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EDITOR A. EVERETT, B.Sc. (ENG.)

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PROCEEDINGS AT THE THREE HUNDRED AND EIGHTH MONTHLY GENERAL MEETING.

22nd February, 1940, at 8 p.m.

Mr. T. P. Stratten (President) was in the chair, and there were present 75 members and visitors, and the Secretary.

OBITUARY.

The President: Gentlemen, before starting the business of the meeting, it is my sad duty to record the death of Mr. H. Denehy, a Member, and that of Mr. P. J. Charlton, an Associate Member of the Institute. Mr. Denehy joined the Institute in 1918 and died on the 21st February, 1940. He was a Vice-President of our Institute in 1935. Mr. P. J. Charlton joined the Institute in 1920 and died in tragic circumstances in an accident on the 19th February, 1940. (All present rose and remained standing in silence for a few seconds as a token of respect to the deceased.)

MINUTES.

The Minutes of the Annual General Meeting, held on the 25th January, 1940, were confirmed.

MEMBERSHIP.

Messrs. C. J. Monk and A. W. Lineker were appointed scrutineers of the ballot, after which the President said he had pleasure in announcing that Mr. Elwin Eugene Schweizer had been transferred from the grade of Associate Member to Full Member, and that Messrs. James Douglas Dinwoodie, Robert Rogerson Lyall, William Norman Powell and David Coote Ripley had been elected as Associate Members of the Institute. (Applause.)

The Secretary announced that an application for transfer was received from Mr. Allan Biddulph Cowen (Associate Member), and the Council had graded him as a Full Member. Mr. Cowen would stand for election at the Monthly General Meeting in March. That the Council having considered applications from the undermentioned gentlemen had graded them as Associate Members of the Institute, and their names would be submitted for ballot at the Monthly General Meeting in March: Messrs. Charles Ritchie, Leslie Webster and George Henry Woods. That, in terms of Clause 17 of the Constitution and Rules, the Council had transferred Arnold Ehrenberg and Thomas Montgomery (Members) to Life Membership of the Institute; and that, in terms of Clause 18 of the Constitution and Rules, the Council had transferred Evers Musgrave (Member) to Retired Membership of the Institute. That Mr. Gerald Claude Heaton (Student Member) had applied for transfer, and the Council had graded him as an Associate.

HONORARY MEMBERSHIP.

The President: Gentlemen, the Council of your Institute recommends the election, as an Honorary Member of the Institute, of Dr. Bernard Price, O.B.E., D.Sc. (Eng.), Past President. (Loud applause.) When the Agendas of this meeting were circulated, it was stated therein that Dr. Bernard Price would stand for election at the Monthly General Meeting in March; but I have taken it upon myself to arrange that Dr. Bernard Price will stand for election at the Monthly General Meeting in May, as he will be away from Johannesburg in March.

GENERAL BUSINESS.

Grants in Aid of Research.

The President: Under the heading of "General Business," I am asked to announce that the Council would like to take this opportunity of advising those members who intend making application for Grants in Aid of Research, this year, to get in touch with the Secretary of the National Research Grant Council and Board immediately.

Gentlemen, is there anything else under the heading of "General Business"? If not, I will ask our Senior Vice-President to take the chair while I address you.

PRESIDENTIAL ADDRESS

By T. P. STRATTEN, M.A., B.Sc. (Eng.).

Before starting on the main subject of this Address I should like once again to thank you for electing me as President of our Institute for the coming year. The Institute, with its large and varied membership, totalling now to the imposing figure of 819, as given in our last year's Report, has gradually over the years grown from strength to strength, until to-day it is accepted as being one of the principal bodies of technical opinion in this country. To be elected President of the Institute is, therefore, an honour which I shall certainly value highly for the rest of my life.

The year we have just entered finds our country passing through a stirring page in its history and engaged in a war the length, finality and repercussions of which none of us can yet foresee. Our Institute, in common with other kindred societies, has, through the Associated Societies of South Africa, offered its services to the country in any way that the Government may find desirable. In what specific and material way this assistance may be sought will depend on the future march of events, the course of which none of us can predict. In addition to any direct help that we may be called upon to give, let us not forget the less tangible assistance that our Institute can give in the difficult years ahead to this country's mining and industrial life, the maintenance of which is considered a vital part of the Empire's war effort. In keeping with our past high traditions, let us, therefore, maintain our activities unbroken in the belief that in their own peculiar and indirect way they will assist towards the ultimate victory for which we are all striving.

The purely technical value of our proceedings is perhaps not as high as that of larger electrical institutes overseas, but our Institute has a particular value in affording a meeting place for electrical engineers on or near the Witwatersrand, no matter what their employment or interests may be, and in doing so it has helped us all to grasp more fully such problems of electrical engineering as do not normally form part of our everyday work. This is usually done by means of papers presented at our monthly meetings and by the discussions both formal and informal which such papers bring forth, but there are some subjects which, on account of their wide and general nature, are scarcely suitable for presentation in the form of papers in this way. One such wide subject is, in my opinion, the supply of electricity to the Mining Industry, and it is my intention, therefore, in this Address, to deal with certain general aspects of this subject, the ventilation of which will, I believe, assist those members who are directly concerned with this matter and will also, I hope, be of interest to those other members who are in no way directly concerned with it.

The subject formed the basis of Doctor Bernard Price's Presidential Address to this Institute as far back as 1915, and Mr. T. G. Otley's Presidential Address to the South African Institution of Engineers in 1924, and in an Address to the Empire Mining Congress in 1932 Doctor Price also dealt with the whole subject of power supply by the Victoria Falls and Transvaal Power Company in a very comprehensive manner. Nevertheless, the subject seems of such fundamental importance to the whole electrical engineering profession in this part of the country that I make no apology for selecting it as the basis of this Address, particularly because the previous Addresses mentioned were given some time ago before the country went off the gold standard, and were also presented more from the point of view of the power supply authorities than from the point of view of the mining consumer.

The preparation of this Address has necessitated the obtaining of a large amount of

statistical information, and I should like to take this early opportunity of thanking the engineers of the Power Company, as well as those members of my own staff who have so readily helped in this work. Without their assistance the compilation of these notes would not have been possible.

To provide as a starting-off point a general picture of the size of the Mining Industry's power consumption there is shown on Diagram No. 1 a graph of the units sold by the Power Company in kilowatt hours per annum and the Power Company's hourly maximum demand in kilowatts each year. The figures show that this great power undertaking which, as members know, is owned partly by the Electricity Supply Commission and partly by the Victoria Falls and Transvaal Power Company, and which is operated, as far as the mines are concerned, by the latter Company, is among the largest power busi-

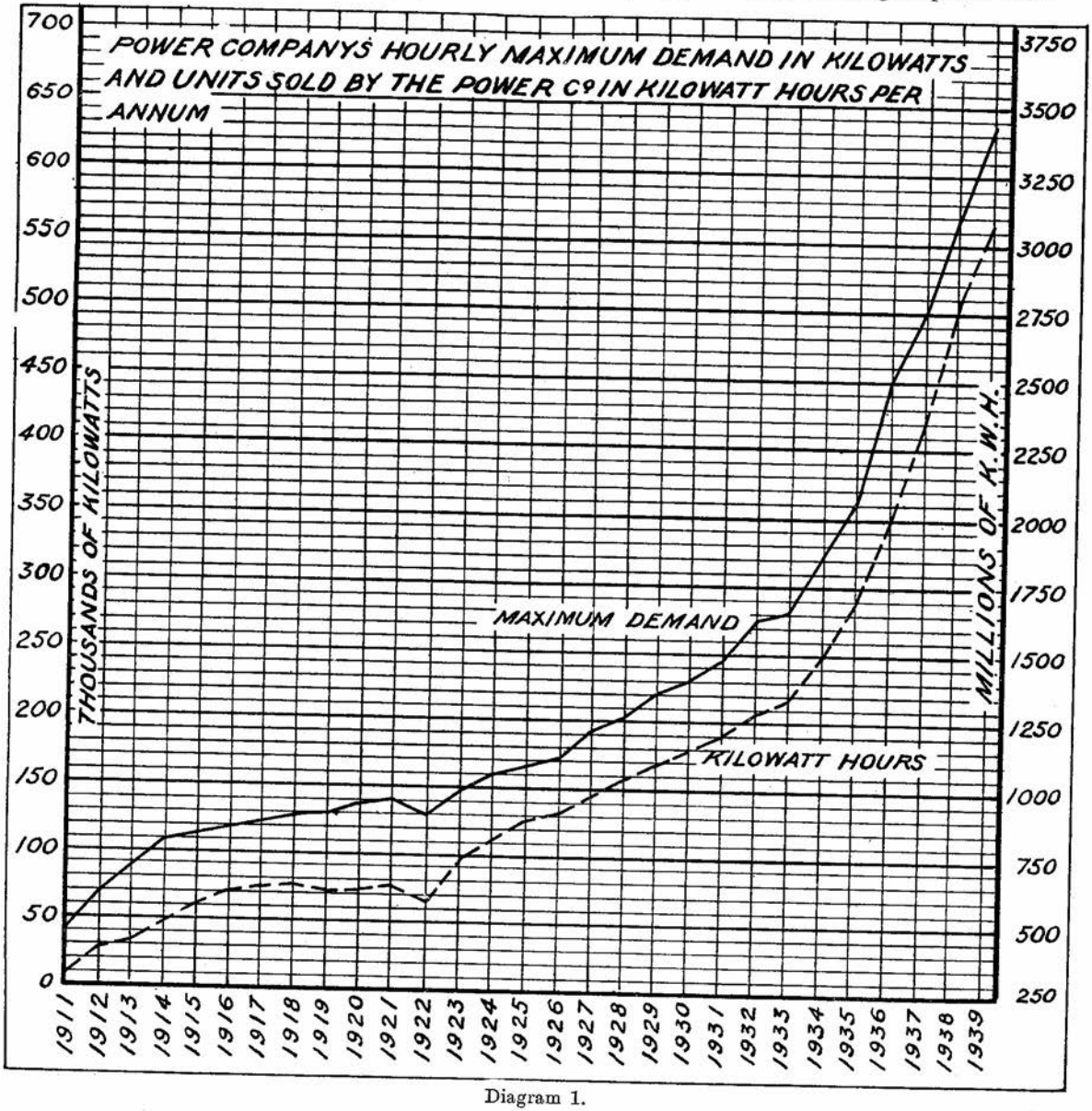

Diagram 1.

nesses in the world. No better reflection of the Mining Industry's fortunes could be given than is provided by these graphs, showing the very slow advancement during the 1914-1918 War period, the lack of confidence and hesitation prior to the 1922 strike, the quicker advancement after the settlement of the labour troubles of that period, the rapid advancement after the abandonment by this country of the gold standard, and the maintenance of this rapid advancement since that date. As yet it is, of course, too early to see from these graphs the effect which the present war conditions will have. Of the total supply furnished by the power company in the Witwatersrand area, the Industry's consumption at present represents about 89 per cent. of the units sold, and is estimated at about 90 per cent. of the maximum demand of the power system. I cannot but feel that these conditions are unique for I know of no company which supplies power in such quantities as those indicated to what, for all practical purposes, can be regarded as one consumer, with a steady daily and weekly cycle of operations.

I feel it is necessary for the better understanding of this Address by those members not directly connected or familiar with the subject to give, at this early stage, a very general picture of the agreement by which these exceptionally large power requirements are sold to the Mining Industry. I will further, for the sake of clarity, refer to certain more technical aspects of the agreement as need arise during the remainder of the Address.

In general, each Mining Group undertakes that each of its subsidiary companies will purchase power exclusively from the Power Company, and will not erect power generating equipment of its own nor alter to any other form of motive power machinery once driven by power bought from the Power Company. In return for this undertaking the Power Company grants to such subsidiary companies what are known as "group" terms, which are more favourable than such companies would normally be able to obtain separately as individual consumers. While under the group agreements the Mining Industry, therefore, places its whole power supply arrangements in the hands of the Power Supply Company, there are strong reasons why the Industry cannot divorce itself entirely from its power supply problems, in spite of the outstandingly excellent record of continuity which the power company has maintained throughout the length of the agreements in an area renowned throughout the world for the severity of its lightning disturbances. To begin with, the present agreements are such that the mining companies participate according to a set formula through what is known as the Rebate Account in the profits of the Power Company. This profit-sharing agreement which leaves the Power Company with the incentive of a private concern to reduce its costs for the sake of making larger profits, and at the same time automatically returns a large proportion of such profits to the Mining Industry, has been extremely successful in reducing the nett price per unit to the Industry. As evidence of this there is shown on Diagram No. 2 the nett price per unit to the Industry since 1916, from which the ever-decreasing price paid is at once evident. The graph is a fitting record of the energy and efficiency of the power supply engineers, and of the foresight of those who were responsible for the framing of the agreement. This automatic reduction, avoiding as it has done any undesirable yearly discussion between the Power Company and the mining consumers over the price to be paid per unit, has been a most successful aspect of the Industry's present power supply arrangements.

Over and above this direct financial interest, and what is probably of even greater importance, is that the loss of profits to a mining company consequent upon a shortage of power supply is so large as to dwarf the penalty under the power supply agreement. As an example, a typical East Rand mine whose case has been examined in detail, would be involved in a loss some 15 times higher than the penalty enforcible on the Power Company under the agreement and rebate account arrangement. I am not suggesting that the agreement errs in having too low a penalty because I believe that the penalty amounts are comparable with other power supply undertakings. The peculiarity of the position lies rather in the abnormally large losses incurred by the consumer, losses too large to be covered by a simple readjustment of the power contract. This being so, the financial risks of power stoppages on the Reef must inevitably be carried by the

mining companies, and hence the Mining Industry must, in my opinion, always interest itself closely in its power supply

during 1938 was only approximately 6 per cent. of the Industry's total working costs. The smallness of this figure compared with

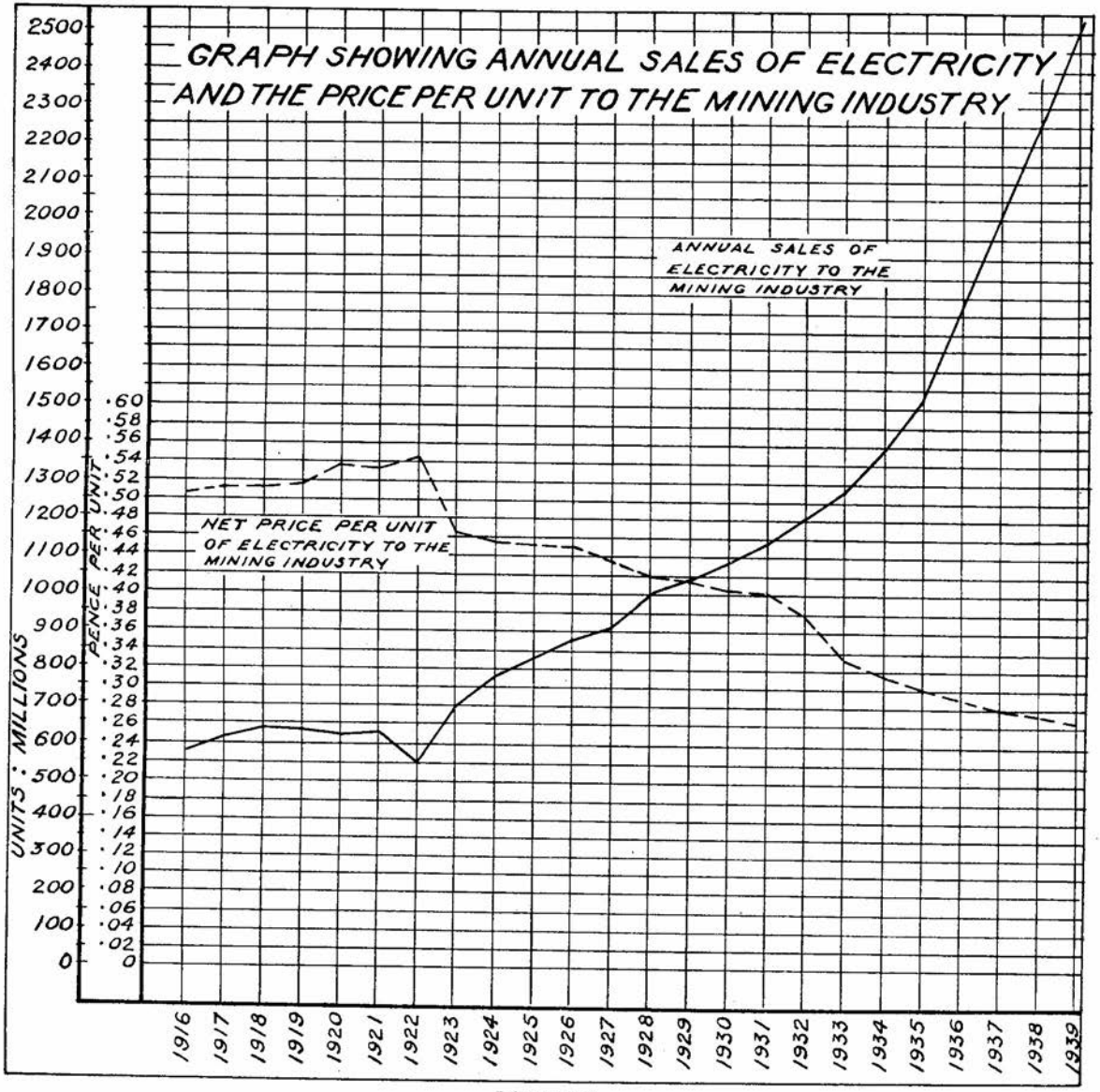

Diagram 2.

problems—in particular in the absolute reliability of the supply.

While the price per unit paid by the Industry is of great importance, and further reductions in price would be extremely welcome, the cost of power to the Industry

the tremendous financial loss consequent upon any power shortage will, perhaps, help to explain the attitude that many engineers connected with the Mining Industry take in considering the installation of additional spare generating plant and other similar questions.

I did not intend, when I first got these notes together, to say anything more about the question of spare plant, as it is a matter at present under discussion between the Power Company and the Mining Industry, but in the January *Journal* of the Institution of Electrical Engineers, London, which has just been received, the President, Mr. Johnstone Wright, in his Inaugural Address, gives figures of the spare plant position of the British grid, and these will, I think, be of interest and assistance to us in this matter. Mr. Johnstone Wright shows how the incidence of the grid has enabled the margin of spare plant to be gradually reduced until in 1938 the total installed capacity of all generating stations controlled by the grid is approximately 15 per cent. above the aggregate maximum demand. Beyond 1938, Mr. Wright indicates that plant extensions are likely to be in proportion to increase of load. Unlike the maximum demand of the Mining Industry which comes on every week-day of the year, summer and winter alike, the maximum demand on the British grid is largely seasonal, and the maximum demand on a normal summer day is given as about 60 per cent. of that on a winter day. Thus, there is a long period of the year when almost half the generating plant is available for routine overhaul. In considering what margin of spare plant should be available to safeguard the Mining Industry, the steadiness of the mining load throughout the year should be borne in mind. In addition, we must realise that the British grid is some ten times larger than our undertaking and has some 171 stations under its direction, and that it is in close proximity to manufacturers' works.

I intend now to deal with the subjects of load factor and power factor of a mining consumer, since both these subjects have considerable influence on the power supply problem. The group agreements take into account a group load factor—in other words, each subsidiary company of a group pays its power bill, not on the basis of its own particular load factor, but on the basis of the load factor of all its sister subsidiary companies summated for this purpose as a single consumer. The method of doing this summation was described by Doctor Price in his paper to the Empire Mining Congress in 1932 and need not be described here. The payment clauses of the agreement are so framed that, provided the group load factor does not fall below a fixed figure, the price per unit consumed remains the same and is unaffected by changes in the group load factor. In addition, the payment clauses take no account of power factor so that, in actual practice, beyond a general watch being kept by the group's head office of the " group load factor " to see that it does not approach dangerously close to the fixed minimum figure, the mining consumer concerns himself in no way about either load factor or power factor. This is perhaps the most unique part of the agreement since in most industrial enterprises elsewhere in the world the consumer's electrical engineer devotes a large amount of his time and energies to the arrangement of as high a load factor and power factor as possible.

While the present supply agreements may remove a certain amount of immediate concern from the question of a mine's power supply problems it results, I am afraid, in concealing to a certain extent the long term advantages which the best possible load factor and power factor, with their consequent lower generating and distribution cost, would bring to the Mining Industry. The monthly group load factor, on an hourly maximum demand basis above which no reduction in price per unit accrues, is, under the present agreement, 65 per cent., and the load factor of the Industry as a whole is slightly above this figure. The statistics of some 33 Canadian gold mining companies which have been made available to me through the Secretary of the Canadian Institute of Mining and Metallurgy, and which reached me only two days ago, show a much higher load factor than Witwatersrand mines, the five largest properties giving an average load factor as high as approximately 84 per cent. This may be due in a large measure to their local conditions, but I feel convinced it is also due to buying power on a maximum demand basis since some of these companies, in providing their power

figures, describe the measures they adopt to keep their load factor as high as possible.

The load factor of the Union Corporation Group of mines over the past few years is shown on Diagram No. 3, and it will be seen that there remains at present a comfortable working margin above the minimum of 65 per cent. This load factor curve, which I believe is higher than that of other groups, is the result of good luck rather than good management, since it is brought about by the load of some of our older properties, the steady nature of which will be explained later. Since this load factor curve has thus been obtained without any real effort towards load factor improvement and without any contractual advantage, one cannot help feeling that, if the inducements were there, improvements in this load factor curve might have been possible.

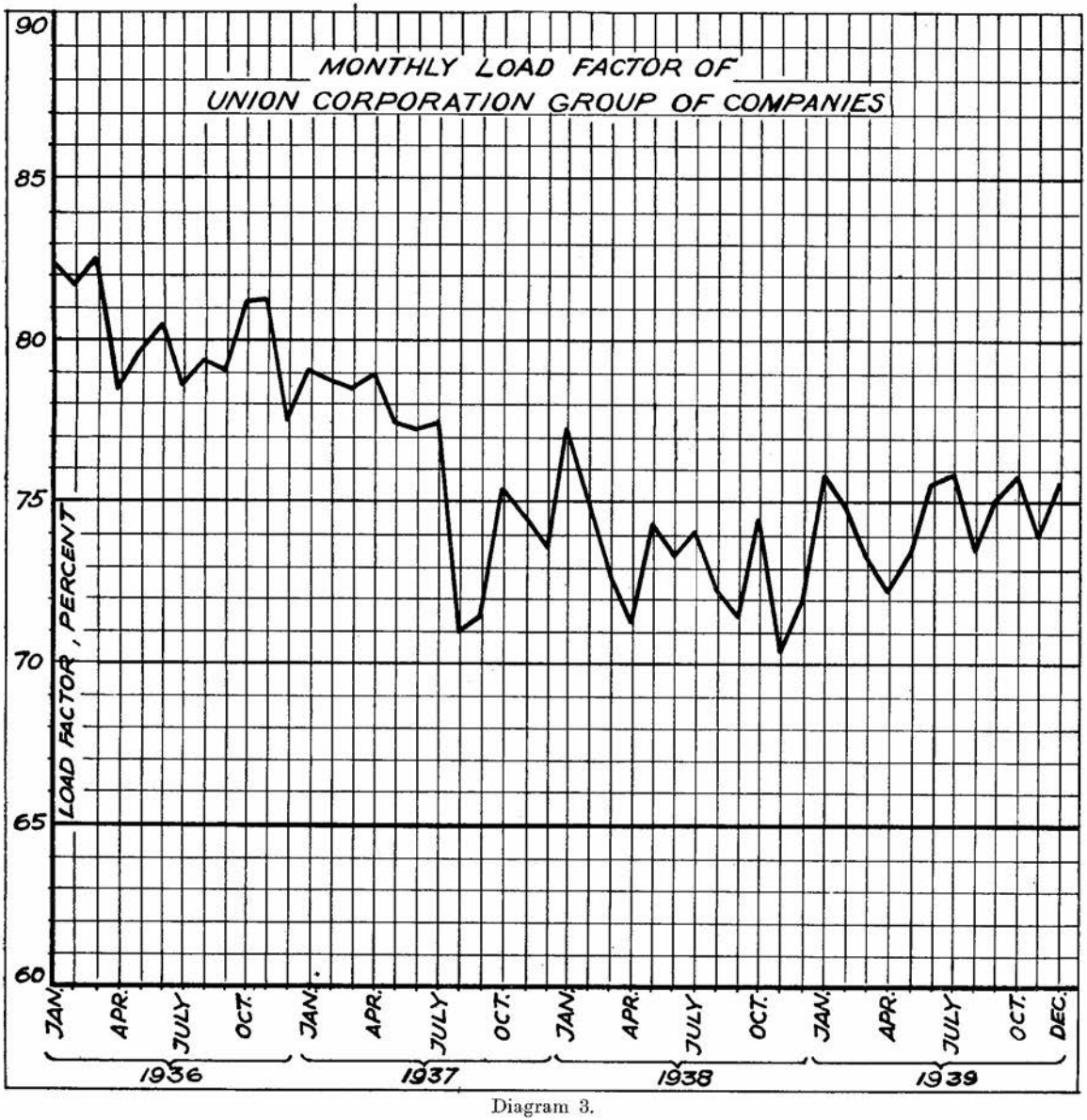

Diagram 3.

In considering the possibilities of load factor improvement it is first necessary to analyse the power consumption of a typical mine of the group during a normal 24-hour cycle of operations. To do this there is shown on Diagram No. 4 the load of the various sections of a mine over a normal 24-hour week-day, viz., the power used for tube mills, reduction plant other than tube mill load, main underground pumping, underground distribution (including small pumping plants, small fans, scrapers, haulages, etc.), general surface, hoisting, compressors. On Diagram No. 5 there is shown the load of all these various sections summated to show how the total load of the mine is built up. The mine in question is an "all electric" mine with electric hoists and electrically driven compressor plant. The load of a typical older property, of which the

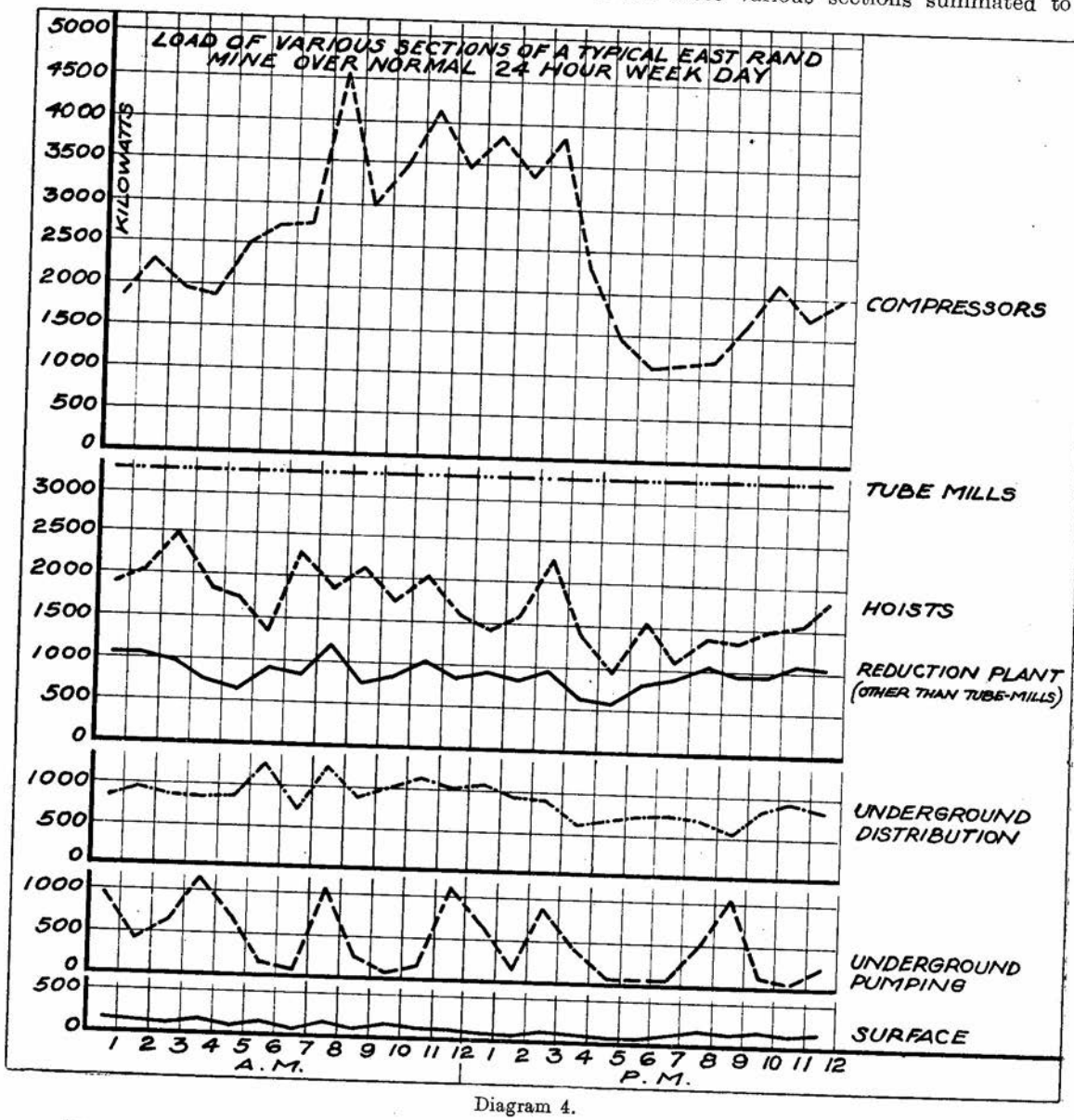

Diagram 4.

Geduld Proprietary Mines and The Modderfontein Deep Mines in the Union Corporation Group are examples, with steam hoists and steam-driven compressor plant, can be assumed as similar to the one shown on

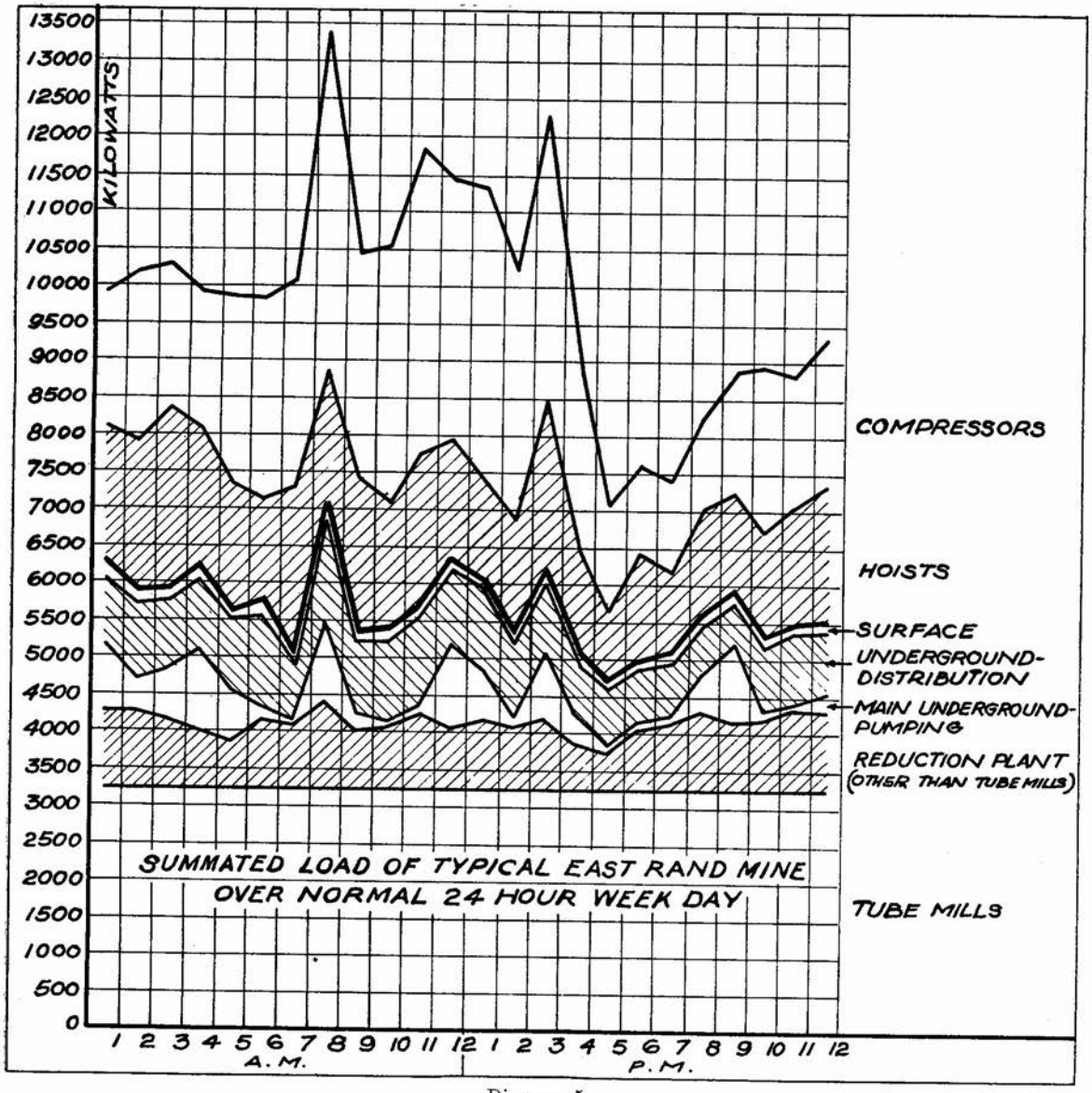

Diagram 5.

this diagram with the hoisting and compressor load removed. From these diagrams it becomes apparent that the most substantial improvement in the load factor diagram is obtainable if the load factor of the compressor plant can be smoothed out more evenly over the 24 hours. In practice, however, this is far from easy, since it means the adoption of double shift as compared with single shift working, which is highly undesirable from a general management point of view and has already been discarded from this and other major considerations wherever possible on the mines of the Reef. Another possible method of improving the

load factor of the compressor plant which has been suggested by some engineers would be to make use of a large area underground such as a discarded tunnel and wall it off as a vast air receiver which would be pumped up to pressure during the off peak period and would discharge during the peak period, thereby smoothing out the compressor load. A description of such an installation as this was given to the Association of Mine Managers in the case of the West Springs Mines, Limited, where a disused haulage some 2,527 feet long was utilised for the purpose but, as far as I know, the scheme has not been adopted elsewhere. While the scheme is, of course, technically sound, I do not think it can be considered at all as a general corrective measure for improving load factor, since the size of the receivers involved is so large that few mines could make such an underground receiver readily available. There may, however, well be individual cases where its adoption might prove advantageous. The load factor of the mine whose diagram was shown could most readily be improved by avoiding underground pumping operations during the peak periods, and this should represent no great difficulty provided sufficient underground sump capacity is available.

The load factor of a *group* of mines, as distinct from the load factor of an individual mine could, of course, be greatly improved by staggering the operations of some of the mines of the group to another time of day. While this might be possible in an emergency of short duration, there seems little doubt that if it were continued for any length of time it would cause serious labour and management difficulties. One is, therefore, forced to the conclusion that any substantial improvement over and above the present conditions in the load factor of a mine or a group of mines by some simple rearrangement of large loads is not feasible. Small improvements, however, might well be obtained, particularly in the avoidance of all underground pumping during the peak period, but in the absence of any contractual advantage in the power agreement it is not reasonable to expect that such improvement could be brought about or maintained for any length of time.

Although, as indicated above, any load factor improvement with our present mining arrangements is likely to be small, one must not overlook what even a small improvement in this direction would mean from the point of view of power generation. Thus, if we take the present maximum demand of the Industry as 700,000 kilowatts an improvement of, say, 3 per cent. in the load factor represents a reduction in the maximum demand of some 20,000 kilowatts, which indicates that no matter how small the improvement in load factor may be, the ultimate saving is substantial.

The load factors of mines on the Witwatersrand vary considerably. From the load diagrams shown it is at once clear that the mines with the best load factor are those without electrically driven compressor plant, whereas the mines with the worst load factor are those with electrically driven compressor plant and which, due to a narrow or patchy reef or a large development programme, require the breaking of a considerably larger tonnage than is milled. Considering that the older mines which either buy compressed air or generate it from steam are becoming fewer, that those which are permitted to mill on Sundays are becoming a smaller and smaller percentage of the whole, and that there is always the tendency to adopt single shift working wherever possible, I am of the opinion that, in the long view, if our present method of running the mines continues as it presumably will, the load factor of the Industry as a whole is likely to decrease rather than increase.

Turning now to the question of power factor, a mining company again has no contractual advantage to keep its power factor high since it buys power purely on a kilowatt as opposed to a kVA basis. While this has enabled mining consumers to exercise complete freedom in the choice of motors, and may thus have led to small savings in capital cost in some instances, I agree with Doctor Price's remarks in his paper in 1932 to the Empire Mining Congress that it is doubtful whether this has been the wisest policy to follow in the long run.

The problem of power factor correction, more perhaps than any other problem, is one which must be considered by the consumer and supplier jointly, since it is fundamental to the problem that the correction be made as close to the load as possible and preferably in the selection of the motors themselves. The low power factor of the

average mining load has led the Power Company to instal some 320,000 kVA of synchronous condenser plant, and while this corrective kVA has reduced the kVA of the generating plant required and has brought down the transmission losses, it has not reduced the kVA of the transforming plant at the consumer's sub-stations nor has it assisted the consumer's own distribution losses. Recently the Power Company has, in conjunction with some of the mines of our group, used static condensers placed as close to the load as possible in the manner described by Mr. Pickles in his Address in August of last year to the South African Institution of Engineers. This indicates what can be done in some instances in the case of the older properties. In the case of new load, and particularly of completely new properties, one feels that it would assist the power supply problem for the consumer to instal synchronous as opposed to induction motors in some instances although there is at present no immediate or tangible advantage to the consumer to do so.

In both of these questions, namely, power factor correction and load factor improvement, it cannot be emphasised too strongly that it is not lack of understanding of the problem but the absence of contractual inducement to the consumer which is missing.

I wish now to say a few words about the sub-station arrangements by which the mining companies take power from the Power Company. In terms of the agreement, the mining company pays for the necessary sub-station building and the Power Company pays for the necessary switchgear and transformer equipment. This arrangement has worked very successfully over many years and one must, therefore, hesitate before suggesting any alternative scheme. The arrangement, however, precludes the use of outdoor switchgear with its consequent savings in the cost of buildings to the mine company. With the continued use of this type of gear all over the world, including South Africa, one cannot help feeling that outdoor sub-stations, involving lower capital costs to the mining consumer, could be used without sacrificing any of the security which has attended this portion of the supply arrangements. The point is perhaps a relatively small one but nevertheless the capital expenditure figures involved are by no means negligible. The records of our group show that the cost of a standard sub-station building for two transformers each of 2,000 kilowatts is approximately £2,600, so that if we refer back to Diagram No. 1 it will be seen that the cost of these sub-station buildings to the mining consumers over the past twelve month must have been of the order of £34,000. Not all of this money could, of course, have been saved, since the cost of outdoor switchgear would probably have been higher than the indoor switchgear installed. Nevertheless, the figures show that the subject is one worthy of consideration.

While on the question of sub-station design I wish to comment on the supply voltages specified in the power contract, i.e., 2,000 and 500 volts. These may be regarded as a legacy from the past, when power requirements were small and much of the machinery steam driven. The total power input for a sub-station was then of the order of 2,000 to 3,000 kilowatts. The modern all-electric mine sometimes has an input at a single sub-station of the order of 18,000 to 20,000 kilowatts. This leads to considerable difficulties on the mine distribution side in the selection of switchgear and the subdivision of loads so as to keep the equipment within the short-circuit current limit of 44,000 amps. specified by British Standard Specification No. 116/1937. The modern tendency for a new mine supply point is to adopt supply voltages of 6,600 with 2,000 as a possible second lower voltage, and the assistance which the Power Company has given in not adhering rigidly to the supply voltages in the agreement and in allowing new mining consumers to take power at any two voltages most suited to a particular case cannot be too highly stressed.

I wish now to deal at some length with the question of the frequency of supply. In terms of the power contracts, the Power Company may vary the frequency from 48 to 52 cycles per second without incurring penalty, and in practice the supply has been kept at 51½ cycles per second for so many years past that many engineers have come to regard this frequency as so established that its reduction to the standard figure of 50 cycles per second would involve the mines in grave difficulties.

In asking my older colleagues in the Mining Industry about the history of the frequency of supply I have been confronted with varying accounts of the causes which gave rise to the frequency of 51½

cycles, and I have come to the conclusion that the reason for this is partly that it all happened so long ago, but more particularly because at the time there were advantages both to the Power Company and to some of the mining consumers to run at a frequency slightly above the standard figure of 50 cycles. The slightly higher frequency increased the output of portions of the generating plant, particularly by increasing the draught of boiler house fans and also helped some mining consumers in their ventilation, pumping and milling problems. Thus the Power Supply Company and the mining consumers to their mutual advantage settled down to a frequency of 51½ cycles per second. In those days the proportion of power generated by the Power Company and sold to consumers other than the Mining Industry was smaller than it is to-day. As evidence of this there is shown on Diagram No. 6 the percentage of power sold to min-

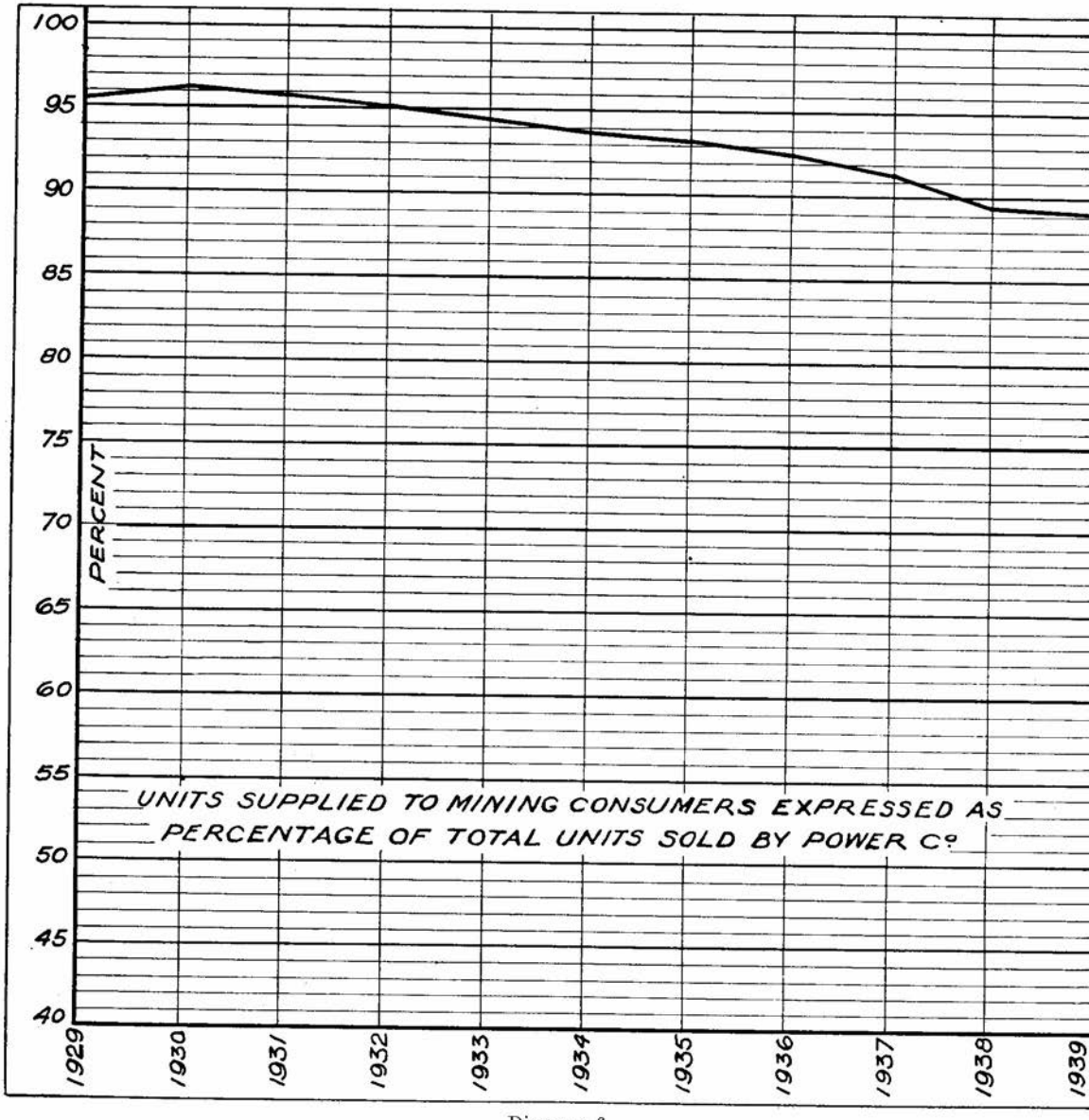

Diagram 6.

ing consumers from the Power Company's system since 1926 from which the growth of non-mining consumers as a percentage of the whole can be clearly seen. The desires of these non-mining consumers in such matters as frequency of supply is thus likely to receive increasing consideration. Furthermore, with the disclosures of gold-bearing reefs to the south of Odendaals Rust and the consequent probability of mining operations in this area, there is the possibility of large power requirements for mining in this part of the country at a later date. The position of the area is shown on a rough map of the country on Diagram No. 7. There are many difficulties, both engineering and economic, in connection with power generation in the area itself so that, in the early development stage mining work would probably be carried on with a single power

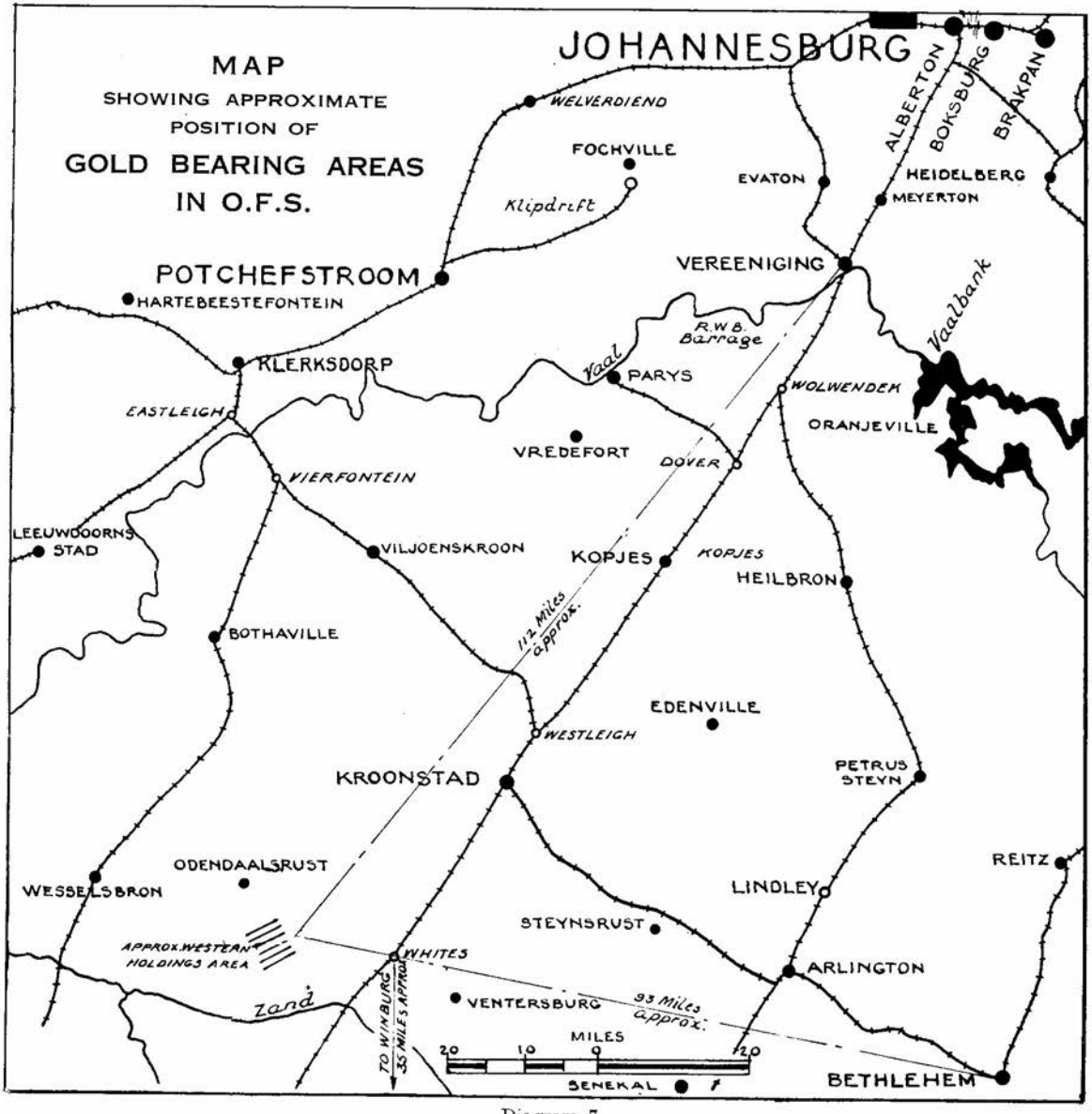

Diagram 7.

supply line from Vereeniging, and a stand-by steam engine for evacuating men from underground in an emergency. Once milling commences, however, and there is a heavy financial loss for a power stoppage, as well as many more men underground, a mining consumer would want a duplicate power supply line. The cost of a single supply line can usually be divided between various consumers along the route such as municipalities, but these bodies would scarcely be interested in contributing towards the cost of a second line. Hence there may well be advantages from a capital cost point of view to have the district served ultimately by one line from Vereeniging and one line from Bethlehem, both of which lines could pick up a number of consumers on the way. Thus there looms up the possibility of the Reef Power System and the Natal Central System becoming linked up through future mining developments in the O.F.S.

The possibility of the power systems becoming linked through the complete electrification of the Johannesburg-Durban railway system is well known to most members.

We also have to take notice of the ever-increasing size of the Municipal Power Plants in the Witwatersrand and Pretoria area.

We on the mining side must, therefore, realise that a time may come when in the interests of economy all the power stations in this section of the country and Natal, whether they belong to the Victoria Falls & Transvaal Power Company, to the Electricity Supply Commission or to Municipalities, will be operated jointly by these bodies in the form of a grid system, as is being increasingly done all over the world. I am not suggesting that the time for this is immediately ripe, but it is definitely something for which we should prepare ourselves and, that being so, the frequency of supply for the Mining Industry becomes of paramount importance, since the continued use of a frequency of 51½ cycles prevents the linking up of power stations supplying the mines with other power stations run at 50 cycles, except as is done at present by means of individual machines run specially for the purpose on separate busbars.

The dimensions of the Mining Industry's consumption are so large that one is tempted to suggest that instead of altering the existing frequency of supply to this Industry, other power stations and other suppliers should run at 51½ cycles as opposed to 50 cycles. The adoption, however, of a general frequency of 51½ cycles throughout the major part of this country would, in my opinion, be a retrograde step, since it would establish for all time a frequency of supply different from the internationally accepted figure laid down by the British Standards Association and by Statute in this country and other parts of the world.

In considering this problem one must realise that the present frequency of 51½ cycles is established very firmly by many years of successful operation and that any reduction to 50 cycles must inevitably be attended by some small risk that it will lead to a small reduction in the operations of the Mining Industry. Some engineers believe that general difficulties throughout the Industry would arise due to a drop in the tonnage that could be hoisted and mined, and due to a possible reduction in milling efficiency due to slower tube mill grinding. Others do not hold this view, but believe rather that the difficulties encountered would be isolated individual difficulties particularly of fans, pumps, and rotary type compressors, with characteristics such that a small change in speed has an appreciable effect on output. Such tests as have already been conducted are accepted by all as not long enough to show which of these views is correct. From the point of view of hoisting a small reduction in frequency of supply would not, of course, affect Ward Leonard hoists. A.C. hosts would drop their full speed by 3 per cent., but this by no means would result in a reduction in tons hoisted by 3 per cent., since A.C. hoists are generally used for shallower winding where the times of loading, unloading, acceleration and deceleration represent a large proportion of the total winding cycle. As a typical example, an A.C. hoist winding from 1,500 feet would drop its tonnage hoisted per hour by 1·2 per cent. if the full speed were reduced by 3 per cent. Endless rope haulages, whose

speed would be reduced by 3 per cent., could probably be made to deliver the same tonnage by increasing the trucks connected to the rope by the same percentage. Certain compressors, fans and pumps would be particularly affected, and might in some cases require augmenting or altering. In reduction plants all drives would run 3 per cent. slower so that, to maintain tonnage, conveyor belts, feeders, etc., would have to be loaded 3 per cent. higher. With regard to tube mills, the immediate effect is not so easy to see, and the speed of a tube mill is very much the province of the metallurgist as opposed to the province of the engineer. One cannot help feeling, however, that a tube mill is not so finely adjusted a machine as to be affected by 3 per cent. speed variation, since, for example, the liners of a 6 ft. diameter tube mill are allowed to wear down some 6 in. before they are renewed. Such metallurgists as I have been able to consult seem to feel that a change in speed of 3 per cent. in a tube mill would not be noticed, since the speed output curve of a mill is flat near the operating region, and because there are also compensating measures which can be employed by the operators to maintain output with a slight speed alteration.

I have gone somewhat fully into this problem because I wish to show that there are many cases in which the mining work might be slightly affected by a change in frequency, and I believe myself that if the change from 51½ to 50 cycles per second were imposed in one sudden drop on the Industry it would take some time for the various mines to discover what compensating measures were necessary, and consequently there would appear to be some small risk that the tonnage might be affected for a month, or even two months, until such compensating measures had been discovered and adopted.

This would, of course, be highly undesirable and, in addition, it would be a pity if the suddenness by which the change was made concealed the long term advantages of a standard 50 cycle frequency by producing a multiplicity of annoying, though easily soluble, difficulties. It would appear, therefore, to be wiser for the change from 51½ to 50 cycles to be done very gradually over a period of, say, two years, by slight reductions each month, thus providing the consumers ample time and opportunity for making such adjustments as may be necessary.

I mentioned at the beginning of my remarks on frequency of supply that I thought that a time might come when all power stations in this part of the country would be operated in parallel. As early as 1915 Doctor Price drew attention to the load curve of the Mining Industry, and emphasised that it would dovetail very well into a normal lighting and traction load of a big city. If members compare the diagrams and figures dealing with load factor, and given earlier in this Address, with the similar figures given to us on the occasion of our visit to the Johannesburg Municipal Power Station in August of last year, showing a 40 per cent. load factor for the year with the peak at 7 o'clock in the evening, they will see that the picture given by Doctor Price in 1915, and by many others since, still holds good. This side of the problem is, I think, obvious to all members, but there is one feature which has occurred to me from my experience of industrial undertakings and which, I think, is worth while mentioning. In most large cities the load factor tends to improve rather than to deteriorate. One of the fundamental reasons for this seems to be that railway rates are so arranged that the tariff on raw materials to a factory is considerably lower than the tariff on the finished product produced by a factory, so that, in locating any new industry it is usually found economical to choose a position as close as possible to the market, which means as close as possible to the centre of population. A large municipal electrical load thus becomes more and more industrial, with a consequent improvement in load factor. In this country our Railway Tariff Book differentiates very strongly between the rates on raw materials and on finished products, with the result, that, except in a few special cases, it has been found economical to locate an industry as

near to its market as possible, and avoid the high costs of transporting the finished product

Over and above this we have, in the case of the Reef itself, what is known as the Motor Transport Area, within which a manufacturer is not forced, as he is elsewhere, to transport his products by rail, but may transport them by road if he so wishes. As road transport for finished products is invariably cheaper, there becomes an added inducement to locate a factory within this Motor Transport Area. There are thus strong reasons for influencing the establishment of industry as close to Johannesburg as possible, as is the case in most other large cities of the world, but what is unique here is that outside the municipal area of power supply where one can expect land to be cheaper an industry can usually obtain both power and water at very low rates from separate supply companies. Taking the long view, this can only mean to me that the municipal load of Johannesburg must become more and more predominantly a domestic load, with a consequent deterioration in load factor. I have, in discussing the load factor problem of the Mining Industry earlier in this Address, expressed the view that it also is likely to deteriorate in time, so that, if my picture is the correct one, the case for operating all power stations in this part of the country in parallel will become all the stronger as time goes on, and the necessity of frequency standardisation all the more important.

I want now to come to what is to me one of the most interesting aspects of our power supply problems, namely, the manner of forecasting the future load requirements of the Mining Industry. The present group agreements, to which reference has been made earlier in this Address, are such that when a mining company intends to increase its load it notifies the Power Company, who require certain stipulated periods for the ordering of new transformer and transmission equipment, and who further require a period, to be mutually agreed between the parties, in the event of the notified increase of load requiring the purchase of new generating plant. In practice this arrangement is not followed, since obviously a power undertaking of the size of the Reef system cannot proceed with the purchase of large new generating plant on the basis of a single notification, nor can such generating plant be obtained and put into commission nearly as rapidly as can the mining plant for which it is required. As an illustration, the more recent reduction plants have been completed and put into operation in a little over one year from the decision to advance a developing mine to the production stage, and in some cases in even less than this time. The ordering, delivery and erection of new generating plant is, of course, something very much longer, being more of the order of two years when an existing power station is being extended and, of course, longer still if a new generating station has to be started. It thus becomes obvious that the necessary forewarning to the power company to order new plant cannot be given as late as the time when an individual consumer notifies a specific power increase, and must come from the Industry as a whole on a very much wider basis. Although in no way covered by the group agreements, the necessity of a total co-ordinated Industry load forecast has long been realised, and has resulted in much technical discussion as to the best method by which it should be compiled.

In some groups load forecasts are made by listing out the actual motors likely to be installed over a period of, say, three years. This, at first sight, would seem an admirably exact method but, in the work with which I have been connected, we have found it virtually impossible to compile such lists with any feeling of accuracy. This is possibly because such work has been largely connected with new properties where the future of the mine for, say, three or four years ahead was far from cut and dried. Even with established mines, we have not felt confident enough of the detailed work coming forward to put up motor schedules any distance ahead of time. In forecasting the load increase of any property we have, therefore, been guided only by the tonnage to be mined and to be

milled. It must not, however, be imagined that each mine has the same characteristics in this respect. As an example, there are shown on Diagrams Nos. 8, 9, 10

From these diagrams it will be noticed that if we take in the case of each of the properties, a tonnage milled per month of 90,000, we get the following results:—

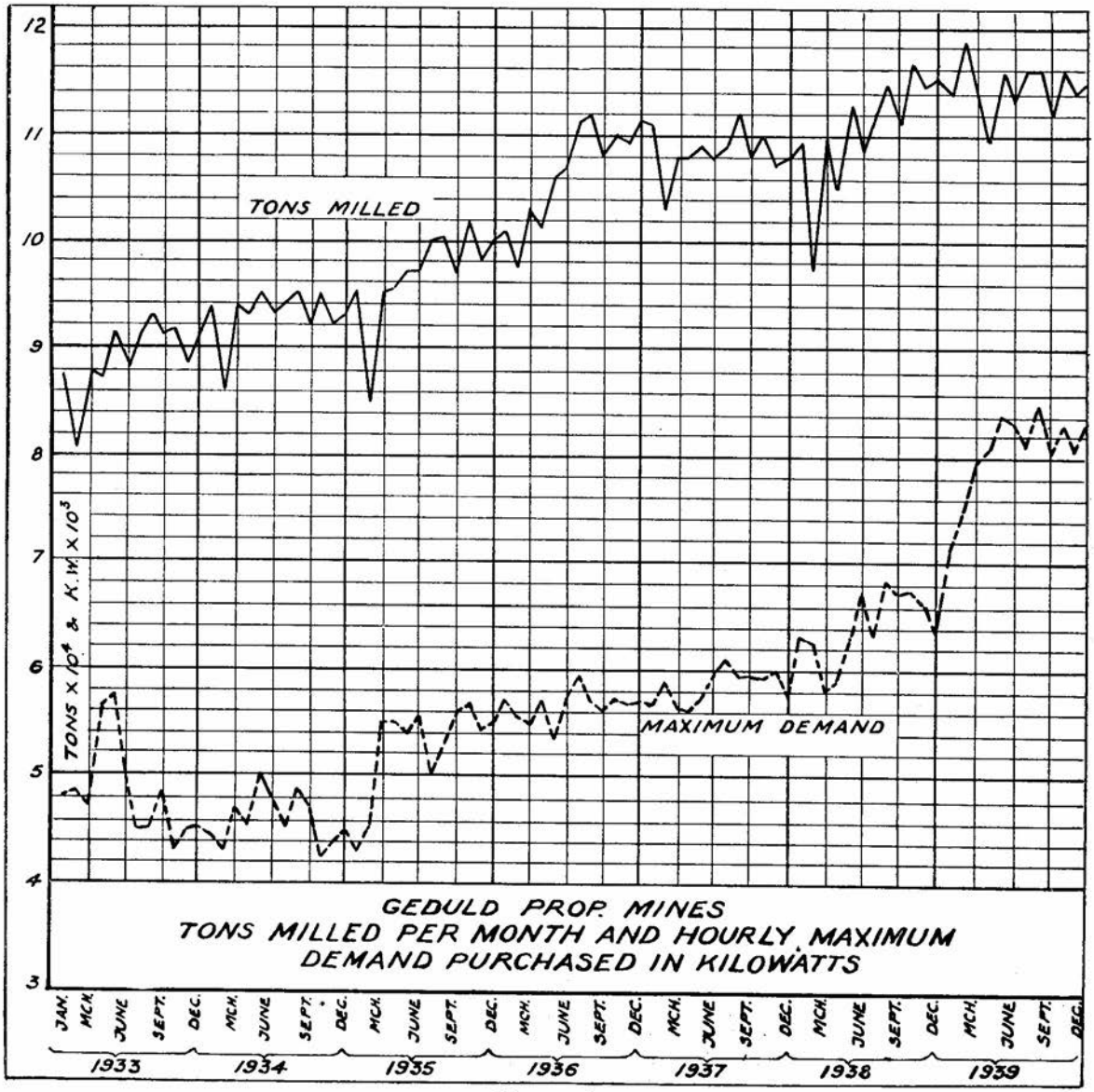

Diagram 8.

and 11 the kilowatts of maximum demand plotted against the tons milled per month for the Geduld Proprietary Mines, the East Geduld Mines, the Grootvlei Proprietary Mines and the Van Dyk Consolidated Mines.

Property.	Tons milled per month.	Maximum demand in kW.
Geduld	90,000	5,000 (approx.)
East Geduld ...	90,000	14,000
Grootvlei	90,000	14,300
Van Dyk	90,000	12,700

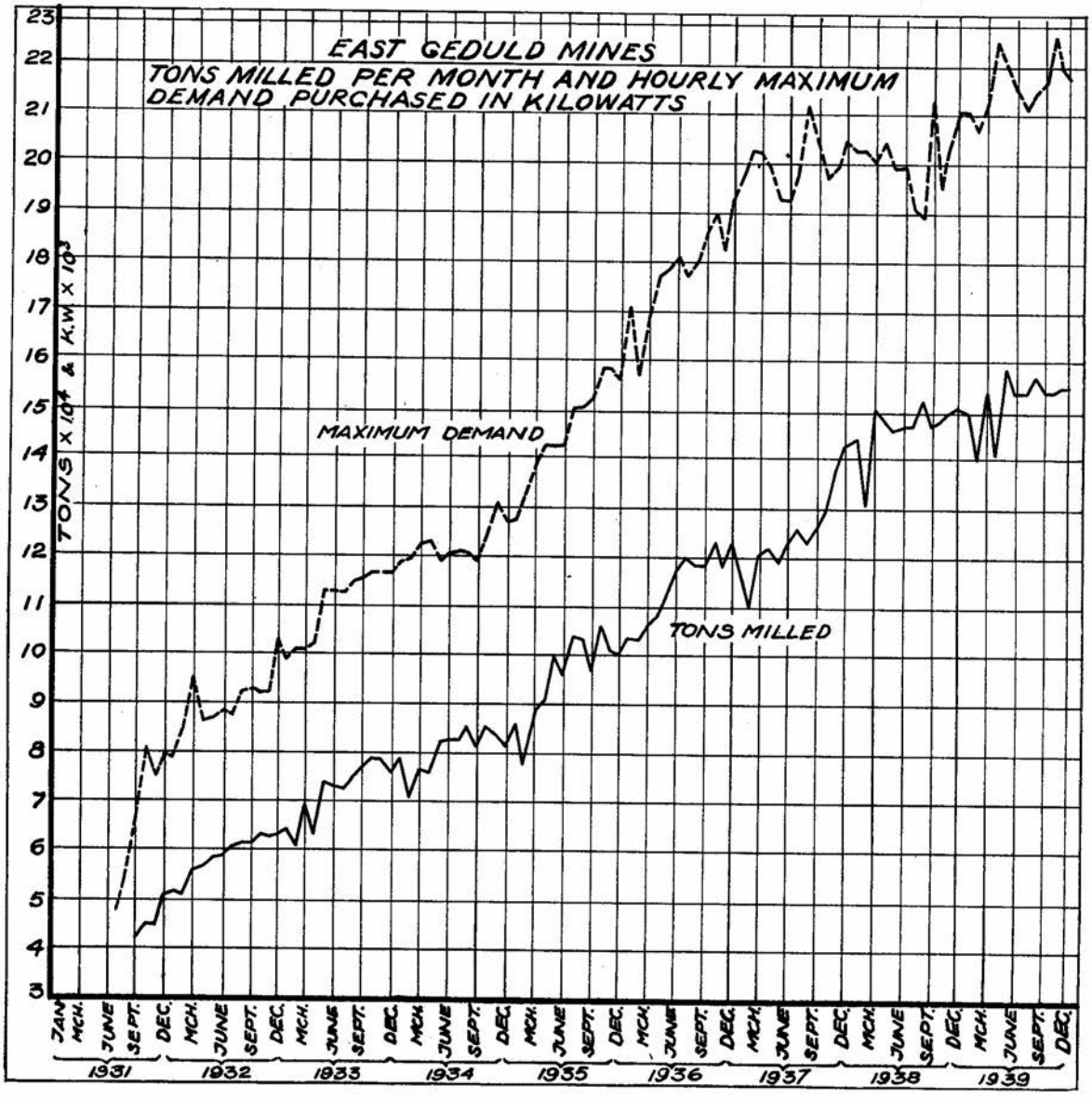
EAST GEDULD MINES
TONS MILLED PER MONTH AND HOURLY MAXIMUM DEMAND PURCHASED IN KILOWATTS
TONS x 10⁴ & K.W. x 10³
MAXIMUM DEMAND
TONS MILLED
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
JAN.
MCH.
JUNE
SEPT.
DEC.
1931
1932
1933
1934
1935
1936
1937
1938
1939

Diagram 9.

From these figures it becomes clear what a large difference in kilowatts of maximum demand per ton milled per month there is between a typical older property, such as Geduld, with its steam hoists and steam

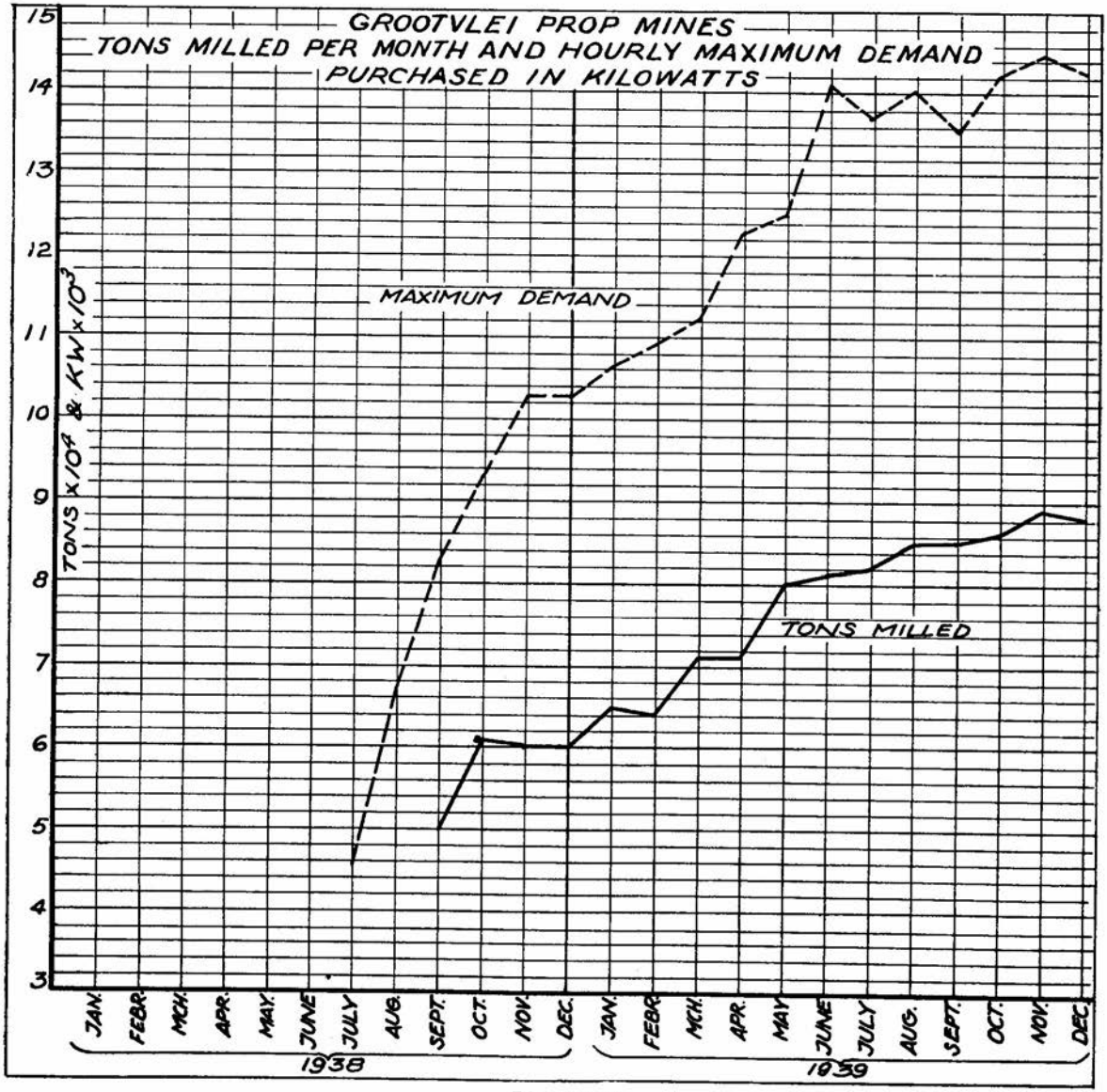

Diagram 10.

compressors, and the new all-electric mines exemplified by East Geduld, Grootvlei and Van Dyk. It is also important to notice the similarity between the East Geduld and Grootvlei figures, where the mines are adjacent to each other with similar mining and milling conditions. The fact that Grootvlei is doing comparatively more development footage and is a little deeper probably explains the slightly higher figure in its case. It is also important to notice that the Van Dyk figure is appreciably below the East Geduld and Grootvlei figures. Here we have a case where, due to different mining conditions and a more

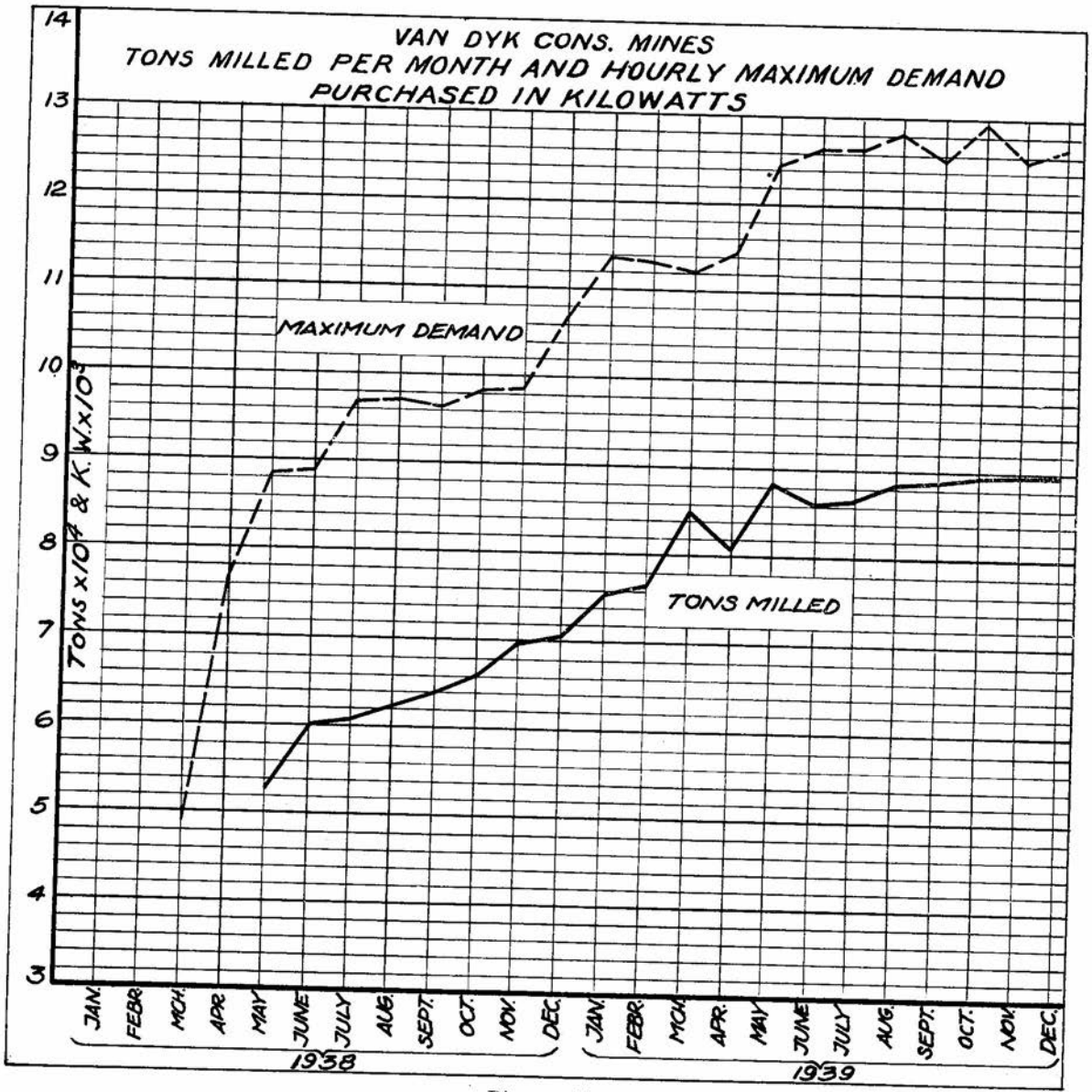
VAN DYK CONS. MINES
TONS MILLED PER MONTH AND HOURLY MAXIMUM DEMAND PURCHASED IN KILOWATTS
MAXIMUM DEMAND
TONS MILLED
TONS x10³ & K.W.x10³
14
13
12
11
10
9
8
7
6
5
4
3
JAN.
FEBR.
MCH.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
1938
JAN.
FEBR.
MCH.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
1939

Diagram 11.

amenable ore permitting two-stage as compared with three-stage grinding, the kilowatts of maximum demand per ton milled per month is a lower figure. These examples are in no way meant to be taken as

know from which localities extra tonnage is likely to be mined.

In general, the total maximum demand on the Power Company's system has followed the general trend of the tons milled

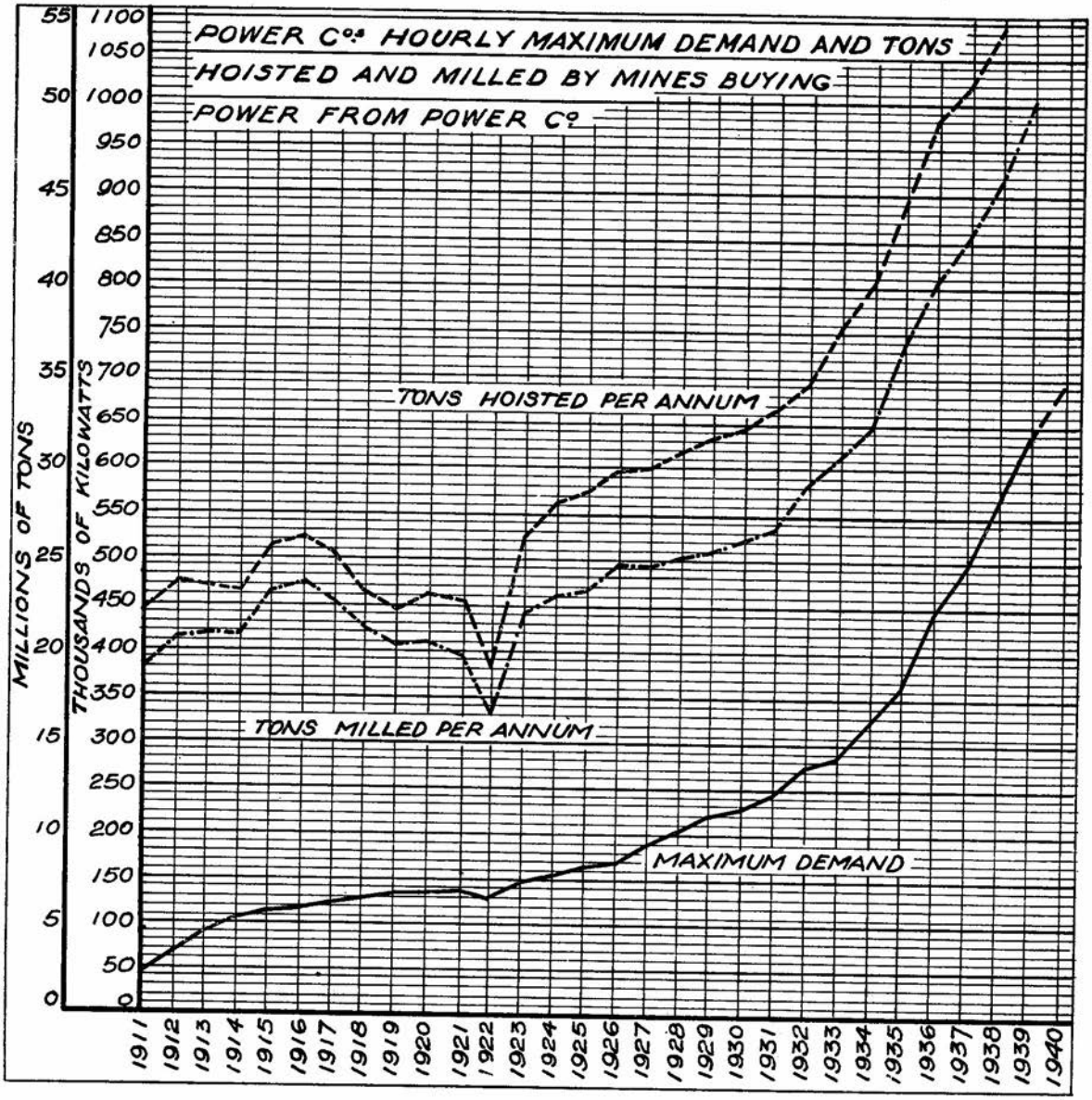

Diagram 12.

applicable to the Industry as a whole, but are quoted to show the variations which exist and to prove how necessary it is in forecasting the total Industry demand to

and the tons hoisted by the Industry as a whole, as is shown on Diagram No. 12. The relationship between purchased electric power and tons milled has, however, been

by no means constant, and the kilowatt hours of purchased electricity per ton milled by the Industry is gradually increasing, as is shown on Diagram No. 13. As the load factor of the Industry is also likely gradually to deteriorate, as explained previously, the kilowatts of maximum demand per ton milled per month by the Industry as a whole is likely to increase at an even steeper rate. Many engineers believe that the increase is due mainly to greater mechanisation underground consequent upon native labour shortage, but, while this is undoubtedly a contributing cause, I believe it is one of the smaller rather than the larger factors involved. In support of this there is shown on Diagram No. 14 the kilowatts of maximum demand

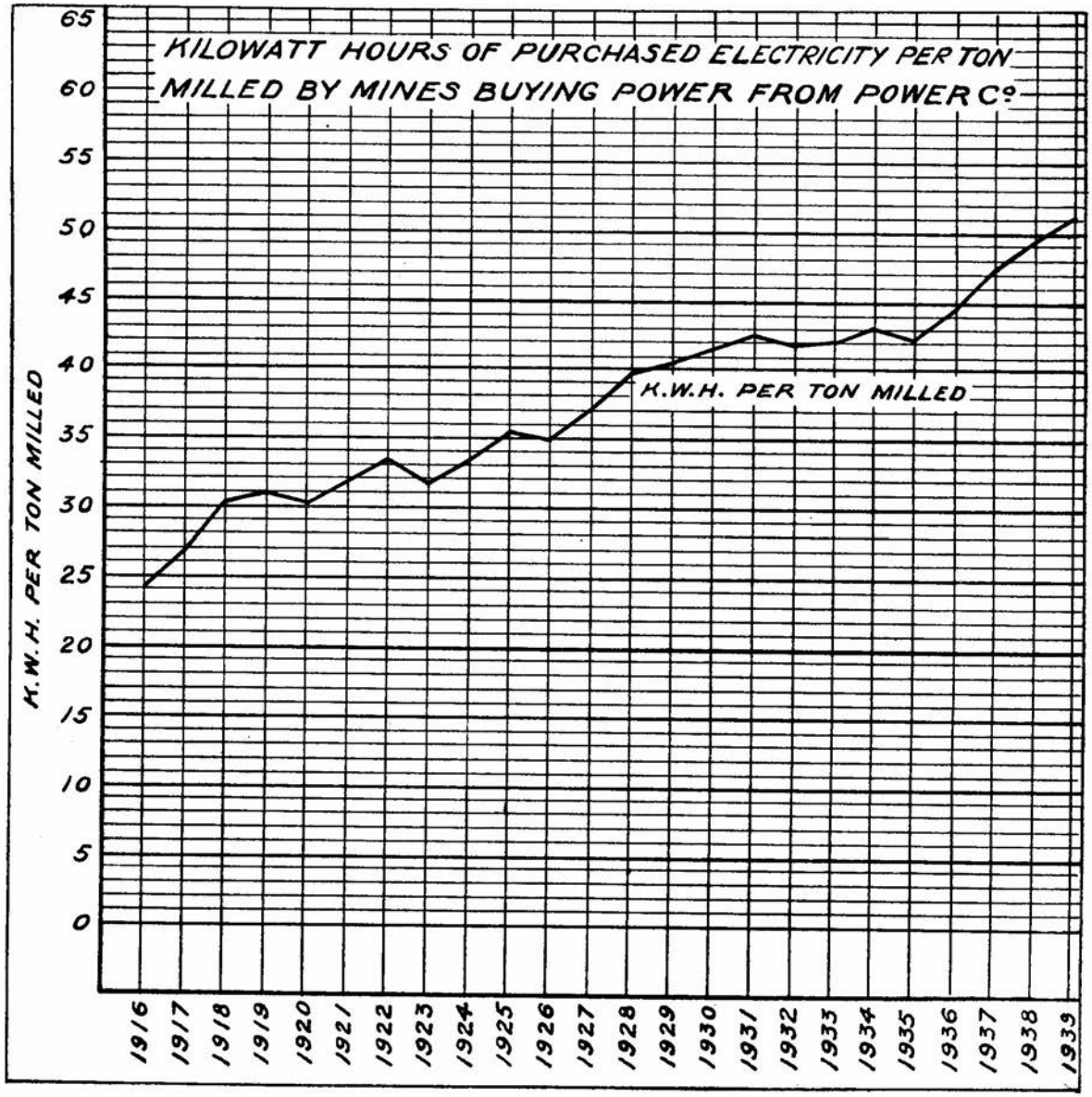

Diagram 13.

per ton milled per month at the East Geduld Mines over the past seven years, which shows that, in the case of this mine, there has been little alteration in this figure and, if anything, it has fallen off

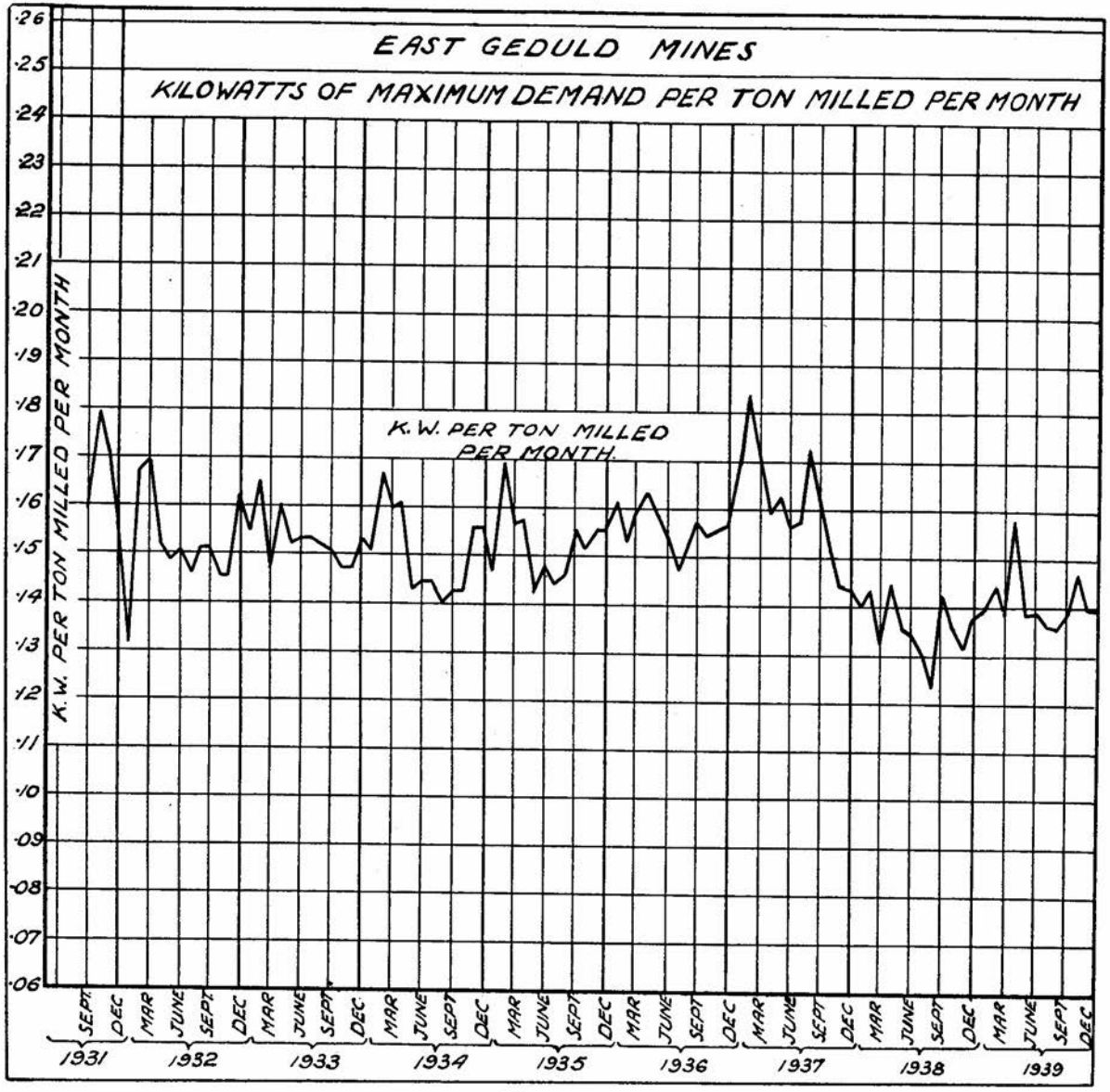

Diagram 14.

slightly instead of increasing. The falling off is probably due to less underground pumping and to economies in compressed air consumption, which is the one power economy which can be exercised by a mining consumer. While one must not generalise from the evidence available at one property, the East Geduld case at least seems to indicate that the increased power demand due to mechanisation is likely to be small. It was particularly in further pursuance of this idea that I obtained through the Canadian Institute of Mining and Metallurgy, information from a large number of Canadian Gold Mines as to ton-

nage and power consumption figures, segregated into the headings given earlier in this Address.

The statistics of some 33 Canadian companies, as I mentioned earlier, arrived only some two days ago, so there has been little time to analyse them in detail. In interpreting them one must, of course, be careful not to make detailed and exacting comparisons, since the local conditions of mining, and the nature of the rock to be milled, affect the position. In general it is safe, however, to say that the power used by these Canadian companies (which, as members know, are faced with extremely high labour costs) for general underground purposes other than pumping and ventilation is an even smaller percentage of the whole than is ours here on the Witwatersrand. This may well be due to the generally steeper dip of their ore bodies which results in less work to get the ore from the stopes into the trucks. Taking into account the possible influence of all local conditions, the figures seem in general to confirm the opinion I have already expressed that any accentuation of native labour shortage is unlikely to have any appreciable effect on our power requirements per ton milled.

Deeper mining has, of course, been a contributing factor in the gradual rise of power per ton milled by the Industry, but I think again that the effect of this has not been very great. The main reasons of the increase appear to me to be firstly, that the newer mines have installed almost exclusively electrically driven hoists and compressors and, with the ever-decreasing cost of power, the further installation of steam hoists and steam compressors, even on older properties which are classed as steam mines, is not common. Secondly, there is a tendency to concentrate more and more on single shift working, and thirdly, the older mines which are still able to run their milling plants for seven days a week instead of six days a week are becoming fewer and fewer, and fourthly, the amount of development work done in comparison with the tonnage milled is higher than it was, say, ten years ago. These four factors are, in my opinion, the main reasons behind the gradual rise in the kilowatts of maximum demand compared with the tons milled per month.

I mentioned in prefacing my remarks on Load Forecast that I meant to discuss the manner in which such forecast could be made and I do not intend, having done this, to attempt to forecast what the actual load of the Industry is likely to be some years in advance. We have seen during the 1932/1933 period how rapidly and unexpectedly our mining operations here may change consequent upon a change in the price of gold over which we have no control. We must expect other changes over which we have no control, and which are equally unpredictable, to take place in the future. In particular, the present great conflict in which we are expected to maintain and may even be called upon to increase our gold production; in which to conserve the Empire's foreign exchange position we are all anxious to place large machinery orders, including generating plant, as far as possible in Great Britain; in which the delivery of such plant across 6,000 miles of ocean is precarious, and in which Great Britain may become at any minute engaged in severe aerial warfare, threatening, in particular, her power supply centres, and consequently necessitating the confiscation by the British Government of all generating equipment being manufactured for export—this great conflict must in the end profoundly affect us. The moment at which, and the manner in which, it will affect us no one can say, and all that we as electrical engineers can do is to make ourselves fully prepared to translate immediately any alteration in mining operations into the effect it will have on the Industry's power supply arrangements, and *vice versa*.

To do this efficiently it is fundamental that we engineers on the mining side understand as far as possible the major power supply problems, and equally, that the power supply engineers understand some of the engineering problems connected with the Mining Industry. I hope, therefore, this Address may assist in some small measure to further this understanding.

In conclusion, I would like to recall the sentiments expressed by Doctor Bernard Price in 1915 when he said:—

> "As engineers, we desire to get the best possible results out of our work. As business men we want to supply the greatest possible amount of service at the lowest possible cost to the consumer and the greatest possible profit to our own particular concern, but whether we be engineers or business men, or both, we

all desire to avoid unnecessary waste of capital and of the world's resources."

I would like to reiterate these sentiments and to say that it is only in the spirit which they envisage that I, who am a comparatively newcomer to the Mining Industry have thought it fit to select the subject of power supply as the basis of this Address.

The Chairman (Mr. E. T. Price): Gentlemen, as a member of the staff of one of the supply authorities referred to, I have listened to our President's Address this evening with particular interest. There are a few remarks which I would like to make in appreciation of the Address, but these I shall reserve until later, in case I steal the thunder from the proposer and seconder of the vote of thanks. These speakers are both closely bound up with the question of power supply: Dr. Bernard Price being associated with the supply side of the question, and Mr. Joseph White with one of the largest industrial consumers in the Transvaal. I, therefore, have much pleasure in calling upon Dr. Bernard Price to propose the vote of thanks to our President for his most interesting and valuable Address. (Applause.)

Dr. Bernard Price (Past President): Mr. President, Gentlemen, I feel specially privileged in being asked to propose the vote of thanks to our newly-elected President for the most interesting address he has just delivered, not only because of the important position which Mr. Stratten occupies as one of the leading consulting mechanical and electrical engineers on these fields, but also because the subject he has chosen is one of special interest to the company with which I have for so long been associated. Looking back over the list of Past Presidents it is surprising to see how few of the consulting engineers of the mining groups have taken an active part in the affairs of the Institute or been honoured by election to its Presidential Chair. The Institute is indeed to be congratulated in having as its President this year a South African engineer who has attained to so distinguished a position, and I would like to assure Mr. Stratten, on your behalf, that we very greatly appreciate the keen and active interest he has shown in the Institute and its affairs.

That so few of the leading engineers of the mining groups have participated actively in the proceedings of the Institute partially explains, perhaps, the fact that a subject of this importance has for so long been absent from our proceedings. It is, I think, unfortunate that power supply from the mining consumers' point of view should not have received attention at these meetings long ago, and I am sure I speak for everyone when I assure Mr. Stratten that his address has been both welcome and opportune, and that it will form a very valuable addition to the Institute's proceedings.

In an eminently fair and impartial manner, Mr. Stratten has discussed certain salient features of power supply to the mines and the agreements which govern that supply. During the thirty years of my association with the scheme I have seen it develop almost from its inception through many vicissitudes to become one of the most important undertakings of its kind in the world. Without encroaching upon controversial ground, I should like to take the opportunity which has been so kindly afforded me to comment briefly upon some of the matters referred to in the address, and it may perhaps be of interest if I fill in a little of the historical background lying behind the position as we find it to-day.

Before doing this, however, I desire, on behalf of the Power Company, to thank Mr. Stratten most sincerely for the appreciative references he has been kind enough to make to the V.F.P. and the success it has achieved in furnishing a reliable and ever-cheapening supply to the Industry. I speak for all V.F.P. men when I say that, in our endeavour to render the best possible service to our consumers, we derive no less pleasure and gratification than they do from the improvements of various kinds we are able to bring about—the steady increase in the efficiency and reliability of supply and the progressive and impressive fall in the net cost of energy to consumers. We realise that we are the servants of the Mining Industry as well as of the Company's shareholders and desire to co-operate as closely and effectively as possible with those we serve.

I should like also to record our keen appreciation of the helpful and cordial manner in which the technical officials of the mining groups have, on their side, always co-operated with us. Not only at head

offices, but on every mine the managers and engineers have always shown us the greatest consideration and have, on many occasions, lent us their aid when we were most in need of it.

Mr. Stratten has rightly emphasised what is, I think, an outstanding characteristic of the business, namely, the arrangement by which consumers share in results. While in some respects the relationship may be said to be a co-operative one, and while it is not wholly incorrect to speak of it as a partnership, these descriptions are not strictly accurate because the running and control of the business remains entirely in the hands of the Power Company. The arrangement is rather a profit-sharing one and consequently consumers are no less interested than the Power Company in the financial results achieved.

As Mr. Stratten has said, the arrangement has been a great success and one may ask "How did it come about?" How is it that South Africa came to adopt this particular method of controlling privately-owned power supply undertakings?

Electricity is one of the most essential of modern needs. To produce it in the most economical manner and sell it at the cheapest rate the supplier must be given a monopoly within a wide area embracing the largest possible number and variety of users. Consequently, means must be devised for ensuring an adequate measure of control over the Undertaking's operations with a view to ensuring that consumers' interests are adequately safeguarded.

Various methods of price control have been adopted in different countries. In America statutory Commissions are set up for regulating the prices to be charged by supply undertakings year by year. This is a whole-time business, and there is a battle royal annually between the commissions and the undertakings as to whether prices are to be raised or lowered and to what extent. To avoid undue hardship, investigation has to be very thorough and special staffs are set aside to work continuously on these investigations. With the best intentions in the world it is very difficult for any commission to evaluate accurately the numerous and complicated factors which enter into the question of what the fair price should be under any set of circumstances, and politics often loom large in these determinations. To me it has always seemed that such a method is very far from ideal and savours too much of State interference.

In other countries attempts have been made to place restrictions, often somewhat arbitrary in nature, upon the return which shareholders of the supply undertakings shall enjoy from the businesses they own, but this also, in my view, is unwise in principle. Surely the question is not to what maximum the Company's return should be limited but how fairly to apportion an increasing or decreasing return between supplier and consumer. The return to the Company should depend directly on the results achieved and there should be no barrier to an increasing reward.

Fortunately, in South Africa, the principle of proportional sharing between consumers and shareholders is the basis of the Electricity Act and it came to be adopted in the following rather interesting and unusual way.

Shortly after the Power Company was formed in 1906, the Government of that day, realising the future importance of power supply to the Rand, and indeed to the country at large, and with prophetic insight, set up a Commission to enquire into the question of whether the establishment of such undertakings was desirable, and if so, in what manner their operations could best be regulated and controlled. The Commission favoured the establishment of such undertakings and recommended that special legislation should be enacted for controlling them, and this led to the promulgation of the Transvaal Power Act in 1910. In the meantime, the Power Company had entered into contracts with several of the mining groups but not, as yet, with the largest group—The Rand Mines, Ltd., now The Central Mining and Investment Corporation, Ltd. At that time a London consulting engineer, Mr. W. A. Harper by name, happened to be visiting the Rand in connection with the big arbitration case then pending between the Johannesburg Municipality and Messrs. Beardmore—the gas-driven plant installed by the Municipality in its electrical generating station having proved a failure. Mr. Harper, in spying out the land, seized the opportunity to negotiate for a power supply contract with the Rand Mines, Ltd., the idea being to establish a separate power supply under-

taking for furnishing the requirements of that group. The financial and technical advisers of the group had the whiphand in these negotiations. I think what they probably said to themselves was that, while they did not know much about Mr. Harper or his ability to raise money for new power undertakings, an agreement with him would do no harm so long as it was sufficiently favourable to the group. Anyway, the contract which Mr. Harper carried back to London was a very safe one for the consumer, and this contract subsequently was acquired and taken over by the V.F.P. Company.

One of the major considerations for the group when negotiating with Mr. Harper was how to regulate the prices they were to pay for energy supplied, and, being good business men, they adopted the very practical method of stipulating that the consumer should share in what they called the surplus profits of the Company. All surplus remaining after working expenses and certain capital charges had been met was to be shared between the parties and it is interesting to observe that even when negotiating with an exceptionally free hand the leading mining group at that time considered a 25 per cent. share to the group and a 75 per cent. share to the Company to be an eminently reasonable basis of division, subject, however, to the proviso that if the cost of production fell below a specified figure the consumer's share should thereafter be increased to 50 per cent.

It would take too long to trace the further history in detail, but when it came to drafting the Transvaal Power Act the Company put it to the Government Mining Engineer, Sir Robert Kotzé (Mr. Kotzé as he then was), that it would be difficult to devise a better basis for general application than that which the largest mining group had itself chosen for protecting its own interests. Sir Robert was impressed by this suggestion and thus it came about that legislation framed for the Transvaal in 1910, and since extended by the Electricity Act of 1922 to the Union as a whole, embodies the principle of profit-sharing as the means for regulating automatically the prices charged by Power Companies.

To complete the picture of the Group Agreements, I may say that as only a general basis had been laid down, difficulty not unnaturally arose in interpreting the clause defining surplus profits and this led to a revision of the Contract in 1924 when all those difficulties were cleared up and the basis of division was changed from the original 25/75 to 50/50. Since then the method has worked smoothly and well and, as Mr. Stratten has shown, has resulted in a steady and, at times, rapid reduction of the net cost of energy, not only to the Mining Industry but, with few exceptions, to all consumers of the Power Company. Later still, in 1934, the contracts were again revised and the basis of division was again altered to what it is to-day, namely, 70 per cent. to consumers and only 30 per cent. to the Power Company. This final basis was the result of much careful consideration, and it was agreed on both sides that any increase of the consumers' share beyond 70 per cent. would defeat the object in view, namely, to secure the lowest possible net cost to consumers. Human nature being what it is, a reasonable incentive is necessary to ensure the best results and it has been accepted by both sides that a 30 per cent. share is not too large an incentive nor is it more than a fair reward for achieving the best results.

It is part of the arrangement that the Rebate Account and all that goes to its compilation shall be open to investigation and approval by inspectors appointed by the groups and, needless to say, non-group consumers are quite content to leave this checking to the mining groups.

As Mr. Stratten has pointed out, the supply to the Mining Industry in the early days represented almost the whole of the Power Company's business, a unique condition which facilitated the adoption of the profit-sharing method for regulating prices and led to other exceptional conditions appearing in the power supply contracts. It is quite unusual, for example, for a power undertaking to accept any guarantee as to the minimum quantity of spare plant which it will maintain on its system.

Mr. Stratten has pointed out that the penalty recovered from the Power Company is negligible compared with the loss incurred by the mining consumers when a stoppage occurs and that it is far more important to the Industry to avoid the risk of a serious curtailment of supply than to save its share of the capital and other charges on additional spare plant. In principle this is, of course, entirely correct, and

it is purely a question of where to draw the line.

It will be generally agreed, I think, that penalties in agreements of this kind are not intended as compensation but rather as a deterrent against any slackness on the part of the supplier in providing a thoroughly reliable supply. Moreover, it is, I believe, a fact that unless the stoppage is prolonged the mine, as a general rule, has little difficulty in making up lost tonnage by a small temporary increase in the subsequent rate of crushing or, alternatively, profits can be maintained by a very slight increase of grade.

As regards spare plant, the present clause in the contracts was framed when the system was much smaller than it is to-day, and, in formulating plans for system extensions, the Company, of its own free will, now provides for a larger margin than that called for under the Agreement. The Company also, though in no way bound to do so, has indicated its willingness to discuss a modification of the clause if the Industry feels that the legal obligation under which the Company operates should be amended.

There is certainly no desire on the part of the Company to cut things fine, and the Industry need have no fear that adequate provision will not be made to safeguard security of supply to the mines, the importance of which is fully recognised.

Incidentally it will have been noted that as a result of the sudden increase in the price of gold after this country left the gold standard the Power Company, already the largest undertaking of its kind in the British Empire, was called upon to double its plant capacity and output within the relatively short period of five years. This was no mean task. As Mr. Stratten has pointed out, a mine can put a new reduction plant into operation in a little over one year from the decision to proceed, whereas the ordering, delivery and erection of new generating plant takes very much longer. When a new power station has to be planned, designed and constructed, and a new site and additional sources of supply for fuel and water have to be acquired, at least three years is needed and even this may easily prove insufficient. In the case of the Klip Generating Station, which enabled the Company to double the size of its business, legal and other essential preliminaries occupied still further time but, in spite of all this, the Company, by conserving all its resources and making every possible provision for maintaining its available plant in service, succeeded in meeting the full requirements of the Industry without any curtailment or shortage of supply. It is unlikely that so heavy and rapid an increase in demand will ever again arise, but if it does the Company will not be found wanting.

Mr. Stratten has referred to the favourable conditions of the Agreement in respect of group load factor and power factor, and he suggests that a contractual inducement to the consumer to improve these characteristics of the supply taken might be justified by the resulting savings. There is no doubt that if control throughout were in the hands of one party improvement of load factor and power factor would be effected by regulation and correction of the load at the consuming end rather than by installing plant on the supply system, but the ultimate overall financial saving as between the two methods would not be large and if it were divided between the Company and the consumers, the consumers' share would, I fear, be considered inadequate as an inducement to them to incur the trouble and expense of making the improvements. Clearly it would be unreasonable to expect the Power Company to incur a loss, and there does not seem to be much room for a gain.

I remember going very carefully into the whole matter of power factor in the early days and trying to persuade the mines to adopt synchronous motors or to instal power factor correcting plant for some of the larger units on their properties. My contention was that the reduction of current loading and losses on consumers' installations, together with the consumers' share via Rebate Account in the benefits accruing on the supply system would more than compensate consumers for any additional expense they might incur. Eventually, I managed to persuade one consulting engineer to purchase phase-advancers for improving the power factor of several large motors driving compressors on one of the mines, but I regret to say he got cold feet and the plant was never installed! When the plant arrived one phase-advancer was donated to the Witwatersrand University and is, I believe, still in use in the electri-

cal laboratory there. The others remained for some time in their packing cases on the veld, and what ultimately became of them I do not know.

This experience was not encouraging and I came to the conclusion that it would cost too much to overcome consumers' prejudices and that the Company would have to tackle the problem on its own system. As Mr. Stratten has mentioned, a large number of rotary condensers have been installed at main distributing centres and static condensers are now being installed on the low tension side of transformers in many sub-stations scattered over the distribution networks. I agree with Mr. Stratten that there are probably many cases on the mines where it would pay the consumer to arrange for these static condensers to be installed as near as conveniently possible to the motors, thereby reducing the current loading on the mine circuits and switchgear. The Company will, I am sure, be glad at all times to co-operate with consumers in order to give them this benefit.

While, as I have said, there seems little room for providing an adequate inducement to consumers to improve their load factor and power factor, the position would, of course, be different if agreements were being formulated *de novo* for a new undertaking. In such a case it would probably be wise from the start to apply the tariff to all load factors and base the demand charge on kVA rather than kW, but the difficulty, when introducing these changes at a later stage into an existing agreement, is to avoid imposing a loss on the Power Company.

As regards the question of frequency, Mr. Stratten is probably correct in saying that in the early days it suited both parties to run the system at a frequency of more than 50 cycles. The 3 per cent. rise enabled both parties to get a bit more out of their plant. My understanding at the time was that it paid the groups to run their mills at the highest speed consistent with avoiding what was known as "camming." In those days most of the crushing was done by stamp mills, and if the speed was increased a point was reached where the falling stamps had not sufficient time to come to rest on the rock they were pulverising before hitting the base of the cams by which they were about to be relifted. In such circumstances the impact between the collar on the heavy stamp and the base of the cam broke the shafts and held up the mills. Experience showed that a frequency of 51½ cycles allowed a minimum safe margin for avoiding such catastrophes.

For many years now the Power Company has been under a contractual obligation to maintain its frequency at 50 cycles per second, but the Mining Industry stipulated that there should be no departure from the existing practice until a request to that effect was given. The change, when it comes, will necessitate certain somewhat costly changes to plant on the Company's system, but, nevertheless, I support wholeheartedly the broadminded attitude which Mr. Stratten has taken up in regard to this matter.

While I am not fully convinced that the load factors of the Municipal and V.F.P. undertakings will, in future, both tend to fall, there can be little doubt that the case for operating all the power stations in this part of the country in parallel will become stronger as time goes on.

The matter of sub-station buildings, as Mr. Stratten says, is not of great moment, and in these abnormal times it would perhaps be undesirable to increase the vulnerability of sub-station gear to damage from outside sources. Here again, one must not forget that consumers receive through rebate the major portion of any reduction in the Company's capital and other charges resulting from the use of indoor gear.

The latter portion of the address, in which Mr. Stratten deals with the forecast of future load requirements and the demand and consumption of the mines per ton milled, is, I think, of special interest and importance. For the reasons mentioned in the address it would not be safe for the Power Company to defer the ordering of additional plant on its system until the mines were in a position formally to notify their additional requirements, and it is, therefore, necessary to compile periodically forecasts of the probable growth of the Industry's requirements several years ahead based on an estimate of the increase of tonnage milled. This can, of course, only be done with the assistance of the Industry, and I should like, on behalf of the Power Company, to take this oppor-

tunity of thanking the Chamber of Mines and the technical advisers of the groups for the ready and helpful manner in which they have always co-operated with us in the compilation of these forecasts.

I have touched upon only a few of the matters referred to in the Address. A great deal could be said on both sides of many of these questions, and in preparing these remarks I have frequently had to apply the blue pencil lest I should abuse the privileged position in which I find myself. Some of the matters referred to are at present the subject of discussion between the Power Company and the Industry, and this is a further reason for my restraint.

I have now much pleasure in asking you to accord a very hearty vote of thanks to Mr. Stratten for his most interesting and valuable address. In his concluding remarks he expresses the hope that his Address will, in some small measure, assist towards a better understanding of power supply problems by consumers and of the engineering problems of the Mining Industry by power supply engineers. You will be with me, I know, when I assure Mr. Stratten that his hopes in this direction will be amply realised and that we all feel deeply grateful to him for having dealt so ably with matters of such special interest to so many of us.

The Chairman: I now call upon Mr. Joseph White to second the vote of thanks.

Mr. Joseph White (Past President): Mr. Stratten, Dr. Price, gentlemen, in seconding the vote of thanks to our President for his Inaugural Address, I would like to compliment him and also the Institute on his masterly review of the power supply question as applied to the Witwatersrand.

Though the President modestly states that his Address may only assist those of our members who are engaged in the Gold Mining Industry, I feel sure that all our members, whatever branch of electrical engineering may have fallen to their lot, will find in the Address much to interest them, and much to give them food for serious thought.

Mr. Stratten's review of the "Group" system for the purchase of electrical power I found particularly entertaining. I imagine that the successful working of such a novel type of co-operative buying is only possible due to the non-competitive nature of the Gold Mining Industry. One cannot conceive that this scheme would be as satisfactory in secondary industry, where the financial success of an industry may be due to low power costs, in turn due to high load and power factors. The sharing of these advantages with a group of miscellaneous competitors would scarcely be an attractive proposition.

The installation of 320,000 kVA of synchronous condenser plant by the Power Company must have entailed considerable expenditure, though no doubt this installation is justified by increased saleable output from the generating plant; in any case, some condenser capacity would be required to reduce transmission losses. It is, however, an axiom of electrical engineering that low power factor should be corrected at or near its source, and the cost of this should be borne by the consumer, always providing that he obtains some commensurate financial benefit by so doing. Given a consumer's load with a high power factor the power suppliers would be saved capital expenditure, which in turn would be reflected in a lower power cost to the consumer.

It is very interesting to learn that the cost of power to the Gold Mining Industry is only 6 per cent. of total working costs. I believe I am correct in stating that the power costs in secondary manufacturing industry are of the order of 4 per cent. of total works costs on the average; this, of course, is exclusive of electro-chemical and electro-thermal industries, where power costs may be as high as 50 per cent. of the total manufacturing costs.

Improving power factor presents no particular technical problems, but to improve load factor is a very different matter. Industries operating on a continuous process have almost a straight line load, and load factors approaching 100 per cent. are possible, but industries working a normal eight hour day and shut down on Sundays can never approach this ideal. Since, to most of these industries power costs are a small percentage of total costs, the matter of load factor is probably not a serious one, though every effort should be made to avoid creating peak loads. The power supplier suffers, but it would seem that this

disability is part and parcel of modern conditions and little can be done to improve the position until large scale storage of power, either mechanical or electrical, becomes a practical proposition. The difficulties of correcting low load factor have been clearly set out in the President's Address, and though something can be done to improve matters, I agree with him that in the absence of financial advantage very little effort is likely to be made by consumers purchasing power on a flat unit basis.

Mr. Stratten's Address is packed with interesting matter, and the intensely practical and logical manner in which he has dealt with his subject has resulted in an illuminating and valuable treatise which will give added lustre to the Institute's *Journal*. It gives me great pleasure to second the vote of thanks to our President for his excellent and invaluable Inaugural Address.

The Chairman: Gentlemen, the hour is late, and the remarks I intended making at this stage have all been covered by the previous speakers. (Laughter.) I, therefore, feel it only necessary to say that I associate myself fully with their remarks. You have heard the vote of thanks proposed by Dr. Bernard Price and seconded by Mr. Joseph White; and, as I feel certain you are in entire agreement with their remarks, I will now call upon you to show your appreciation of our President's Address in the usual manner. (Applause.)

The President: As Mr. Price has said, the hour is very late, so I would like just to confine my remarks to thanking Dr. Price and Mr. White for the remarks they have passed. I myself have found their opinions extremely interesting and valuable, and I would like to thank them for proposing the vote of thanks and for coming here this evening. I thank you.

The Chairman: Thank you, Mr. Stratten. I must now ask you to resume the Presidential Chair.

The President: As there is no further business, gentlemen, I declare the meeting closed. (10.25 p.m.)

COL. R. E. CROMPTON, C.B., F.R.S.

The Institute desires to pay its respects to the memory of one of the pioneers of the Electrical Industry, and regrets to record the death of Col. Rookes Evelyn Bell Crompton, who died on February 15th, at the age of nearly 95, having been born on May 31st, 1845, at Sion Hill, near Thirsk in Yorkshire.

Col. Crompton was a man with a wide and varied experience, from being a cadet in the Royal Navy in the Crimea; in the Rifle Brigade in India; as a manufacturer of electrical machinery and equipment; in charge of the Electrical Engineers Volunteers during the S.A. War, to the designing of tanks in the Great War.

As a result of experience gained in lighting the Stanton foundry with Gramme dynamos and Serrin arc lamps, Col. Crompton began business as a manufactuing electrical engineer at Chelmsford in 1878, these works being the forerunner of the present Crompton Parkinson organisation in that town.

During the present century, much of Col. Crompton's time was given to technical committees and, amongst other positions held, he was President of the Institution of Electrical Engineers, 1895 and 1908; first President of the Institution of Automobile Engineers; Honorary President 1926 International Electrotechnical Commission; Founder Member, Vice-President and Deputy-Chairman, Royal Automobile Club; Vice-Chairman, Roads Improvement Association; Honorary Member of the Institution of Civil Engineers; Member of the Institution of Mechanical Engineers, etc.

ELECTRICAL WIREMEN'S AND CONTRACTORS' ACT.

The attention of members is drawn to the new Registration Board which has now been established under the conditions set forth in the above Act.

The personnel of the Board is as follows:—

In addition to Francois Willem Joubert, M.I.Cert.E., Chief Inspector of Factories, as members of the Electrical Wiremen's Registration Board for a period of three years as from the 1st January, 1940:—

Arthur Rodwell, M.I.E.E., M.I.Mech.E., M.(S.A.)I.E.E., M.I.E.(S.A.).
Charles Henry Curnow Clutterbuck, M.I.Mech.E., M.I.E.(S.A.).
Horace Gosse.
John Leslie Greet.
Alfieri Elisio.

In terms of sub-section (1) of Section five of the said Act the Minister has designated Mr. C. H. C. Clutterbuck as Chairman of the Board.

Particular attention is drawn to Section 21 of the Act having special reference to Contractors' Licences and Registration as Contractors, the onus being on the persons concerned to see that they are duly registered.

The necessary application forms may be obtained from the Divisional Inspector of Labour, Johannesburg, or from the Secretary of Labour (Electrical Wiremen's and Contractors' Registration Board), Pretoria.

MEMBERSHIP.

In accordance with Rule No. 24, the membership of the following members has ceased:—

Members:

E. C. Sprighton.
E. Struckell.

Associate Members:

W. du Plessis.
H. English.
O. McI. Goddard.

Associates:

V. O. Goument.
W. J. Polis.
A. G. Shimwell.
G. A. Snoddy
A. B. Welch.

Students:

R. I. Anderson.
N. F. Clarkson.
A. Jones.
L. W. Newbery.
G. R. Ockerse.
R. Palfrey.
P. J. van der Merwe.

INSTITUTE ANNOUNCEMENTS

AWARDS.

The Council is empowered each year at its discretion to award the Gold Medal of the Institute, together with a certificate and, if considered desirable, a premium not exceeding £10 10s., to a member of any grade for an original paper of outstanding merit submitted during the year.

It is also authorised to award at its discretion the Bronze Medal of the Institute, together with a certificate and, if considered desirable, a premium not exceeding £5 5s., to a member of the Student grade for an original paper of outstanding merit submitted by a member of that grade.

The Institute is indebted to the Management of the Victoria Falls and Transvaal Power Company, Limited, for an annual donation of £25 for the purpose of awarding premiums, not exceeding £10 10s. in value for any one award, for the purchase of scientific and technical books or instruments for papers and contributions to the discussion of papers, which, in the opinion of the Council, merit special recognition.

The papers and contributions of Student Members are eligible for awards both in their own Section and in the Senior Section, and all awards are at the discretion of the Council, which may vary them in amount according to the merit of the papers and contributions submitted during the year.

The Institute is also indebted to the South African Cable Makers' Association for an annual donation of £5 5s. for the purpose of awarding one or more premiums each year to the total value of £5 5s.

The conditions governing this Award are the same as those for V.F.P. Awards, with the exception that all Papers and Contributions read before the Institute are eligible for the Award irrespective of whether the authors are members of the Institute or not.

PAPERS.

Members presenting papers before the Institute are requested to forward a copy of their paper, in final form, to the Secretary at least one month before the date of the meeting at which it is to be read.

Where symbols or abbreviations are considered necessary, it is desirable that definite standards should be used.

Attention is drawn to the publications of The British Standards Institution dealing with "terms" and graphical symbols used in electrical engineering, with the suggestion that these be employed.

DIAGRAMS FOR TRANSACTIONS.

It is requested that the following rules be observed by members preparing illustrations for publication in the *Transactions*:—

Drawings accompanying papers should be made in India ink on white paper; hand sketches, if they are bold and heavy in outline, are suitable for reproduction in the *Journal*.

Drawings and photographs to be shown on the screen by means of the epidiascope should not exceed 6 in. x 6 in. in size, and slides must be 3¼ in. x 3¼ in.

All drawings and photographs require to be numbered to ensure their use in the correct order.

As it is necessary when preparing blocks for the *Journal* to reduce any diagrams used by authors to such sizes as will enable reproduction in either single- or double-column width (the former being preferable in view of cost and space), the effect of this reduction should be borne in mind when lettering diagrams. Disproportionately large lettering in disproportionately bold line is essential if the diagram, when reproduced in the *Journal*, is to contain legible printing. Lettering when reduced to block proportions should not be smaller than 1 mm. in height, the thickness of line to be at least the same as that used for outlines in the main diagram.

LETTERS OF DESIGNATION.

The attention of members is drawn to Rule 26 of the Constitution and Rules of the Institute, which reads:—

The authorised letters designating the class in the Institute to which a member belongs shall be as follows:—

For an Honorary Member, Hon. M.(S.A.)I.E.E.
For a Member ... ... M.(S.A.)I.E.E.
For an Associate Member, A.M.(S.A.)I.E.E.
For an Associate, Associate (S.A.)I.E.E
For a Student, Student (S.A.)I.E.E.

"In each case the letters S.A. shall be in brackets and be less in size than, but not less than half, the size of the other letters."

ADDRESSES WANTED.

Addresses are wanted for the following:—

R. J. S. Caldwell.
S. Hampton.
M. Havinga.
N. E. Herberg.
C. A. Mitchell.
H. J. Morris.
H. S. Potgieter.
G. E. Richards.
P. R. Simmonds.
G. F. Stegmann.
S. Suttner.
P. du Toit.
J. A. t'Hooft.
V. L. Webb.
A. H. Winchester.

Kindly communicate with the Secretary, P.O. Box 5907, Johannesburg. Telephones, 33-5248/9.

TO COUNTRY MEMBERS.

The Council is particularly desirous of receiving written contributions from members resident in the country on any of the papers up for discussion as set forth in the Agenda.

Members who are unable to attend the Ordinary General Monthly Meetings should avail themselves of this opportunity.

In this connection members should bear in mind the Institute, V.F.P., and Students' Awards which are available for members presenting a paper or contribution of sufficient merit.

Kindly address all contributions, etc., to the Secretary, P.O. Box 5907, Johannesburg.

MINUTES OF THE BRITISH STANDARDS INSTITUTION.

The Minutes of the above Institution are regularly received by the Institute, and may be obtained for reference purposes on application to the Secretary.

BRITISH STANDARDS SPECIFICATIONS.

H.M. Acting Senior Trade Commissioner, Johannesburg, has advised the Institute that he has received from the British Standards Institution, of London, a complete set of British Standards Specifications.

These Specifications are filed in his office, and may be consulted there when required.

The Specifications are for consultation only, and cannot be loaned from his office.

BOOK-PLATES.

Book-plates for publications purchased from Award Premiums may be obtained from the Secretary of the Institute.

TECHNICAL PUBLICATIONS.

By the kindness of Doctor H. J. van der Bijl, the chairman of the Electricity Supply Commission, the Institute is favoured with copies of the weekly library extracts of current technical literature prepared by the Librarian of the Commission.

The Council desires to announce that the Extracts are available for reference by members on application to the Secretary, and a copy is also available on the bookshelves in the lounge of Kelvin House.

RECIPROCITY ARRANGEMENTS.

Reciprocity arrangements exist between the South African Institute of Electrical Engineers and the Institution of Electrical Engineers, London, the American Institute of Electrical Engineers, the Société Française des Electriciens, Paris, the Association Suisse des Electriciens, Switzerland, and the Verband Deutscher Elektrotechniker, Germany. It is hoped that members proceeding overseas will avail themselves of the facilities offered. Full particulars are obtainable from the Secretary.

CLIPPINGS FROM TECHNICAL PRESS.

Members are invited to send in any clippings from the Technical Press which may have bearing on papers up for discussion, or may be of general interest. Please state source. These clippings will be submitted to the responsible editor, who will pass for publication such items as can be accommodated in the *Transactions*.