Rural Electrification and the pioneering scheme of the Hereford Corporation (1918 – 1928)

by

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WHY HEREFORD?

This paper is primarily concerned with the pioneering rural electrification scheme of the Hereford Corporation during the period following the First World War. To set this in its context it will be necessary to give at least a brief discussion of the developments and problems of rural electrification generally, and as rural electrification was largely concerned with the application of electricity to agriculture, this will have to be discussed also. But let us first consider why it should be Hereford Corporation who were the pioneers as far as England was concerned.

The expansion of electricity generation was proceeding rapidly before 1914. During the First World War many towns in Britain had to continue to expand their electricity generating capacity in order to meet the needs of wartime manufacture of machinery, plant and munitions. Many new factories were built, but most of these could be used after the war for the needs of commercial manufacture. Fig. 1 shows in graphical form the expansion in sales of electricity in six English towns of moderate size, including Hereford, during the war and immediate post-war periods.[1] The five towns other than Hereford were chosen at random among those which were roughly comparable with Hereford in both size and generally rural surroundings. It will be seen that there is great variation among the towns, ranging from no expansion at Taunton to a maximum expansion of 4 to 1 at Hereford. No other town in the group had an expansion greater than 2.3 to 1. The reason for Hereford's large expansion was the establishment in 1916 of a large munitions factory at Rotherwas in the southern part of the city, which represented an enormous increase in the city's very limited industrial development. To meet the need for electricity for this factory, the Corporation's electricity generating station in Widemarsh Street was expanded to no less than six times its previous installed capacity, as Table 1 shows. No other of the towns illustrated in the table had anything approaching this expansion. In the country as a whole, the installed capacity had increased during the War by a ratio only between 1.5 and 2.0.[2]

Then, two years later, the war was over and the munitions factory closed. Hereford was left with a large modern generating plant and very little load for it. Others of the towns which had had a significant expansion of electricity production during the war suffered a contraction of sales after the war, but it can be seen from Fig. 1 that Hereford's loss of sales was the only catastrophic one shown there. The Corporation hit on the plan of trying to develop a rural supply network for the whole county of Herefordshire well before the end of hostilities in November 1918. Not only would this, hopefully, provide a load for their generating plant, but it would attract generous loans from the Development Commission (discussed more fully later) as it would be expected to lead to a significant development of electrification in agriculture. The Electricity Committee of the Corporation was quite clear as to the purpose of the scheme[3]:

> ... the scheme should be proceeded with having regard to the supreme importance of keeping the efficient plant the Corporation now possesses at the Electricity Works.

It was a good idea, and was hailed with enthusiasm in the technical press.[4] Unfortunately it did not work out very well, as we shall see. No other town in Britain, nor any other electricity

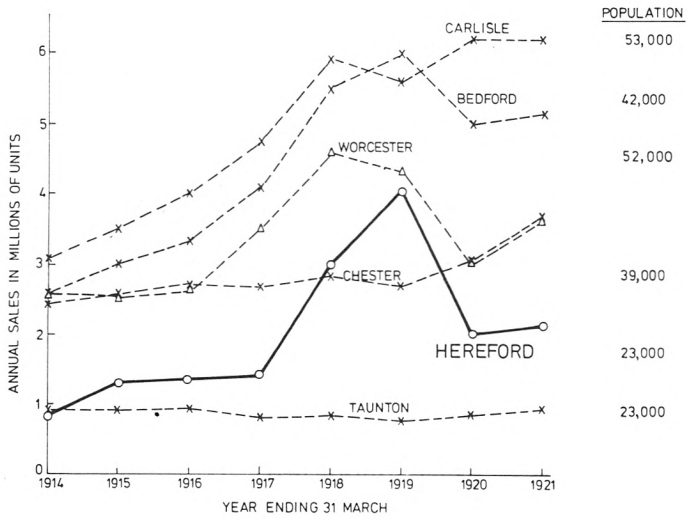

Fig. 1. Annual sales of electricity over the years 1914 – 1921 for Hereford and five other roughly-comparable English towns.

undertaking, developed any similar scheme for some years after the war. Hereford was undoubtedly the pioneer in this country. Clearly, its pattern of electricity generation and sales was very exceptional and this undoubtedly provided a major reason for its pioneering role in rural electrification.

TABLE 1

INSTALLED CAPACITY OF POWER STATIONS (MW)

Town	1913-14	1915-16	1917-18	1919-20	1921-22
Hereford	0.8	0.8	4.8	4.8	4.6
Bedford	2.2	3.0	3.0	3.5	5.0
Carlisle	2.2	3.5	3.5	5.5	5.5
Chester	2.0	2.0	1.9	1.9	1.9
Taunton	1.1	1.0	1.0	0.9	1.3
Worcester	2.2	3.7	4.7	4.7	4.7

Another major reason why Hereford was the pioneer was the personality of its Electrical Engineer, Mr. W.T. Kerr. There is no doubt that he was a man of immense drive and vision, although he had some faults as we shall see later. The electrical press was very impressed by him and his scheme.[5] He had worked hard for years to interest farmers and other rural dwellers in the agricultural and rural use of electricity, and had attracted favourable notice from the Ministry of Reconstruction.[6] He carried the Electrical Committee of the Hereford Corporation with him against very severe opposition from sceptical members of the Council.

Herefordshire, as an almost exclusively agricultural county, was not an unsuitable place for such a scheme, as it might be supposed that there would be enthusiasm and support for such advances. Its agriculture was dominantly based on grass rather than arable, with an acreage of grass approximately twice that of arable, as in most western counties, contrasting with the inverse ratio in most eastern counties such as Lincolnshire.[7] This would have been a favourable factor as there were more uses for electricity in dairying than in cropping. However, Herefordshire suffered from a low density of population, curiously below the average density of rural population over the whole of England and Wales. The latter figure was quoted as about 154 per square mile around 1930[8]; my estimate for Herefordshire is only about two-thirds of this. This would have been an undoubtedly adverse factor in relation to a rural electrification scheme.

RURAL ELECTRIFICATION AND ELECTRICITY IN AGRICULTURE BEFORE WORLD WAR I

In Britain, Hereford Corporation, under the stimulus of its Electrical Engineer, W.T. Kerr, was trying to encourage the use of electricity by farmers in the country area immediately around Hereford well before 1914, not only for lighting but also for driving agricultural machinery.[9] Well before that, other sporadic experiments in the application of electricity to agriculture in Britain were reported. For example, in 1893 a farm at Ardwell in Wigtownshire had its threshing, corn-crushing, sawing, etc. done by a 16 h.p. electric motor, the electricity supply coming from a small hydro-electric installation which also provided light for the house and farm buildings and power for water-pumping.[10] However, in general, such developments in Britain lagged well behind those in other countries of Europe and America, and in particular, the development of rural electrification systems based on transmission lines from a central station was pioneered entirely outside Britain.

In addition to the type of agricultural electrification mentioned above, there was another potential application of electricity to agriculture called electro-culture. This was the use of electricity to stimulate plant growth. It was an old subject, stretching back well into the mid-19th century or even earlier, but received a very great deal of study in the years from 1880 to 1930. Although there were many negative experiments most workers reported more rapid growth, earlier germination, earlier ripening, etc. when an electric field was established, generally between suspended electrodes and the ground, but sometimes in the soil itself. However interesting and important this was, it made little demand for electric power and had no significance in the development of rural electrification. We shall therefore not pursue it further here, merely giving some references for further reading.[11] Britain made a leading contribution in this subject.

The use of electric lighting to accelerate plant and animal growth was a more potentially important topic in regard to rural electrification, and is indeed significant at the present day. Nevertheless, it made little impact in our early period, and we shall here again dismiss it with some references.[12]

The type of application of electricity to agriculture that was envisaged in early rural electrification schemes was based on the electric lighting of houses and farm buildings, yards, etc., and on the use of electric power for all the work normally done by horses, man, steam engines, etc. Experiments in France on the use of electricity for ploughing and threshing were reported as early as 1880.[13] The principles of electric ploughing were essentially the same as in Fowler's steam plough, with electric motors replacing the steam engines, although electric tractors were also developed for use in field operations. The problem was, of course, to provide temporary electricity transmission lines to the various fields involved. The 1880 experiment avoided this by having a semi-portable steam engine driving a dynamo in a convenient place near the field concerned! Although the experiment was considered successful, electric ploughing was never used to any great extent—certainly not to the extent that steam ploughing was used—and even in 1922 Matthews had to report that[14]

> much experimental work in electric ploughing has been carried out, but no entirely satisfactory solution has been reached.

The general arrangements developed for electric ploughing are shown in Figs. 2 - 4, taken from Matthew's paper. Only very large farms could employ such methods economically, and then only on the basis of using an electric-ploughing contractor. The system never displaced its steam competitor, and never provided an intermediate stage between the horse and the now ubiquitous internal-combustion tractor.

By contrast with ploughing, and also with transport, most of the other uses of power on a farm are essentially fixed in location, and are quite suitable to be provided electrically. There were no serious mechanical or electrical difficulties, and the limitations were basically economic. To provide transmission lines to remote rural communities and isolated farms involved large capital outlay which, generally speaking, neither supplier nor consumer regarded as a good investment. Where attractive tariffs could be offered, there was a good response. For example, in Ontario in 1911[15]:

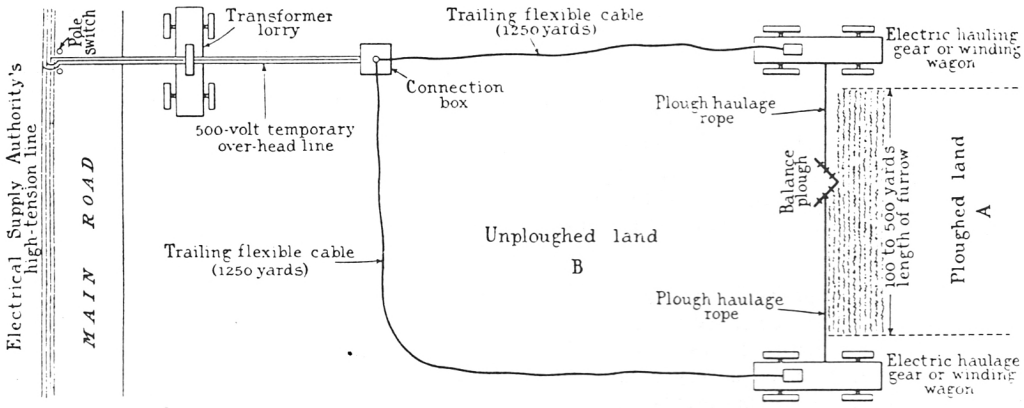

Fig. 2. Electric ploughing on the double-winder or Fowler steam 2-cable system. [From R. B. Matthews, *J.I.E.E.*, **60**, (1921 – 2)].

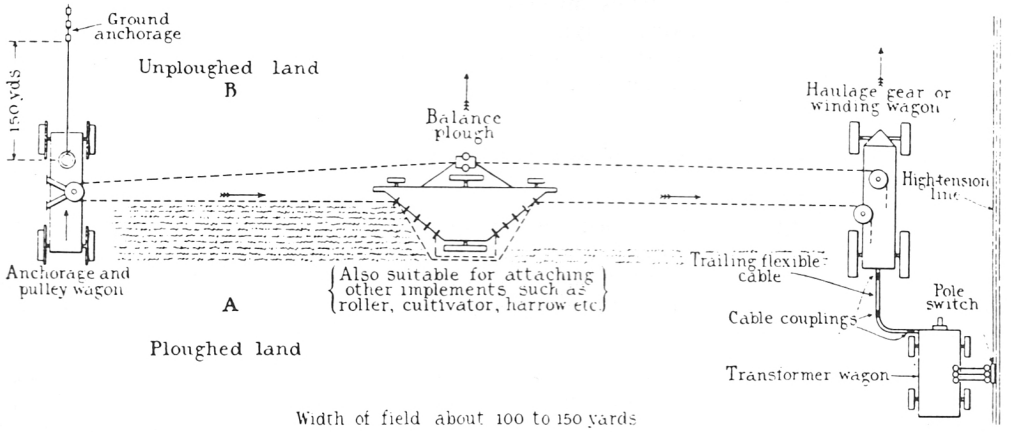

Fig. 3. Single-winder electric ploughing system (single-cable). [From *J.I.E.E.*, **60**, (1921 – 2)].

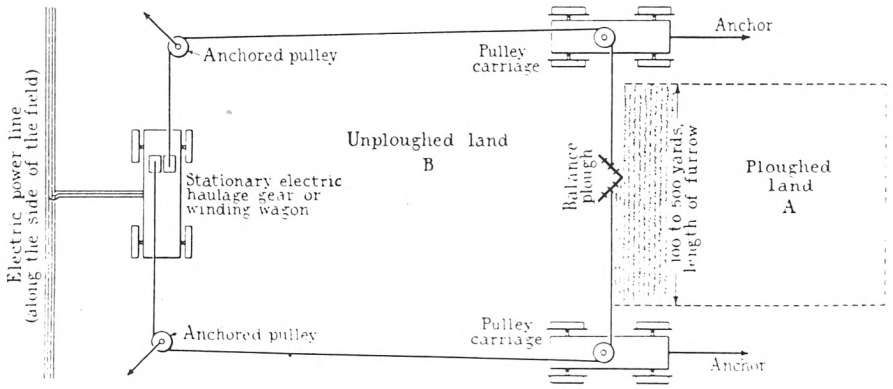

Fig. 4. Electric ploughing on the Roundabout single-winder or Howard steam single-cable system. [From *J.I.E.E.*, **60**, (1921 – 2)]

> The Hydro-Electric Commission, which act as distributors of Niagara electric power at cost price to the cities and towns of Western Ontario for civic, domestic and industrial purposes, is taking steps to bring these advantages within reach of the farming communities in the rural districts surrounding these centres.
>
> By a demonstration transmission line which was run out to the farms surrounding Ingersoll (Ont.) it was found that a charge for power based on the city rate, with 10% added, was financially sound, and a large number of farmers are now taking power for all kinds of farm work ....

Advantage could sometimes be taken of an inter-urban bulk supply transmission line. Thus, in 1912[16]:

> 'When it became known that the Petersburg Electric Light Co. (U.S.A.) were building a 16,500 volt transmission line to Greenview and Mason City, a number of prominent farmers along the route served notice on the company that if they could have the privilege of taking service at the town rates the right of way of the proposed line would be furnished free of cost.

This proposition was agreed and single-phase transformers were mounted on 25 foot poles to give 2400V for distribution to the farms.

Perhaps the most interesting cases of all were those where an interurban electric railway provided the main medium of transmission. As transmission lines had to be erected to serve the railway itself (with typically 20 miles or more between the towns in rural U.S.A.) the surrounding rural area could be supplied with electricity on an economical basis. An example from 1914 is that of the Indiana Railways and Light Co. shown in Fig. 5.[17] The 'interurban' (a common feature in the American scene but uncommon elsewhere) linked the small manufacturing town of Kokomo (c. 20,000 pop., lying some 50 miles north of Indianapolis) with the farming centre of Marion (also c. 20,000 pop. with some manufacturing) and with the much smaller town of Frankfort (less than 10,000 pop.), a total length of some 45 miles. From various points on the railway, as shown, transmission lines were run to serve small farming communities. The number of consumers in relation to the total population of each community is shown, and it is clear that the vast majority of farmsteads and households were connected to the electricity supply. The basis of provision was a minimum of five customers per mile of transmission line, each customer paying his proportion of a maximum cost of $300 per mile in the form of advance payment for electricity subsequently consumed. The standard tariff was 12 cents per kWh for small loads and 5 cents for power loads. By British standards these were very reasonable charges.

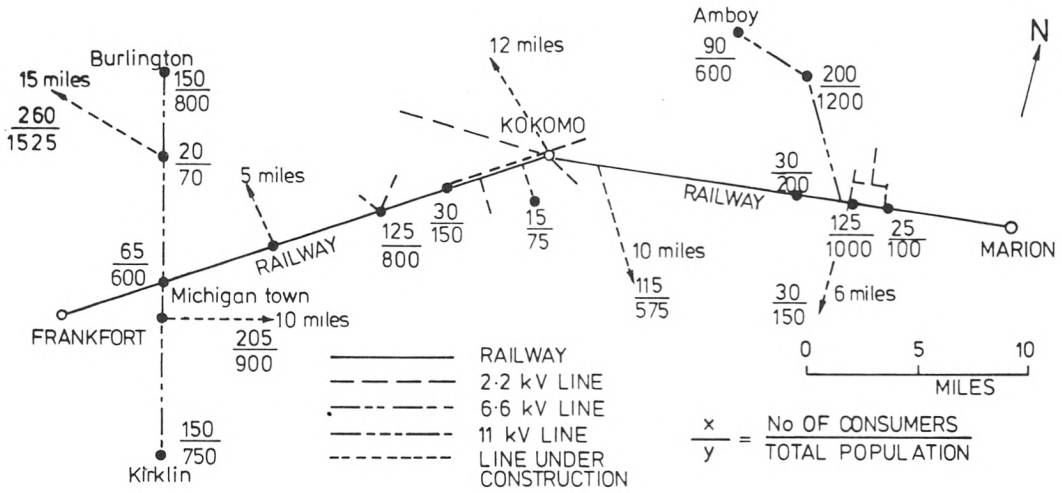

Fig. 5. Diagrammatic map of the Indiana Railways and Light company in 1914, showing its role in rural electrification.

In California especially, much use was made of electricity supplied over transmission lines from central generating plant (generally hydro-electric, such as the Mount Whitney Power and Electric Co's system), for the primary purpose of pumping for irrigation, on which the success of Californian agriculture (e.g. fruit) depended. In 1913, the Mount Whitney Co. supplied about 6000 h.p. for irrigating about 25,000 acres.[18]

By comparison with America, the rural use of electricity in Europe was very small. Only in Germany was there any development of rural distribution networks before 1914; there the rural network was often provided by a local co-operative which purchased its electricity in bulk from a generating company; there were said to be over 600 such co-operatives in 1913.[19] Elsewhere, including Britain, what electricity was used on farms was generally generated by small private plants. For example, it was claimed that one firm installed for use by farms in North Wales, 234 small hydro-electric plants ranging from 1 to 9 h.p. between 1907 and 1911.[20] Thus Mr. Kerr at Hereford, in trying to develop an agricultural load based on a rural distribution network was not exactly pioneering in the context of world developments, but he was attempting something not previously attempted in Britain.

THE HEREFORD SCHEME

Origins of the rural electrification scheme.[21] The proposals for rural electrification in Herefordshire arose, as we have seen, very largely from the surplus generating capacity at Hereford after World War 1. But plans for the expansion of the generating station in Widemarsh Street had been put forward before the War, early in 1914; they were, of course, much less ambitious than the expansion actually made. In 1916 the Government (Ministry of Munitions) established a shell-filling factory at Rotherwas on the southern side of Hereford City, and to meet its needs the generating capacity at Widemarsh Street was expanded far beyond what was originally intended. This was done by the Corporation using Government loans made for the purpose. The Corporation saw that they would be faced with a difficulty after the War, having either to retain this large plant for their own use, or to ask the Ministry to remove it. They thought they would want to keep it, and hence worked out a plan for developing rural electrification as a means of producing a load for it. This plan had been informally discussed with the Ministry before the end of the War.

The capital charges to be met with respect to the new plant were of the order of £10,000 per annum. This, therefore, was the amount of the excess of receipts over cost of generation which they had to achieve. Some idea of the size of the problem may be gained from the fact that for the year ended 31 March 1919, the gross receipts of the electricity undertaking were £30,000 of of which £18,000 came from the factory; the profit was stated to be only £500.

The Government gave the Corporation the required six months notice of closure of the factory on 1 December 1918. By negotiation, the Corporation were able to obtain the concession that, in order to give them time to build up a remunerative load before having to pay the heavy capital charges, no such charges would be required until July 1923. This clearly put a premium on speedy execution of the rural plan. The Corporation's Electricity Committee and its Electrical Engineer, Mr. W.T. Kerr, lost no time in putting forward the plan and starting negotiations for appropriate loans.

The plan and the end-product. The ambitious scheme for a rural network put forward by Mr. Kerr and developed on paper during the period 1918-1919 was approximately as shown in Fig. 6. No copy of his actual plan has been found, and the diagrammatic map here presented is based on several published plans together with numerous note in the minutes of the Electricity Committee.[22] As there is a certain amount of conflict in these sources, the map of Fig. 6 must not be taken too literally. The full lines show the routes actually constructed, with the dates of opening, while the dashed lines show those routes which were planned but not constructed. The circles show villages where transformers were to be fitted to provide a local low-tension service. No information has been found as to where transformers were actually fitted during the period covered by this study.

It was intended that all the main routes should initially work at 11 kV, while the local spurs and links should be at 3.3 kV. It was hoped that the main routes could later be raised to 33 kV, and those actually constructed were designed with this in mind. As far as is known, however, they were never thus upgraded.

The northern main route from the Hereford outskirts to Weobley, and the southern main route from Hereford to Lydbrook, were built with steel lattice towers standing 36 ft. above ground

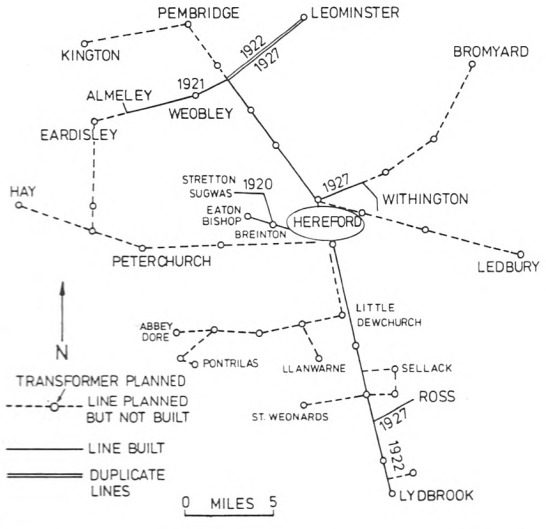

Fig. 6. Diagrammatic map of the Hereford Corporation's rural electrification system.

and weighing 15 cwt., with spans of between 320 and 440 ft., and with bare copper wire of 19 strands 0.083 inch diameter. A few of these towers remain in 1979 and photographs of them are shown in Fig. 7. The extensions to Leominster and Almeley, and probably also that to Ross, were on wooden poles, although still at 11 kV. The early short route to Breinton, Stretton Sugwas and Eaton Bishop was on wooden poles and operated, at least initially, at 3.3 kV.

Within the confines of the city, the routes operated in underground cables at 11 kV. The supply was 3-phase A.C. at 50 Hz.

The capacity of each of the main routes was planned as 3000 kW. It was expected to supply 5,256,000 units (kWh) per annum to consumers over this network. The lines with wooden poles were constructed by direct labour. The steel tower lines were built by British Insulated & Helsby Cables Ltd. on a controlled-profit basis while the underground cables were laid by Callender's Cable Co. Ltd.

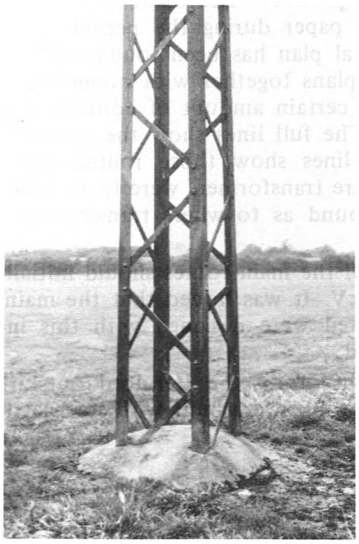

Fig. 7. Photographs taken in 1979 of the few steel lattice towers, understood to date from the early 1920s, which still remain near Watery Lane, Hereford.
(a) (Left) Base of tower; the corner steel angles form a square of side 20½ inches where they enter the concrete base.
(b) (Right) Top of tower, showing three line wires, and an earth wire which is not continued to the adjacent timber pole.

Proposed financial arrangements. The proposals for rural electrification had, of course, to be accompanied by realistic proposals for their finance. Kerr and the Electricity Committee, no doubt advised by the Town Clerk and by the Government departments they had consulted in 1918, saw their best hope for finance in loans from the Development Commission. This was a body set up under the Development and Road Improvement Funds Act of 1909, and the relevant passages in the Act were as follows:

> The Treasury may, upon the recommendation of the Development Commissioners appointed under this Act, make advances to a Government department, or through a Government department to a public authority, university, college, school or institution, or an association of persons or company not trading for profit, either by way of grant or by way of loan, or partly in one way and partly in the other, and upon such terms and subject to such conditions as they may think fit, for any of the following purposes.

And the relevant purpose was[23]:

> Aiding and developing agriculture and rural industries by promoting scientific research, instruction and experiments in the science, methods and practice of agriculture .... and by the adoption of any other means which appear calculated to develop agriculture and rural industries.

The development of a rural electricity supply network in Herefordshire, although calculated primarily to exploit the surplus generating capacity in Hereford, was thought also to 'appear calculated to develop agriculture and rural industries'—indeed Kerr had worked hard to demonstrate this potentiality—and thus to qualify for a loan from the Commissioners.

As a sort of pilot project, the Electricity Committee, with the approval of the Town Council, applied in January 1919 to the Commissioners for a loan for the small rural development just to the west of Hereford, at Breinton, Stretton Sugwas etc., involving a total of about 20 miles of distribution lines and a sum of £13,000. This was granted by the Treasury, on the recommendation of the Commissioners, in December 1919 and work started immediately. The main part was opened in July 1920. Curiously, the minutes now referred to this scheme as involving 3 miles of high-tension (h.t.) line and 5 miles of low-tension (l.t.) lines when complete; rather less than the total of 20 miles mentioned earlier! By October, the scheme was sufficiently advanced to be demonstrated to other electrical engineers and to the press; the latter gave, as we have already mentioned, very enthusiastic accounts of the plant and of Mr. Kerr.

For the remainder, i.e. for the main part of the network shown in Fig. 6, Kerr put his estimates before the Committee in a report of 5 July 1919. For the total of 79 miles of h.t. and 60 miles of l.t. line the capital expenditure was estimated at £81,407. This was later shown to be made up as follows:

			£
A.	Transmission line and equipment,	Leominster, Weobley and Kington area	19,857
B.	do	Ledbury and Frome Valley area	14,400
C.	do	Ross and Lydbrook area	21,250
D.	do	Pontrilas and Golden Valley area	7,400
E.	Rotherwas sub-station		3,500
F.	Low-tension distribution lines		15,000

Allowing interest on the loan at 5% (£4070) and an annual contribution to a sinking fund of £5427, the total annual capital charges were £9497.

Working on a load factor of 20%, it was calculated that 5,256,000 units per annum could be delivered to consumers. The estimate then proceeded:

Capital charges per unit	=	0.4337d
Cost per unit delivered to consumer from Hereford generating station in the year 1919	=	1.748d
Total cost per unit	=	2.181d
Assuming consumers charged 3.5d/unit 5,256,000 units sold would bring in		£76,650
Cost of production at 2.181d/unit	=	£47,750
Annual balance (profit)		£28,980

If the load factor could be increased to 30% (which was considered quite possible), a further 2.5 million units could be supplied each year.

Kerr pointed out that Hereford's generating cost was much below the average for small towns (only one-half the average of the eight towns he considered) and, indeed, the proposed charge to consumers (3.5d/unit) was almost identical to the average cost of production in the other towns (3.4d/unit). There was thus a good basis of expectation of a good response to the scheme. Hereford's Council and all the Rural District Councils in whose area the scheme would operate gave their approval.

Unfortunately the Development Commission and the Treasury did not respond enthusiastically. They delayed their response so much that a complication arose in that the Electricity Commissioners—a body set up by Parliament on 23 December 1919 to co-ordinate electricity supply[24]—had then also to consider the scheme. They made a mess of it by getting it divided between two of their proposed Electricity Districts, and this had to be resolved after strong protests from the Corporation. Eventually, after 18 months delay, on 15 January 1921, the Treasury notified Hereford that only part A of the scheme (£19,875) would be approved at that stage. They requested that the work be put in hand at once to provide employment during the current winter. The loan would bear interest at 6.5% (not the 5% assumed by Kerr), should be repaid over 20 years, and be secured upon the Hereford City rates.

Now both the delay in approving the scheme, and the securing of the loan on the City rates, were a source of great embarrassment to the Corporation. The second factor gave rise to a strong opposition among the public[25] and on the Council,[26] and the Chairman of the Electricity Committee, Mr. E.R. Dymond, had to do a lot of talking to wear down the opposition. It was a pity that the opposition turned out to be right in seeing the scheme as a bad risk rather than a guaranteed success. But it was at least partly the delay which caused the failure.

Execution and emasculation. We have noted that the Corporation would have to pay capital charges from July 1923 on the money provided by the Government for the extensions made to the generating station in 1916. It was thus vitally important that the rural scheme, which was to provide revenue to pay these charges, should be fully developed by 1923. The delay in obtaining the loans for the rural scheme was therefore very frustrating, and Kerr tried to save time by obtaining much of the material required in advance of the loan. This led to difficulties later, but it did mean that it was possible to construct the northern line to Weobley quickly, and have it working by 22 May 1921, although at first it worked at 3.3 kV, being raised to 11 kV in October that year.

In the meantime, the Treasury, on the recommendation of the Development Commissioners, had agreed to a loan of £34,750 for the line to Ross and Lydbrook (item C), for the sub-station (item E), and for the two-thirds of the l.t. lines corresponding to items A and C, but had required the deletion of the items B and D, and the corresponding one-third of item F, namely the lines to Ledbury and Pontrilas and the associated areas. So already the scheme was being compulsorily reduced by about one-third of its extent.

The line to Lydbrook was put in hand quickly, was 'proceeding' in June and was well-advanced by September 1921. In that month, however, the bombshell was dropped, from the shock of which the Corporation, and in particular the Electricity Committee, never recovered. It was disclosed that although only £67,607 had been obtained in loans, Kerr had already spent £72,000 according to his own statement,[27] and the work was very far from complete; the Lydbrook line required another £17,500 approximately (bringing its total cost, without the spur to Ross, to £26,717) and the extension of the northern line to Leominster required approximately £3000. Little of the l.t. distribution network had been provided, although Kerr had purchased materials in anticipation. He had a total stock worth over £10,000, some of which was needed for the Leominster line, but he suggested selling £6000 worth.

This was a catastrophic situation, and the Corporation wondered whether it should sell all stock and abandon the scheme forthwith, allowing the uncompleted lines to go derelict. However, the more sensible view of trying to raise enough money to complete the Lydbrook line and get some revenue from it prevailed, and it was eventually decided to apply for a loan of £19,000, of which only £13,000 would actually be borrowed as £6000 would be raised by selling stock as suggested by Kerr.

Meanwhile, of course, the reasons for the overspending were investigated. Kerr explained that prices had risen during the period of delay imposed by the Government bodies and that it was inevitable that estimates should be exceeded. However, it transpired later[28] that Kerr had been extremely slack in his accounting, had ordered materials and work without authority, had not notified the authorities of his expenditure, and was quite unaware himself of how his expenditure was related to the estimates. Later still, Kerr was convicted of fraudulently paying Corporation money into his own private account.[29] But Kerr resigned his position with Hereford Corporation in December 1921, after about 17 years hitherto satisfactory service, to set up the Norchard Syndicate (see later) in the Forest of Dean. He was replaced by Mr. James Makin.

One result of the investigations was to disclose that expenditure had been still higher than suspected. There was another £14,371 of outstanding accounts, and it was, moreover, found that the stock of materials which it was proposed to sell was now worth much less than its original price.[30] The proposal which was eventually approved by the Council was to try to get a loan of £40,000 instead of £19,000 so that the scheme could become solvent again. Dymond retired from the Chair of the Electricity Committee and was replaced by Alderman Wallis.

It was now accepted by the Council and the Electricity Committee that the southern line no longer represented a scheme of rural electrification, as there was no money to put in an l.t. system to supply the villages en route; if they wanted electricity they would have to pay for the

transformers and l.t. lines themselves. The Corporation would concentrate on finding a bulk-supply load at Lydbrook and in the Forest of Dean. There was much protest over this[31], but, of course, there was no alternative. By the end of February 1922, H.W. Smith's metallurgical works[32] (TEMCO) at Lydbrook had signed an agreement to take 100 kW, and the Cable Works (later the Edison-Swan Works) were expected to take 150 kW. The electrical demand of the collieries in the Forest of Dean so greatly exceeded the capacity of the line (then rated at 2000 kW) that a provisional agreement was reached in June 1922 with the Norchard Syndicate whereby the latter would take electricity in bulk from the Hereford line while also generating its own supply for serving the collieries.[33] The negotiations with the syndicate, which soon became the West Gloucestershire Power Company, were extremely complicated, and at times acrimonious, largely due to the Corporation's distrust of the Syndicate whose chief executive was W.T. Kerr, their lately-erring Electrical Engineer! The Power Company built the power station at Lydney, opened in 1923, and served a much wider area than the Forest of Dean, extending to Stroud and the Cotswold valleys. The provisional agreement with the Corporation was never ratified, and thus the load at Lydbrook never developed as hoped.[34]

Somehow the Corporation managed to get the Lydbrook line completed by April 1922 and it was put into operation immediately. They also managed to build the extension line to Leominster and started to supply electricity in bulk to the Leominster Electrical Supply Co. Ltd., on 25 September 1922. In September 1922 they were negotiating with Monmouth Corporation to supply electricity in bulk to them by an extension from the Lydbrook line, but the Electricity Commissioners vetoed the arrangement because they thought Hereford's price (even after negotiated reductions) was too high, and the Commissioners encouraged Monmouth to extend their own small generating station.[35] In 1923-24, Abergavenny Corporation was negotiating for a supply from Hereford, from a point near St. Weonards on the Lydbrook line, but Hereford would not reduce its charges sufficiently to compete with a company which was offering Abergavenny better terms. From early 1924, Hereford was negotiating with the Ross Electric Light & Power Co. Ltd., about a bulk supply, which eventually materialised in 1927.

It will thus be seen very clearly that what had started as a rural electrification scheme had become a dominantly bulk-supply system, and the only significant rural electrification involved was the original Breinton section and some areas on the line to Weobley. By December 1921, it was reported that only thirty farms (totalling 5285 acres) had been connected to the system.[36]

The loan of £40,000 which the Corporation wanted was made the excuse for searching enquiries by the Development Commissioners, but a loan of £25,375 was sanctioned in August 1923, 'to meet hitherto unauthorised expenditure'. The Corporation wanted to use £10,000 of the £40,000 proposed loan to develop the l.t. network in order to get consumers. The provision of genuine rural electrification was still the main aim of the Commissioners in relation to Hereford. But the loan arrangements became very complicated.

Personal comments. At this stage I feel it is desirable to express some purely personal views on the case described above. It seems to me that Hereford was fortunate in having a man of Kerr's vision, technical competence, and drive, as its Chief Electrical Engineer, and in having an Electricity Committee and Chairman willing to support him. His scheme was good. It failed because of three main factors:-

(a) it got bogged down in a morass of Government procedures, and tied up in Government red tape, and thus suffered delays and interference which minimised its chances of success,

(b) it suffered from the inadequate control and accounting procedures of the Hereford Corporation (i.e. from a lack of local red tape!) and relied too much on one man's control,

(c) that one man—the Chief Electrical Engineer, W.T. Kerr—was more concerned with getting the job done than in worrying about accounting. Estimating and financial control were not his strong points, but he had a genuine concern with making the scheme a success. With proper financial supervision he would probably have been successful.

Still on a purely personal basis, I would hazard the view that, although Kerr was convicted on a criminal charge and sentenced to three years penal servitude, he was not really guilty of any

major crime. Having read the published verbatim reports of the case, I feel that Kerr's alleged crime of selling plant apparently belonging to the Corporation on his own account, could have been the product of the lax system rather than of any criminal intent, and that simple repayment of the money involved would have been an adequate settlement of the case; I cannot help wondering whether he was really paying the price for getting the Corporation into a very embarrassing situation, which exposed the incompetence of the senior officials.

I think I should also say that I have presented the story—while I hope accurately—yet in a highly-simplified form which gives no idea of the immense procedural complexity of getting a scheme like this 'off the ground'. Anyone who doubts me should read the minute books!

DEVELOPMENTS OF THE SCHEME AFTER 1923

After the upheavals of the early years of the rural electrification scheme, it is perhaps understandable that the emphasis of the next few years was on caution. The Corporation was quite adamant in refusing to invest any substantial capital in extensions, and tried to build up a load without further capital expenditure. Thus rural supplies would be given only if the local residents who wanted it were prepared to give guarantees to cover capital expenditure on lines and transformers, etc. It is therefore not surprising that there was little development of the rural load.

The Corporation was naturally worried that the expensive Lydbrook line was carrying barely 5% of its rated load, and looked for additional load in three places: Lydbrook itself, the Forest of Dean collieries, and the town of Ross-on-Wye. They did obtain a load of 220 kW from the Cable Works (now the Edison-Swan Works) at Lydbrook in late 1926. They lost the battle to supply electricity in bulk to the West Gloucestershire Power Company, but still hoped to be able to supply power to the Trafalgar and Waterloo Collieries which were relatively close to Lydbrook, although well outside Herefordshire and therefore outside the authorised area of the Corporation.[37] It is believed that the Electricity Commissioners never agreed to this plan. At Ross, however, the local electricity company was interested in a bulk supply and the negotiations were encouraged by the Commissioners. The discussions took a long time, however, and were very confused; eventually it was agreed, in September 1925, that the Corporation would provide the extension transmission line from the Lydbrook line but the Company would have the right to supply at their own cost any rural load in the area traversed by the extension. The Corporation would provide electricity on the basis of £6 per kW of maximum demand plus 0.6d per unit with a clause permitting adjustment according to variation in the cost of coal (a 'coal clause'), with the Company guaranteeing a minimum annual payment, over three years, of 20% of the capital expenditure incurred by the Corporation, security for this being deposited in advance with the Corporation. It was expected that the demand would be initially 90 kW and the annual consumption about 100,000 units; still only a small contribution. Service commenced in January 1927.

At the other extremity of the system, the Leominster company had been complaining of unreliable service over the extension line from Chadnor, and early in 1925 the provision of a duplicate line was proposed. At first it was intended to lay a 6-mile cable at a cost of £5,000, the interest at 8% to be guaranteed by the Company in return for the Corporation giving up its right in the Kingsland area in favour of the Company. Later it was agreed to run a duplicate overhead line on a route about a mile away from the existing line, with the Company guaranteeing a minimum annual payment of £1,350, the Corporation's charges being reduced from £10 to £5 per kW of maximum demand plus the same 0.75d per unit. The new line (also on wooden poles) was opened in April 1927. In the light of the guarantees obtained from Ross and Leominster, the Corporation had obtained small loans of £3,403 and £4,120 respectively for the construction of the lines.

Mr. Makin, the Chief Electrical Engineer, resigned in September 1927 to take a post at Altrincham, and was replaced by Mr. G.D. Coe, who quickly saw the Corporation's policy of demanding a 20% p.a. guarantee from rural consumers to cover the capital cost of their installation was seriously discouraging business. In view of the urgent need for load, he proposed this be reduced to 12½% over a longer period. In June 1928 the Committee agreed to make it 15% over 7 years in a drive to get business in the Whitchurch and Symonds Yat area. (N.B. The basis of the rural supply charges was £10 p.a. per kW of "maximum demand" plus 2.5d per unit.)

Another hopeful development in late 1928 was the proposal to provide a bulk supply to Kington and Lyonshall. In both places small local generating plants were proving unequal to the demand, and the operators were interested in bulk supply from Hereford over the underloaded Almeley line.

But before any of these proposals could take effect, a much more far-reaching proposal had to be considered—nothing less than the taking-over of the whole Hereford electricity undertaking by the Shropshire, Worcestershire and Staffordshire Electric Power Company.

THE TAKE-OVER

It appears from the minutes of the Electricity Committee that the approach was first made by the S.W.S.Co. to the Chairman of the Committee early in October 1927. The Chairman had received a visit from Mr. J.T.H. Legge, Chief Engineer of the Company and his notes of Legge's arguments were recorded thus:

> The City would gain the benefit of mass production and mass organisation and big services .... City would be saved the cost of big extensions .... That in view of what was taking place all over the country, the Government would press the City to extend. That Government won't leave Undertakings which refuse to go ahead. That Hereford might be afraid of the prospect. Proposal was that if Committee cared to consider the matter, the Company would take us over lock, stock and barrel. City would have no more responsibility. That a big undertaking had greater command of capital ....

The Chairman said he had given no encouragement to Mr. Legge. The Committee resolved to leave the matter in abeyance.

At the end of 1928, Mr. E.F. Bulmer replaced Wallis as Chairman of the Electricity Committee. He was clearly more sympathetic to the idea of the S.W.S. take-over. On 9 May 1929, Mr. W.G. Bond, Managing Director of the S.W.S.Co., wrote to him making a formal proposal to take over the undertaking and its liabilities. At this stage the West Gloucestershire Power Co. also showed interest in possibly taking over the undertaking, but it did not follow the matter up. The Electricity Committee wisely appointed Mr. J.H. Rider, of Preece, Cardew and Rider, Consulting Engineers, to advise them. His report, dated 27 June 1929, is a full and illuminating document.[38] Some extracts and points from it are given below:

> The city and rural systems, although accounted for separately, were legally inseparable. Nevertheless there was no doubt that the city part was making a profit, and the rural part a loss.
>
> 'While it is comparatively easy to be wise after the event, it is an obvious fact that, without the Rural area, the Electricity undertaking would be in a sound financial position... Notwithstanding the large capital expenditure, the supplies now being given... are relatively very small.' The Corporation had failed to develop the area, and had lost half of it already to the S.W.S. and other companies by being unwilling to provide supplies when development was proposed. The half retained had no development value. 'My opinion of the Rural area, from an electrical point of view, is that it is a white elephant to the Corporation, and should never have been acquired. I do not see how it could ever be made into a paying proposition, if worked as a portion of the Corporation's electricity undertaking.'
>
> While he thought it would be nice to dispose of only the rural part, he could not see any likelihood of any company taking it on—it must be the whole undertaking or nothing. The transfer (not 'sale') to a company would be for a period of 42 years.

The offer from the S.W.S.Co. meant that the Corporation would hand over all assets at their present book value, while the undertaking with its goodwill would be transferred for nothing. Seeing it had been making a loss, 'the goodwill cannot be said to be worth much'.

The company would supply the main load from their large generating station at Stourport, using Hereford's generating station to assist during peak hours.

The matter was very fully discussed, indeed argued about, in the Council;[39] a public inquiry was demanded[40] and eventually obtained on 20 December 1929.[41] As a result of the inquiry, the Electricity Commissioners approved the transfer on 20 January 1930,[42] and the deed of transfer was signed on 21 January 1930.[43]

The Company announced its intentions of spending about £85,000 on the development of the undertaking during the following two years.[44] The Company was a large one, with an authorised capital of about £2 million, and selling about 90 million kWh per annum. They would provide about 70 miles of additional power lines to supply villages, hamlets and small towns. The system would be interconnected to the main S.W.S. system by a ring-main. The city electrical distribution system would also be improved. It seemed that at last the undertaking would get the capital it needed.

So ended Hereford's pioneering experiment in rural electrification. Instead of supplying over 5 million units a year as originally intended, it had never reached 1 million, except possibly at the very end. It was a noble, ambitious experiment, but obviously (in retrospect) too big for the Corporation of a small country town to handle.

RURAL ELECTRIFICATION ESTABLISHED

The Hereford scheme failed partly through bad management and partly because its financial justification depended on a speed of execution which could not, in the event, be achieved because of the complexities of Government procedures. Perhaps too it was basically unsound in being devised in terms of utilising surplus generating capacity rather than of meeting a certain demand for supply. Immediately subsequent local-authority schemes at Chester[45] (operational from 1924), Aylesbury[46] (operational from about 1926), Bedford[47] (operational from about 1929-30), and probably at some other places, were less spectacular and ambitious, and much less hurried, in their conception. So also were the developments by companies such as the Shropshire, Worcestershire and Staffordshire Electric Power Co.[48] (which took over the Hereford scheme). This company was advertising in 1929 with a photograph of its new Stourport generating station and a caption which read 'The Power House behind Rural Electrification over an area of 1,400 square miles'.[49] Thus rural electrification began to be established, and the acceleration of the process was officially encouraged by the Government through the Electricity Commissioners. There was also considerable effort put into developing and demonstrating the applications of electricity to agriculture by men like R. Borlase Matthews,[50] who himself applied electricity to all possible uses on his own 600-acre farm.

Thus by the early 1930's there was a considerable body of experience in rural electrification, and some general theoretical planning principles began to emerge.[51] This process of codification of ideas and planning procedures had evidenced itself much earlier in the United States because of the very much earlier development of rural electrification there,[52] but there appears to have been very little trans-Atlantic transfer of experience. In Europe, rural electrification had expanded rapidly after World War 1. In 1924 it was claimed that 40% of the arable land area in Sweden was supplied with electricity,[53] and in France progress was good too, with much State aid.[54] Again, while this European progress was reported in Britain, little seems to have been learnt from it. Dickinson and Grimmitt[55] complained in 1932:

> Although in recent years quite a considerable amount of rural electrification work has been carried out, development has unfortunately been restricted by various factors, including high cost of electrical energy, high cost of transmission in bulk, costly transmission lines and electrical apparatus, lack of well-considered systems of propaganda and of good organisation, absence of attractive tariffs, and want of adequate deferred-payment facilities for the provision of electrical wiring installations and apparatus in consumers' premises.

Thus, although by the early 1930's the planning of rural networks was improving and the basic 'electricity grid' for the country had been brought into operation and almost all areas were benefitting from it, yet only about 12% of British farms were connected to an electricity supply by the outbreak of World War 2.[56]

The British electricity supply system was nationalised in 1948. Penetration into agriculture progressed more rapidly, and for the last 20 years or so the vast majority of farms have been using electricity.[57] The internal-combustion tractor now provides most of the motive power used in agriculture, but the applications of electricity are nevertheless varied and widespread; electric lighting, milking, refrigeration, heating, etc. are universal. From the social point of view, in containing the drift away from the country, the fact that electricity supply enables television

to be watched may be as important as the electric light and the motor car. But the 'balance of power' in the countryside cannot be regarded as static, and new energy-conservation policies may well alter it.

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DISCUSSION

Mr. R.A.S. Hennessey opened the discussion by saying that Ballin, in his standard work on the organisation of electricity supply, states that there were only 600 farms connected to mains electricity in the mid-1920s. The numerous electricity supply undertakings at the time, and the general absence of large-scale distribution kept power costs high and made electrification in the U.K. a less attractive proposition than in, say, Sweden, Norway or Montana. Of the towns compared in table 1, Hereford alone had no local electric tramway system, so possibly the table did not compare like with like? He wondered if rural electrification was such an unmixed blessing, of the kind envisaged by Colonel Crompton who saw it as a decentraliser of industry. Trading estates had indeed relocated industry, but generally to towns. By raising productivity, electric power had enabled British agriculture to shed labour, to do 'more with less'. This had reduced the proportion of the working population engaged in agriculture to some 2% in 1980–the lowest in the world. In the 1920s, agricultural wages were very low (28/- per week, compared with £3 15s for a bricklayer) and the relative attraction of towns had already drawn large numbers of people out of the countryside. Rural areas cannot offer such attractive markets to public utilities as can urban ones, hence Brighton or Kensington naturally got electric power much earlier than agricultural regions, because of closely packed customers with higher incomes. For similar reasons, rural transport and rural postage suffer high costs per unit of service. It is part of the logic of technology that rural and urban areas will be very possibly affected in entirely different ways by new processes or machines. Thus, whilst Mr. Hennessey agreed with Professor Tucker that rural electrification did improve the standard of living of those now living in rural parts, it had still played an important part in hastening some varieties of rural decline. **Professor Tucker** agreed that Hereford did not have trams, and that certainly might make a difference to the composition of the figures in table 1. He noted Ballin's figures, and observed that with 600 undertakings at the same time, that worked out at one electrified farm per undertaking, not a very impressive figure.

Mr. R.E. Zoller asked how many authorities had to be asked to give their agreement to the scheme? **Professor Tucker** said that the number was about ten and the Hereford Council had no difficulty from them.

Mr. J.A. Williams said that Hereford had no trams but they did have a cider making factory. How much base load did Bulmers take? In Gloucestershire farmers cut up their apples before sending the pulp to the factories; if they did this in Herefordshire they may have used electricity to power the cutters. **Professor Tucker** thought that in the early 20s it was more likely that the farmers would have used horse gears. The use of electricity on the very small number of farms connected to the supply network would only have made a very small contribution to the load. The steep rise in load during the war years was certainly due to the requirements of the munitions factory and the collapse after the war was catastrophic; some of the difference between the loads before and after the war may have been due to the electrification of the Bulmers' factory and other cider factories too. They were the only substantial factories in the area and were interested in the electricity supply, the last Chairman of the Electricity Committee before it was taken over by SWSEP Co. being Mr. E.F. Bulmer.

Mr. D.J. Bryden asked whether Kerr had been over-enthusiastic in his belief in rural electrification and whether the munitions factory could have been converted to peacetime uses. **Professor Tucker** thought that the assessment of Kerr's character was probably correct; during the first years of the war he had written a paper on the applications of electricity to agriculture; he was an enthusiast and, very skilfully, he took his Committee and Council with him.

Mr. Zoller said that in the early 20s it was quite practicable to move the boilers and machinery of a power station to another site. The Author agreed; it would not have been necessary to scrap the Hereford plant.

Mr. N.D. New was interested to see that the Hereford supply had been 240V and 50Hz. **Professor Tucker** added that in 1924 there were 17 different supply frequencies in the UK lying between 16 and 100Hz; some were not standardised until the 1950s.

Mr. J.W. Butler asked whether there had been any suggestion about rural gasification. **Professor Tucker** said that the 1974 Summer Meeting had seen the Fakenham Gas Works which had supplied

an essentially rural area. (Trans **46**, 83) In towns the gas lobby strongly opposed the introduction of electricity but the growth of demand for energy led to there being room for both gas and electricity. In rural areas extensive gas mains were never laid. **Mr. R.B. Matkin** said that this was probably because of the drop in pressure in the long mains.

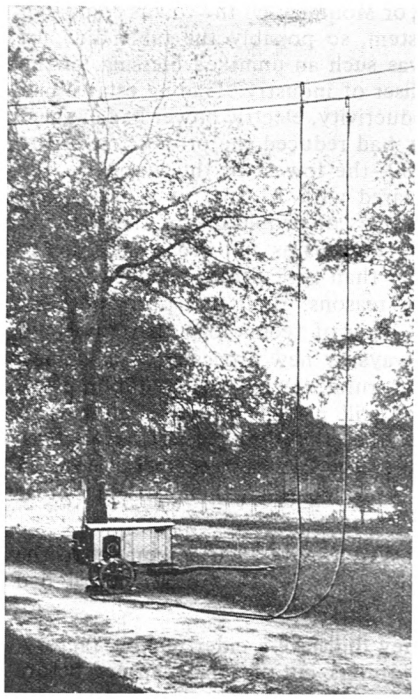

Fig. 8. A Continental method of getting power on a farm when and where required. [From *Electro-Farming*, Vol **4** (1928 – 29), 81].

Mr. C.C. Affleck referred to the last slide (Fig. 8) which had shown a permitted tapping made in France to an overhead main. Some 30 years ago he said it was the practice in Co. Durham for gypsies to tap illegally into overhead mains by the use of uninsulated wires which they threw over the mains during the hours of darkness; the leads were not there during the daylight hours and no payment was made for the electricity which was used for lighting and heating!

Dr. Brian P. Bowers was asked to propose the vote of thanks. When he had read the programme for the 1979/80 Session he had looked into reference books to discover more about the Hereford scheme, but had found nothing. He had been pleased to find that Professor Tucker had discovered the same difficulty. The electricity supply of the country was now approaching its centenary and this has increased the interest taken by Societies such as ours in the early history of the supply authorities and Professor Tucker has given us a detailed and interesting insight into the history of one of the local electricity authorities. The vote of thanks was passed by acclamation.

CORRESPONDENCE

Mr. J.G.B. Hills later wrote to ask what additional plant had been installed at Widemarsh Street in 1916. Professor Tucker replied that the addition comprised two 1500 kW Brush-Ljungstrom sets and one 1000 kW Fraser & Chalmers-Siemens set. The lower operating cost was claimed to be largely due to the use of coke-oven dust as fuel. (See *Electrical Times,* **58**, (1920), 307).