power by electricity of high voltage is now of a common occurrence over large areas in foreign countries. Why not in Australia?

In this State and Queensland we have an abundance of coal and an unlimited supply of artesian and sub-artesian water, but a limited and variable rainfall, and it is a well-established fact that it is cheaper to generate, transmit and apply power by means of electric motors, than to transport the coal for power purposes inland.

The coalfields of the two States mentioned are inexhaustible resources of power, and nearly all the States have coalfields more or less valuable.

The coalfields of New South Wales are favourably situated for the distribution of power to all parts of the State, but as a means of supplying power for agricultural or industrial development, we are not utilising them to the best advantage.

Sydney, which is the principal centre of the States' manufacturing industries, has the coal districts of Newcastle on the north, distant 96 miles; Lithgow on the west, distant 96 miles, and Bulli on the south, distant 42 miles, at either of which places it would be possible to erect power-production works, where the coal, as it comes from the pit mouth, could be converted into gas for driving the engines generating the electric current for transmission to Sydney, without any of the attendant losses due to haulage of coal.

In our steam-driven electric plants in Sydney, only one-seventh to one-tenth of every ton of coal is converted into work, but a great deal is converted into smoke and soot, whereas, if gas engines were used, one-fourth of every ton would be available, and there would be no smoke or soot.

By centralising our power-production plants in the coal districts, and turning the coal into gas for mechanical power, other savings would accrue by the abolition of a great deal of machinery and a reduction of labour—boilers, furnaces, smoke stacks, coal bunkers, and many other of the adjuncts of our multiple power-plants in Sydney would be obviated.

In addition to all these economies, we should have another of vast importance to an agricultural country, that is, the saving of that valuable by-product of the manufacture of gas, the sulphate of ammonia, and which amounts to about 20lbs. in every ton of coal converted, the market value of which is about three shillings. We should also have the tar and tar oils.

There is no difficulty to-day in transmitting power a hundred and fifty miles, so that the places I have mentioned are admirably suited for the establishment of large centralised plants for the generation and distribution of electric power, not only to Sydney, but in all directions throughout the State.

Another advantage of such a system will be the great hygienic gain to our towns and cities by the abolition of the smoke, dirt and poisonous fumes from the multitude of chimneys, necessary for steam-driven multiple plants (which lowers the vitality of modern urban population), and inferentially the transformation of our cities into bright, smokeless and prosperous centres.

The soil in our arid parts is simply magnificent, and in large areas there is plenty of subterranean water that only requires pumping; if electric transmission lines were run to these areas from the nearest coalfields, the productivity of the land would be amazing, and not only would settlement be stimulated where at present there are only sheep, but light railways could be operated, houses and towns could be lighted, and machinery driven, so all the comforts and blessings of civilisation could be brought to the dwellers in the bush.

I was much impressed during my recent travels in Victoria and South Australia to see how much greater the development of electric light and power was, than is to be seen in the Eastern States. I suppose it is owing to the greater supplies and cheapness of coal for gas-making, for lighting purposes in the Eastern States; but it is high time that we recognised that gas illumination is most unsuitable and insanitary for these warm climates. It is remarkable that we still retain such a dirty, inferior, and hot illuminant as coal gas, when we can have the clean, superior, cool light from electricity, that can be switched on and off as necessary.

The gas strike has brought home to us quite recently how unreliable gas is for light and power, and what a splendid weapon it is for the Unions to bring the public to its knees; but it has also taught us that gas is not by any means a necessity, and has shown us that electricity is in every way more excellent both for lighting and power. The most strenuous and praiseworthy efforts of our undergraduates and other volunteers could hardly lift one receiver, but a tithe of their efforts would have kept the electric lighting plants running with ease, and if electric lighting were universal, it would be next to impossible to plunge a great city like Sydney into darkness at the fiat of some labour bosses.

Another aid to the subjugation and settlement of central Australia will be wireless telegraphy and wireless telephony. So far the range of effective wireless messages is about 1,250 miles, and transmission over sea is necessary to accomplish even that distance, but advances in science are so rapid nowadays, that any morning our newspaper may inform us that all hampering limitations have disappeared.

Wireless telephony has advanced a great stage, owing to the system invented by Professor Poulsen, of Denmark, of speaking into an electric arc lamp.

At present, about 300 miles is the extent over which human speech can be transmitted without wires, but it is only a question of time when human speech will annihilate distance, and when the settlers of Central Australia will hold wireless telephone communication with the seaboard stations.

Mr. A. J. Sharman's late invention of a portable wireless telephone, which is light enough to be easily carried about in the hand, will prove another valuable aid for keeping isolated country settlements in touch with one another, and will enable the solitary settler to call up a neighbour in case of sickness or other need, so that the horror of loneliness, that bugbear of modernity, will be greatly minimised.

Our very existence in Australia, on which we have only just a footing, will be in jeopardy unless we fill up our waste places and make an effective settlement, and in order to do that, the very latest scientific methods will have to be adopted, which will call for the services of Australian Engineers, and, provided they are equipped with the necessary scientific training, and are endowed with initiative and resource, there is an unlimited sphere of action at their disposal. This University could take a leading part in the solution of the great problems I have been speaking about, by research work and demonstrations on the best means of improving communication in sparsely populated areas, and in speeding up our means of travelling.

In that way the value of the trained and versatile Engineer would be impressed upon the public, as contrasted with the so called practical man, who travels in grooves and fears to do anything without precedent.

It is possible that we may have amongst us to-night many embryo empire-builders who will be called upon to assist in solving the problems I have alluded to, but I am bold enough to assert that in Australia, we have a goodly heritage, which is worth our most strenuous endeavours to keep, and, if Patriotism, Science and Engineering can do it, this Society may be relied upon to furnish its quota.

APPENDIX.

SEWERAGE OF SYDNEY, NEW SOUTH WALES.

Southern and Western Suburbs Ocean Outfall Sewer.

This sewer will provide for discharging by gravitation into the Pacific Ocean, near Long Bay, the sewage from the western, southern, and Illawarra suburbs of Sydney, together with that from a large tract of land, including Botany, lying between

Cook's River and the ocean, and south of Coogee At the present time the sewage is being dealt with at the Botany sewage farm, where about 200 acres are used partly for irrigation and partly for intermittent downward filtration. The soil on the farm is raw sand, and as much of it is subject to tidal influence, it becomes saturated with salt water and sewage to such an extent as to render successful operation impossible, and great exception has been taken to the objectionable odours which prevail at certain seasons.

The total area to be dealt with by the new sewer is about 38,142 acres, with a population estimated in 1907 at 193,820, and a prospective population of 902,890 persons.

The sewer will have a total length of about 6¼ miles, exclusive of the branch to connect with the existing screening chamber for the sewage from the southern suburbs, and will have a discharging capacity of 210 cusecs, with a depth of flow of 5 feet 5 inches at the outfall end. The section will vary from 11 feet 4½ inches x 5 feet 9 inches to 12 feet 3 inches x 7 feet 6 inches, with vertical side walls and slopes 1 in $3\frac{1}{6}$ on the bottom, corners at the junction of the bottom and side walls being rounded off. Concrete, plain or reinforced, is being used throughout.

The grade will be 1 in 3,650, and the sewer will discharge into a large air chamber, where the invert will be at 2 feet 6 inches below high-water of spring tides. From the air chamber two outfall pipes, 5 feet in diameter, will spread in the form of a V, and will discharge, on a grade of 1 in 22, to the face of a rocky ledge, where the soffits will be at 20 feet below high-water of spring tides. The estimated cost of the scheme, which is now being carried out by day labour throughout, is £484,000.

SECTION No. 1.

This section includes a length of 11,406 feet of sewer at the outlet end. Excepting for about 1,100 feet of deep trench, the construction is in tunnel through sandstone rock, which is chiefly of a hard character. In the shallower working, the rock is softer in parts, and here and there bands of shale are met with. The longest drive is 1,586 feet, and the shafts range from 40 to 132 feet deep.

The size of the sewer, when completed, will be 12 feet 3 inches by 7 feet 6 inches, and the shafts have been sunk 12 feet by 6 feet for convenience in alignment and working.

In the tunnelling operations under the Department hand-drilling has been chiefly used. Pneumatic drills were used in four drives, but it was found that no saving in the cost of excavation was effected, and they were not further installed.

For dressing the tunnels to section in the harder rock lengths, pneumatic popper drills and explosives are used, each drill being perforated and used in conjunction with a water jet, thereby keeping down the dust, which, in hand-scabbling, has, in the past, proved so injurious to the health of the workers in sewer tunnels, and in the softer rock hand-drilling and "popping" is adopted. Electric current, supplied by the City Council, has been installed along the full length of this section, and is used for driving air compressors, ventilating fans, shaft hoists, etc. A transformer house has been erected on the works, where the current is reduced from 5,000 to 415 volts.

The drives are all holed through, and are being dressed to section preparatory to concreting.

A start has been made upon the excavation in open trench, the spoil from which will be used in levelling up the Long Bay Park adjoining.

SECTION No. 2.

The length of this section is 9,420 feet, and the sewer construction is in trench principally through sand, the lower portion of which is very wet. The depth ranges from 14 feet to 60 feet below the surface. To a height of 30 feet above the bottom, the excavation is being taken out with vertical sides; above that level the excavation has sides cut to a batter of two horizontal to one vertical, sloping to a 10-feet berm on either side of the vertical trench.

There were serious delays at the outset with regard to the supply by the City Council of electric current for power for driving the excavating plant, and there have also been delays owing to the suspension of the supply from Lithgow of the steel rods, and to the shortage of blue metal required for the concrete. Good progress is, however, now being made. The excavation through the sandhills to the berm level has been completed, and the trench excavation is being proceeded with at three places on this section. Concreting is at present proceeding at only one face, but will shortly be in progress at five faces. In the shallow trenches the ground is being held with timber runners, but in the deep trench steel interlocking piles are used. These piles were obtained from the Carnegie Steel Company, and are 12 inches wide and 40 feet long, weighing 40lb. per lineal foot.

A travelling gantry 52 feet high, equipped with a 2-ton Arnott pneumatic hammer, has been constructed for driving the sheet piling, and two water jets are being used, one at the back and one in front of the toe of each pile. The excavated sand is being taken out to a depth of 12 feet below berm level between the steel piling by shovelling into skips, and led out of the end of the cutting. Walings are suspended from the top of the steel piling, and struts placed as required, and below 12 feet the sand will be lifted in buckets by a travelling excavating gantry, which will follow the driving gantry.

At the lower end of the section, water has been met with in such quantity that a large quantity of sand is being lifted by a dredge pump and pumped clear of the works into a paddock, where the sand is deposited and the water flows off into a creek.

In the shallowest trenches the excavation has been taken out by hand, but now that the depth is increasing, two electrically-driven travelling cranes are being installed, which will be shortly supplemented by several travelling steam cranes.

The sewer on this length is 12 feet wide by 7 feet 6 inches high inside. It is heavily reinforced.

Electric power has been installed the full length of section, and is being used for pumping, hoisting, air compressing, concrete mixing, and lighting.

The difficulties of carriage of material to site have been considerable, and are not altogether surmounted. To convey material between points on the section, a track with a 2-feet gauge has been laid parallel to the line of sewer, along which a ''Krauss'' locomotive draws trucks, carrying material or spoil to the dumps.

The pumping on this section is very heavy, and 6-inch pumps, electrically driven, are running continuously.

SECTION No. 3.

This section, which is 12,038 feet in length, includes sewer construction both in trench and aqueduct, and also a syphon under Cook's River.

Good progress has been made with its construction, about 2,400 feet of sewer having been completed and another 600 feet of bottom concreted, ready for the superstructure. In addition to this, all the piles for the piers of the aqueduct have been driven, the shafts at each end of the syphon sunk, and the tunnel under the river excavated. Extensive road deviation works have been carried out, the Bald Face quarry has been developed, and a stone crusher installed. A wharf on the Arncliffe side of Cook's River has been built, and a long length of coffer-dam erected to protect the concrete aqueduct construction.

The internal dimensions of the sewer on this section are 11 feet 2 inches by 6 feet from the end of section to the river, and 11 feet 4½ inches by 5 feet 3 inches from the river to the present terminal of the main western sewer.

Concrete and steel are used in its construction throughout. In shallow trench under roadways, a heavy concrete section, with covering of I girders and jack arches, is adopted. In deeper trench a concrete section, heavily reinforced, as for Section 2. The aqueducts will consist of reinforced concrete arches of 50 feet span, carrying the sewer, which will have expansion joints at suitable positions, the foundations for abutments, where not on rock, are carried on a piled foundation. At each end of the aqueduct, where the sewer is out of ground, a foundation in the sand is formed a short distance below the surface with reinforced concrete, and cross walls carry the sewer. In this form of construction expansion joints are provided at 50 feet intervals.

Self-contained continuous concrete mixers, driven by benzine engines, have been used for mixing all concrete on this section, and have been found to be economical and satisfactory.

Of the staff of the Water Conservation and Drainage Branch of the Public Works Department engaged upon this scheme, the principal officers are:—

Mr. H. H. DARE, M.E., M. Inst., C.E., Engineer in Charge of the Branch.

Mr. A. PEAKE, Assoc. M. Inst., C.E., Deputy Engineer in Charge of the Branch.

Mr. H. FLEMING, Supervising Engineer.

Mr. R. RUTLIDGE, Engineer for Design.

Mr. C. SIMONS, Resident Engineer.

Mr. H. M. CLARKE, A.M.I.C.E., Resident Engineer.

Mr. H. BELLAMY, A.M.I.C.E., Resident Engineer.

Mr. L. A. B. WADE, M. Inst., C.E., was Chief Engineer for the Branch when the sewer was designed.