increase the running expenses than having to run large engines at small loads.

It will have been noticed that so far as the author has yet gone he has not suggested which system of generation and distribution of electrical energy he proposes to use for supplying the area mentioned, for, before doing so, he wishes to bring forward for your careful consideration the different points of advantage existing in the various methods or systems that are capable of being utilised for the purpose, From various reasons, but principally because incandescent lamps, suitable for house lighting, cannot be substantially manufactured for use at electrical potentials much above 110 volts, and, further, as higher potentials than this are extremely unpleasant in the sensation they produce on the human body, it is necessary to arrange that the potential of the current used in the houses is not above 110 volts, or what is known as low tension,

When the distance that the current has to be sent is small, such as when it is distributed from machinery within the building, or within an area of say a quarter to half a mile square, then the current is usually generated at the pressure at which it is intended that the consumers should use it. But should the distance of transmission be long, then the current is generated at a much higher pressure, and having arrived at the point to be supplied, can be transformed or reduced in pressure, by various means, to that suitable to the purpose for which it is required.

In a large city, however, situated as Sydney is, there can be no question that the best place to put the engines is near the harbour, where there is every facility for obtaining coal cheaply, and where there is abundance of water for condensing purposes. And the question therefore of supply and distribution reduces itself to this, that it is necessary to have a network of low tension mains for supplying the houses, fed at different points by high tension currents by means of some kind of transforming device. Broadly speaking, there are in practical use at present only two ways of doing this, and they are—

(*a*) By means of Continuous Current Transformation.

(*b*) By means of Alternate Current Transformation.

The first of these two may be again subdivided with two systems, viz., the Moter Transformer System and the Battery Transformer System.

In the former of these two, the Motor Transformer System, electrical current of the continuous kind, is generated in the Central Station at high pressure, by which means the current is kept small, and can therefore be conveyed by a small conductor to the district where it is required It has before been mentioned that the whole of the area proposed to be lighted has a system or network of low tension mains permeating it, and the mains from the central station are led to points called sub-stations, which are distributed over this area. At each one of these the current is caused to actuate a motor transformer which is a sort of combined electro-motor and dynamo. This machine has a "Field" similar to that of an ordinary dynamo, but the armature is wound with two independent circuits, through one of which the high tension current from the central station is made to pass, an l by this means cause the armature to revolve, and make the machine act as a motor. The other circuit on the armature is connected to the low tension mains, and as it revolves generates a current in the same way as an ordinary dynamo, the winding of this latter circuit being so proportioned as to produce the desired low potential current required for the low tension mains. Machines of this description are, the author believes, used in the distribution of the current from the central station recently erected by the St. Pancras Vestry in London.

Distribution by means of Battery Transformers is carried out on similar lines. The current is generated as before-mentioned at the central station, viz., at high pressure, and sent to the sub-stations where the Battery Transformers are. The main current from the central station is caused to flow through a large number of secondary batteries or accumulators, arranged in series, a sufficient number being placed one after the other to absorb the available E.M.F. of this current. The current for supplying the Low Tension network is taken from intermediate points along the string of cells, thereby splitting them into groups having a suitable E.M.F. existing between the ends of each group. Thus, if the E.M.F. of the main charging current were, say, 1,000 volts, it can by this means be split up into ten circuits of 100 volts each.

During that part of the day in which the supply has to be the heaviest, the dynamos at the central station practically supply all the current, but after about midnight either all, or the principal portion of them, are stopped, and the Battery or Accumulator then takes up the supply until about noon the next day, when the machinery is again started and re-charges the cells, making up what has been taken out during the night.

Under either the Battery Transformer or the Motor Transformer systems the current delivered to the consumer is continuous, viz , not alternating, and can readily be used for driving motors, as well as for electric lighting.

The use of motors during the day should tend very much to incr ase the load factor of the supply, and to reduce some of the annoying abruptness of the load curve. Further, the use of Battery Transformers inspires a sort of confidence against any partial stoppage, as current can be supplied from the accumulator. In London, much more than would be the case in Sydney, is this advantage felt, for at certain times in the year London is suddenly, and without warning, liable to be enveloped in dense fogs, at which time the accumulators form a valuable aid in coping with the sudden demand for current, as they are able to maintain the supply while steam is being raised to compete with the increased load thus suddenly thrown on.

We now come to the Alternate Current Transformer system, and this also can be divided into two heads, viz., Simple Alternate Current Transformer system, and Multiphase Alternate Current Transformer system.

The method of sending high potential currents from the central to the sub-stations has already been dwelt upon and it will suffice to say that in both the systems just mentioned this remains the same, with the exception that the current is now alternating in character instead of being continuous.

The transformers at the sub-stations consist of a laminated iron frame or core, on which is wound two independent circuits, one to receive the current from the alternators at the central station, and the other to supply the low tension mains. The current, when alternating, and sent through an apparatus of this description, induces a totally independent current in the second circuit by means of phenomena called induction, which there is no necessity to dwell upon here. Suffice it to say that the potential of this second current can be made whatever may be desired. It is, therefore, proportioned so as to be suitable for the low tension mains

So far as lighting goes, this method of distributing the current answers all requirements, but up to the present it has not been found suitable for actuating motors, or rather suitable commercial motors have not yet been made that will work as satisfactorily as a continuous current motor. The main or principal advantage that can be derived from its adoption is that it can be worked at much higher pressures than is practicable with continuous current work, and therefore be transmitted with smaller losses over longer distances,

We have now come to the last mentioned method, viz., Multiphase or Rotary Current Transformer System. This is the latest development of alternate current work, and, up to the present time, has chiefly been confined to the transmission of electricity for power purposes. It is claimed, however, that it can be used equally well for lighting

The details of the arrangement of the central and sub-stations in this case also remain the same as those already described, the chief difference between this and the systems already mentioned being in the nature of the current, which, although alternating, posseses what, for want of a better term, may be called a cycle or period of rotation.

This system owes its origin to the discoveries of Ferraris, and to the inventive faculties of Tesla, Bradley, Wenström, and Dobrovolsky, who have by their individual efforts gradually reduced the machines and systems to their present condition.

Plate XVII., Fig. 3 shows diagramatically the idea in its simplest form, so far as the transmission of power is concerned. A represents one of the dynamos at the central station, B the high pressure mains from thence to the sub-station, C is the transformer, D the low tension mains for supplying consumers, E is a motor connected to these lines, F are groups of electric lights.

As the system is somewhat new it may be interesting to generally describe the method of working. In the diagram the Dynamo A. consists of a revolving Field Magnet N.S. which is supplied with current from an exciter in the same way as an ordinary alternating current dynamo. The armature G is stationary and is wound with three coils. The end of the wire of each coil is joined to a common wire H, and the remaining three free ends are connected to the mains, of which there are three, these are led away as far as may be necessary to the transformer, to which they are connected in a like manner. Another set of wires for the low tension mains are similarly wound on the transformer as is common in ordinary alternate work, and these supply directly all the current that the consumers use. The motor E consists of a three-legged laminated magnet, the coils on which limb are connected to the three mnins and their ends to another common wire R.

When the field magnet N.S. in the dynamo is driven by the steam engine, it will induce carrents in the armature, which, when communicated by the mains to the motor magnet, will produce successive polarities at the ends of the three legs, or in effect create a revolving magnetic field.

The armature of the motor is wound with coils which are not connected to a commutator, but are closed in themselves, and the effect of the revolving field is to induce currents in these coils and cause the armature to follow the field of force, or in other words to revolve.

The action at first sight seems somewhat puzzling, but in order to obtain a better grasp of the idea, imagine to yourself an ordinary continuous current dynamo, so arranged that the armature could remain stationary, and the field magnet frame be revolved on the shaft. If the brushes of the armature be now short-circuited, and field magnet excited from an external source, and then while excited revolved, the armature will commence revolving too, and give off a certain amount of power.

In the case of the motor E, the magnet frame does not revolve, but what is the same thing the "magnetic field" does, and so causes the armature to follow it.

The current in each of the mains is practically an ordinary alternating current, and, it is said, can be used for any of the purposes to which alternating currents can be applied, such as lighting arc or incandescent lamps, or for cautery or heating purposes.

You will recollect that it was stated that the main advantage of the simple alternate current system was that the current could be transmitted with ease over longer distances than is possible with any continuous current system, but at the same time it was practically useless so far as driving motors was concerned.

If all that has been written of the multiphase, or three phase system as it is sometimes called, is practically feasible, in the author's opinion it appears to possess all the advantages of continuous currents and more, added to the benefits of long distance transmission by means of alternate currents. Motors actuated by multiphase current have no commutators to look after nor even rubbing contacts, a great and unassailable advantage over continuous current motors, for, as a rule, the commutator is the weakest point of a machine when in unskilled hands.

Objections will doubtless be raised against what appears at first sight to be the complexity of the wiring, or rather the necessity of using three wires instead of two, it may, however, be pointed out, that the collective area of the three wires is not greater than that of the two necessitated under other systems, although it is true there is another wire to insulate.

Again, even with continuous current systems, the use of three wires is common practice, and in some places as many as five.

Another advantage that may possibly arise in the near future from the use of a system in which the current is alternating, although not so practical a one as those previously referred to, is that in view of the remarkable experiments recently demonstrated by Tesla before the Royal Institution, relating to the lighting of incandescent lamps with alternating currents of extremely high frequency and potential, it may yet become common to take current from such mains through an apparatus designed to increase the potential and frequency such as that exhibited by Tesla, and light our rooms and houses without conducting wires.

Having broadly considered and described the principal available means for successfully electric-lighting Sydney and its suburbs, the question naturally arises as to whether such work should be carried out by private enterprise or by the Government, or by a conjoint action of the several municipalities.

Much has already been written and said on this subject, both at public meetings and in the newspapers, so much so, in fact, that really very little remains to be said that has not been previously suggested.

Strong arguments can and have been brought forward extolling the benefits likely to arise to the consumers if the work is carried out by private enterprise, and they have been ably answered in a lecture given by Professor Threfall on "The Lighting of Sydney for the Municipal Council."

If we refer to other large concerns at present being carried on in this Colony, such as our Railway System, or the work controlled by the Water and Sewerage Board, to those of us who have been used to London, where such are in the hands of private companies, it undoubtedly appears new or strange.

There are few who will deny that the railways in New South Wales are not as well managed as those in any other part of the world, or that the fares charged are not as low, taking into consideration the increased cost of labour, and the author doubts if any private company or companies would give a better service on the whole.

Again the excellent supervision exercised by the Board of Water and Sewerage over all work executed by the plumbers and drainers of Sydney is undoubtedly felt, and will gradually make an already healthy city one of the most sanitary in existence.

To the author's mind it appears that if the lighting of Sydney and suburbs were carried out, and afterwards controlled by a Board of Commissioners in the same way as the railways, and if a similar supervision were brought to bear on all wiring firms, as is done in the Water and Sewerage Board with the plumbers, it would secure to the general public a system of supply that could not fall to their lot by any other means.

Many of the annoying troubles that occasionally occur in electric lighting, more often arise from careless work on the part of the hands employed—such as wiremen, &c., than from any fault of the system or system as a whole, and no one, the author ventures to state, will refuse to admit, if the wiremen were required to be as competent in their art as the plumbers are under the regulations of the Water and Sewerage Board, that such troubles would gradually disappear.

In a paper such as this you will probably expect that the question of cost of laying down the different systems should be rather fully gone into. The author, however, has stated that he has not had sufficient experience of this class of work on such a large scale as that suggested to enable him to go fully into the cost, and, therefore, trusts that those persons interested, and who have been connected with similar work in England and America, will bring forward figures during the discussion.

With as large a system as that suggested in this paper, the difference in the original cost of plant, if carried out in accordance with any particular system as contrasted with another, may be so small as to be negligable when the most important point, viz.—that which will best serve the varied requirements of the public is taken into consideration.

In conclusion, a paper that occupies merely an hour in its reading is all too short to do justice to the Electric Lighting of Sydney and Suburbs, and much that might have been said has been left untouched. The author feels that he would have liked to have considered the all important, if not the most important, subject of mains, the position and number of several transformer sub-stations, or the efficiencies and losses entailed under the different systems mentioned, and must therefore apologise if the paper appears somewhat superficial. The subject is so large a one that it is difficult to know where to leave it, but the author trusts he has already said sufficient, and that more would trespass too much on the patience of the members, he therefore leaves the matter in their hands.