

## DISCUSSION ON

## "A TWO-RATE TARIFF SYSTEM WITHOUT TIME-OPERATED CONTROL."\*

MANCHESTER LOCAL SECTION, 18TH NOVEMBER, 1913.

Mr. Frith. Mr. J. FRITH: In discussing this question it is well to consider what are the objects of a tariff. They can be broadly divided into two distinct categories. The first aims at doing justice to every consumer connected to the mains, *i.e.* endeavours to charge every consumer in some way proportionally to what he costs the supply undertaking. The second aims at obtaining the maximum financial success for the supply undertaking. Broadly speaking, the policy in the case of a municipal undertaking should approximate more toward the first, and that of a company to the second of these categories. It is hardly possible to explain to the lay consumer the meaning of the term "load factor," but it can be explained to him that if he wants his supply at the same time that everybody else is wanting it, it is only fair that he should pay more than if he were taking his supply at a time when other people were not using electrical energy. I think when we have decided which of the above aims we are trying for, a few of the other conditions of a good tariff are worth discussing. The first thing is that a tariff should be understandable by the customer. He should be able to estimate what the supply is going to cost him. The next point is, of course, that the tariff should encourage the free use of electricity. Personally, I think the tariff best adapted to do this is a fixed charge per annum and a small price per unit irrespective of the use made of the energy, but I am not quite sure how the fixed charge should be based. The rateable value method is simple, but it is not easy to see why an electricity bill should depend on the size of a garden. I wonder whether such apparatus as that described in the paper will give results which can be easily understood by the customer and which will gain his approval; it would be interesting to know if any such information is available.

Mr. Watson. Mr. S. J. WATSON: I myself have not had any experience in the use of two-rate meters. The most important point to be borne in mind in framing any tariff is that it can be understood by the consumer. A few years ago many undertakings charged on the maximum-demand system, but I do not think that there are many to-day who continue to use that system. It was condemned because consumers could not understand it. It is doubtless quite correct in principle, but it is impossible to make various classes of consumers understand why one class should pay at a higher average rate than another. I feel convinced that for a general supply for domestic and similar purposes some method whereby only one circuit inside the house and one meter are required is the simplest and the best that can be adopted. It is only a question as to the basis of the standing charge. People know that the municipal rates are based on the rateable value of their property, and they know the rent which they have to pay; they can therefore tell approximately what their liability will be if the rateable value

system is used. Some time ago the chief engineer of one of the London supply companies explained to me how very different are the conditions in the residential districts of London from those which obtain in Lancashire manufacturing towns. He pointed out that in order to sell as many units per annum as are used by a 5-h.p. motor operated during factory hours, it would be necessary to connect up about 150 small heaters or similar appliances on the premises of his domestic consumers.

Mr. C. C. ATCHISON: In Rochdale my experience is entirely different from that of Mr. Watson at Bury, as I certainly find that the public-house consumers are those who appreciate the maximum-demand system. It seems strange that two towns so near together as Bury and Rochdale differ in this respect, and it emphasizes Mr. Watson's remarks as to how much greater must be the difference between Lancashire and London with their entirely different problems. Mr. Watson also mentioned that the demand indicator appeared to him to be a correct method of charging. I cannot quite agree with him on that point, but whether the maximum-demand system is or is not correct it is certainly a very difficult tariff to use. It can be explained to the consumer and he may fully understand it, but at the end of the quarter when he receives his bill he has probably forgotten all about the explanation. In regard to the flat charge based on the rateable value with a uniform price per unit, the remarks this evening have called my attention to what appears to be a weak point in that system. Take the case of two houses of similar size supplied by electricity, one having no garden and the other a large garden; each may have identically the same number of lights and consume the same amount of electricity, but the man with the large garden, if charged on the rateable value system, will pay a larger annual sum than the man without a garden. Is it reasonable to make this difference in the price? As against this, I should like to call attention to Mr. Frith's statement that apparently the system of charging adopted by municipalities is equity and that of companies profit. Surely although we try to bring equity into it the municipality has also to aim at a profit; but whether we wish to bring in equity or not, a low price per unit is useful, no matter what other charge there may be. Possible consumers always quote the charges paid in other towns; and in almost every case, whatever the other rates may be, the lowest figure is stated as being the charge for the class of supply required. Only during the last few days the Bury tariffs have been quoted twice to me, and I may point out that the price mentioned by the possible consumer was only applicable after a certain number of units had been consumed at a higher rate. It will be seen that each one tries to bring in equity and at the same time look after the profit. If it is possible to state a low price per unit it is taken into consideration by the consumer and further

\* Paper by Mr. H. H. Perry (see p. 42, No. 223).

Mr. Atchison.

charges almost overlooked. Perhaps this idea is somewhat of a "catch-penny" business, but it pays in the long run.

Previous speakers have advocated one circuit for all purposes; in some ways I should do so myself as it is certainly convenient to have only one meter, but at the same time I should like to see a uniform price. There is quite enough to do without adding to the clerical work, as we find to our cost in Rochdale where we have 28 different prices to deal with; perhaps it is not readily appreciated how easy it is to increase this kind of work and how difficult it is to reduce it. While one circuit no doubt sounds the right thing, experience does not always prove it to be so. Probably all supply engineers know how a consumer who first installs a certain number of lights and later wants to add to these, naturally not wishing to spend more money than is necessary to provide the original installation, finds that his wiring is not sufficient and that it means starting from the service terminals and installing new wiring to the various points of the house where it is desired to increase the supply. This question is very closely allied to the undersized plug circuits; as a supply engineer I do not think it matters whether the undersized plug circuit is in order or not since this is a matter purely for the consumer and his contractor. If it were necessary to inspect all the installations in order to see that suitable sections of wire were used it would mean that a spare man would have to be employed, and even then we could not be quite sure without having a man permanently on the spot while the installation was being carried out; this of course might not be convenient. I think the present arrangement of leaving it to the consumer himself is the only reasonable method, as he will be certain to find out for himself sooner or later, and it remains then for the supply undertaking to refer him to the contractor who wired the installation. Also in regard to one circuit, in this paper a meter has been described which may be utilized for one circuit, but the author has been cute enough to provide also for two circuits, and the meter has been designed to meet the requirements—much as they appear to differ—of Lancashire and London. The whole question of tariffs seems to me to remind us that we have to get as much money as we can from consumers, and if there is any instrument that will ensure equity at the same time as profit we should endeavour to find it.

Mr. Hollingsworth.

Mr. E. M. HOLLINGSWORTH: The author has put forward a very ingenious and no doubt quite practicable device, but I am afraid it has arrived too late in the day, for central-station engineers are rapidly getting away from the complicated and costly two-meter systems. In proof of this I would point to the general adoption of one or other of the "contract systems" which are proving satisfactory to the user and the supply undertaking alike. The author states that no paper on the subject of tariffs has dealt with the question of giving the consumer a lower rate during the light-load hours. Surely, a contract system does give such an advantage, and such systems have recently been the subject of several papers. I do not agree with the author in his reference, on page 43, to the diversity factor in connection with the supply for power. In determining the charges to large power users, the diversity factor plays no part; it is entirely a question of "value of service." To bring in such users, the supply authority has to prove that it is to their advantage to adopt the supply, hence the low

charges at present prevailing. One of the advantages claimed for the use of the author's switch is that a consumer can tell what his cost per unit will be. It is my experience that the user is more concerned about the total cost per quarter or per annum than about the cost per unit; and in any case this system does not give the average cost.

Mr. Hollingsworth.

Mr. P. P. WHEELWRIGHT: My experience of a two-rate tariff and two-rate meters, although I have only tried them on a small scale, is, I regret to say, far from satisfactory and bears out the disadvantages mentioned by the author. I quite agree that there are places where the system and apparatus described in the paper could be used with success, but I think that the following points ought not to be ignored, and in many towns are sufficient to prevent the system being put into operation. The use of lighting circuits for heating apparatus may lead to trouble and possible disaster, as after all when purchasing a small radiator or a kettle the consumer has only a very vague idea what the probable consumption will be. Consequently when the radiator causes the fuses to blow, and lampholders and lighting plugs to overheat, considerable annoyance is caused and the supply department is called in, with the result that the consumer is notified that the wiring is not suitable for anything but small apparatus. The contract prices accepted during the last few years for wiring large installations bear out my contention that after all there are few houses where the double use of the wiring may be carried out with safety and satisfaction to the consumer. The question of satisfying the consumer that his meters are registering correctly, should he doubt it with this two-rate apparatus in use, is one that cannot be overlooked; personally I can see considerable difficulty in explaining any sudden increase in the higher priced units in a quarter's account. The suggestion that the capital outlay required to install this apparatus with an extra meter may be overcome by the payment of a rental is, I think, wrong. I maintain that the price of energy ought to cover the cost of the necessary measuring instruments, etc., as in all other trading concerns. At the present time I think most supply departments will acknowledge the difficulty in getting consumers to notify them of any extensions which they may make in their lighting installations or any increase in heating or other apparatus. Consequently where the instrument is in use it is very liable to be considerably overloaded, if not burnt out. I quite agree with the author that the simplicity in working is an advantage of the instrument, but simplicity in the method of charging for energy is the only point that the consumer really appreciates.

Mr. Wheelwright.

Mr. A. G. COOPER: This paper takes me back many years. When I was with the City of London Company in 1892 I brought out a meter on practically the same lines as that described in this paper. The only alternating-current meter at that time was the Thomson meter, and I took out a patent for splitting the windings. The British Thomson-Houston Company bought the patent and I gave the foreign rights to the French meter company. Very few meters were sold. Unfortunately at that time all electric light stations were run on more academic lines than at present. The stations then were not content to know how much money they had to receive, but also wished to know what was the loss in distribution. The meter would not indicate whether one unit had been used for lighting at 6d.,

Mr. Cooper.

Mr. Cooper. or 3 for power at 2d. (I have assumed these prices.) I wanted to charge according to the rateable value and get rid of the meter; I therefore took about 40 consumers and found that the conditions in the different cases varied so widely that I came to the conclusion that no tariff could be framed to meet all cases. I also found that the demand indicator was disliked by the publicans. The only thing to do with the latter was to charge them all on the 3-hour rating, *i.e.* one hour at 6d. and two hours at 2½d.; they were then all satisfied.

Mr. Peck. Mr. J. S. PECK: It would appear that the idea underlying Mr. Perry's instrument is that the off-peak load on the station can be increased by offering the consumer a low rate for his lighting, provided this is kept down to a small percentage of his usual load. It is purely a matter of opinion, however, whether there will be an increase in the net profit when it is considered that the increased load is supplied at a lower rate, and also when the extra cost of the automatic switch with the necessary maintenance charges are given due weight. In Fig. 4 an arrangement is shown by which the greater the power load the greater the lighting load which can be obtained at the low rate. This seems to me to be wrong in principle; for if it is desired to keep down the peak load, then the arrangement should be reversed so that the greater the power load at any time the less the lighting load which can be taken at the same time and at the low rate. In regard to the construction of the instrument itself, I should anticipate more or less trouble due to burning at the contacts; for while it is true that only a low voltage has to be broken at the switch, the forces for operating the moving element are very small, and it may happen that the switch can stick in the balanced position, thus causing an arc to continue for a sufficient time to do serious damage. In any case the switch in its present form would only be suitable for use with very small currents. The author states that there is a loss in the switch of 4 watts with continuous current, and of from 8 to 10 watts with alternating current. If the loss on alternating current is 8 to 10 watts, the number of volt-amperes across the switch will be several times that figure on account of the poor power factor, so that the voltage drop will be very considerable.

Mr. Wilkinson. Mr. H. T. WILKINSON: I should be glad if the author would give us some examples of the actual operation of this switch in practice. I should like to have one or two instances; the prices applying to the two rates, and the average price obtained. When I was with the Lancashire Electric Power Company a few years ago we found it a great mistake to talk to consumers in terms of units. In one case one of our engineers was trying to convince a prospective consumer that 0·8d. per unit was a low price for him to pay. He could not impress this on the customer, so told him that in some places 5d. or 6d. was charged. The reply was that he did not know what a unit was, but 5d. seemed a lot to pay for one of them. The Acme Spinning Mill at Pendlebury, the first electrically-driven cotton mill in this country, was supplied at a fixed sum per annum for driving and lighting. We took on weaving sheds, and charged at so much per loom per annum. We found this worked out satisfactorily, the price of course varying with different types of looms.

Mr. W. CRAMP: There is one very important point in this paper which has been barely touched upon, and deserves much more comment than it has received. It is to the effect that under the proposed tariff the smaller the amount of energy used the less is the price paid per unit. Consumers hitherto have been encouraged to take as much electrical energy as possible—when they have taken as much as possible for lighting, the supply authority offers a lower rate if energy be taken for some other purpose. Here, however, the author has suggested a system whereby the customer using lights only will receive a distinct advantage. The man at whom the author is aiming is he who uses a few lights for many hours. If this system were adopted, the electricity bill would be of this character; for a few lights, a low rate; for more lights, a higher rate; and for lights plus power, a lower rate again. Mr. Wilkinson is, I think, quite correct in stating that the rate for electrical energy should be expressed in a unit which consumers can understand rather than in an electrical unit. Take a flour mill for instance; if the cost of electricity can be expressed at so much per sack of flour produced, the miller knows just what is meant.

I should like to say a word from the consumer's point of view about the two-circuit system of wiring. The fact is that a very small proportion of people own the houses in which they live, and consequently two cases are constantly arising: (1) If the landlord or the previous tenant has done the wiring, it is more than likely that the single system has been employed, and the new tenant has a strong objection to paying for the installation of a power circuit. (2) If the tenant has the whole wiring to do he grudges very much the cost of a double system which at the end of a short lease becomes the landlord's property.

A very important question which arises out of the paper is the cost of apparatus installed by domestic consumers to make use of the power rate. I refer to apparatus for cooking, heating, etc. The suggestion which the author makes in this connection "that the supply authority should have a hiring department" is a very good one, but in my opinion to charge for hire without maintenance would be a mistake. The fact is that domestic consumers experience very great trouble owing to the fact that there is so little standardization of parts of domestic apparatus, and also that the cost of repairs is so high. As an example, an electric iron may cost the consumer from 12s. to 15s. It may give trouble owing to the breakdown of the flexible wire or the burning-out of the heating unit. In the latter case on returning the iron to the makers it will often be six weeks before it is repaired, and the cost of the repair may be half the cost of the iron. So long as such cases occur domestic consumers will be necessarily shy of purchasing apparatus, but if they could hire it on a maintenance agreement they would be glad to do so. Such hiring with maintenance would lead to two very desirable results: First, in towns like Manchester the electric apparatus would be on a footing similar to the gas apparatus; and second, large purchasers like the supply authorities could bring pressure on makers to improve and standardize their wares. With regard to the difficulty of using domestic apparatus upon ordinary lighting plug circuits, I should like to say that if the lighting wiring has been installed to a proper specifi-

Mr. Cramp. cation there need be no fear at all of overloading the lighting plugs so long as not more than 1 kw. at 200 volts is used per plug. I consider that a great deal too much has been made of the danger of over-running wires and flexibles. It is quite possible, and usually quite safe, to take 1 kw. at 200 volts from an ordinary lighting pendant.

Mr. Barlow. Mr. F. BARLOW : I should like to ask the author if at the end of a quarter a check can be taken on the readings for the preceding quarter ; if not, how is it possible to be in a position to enforce the charges should the consumer dispute them ?

Professor Marchant. Professor E. W. MARCHANT : Speaking as a consumer, I am of opinion that it is an advantage to know, approximately, how much one will have to pay at the end of a quarter, and I think that any system which leaves any doubt about it is not altogether satisfactory from a consumer's point of view. That seems to me the objection to the maximum-demand system, and to a certain extent to the system described by the author. I also have doubts as to how the working of the author's switch is to be checked. If the switch sticks, it seems to me that there might be a very heavy charge due to the high-rate meter. I should like to know whether there are any devices on the switch which will provide for such a contingency.

Mr. Perry. Mr. H. H. PERRY (*in reply*) : The origin of my idea first centred around the two-rate clock, which as a system has very distinct advantages and has given good results in practice where tried. The disadvantages mentioned in the paper, however, outweighed the claims of that system for general use. The advent of heating and cooking by electricity suggested that a two-rate system might be used if the switch could be automatically controlled ; for there is this curious anomaly, that a relatively high price is charged for lighting and a very low one for heating. So long as the domestic consumer uses the supply, it matters little for what purpose he uses it—if light is not required at certain hours he may be induced to use the supply for another purpose. When the time comes for offering an average rate of, say, 1½d. or 1¼d. per unit, then the central station can depend on a regular day load.

Mr. Frith referred to the desideratum of charging a fixed price and a small rate per annum. If all consumers are satisfied, this is an excellent plan. I am asked for information regarding the operation of this two-rate switch. It has only been tried experimentally, but it has been subjected to very exhaustive tests under the most varying loads. I am rather surprised that nobody has mentioned electric heating and cooking and the results therefrom. It seems to me that a new field has opened up rapidly, and it would have been very interesting if members had given their views as to the desirability of pushing this new departure.

Mr. Watson laid emphasis on the fact that whatever system was chosen it should be capable of being understood by the consumer, and he approved the principle of the maximum-demand system. I am perfectly in agreement with him there, but the system, as stated, has its limitations. If a flat-rate system can be adopted on a primary house assessment charge, it is possible to have one meter for the whole supply, with heating and lighting at the same rate, but the short-hour consumers with a high maximum demand, such as shops, derive too great a benefit.

Mr. Atchison laid stress on the clerical work side of the question, and in consequence generally prefers a primary charge system. I am afraid the clerical work must always be a trouble; and I do not see how it can be got rid of ; but if extra business can be derived with advantage, this department must necessarily increase. He also raised the question as to the size of the contacts in the switch shown. They are quite large enough to carry at least 25 amperes. The instrument described will only have to carry a quarter of this load on the low rate, and I do not think there is the least chance of any trouble, since on the high rate, the greater the load the greater is the pull on the contact. The point where there may be trouble is at the position of equilibrium, but the auxiliary contacts are so designed that the switch is practically never broken. The switch operates equally well on either alternating current or continuous current.

Mr. Hollingsworth claims concessions for light-load usage by other systems, and while this is true for some of them, they do not bring that knowledge clearly to the consumer—as stated in the paper. I think he rather misses my point as to the diversity factor when domestic tariffs are considered. Here the power takes the form of heating or cooking, and is to-day a class of business eagerly to be sought after, and in a few years' time likely to cause a further revision of tariffs. Should this prove to be the case, the diversity factor will enter very largely into the calculations. As regards being late in the field with the proposed tariff, I am inclined to the belief that it may be too early.

Mr. Wheelwright asked for some information as regards the working of the switch, and he rather doubted the reliability of the same. He advocated that there should be no meter rent, and I quite agree with him if the rent can be omitted and its equivalent included in some way in the tariff. If the consumer doubts the sub-division of energy between the high- and low-rate meters, it should be a simple matter for the inspector to show the switch in action on a critical load for which it is set.

I am interested to hear from Mr. Cooper that he patented a single meter for two-rate use as far back as 1894—I was unaware of the existence of such a patent. He mentioned the question of lighting circuits being inadequate. As far as the general size of wiring goes for this system or any other, it is of course impossible to add heaters and use them indiscriminately over a house not originally wired for their inclusion. If large radiators or heaters are going to be used, it invariably means new circuits. This is one of the greatest troubles in persuading people to add to their existing circuits. It leads to obvious inconvenience and they hesitate a long time before giving their approval to a structural disturbance. I suppose time will show whether this expression of opinion is the same all over the country when electric heating and cooking are more generally adopted. When electric cooking is adopted, the present consumers' circuits need not be disturbed, since cooking is usually carried out in the kitchen or scullery near the meter, and only a very short length of additional wiring will be required.

Mr. Peck raised a point with regard to Fig. 4, and thinks the conditions as regards load on the opposing windings should be reversed. The argument may be amplified :— If a valuable consumer of power is to be encouraged, it

## 154 DISCUSSION ON "THE CHARACTERISTICS OF INSULATION RESISTANCE."

Mr. Perry will be safe to give him better terms for his lighting, should his heating peak, if one only, not overlap the normal peak on the system due to lighting. If he had three peaks per day due to heating, as instanced at Derby, it would still pay the supply authority to allow one peak to overlap the lighting owing to the increased revenue from the day load. It is not suggested that the consumer should get the whole of his lighting at the low rate, but a greater proportion than in Fig. 3. Mr. Peck also raised the question of arcing at the contacts when the apparatus in use with the switch has a large self-induction. The switch has been tried under such conditions and found to work very satisfactorily.

Mr. Wilkinson asked whether the switch had been actually used in practice. Owing to the unexpectedly early date of this paper, I regret to say "No," but I hope in a very short time to give the results of actual working. As regards the rates proposed, the high rate should certainly not exceed that charged at present.

Mr. Cramp raised the question of the consumer with a large number of lights and whether he gets any benefit from the use of the proposed two-rate system. The object in view with the proposed system is to meet the rational demands of an ordinary household, irrespective of the number of lights. There are hours when only a few lights are required, but the majority are "necessitated" lights and are kept on for long hours—such loads are valuable and a low tariff is naturally offered. But household customs

demand at other hours—all too few—a number of lights Mr. Perry. approaching the maximum, for which the generating station must be prepared every day. It is fair to charge a higher rate for a perfectly logical use. If the same consumer adopts heating or cooking by separate circuits, it is true that his average rate does decrease for the dual supply, since heating could not possibly make any headway unless a low rate were given—and its load factor should warrant the low rate. It is inconceivable that any ordinary consumer would designedly use only a quarter of his maximum number of lights in order to gain the low-rate charge.

The answer to Mr. Barlow's question is contained in the reply to Mr. Wheelwright, and, moreover, much the same contingency might arise with the instrument on the maximum-demand system. If it would facilitate matters, a counter could easily be fitted to the automatic switch, or a relay indicator placed in some conspicuous part of the premises to meet the requirements in special cases only.

In reply to Professor Marchant, the private consumer who is content to make regular payments for his supply, however used, would probably prefer the flat rate or the contract rate. Under the proposed system he would certainly pay no more, and very probably less. Owing to the decided gravity action, there is no tendency for the switch to stick on the high-rate side, other than fusing action; which contingency has already been discussed. The indicator would at once show a false position.

## DISCUSSION ON

### "THE CHARACTERISTICS OF INSULATION RESISTANCE." \*

BIRMINGHAM LOCAL SECTION, 26TH NOVEMBER, 1913.

Dr. Garrard. Dr. C. C. GARRARD: The characteristic shape of the moisture conductivity curve found by Mr. Evershed is of great interest, and in view of the microscopical and other researches given in the paper one is rather diffident of expressing any doubt as to the underlying theory of endosmose which seems to fit in excellently with the facts of the case. I should only like to ask the author if he has considered whether the phenomenon cannot be explained on the basis that the conduction of the moisture within the insulator is electrolytic in character. If two electrodes be placed in a vessel of water, and a gradually increasing voltage be applied, it is found at first that the current flowing is very small, but that after a critical value has been reached the current very rapidly increases, that is to say the electric resistance rapidly decreases. This phenomenon, with a single cell, only occurs between zero pressure and a pressure of, say, 2 or 3 volts, but in a porous insulator one can regard the moisture as being split up into a large number of cells in series, so that the pressure over which the action will be shown might be several hundred volts, as is the case in Mr. Evershed's experiments. On this basis could also be explained the fact found by the author that when the insulator is very

wet the conductivity follows Ohm's law; for, with a very Dr. Garrard wet substance, instead of a number of electrolytic cells in series we only have one, and a variation in resistance over the first volt or two is of no effect when working with a pressure of several hundred volts. I do not put this theory forward in any sense as a rival of Mr. Evershed's, as I have not had an opportunity to put it to any experimental test. I merely mention it as an alternative suggestion. Possibly Mr. Evershed as a result of his prolonged work on the subject has sufficient experimental data to upset it. The electrolytic action might also account for another phenomenon which I have often observed when testing the insulation resistance of apparatus, and that is that it improves if the testing voltage be applied for a long period.

One outstanding feature of the paper is the impossibility of using porous insulating materials in electrical machinery. At the present time these are of course no longer used by up-to-date manufacturers. The fibrous materials such as cotton, paper, and the like, are used simply as mechanical carriers for the insulating compound. The experiments showing that even impregnated windings absorb moisture are remarkable. They do not, however, bring out the im-

\* Paper by Mr. S. Evershed (see p. 51, No. 224).