Du Toit's Pan and Bultfontein mines were discovered in 1870 at a distance of 24 miles from the river-diggings. The diggers took possession of those places. Licences were granted giving the first diggers a right to work. In 1871, De Beer's and Kimberleys mines were discovered, and, in 1872, Mr. Spalding's great diamond of 282¼ carats was found at the river-diggings.

The mines were of irregular shape, and were surrounded by reef. The top reef was a loose shale, and had given great trouble from the frequent slips. Below this were strata of trachytic breccia and augite the formation was then seamy to an unknown depth.

Within the reef, the surface soil was red, and of a sandy nature. The next stratum was of a loose yellow gravelly lime, and the third blue, of a hard slately nature. This was the real diamantiferous soil. Large stones had been found in the "yellow," but the working of this generally did not pay. Kimberley mine, however had paid very well all through. The method of working in deep ground was determined by roadways running north and south. The soil was hauled up to these roadways, and taken to the sorting tables. The roadways decaying shortly after exposure to the atmosphere, a system of hand windlass was adopted, which worked very well for a time until horsewhims were introduced in 1873. The depth of the mines increasing, horsewhims had to give way to steam-engines in 1876.

The first diggers treated on an average 10 loads per day each party. At the present time, the least taken out by any engine, when fully employed, was 250 loads per day. The cost of working, with present appliances, the first 100 feet in depth, was 3s. 6d. per load; the second 100 feet (mostly blue) 5s., the third 100 feet 8s., and the fourth 100 feet 11s. Through scarcity of water a system of dry sorting had to be resorted to for several years, but it was superseded by the introduction of washing-machinery, which was now generally employed.

At the commencement, through inexperience, many serious mistakes were made. When the first diggers reached the bottom of the red sand, they thought no diamonds would be found in the next stratum. When, however, diamonds were found in the second stratum, the diggers had again to remove the *debris*, and so also when the "blue" was reached. Some of the claims in the Du Toit's Pan and Bultfontein mines were irregular in shape. The other mines, however, had been properly and regularly laid out. One or two shafts had been sunk and connected with the mines by underground galleries. These galleries were convenient in the case of falls of reef. Labour, at first, was cheap; but from 20s. per month, wages rose to 30s. per week, and food. The yellow soil offered no difficulty in working, being loose and broken, but the blue soil required blasting.

Several methods were adopted for extracting the soil and carrying it from the mine before steam was introduced. The cost of wood for heating purposes was a serious item, but good coal had now been found at 160 miles from Kimberley, costing £13 per ton, another serious item of expense was the transport over natural roads only, costing from £18 to £30 per ton.

The machinery designed by the Author for this industry was described. A 16 H.-P. direct-acting winding-engine was introduced for hauling up loads at the rate of about 1,000 feet per minute, and a 25 H. P. geared-engine, for hauling up heavier loads, at the rate of from 600 to 700 feet per minute.

Water was dear, and water-heaters were fitted to each engine, by which 33 per cent. of the water was again used, thus saving one-third. The boilers were as the locomotive type, mostly of steel, to save weight, and thus reduce the cost of transit. The fire-boxes were also made of steel of very soft and ductile quality. A semi-portable engine was made for driving the wash-mill. The engine was so arranged that it might be removed from the boiler and placed separately. The boiler was made to work at a pressure of 140 lbs. per square inch. Automatic cut-off gear was fixed to each engine, and the governors were provided with a spiral spring for adjusting the speed. A screen, or cylinder wash-mill and elevator, were used for dealing with the diamantiferous soil, and were described. Standing wires were fixed at the back of the machinery, and passed over a frame fixed at the top of the mine, the end in the mine being secured to strong wooden posts. After the blue soil had been blasted and collected into trucks, it was placed in tubs, which ascended the standing wires. It was then emptied into the depositing-box. The yellow soil might be put into the wash-mill direct, also that portion of the blue which had passed through the screen fixed over the depositing-box. The remainder of the blue, which was spread out to a thickness of 4 or 6 inches on the depositing-ground some distance from the mine to dry, was delivered into the upper part of the screen. The return-water from the elevator, with a portion of fresh water, was also discharged at this point, and operations were thus greatly facilitated, the soil becoming thoroughly saturated, and passing more easily down the shoots. The large pieces which would not drop through the meshes of the screen were discharged into trucks at the lower end and carried away. The smaller pieces with water, in the form of sludge, fell through into a shoot, and thence were conveyed into the wash-mill pan, and there kept in constant rotating motion by agitators. The diamonds, and other pieces of high specific gravity, sank to the deepest part of the pan, and the remainder of the sludge was forced over the inner ledge to the elevator. The sludge was then lifted, and thrown upon an inclined screen and down the shoot over the side of the bank. The residue left in the pan at the end of the day's work was passed through a pulsator, in which, by the force of water, the mud and lighter particles were carried away, leaving behind the diamonds, agates, garnets, and other heavy stones. It was the practice occasionally to put a few inferior stones in the soil, to test the efficiency of the machinery.

In 1881 the Author paid a visit to Kimberley, and found the industry a large one. The Post-office return showed the value of diamonds passed through the office in one year to be £3,685,000. Illicit diamond traffic had hitherto been a source of great trouble at the Fields. It was a question whether this industry would ever cease; in any case there was no doubt but that it would last for over a century. It was believed that the main bed of diamonds had not yet been reached, and that the mines in operation were merely shafts leading to it. Now that the waterworks were finished, with a bountiful supply of water, coupled with the great boon of railways to the Fields, and the advantage of a law recently passed for the prevention of illicit buying, a great and prosperous future was in store for the Diamond Fields.

THE DETERMINATION OF COPPER IN STEEL, by Magnus Troilius Chemist to the Midvale Steel Company, Philadelphia. Read at the Boston Meeting, February, 1883.

The following is a very rapid method for determining copper in steel. I have found it to give results very closely agreeing with those obtained by galvanic precipitation of the copper.

Five grams of steel are dissolved in a mixture of 100 c.c. of water and 100 c.c. of sulphuric acid. When all is dissolved, add 2 c.c. of a concentrated solution of hyposulphite of soda and stir well. After 15 minutes boiling, all the copper is down as black sub-sulphite of copper (Cu_2S) and the solution regains its greenish color. Filter rapidly, wash a few times with hot water, pierce the filter, and wash the precipitate back into the beaker, in which it was made.

Dissolve in a little aqua regia and evaporate with about 2 c.c. of sulphuric acid, until white fumes appear. Dilute with water, heat to near boiling and add excess of ammonia (sp.gr. 0.96). Allow to settle in a warm place, filter and wash with hot water containing some ammonia. From the filtrate evaporate the excess of ammonia, add a little dilute sulphuric acid till it is slightly acid, and precipitate the copper as before with a few drops of hyposulphite of soda. Filter on a washed filter-paper, wash with hot water, place the wet filter in a weighed porcelain crucible, ignite and weigh as oxide of copper (CuO).

When an ordinary Bunsen burner is used, care should be taken not to let the crucible come into contact with the inner cone of the flame.

ENGINEERS' CLUB OF PHILADELPHIA.—Record of regular meeting, April, 21st 1883: President Henry G. Morris in the Chair, 22 members and 2 visitors present. Mr. Percival Roberts, Jr., exhibited a turning from a cast steel roll. The dimensions of the roll, which was cast from open hearth steel, were about 30 inches by 5 feet 6 inches. The turning is 4 inches wide by 12 inches long, 1-32 inch thick, showing the roll to be very homogenous and very tough for cast steel. A communication from Mr. E. H. Talbott, Secretary National Exposition of Railway Appliances, requesting the cooperation of the Club in the proposed Department of Engineering Exhibits, was presented and discussed.

Record of Regular Meeting, May 5th, 1883.—President Henry G. Morris in the Chair: 22 members and 2 visitors present. Mr. T. M. Cleemann was enabled to show, through the courtesy of Mr. W. W. Evans, of New York, a map and profile of the Southern Pacific Railroad in California, showing where it crosses the dried up bed of a lake, being below the surface of the Pacific Ocean for 58 miles, and attaining a depth below said surface of 266 feet. At this point it skirts a deposit of salt from 6 to 24 inches in thickness. He also showed a number of photographs of the Tehachapi Pass on the same railroad near San Fernando. In order to attain the summit with a sufficiently reduced grade, the line was "developed," advantage being taken of a conical hill to wind about it in the form of a helix, crossing itself and continuing on its way with several meanderings. The St. Gothard Railroad has several such helices, but they are cut in the solid rock. A similar location was made about 18 years ago in the Southern Pennsylvania Railroad, but it was not built. Another piece of interesting location was also exhibited, namely, the mountain division of the Western North Carolina Railroad, which shows great skill in fitting a line to the country. Mr. George S. Strong described a new method of manufacture of corrugated boiler tubes. Mr. E. F. Loiseau gave a sketch of the progress and condition of the manufacture of artificial fuels. Mr. R. H. Sanders described a derrick used for hoisting material from a slate quarry by means of cable and bucket, and Mr. T. M. Cleemann noted a similar method pursued in the construction of a viaduct in Peru, 252 feet high, when the pieces were conveyed by a traveller to the pier. Mr. C. G. Darrach continued his remarks with regard to the relative quality of water at the top and bottom of deep reservoirs, and discussed methods of meeting the difficulty encountered in the accumulation of impurities below the surface.

THE AUTOMATIC GAS SEAL.

The tendency of improvements in blast furnaces has been almost exclusively in the direction of increased capacity. The marked success attained has naturally resulted in a very keen competition so that, in the future, economy in fuel, repairs, etc., will of necessity be the most important object to be sought by the iron smelters.

The automatic gas seal, shown in the accompanying illustration, is an invention of which the prime object is economy. It consists in a covering for the feeding hopper of a blast furnace, which covering has two or more openings (the number is determined by the size of the furnace), provided with lids N N hinged near the center. The lids are opened and closed by the movement of the lever arm B O C, which is pivoted at O. The moving power is derived from a cylinder connected to the arm B O at D and supported on trunnions in the fork of the lever F O1 G. The latter is pivoted at O1, and connected with B O C at C by a pin and slot.

In connecting and supporting the cylinder in the above manner its weight acts as a counterbalance to the lips, and action and reaction, that is, the upward thrust on the piston as well as the downward pressure on the bottom of the cylinder, both become effective in raising the lids, in consequence of which a much smaller cylinder will operate the seal than would be possible by any other arrangement. Furthermore, it is out of the way and easily got at. The illustration represents a design in which the blast is the motive force. The cylinder is eighteen by thirty inches, and cylinder K is twenty