wounds, that this was a peaceable and sedentary community, not a nomadic or predatory one." It is interesting here to note that not a single coin has been unearthed, which, as Sir John Evans, who made an exhaustive examination of the implements, said, virtually confirmed the very ancient age of the cemetery. "The discovery of a single coin," he declared, "might have put a different aspect on the matter."

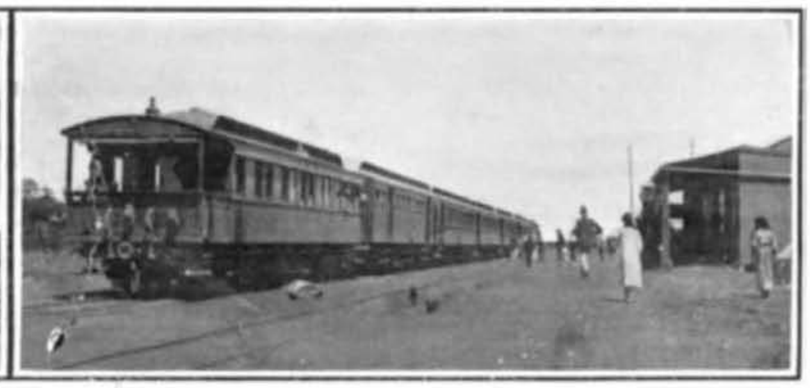
THE CAPE TO CAIRO RAILROAD.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

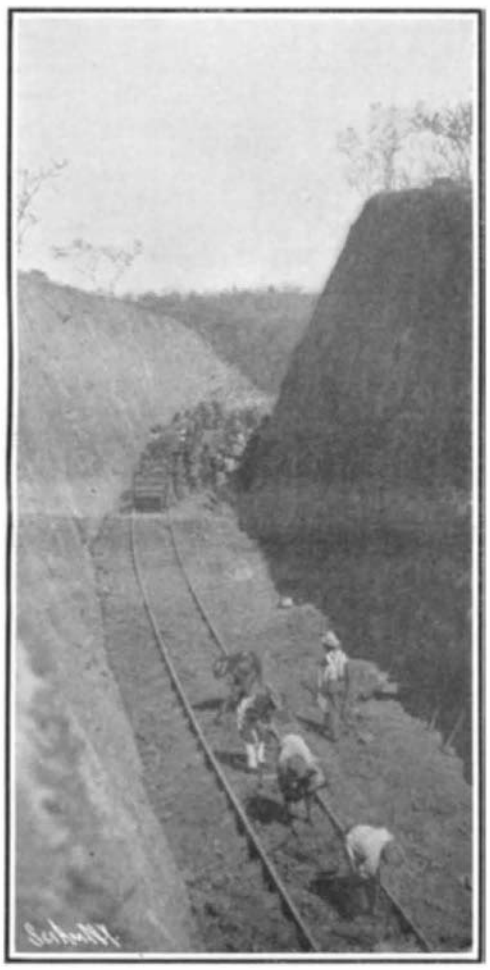
One of the most remarkable railroad enterprises that is at present in process of development is the construction of the railroad bisecting the African continent from Cape Town to Cairo. The scheme is rapidly approaching completion, from both the southern and northern termini simultaneously, so that what was considered purely a dream on the part of Cecil Rhodes when he first mooted his project gives every sign of becoming *un fait accompli* during the present generation. The southern road from Cape Town has already penetrated to the interior of the African continent, having reached a point about 374 miles north of the Victoria Falls on the Zambesi River and some 2,014 miles north of Cape Town.

Temporary Wooden Water Tanks and New Overhead Cast-Iron Tank of 30,000 Gallons Capacity.

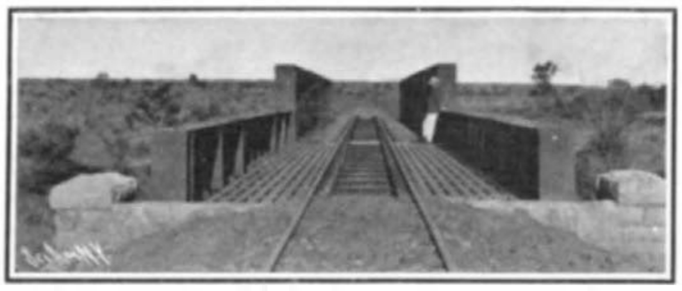
Standard Eight-Coupled Locomotive of the Cape to Cairo Railway.



The "Train de Luxe," Zambesi Express, Which Runs Between Buluwayo and Cape Town, a Distance of 1,736 Miles.



Typical Cutting in the Wankie District, 1,545 Miles From Cape Town.



The Umgusa River Bridge, 56 Miles From Buluwayo.

Typical Double Gangers' Cottage.

Type of Bridge Adopted for 50-Foot Spans on the Victoria Falls Section.

The Luxuriant Country Through Which the Road Passes After Crossing the Victoria Falls.

Construction Party North of the Zambesi River in Northwestern Rhodesia.

THE CAPE TO CAIRO RAILROAD.

The scheme was started in 1889. At that time the northern terminus of the Cape Colonial railroad system was at Kimberley, 647 miles from Cape Town. Mr. Rhodes decided to start from this point, carrying the track through the center of the African continent to link with the Egyptian railroad in the Soudan, and thus form a continuous track from the Cape to Cairo. This original scheme, however, has since been considerably modified, because in the interior of the continent the engineering difficulties that would have to be surmounted are so prodigious, that a continuous line could only be carried through those regions at an enormous expense, whereas by availing themselves of the excellent waterways offered by the various lakes lying in the line of the projected route, and linking them together with short spans of railroad, a combined railroad and water artery of communication through the continent equally efficient can be assured at much less cost.

In regard to the character of the roadbed and track, in view of the fact that rapidity in construction was insisted upon, the builders were given full liberty to carry out this phase of operations in the manner which they considered to be the most desirable to attain the object in view. In laying the railroad, but little regard is paid to formation, the location following the surface of the ground pretty closely, and the cross-ties being packed up with a minimum of ballast, in order to give a moderately smooth running top. The second section of the road, extending from Vryburg to Mafeking, was originally laid with rails of 46¼ pounds to the yard, but was subsequently relaid with rails of 60-pound section, in order to correspond with the standard adopted on the north extension. For the 492 miles between Mafeking and Buluwayo, steel Vignoles rails were utilized in 30-foot and 33-foot lengths, of 60-pound section, connected by fishplates weighing 15 pounds per pair with four bolts to each joint.

Owing to the ravages of white ants and other termites, it was found impossible to use wooden cross-ties. Under these circumstances, the rails are laid upon steel trough cross-ties of the India state pattern, weighing 68¼ pounds each, and numbering 1,940 to the mile. These ties have been found to answer very well, and when well packed with ballast afford an excellent road, which can be easily maintained.

The greatest difficulty that has been encountered in the course of the constructional work has been the obtaining of adequate supplies of water. As far as possible, water supplies have been established at intervals of 40 miles. As the railway was laid, these water supplies were pumped into huge wooden reservoirs, but as the traffic develops the wooden receptacles are replaced by cast-iron overhead tanks ranging from 20,000 to 30,000 gallons capacity, while concrete walls and dams are being constructed across the waterways, for the purpose of conserving the water during the dry season. The wet season extends from November to April, during which period the rainfall averages 24 inches. After leaving Kimberley, from which point the transcontinental railway commences, the road passes over the Vaal River near Fourteen Streams by a bridge 1,354 feet in length between abutments and built in ten spans of 130 feet in the clear. The girders are connected at their bases by cross-girders to form the roadbed, while each pair of main girders is also connected overhead by four arched girders. During the Boer war this massive structure was blown up by the Boers, but was replaced in 1901.

After leaving the Vaal River the line makes a steady climb to the high plateau of Bechuanaland, which it traverses at an altitude of 4,000 feet above sea level to Mafeking. Upon this section no bridges were found necessary, while the tangents are long and the grades easy. The ruling gradient is 1.25 per cent uncompensated for curvature, of which latter the maximum is 6 deg. The soil is sandy with granite underlying. The grass grows luxuriantly and prolifically, the trees being sparsely dotted over the veldt, which is inhabited principally by aboriginal natives.

Sixteen miles beyond Mafeking the road passes over the border of Cape Colony in the Bechuanaland Protectorate, and still rises for a considerable distance, there being many stiff climbs. The country is thickly wooded, and on the lower levels the soil is sandy. After attaining a maximum altitude of 4,400 feet the road drops 1,400 feet to 3,000 feet, at which level it extends for nearly 300 miles to Buluwayo. On this section the greatest difficulty confronting the railroad engineers has been in respect of water. Supplies are very scarce, and the reservoirs which have been established are perforcedly placed at long intervals apart, and to aggravate matters even these supplies occasionally fail entirely. The principal waterways are the Mahalapye, Macloutsi, Shashi, and Tati rivers, which are quite dry for the greater part of the year, but which during the wet season run very strongly.

At a point near Plumtree, 419 miles north of Mafeking, the railroad passes into southern Rhodesia, and has now a tortuous climb to an altitude of 4,400 feet to Buluwayo, at which level the important town and capital of Rhodesia is situated. On this last stretch a greater number of short-span bridges and culverts have had to be constructed than on any other section up to this point, while the percentage of curves is much higher. The curves are generally of 4 deg., while the ruling gradient is 1.25 per cent. Between Mafeking and Buluwayo the country through which the road passes is peopled almost entirely by natives, there being only one white settlement at Francistown, 364 miles from Mafeking, where the government administration offices are located, together with a rapidly-rising mining and trading community. The railroad enters Buluwayo from the west, and after leaving the town falls steadily for 1,200 feet to the Gwaai River, which is 89 miles distant from Buluwayo. More sandy and thickly-wooded country is here encountered, and owing to the peculiar configuration of the ground, it has been found possible to lay the road in a perfectly straight line for a distance of 71 miles toward the Zambesi River. Still falling between hills and through thick bush, the Wankie coalfields are at last reached at the comparatively low level of 2,400 feet. In the last 50 miles of this section several engineering difficulties were encountered. Up to this point the engineers had successfully obviated the necessity of heavy deep cuttings and high embankments, but in this stretch such undertakings could not be avoided. The ruling gradient, however, was still retained at 1.25 per cent with curves of 4 deg. After leaving Wankie the country rises steadily toward the Zambesi River, and it was found necessary to increase the ruling gradient from 1.25 to 2 per cent, though the curves were easier, being of 6 deg. The summit of the climb is attained when the watershed of the river is gained, some 13 miles from the southern bank, and at this distance the spray of the falls rising to a height of 3,000 feet is plainly discernible. The river station is just below the falls and about 282 miles north of Buluwayo, and the gorge is crossed by the single-span bridge, from which a magnificent broadside view of the river rushing over a gorge 400 feet in width and of a similar depth is obtained, the railroad itself being often immersed in the spray.

At the point where the bridge sweeps across the gorge the latter is 650 feet in width, and the height from the rail level to the surface of the water below in the dry season is 400 feet.

The bridge consists of a single span 500 feet in length, the arch being 15 feet deep at the center and 105 feet at the springing, while its rise is 90 feet.

From the northern bank of the river the railroad engineers made their way northward, Kalomo, the capital of northwestern Rhodesia, 92 miles distant, being the objective. This part of the undertaking was especially arduous, as the country was practically unexplored, and the surveying party some hundred or more miles in advance of the railroad experienced terrible privations and hardships. They had to cut their way through the thickly-wooded country and dense vegetation. From Kalomo the line wends its way for a further distance of 282 miles in a north-easterly direction to the Broken Hill Mine. The tapping of this district will have a decided effect upon the prosperity of South Africa, since it is unusually rich in deposits of zinc, lead, and copper, while immediately beyond the land abounds with vast supplies of India rubber. The copper deposits are abnormally rich. In past times there have been taken out of the hills copper ore in two parallel cuts, one about 12 feet wide and the other 5 feet in width, and both cuts run close together for a distance of 3,000 feet. Under the hills are caves of green malachite, which is also richly impregnated with this mineral.

On this section of the road the engineers carried out a smart piece of work, which is additionally remarkable in view of the fact that native labor is being exclusively employed. A French railroad engineer, who had been engaged in constructing railroads in French West Africa, visited the railroad, and refused to believe that the road could be laid at the rate of a mile a day, which is the average speed of construction, remarking that half a mile was the maximum. In order to demonstrate to the French engineer the methods adopted upon the transcontinental railroad, the natives set to work and laid a quarter of a mile of track in twenty minutes, following up this achievement by completing 5¾ miles in ten hours.

At the present moment there are over 2,000 miles of track open for traffic, and the traveler landing at Cape Town can proceed to a point 374 miles north of the Zambesi River without the least delay. There is a through *train de luxe*, the Zambesi express, which runs between Cape Town and Buluwayo weekly in each direction, and is so scheduled as to operate in conjunction with the arrival and departure of the mail steamers to England; while upon arrival at Buluwayo there is a train in connection which conveys passengers and mails northward as far as the road is open for traffic.

Simultaneously with the construction of the railroad, a telegraph line has been erected. This must not be confused with the transcontinental line, also inaugurated by Cecil Rhodes, and which is now practically completed, as the latter follows a different route from the railroad.

In the original scheme the projector stipulated that all stations and buildings should at first be regarded as simply temporary structures, and consequently they have been constructed of the lightest description and are of an inexpensive and portable character. Galvanized corrugated iron lined with match boarding has been largely utilized for this purpose. The wisdom of this step has been fully justified, since trade has in some instances developed at points where station facilities are not provided in the original plans, while in other cases the sites selected have proved too unhealthy. The removal of the buildings has consequently been considerably facilitated, and as the exigencies of the traffic are becoming better known, the frail structures are being replaced by permanent brick buildings.

The standard locomotives are of the eight-wheeled coupled driving wheel type, the drivers being of 4 feet diameter with a leading four-wheeled bogie. The cylinders are of 18½ inches diameter by 24 inch stroke. The tubes have a heating surface of 1,184 square feet, and the area of the firebox is 131 square feet, steam being supplied at a pressure of 180 pounds per square inch. The total weight of the engine and tender in working order is 120 tons, and the haulage capacity 500 tons. The tender capacity is 10 tons of coal and 27,000 gallons of water. The average fuel consumption per mile is 64 pounds Wankie coal.

The freight cars employed are of varying types according to the nature and volume of the traffic, ranging from small wooden bogie trucks of 25 tons capacity to steel bogie trucks of 34 tons. The passenger coaches are of the latest type, replete with every comfort and convenience, carrying first, second, and third class passengers. In the last-named coaches sleeping accommodation is provided for sixty persons. The average speed of the trains is 30 miles per hour in the case of passenger and 20 miles per hour for freight trains. The locomotive workshops and executive headquarters of the running staff are established at Mafeking. The town has been laid upon the latest lines, and the quarters for the staff are substantial and comfortable.

The line is being constructed throughout by unskilled native labor, of which a plentiful supply is available. They are divided into small gangs, each of which is directed by a white man, and their duties comprise plate-laying, excavating, coaling, portering, and such tasks, the finer work being carried out by white labor. The natives are paid at a uniform rate of 50 cents per day, and have been found to be eminently adapted to the work for which they are engaged. The ratio of white to native employees averages one to four.

Profitable Mechanical Invention.—II.

BY THALEON BLAKE, C.E.

(Concluded from page 329.)

Other causes besides the innate tendency of human ambition to drop substantials to run after big projects, are responsible for this wasteful divergence of energy. Among them may be mentioned the fraudulent lists—I call them fraudulent because all their merits are more than counterbalanced by the harm they work, and have wrought, however unconsciously—which unscrupulous schemers publish to inveigle the unwary inventor, and to capture patent fees. Under some such caption as "Inventions Wanted," this bait is sent broadcast. These luring lists all purport to be composed of unsolved machines and other inventions of a value which must appear almost immense to a man working for small wages. Some of the inventions listed are of a doubtful utility, others have a fabulous value assigned them; many are old and some even unpatentable. This the novice cannot know offhand.

Now and then a *bona-fide* invention is wanted, and advertised for, by a responsible company; but generally, the cash prizes which are offered come from foreign governments, and invariably relate to improvements and discoveries valuable to their national industries. These, however, are very seldom, or never, enrolled in compilations of any kind, fair to dishonest, for free distribution to the gullible part of the public. In a true sense all inventions are "wanted," if needed; otherwise, not. And it is wisdom to assume that if any invention is really "wanted" badly, it will not be for a long time. The inventive spirit seems to be ubiquitous, and its manifestations sleepless, as wants of this nature are supplied quickly after they are discovered.

An untold amount of effort has been squandered because of deceptive lists, as any large employer of mechanics can soon verify. Even those devices that, theoretically, have a future use may be productive of much loss of time to experimenters. The man who can provide the novelty and department stores with "taking" devices, from toys to useful appliances that win women's hearts and open their purses—like the latest wrinkles in skirt, hat, or hair fasteners, or similar baubles—is camping on the hot trail of big financial game.

To what, then, should an inventor, who does not secure a school training in mechanical engineering, nor expect to make of inventing a vocation—to what should he confine his inquisitive attention? The answer to this question conveys the Open Sesame that unlocks Aladdin's cave and bares all its treasures. It is : Give over the discoveries to the scientist, and the application of them to the technician, and invent along the line of trade, business, or professional interests, if with these you are familiar.

Some time ago a civil engineer of my acquaintance talked to an ingenious workman who had made for himself a little tool that was superior to any of its kind known to the hardware trade. It may be said justly of both, that the civil engineer became interested in the value of the tool; the workman had not a thought for its commercial value.

However, the workman had interests, and large ones. In twenty minutes' conversation he mentioned several things on which for days he had racked his brains. The catalogue of his grandiose conceptions alone will demonstrate the fertility of ideas which is so noticeable in our native mechanics. One of them was an emergency automobile brake, automatic and absolutely infallible; another was a keyboard attachment for the Italian harp, which did away with picking the strings; a third was a steering apparatus for a dirigible balloon, so simple and safe it could be operated by a child.

The workman grew enthusiastic on each of these in turn. Yet he had not a word to say for the humble tool. His brake, keyboard, steering device, may possess intrinsic worth; but he cannot know that without delay and expense. The little tool does possess intrinsic merit—but it is so common, so simple, that he cannot dream of any future for it. It is only a hand tool! And what is a hand tool in competition with human flying as an essay in invention for his talents and energies?—fudge!

There scarcely lives an intelligent human being in a civilized country who has not some time felt the need of an improvement in some of the daily used accessories of life. Improvements in household utensils, appliances for the home and office, novelties for men's and women's personal needs, apparatus for stores or shops, tools for the various trades, and mechanical aids for the farmers, are among the most