the shaft went on.

A small two-cylinder hoisting engine operated by compressed air was placed at the mouth of the shaft, which is a five compartment affair, measuring 29 feet, 2 inches, by 8 feet, 10 inches. This engine was provided with loose running drums with grooves turned in the wooden lagging for the wire to be wrapped upon. Pulleys were placed over this shaft and the wires were lowered, after weights had been placed upon them, after the manner of lowering any sort of a line.

It was necessary, of course, that each wire have something attached to it to carry it down. It was not thought best, however, that common weights be used, as it was feared they would in some manner get caught in the timbering and ruin the whole experiment. Two "balloons" were, therefore, constructed. They were each ten feet long and built entirely of wood, weighing 20 pounds. They were two and one-half feet in diameter at the centre, tapering to a point at either end, and were made of slats so that a lantern hung in the centre cast its light about and the progress of the balloons could be watched from above and from below.

Thus equipped the lines were dropped. In just half an hour the 4,250 feet had been reeled off and things were about ready for the actual test. Absolutely no difficulty was experienced in dropping the lines; they went down without interference from anything, and perhaps the most difficult part of the experiment was the most easily accomplished.

It was now desired to get the lines as far apart at the surface as possible, and so eight-pound plumb bobs were substituted for the balloons. The engineers had been afraid to lower the lines too near the timbering for it was not desired to have the balloons come int contact with anything on the way down; for this reason the pulleys over which the wires ran at the surface were not placed as far apart as was possible. With the balloons out of the way the distance between the lines at the surface was increased to 17.58 feet.

When this had been done 50-pound cast-iron bobs were substituted for the eight-pound ones, and the wires stretched a distance of 15 feet. They were cut to the proper length and then the bobs were immersed in pails of engine oil in order to kill all the vibration possible. Here something un-looked for happened; the wires shortened up 25 inches because of the buoyancy of the oil.

The greatest surprise developed, however, when the distance between the two wires was taken 4,250 feet below the surface. It was found that they were 17.65 feet apart, showing a divergence of .07 feet. It was quite unexpected and no one about the work could explain it. After careful examinations had been made both

on the surface and at the twenty-ninth level and the measurements had been verified, it was decided that some timbering or something somewhere in the shaft was the cause of the difficulty, and one of the men volunteered to climb down the entire distance and examine the wires. Thus he did, but found nothing, and to this day no one has offered a solution for the phenomenon.

President F. W. McNair of the Michigan College of Mines, was present and he conducted an experiment with one of the lines as a pendulum. The bob was drawn aside one foot and fastened with a thread. He then set his instruments, and the thread was burned. The great pendulum swung back and forth, but again great surprise resulted. In 20 minutes the bob came almost to a standstill, which was something the observers were not prepared for. It was, however, explained by the fact that water was continually dripping down the shaft and evidently exerted a restraining influence.

Observations were also made by the engineers to ascertain just what was the vibration of the lines while the bobs were suspended in the oil and there was nothing but natural causes to cause vibration. A scale six inches in length and graduated to thirtieths of an inch was placed behind each of the wires. The vibrations were found to be very slow and not over one-quarter of an inch as a maximum. This was done in order that the mean might be learned by which the instruments could be lined up.

Thirty-six hours from the time the work was begun the engineers had finished and the lines had been drawn back to the surface. It required about a half hour for the engine to hoist the wires. The balloons were replaced and the two lines were taken to the surface without difficulty.

Within a week from this time the same test was made at No. 2 shaft. The same engine and apparatus were used and the whole experiment was done in a day. The experience at No. 5 was of much value and assisted greatly in hastening the work at the old shaft. Before the work was begun this time a telephone was installed at the twenty- ninth level and connected with one at the surface so that the engineers could communicate with each other with ease.

At this shaft the same phenomena were noted and with very little change, except that the divergence of the lines was even greater. Lead bobs instead of cast-iron were used, but no change was effected, as there was a divergence of one-tenth of a foot, the distance between the wires at the surface being 12.6 feet and down in the mine 12.7.

Several explanations have been offered for the fact that the wires supposed to hang parallel to each other were farther apart 4,250 feet below the surface than they were at the surface, but no one has suggested anything that seems to cover the question. It seems to be the general opinion that attraction or repulsion somewhere accounts for the phenomenon, but where it is, and why it should be no one knows. Were there no disturbing forces at work there should be a slight convergence.