

car service; and, although I have no desire to organize a crusade against this noble servitor of man, yet the demands of the investor for increased capacity with decreased cost are such that there is no other alternative than to accept the inevitable and adopt modern methods, and install the most modern machinery.

SIMULTANEOUSLY DEEPENING AND LINING A BELGIAN COLLIERY-SHAFT.*

At Ougrée Colliery, in Belgium, the air-shaft to be deepened 20 m. (22 yards) from the winding-shaft has a clear diameter of 3 m. (10 ft.), and it had to be sunk from the level of 480 m. (262 fathoms) to 580 m. (317 fathoms)—*i.e.*, for a depth of 100 m. (328 ft.)—and the measures to be passed through were perfectly well known from the sinking of the winding-shaft, which had preceded the air-shaft. As regards the first 50 m. (164 ft.) the measures were regular and tolerably compact; but as to the last 50 m., although of about the same resistance, the measures were more disturbed. In the sinking of the second portion of the winding-shaft they caused many difficulties; and when the sandstones were reached feeders showed themselves, while the dip of the strata varied between 50° and 75°.

The first 50 m. were sunk by the ordinary method—*i.e.*, with a temporary lining, followed up by a definite brickwork lining; but as regards the last 50 m. a new method was adopted, dispensing with a temporary lining, by putting in a definite monolithic lining at the same time that the sinking was proceeded with. As regards the excavation, the sterile rock, consisting of shale and sandstone, had practically the same thickness in each of the two 50 m. passes, so that an exact comparison could be made of the two methods.

All sinking operations in the coal-measures comprise the sinking proper and the lining, while the former generally comprises excavation of the rock, clearing away the matters excavated, keeping up the sides, taking off the water, the establishment of ventilation, and the arrangements necessary for taking down and bringing up the workmen. All these operations were the same in each of the two passes; but for the first, in which the definite lining was of masonry, a combined platform and template was employed, made of two plate-iron concentric cylinders, which permitted of placing the masons on a floor, also of plate-iron, situated practically in the middle of the height of the annular space, and to effect the service of the materials for the lower level by the central space, in which manner all cause of accident was avoided that might proceed from the fall of bricks or parts of the temporary lining while it was being dismantled. As the brickwork advanced the platform was drawn up by blocks and falls from above, the iron frame and the timbers being taken out when necessary and let down to the lowest level reached.

A brickwork lining in the coal-measures is generally considered the best, although it costs a great deal, while requiring much time and care; but it is not watertight, and requires the temporary lining with all its disadvantages, without counting the accidents that may arise during its erection, or while it is being taken down. This is so true that some coal-masters content themselves with this temporary lining, merely putting in planks close together behind the iron frames for constituting a definite lining. Now, if means could be found for economically and simultaneously putting in a definite monolithic lining as good as one of brickwork, if not better, without having to employ a temporary lining, and if at the same time, for effecting this monolithic lining, no more time, or even less time, be spent than in the temporary lining, it is evident that a considerable step in advance will be made.

There is simultaneity of sinking a shaft and putting in the definite lining when the latter is effected immediately after the sinking, but when, in passing from one of these operations to the other, recourse is had to a temporary lining there is no longer simultaneity. Starting from this principle, an attempt was made for the second 50 m. pass to obtain simultaneity between the sinking and the definite lining, which led to the seeking after a new method, and the formation of a first project. It was decided in principle to establish directly, after sinking for a few metres, a definite iron framework, well fastened to the inside of the shaft, to immediately fill up with masonry the space between the frames, and to continue in this manner by small successive passes. These frames were to consist of rolled joists bent and fished, being kept a metre apart by uprights of same section, the web of the bent joists being placed horizontally for opposing a greater resistance to the thrust of the measures, and the distance between the flanges would have been sufficient to receive half a brick, so as to permit of lining for this thickness the space between two frames.

There was the certainty that this lining would afford a thorough solution of the problem, perfectly standing the thrust, which would be limited to a small radius; and then this very strong lining might easily withstand pressure, whereas if it were due to working being brought too near the shaft no lining would stand. A difficulty was, however, experienced in getting the joists bent with the web horizontal, which led to this first project being abandoned.

Method adopted.

Matters had reached this point when M. Armand Mahiel's work on concrete construction fell into the author's hands. Works in concrete have nearly always given good results, and during the last few years their vogue has greatly extended; and why should not concrete be tried for solving one of the most important problems connected with mining? Accordingly, it was decided to sink the second 50 m. pass, while at the same time putting in a lining of cement concrete, its low cost, its tightness, the absence of joints, and its great adhesion to the inside of the shaft appearing at once

* From a communication to the Liège section of the Association des Ingénieurs sortis de l'Ecole de Liège, by M. Julien Linet, manager of the Ougrée Colliery, Belgium.