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Convention Impressions.

Everyone agreed that the Summer Convention of the Association of Mining Electrical Engineers was entirely successful. The national virility of the Association was amply confirmed by the large muster of members who represented every branch of the Association. We know of some who voyaged overseas from Leith, and of others, junior members these, who burnt the highway on motor-cycles from Yorkshire. When men journey to London from remote Scotland and the West Country to attend the "Annual" there is no shadow of doubt as to the healthful vigour of the Association as a whole.

It seemed, moreover, as if the programme had been deliberately planned to put the individual member through an endurance test on load. He was called upon to see, and walk through, no less than three large works on the one day. The results of the trial were quite satisfactory for his temper(ature) rise was not noticeable. It was quite a smart idea to open the proceedings with this strong demand for stamina—the round of succeeding days was made easy after that—and it was really a stroke of genius on the part of the organisers to arrange for "Doctor Brighton's" services on the last day.

The serious domestic business affairs of the convention—the Committee, Council, and Annual General Meetings were marked with the brevity and placidity which automatically follow a year's work well done. The Association was shown to be successfully pursuing its well organised policy. There were no complaints and the proceedings were in the main carried evenly along a stream of mutual congratulations and thanks for the services rendered by the committee men whose reports were so favourably received.

If there was any expression of disappointment regarding the work of the past year it was exhibited in regard to the Association's Examinations. It is, however, important to read the Report of the Chief Examiner in the right spirit and, in particular, to note with great satisfaction that the A.M.E.E. Certificate of Proficiency is not easily to be got. The sterling value of the Certificate must be kept above suspicion. Even those who failed to pass will, despite their natural disappointment, grant that an easy ticket is of no use and is not what they had hoped to acquire. Let them therefore be stimulated to try again for the qualification which is so well worth while. If it be the fact that the examinations are so stiff as to deter many would-be entrants—and the number of candidates is regrettably few—then, to put the matter bluntly, those who fear to study for and enter the examinations are not worthy of consideration and not deserving of the reward. Far better is the man who has to the best of his ability endeavoured to gain the certificate and failed than he who shirks the work of preparation and the contest. There is surely a high personal qualification in having educated oneself up to the standard of the examination even though the pass may not have been won.

Amongst mining electrical workers there are some very efficient and fully competent men who are not cut out for written examinations: the institution of an oral test, such as we suggested some time ago, and which is now proposed as a development of the A.M.E.E. examinations system, will effectively aid the competent practical man to succeed in acquiring a certificate of proficiency: and equally, if not more important, is the point that the oral or practical test will make it more difficult for the man who is only expert in "book-knowledge" to satisfy the examiner.

Each succeeding year the real value of the A.M.E.E. Certificate is ever more widely recognised and acknowledged; that satisfactory progress will continue whilst the examiners insist on a very high pass standard. To simplify the test and cheapen the certificate would be to stultify one of the foremost objects of the Association—which is to raise the status of the mining electrical engineer and which too can only be obtained by his education. In this connection it is pleasing to note that the educational work of the Association is to be still further extended and, in particular, by devising means whereby technical instruction will be provided for those who are in places and districts where suitable classes are not available or sufficiently easily accessible.

In his Presidential Address, Mr. Gibson did well to emphasise the principal impediment retarding the rationalisation of the British coal industry. He quoted leading facts concerning the drastic changes made on the Continent: in Germany, between 1924 and 1928, eighty-nine bad collieries were deliberately closed down, and the trade was thus rationalised by concentrating efforts at the remaining best collieries so that, in effect, the production of coal per man-shift had been increased by over 30 per cent. All that the mass of modern machinery has done for our collieries has been to raise the production, between 1913 and 1928, by less than a paltry 5 per cent. per man shift. There are, of course, other causes for the discrepancy—but the fact before us is that (as Major David pointed out at the annual dinner) we have some of the very finest collieries in the world, and we also have, in work, some of the very worst. Mr. Gibson advocates the ruthless shutting down of the bad properties and makes the crucial point very clear—that it is not to be expected that the good colliery will enter into any rationalisation scheme with the bad one. We recommend careful study of the facts and opinions of Mr. Gibson and Major David: they are ominously convincing.

Keen as is already the competition of rationalised Continental coal, it threatens to be still more so by the proposed mutual money sacrifice between the German owners and workers. We would not suggest that this country should follow suit in this respect. It is not yet necessary for us to reduce our general standard of living, for that is obviously what a change of that kind would mean: let us first adopt the reasonable and logical economic policy of rationalisation, and augment still further the mechanical and electrical equipments and their skilful use: these are some of the visible means of improvement. There is time enough after adopting all these and other available and obvious progressive measures to think of retrograde reversions towards the bad old days.

Mr. J. W. Gibson, President of The A.M E.E.

As always, the Association of Mining Electrical Engineers has chosen wisely and well in its selection of the member to fill the presidential chair for the ensuing twelve months. Mr. Gibson has many notable credentials, personal and technical, to ensure his success in the premier office of the Association, but perhaps the qualification which will most favourably impress his fellow members is that he is a real and practical mining electrical engineer. It was at the Wallsend and Hebburn collieries that Mr. Gibson served his engineering apprenticeship ; he subsequently worked as colliery electrician at the Harton, St. Hilda's, Bolden, and Washington collieries in Durham. His practical work as a mining electrician was supplemented by technical studies at the Durham College of Science (now the Armstrong College, Newcastle).

Those were the pioneer days of electricity in collieries and Mr. Gibson has an entertaining and useful store of memories of his personal experiences some thirty years ago with experimental electric coalcutters and other primitive mining electrical inventions and devices. This experience stood him in good stead when he was appointed electrical engineer surveyor in the newly-created electrical department of a leading insurance company.

For many years Mr. Gibson has made a special study of main and auxiliary mines ventilation systems and it was in connection with this particular phase of engineering that he joined the staff of Davidson & Co., Ltd., the Belfast firm of "Sirocco" fame. He is still with that Company: for thirteen years he has been a member of the Board of Directors and has gained a high reputation as an engineering expert in mining ventilation, draught systems and dust collecting problems, with all of which he has dealt in the form of actual installations in all parts of the world. The paper which Mr. Gibson read before the London Branch of the Association last session was accepted immediately as the word of an authority and, judging by the requests for copies and sanction to reprint which have come into this office from many home and foreign quarters, it might already be named a classic work on chimney dust problems.

Mr. Gibson has been a member of the Association for nineteen years; he has served as President of the London Branch and actively interested himself in council and committee affairs—to put it briefly, and without piling on the compliments which he would be the first to resent, Mr. Gibson has merited his promotion and the members of the Association will in him find their confidence and favours well placed.

NEW BOOKS.

H.M. STATIONERY OFFICE.

The following, printed and published by His Majesty's Stationery Office, can be purchased through any bookseller or directly from H.M. Stationery Office at the following addresses: Adastral House, Kingsway, London, W.C. ; 1 *York Street, Manchester ;* 1 *St. Andrew's Crescent, Cardiff;* 120 *George Street, Edinburgh; or* 15 *Donegall Square, W., Belfast.*

Mines Department.—THE EXPLOSIVES IN COAL MINES ORDER of the 13th May, 1930 (No. 354). Price 2d. nett.

This order made under Section 61 of the Coal Mines Act, 1911, approves the "Cardox" Carbon Dioxide Cartridge for use in all mines to which that Act applies, subject to the conditions specified in the Order. A large scale sectional drawing of the "Cardox" Cartridge is appended to the leaflet.

Mines Department.—TESTS OF DIRECT CURRENT BELLS AND RELAYS FOR SIGNALLING IN COAL MINES.

This Memorandum amends the conditions governing these tests. The principal alterations are in regard to the nature and requirements of (1) the tests for intrinsic safety of instruments intended for use singly or two or more in parallel, and (2) the tests applied to a flame-proof enclosure when it is a necessary condition of safety, or where it is desired that the enclosure shall be certified to be flame-proof. Some variations have also been made in regard to the procedure to be followed when forwarding instruments for test.

Mines Department.—PAPERS SET at the EXAMINATIONS FOR MANAGERS' CERTIFICATES OF COMPETENCY (First and Second Class) and SURVEYORS' CERTIFICATES: 28th and 29th May, 1930. Price 1s. 6d. nett.

Square Driving Ropes.

Mr. E. J. Christian, author of the Paper "Square Driving Ropes," published last month, writes as follows:

May I correct a little inaccuracy in your report of my Paper on Square Driving Ropes. At the end of the two paragraphs of comparative figures you speak of the speed ratio as 11 to 1 and 7 to 1, these figures do not refer to speed, but to the length of life of the ropes. In one case the square rope has lasted 11 times as long as the round rope and is still running, in the other case the square rope lasted 7 times as long as the round rope.

Presidential Address

TO THE

Association of Mining Electrical Engineers.

PROGRESS AND OPPORTUNITY.

J. W. GIBSON, A.M.I.E.E., F.Inst.F.

MAY my first pleasure as your President be to express my thanks to the Council and members as a whole for electing me to the highest office of the Association. I accept this honour with warm appreciation as a friendly tribute to the London Branch, and perhaps to my long period of membership. I shall do my best to uphold the high standard which has been set by our immediate past President and his predecessors, and to support loyally the cause which the Association has at heart, and which it exists to further.

The main object of our Association is the propagating of technical knowledge in relation to the application of electricity in mining; to promote economical production and safety in the winning of coal.

It is about 21 years since the Association was formed, and during my Membership of about 19 years, there have been great changes in engineering science, and in the mining industry. Education and knowledge is now upon a different scale, and those who are undergoing their training to-day have the advantage of the result of years of development and experience to assist them in arriving at the goal of proficiency.

Going back still further to the time when it was my duty to attend to some of the earliest colliery plant, there was then scarcely enough electrical apparatus to justify the titles we hear to-day. The term "Electrical Engineer" was very seldom heard, "Colliery Electrician" only sometimes, but more frequently the person responsible for the electrical plant came under the term of Electric light man, or Telephone man, as the case might be. This may convey some idea of the small amount of plant which fell within the range of responsibility about 30 years ago. Some of the earliest plant I had through my hands at that time would qualify for exhibition at South Kensington Museum, although not so venerable as the "Rocket" of Stephenson fame. One particular machine must have been old even at that time. You find it mentioned in some of the older electrical works under the description of the Thomson dynamo, the design of which was entirely different from the established lines of to-day. The armature was almost spherical in shape, rather like a rugby football. The commutator was made of brass or gunmetal segments, and the brushes were bundles of brass wire held together in a clip, more like a shaving brush than anything else. This ancient machine was a reliable arclighter, and supplied several groups of arc lamps in series, and it almost took up the full time of one man in attending to the sparking of the commutator, and to the substitutional resistances of the arc lamps.

These were days which required quite a good deal of winter pole climbing. A 50 h.p. dynamo required more personal attention than a 10,000 k.w. engine room of to-day.

Another item of interest was one of the earliest coalcutters which came under my care. This machine was of the undercutting wheel type. The supply was d.c. 200 volts. The coal cutter was driven by a very old type Immisch motor, having an armature of the Gramme Ring wire-wound type. We became quite proficient in drawing this armature for rewinding or patching up about twice a month. I need not remark that the machine was working in a non-fiery mine, otherwise the sparking at the commutator would have been sufficient to seal its doom. There were no safety precautions, the fuses were open and accessible to anyone and it was not unusual, when the supply of fuse wire had run out, to find a 6 in. nail inserted for this purpose.

My object in digging into ancient history like this is to show, lest we forget the fact, that there has been a substantial degree of progress since those days, and progress such as this cannot take place without experience and development, the result of which is available for the improvement and knowledge of those who are at the early stages of their career. Progress such as this cannot help but provide greater opportunities. The application of electricity to mining since those days has developed to such an extent that in many collieries no other power is used.

The nature of the work in connection with mining makes heavy demands upon physical effort, and the arduous duties have acted as a spur to enterprise and invention. No other industry has contributed so handsomely as mining in the way of inventions to lessen manual labour. This object is still being pursued in the mechanisation of mining. The progress of electrical science and development of apparatus now permits of using higher pressure supply with comparative safety at the coal face. To this achievement members of this Association have been substantial contributors. Recently an extra high tension cable system of British manufacture was installed in a South African mine shaft, having a depth of 4739 feet. The total cable run was 6339 feet, and conveyed power to an underground transformer station, the supply pressure being 20,000 volts, transformed down to 2100 volts for distributing busbars.

The Association is interested more intensely in encouraging the provision of educational facilities for the better training of mining electrical engineers, and for testing the results of their training by means of examinations. I have sometimes heard the question asked as to why students should follow an intensive course of study when they could not see any reasonable opportunity of making use of their knowledge thus gained, and yet when one looks back over 30 years, there have been, if anything, more opportunities than there were qualified men to fill.

In an organisation so complex as a modern colliery, one innovation inevitably leads to another. No sooner is one operation accelerated than the necessity for quickening another becomes apparent. The penalty for lack of synchronism in the cycle of operations concerned in the winning of coal means a sacrifice of the benefits connected with the acceleration of any individual process in the cycle. In colliery work there is no escape from the consequences of slovenliness in the matter of detail. Weak points are inevitably discovered by usage, and in no section of electrical work are the results of carelessness more dangerous, or the benefits of thoroughness more apparent than in colliery work.

These remarks are retrospective, but serve to show that something has been accomplished, although a great deal more requires to be done in this and in other directions to keep the mining industry abreast of the times.

In recent years demands for power at collieries have been greatly augmented. The demand for increased acceleration in the rate of winding and haulage, especially in the deeper mines, a higher standard of ventilation, the replacing of horse by mechanical haulage, the introduction of coalcutting machinery and face conveyors have all contributed to increase the electrical equipment required at collieries. This in turn increases the range of usefulness of the colliery electrical engineer, and tends to raise his status relative to that of other officials.

In the matter of reconstruction and rationalisation, however, the coal mining industry seems to offer the widest scope at the present time. On the Continent, more particularly in Germany since the collapse of the mark, the coal industry has been entirely reorganised during the last 10 years; yet, in this country, in spite of transparent necessity, coal mining still remains an unrationalised industry.

Competition for export markets has become very much intensified, and the chief victim of this intensification is the British coal industry. According to figures quoted by Prof. Jones, the annual capacity of this country has grown since the War from about 287,000,000 tons to 330,000,000 tons, but the output has fallen from 277,000,000 tons in 1913 to 250,000,000 tons in 1929. Under the regime of free competition the industry has been working at an average output of approximately 75 per cent. of its rated capacity, and consequently, excepting for occasional periods, mostly at a loss. It is true that since the setback of the general strike in 1926, we have been able to recover some of the export trade lost due to the stoppage, but the process has been enormously wasteful.

There is little doubt that were the industry properly organised it would be placed upon a profit-making basis. The real defect of the policy of "free competition" is that instead of concentrating upon production from the most efficiently equipped and modern collieries, and keeping these running at their full output, production is maintained over the whole field, with individual collieries working at much below normal output, to the detriment of the industry as a whole. It is a wasteful way of working and marketting one of our greatest natural assets. With our geological and geographical advantages, the British coal industry ought to be the most prosperous in Europe.

One reads of the difference between the German rationalised coal industry and our own unrationalised coal industry, and the figures do not make good reading, from our point of view. The result of the re-equipment of the Ruhr mines was very quickly apparent in Germany. The output per man shift was increased by over 30 per cent. between 1924-1927. In this country the average increase in output per man shift from 1913-1928 was less than 5 per cent. At the end of 1927 the average output per man shift in the Ruhr mines was 22.6 cwts. The corresponding average for U.K in 1928 was 21.3 cwts. It is interesting to note that the highest district average for U.K. was 23.6 cwts. for Scotland, where the percentage of coal mechanically mined is double that of England.

There can be little doubt that given the degree of reorganisation and re-equipment comparable with that of Germany, and possibly other European countries, the average output in this country would be equal to, or even surpass that of the Ruhr.

I feel that our only way back to prosperity is by shutting down our under-producing collieries, many of which are out of date in regard to electrical equipment, and are too unprofitable for re-equipping, but there will naturally be great reluctance on the part of owners of prosperous concerns to agree to amalgamation with less fortunate companies.

The Vice-President of the Staffordshire Branch of the Association of Colliery Managers, Mr. Smart, remarks in his book on Economics of the Coal Industry: "it may be stated quite definitely that though we have some of the best equipped and finest coal mines in the world, the general level as regards mechanisation of plant and engineering methods in this country is sadly behind that of our competitors. In this country, some 1400 independent producers, owning about 2000 pits, produce an output of approximately 240 million to 250 million tons annually. In Germany in the year 1928, about 70 companies, owning 175 collieries, produced 152 million tons. About three quarters of this production is concentrated in the Westphalian coalfield, where over 90 per cent. of the output is controlled by about a dozen companies, some 25 per cent. being in the hands of a single concern, The United Steel Trust. Practically all the coal in this coalfield is mechanically mined, and in Germany as a whole, approximately 80 per cent. of the coal is hewn by machinery. The corresponding figure for Great Britain is 26 per cent.

Some idea of the drastic nature of the reorganisation which took place in Germany after the collapse of the mark may be gathered from the fact that between 1924 and 1928 no fewer than 89 collieries were deliberately shut down. The Westphalian Syndicate alone closed 26 medium and large sized collieries in 1925.

The results obtained at well-equipped Scottish Collieries (both electrical and mechanical) go to show that satisfactory results can be secured compared with German competing collieries, and if such is the case our higher selling prices for export coal must be accounted for by factors outside the responsibility of those who are working the collieries. Our transport charges are too high and the effect of taxation too heavy. I feel that given a fair and equal opportunity, we are in no way inferior in technical skill or administrative ability to our competitors on the continent.

Proceedings of the Association of Mining Electrical Engineers.

THE ANNUAL CONVENTION.

THE twenty-first Annual Convention was held in London and District from June 24th to 28th 1930, some 150 to 200 members, ladies and visitors taking part in the very varied programme that had been arranged under the general supervision of Mr. J. R. Cowie, the Honorary Secretary of the London Branch. Without making comparisons, invidious or otherwise, with previous Conventions, all who took part in the 1930 Convention agreed that it was thoroughly successful and as enjoyable as could be wished. Mr. Cowie was so thoroughly modest as generously to solicit the thanks of the party for various people who had a hand in the detail work of the arrangements for the various visits, but, without detracting in the slightest from the credit due to the many other workers, it was to Mr. Cowie primarily that the thanks of everybody were particularly due for the wonderfully smooth working of the Convention.

The proceedings began with an informal gathering on the Tuesday evening at the Midland Grand Hotel—which was the headquarters during the Convention—for the issue of tickets, badges, etc., to members and their ladies arriving from all parts of the country.

The serious work of the Convention led off quite early on the following morning with a journey by motor coach to Chelmsford for the purpose of visiting the works of Messrs. Crompton Parkinson Ltd., the Hoffmann Manufacturing Co. Ltd., and Marconi's Wireless Telegraph Co., Ltd.

CROMPTON PARKINSON Ltd.

There is no name better known in the electrical industry than that of Crompton, and although the history of the firm is familiar to the older school of electrical egineers, a few details may be here recorded for the interest of the younger members. The business was started in 1878 by Col. R. E. Crompton, C.B., still hale and hearty at 85 years and, indeed, he was present at the sports of Crompton Parkinson Ltd., on the Saturday previous to this visit. Before the year 1878, with the exception of Mr. J. Wilde of Manchester, no English manufacturer had thought it worth while to go thoroughly into the question of the universal supply of electricity. It was in that year that Col. Crompton visited the Paris Exhibition where he made the acquaintance of Mr. Gramme and brought back with him to

Photo.: Sims & Co., London

'Neath Sylvan Shade in the grounds of the Chelmsford Works of Crompton Parkinson Ltd.

England a pair of the famous French electrician's dynamo machines. The first electrical work undertaken after the formation of the Crompton Company was the manufacture of arc lamps, these being proved at official trials to be superior to the best examples of American and Continental lamps. Then followed the first electric lighting installations in this country and on the Continent, and in regard to the latter it is often overlooked that British engineers were responsible for the introduction of electric lighting there. Some of the earliest Crompton electric light installations were at the Mansion House, the Law Courts, Vienna—where the Austrian engineers made boilers with lead rivets and tried to blame Crompton—and Kensington. Then followed a time of great activity on the part of Col. Crompton in regard to the Electric Lighting Act of 1882 and its modification in 1888 by which the period of life of 21 years, granted to a Company under the 1882 Act, was extended to 42 years.

In 1881, Col. Crompton was experimenting with the application of electricity to mines, tests with electric lighting at the Pleasley Colliery being carried out in 1881 before the Mines Accidents Committee. A little later the first electric haulage in South Wales was installed. This had a 100 h.p. motor and besides displacing 27 horses increased the output by 100 tons per day. Other early colliery and similar jobs included lighting at Abercarn, Stanton Ironworks, Glamorgan Coal Co., Ocean Coal Co., etc. Col. Crompton was a great believer in direct current, whilst the late Dr. Ferranti was the leading advocate of alternating current, the "Battle of the Systems" being a great feature of electrical development in these early years. Indeed, it is even now rather doubtful if the battle has yet been fought to a finish for during the visit to the Chelmsford works it was surprising to many to notice the large number of d.c. motors finished or in course of manufacture.

It is not possible here to carry a descriptive history of the Crompton firm much farther. Almost everything electrical has been made at the Chelmsford works, from the electric locos. for the old City and South London Railway to arc lamps for the Crystal Palace, and searchlights for the Boer War, during which, by the way, it is interesting to note that Col. Crompton commanded the Corps of Electrical Engineers sent out from England; he was mentioned in despatches and given the "C.B." for his services.

The early pioneer work of Col. Crompton already referred to shewed the way for the enormous developments in mining electrical usage that have taken place since. After the successful tests on electric light underground at the Pleasley Colliery, an endless rope haulage was installed and this was followed by a main and tail haulage installed at one of the Hill's Plymouth Collieries. This contract was undertaken under very stringent conditions. In those early days there was much opposition to the introduction of electricity in mines and the cable from the generating plant to the motor was carried down the side of the shaft and fixed 12 inches underground on each side of the roadway. The cable was so constructed that in case of "falls" it could withstand a shearing strain of 10 tons per square inch.

As mentioned, during the course of the Association's visit surprise was expressed at the large amount of d.c. work still persisting as evidenced by the big scale production of this type of machine in the very modern design of the Crompton Class F motor. The production of this type of motor has actually shewn a continuous growth of 100 per cent. in 12 months, notwithstanding the advent of the Grid scheme and the contemplated universal use of alternating current. It might be added here that all a.c. machines, except the largest a.c. motors, are manufactured at the Company's Guiseley works.

Much interest was naturally shewn in the flameproof direct current motor which has received the Sheffield University Certificate and many of the visitors who have been responsible for its installation below ground were interested to make a detailed examination of the machine under more favourable surroundings. Incidentally, there were among the party a few who in their earlier days had been engaged at Chelmsford and received their training there and they were greatly impressed with the remarkable developments which had taken place since their time. The corresponding a.c. machine with flame-proof slip-ring covers was perhaps more familiar to most of the visitors and another product of the Guiseley works which intrigued the party was the "Klosd" a.c. motor with removable sections which, as an exhibition model, allowed inspection of the interior. This type uses forced air cooling between two shells, the motor itself is thus totally enclosed and at the same time is provided with effective cooling without assuming an exaggerated size.

In the shops where the larger a.c. machines are manufactured, a group of eight 600 h.p., 6000 volt 50 cycle auto-synchronous motors designed for 214 r.p.m. with vertical spindles for pump drives were well advanced, a few being shewn on test at that load. A further addition to a plant of 14 such motors supplied to one company was a 750 h.p. auto-synchronous motor, to work at 3300 volts, 158 r.p.m., and 50 cycles for direct coupling to rotary grinders.

A wide range of apparatus was seen in the instrument section and one that made a special appeal was the A.C. Test which measures the current in a circuit without the aid of any connections. A laminated clamp bridging the coils provides the essential current transformer, the ratio and therefore the range of the instrument being widely variable by increasing the number of coils of the cables enclosed by the clamp. The long lineage of Crompton transformers was recalled by the presence of a Hedgehog transformer built by Mr. James Swinburne in 1889 but few of the visitors saw this because of a 100,000 volt test which was taking place in close proximity.

The present up-to-date design of transformers was, however, well observed in a very extensive department manufacturing this particular product, a large number of the units in course of construction being destined for Poland, Spain and the Colonies.

In one of the yards an example of h.t. pole type switchgear had been erected, this being a 11,000 volt air-break three-pole switch fuse of special design allowing for the replacement of the fuses from the ground in a few seconds. The fact that a fuse has blown can be seen at a glance when the spring in the glass container, instead of being extended from end to end, has fallen to the bottom of the container. This is quite one of the latest developments in protective gear for overhead supply at a minimum cost.

A unique and recent development in h.t. fused type circuit breakers was demonstrated in the switchgear department where this unit, known as the "T.A.P." was the centre of an interested group. Its mistake-proof operation, ingenious design and wide applicability to both indoor and outdoor services, with the advantage of unit construction for ring main and transformer equipments were keenly appreciated. In this department, also, the large number of 11,000 volt truck type cubicles and kiosks, a number of which were for mine surface installations, were much admired and are favoured by mining electrical engineers.

Finally, the visitors were shewn the Diesel engine power station at the works which enjoys among Diesel users the distinction of having the lowest generating costs of any in the country. The valuable reports by the Diesel Engine Users Association give the figures which shew that the Crompton plant for the year 1928-29 gave the total engine costs per unit generated—the output being nearly 2,000,000 units—of only 0.377d. The Crompton-Parkinson dynamos are also famous among Diesel engine users for their extraordinarily low maintenance costs. In the ordinary course these engines supply all the power required on the works but there are arrangements for switching over to the public supply in case of need.

After the completion of the inspection of the Crompton Parkinson works, the party were entertained at luncheon as the guests of Messrs. Crompton Parkinson Ltd. and the Hoffmann Manufacturing Co., Ltd.

Col. HARDY (Crompton Parkinson Ltd.) presided and offered a cordial welcome to the visitors on behalf of the three works visited in the town. The works of Crompton Parkinson, he said, in addition to being one of the largest was also one of historic interest for they had been started by Col. Crompton more than 50 years ago and the firm had been one of the pioneers in electrical engineering. He had been rather shocked, he said, when he heard that ladies were to accompany the party round the works, because it was a rule that on no account should ladies go round the works, for it had been estimated that when ladies went round it cost the firm £25 in the time lost by the workmen stopping to look at them !

Mr. T. W. COOPER (Hoffmann Manufacturing Co. Ltd.), who also welcomed the visitors, said that whilst the history of his firm in Chelmsford could not go back so far as that of Crompton Parkinson, he could claim that the Hoffmann Company were pioneers in their own particular business. He thought he might say that in the Hoffmann works they would see something unique because the manufacture of bearings was a highly specialised business and it was not very often that people were allowed to go over the works. They were going to break that rule on the present occasion, however, although he was afraid in the time available it would not be possible to see everything because the works covered 14½ acres and there was only about an hour or so available. However, he sincerely hoped they would all be interested in what they would see.

Captain WALTON-BROWN (Retiring President of the Association), in expressing the thanks of the visitors to the three firms in Chelmsford for affording facilities to see their works and also for entertaining them, said it was particularly pleasing for those who were constantly engaged in coal mining areas to come to a place like Chelmsford where works were situated in such delightful surroundings. In making the journey by road to Chelmsford, the thought had occurred to him that if he could only bring his colliery to a place like Brentwood, which was passed on the way down, all his troubles would be at an end. Col. Hardy had referred to the effect of allowing ladies to visit the works. When he, Capt. Walton-Brown, was in America some time ago he remembered what were known as the Hoffmann girls on the stage and he believed they were very attractive. He understood that there were a large number of girls employed at the Hoffmann works and he could only hope that the attention of the male portion of the party would not be too much distracted by the Hoffmann girls of Chelmsford !

Mr. J. W. GIBSON (President-elect of the Association), supported Capt. Walton-Brown in thanking the three Chelmsford firms for the arrangements that had been made for the visit. They might, he said, be inclined to regard Chelmsford as a market town principally devoted to agriculture, but it was now really something very different for it was the home of three pioneers in industry. They had seen something during the morning of the great achievements of the Crompton Parkinson concern during a period of 50 years, and he recalled tests that had been put forward 30 years ago in examination papers involving the use of the Crompton potentiometer and the struggles he had had with calculations by the late Dr. Gisbert Kapp on transformer design. Then they were to see the works of the Hoffmann Co. and the Marconi Co., in connection with the products of both of which there had been remarkable developments in recent years. Only three weeks ago he had a quarter of an hour's warning to stand by for a telephone conversation with Detroit and the voice from the other end was as clear as if it had been in the next room. As regards bearings, he had had some experience. There was nothing so disturbing in an engine as a hot bearing which finally seized. A few weeks ago he was in a large power house in the Midlands when a 6 inch plain bearing seized. The man who was sent for to put it right said: "Why don't they use ball bearings ?" and most engineers would endorse that opinion. For that reason, therefore, he hoped they would see something of Messrs. Hoffmann's works which would help them out of such troubles

The party then proceeded to the works of Messrs. Hoffmann.

THE HOFFMANN MANUFACTURING Co. Ltd.

Notwithstanding the highly specialised character of the manufacture of ball and roller bearings, the utmost freedom was accorded the visitors in these works and it is correct to say that many matters, especially in relation to the grinding of balls and ball races, were shewn and explained to them which are rarely made available to outsiders. At the present time there are employed between 3000 and 4000 workpeople, and whilst orders for the smaller sizes of bearings may have fallen off a little, the demand for larger bearings is such that night shifts are being worked in certain sections of the works.

The extraordinarily wide range for the application of ball and roller bearings is manifest to all engineers and therefore it is only possible to discuss what was seen at these works in general terms without specific reference to mining machinery. Over a quarter of a century ago there were produced at the Hoffmann works at Chelmsford the first steel balls guaranteed to be within one ten-thousandth part of an inch of standard for both sphericity and size. This claim was at first received with incredulity but the truth of the achievement was soon borne in upon engineers. The effect was immediately apparent. Before this, ball bearings had been but partially successful, suitable only for low speeds and light loads, but the production of a really accurate ball widened the field tremendously.

The attention thus directed to ball bearing design soon spread to roller bearings. At the Hoffmann works they use British materials only. The races are made of steel specially manufactured at Sheffield; no expense is spared in the preparation of this material and every bar is carefully tested in the firm's up-to-date metallurgical department. The larger sizes are made from a low carbon steel carburised and hardened by the firm's own special process. Whilst this method is more costly it is claimed to provide bearings which are unrivalled for heavy work. The smaller sizes of bearings are made from a chrome carbon steel of an exceptionally high grade. Hoffmann steel balls and rollers are also made from chrome carbon steel manufactured to a special specification.

The heat treatment is of prime importance and special attention has been paid to the character of the equipment and methods of operation. The furnaces are gas-fired and by means of a system of central control—developed by the firm's own technical staff—complete uniformity of heat treatment is ensured. Connected to each furnace are three electric lamps; red, white, and green. For the correct temperature the white light glows; if the temperature is too high the red light glows whilst if the temperature is too low the green light glows. Thus the operator is given an indication immediately the temperature rises or falls. In the meantime, attached to the furnaces is the temperature recording room where a staff is employed continuously recording the actual temperatures so that in the event of any trouble manifesting itself in the product, a reference to the temperature records gives an indication of whether the temperature was the cause. Gas for the furnaces is made in the firm's own producer gas plant which is capable of gasifying 60 tons of coal every 24 hours.

The main race grinding department is the largest shop in the country devoted to precision grinding and an enormous expenditure has been incurred in special machines for this purpose. The steel balls and rollers are produced in separate shops in another part of the works. The main grinding department has an area of 63,000 sq. ft. In this connection may be mentioned the single row self-aligning bearing. The provision for self-aligning is obtained without in any way interfering with the ball or roller tracks and thus without sacrificing the load carrying capacity of the bearings. The periphery of the outer race of these bearings is ground to a spherical form and, together with the two end covers, is carried in a spherical seating provided in the housing. These end covers must necessarily follow the bearing in its movements within the spherical seating, and thus maintain at all times their correct relation to the revolving shaft. They therefore cannot bind on the shaft and cause friction and heat, or gape open and admit dust and dirt.

Some of the grinding machines are highly ingenious and much of the plant used has been specially designed and made in the works. The whole of the tools and gauges are made in the tool and gauge department and the most casual inspection of the works impresses the visitor with the meticulous attention paid to the very fine limits to which these bearings are made.

Special machines are used for cutting the steel rods and, in the case of balls, giving them a rough sphericity before the various grinding operations or, in the case of rollers, giving them their rough shape before grinding. These machines work automatically and one operator is able to watch a number of them. Special lapping machines give the high accuracy and fine finish associated with these balls. There is a special machine and tool repair shop. As in the case of the Crompton Parkinson works, electric power is generated on the premises and some exhaust steam boilers are used.

MARCONI'S WIRELESS TELEGRAPH CO.

The party then walked over to the works of Marconi's Wireless Telegraph Company, where a great deal of interest was seen, although not of direct mining application. Being fitted up in the yards were a number of Morris commercial vans, their equipment consisting of apparatus for long and short wave work for the Egyptian Government. A beacon wireless set for automatic operation in dangerous coast positions was a two-valve apparatus all duplicated so that if for any reason one portion went out of action the other was automatically switched on and at the same time an audible signal was given of the fact. An instance of the size to which wireless apparatus for commercial purposes has attained was a ground station for an aerodrome in Greece, the whole outfit in point of actual size approximating to that of a power station switchboard. Here again, although in a different form from that seen at Messrs. Hoffmann's works, the visitors were shewn manufacturing methods of the highest precision.

THE TILMANSTONE COLLIERY.

On Thursday, June 26th, the members and visitors travelled by motor coaches to East Kent, through Canterbury, and inspected the surface plant at the Tilmanstone Colliery, including the recently constructed aerial ropeway which conveys coal from the colliery to Dover Harbour. They also went on to Dover to view the terminal point of the ropeway and the storage bunkers and plant installed for the loading of ships. They were entertained to luncheon and tea at Canterbury, as the guests of the London Branch and the recently-formed Kent Sub-Branch.

All the haulages and pumps at Tilmanstone are worked electrically, and there is some very modern plant. The visitors first inspected the boiler plant, which consists partly of boilers with underfeed stokers, and partly of pulverised fuel fired boilers, the evaporative capacity of the latter being 50,000 lbs. per hour. The generating station is already a large one and it is undergoing extension. The present plant includes two Westinghouse turbines, each working at 190 lbs. per sq. in. 180 deg. superheat, at 3000 r.p.m., with Leblanc type rotary air and water extraction pumps; two Westinghouse alternators, each 1000 k.w., 3300 volts, three-phase, 50 cycles, with induction type reverse current relay protection. The second generator is a turbine by Messrs. Fraser & Chalmers, working at 190 lbs. per sq. in., 180 deg. superheat, at 3000 r.p.m., with Edwards' type combined air and water extraction pump; and a Siemens alternator, 3000 k.w., 3300 volts, three-phase, 50 cycles, with induction type reverse current relay protection.

The medium pressure power is supplied through transformers: the plant in the transformer house includes a bank of three 183⅓ k.v.a. self-cooled transformers, the ratio being 3300/440 volts.

There are three shafts at the colliery. The first (through which coal is being raised) has a depth of 1560 ft. The second is 1620 ft. deep, and the third, which has been sunk to a depth of 3060 ft., is said to be the deepest in the country. The two latter shafts are being used to ventilate the mine.

To guard against the raising of an excessive amount of dirt in the coal—the men are paid on the tonnage basis—there is an electrically-driven dirt-checking plant, on which the contents of some of the tubs are dealt with. A scraper elevator and rotating screen are driven by a 5 h.p., 440 volt, 720 r.p.m., S.C. motor, and there is a reversible picking belt, with slow forward and quick return motion, driven by a 3 h.p. motor. The coal examined is conveyed by means of the elevator to a screen; the material which passes the screen goes on to a slowly-moving belt, from which the remaining dirt is picked. and the belt then returns at increased speed with the clean coal.

A new briquetting plant was operated for the enlightenment of the visitors. The coal used is pulverised in electrically-driven mills and conveyed through pipes to a chamber in which it is mixed with warm pitch, the mixture then being conveyed through a trough, (in which there is a revolving paddle) to the briquetting plant. From the trough it is delivered on to the top of a pair of rollers, on the surface of which there are indentations or dies, each indentation representing half a briquette. As the rollers revolve inwards the mixture fills the indentations, which are synchronised on each roller, and the completed briquettes are delivered beneath the rollers, whence they are conveyed to store by means of an endless conveyor. The storage arrangements are not yet completed. The briquettes contain about 6½ per cent. of pitch.

After viewing the tipping of the tubs of coal, and the passing of the coal over a screen on to a belt for hand-picking, the visitors inspected the ventilating plant. The main ventilating fan has a maximum capacity of 400,000 cubic feet per minute. It is belt-driven through centrifugal clutches by a 150 h.p., 3300 volt, 960 r.p.m. squirrel cage motor; as an alternate drive there is a 50 h.p., 3300 volt, 480 r.p.m., S.C. motor. Auto transformer starters are provided.

The compressing plant includes a twin-cylinder steam-driven two-stage air compressor, with intercooler, delivering 599 c. ft. per minute at 100 lbs. per sq. in. pressure. There are also two multi-cylinder single-stage air compressors, each delivering 500 c. ft. of air per minute at 100 lbs. per sq. in. pressure, and they are direct driven by a 160 h.p., 3300 volt, three-phase motor, running at 245 r.p.m.

A great deal of attention was paid to the aerial ropeway, powers for the erection of which were granted by the Railway Canal Commission, under the provisions of the Mines (Working Facilities and Support) Act, after a somewhat lengthy enquiry in 1927. The scheme was promoted by the late Mr. Tilden Smith (who was the principal shareholder in the Tilmanstone Colliery Company); the Company's application for powers to erect the ropeway was opposed by the Southern Railway Company and other owners of property in the district. It is too early yet to give results of the costs of operation, but the estimated costs of the transport of coal to Dover by this means are considerably less than half the price previously paid for carriage by railway, and there is an added advantage in the fact that the Colliery Company now has the carriage of the coal from pit to port in its own hands, and is better able to control output.

The length of the ropeway from the pit to the bunkers at the end of the eastern breakwater at Dover Harbour is 7¼ miles. There is a divide station at a point approximately half way along the route, from which both sections are driven. The ropeway traverses a tunnel at the edge of the cliffs, and emerges opposite the shore end of the breakwater. It is supported by 177 trestles, the average height of which is about 30 ft. there being a net minimum clearance beneath the buckets of 12 ft. at any point along the line, except where the ropes are brought down to the entrances or exits of stations. The trestles are mounted with single, pair, or four wheels fitted into compensating balance beams for supporting the rope, which is 4 ins. in circumference and has an actual breaking strain of 58 tons. The crossings of roads and railways are protected by girder type lattice bridges.

The ropeway is designed to carry 120 tons of coal per hour, and the coal buckets traverse the full length of ropeway in approximately 110 minutes. Each bucket carries a net load of 14¼ cwts. The carrier heads are of the standard "Roe" type, saddle clips being used to effect the grip on the rope; the carrier heads are also fitted with auxiliary wheels, which engage with shunt rails at the stations and lift the buckets from the rope.

The loading bunkers at the pit are of 1000 tons capacity, and are served by conveyor belts from the screening plant.

The A.M.E.E. at Tilmanstone Colliery.

At the divide station each section of the ropeway can be operated independently or the two can be operated together, the driving gears being coupled to one countershaft through a double clutch. Tension gears are also provided for tensioning the ropes.

At the end of the breakwater at Dover there is an unloading and return terminal station built directly over the bunkers, and the buckets are tipped automatically at any point over the bunkers. The rope goes round a terminal wheel; the empty buckets are passed round a shunt rail with which the wheels on the carrier heads engage automatically, and the saddle clip engages with the rope on the return side.

The bunkers on the breakwater are 250 ft. long and have a capacity for 5000 tons, but they are so designed that their present length and capacity can be doubled if necessary. The coal is discharged from the bunkers through a series of outlets, 2 ft. square, to which slide valves are fitted, these being operated by a rack and pinion device attached to the hopper of a travelling feeder.

The coal delivered by the feeder is dealt with by a series of conveyors and is loaded into ships by means of a travelling tower. The tower, which is a steel structure carried on a set of bogies travelling on a single rail on the edge of the quay, is provided with a loading-out belt, hinged at its inner end and supported at the outer end by steel wire ropes from the hoisting winch at the top of the main structure. The conveyor is carried in a totally enclosed boom provided with a telescopic chute into which the coal is delivered. This chute acts as an anti-breakage device, and is controlled by a special winch and a latticed steel jib attached to the same centre as the conveyor boom. The bunkers are of reinforced concrete construction.

The plant at the terminal point is worked by two men, one being in charge of the conveyors and the travelling feeder, the other being stationed in the cabin on the travelling tower from which he can control all movements of the plant during the coaling of a steamer. Ships can be loaded by this plant at the rate of 500 tons per hour.

Capt. S. WALTON-BROWN (President of the Association for the year 1929-30) at the colliery expressed the visitors' thanks to the Directors of the Tilmanstone Colliery Co. Ltd., for having provided facilities for the inspection of the colliery plant, and to the members of the staff who had conducted them around. On behalf of the coal industry as a whole he paid a tribute to the Company for the fight it had made to secure powers to erect the aerial ropeway, though opposed by extremely powerful vested interests. It was a matter for congratulation not only that it had had the ropeway constructed, but also that it had secured the powers to erect it, for in so doing it had blazed a trail.

The visitors could see for themselves the difficulties which the Company had to meet, and he hoped that the Company would meet them successfully. Capt. Walton-Brown also sympathised with the Company in respect of the loss of the great rousing force of the late Mr. Tilden Smith, but he had no doubt that the Company was still served by men who would carry on his great work.

THE METROPOLITAN ELECTRIC CABLE AND CONSTRUCTION Co., Ltd.

On Friday morning, June 27th, many of the members were the guests of the Metropolitan Electric Cable and Construction Co. Ltd., which has a very modern works at Chadwell Heath, Essex, and to which a large extension has recently been added, containing examples of the most up-to-date cable machinery of all types. The Company makes paper-insulated cables for working pressures up to 33000 volts, and the visitors were able to see the processes of manufacture of the many types of power and lighting cables required for use in collieries. They inspected the preparation of the rubber, the making and insulating of the cables, the oil impregnation, lead sheathing, the vulcanising of completed rubber-covered cables, etc., and finally witnessed some tests to breakdown limits.

The manufacture of cables is one which lends itself to a very great extent to mechanisation, and there are at the works long lengths of machinery in which cables are made from the copper wire and paper-wrapped as a continuous operation.

Among the specialities which attracted considerable attention at these works was the "Rubite" mining cable, the armouring of which is guaranteed not to bird-cage. This is being used in a large number of collieries in this country, and it is claimed that it can be run at a higher current density than the original bitumen without decentralisation; that the insulating compound will not deteriorate owing to heat, acids, alkali, etc.; and that the breakdown pressure is considerably higher than on a bitumen cable.

Another interesting product of these works is the "Froid" earth-screened C.T.S. trailing cable, which is so designed that it is impossible for a pick or any other sharp instrument to be driven into the power core without first coming into efficient contact with the earth screening, thus making the cable absolutely safe. Furthermore, owing to the special construction of the cable, in the event of the earth screening being broken in a length of the cable it does not affect the utility of the earth screening on the cable. A further important feature of this cable is that efficient repairs may be made at a very low cost.

The visitors were entertained to luncheon by the Company at the works after their inspection.

Capt. S. WALTON-BROWN expressed the hearty thanks of the visitors to the Company for having opened the works to their inspection, for having provided an excellent luncheon, and for having provided motor coaches to convey the visitors from London. On behalf of the ladies also he thanked the Company for having given them the opportunity for a most enjoyable drive through Epping Forest whilst the men-folk were inspecting the works.

Commenting upon the plant, which was extremely up-to-date—particularly that installed in the new extension—Captain Walton-Brown added, jocularly, that when one saw how apparently simple the manufacture of cables had become, and how small was the percentage of labour employed, one wondered why cables were not cheaper than they are. No blame could be attached to the Metropolitan Cable Co. in this respect, however, because it had shown a delightful spirit of enterprise and was to be congratulated on the results of its efforts and the progress it was making. During recent years he had himself used the products of this Company. One could not, of course, express a definite opinion on every type of cable after only a short experience of its use, but within quite a short time one could get some idea of the efficiency of trailing cables, and he had found this Company's trailing cables to be exceedingly good.

Photos. by Mr. Theodore Stretton, Past President.

1 and 2, *Arrival at Tilmanstone Colliery*; 3, *Canterbury Cathedral*; 5, *Capt. Walton-Brown acknowledges the hospitality of the Tilmanstone officials*; 6 and 7, *Dover Pier*; 8, *the Aerial Ropeway*; 9, *Briquette Delivery.*

Captain Walton-Brown, in the course of his speech, also expressed indebtedness to Mr. William Brown (the Managing Director of the Company) and other officials who had been indefatigable in explaining the various processes to the visitors, and in answering their many questions. The visit, he said, had been most enjoyable and instructive.

Mr. WILLIAM BROWN (Managing Director), responding, assured the visitors that it had been a privilege to conduct them round the works, and he expressed his indebtedness to them for the interest they had shewn in the various products. Further, he acknowledged that mining engineers were critical, and that the Company had the opportunity of learning a great deal as the result of their visits. Sometimes he felt that if only he could get the mining engineers to visit the works and say what their difficulties were, then he and his colleagues could gain information which would help them to improve the Company's products, to the benefit of themselves, as producers, and of the users.

EVERSHED & VIGNOLES, Ltd.

Another of the works visited by the members of the Association was that of Messrs. Evershed & Vignoles, Ltd., at Acton, in the west of London—on Friday, June 27th. At these works there is produced a wide range of instruments, covering resistance testing instruments, the "Megger" and its family, recording instruments, ordinary ammeters and voltmeters, a water purity meter, the Midworth distant repeater, and various kinds of marine instruments.

One of the features upon which some of the visitors commented was the pleasant situation of the works, which is enhanced by their well-kept garden, and the evidence they provided of the care which has been taken, particularly in the new buildings, to provide the maximum of light and to ensure pleasant conditions generally for the employees—of whom there are about 700. The works were started in about 1904, and buildings have been added from time to time as the business increased, so that at present they cover a fairly wide area. In works which have developed gradually in this way it is not so easy to provide the best conditions as it is when starting *de novo*; nevertheless, the firm is to be commended upon its efforts in this direction, and the workers' appreciation is reflected in the fact that a large proportion of them have served the firm continuously for many years. A new wing was added as recently as last year, and the works are among the largest engaged in the manufacture of electrical instruments in Great Britain. There is a general impression of "roominess" throughout the whole works.

Necessarily, in the making of anything so delicate as electrical instruments, extreme care must be exercised in all stages of manufacture, and there are elaborate arrangements in the various shops for testing. It is the policy of the firm to produce its best in all types of instruments, and in furtherance of this policy it produces only one grade. As an example of the severity of the tests it might be mentioned that the armatures used in the "Meg" insulation tester—which is a 500 volt instrument—are tested up to 4000 volts in the various stages of manufacture, and visitors to the works are free to test any one of them, chosen at random, up to 6000 volts, which they will usually stand. These armatures are tested several times before leaving the works, as, for instance, during winding, during assembly, and when finished.

Many of the machines and instruments used for making and for testing the various products have been designed by the staff and, a good many of the accessories which at one time were bought outside are now being made on the premises, so that the firm can control its production to an increasing extent. The coil-winding machines were made at the works. Among the accessories which are made at the works are the mouldings and even the springs used in the construction of the various instruments. There is no foundry there, so that castings have to be obtained from outside. Electric power is generated at the works by means of crude-oil engines, so that presumably the firm finds it at least as cheap to generate as to buy from the local supply authority.

The visitors were conducted through the various shops, and during their tour of the machine shop they were able to appreciate the fine limits to which the work is carried out, the actual turning being carried out to an accuracy of half a "thou." A feature which strikes the eye in the grinding shop is the very large exhaust installation for carrying away fumes and dust.

The room in which the coil-winding is carried out is one of the most modern, and is almost entirely surrounded by windows. The motors used were at one time above the benches, and controlled by hand, but they have now been installed below, and are controlled by pedals, thus leaving the workers' hands free; further, there is no obstruction of the light.

Among the many ingenious devices which have been designed by the staff there is a machine which prints in three colours the rolls used in the recording instruments. Also there is an a.c. Bridge for detecting shorted turns in armatures, and a machine for testing defects in the enamelling of fine insulated wire. All enamelled wire is tested in this machine, which gives a continuous record and indicates by a deflection of a recording pen on a chart the position of any break in the enamelling. A machine for marking the graduations for various instruments has also been designed and built at the works, the graduations being marked on a matt white surface produced on a zinc dial by a special process. They reproduce faithfully the calibration for each particular instrument.

The Midworth Distant Repeater.

Among the instruments made by Eveshed & Vignoles, and which are of particular interest to mining engineers, mention might be made of the Midworth distant repeater —an electrical system designed both to transmit information to a distance, and to control distant appliances. The system may be used to repeat at a distance the angular movements of electrical and other instruments; to show at a distance the direction and amount of motion of any mechanism, such as lock gates and hydraulic valves; and to select from one of several distant indications, or to control the actual operation of distant mechanism of any kind. The system is fully automatic. It is not affected by variations in voltage or resistance; in the event of a break in the circuit it will close down, and will resume normal working immediately the break is repaired.

The apparatus employed in the system includes a transmitter and one or more receivers—the latter being indicators, recorders, or apparatus used for selective switching or other control work at the distant station. The transmitter contains an originating movement, giving the indication or movement which it is desired to repeat, associated with a control movement which translates the quantitative information to be transmitted into variations of an electrical current in a series repeater circuit which includes the receivers. The transmitter maintains this current at a constant value for every indication to be transmitted, whatever the variations in the voltage applied to the circuit or in its resistance.

The distant receivers are suitably designed moving-coil milliammeters scaled in terms of the information to be transmitted. The transmitter is made up of two parts—the control unit and the motor unit—either combined or supplied separately, as desired. There are two types of receiver supplied, viz., the simple indicating and recording instruments, and power-driven instruments.

The possible applications of the system are numerous and varied, and may be combined in many different ways, but the more important uses are indication, summation, selection, and control. As shewing its scope, it is worthy of note that schemes are in operation, or are being prepared, in which the system is applied to the automatic control of steam pressure between high and low pressure turbines, the indication of the quantity of gas in holders with alarms for maxima and minima, the indication of tap positions on outdoor transformers on the South East England Grid Scheme, and the indication of the input and output of 15 power stations at a central control office in connection with the Central Scotland Grid Scheme.

The Megger Earth Tester.

Another interesting instrument is the "Megger" earth tester, for measuring the resistance of earth contacts. It gives readings of the resistance to earth directly in ohms without calculation or adjustment, which readings are not affected by soil electrolysis or vagabond currents, and it is self-contained and readily portable. The instrument is a combined ohmmeter and generator of specialised type, so designed that alternating current is supplied to the soil section of the testing circuit to overcome difficulties due to electrolysis and back E.M.F., and direct current to the measuring part of the testing circuit to allow the use of the direct reading moving-coil ohmmeter with its large working forces and uniformly divided scale.

The Bridge-Meg Resistance Tester.

The Company has spent some years on the development of a combined Wheatstone Bridge and insulation measuring instrument which should be compact, light, and cheap, and as a result has placed on the market the Bridge-Meg Resistance Tester, in self-contained form. The instrument is a combined ohmmeter and generator of the "Meg" type, built into one case with a set of adjustable resistances. By the turn of a single switch the instrument serves either for measuring high resistances—testing insulation—or for the determination of conductor resistances by the Wheatstone Bridge method. It has a continuous range of readings from 100 megohms down to 0.01 ohm. The "Meg" range is 100 megohms to 10,000 ohms; the "Bridge" range is 999,900 ohms down to 0.01 ohm. A 500 volt constant-pressure generator is employed.

Four separately assembled elements are contained in a rectangular case of aluminium alloy, having a lid and base of moulded bakelite. These elements are a generator, an ohmmeter, a rheostat (or set of adjustable resistances), a "Bridge-Meg" change-over switch for changing from insulation to conductor measurements, and a ratio switch for use on the "Bridge" setting. A system of guarded circuits is employed, and by this means errors due to leakage over the surfaces of the instrument, which might otherwise arise when it is used in damp or dusty surroundings, are eliminated. On the "Meg" setting direct readings are given on a dial, and on the "Bridge" setting the results are in plain figures. The total weight of the instrument is 12¾ lbs.

The Main Entrance to the Brighton Works of Allen West & Co., Ltd.

ALLEN WEST & Co. Ltd.

The final visit of those attending the convention was made on Saturday June 28th, when a party of nearly 100 went to Brighton and inspected the works of Messrs. Allen West & Co. Ltd. This firm now has three works, viz., the original works in the Lewes Road which were opened in 1910, what is known as the South Factory, close by, which was opened in 1926, and a new factory at Woolston, Southampton, which was acquired this year and is gradually being brought into working order. Messrs. Allen West & Company was established twenty years ago for the sole purpose of manufacturing gear for starting and controlling electric motors. The design of electric controllers for industrial purposes was then in its infancy and control gear in general was designed more with a view to electrical than mechanical requirements with the result that frequent mechanical troubles were experienced on the progressively severe duties for which controllers were required. It was the need for sound mechanical design at that period which gave the firm its opportunity of introducing to the market electrical control gear of a type more robust mechanically than anything then available, and the appreciation of this fact was general during the visit on the present occasion. Even representatives of other electrical manufacturing firms who were among the party could not refrain from admiration of this feature of the apparatus they saw.

The success which followed the manufacture of heavy service drum controllers on these line exceeded all expectations and large orders were received from steel works all over Europe, almost the first important contract being for the complete live roll and crane control equipment of one of the largest German steel works. This was followed by the standardisation in 1911 by the British Admiralty of the firm's hinged controller finger, which remains the British Admiralty standard to-day.

The two works at Brighton have a total floor space of 200,000 sq. ft., and here is to remain the headquarters of the Company. The bulkier and heavier products will be manufactured at the recently acquired works at Woolston which have a floor space of 400,000 sq. ft. It is a remarkable fact that 80 per cent. of the output of the Company is sold on the Continent and overseas, and the measure of the success of the firm is shewn by the increase of the floor space in the Brighton works from 2500 sq. ft. and 12 machine tools in 1910 to 200,000 sq. ft. and more than 750 machine tools at the present time. Gradually all manufacture of heavy switchgear, liquid controllers and overhead line equipment will be transferred to Southampton.

It was due to the failure of the praiseworthy attempt to establish the diamond cutting industry in this country to provide employment for men disabled in the War that the firm was able to acquire the South or Coombe Road factory. One striking feature of this factory is the wonderful natural lighting, which was arranged so that every worker should have the maximum amount of daylight for his work of diamond cutting, and this has proved invaluable for the purpose to which the premises are now put. All five floors are now in full operation. The employees in Brighton number about 2000, and it was noticeable there was a much smaller proportion of female labour than in some of the other works that were visited. At the moment at Southampton there are only about 100 men engaged owing to the fact that they are only just commencing there.

A feature of the two Brighton works is that each floor is self-contained in every respect and the value placed upon adequate and efficient research and testing is seen in the employment of 100 engineers, chemists and assistants in this work and the allocation of 15,000 sq. ft. of floor space to it. It says much for the enterprise of the management that when three years ago a fire occurred in one of the test rooms and destroyed over £30,000 worth of meters, instruments and testing and experimental plant the department was in working order again within three weeks.

In the two factories there are ten machine shops each having an average of 75 machine tools. Of these shops, two are general machine shops and the remainder specialised ones for each separate department. The importance of the lavish use of repetition tools and jigs has been fully appreciated and machining costs have been reduced to a minimum in this way and by the lay-out of the machine shops. Indeed, it is remarkable and a tribute to quality, that the firm is able to sell their products both at home and on the Continent and elsewhere at higher prices than similar competing goods, it being recognised by buyers nowadays that for this class of equipment robust mechanical construction together, of course, with the necessary electrical efficiency, is worth paying for.

In the tour round the works, the visitors were shewn the processes of manufacture of the Reason Manufacturing Co.'s electrolytic meter—which concern has been absorbed by Allen West & Co.—and, just as at the works of Crompton, Parkinson Ltd., a few days previously, there were seen surprisingly large numbers of direct current motors in course of manufacture, so here were noticed a large number of d.c. meters going through the works. All the glass blowing and annealing in connection with these meters is carried out at the South works. The increasing use of automatic time switches was also made manifest in the number that were being made.

Special interest was shewn in a switchboard being supplied for the new Empress type of vessel that is being constructed for the Canadian Pacific Steamship Co., this being arranged for mass control of all ventilating fans at the switchboard or local control at each ventilating fan. Other apparatus seen were flame-proof controllers, electromagnetic brakes and various forms of starters for marine work. On the high tension switchgear floor were some extremely ingenious and interesting apparatus. There was a 20,000 volt two-phase switch destined for use on the 20,000 volt distribution around Paris and switches for use on the on-load tap changers on the Grid, whilst some large and extremely robust switchgear for Sweden and Holland were specially admired.

Allen West & Co. Ltd. have invested large sums in subsidiary companies the turn-over of which amounts to several hundreds of thousands sterling per annum. The firm's French Company is the Société d'Usinage de Matériel Electrique, and this has been successful in obtaining large contracts from nearly all the important steel works and collieries in France, Belgium and Luxemburg in recent years. The French Government has standarised the firm's control gear throughout the Potasse Mines in Alsace Lorraine, this contract alone involving the use of over 500 flame-proof controllers per annum.

The French Company has a well equipped factory and warehouse at Boulogne-sur-Seine, Paris, this being used for assembly work and for making flame-proof cases for controllers sent from the Brighton works. Another associated company is Electric Control Ltd. which specialises in high tension overhead line equipment whilst Allen West (South Africa) Ltd. has been successful in securing a considerable turn-over in mining and industrial controllers throughout South Africa.

One of the Brighton works was inspected before luncheon and the other during the afternoon, a full day being spent in this way despite the attraction of a specially fine day in a seaside resort such as Brighton.

Luncheon.

Mr. ALLEN WEST presided at the luncheon given by the firm at the Hotel Metropole.

Mr. J. W. GIBSON, (President of the Association) in proposing a hearty vote of thanks to Mr. Allen West and his firm for their splendid hospitality and the facilities afforded for inspecting their works, said that when Mr. Allen West invited the members of the Association and others to spend a few hours in Brighton, he did not know he was inviting a 21st birthday party. In looking round the works so far he had been impressed not only by the splendid finish of the apparatus being made and the amount of work in hand but by the large proportion of work which was for export. It was very pleasing that a British firm could secure orders for abroad in the open market for high tension and medium tension switch work. In congratulating the firm on their progressive policy and the success attending their efforts, Mr. Gibson said a feature of the visit was that Mr. Allen West had actually invited some of his competitors to join the party. Mr. West frankly said there was nothing to hide and he therefore welcomed his competitors as well as his customers. He asked all those who were present to join him in heartily thanking Messrs. Allen West & Company for their great generosity and for the facilities that had been afforded the party.

Mr. ALLEN WEST, acknowledging the vote of thanks, said it had given as much pleasure to himself and the firm to see the visitors that day as it seemed to have given the visitors themselves. As to competitors having been invited, the firm had invited all those whom they thought would like to come because he had always found British firms were equally keen to shew others round their works. He had also found that to be so in America and on the Continent where certainly switchgear makers were only too glad to show their rivals round. For that reason he hoped that not only colliery engineers but others would take the opportunity of seeing as many works as possible. Mr. Allen West said it was rather an astonishing thing to him to find that it was far more easy to get a colliery engineer from abroad to visit his works than it was to get a colliery engineer in this country to do so. Perhaps that was because British colliery engineers were forced to work too hard and therefore they did not get the opportunity of getting away to see what was happening in works and other collieries either in this country or abroud. If they could do so, however, they would find they were helping not only themselves but also manufacturers. He hoped, therefore, that those who could would rub it into their colliery managers that their engineers should be allowed facilities for going round collieries and works as often as possible. In conclusion, Mr. West expressed his pleasure that so many had accepted the invitation to come to Brighton to see the firm's works.

Mr. J. R. COWIE (Hon. Secretary, London Branch) said it would be wrong, as this was the last public function in connection with the Convention, if he did not take the opportunity of proposing a cordial vote of thanks to all those who had been concerned with the arrangements for the various visits. In the first place, there was Mr. Allen West and the members of the committee of the London Branch who had organised the Brighton visit; the Metropolitan Cable Co. and Mr. Seymour, their Commercial Manager, for the hospitality afforded on the occasion of the visit to that firm's works on June 27, and to Messrs. Evershed & Vignoles and and Mr. Knowles for similar hospitality on the same day when a visit was paid to the Acton Lane works of that firm; Mr. A. R. Cooper (President) and Mr. C. C. H. Smith (Hon. Secretary of the Kent Sub-Branch) and the representative of the London Branch Committee on that sub-committee—Mr. Edger—for the arrangements in connection with the visit to Tilmanstone, and to Mr. Spencer who made the arrangements for the visit to Chelmsford.

THE ELECTRICAL APPARATUS Co. Ltd.

Although not included in the official programme of the Convention, several members formed a party to visit the St. Albans works of the Electrical Apparatus Co. Ltd., on the Friday afternoon, for the purpose of seeing the manufacture of drum type motor control gear and particularly the new range of mining type flame-proof, airbreak gear which the Company has lately evolved. The illustrations, Figs. 1 and 2 illustrate a typical motor control panel which is complete with an interlocked isolating switch, overload and no-current releases, and starter. The inclusion of the isolating switch means that the panel cannot possibly be made alive whilst a man is working on it. The protective features of this panel are of great interest as no shunt-wound no-volt coil is fitted, the series coils being arranged to give both the usual overload and also no-current protection, this latter arrangement making it impossible for the motor to run single phase.

A new form of haulage control equipment embodies an automatic circuit breaker for the control of the stator circuit together with main isolating switch. It completely eliminates the separate draw-out type oil switch com-

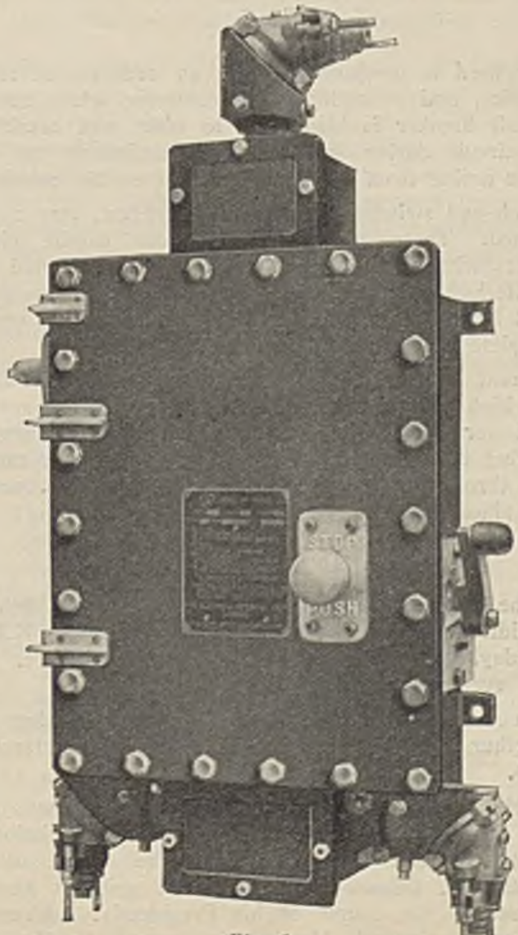


Fig. 1.

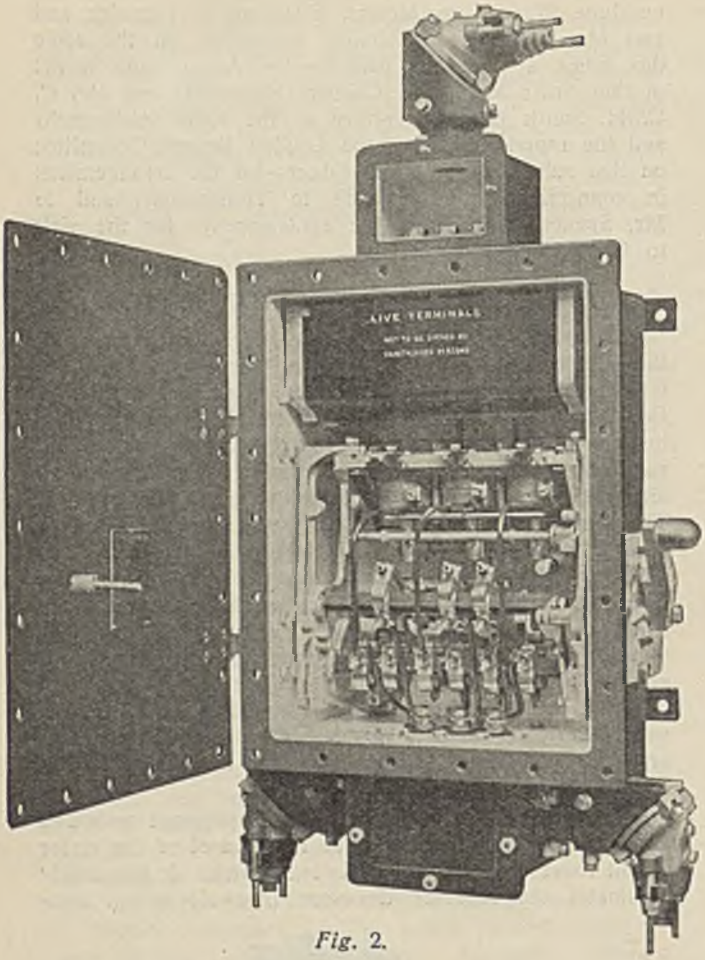


Fig. 2.

monly used in conjunction with an ordinary reversing controller, and in addition the contactor which acts as a circuit breaker is also used to make and break the main circuit during inching, thus eliminating the destructive arcing from the stator contacts on the controller.

Gate-end switches, being of first interest, were closely inspected. These are air-break, loose handle circuit breakers with B.S. plug and socket. It was noted that the interiors of these gate end switches are made up in unit form so that it is very easy to remove and replace a complete interior, should necessity arise.

Great interest was also exhibited in the firm's air-break high tension contactors. These contactors are designed for heavy duty and as their arrangement is such that the circuit is always broken when the current passes through the zero point, very little contact burning takes place.

The Annual Dinner and Dance.

The Annual Dinner of the Association was held at the Midland Grand Hotel, St. Pancras, London, N.W. 1, on Friday, June 27th, and was followed by a dance. The whole evening was most enjoyable.

One of the principal guests on this occasion was Sir Arthur Faulkner, C.B.E., (H.M. Under-Secretary for Mines).

THE PRESIDENT (Mr. J. W. Gibson), who was in the chair, proposed the toast of "The Association of Mining Electrical Engineers." In the course of his remarks, Mr. Gibson emphasised the opinions he had expressed in the course of his Presidential Address at which the Association had played in the dissemination of technical knowledge throughout the mining community, and congratulated the Association upon the position which it had acquired. He coupled with the toast the name of Sir Arthur Faulkner.

Sir ARTHUR FAULKNER, C.B.E., assured the members of the importance which the Government attached to the use of electricity in mines, as evidenced by the fact that it was about to increase the electrical staff of the Mines Department by 400 per cent. This appeared to be a very big increase, but, when it started with only one, the increase was not so very large. Whilst professing his incompetence to respond to the toast adequately, on the ground that he had not sufficient technical knowledge of electricity, Sir Arthur went on to preach a short sermon, as he himself described it, on the importance of ensuring safety in the use of electrical machinery in mines. He appreciated that the Association had devoted a very great deal of attention during the last few years to the problem of ensuring safety in the use of such machinery, but he urged that it should redouble its efforts in this direction.

A revival of the mining industry, said Sir Arthur, could only be effected by two reforms. The first was sales re-organisation, but in view of the prominence which had been given to this matter recently he did not on that occasion propose to discuss it at length. The second reform was in matters of production, so that costs of production could be reduced. The costs of production of coal could not be reduced much further by reductions of wages or of the ordinary costs of mining; if there were to be any really big saving in production costs, it must come from the introduction of machinery. He knew too much to be able to agree with those of the ordinary public who held that the mining industry was far behind in regard to the introduction of machinery; that view was wrong, but, at the same time, there was room for a very great deal more activity in this direction. To a layman such as himself it seemed so obvious that, if power had to be used at the coal face at distances up to 1½ miles or more from the shaft, simplicity of conveyance of that power must be aimed at.

Commenting on the objections of the workmen to the use of electricity in mines, Sir Arthur urged that those objections were not due to conservatism or any desire to be obstructive or awkward. There was a genuine fear in the minds of the men that the introduction of electrical machinery into the mines would make still more dangerous an already dangerous occupation, and if electrical machinery were to have full scope in the mines in the near future it must be made so safe that that fear would be overcome. Therefore, he urged, that the Association should devote every moment it could to the task of making mining electrical machinery not merely safe, but as nearly as possible foolproof.

Captain A. C. SPARKES, M.C. (President of the London Branch) proposed the toast of "The Visiting Branches", and coupled with it the name of Major E. Ivor David (the Senior Vice-President of the Association, and one of the representatives of the South Wales Branch). In extending, on behalf of the London Branch, a very warm welcome to the visitors, he said the Branch was indeed honoured by the presence of so many ladies, so many Past-Presidents of the Association and so many other gentlemen who were actually working in the collieries of the country, and was fully compensated for anything it had been able to do to entertain them. Whilst

Captain Sparkes said he had to acknowledge that the whole of the work had been done by Mr. J. R. Cowie, (the Hon. Secretary of the London Branch) and his very able staff (applause), and by the Branch Hon. Treasurer (Mr. John W. Wilkinson). Finally, he expressed the hope that the visitors had derived as much pleasure from their visit as the London Branch had derived from their presence.

Major E. IVOR DAVID, after voicing the pleasure it gave him to respond to the toast, so appropriately proposed by Capt. Sparkes, whose name was associated with the highest standard of mining electrical engineering. In acknowledging the splendid hospitality which the London Branch had extended to the visitors, he said there was a healthy rivalry between the various branches of the Association in this and other spheres of activity, which was a great aid to the development of the Association. At Newcastle, in 1929, it had appeared that the high-water mark had been reached in the matter of entertainment, and all who had attended last year's convention retained the happiest memories of it. It must be confessed, however, that the London Branch had made a very strenuous effort to equal, if not to surpass, the joys of the Newcastle Convention. The works visits and motor tours were excellently selected for variety and interest, and he knew that the London Branch would feel rewarded for its efforts—which must have been very great —by the assurance that the visitors had thoroughly enjoyed themselves. On behalf of the visiting branches he expressed to the London Branch, and particularly to the Committee which had organised the Convention the heartiest thanks and best wishes for the success of the Branch.

The friendly rivalry between the various branches of the Association extended not merely to the provision of entertainment, but also to their meetings, their papers, their membership, examination candidates, etc. The membership of the North of England Branch was gradually creeping up (as was fitting, inasmuch as the Association had its origin in that area), and the Branches in South Wales and Scotland would have to look to their laurels or they would be overhauled in respect of membership. He claimed that in areas where the membership of the Association of Mining Electrical Engineers was greatest the percentage of accidents in mines was least, and that claim would be supported by His Majesty's Chief Electrical Inspector of Mines (Mr. J. A. B. Horsley), who was present at the dinner.

The South Wales Branch was not only the strongest branch in the Association, but it had the largest membership of any branch of any national association; in that area, its membership was higher than the resident membership of the Institution of Electrical Engineers.

The standard of the meetings of the Association all over the country, and of the papers presented, was high; the younger members of the profession were encouraged to take part in the discussions, which were becoming increasingly lively and interesting, and there was not the slightest doubt that the papers were of the greatest value, not only to the mining industry, but to other industries also, such as the electrical machinery manufacturing industry. Their value was proved—if proof were necessary—by the fact that the paper for which most appropriately, the Association's Gold Medal had been awarded in the past session (the paper by the President, Mr. J. W. Gibson, on "Chimney Dust Problems") had achieved not merely national, but international, recognition The press in different parts of the world were asking for copies of it, and it was to be published in the American, the French, and the German press forthwith.

Major David said he might be permitted to recall that a paper which he himself presented to the Association's Convention in 1928, dealing with the measurement of reactances—and for which he too had been awarded the Association's Gold Medal—had been applied for from South Africa, Mesopotamia, India, South Australia, and America (one of the applicants being the American Bureau of Mines), which was another example of the Association's international reputation.

Furthermore, the Association's certificates were becoming recognised more and more as evidence of the competence of the holders—which was very necessary in such a technical profession as that of electrical engineering in mines. That recognition had been achieved in spite of a certain amount of veiled opposition.

Unfortunately there had been a slight fall in the membership of the Association during the past twelve months, but, as a member of eight organisations connected with electrical, mechanical, and mining engineering, Major David could reassure the Association that the fall in its membership had been considerably less than was the average of other organisations connected with the mining industry. Therefore, the Association could claim to be maintaining its position in the industry which was probably the most depressed of all the industries in the country at present. Great benefit was derived from attendance at the Branch meetings and Annual Conventions of the Association. He did not know where the next convention would be held, but wherever it might be he could promise that those who attended would have a very good time and would see many interesting things.

Dealing generally with the application of electricity to mining, Major David went on to say that the public had only a vague idea with regard to it. To illustrate the extent of the application of electricity to colliery working, however, he pointed out that the Powell Duffryn Company, with which he had been associated for many years, produced, distributed, and utilised more electricity and other power than the London Underground Railways undertaking used. Yet it was said that the coal industry was effete and inefficient! It could produce and distribute electricity cheaper than could any supply company in the country, and utilise it to more advantage.

There was also a general impression in many quarters that electricity should be used in every hole and corner of the mines—but Mr. Horsley (H.M. Chief Electrical Inspector of Mines) took care that that was not done. The standard of the mines equipment, both on the surface and underground, in this country, was superior to anything in the world. Major David had met Germans, Japanese, Chinese, Americans, Austrians, and Frenchmen, who had come to this country to see the plant installed at various collieries. Our best collieries were the best in the world, but our worst were the worst in the world; unfortunately, there was not a happy medium. It was stated frequently in the press that the coal industry needed reorganisation; that might be so, but he would urge the point that there were brains and ability in the industry for the carrying out of that reorganisation, and that the industry was quite capable and competent to reorganise itself if it were left alone, and if it were given the least bit of encouragement to do so.

COUNCIL MEETING.

A meeting of the Council was held on Friday, June 27th, at 2-30 p.m. There were present :—

Capt. S. Walton-Brown, President, in the Chair; Mr. F. Anslow, Past President, Publications Committee; Mr. A. B. Muirhead, Past President, Advisory Committee; Mr. D. Martin, Past President, Advisory Committee; Mr. T. Stretton, Past President, Advisory Committee; Mr. G. M. Harvey, Past President, Examinations Committee; Mr. W. T. Anderson, Past President, Certification Committee; Mr. G. Raw, Past President, Finance Committee; Mr. R. Holiday, Past President, Treasurer; Mr. J. W. Gibson, Vice-President, Examinations Committee; Major E. Ivor David, Vice-President; Mr. H. J. Fisher, Certification and Examinations Committees; Mr. T. H. Williams, Certification, Examinations, and Prizes Committees; Mr. J. A. B. Horsley, Examinations Committee; Mr. F. Beckett, Finance Committee; Mr. S. A. Simon, Papers Committee; Mr. G. Henderson, Papers Committee; Mr. W. Bolton Shaw, Papers Committee; Mr. A. C. MacWhirter, Papers Committee; Mr. J. R. Cowie, Prizes Committee; Mr. A. Dixon, Prizes Committee; Mr. Dawson Thomas, Prizes Committee; Mr. S. H. Morris, Publications Committee; Mr. J. Walker, Lothians Branch; Mr. J. Dinnen, West of Scotland; Mr. J. Howat, West of Scotland Branch; Mr. J. R. Laird, West of Scotland Branch; Mr. H. Smith, West of Scotland Branch; Mr. A. F. Stevenson, West of Scotland Branch; Mr. T. M. McGlashan, Ayrshire Branch; Mr. E. E. Shatford, North of England Branch; Mr. A. R. Hill, Cumberland Branch; Mr. C. C. Higgens, Yorkshire Branch; Mr. A. F. Bull, North Western Branch; Mr. F. E. Harris, North Western Branch; Mr. A. V. Heyes, North Western Branch; Mr. J. Whittaker, North Western Branch; Mr. E. R. Hudson, Midland Branch; Mr. H. J. Norton, South Wales Branch; Mr. A. C. Sparks, London Branch; Mr. J. W. Wilkinson, London Branch; Mr. C. St. C. Saunders, Secretary.

Letters of apology for absence were received from Messrs. A. Anderson, Past President; C. Augustus Carlow, Past President; W. M. Thornton, Past President; A. W. Williams, Advisory Committee; W. T. Mittell, Lothians Branch; and W. G. Gibb, West of Scotland Branch.

The Minutes of the Council Meeting held on February 22nd, 1930, having been distributed, were confirmed and signed by the Chairman.

Membership and Finances.

Reports were submitted with regard to the Membership of the Association at March 31st, 1930, Resignations, deletions, and transfers; the state of the General and Publication Accounts on that date, the Receipts and Disbursements, Branch Balances, and an analysis of the various increases and decreases of the Working Accounts and Balance Sheets of the General and Publication Accounts of the Association.

The Auditors' Reports were read to the Meeting, and the Annual Accounts of the General Fund and Publications Account were received and adopted.

Branch Reports.

The Quarterly Reports of the Branches were available, but not considered in detail. The Branches were reminded that it was in their interests to invest their Funds in the General Account, and this had already been adopted by two or three Branches.

"The Mining Electrical Engineer."

In the absence of Mr. R. Ainsworth, the Convener of the Committee, Mr. Anslow presented this report. The General Secretary was instructed to write a letter of sympathy to Mr. Ainsworth expressing the best wishes for his rapid and complete recovery.

Advisory Committee.

Mr. Muirhead reported with regard to the suggestions made by the South Wales Branch regarding Student Members; he stated that the Advisory Committee had given the matter very careful consideration, after having received from all the Branches relevant particulars, and the Committee was of the opinion that the time was not opportune for a change. The Committee was in sympathy with the suggestion of the South Wales Branch, and appreciated the importance of helping the Branches to enrol as large a number of Student Members as possible.

East of Scotland Development.

Mr. Muirhead reported that the Committee appointed to assist in developing the East of Scotland district had arranged a series of three propaganda meetings. One of these meetings was held at Cowdenbeath on May 2nd, 1930; it was proposed to hold a second meeting at Kirkcaldy in September, and a further one at Dunfermline. There had been a large attendance at Cowdenbeath; Mr. C. Carlow Reid (General Manager of the Fife Coal Co.) presided, and Mr. James Walker, of the Lothians Branch, delivered a most interesting lecture on electrical breakdowns and their repairs. Mr. Muirhead stated that there was every reason to hope that as the result of the meeting there would be a revival in the Cowdenbeath District, and it was felt that the ultimate outcome would be the forming of at least two Sub-Branches and perhaps three in the East of Scotland. He also stated that there would in all probability be a large increase in membership there.

Scrutineers.

Mr. S. A. Simon and Mr. J. R. Laird were appointed Scrutineers to report upon the Ballot Papers received.

Examinations.

The Chief Examiner's Report upon the Examinations held in April and May, 1930, was read to the meeting, and was adopted. It was resolved that copies of the report be distributed to the members of the Council and to the Association's Branches, in order that full consideration might be given to the recommendations and observations of the Chief Examiner.

A vote of thanks to the Chief Examiner (Prof. I.C. F. Statham) was passed and Prof. Statham was unanimously reappointed Chief Examiner for the ensuing year.

Mr. Harvey reported upon certain proposals in regard to amending the examinations syllabus and conditions; also regarding the award of medals as prizes for the respective grades. These matters were referred for decision to the discretion of the Examinations Committee.

Technical Classes.

Mr. Harvey further reported upon the drafting of a course of Evening Classes suitable for Working Colliery Electricians. The question of instituting Evening Classes and the method to be adopted in approaching the Educational Authorities was left to the Committee's discretion.

Prizes for Papers.

Mr. Cowie presented the Committee's report which unanimously recommended that the Gold Medal of the Association be awarded to Mr. J. W. Gibson (London Branch) for his paper on "Chimney Dust Problems" read before the London Branch and published in *The Mining Electrical Engineer,* February, 1930, page 281.

It was recommended that a special letter of thanks be sent to Mr. B. Samuels (Warwickshire & South Staffordshire Branch) for his paper on "Low Grade Fuels and Their Utilisation for Steam Raising" (M.E.E., page 139); Mr. B. J. Higham (South Wales Branch) for his paper on "Cotton in Engineering" (M.E.E., November, page 163); Mr. G. E. Rider (Western District Sub-Branch) for his paper on "The Problem of Peak Loads" (M.E.E., January, page 257); Mr. R. E. Horley (London Branch) for his paper on "Oil-filled Electric Cables" (M.E.E., March, page 351); Messrs. Robinson and Whish (London Branch) for their paper on "Voltage Regulation as Applied to Transformers" (M.E.E., October, page 125).

Colliery Electricians Awards.

The Prizes Committee recommended that the first prize of £8 8s. should be presented to Mr. W. Mitchell, of the West of Scotland Branch, for his paper on "The Operation and Maintenance of High Lift Mining Pump" (M.E.E., December, page 198).

The second prize of £5 5s. to be presented to Mr. F. E. Pring, of the South Wales Branch for his paper on "Coal Cutting in Low Seams" (M.E.E., May, page 376).

The third prize to be divided between Mr. C. L. James, of the South Wales Branch, for his paper on "Power Factor—Its Causes and Effect" (M.E.E., June, page 399), and Mr. G. Denholm of the West of Scotland Branch, for his paper on "The Routine of the Electrician-in-Charge" (M.E.E., March, page 343).

The Prizes Committee directed general attention to the high standard of matter which is being presented to the Association for general papers and regretted that many of these high-class papers were not eligible for an award because the authors were not members of the Branches before which the papers were read The Committee would also like to see many more papers coming through from colliery electricians. As there would appear to be some uncertainty as to what class of paper was eligible for award, the Prizes Committee indicated that any engineering subject may be chosen by Colliery Electricians and the papers need not of necessity be of an electrical nature only.

Annual Report of the Council, 1929-30 (see page 22).

This was received and adopted.

COMMITTEES.

Advisory Committee.

Mr. A. B. Muirhead, the retiring member was re-elected. Messrs. A. B. Muirhead, D. Martin, T. Stretton, and A. W. Williams. President, Treasurer, and two elected Vice-Presidents, *ex-officio* Members. Convener: Mr. A. B. Muirhead.

Examinations Committee.

Messrs. G. M. Harvey, Major E. Ivor David, J. W. Gibson, H. J. Fisher, G. Henderson, R. Holiday, J. A. B. Horsley, W. M. Thornton, and T. H. Williams. Convener: Mr. G. M. Harvey.

Finance Committee.

Messrs. R. Holiday, A. Anderson, F. Beckett and G. Raw. Convener: Mr. R. Holiday.

Papers Committee.

Messrs. S. A. Simon, J. W. Gibson, G. Henderson, A. C. MacWhirter, S. H. Morris, and W. Bolton Shaw. Convener: Mr. S. A. Simon.

Prizes Committee.

Messrs. J. R. Cowie, A. Dixon, Dawson Thomas, and T. H. Williams. Convener: Mr. J. R. Cowie.

Publications Committee.

Messrs. R. Ainsworth, F. Anslow, S. H. Morris, and A. W. Williams. President and Treasurer *ex-officio* members. Convener: Mr. R. Ainsworth.

Certification Committee.

Messrs. G. Raw, W. T. Anderson, T. H. Elliot, H. J. Fisher, G. M. Harvey, R. Holiday, A. B. Muirhead, W. Bolton Shaw, Dawson Thomas, T. H. Williams, R. Wilson and Capt. S. Walton-Brown. President *ex-officio* member. Convener: Mr. G. Raw.

British Engineering Standards Association Sub-Committees.

Representative: Mr. Theodore Stretton.

Flame-proof Motors for Coalcutters and Conveyors.

Mr. A. B. Muirhead and Mr. G. Raw were appointed the Association's representatives.

Next Meeting of the Council

It was resolved that this be held at Preston on October 18th, 1930, at 9-30 a.m. at the Park Hotel.

British Engineering Standards Association's Committees.

Mr. Stretton reported upon the recent specification in relation to Miners' Lamp Bulbs.

"Mining Electrical Engineer" and the A.M.E.E. 21st Year.

In view of the fact that the Year 1930 was the Twenty-First Anniversary of the commencement of the Association, it was resolved that a special number be issued in October 1930, which should contain special features, and a review of the Association's work during the course of its operations.

Fifty Years of Mechanical Coal Mining.

Mr. Muirhead reported that *The Iron and Coal Trades Review* were appointing a representative Organising Committee to deal with a recognition of this fact and suggested that Capt. S. Walton-Brown should represent the Association in this matter: it was agreed that Capt. Walton-Brown would act in this capacity.

ANNUAL GENERAL MEETING.

The Annual General Meeting of the Members of the Association was held at the Midland Grand Hotel, St. Pancras, London, N.W. 1 on Friday, June 27, 1930, Capt. S. Walton-Brown (retiring President) in the Chair.

Apologies for Absence.

Letters expressing regret for inability to attend were received from Mr. A. Anderson (Past President); Prof. W. M. Thornton (Past President); Mr. C. Augustus Carlow (Past President); Mr. W. T. Mittell (Lothians Branch); Mr. W. G. Gibb (West of Scotland Branch); and Mr. A. W. Williams (Advisory Committee).

Minutes.

The Minutes of the preceding Annual General Meeting, held at Newcastle-on-Tyne on July 5, 1929, were confirmed and signed.

Council Report and Accounts.

The Report of the Council and Statement of Accounts for the year ended March 31, 1930, were adopted.

Mr. J. R. COWIE (Convenor of the Prizes Committee) submitted the Committee's Report, and mentioned, as of general interest, that since the Committee had decided to recommend the award of the Association's Gold Medal to Mr. J. W. Gibson for his paper on "Chimney Dust Problems," read before the London Branch, requests had been received from the Continent and from America for permission to reprint the paper. The Committee's Report was unanimously adopted and thanks were accorded to the members of the Committee for their good services.

Mr. G. M. HARVEY (Convenor of the Examinations Committee) presented the Report of the Chief Examiner (Professor Statham, of the Mining Department, University of Sheffield) on the Association's Examinations held in April and May, 1930. This was adopted, and thanks were expressed to the Chief Examiner for the able manner in which he had drawn up his Report; and also to the Committee.

Mr. F. ANSLOW deputised for Mr. Rooke Ainsworth (Convenor of the Publications Committee) whose absence was due to a serious illness, from which he was recovering. Mr. Anslow said that the General Secretary of the Association had been instructed by the Council to write a letter to Mr. Ainsworth expressing sympathy with him and the hope that his recovery would be rapid and complete. The Report of the Committee was adopted and thanks were expressed to the members for the excellent manner in which they had carried out their duties.

Mr. A. B. MUIRHEAD (Convenor of the Advisory Committee) reported upon the efforts which were being made by that Committee to increase the membership of the East of Scotland Branch. A General Committee had been formed, consisting of three members of the West of Scotland Branch, three members of the Lothians Branch, and the Advisory Committee, and it had been assisted by Mr. Paterson and Mr. Dawkins (Chairman and Secretary, respectively, of the East of Scotland Branch). Three propaganda meetings in Fife had been arranged, the first of which had already been held at Cowdenbeath, on May 2, 1930, at which Mr. C. Carlow Reid (General Manager of the Fife Coal Co.) had presided. It was attended by a large number of local men interested in electrical work in various collieries and a very able paper was read by Mr. Walker, of the Lothians Branch, dealing with electrical breakdowns and their repair, illustrated by lantern slides. This was followed by a good discussion. The reason for calling the meeting was explained there and steps taken which, Mr. Muirhead believed, would result in a substantial addition to the membership of the East of Scotland Branch. The second meeting it was proposed to hold at Kirkcaldy in September, and Mr. G. Henderson had undertaken to give a lecture on that occasion. The third meeting was proposed to be held at Dunfermline, the details of which were now being arranged.

Another matter to which Mr. Muirhead referred was that a communication had been received from the proprietors of the *Iron and Coal Trades Review*, relating to a movement to celebrate 50 years of mechanical coal mining. For the organisation of these celebrations a Committee had been formed consisting of many eminent men in the coal industry. Capt. S. Walton-Brown (retiring President) had been appointed to the Committee as the representative of the Association.

The Report of the Advisory Committee was adopted, and members were thanked for the able manner in which they had worked in the interests of the Association in all spheres of activity.

Office Bearers for 1930-31.

The Report of the Scrutineers on the ballot for office bearers for the year 1930-31 shewed that the following had been elected:—

President—Mr. J. W. Gibson.

Senior Vice-President—Major E. Ivor David.

Junior Vice-President—Mr. F. Beckett.

Treasurer—Mr. Roslyn Holiday.

Capt. S. WALTON-BROWN, the retiring President, said that it was always pleasant to take over the office of President and sometimes it had been said that it was always pleasant to give it up, but he personally relinquished it with the sincerest regret. At the same time it was a pleasure to know that he was being succeeded by an engineer who had come originally from the Tyne district, and who had reached a position of eminence by sheer ability. In inviting Mr. Gibson formally to occupy the Chair, Capt. Walton-Brown congratulated him and expressed the hope that his year of office would be as happy and successful as his own had been.

Mr. J. W. GIBSON, having been inducted into the Chair, expressed his thanks to the members for having elected him to the highest office in the Association and said that he accepted his election with warm appreciation as a friendly tribute to the London Branch and, perhaps, to his long period of membership. He assured the members that he would do his best to maintain the high standard which had been set by his predecessors and to support loyally the cause the Association had at heart and which it existed to further.

As President, his first duty in his new capacity—and one from which he derived very great pleasure—was to propose a very hearty vote of thanks to Capt. S. Walton-Brown for his services as President of the Association during the past year, an office which he had filled with dignity and distinction. Capt. Walton-Brown was a very busy man, but he had spared neither time nor effort in his work for the Association during the past year.

Mr. A. B. MUIRHEAD, seconding, said that Capt. Walton-Brown had been a President of outstanding distinction. He had succeeded a number of illustrious

Presidents and he had brought to that office a genial disposition and sympathetic outlook in addition to a thorough knowledge of all the subjects with which the Association was concerned in connection with the mining world. He had been most industrious in visiting the many Branches of the Association, although on many occasions it must have been very inconvenient for him to have spared the time, but the fact that he had done so had been to his credit and to the benefit of the Association.

The vote of thanks was carried with acclamation.

Capt. S. WALTON-BROWN, responding, assured the members that his work as President had been very pleasurable, and it had been rendered easy because everybody connected with the Association had carried out their duties so very well.

Major E. IVOR DAVID, in thanking the members for having elected him Senior Vice-President, echoed the remarks of Capt. Walton-Brown that the work of the Officers was rendered easy because it was ably supported by the staff and the members of Council.

Mr. F. BECKETT also expressed his appreciation of the honour conferred on him by his election to the office of Junior Vice-President.

Mr. ROSLYN HOLIDAY, Treasurer, briefly acknowledged the thanks of the members for his past services and the honour of his re-election as Treasurer of the Association.

Capt. S. WALTON-BROWN, proposing a vote of thanks to the members of the London Branch and the Kent Sub-Branch for the excellent arrangements they had made for the entertainment and instruction of the members of the Association during the Convention, and the hospitality extended to them, said it was very delightful to visit districts other than one's own and to find that one had really nothing to do but to float along in an airy manner and enjoy everything that was provided. The arrangements that had been made by the hosts were delightful, but one could not fail to realise that the making of those arrangements had involved a tremendous amount of work and it must have been a pleasure to them to see that the programme had worked out so nicely. He assured the members of the London Branch and of the Kent Sub-Branch that the visitors had really enjoyed themselves and were indeed grateful.

Mr. F. BECKETT (Junior Vice-President) who seconded, also congratulated the hosts upon the excellent arrangements they had made, which must have involved a very great deal of team work.

THE PRESIDENT proposed a hearty vote of thanks to the various Companies who had invited the members of the Association to visit their works, and had extended hospitality to them. The Companies to whom the Association was indebted were Messrs. Crompton Parkinson Ltd., Messrs. Marconi's Wireless Telegraph Co. Ltd., Messrs. Hoffman Manufacturing Co. Ltd., the Tilmanstone Colliery Co. Ltd., Messrs. Evershed & Vignoles Ltd., Messrs. Metropolitan Cable Co. Ltd., and Messrs. Allen West & Co. Ltd. The only disappointment, he added, was that during the members' visit to the works of Messrs. Crompton Parkinson & Co., they had not had the opportunity of meeting the doyen of electrical engineering in this country—Col. R. E. B. Crompton.

Mr. ROSLYN HOLIDAY, seconding, said he sometimes felt that facilities to visit the various works were given so readily that the visitors were almost apt to forget the trouble and work which had to be done by those who entertained them, and he was glad of the opportunity of emphasising how very sincerely the members thanked their hosts. Commenting upon a remark which had been made by Mr. William Brown (the Managing Director of the Metropolitan Cable Co. Ltd.) to the effect that it was a privilege to entertain the visitors, and that the Company learned much by reason of those visits, Mr. Holiday said it was nice for the visitors to feel that not only were they receiving benefits but also that they were of some help in placing their problems before the manufacturers in such a way that those manufacturers might be helped in the solving of them. It was pleasing to feel that the manufacturers who cast their bread upon the waters in this pleasant manner might profit by so doing.

The vote of thanks was carried with enthusiasm and the Secretary was instructed to write letters of appreciation to the Companies concerned.

Auditors.

Messrs. Harrison and Sedgwick (Chartered Accountants) were re-elected auditors to the Association for the ensuing year.

The Association's Coming of Age.

Attention was drawn by Mr. J. H. C. Brooking to the fact that the Association had reached its 21st year and that it could regard itself as having reached man's estate. That being so, it was justified in reflecting upon its 21 years work and in congratulating itself upon that work.

In the course of further discussion reference was made to the work which Mr. Brooking himself had done in the early days, and for which the Association was much indebted.

Mr. J. W. Gibson, having delivered his Presidential Address (see page 3), Mr. A. B. Muirhead proposed a vote of thanks to the President for his very interesting and able Address. Commenting upon the plant used in the early days of the application of electricity to mining, Mr. Gibson had said that in Durham at that time the efficiency of the machines was measured by the length of the spark from the brush. He did not quite agree with the President that gas was not always present where such machines were used, and suggested humourously that perhaps the electrical machines were regarded as an aid in dissipating some of the gas that was present! Electrical development was unhampered at that time, but he was a supporter of the steps that were taken immediately prior to 1904 to frame a set of regulations governing the use of electricity in collieries, and he believed that on those regulations the progress of electrical machinery in mining in the British coal fields had rested.

Discussing the extent to which electrical machinery is used in the Scottish coal mines, Mr. Muirhead said that its use had been rendered necessary by the conditions which had to be met. Those who knew only the better seams in England might find it difficult to realise the hard struggle which had had to be made in the Scottish coal field to turn out sufficient coal to pay for the operation of the collieries, and that could only be done by the use of electricity. The areas were so worked out and the seams were so thin, that but for the use of electricity, many of the collieries in Scotland would have had to close down. Probably that was the reason why the managers and coal owners in Scotland had been such strong supporters of the Association.

Mr. GEORGE RAW seconded the vote of thanks and it was carried with acclamation.

REPORT OF THE COUNCIL,

Year ended March 31st, 1930.

Branches.—The Branches of the Association are as follow: East of Scotland, Lothians, West of Scotland (Sub-Branch: Ayrshire), North of England (Sub-Branch: Cumberland), Yorkshire (Sub-Branch: Doncaster District), North Western (Sub-Branches: North Wales and Stoke), Midland, Warwickshire and South Staffordshire, South Wales (Sub-Branch: Western District), and London (Sub-Branch: Kent).

The number of members in the various Branches are shewn below.

A Sub-Branch of the London Branch has commenced operations with a satisfactory membership, and is entitled "Kent Sub-Branch."

Meetings.—The Branches have held Meetings regularly for general business, election of members, reading of Papers, discussions thereon, and other matters affecting mining electrical engineering.

Collieries and Works have been visited, and demonstrations of improvements in machinery and other apparatus arranged, which proved of considerable technical and practical value to the members.

Committees.—Committees were appointed to deal with the special questions submitted to them, viz.: Advisory Committee, Certification Committee, Examinations Committee, Finance Committee, Papers Committee, Publications Committee, and Prizes Committee.

The Association has been represented upon the following Committees of the British Engineering Standards Association: Flame-proof Apparatus, Mining Plugs, Trailing Cables, Mining Switchgear, Bulbs for Miners' Hand Lamps, Ball and Roller Bearings for Electrical Machinery, Face Plate Rotor Starters, Field Rheostats, Underground Lighting Fittings, Electric Motors and Generators for Mines, and other matters.

The Secretary of the Committees concerned has expressed his thanks to the Association's Representatives for the practical help given in connection with various matters.

Sub-Committees of the British Engineering Standards Association The six Representatives of the Association appointed to act in the various districts on the Regional Committees of the British Engineering Standards Association for standardisation of Colliery Requisites and the Representatives on the Materials and Mining Electrical Plant Sub-Committees, still represent the Association in that capacity.

Qualifications of Colliery Officials, Departmental Committee.—Evidence upon the Memorandum submitted was given on behalf of the Association, but the Departmental Committee has not yet issued its report.

Mines and Quarries Form No. 10.—This subject, referred to the Association by the Mines Department, has received further attention, and a letter of appreciation for assistance rendered has been received from the Mines Department.

British Industries Fair, Advisory Committee for the Electrical Section.—The Ex-President represented the Association on this matter.

Council Meetings and Annual General Meeting.—Council Meetings were held during the year to direct the general business of the Association, and consider other matters of importance.

Advisory and other Committee Meetings were held during the year.

The Committee of the Lothians and West of Scotland Branches with the Convenor of the Advisory Committee as Convenor, have had under consideration increase of Membership in Scotland, with particular reference to Fifeshire, and have arranged to hold several propaganda meetings and to get in touch with those who are likely to be of assistance.

Branch Secretaries also held Meetings prior to the Council Meetings to discuss general business.

Annual Convention.—The Annual Convention of Members was held in Newcastle-on-Tyne on July 2nd, 3rd, 4th, 5th, and 6th, 1929, and the admirable programme arranged by the North of England Branch was participated in by a large number of members and guests, and was one of the most successful of a long series of these events. A civic reception was accorded by the Lord Mayor of Newcastle-on-Tyne. The Durham and Northumberland Coal Owners' Associations generously entertained to dinner those attending the Convention, and various Firms not only allowed inspection of their works, but extended very kind hospitality.

Examinations.—Examinations were held on April 27th and May 4th, 1929, in six different centres, and there were 36 candidates.

Honours Examination. There were six candidates, of whom one passed.

Ordinary Examination. There were thirty candidates, of whom five gained First Class Certificates, and sixteen gained Second Class Certificates.

Prof. I. C. F. Statham, of the Mining Department, University of Sheffield, acted as Chief Examiner, and the services rendered by him were highly appreciated.

The Superintendents of the Examinations also rendered valuable assistance in conducting the Examinations.

Service Certificates. An oral examination under restrictive conditions, for members whose length of experience and service warrant such examination, is contemplated, but has not yet been put into operation.

Special Educational Facilities for Students of mining electrical engineering in the various Districts. This subject continues to receive careful attention.

Finance.—The finances of the Association are in a satisfactory condition, and the surplus funds are invested in Government Securities and Bank Deposit.

Life Members' Commuted subscriptions amounting to £45 3s. 0d. have been invested.

	Life Members	Honorary Members	Patrons	Donors	Members	Associates	Students	Total
East of Scotland	—	—	—	—	21	2	—	23
Lothians	—	—	3	—	61	3	1	68
West of Scotland and Ayrshire	4	—	13	—	271	12	14	314
North of England & Cumberland	—	—	10	—	209	69	17	305
Yorkshire and Doncaster	—	—	3	—	112	37	9	161
North Western, North Wales and Stoke	—	—	2	5	155	51	14	227
Midland	—	—	—	1	100	11	18	130
Warwickshire	—	—	1	1	78	20	15	115
South Wales & Western District	—	—	4	—	271	79	33	387
London and Kent	—	1	6	—	140	19	7	173
Unattached	—	—	—	—	4	—	—	4
Total Membership	4	1	42	7	1422	303	128	1907

Entrance fees received from members since the commencement of the Association, amounting to £807 3s. 0d. have been allocated to a Reserve Fund, and the sum of £776 6s. 7d. has been invested.

The London Branch has transferred an additional amount of £25 0s. 0d. to the General Fund, making a total of £75 0s. 0d. allocated for this purpose. The action is highly appreciated.

Libraries.—Branches have made arrangements with other local Technical Societies for the formation of Joint Libraries, and have now available for home study a valuable collection of scientific books.

Membership.—The membership of the Association, although affected by the difficulties of the mining industry, continues in a satisfactory condition.

Official Journal.—The Association's monthly Journal entitled "The Mining Electrical Engineer," continues to be of great value to the members, and circulates to most parts of the world. It has attained a high position amongst technical journals, and is considered one of the most progressive of publications. Meetings of the Publications Committee have been held frequently to direct the business of the Journal.

The financial position is satisfactory, and the Reserve has been invested. Notwithstanding the adverse conditions during the past year, it has been possible not only to maintain, but to increase, the standard of the Journal.

The questions and answers published in the Official Journal have proved of considerable value.

Prizes for Papers.—The Committee presented a Report upon the Session 1928-1929.

The various Branches are congratulated on the high standard of the papers both for the Gold Medal and the Special Awards, and the discussions arising thereon elicited much practical information.

The Premier Award (Gold Medal) was awarded to Mr. S. B. Haslam of the South Wales Branch.

Prizes were awarded to Mr. E. I. Westcott, (Cumberland Sub-Branch), Mr. J. N. Gardner (West of Scotland Branch), and Mr. J. H. Aust (Stoke Sub-Branch).

Prizes were also awarded at the different local Branches.

The Coucil desires to draw the attention of members to the importance of preparing and submitting papers before the commencement of the Session, in order that a complete advance programme may be prepared.

It is also desirable that members, when writing papers, should consult the Branch Secretary regarding the subject matter.

Some of the subjects suggested for papers are comprised under headings of Selection of Plant and Fittings Installation of Plant, Management and Maintenance of Plant, Accidents and Breakdowns.

Patrons and Donors.—Colliery Owners and other important Companies continue to support the Association's objects, but it is desirable in the interests of the Association that further efforts should be made to enrol many more Colliery Owners and Firms as Patrons and Donors.

President.—Capt. S. Walton-Brown was unanimously elected President of the Association at the Annual Meeting on July 5th, 1929, and during the Year has visited most of the Branches of the Association.

Vice-Presidents and Treasurer.—At the same Meeting Mr. J. W. Gibson, and Major E. Ivor David were elected Vice-Presidents, and Mr. Roslyn Holiday elected Treasurer.

Past President.—Mr. F. Anslow, the retiring President, was accorded the Association's highest appreciation for the great assistance rendered during his term of office.

A.M.E.E. Examinations, 1930.

Report of the Chief Examiner.

The following notes include the leading points of the very complete report submitted by the Chief Examiner (Prof. I. C. F. Statham) to the Council. The examinations were held on April 26th and May 3rd, 1930.

Certificate Examination.

Thirty candidates presented themselves for examination in this grade and the following is a summary of the results :—

First Class Certificates	6
Second Class Certificates	14
Fail	10

The ten failures include one candidate who withdrew from the examination during the first paper on account of illness.

The names of the successful candidates from the various branches are as follows :—

Name.	*Branch.*	*Class.*
Arthur, Idrid	South Wales	First
Gay, Wm. T.	Do.	First
James, John	Do.	Second
Jones, Evans	Do.	Second
Sansom, Wm. J.	Do.	Second
Walker, Idris	Do.	Second
Eames, Harry	Yorkshire	First
Scargill, Horace	Do.	Second
Faust, Fred	Midland	Second
Randall, H. W.	Do.	Second
Basford, E. J.	Warwick, & S. Staffs.	Second
Horobin, A.	Do.	Second
Hardie, T. W.	North of England	Second
Jeffry, Wm.	Do.	Second
Rogers, Ed.	Do.	Second
Walton, James	Do.	Second
Gerrard, R. A.	North Western	First
Wood, T. W.	Kent Sub-	First
Hastings, Jos.	West of Scotland	First
Scott, Dan.	Do.	Second

The following is a tabulated summary of the results for the various branches :—

Branch.	*No. of Entrants.*	*First Class.*	*Second Class.*	*Fail.*
S. Wales	8	2	4	2*
Yorkshire	3	1	1	1
Midland	3	0	2	1
London	1	0	0	1
War. & S. S.	2	0	2	0
N. England	7	0	4	3
N. Western	2	1	0	1
Kent (Sub.)	1	1	0	0
N. Scotland	3	1	1	1
	30	6	14	10

* Includes one candidate who retired on account of illness.

The results for each of the papers were as follows :

Paper.	*First Class.*	*Second Class.*	*Fail.*
I.—Continuous Current	7	18	5
II.—Alternating Current	6	15	9
III.—Lighting and Signalling	6	14	10
IV.—Special Rules and General	6	17	7

The general standard of the answers submitted shews no appreciable improvement on that of previous years. With few exceptions the standard was disappointing, especially in Papers II. and III., in which the majority of the successes were only just on the border-line between a pass and a fail.

Many candidates have only a vague knowledge of purely mining electrical problems. This was the chief weakness exhibited and was the reason that such a large proportion of candidates obtained only a Second Class.

The would-be Colliery Electrician must, of necessity, possess a knowledge of the special features of Mining Electrical Work in addition to a knowledge of general principles.

Weakness on the mathematical side and inability to make clear sketches continue to give rise to trouble.

The Honours Examination.

Six candidates entered for the Honours Examination but one of these failed to attend on the second day. The distribution of the candidates, according to the branches, was as follows :—

South Wales	3
S. Wales	1
North of England	1
West of Scotland	1

As in the past years a high standard of attainment was demanded for the Honours Certificate and only two candidates qualified for a pass in this grade, viz. :—

Burkle, B. J., of the South Wales Branch.
Cowan, James, of the West of Scotland Branch.

The Award of Medals.

It is regretted that no candidate attained the standard which should characterise the recipient of a Gold Medal from the Association. The highest number of marks in the Ordinary and Honours Grades respectively were 78% and 75% ; with reluctance it is found necessary, therefore, to recommend that the gold medals be not awarded this year.

General.

As already stated, the standard of the work shews little, if any, tendency towards improvement. The small percentage of First Class awards in the Ordinary Grade indicates that the majority of entrants fall short of the standard of attainments which might be reasonably expected from a Colliery Electrician.

Prof. Statham, however, is firmly convinced that the standard of the Honours and First Class examinations should be maintained, and is of the opinion that the proposed institution of a special Second Class Examination to meet the requirements of Assistant Electricians would be to the advantage of the Association and the industry.

The continued dearth of entrants for the examination is to be regretted. During the past seven years the average numbers of candidates for the Ordinary and Honours Grades have been 31 and 8 respectively. In view of the large number of persons employed in Mining Electrical Work, the numbers are very unsatisfactory and would seem to indicate failure to appreciate the facilities afforded by the Association. It is, however, possible that an intensive campaign in the Branches might lead to a larger number of entrants; and the impending revision of the Association's Examination Scheme, together with the inauguration of a special examination for Second Class Certificates should afford an opportunity for the launching of such a campaign.

YORKSHIRE BRANCH.

Out-of-Door Switchgear.

E. E. GROVER.

(*Paper read* 15*th February*, 1930.)

The cost of electric power delivered at the actual load where that power is required is largely dependent on the cost of the generation, transmission and distribution. In many installations the main contributing factors to the cost of power are the generating and distributing costs. At the busbars in a power house the cost has only just begun and the final price paid for current is usually three or four times the cost of the actual generation. It follows that if the distribution costs can be lowered this will be a more effective saving than a reduction in the cost of generation.

The designers of boiler and turbine plant have been very successful in improving designs in order to offer high efficiencies in the generating plant. The out-of-door substation is an out come of the effort to minimise the distribution cost. In dispensing with buildings the out-of-door switchgear saves expense in material labour and transport. The saving that can be effected depends on the voltage and the required current breaking capacity.

For voltages up to 33,000 volts, the switch fuse is an inexpensive form of out-of-door substation equipment. For example, at 11,000 volts the cost of a three-panel board to control an incoming and outgoing feeder and tee-off with a breaking capacity of 50,000 k.v.a. would be approximately £250, as against £450 for indoor gear. Further the indoor gear would require an additional expenditure of anything from £150 to £300 to house the switches. For larger and more important substations, where circuit breakers are essential, the out-of-door switchboard shews an economy at voltages over 33,000 volts, but below this voltage it is usually less expensive to erect a building to house the indoor type of circuit breakers. This provides a much safer arrangement than a small open type substation.

Two types of gear can be used out of doors: (1) Metal-Clad; (2) Open Type.

The leading features of the metal-clad type of gear are:

(a) All live parts are enclosed in earthed metal with weatherproof joints.

(b) The draw-out principle is employed so that the circuit breakers are self-isolating. With this feature only the fixed portion of the board is alive while the circuit breaker is withdrawn for inspection.

(c) The building and assembling is done in the manufacturer's works under better conditions for this work and under better supervision than is possible on site.

In the open type of outdoor gear, the busbars and connections consist of bare conductors which are led through insulated bushings in the top plate of the

Photo. by Elliot & Fry

J. W. GIBSON, Esq., A.M.I.E.E., F.Inst.F.

President of The Association of Mining Electrical Engineers, 1930-1931.

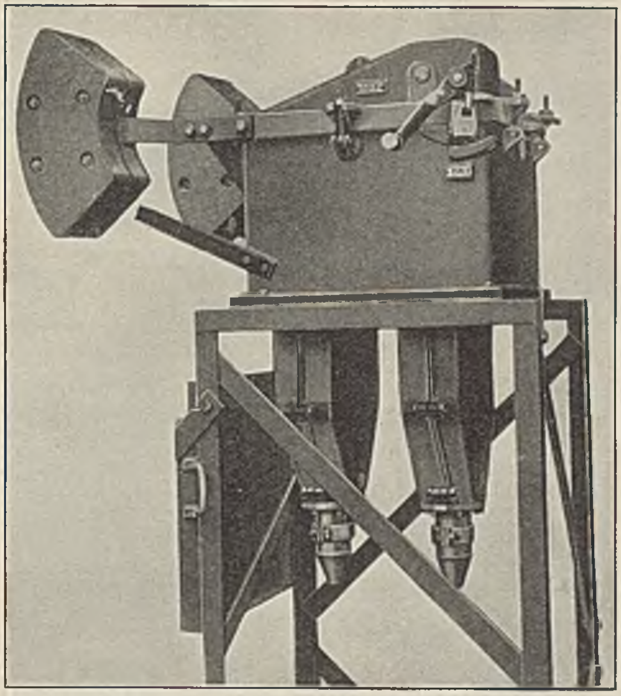


Fig. 1.

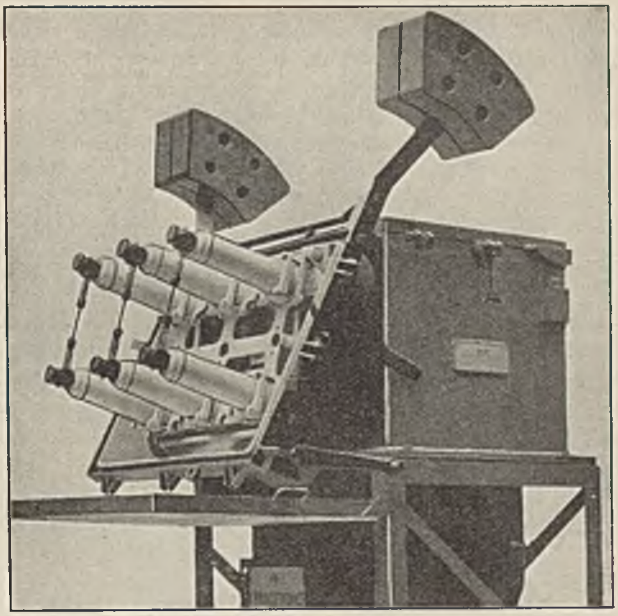


Fig. 2.

circuit breakers. Most of the erection work has to be done on site on such parts as the main frame work, the busbars and the necessary connections. The self isolating feature cannot be employed and the isolation of a circuit breaker has to depend on hand operated isolators.

The type of switch fuse shewn in Figs. 1, 2, and 3 has been designed as a simple but safe means of tapping a feeder to supply subsidiary circuits such as lighting or small power loads at voltages from 660 volts to 33,000 volts. The self aligning fuses are mounted on the underside of the lid and the contacts are oil immersed. The three phases are in one boiler plate tank divided by barriers. The operation of shutting or opening the lid makes or breaks the circuit at the fuse contacts, and is performed by means of a pole. The balance weights fixed to the lid assist in swinging it back without effort to a position for inspection of fuses. All live parts are completely enclosed in earthed metal with weatherproof joints. A busbar chamber, compound filled, can be fitted and also oil-immersed isolators for the incoming and outgoing supply, together with current transformers for metering and cable dividing boxes if required. Incorporated in the lid there is an additional quick make and quick break isolating switch interlocked so that the isolator must be "off" before the lid can be closed, and so that the isolator can only be closed when the lid is right down. Before the lid can be opened the isolator must be "off."

A number of these switch fuses are in use to form out-of-door substations on the 11,000 volt distribution

The following table gives the particulars of sizes of bi-metal fuse wire for use with spring tension fuses, the minimum fusing current being the average current at which the fuse blows after one minute.

3300 *Volt Switch Fuse.*

Normal rating in amperes.	*Minimum fusing current.*
15	45
30	90
60	180
80	240
100	360

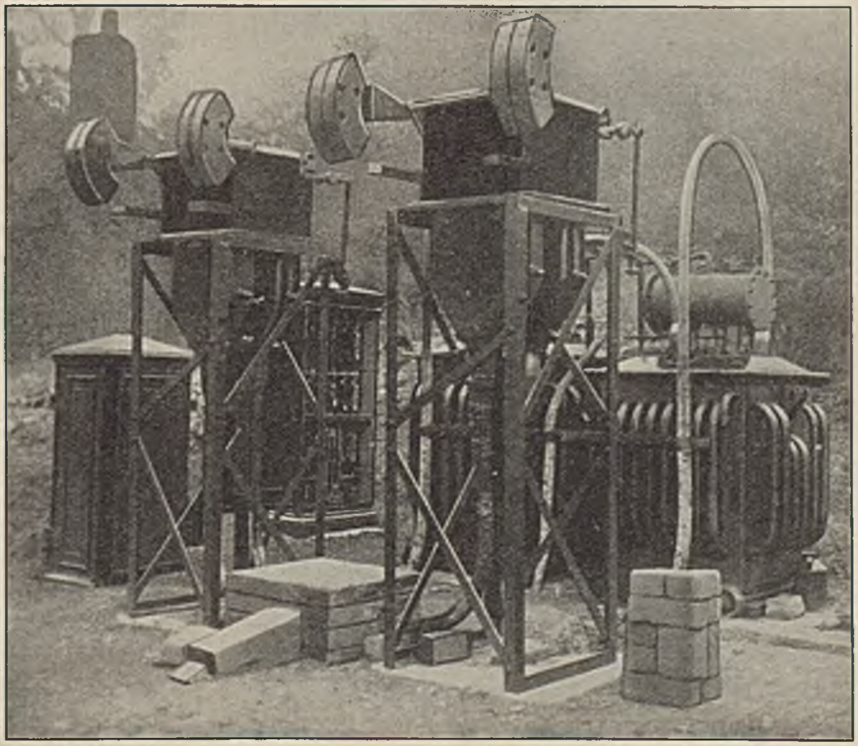


Fig. 4 shews a metal-clad oil-immersed ring-main isolator comprising two isolating switches and a switch fuse for controlling a tee-off to a consumer. For controlling the connections to the ring main there are two isolating switches of the knife-blade pattern with quick break action which are capable of making and breaking the circuit up to their full load capacity. These switches each have three positions: "on," "off," and "earth," in any one of which they can be padlocked. For the purpose of cable testing, orfices are provided in each ring main cable box, with interlocked caps screwed over the outer ends. The tee-off to the consumer is made through the switch-fuse and the cover of the tank and the lid of the switch-fuse are of diving-bell construction to enable the panel to be used in cellars or other underground substations.

With the above arrangement, the following features are obtained:—

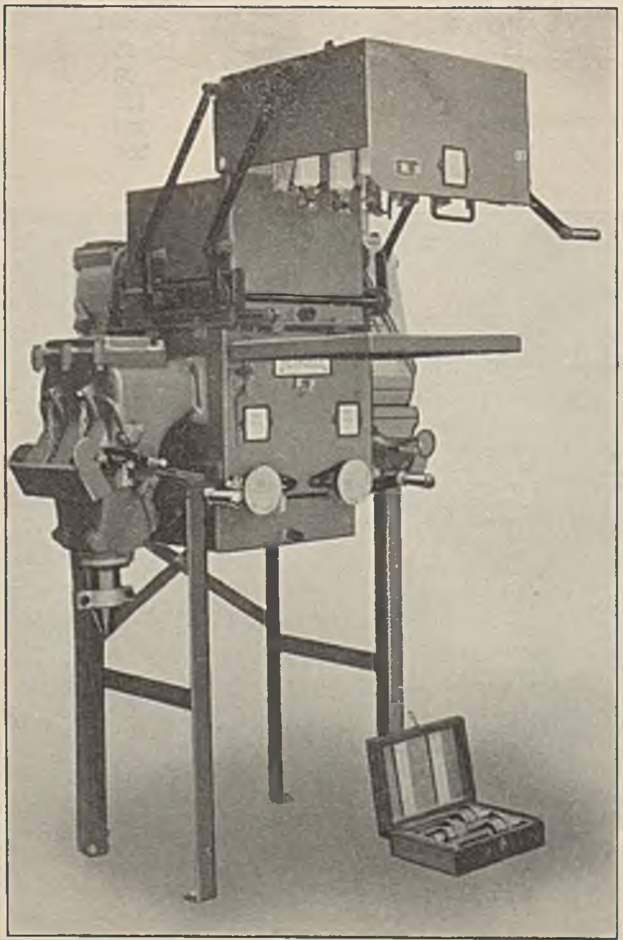
(1) Complete metal-clad enclosure.

(2) Mistake-proof interlocking.

(3) Weather-proof or submersible construction.

(4) Complete in-and-out substation with a minimum of erection on site.

Fig. 5 shews a 400 ampere 50,000 volt feeder panel for outdoor use. It is solenoid operated and controlled from a slate panel inside the power station. This was put into commission at Bradford about September 1928



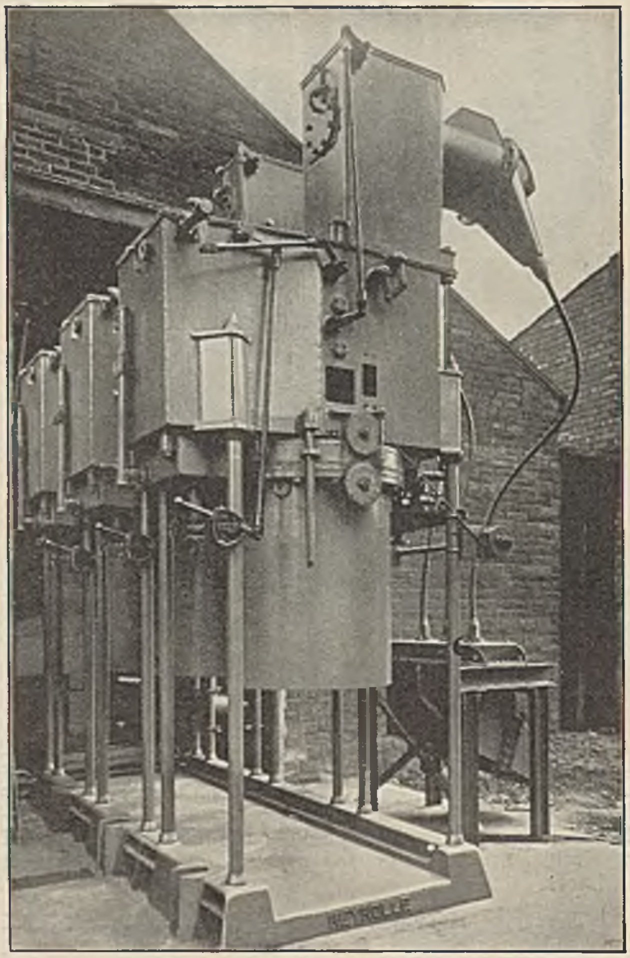


Fig. 5.

and shews the suitability of metal-clad gear for out-of-door substations in country where the smoke and fumes of an industrial town would affect open type gear. A separate dividing box is used for an oil impregnated two-core cable.

A still larger out-of-door metal-clad switch has now been designed with a rated capacity of 1,500,000 k.v.a. for a voltage of 60,000 volts, which up to the present is the limit of voltage for the metal-clad type. In this design the framework is made of welded steel plates and girders and the busbars are oil filled. Duplicate busbars and duplicate circuit breakers are provided of the drawout type with isolating contacts. The switches are motor operated and there is a motor operated truck for isolating the circuit breakers. This truck can run out from below the switch panel carrying the tanks or the complete circuit breaker.

As a contrast to the metal-clad gear for an industrial town, Fig. 6 shews the switchgear for 110,000 volts for New Zealand. The circuit breakers which are motor operated are in one three-phase bank and connections are taken to overhead pole operated isolators. The disconnecting switches are gang operated.

In comparing the open type gear with the metal-clad out-of-door switch in Fig. 5, it is obvious that the metal-clad type occupies less ground space and pro-

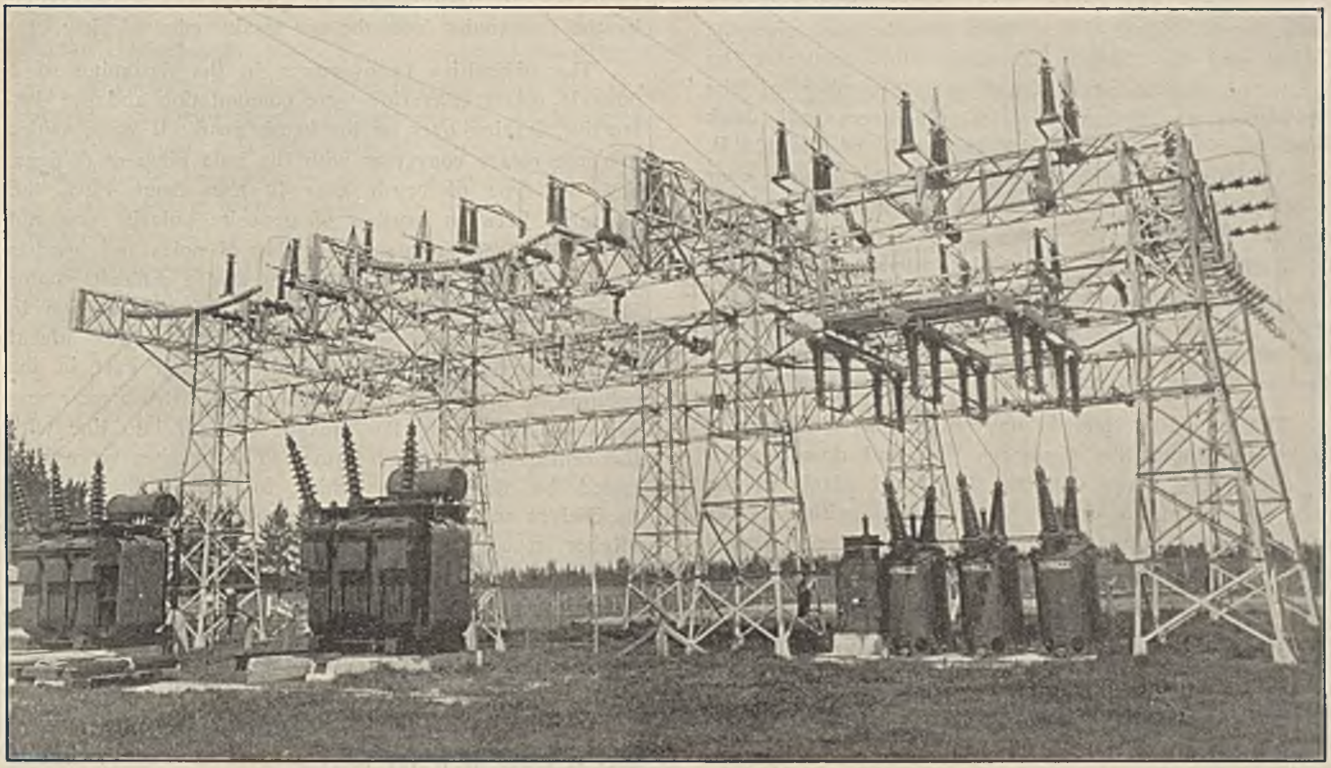


Fig. 6.

the atmosphere. Although the first cost of the metal-clad switch is higher than of the open type it is more suitable than the open type for industrial areas; and against the higher first cost must be set off the lower erection cost and the lesser area required.

Grid Substations.

For the British grid there are six types of out-door substations on the 132,000 volt system. These are of the open type gear and the switches are designed for a rated breaking capacity of 1½ million k.v.a. To deal with these large breaking capacities there are two types of circuit breaker being installed. The British manufacturers are employing the multi-break switch enclosed in a heavy steel tank, while the American method is to surround the contacts in a heavily insulated steel pot. The object of the pot is to reduce the stress and so enable a lighter and less expensive tank to be employed.

In coming to a decision as to the suitability or non-suitability of different types of switchgear in substations, the following points should be considered:—

(1) Complete interlocking to allow only a correct sequence of operations.

(2) Remote Control.

(3) The most useful and suitable form of protection:
(a) Overload; (b) Earth Faults; (c) Selective protection for feeders.

(4) Safety from danger of shock to operators and Staff.

(5) Safety from fire.

(6) Area available for substation.

(7) Cost of erection on site.

WEST OF SCOTLAND BRANCH.

A meeting of the West of Scotland Branch of the Association of Mining Electrical Engineers was held in the Royal Technical College, Glasgow, on 19th March last. Mr. G. N. Holmes, President of the Branch, occupied the chair, and there was a very gratifying attendance of members. In the absence of Mr. W. G. Gibb, Honorary Secretary, Mr. John A. Brown read the Minutes of the previous Branch Meeting. Apologies for absence were intimated from Messrs. Anslow, Hart, Stevenson and Gibb.

Mr. James Laird read the following paper, the interest of which was greatly enhanced by many lantern slides and a free and full discussion.

Frequency Change Problems.

JAMES LAIRD.

In nature, cycle and sequence—intensity and quantity—are all evident in the tide's ebb and flow. Day and night, seasons, our own existence, our organic system, follow in circles and lines with infinte frequency. The Electricity Commission, with Sir John Snell as Technical Adviser, collaborate to promote, regulate, and supervise the supply of electricity in Great Britain, Ireland being able to look after itself. Their decision to establish a grid of 3000 miles of overhead lines, carrying a standard voltage of 132,000 volts, at a standard frequency of 50 cycles per second, gave electrical engineers something to think about. They had to consider ways and means whereby the changes of existing equipments which were not 50 cycles to the new conditions, could be carried out. That this will be done as economically and as expeditiously as the circumstances under their control will permit, the C.E.B. can rest assured. The Author feels that he can give the C.E.B. and the Supply Companies this assurance on behalf of the members, that every member of the Association of Mining Electrical Engineers will work whole-heartedly together with the staffs of the C.E.B. and the Supply Companies, in making this change over to 50 cycles, a credit to the Association so far as mining equipment is concerned; and when it is finished we may think with Longfellow—"Something attempted, something done. Has earned a night's repose". But there is some doubt whether the night's repose will be the lot of the colliery engineer. His status is rising through our Association and his reward will assuredly come.

The regulation margin under the new conditions is to be something like 6 per cent. up and down, which is much worse than with the individual plants at the present time, a fine degree of regulation, within 2½ per cent. being a common figure. That change we must reluctantly submit to, as distribution is a very costly item in the new scheme. The cycles will remain at 50 and the speed of motors will be constant as the kinetic energy in the large turbo-alternator rotors will preponderate over the driven rotors of motors, etc. Standardisation always tends to create economy, but there is no doubt it narrows down the outlet for inventive genius and designers to defined and restricted channels.

Frequencies can be changed by other methods than rotating machinery and may yet become quite commercial propositions. The author would have welcomed the association of monetary value and power production, making the electrical unit the range of exchange. This has been carefully considered and the diagram, Fig. 1, shows the very close relation between the bank debits and power generated in New York, U.S.A., and the diagram for London shows a similarly close relationship. It would seem as if this change must be left to posterity and the day that Burns foresaw "When man to man the world ower shall brothers be and aw that". It is greatly to be regretted that small consumers in rural areas will have to pay 1s. per unit, as electricity at that price will not compete with candles or paraffin oil. Could not a loan be raised based on a definite increased k.w. unit output, which would include the load expected from rural areas by offering the supply at a rate that would induce the rural areas to take a supply and be paid by the economies occurring from the increased k.w. unit output, over a period of years, as at present the supply will be meagrely taken and the plants will be running on a low load factor? The adoption of alternating current in this country for power generating purposes dates from about 1895. Slow speed engine-driven alternators of a few thousand kilowatts at 6000 to 10000 volts at 25 cycles were installed in a number of municipal areas. This was mostly converted to 500 volts d.c. for municipal traction and in a small way for industrial work.

The reason for adopting 25 cycles was that at that time 25 cycle rotary converters were very excellent machines. This factor established 25 cycles and equipments increased in size until the plants were so ponderous that a change to 50 cycles was not, up till now, seriously considered. The 25 cycle system has not been a suitable frequency for lighting and the change will be welcomed by the community from the eye strain point of view.

The difficulties to overcome in the designing of a 50 cycle rotary convertor were commutation and the destructive flashing over on the brush gear. If we consider a 6 pole rotary convertor with the pole pitch at 60 degs. and the type of brush gear in use about 1895, the clearance between brushes of opposite polarity was not very great. To double the number of poles and brushes and get a pole pitch of 30 degs. was a difficult matter in mechanical construction, and this was in addition to the electrical difficulties already mentioned. The advent of the commutation pole played no small part in the solution of the commutation difficulties. Brush gear was narrowed down and the brushes brought into line with the centre of the brush arms. The brushes were protected by flash plates which fold over the brushes themselves and so protect them from direct flashing over. Higher speeds were necessary as the 50 cycle rotary may run at twice the speed of the 25 cycle machine or have double the number of poles. To change a 25 cycle rotary convertor to operate on 50 cycles means that the only part of the machine that may be utilised is the bed-plate and the bearings.

With the progress made by the mercury vapour rectifier, it looks as if the most economical way of making the change over would be to scrap the 25 cycle machine and instal a mercury vapour rectifier.

Where machines are still to be ordered and only a 25 cycle supply is available, the proper course is to ask for dual duty apparatus with the best efficiency on a 50 cycle supply. Taps may be provided in the transformer and the rotary run for the present at half speed, and on the change over the taps changed in the transformer for double the speed on 50 cycle supply. Adjustment of the air gap of the rotary may be necessary, the air gap being increased on the higher frequency. Shims would be provided under the poles to facilitate this adjustment, the pole faces in the first instance being machined for the larger diameter so that with the larger air gap the pole faces will be true and parallel to the armature core.

The Chief Engineer of the C.E.B. saw several of these large 25 cycle schemes evolve and it must have taken indomitable courage on his part to agree to a change from 25 cycles to 50 cycles. The signal honour conferred on him by being made a Knight shows how highly his efforts have been appreciated: we are very proud of Sir Archibald Page and of having been associated with him.

Motor generators on 25 cycle supply will require their motors to be reconnected, rewound, or new motors supplied. Motor generators of 40 or 60 cycles may be run at the increased or decreased speed by slight alterations to the D.C. side. The 40 cycle machine will have slightly increased efficiency and the 60 cycle slightly decreased efficiency. There are very few 25 cycle motor convertors in existence in this country and a new machine is the logical solution.

Frequency changers should be arranged to be synchronised on both frequencies by providing means for rotating the stator of either machine. This should be done through the angle of one pole pitch. This would be easier done on the 50 cycle side, the pole pitch being half of the 25 cycle side.

In considering electrical apparatus from the point of view of changing the frequency from 25—30—40—60 cycles, etc., to 50 cycles, there are certain definite conditions to be aimed for. The cost of making the change is the primary consideration. The conditions are as follows:—

If the machine under consideration be more than ten years old, scrap it. If it can be reconnected, reconditioned, or rewound for one-third of its cost, comparing it with present day values pounds sterling per k.w., by all means do it. Its performance and its utility must be equal to present-day designs, or, if on reconditioning, the value of units lost per annum is not more than the interest on the capital expenditure on new plant to replace the apparatus under consideration.

Under the new supply conditions, we are told we will not require standby plant. We are too old to believe this, and the greatest loss, from the colliery engineer's point of view, is the loss of his standby equipment.

E.M.F. of an Alternator = B.E.V. $\times 10^{-8}$ volts.
B. Flux density. E. length of conductor in cm.
V. Surface speed.

In an alternator we must have at least two poles and a two-pole field magnet rotating at 1500 r.p.m. gives us 25 cycles; 4 poles—750 r.p.m., 6 poles—500 r.p.m., and 8 poles—375 r.p.m. There are many useful high speed engines of the 375 r.p.m. type installed at collieries at the present time. To increase the frequency of an alternator from 25 to 50 cycles, we are faced with the fact that the speed of the turbine or engine is fixed and to double the speed of the rotor by any form of gearing or speed exchange gear, raises many undesirable features, both mechanically and electrically. The field magnet system is designed to run at a definite speed and it would be foolhardy to double its speed of rotation without increased fixing and bracing. Assuming it is feasible to double the number of poles in the rotating field, it will also be necessary to halve the pitch of the stator winding to suit the new pole pitch (Fig. 2). This change would not conform to reconditioning at one third of its cost. A new alternator is the only reasonable solution.

Salient pole alternating current motors come under the same category as alternators with rotating field magnets and a new machine is the logical solution. For the motors the C.E.B. would supply a 50 cycle motor in exchange for the non 50 cycle machine. The colliery engineer should see that he gets a motor of similar value. When making enquiries for electrical apparatus, it is well to ask the weight of core iron and the quality; the weight of copper in the stator and the rotor, also the number of cubic feet of air which passes through the motor and the air gap. If there is a reasonable air gap, which is necessary for mechanical reasons, and a not unreasonable quantity of air being passed through the machine, the copper and iron will be of ample section and a good quality.

It would not be at all just to have installed motors of a very high quality made by manufacturers of repute and get in exchange a motor of the "penny-pie" production method firm.

TABLE I.

INDUCTION MOTORS.

$$\text{r.p.m.} = \frac{120 \times \text{Frequency}}{\text{Poles.}}$$

Table of Synchronous Speeds for Various Numbers of Poles and Frequency.

Poles Number.	Frequency. 25 r.p.m.	40 r.p.m.	50 r.p.m.	60 r.p.m.
2	1500	2400	3000	3600
4	750	1200	1500	1800
6	500	800	1000	1200
8	375	600	750	900
10	300	480	600	720
12	250	400	500	600
16	187.5	300	375	450
20	150	240	300	360
24	125	200	250	300
30	100	160	200	240
100	30	48	60	72

$$\text{H.P.} = \frac{\text{Torque} \times \text{r.p.m.} \times 2\pi}{33{,}000} = \frac{\text{T} \times \text{r.p.m.}}{5252}$$

$$\text{Torque at 1 ft. rad.} = \frac{\text{H.P.} \times 5252}{\text{r.p.m.}}$$

The duty a motor is capable of doing depends on the cross section of the copper conductors and the area and quality of iron to accommodate the magnetic flux. The E.M.F. generated by the motor's rotating field cutting the conductors of its stator coils, must be almost equal to the applied E.M.F. The pitch of the coils must bear a reasonable relation to the number of poles the machine is designed for. The limit of pitch is from ½ to 1½ the full pole pitch. In a 6 pole motor with 72 slots, the pitch would be 12 slots so that the pitch should not be less than 1—7 or more than 1—19. Any change of frequency must be reduced to terms of change in voltage. A change from 440 volts to 2000 volts might be arranged by regrouping, but the coils and particularly the end turns must be insulated for 2000 volts.

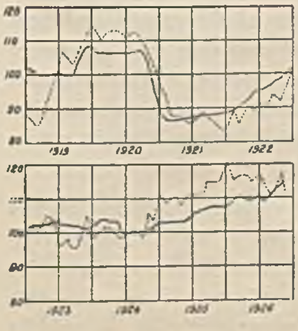
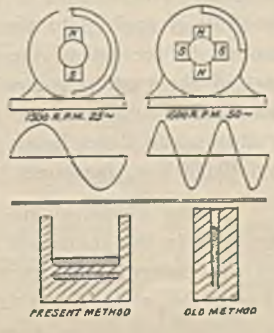
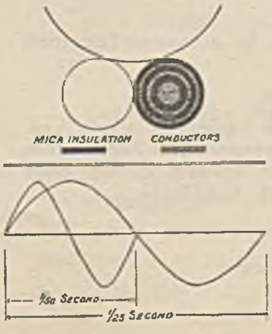


Fig. 1



Figs. 2 *and* 3.



Figs. 4 *and* 5.

Fig. 6.

This is a case for re-conditioning by the manufacturer if the necessary equipments, instruments, etc., are not available in the repair workshop. Machines of higher voltage may be changed to lower voltages if regrouping can be arranged. This can be decided by ensuring that the volts per turn in the coils are reasonably the same as in the original winding, namely the voltage into the total number of turns in the group between phases and whether in parallel or series. If the motor is reconnected to run at twice the speed, centrifugal force may damage the core and windings, unless this has been considered in the original design. The peripheral speed should not exceed 7500 feet per minute.

The rotor, if of the wound type, must be reconnected with the same number of poles as the stator. Squirrel cage motors will not have the same starting torque if changed from 25 to 50 cycles and will be easier stalled on overload. This is an advantage 25 cycle motors always have over 50 cycle motors, irrespective of the change. A four pole motor operated on 25 cycles will have a speed of

$$\frac{\text{Cycles } 25 \times 120}{4 \text{ poles.}} = 750 \text{ r.p.m.}$$

and when changed to 50 cycles

$$\frac{\text{Cycles } 50 \times 120}{8 \text{ poles.}} = 750 \text{ r.p.m.}$$

If the frequency of the motor is changed, the voltage should be changed (per turn in the re-grouping of the coils, to produce the equivalent) in the same direction and by the same amount, otherwise if the frequency is raised without raising the voltage proportionately by grouping, the r.p.m. would increase because the rotating field would rotate at a higher speed proportionate to the higher frequency and cut more conductors in a given time, generating a higher back E.M.F. This E.M.F. must be met with a higher impressed E.M.F. by re-grouping, parallel to series, or Delta to Star, or *vice versa*, so as to preserve the balance of electrical and magnetic circuits as in the original arrangement of the motor. Given a 440 volt, 25 cycle motor to be changed to 50 cycles

$$\text{Cycles } \frac{50 \times 440}{25 \text{ cycles.}} = 880 \text{ volts.}$$

The impressed voltage must remain at 440 volts so that re-grouping the coils may give the desired effect. With 40 and 60 cycles the r.p.m. will be slightly different in most cases (Fig. 6). One difficulty with old motors is to find the quality of the core iron: with 60 to 100 cycles the back of the core must be of such dimension as will accommodate the magnetic flux due to reducing the number of poles.

The H.P. a given core is able to accommodate may be expressed :

$$\text{H.P.} = K \times D^2 \times L \times \text{r.p.m.}$$

K = output co-efficient which varies by size r.p.m. and voltage: a 4-pole motor with 7 inch pole pitch being 0.0000222, a 12-pole motor with 16 inch pole pitch being 0.0000438.

D = Stator bore in inches.

L = Axial length in inches.

Pole pitch in inches.

$$\frac{\text{Dia.} \times \pi}{\text{Number of poles.}}$$

Flux per pole =

$$\frac{45{,}000{,}000 \times \text{volts per phase (star connected)} \times 1.73}{\text{Cycles} \times \text{conductors per phase} \times K_1 \times K_2}$$

K_1 is the distribution factor.

K_2 is the chord factor.

The distribution factor varies with the number of slots per phase and per pole and varies with arrangement. A good average value for three-phase nowadays is 0.955. The chord factor depends on the relation of the coil pitch to the true pole pitch.

Chord Factor =

$$\sqrt{\left(\frac{\text{Number of slots per pole} - 2 \text{ number of slots dropped}}{\text{Number of slots per pole}}\right)}$$

Conductors per phase =

$$\frac{45{,}000{,}000 \times \text{volts per phase} \times 1.73 \text{ star connected)}}{\text{Cycles and magnetic flux per pole} \times K_1 \times K_2}$$

Conductors per phase = Number of Conductors per Slot which are in Series × Number of Slots divided by Number of Phases.

If in doubt send the name plate details to the manufacturers and they will either quote a price or supply a diagram if the change desired can be carried out.

It has now become practical to manufacture turbo alternators of 40,000 k.w. running at 3000 r.p.m., 2-poles, 50 cycles, and generating at 33,000 volts, thus making a generator of lower first cost; and reducing the size of cables, switchgear, etc., and also eliminating step up transformers and, where necessary for stepping up to 132,000 volts, a less costly transformer than previously. The difficulty with the turbine for high speeds was in getting sound steel billets from which to fabricate the turbine rotor (Fig. 3). Steel billets until recently were cast in a mould where length was greater than diameter and tapered from the top. After the cast the outer part and the bottom cooled first and, as the steel assumes its solid crystalline structure, it contracts and fluid metal from the head in the mould makes good the cavities formed by cooling. During the cast foreign matter, sulphides, etc. find their way to the centre of the mould and originate flaws in the ingot which are only found after forging to the diameter of the rotor to be made, and sometimes only after machining when much valuable work has been expended on the job. The method now adopted is to make the mould diameter equal to that of the rotor to be made. The mould is made of highly refractory material and heated to almost the pouring temperature of the metal. The bottom of the mould is provided with a chill. After the cast has been made the chill is applied to the bottom of the mould and heat applied to the top of the mould, insuring that the upper part of the casting is the last to solidify. This prevents segregation and produces roters of a very high quality, fractures and flaws being almost unknown even in rotors for 40,000 k.w. machines.

On the electrical side, the conductors which occupy the slots in the stator are arranged in three separate conductors concentric to each other and joined up in series around the stator. An inner conductor is formed; this is surrounded by a layer of mica insulation, a middle conductor formed round the insulation, a further layer

Fig. 7.—Method of reconnecting the rotor of a motor to ensure its retaining its central position by a corrective pull.

of mica insulation, the outer conductor is formed round the second layer of mica insulation and, finally, a layer of mica insulation round the outer conductor to insulate it from the stator core (Fig. 4). The conductors are stranded. The voltage is graded from the inner to the middle conductor and then to the outer conductor. A machine of this description has been in service over a year in this country.

Regarding switchgear, starter, controller, and contactor gear, it is to be noted that with the frequency change all coils that are interlinked with flux will have an altered value. Current or series transformers run on trip coils are least affected and may have sufficient latitude to function. Adjustment can be made and, if within the scope of the coil, new markings for overload should be made. Potential or shunt coils will require renewal. All operating coils on contactor switches will require renewal and great care must be taken in fitting in the new coils. The bolts must be drawn up equally or distortion may cause mal-alignment of the operating spindle and lock it and so prevent the proper operation of the contactor armature. Trouble will also be experienced on the rotor resistances of slip-ring motors and these should be renewed. Rotor controllers of the "eddistat" type will require renewal for 50 cycle operation. Stator switches require new no-volt or hold-on coils. Also where there is a voltmeter, new potential transformers will be required. Star delta starters will operate quite well on 50 cycles. Instruments have been discussed in a previous paper read by Mr. Roxburgh, Aug., 1928.

Cable sheath losses are only of importance on large single core a.c. cables such as are used between alternators and switchboards, or between switchboards and transformers and convertors. The resistance is not increased to any appreciable extent below 20,000 volts. Lead sheathed cables should be placed as close together as practicable and should be bonded at one end only with a nonmagnetic bond of metal. If cables have no lead sheath and are clamped in insulators, care must be exercised not to make a closed magnetic circuit round individual cables by using magnetic metal to surround the cable. One of the straps used could be of hard wood, etc., or both straps could be iron or steel and alternate bolts could be brass or copper. The reactance is doubled by doubling the frequency which will increase the impedance of the cable. Dielectric hysteresis will also be doubled, but these phenomena have very small values below 20,000 volts. Busbar clamps should not make a complete magnetic ring round the conductors. One half of the clamp should be brass or other non-magnetic metal. Iron washers or tubes should not be threaded on to individual conductors as they generate heat due to forming a closed magnetic circuit. They may be split by a sawdraft or, better still, be made of non-magnetic material. Modern three-phase cables will function quite well on 50 cycles without any special provision being made. It is wise, however, to explore the various phenomena and understand the laws governing their effects.

Mercury vapour rectifiers have seriously challenged rotating converting machines and in many classes of work have ousted the rotary and motor converter. 2000 k.w. is quite an ordinary output for a sub-station converting a.c. to d.c. by mercury vapour rectifiers; which are also able to compete successfully with outputs which are only fractions of a k.w. All that is required for installing the M.V.R. is to be sure that the a.c. voltage is correct to give the proper d.c. supply. The rectification is not affected by frequency change over a wide margin. A 50 cycle rectifier would operate satisfactorily on 100 cycles and *vice versa*. Where a transformer is installed to correct the a.c. voltage for the rectifier, the transformer must be reconditioned to operate on 50 cycle supply. In a large equipment where there are motor-driven accessories, the motor must be reconditioned or replaced. It is possible to run on the existing 25 cycle transformer at 50 cycles on a M.V.R., the only difference being that the regulation will become steeper and the regulation, if 6 per cent. at 25, would be about 10 per cent. at 50 cycles. In cases of doubt, consult the manufacturers, but compare notes and form a personal conclusion from good reasoning.

The output of a static condenser increases in direct proportion to the increase in frequency and also increases as the square of the voltage. Some manufacturers claim advantages operating at 600 volts; where this was done an auto-transformer was used to step up the voltage from 440 to 600 volts at 25 cycles. On a 50 cycle supply and under the same voltage conditions, the output would be double. If the transformer is removed and the condenser put across the 440 volts at 50 cycles, the increase in out-put is limited to 7.5 per cent.

As from 600 to 440 volts the output is reduced in ratio of 600^2 to 440^2: a condenser of 100 k.v.a., 600 volts, 25 cycles, would when connected at 440 volts, three-phase, 50 cycles

$$\frac{100 \times 50 \times 440^2}{25 \times 600^2} = 107.5 \text{ k.v.a.}$$

Generally the change of frequency with apparatus of this kind is a much easier proposition than with power factor rectification motors, and it is really a job for the manufacturers of the apparatus. It is delicate work and parts of the work are done under oil and also under vacuum, and require special apparatus and facilities. Condensers which are designed to operate on say 2000 volts, 25 cycles, may operate on 50 cycles without change if the condenser is sufficiently robust to stand the increased current, which would be doubled. Switches, busbars, and cables, would all require to carry double the current.

Turning now to the matter of transformers: the fundamental transformer equation is

$$E = 4.4 \times A \times B \times N \times f \times 10^{-8}$$

4.4 Constant; A core area; B Flux Density; N number of turns; and f Frequency.

To consider the possibility of using a transformer (wound for and designed for operation on a 25 cycle system) on a 50 cycle system, it is evident by the equation that the turns N are fixed and that the cross section A of the iron core is non-variable. Therefore, we may vary the voltage and and also the frequency. Almost any change amounts theoretically to a voltage change. It will be apparent that to use a 25 cycle transformer on a 50 cycle system and so doubling the frequency will halve the flux density, assuming the voltage is stationary or constant. This may be easier understood by saying the duration of the cycle is halved because the cycle which required 1/25th of a second to complete is now completed in 1/50th of a second (Fig. 5). The voltage is only impressed for half the time and so the flux density is halved, but in a converse design, using a 50 cycle transformer on a 25 cycle system, halving the frequency has the effect of doubling the flux density which means that it is not possible to operate a 50 cycle transformer on a 25 cycle system unless the voltage is reduced proportionately to the frequency, say halved, which of course, means half the transformer output.

With transformers, as with other apparatus, if the transformer can be rewound, reconnected, or reconditioned at a reasonable cost, say one-third of its value, and it is less than ten years old, by all means do it; but its efficiency, power factor, and utility, must be equal to a modern design of the same capacity.

Assuming a transformer has been designed for 6600 volts normally, and has an induction density B at 25 cycles of 15,000 lines per square centimetre, and a reactance of 4 per cent., the assumed k.v.a. to be 500, we consider operating the transformer on a 50 cycle system, with the same impressed voltage, i.e., 6600 volts. We then have a reduced induction density which is exactly halved or 7500 lines per square centimetre, which gives approximately half the iron loss compared with the transformer being operated on 25 cycles. The reactance will now be about 9.5 per cent. It is not practicable to increase the impressed voltage as the iron loss would rise to an abnormal figure and cause overheating. Assuming that the voltage be doubled, that is, operating the transformer at 13,200 volts, this would double the k.v.a. output (1000 k.v.a. 100 per cent. overload) and give an induction density of 15,000 lines per square centimetre which in turn would give an iron loss of a little more than double the loss than when operating on 25 cycles. The copper losses would remain constant and the reactance would be about 4 per cent., but it would not be possible to operate the transformer for any length of time owing to the overheating of the core. The transformer does not conform to the conditions, efficiency, and utility, and should be scrapped, or the question of reconditioning taken up with the makers.

To discuss still further the problem and view it from the other side: assume conversely a transformer designed for 50 cycles and operating on a 25 cycle system. The voltage being 6600 volts, as before, output 500 k.v.a., reactance 4 per cent., induction density, as before. The result is overheating due to the induction density being doubled and the effect is similar to a 25 cycle transformer operating on 50 cycles with double the impressed normal voltage. Assume that we operate the transformer at half voltage, 3300 volts, which would give normal induction density, which will also give approximately half the 50 cycle iron loss, copper loss, etc., will remain the same. Here arises a very important point. It will be observed that the decrease in the induction density gives an increase in the reactance and also a decrease in the short circuit current of the transformer. For this reason it is not advisable for transformers to operate on frequencies lower than that for which they were originally designed, as they are liable to be subjected to extremely heavy short circuit stresses which are mechanical as well as electrical. The advantage of change, if any, lies with raising the frequency as the transformer is much less liable to suffer from short circuit stresses, providing the voltage is not increased above that allowed for in the original design.

From a technical design point of view, it is quite reasonable to operate a 25 cycle transformer at a somewhat higher voltage figure than the normal 25 cycle figure without the possibility of undue heating or stresses or strains, mechanical, electrical or physical being set up. It would be safe to assume that a transformer designed for 25 cycles at 6600 volts would operate quite well on 50 cycles at 10,000 volts and comply with the efficiency and utility standards. With this transformer operating at 10,000 volts the induction density will be somewhat below that at 25 cycles but the iron loss will be approximately the same. The impedance will be increased 6.6 per cent. to 10 per cent., as 4 per cent. is to 6 per cent. This arrangement can be quite conveniently allowed for in the originally designed transformer by operating a three-phase transformer as mesh connected on the H.T. side for 25 cycle operation and, on being reconditioned, for 50 cycle operation to be star connected. It would be wise, therefore, in inquiries for 25 cycle transformers to ask the makers for the dual duty apparatus so that it may be readily changed over to the new frequency with the minimum possible trouble.

Core and shell type three-phase transformers, single phase units grouped together, follow the same fundamental rules within reasonable limits. Three to single phase (Scott connected transformers, three to two phase) may be reasoned out in the same way.

In addition to satisfying one's self about the change, it is not undignified to request the designers' advice and it will be a source of satisfaction to one to find his reasonings and deductions confirmed by those whose daily duties are of a more technical nature than those of the mining electrical engineer. If the apparatus is more than ten years old, iron ageing may affect the efficiency utility standard and the iron worst affected will be at the centre of the core. The transformers may have been subjected to many short circuit strains and stresses and it would be infinitely better to scrap them and start anew on the 50 cycle frequency.

The 132,000 volt grid is nearing completion and the scheming out of subsidiary overhead lines for distribution gives the C.E.B. an opportunity of applying the provisions of the Electricity Act of 1926, whereby surplus energy could be taken from blast furnaces, collieries, etc. To tap the 132,000 volt grid, the minimum size of transformer is decided by the section of wire that can be used in the primary winding. A transformer of 10,000 k.v.a. is about the minimum size. To tap the grid at 132,000 volts costs about £40,000. The subsidiary lines step down to 66,000 volts for distribution to further outlying sub-stations. The next step down is to 33,000 volts and this supply will preponderate in mileage over the higher pressures. The sub-stations fed at 33,000 volts will again step down to 11,000 and 6000 volts.

This is essentially a coal country and will always remain so. The author will not challenge the economies of hydro electric stations, but he wishes to show that many iron works and collieries can economically supply surplus power to the C.E.B. system and compare favourably with hydro electric schemes. One pound of coal with a calorific value of 12,000 B.Th.U. per pound contains as much energy in foot pounds as 40 tons of water falling 100 feet. A good steam generating station can be laid down for £12 sterling per k.w. Hydro stations in this country cost about £50 sterling per k.w. The life of a steam station and its output is a known factor. The iron works or colliery surplus station has no freight charge for coal or ash removal. The fuel may be used as gas in steaming boilers, gas in gas engines, low grade coal on chain grate stokers, or semi-coking with recovery of by-products. Each scheme would be a proposition on its own merits and would be very sound economics from the point of view of affording benefit to the country as a whole. The surplus station could be connected to the network at voltages where the cost of switchgear is at a minimum and transformers could in most cases be eliminated. Time of day is also in favour of the surplus station, as the domestic load is highest after the colliery day shift is over. This proposition should have serious and earnest consideration at the present time by the C.E.B. and all industrial concerns who have surplus supplies which may be converted into electrical units.

The size of the surplus station is a matter for the C.E.B. and industrial economists to decide. Some colliery electrical schemes at present have outputs equal to the largest municipal schemes. To facilitate the broad-minded co-operation of engineers in all power generating and distributing schemes should be the object of all technical associations of to-day. How to increase the employment in this country and make full use of all our resources economically can only be accomplished by economists in every phase of industry being invited to put forward schemes which have been carefully considered and submit them to examination and discussion on broad and unbiassed lines. Each of us wants this country to employ all its manhood and we as an Association wish to give our whole efforts to accomplish this object.

Discussion.

THE CHAIRMAN.—Mr. Laird's paper deals very largely with propositions which will have to be met by practical mining men, and would be of great assistance in solving those problems. There was one relevant point Mr. Laird had omitted, namely, that of reduced output, or temporarily reduced output, while the change-over was being made; and it would be very difficult to estimate to a nearness the time this may require in any particular case. A good deal of progress had already been made in the change-over in some districts, dealing chiefly with industrial works, and Mr. Holmes believed the change had been effected with very little interruption to normal operations. He anticipated, however, a very stiff proposition before the power supply authorities when they came to effect the change-over in the pits. He would ask some of the colliery electrical engineers present to give their views on the subject: there must be many of them who would like to criticise or to add a little further information to Mr. Laird's paper.

Mr. ARTHUR DIXON said he felt some difficulty about the paper because of Mr. Laird's attitude towards the subject. To one who had not been in touch with the question this paper would probably give the impression that the colliery electrical engineer has not only a great deal of work to do, but has a final say in connection with the frequency change. Mr. Dixon said he believed that was not to be the case, as the change would be made by the Central Electricity Board through the supply authorities. Mr. Laird had said in more than one place that if a machine were more than ten years old it should be scrapped: well, who is to scrap it? It would appear that it is not in the province of the mining electrical engineer or even the owner to do so. The decision is out of their hands entirely, excepting that as he, Mr. Dixon, understood the position, the consumer is not supposed to lose anything by the change.

It would seem that in many cases he should gain, if the change-over were properly organised. Mr. Dixon would like to know from Mr. Laird just what his point of view had been in writing this paper. Was it to make them generally conversant with the things that they would be up against, or was it for the guidance of the people who were actually going to carry out the change?

Mr. ROBERT ROGERSON.—One of the points of interest is the author's suggestion that it is cheaper to instal mercury vapour rectifiers than to try and convert a 25-cycle rotary converter to one of 50 cycles. He, Mr. Rogerson had recently tried mercury vapour rectifiers on bell circuits underground with some little success. In that case the rectifier was connected from the lighting mains through a double-pole switch at 110 volts transformed down to 10 volts and converted into direct current through the rectifying valve. Several bell circuits could be operated on the three-wire system from the same rectifier.

As Mr. Laird had suggested, some form of loan should be raised to give rural areas an inducement to take a supply, and thereby create the means, through a higher load factor, of making a cheaper stable unit charge. The high cost per unit chargeable to the small number of consumers in the first instance was the chief cause of domestic load factors being so low as they are to-day. In conclusion, he would like to ask Mr. Laird how he considers the frequency change-over will be carried out. Will a complete change-over be necessary, or will the work be carried out section by section?

Mr. A. P. ROBERTSON.—The author said that, taking a 25 cycle piece of apparatus and making allowance for the induction, the voltage could be raised say from 6500 volts on 25 periods to 10,000 volts on 50 periods, thus enabling the apparatus to run on 50 periods; Mr. Robertson said he could not see where the 10,000 volts supply was to come from. If 6500 volts is the present pressure it will still be the pressure at 50 periods, and to raise the primary voltage on the transformer to 10,000 volts and to work it on the 6500 volts supply would give a very much lower voltage on your secondary side. He did not exactly catch the author's meaning.

With regard to 25 cycle transformers working on 50 cycles there was no difficulty at all: they were just switched right over and worked perfectly well in most cases. Mr. Laird had not made it quite clear that a 50 cycle transformer could not be worked on a 25 period supply; it would probably only stand up about half an hour; there was no 50 cycle transformer that had been working for any length of time on 25 cycles. Two of the difficulties with working a 25-cycle transformer on the 50 period supply were the regulation and the difference in reactance. The reactance was approximately doubled, which was a good point in some ways, as it saved the transformer and the line from short circuit surges but the regulation was also raised, and that had serious consequences.

Then with regard to the dual frequency transformer, the author said that the transformer might be wound delta on 25 periods and star for 50 periods. Mr. Robertson did not know why that should be: it would not make any difference whether it was delta or star from the point of view of the periodicity.

Another point which Mr. Laird mentioned was that if the voltage were doubled, the transformer would give double the output, but that would be useless as the secondary voltage would be 880 volts approximately, and the motors were designed for 440 volts only. The author mentioned doubling the voltage in many cases; Mr. Robertson would like some elucidation on that point: what did the author mean to convey? Then as to rewinding motors and altering connections and so on, those were purely matters for the designers; it was almost impossible for any colliery electrical engineer or distribution engineer to re-design the windings on a motor and, in the case of a colliery, it was hardly ever possible to get it shut down long enough. Mr. Robertson could not see how they were to get time to rewind unless the collieries had a lot of spare plant—which was hardly likely to be the case in the poverty-stricken state of the colliery industry at the moment.

Certainly the sale of surplus energy to the Central Electricity Board would be a good thing, but the cost of tapping the line for taking the service might in many cases be against it. In the North East Coast area of England, which works at 40 cycles, there were a great many waste heat stations which fed into the network and the unfortunate thing about that was that they could not give the energy when it was wanted. When the collieries were shut down there was plenty of surplus power, but unfortunately nobody wanted it then as it was generally during the night. That was one of the great difficulties.

Again, on a 24 hours' supply feeding into any system, the load factor was lowered in the main station, which was generally equipped with more economical plant which it was desirable to keep running. The capital expenditure was also very much greater, and lowering the load factor certainly lowered the efficient generation. As Mr. Dixon had pointed out, Mr. Robertson thought that the question of determining whether new motors or rewound motors would be substituted would lie with the Central Electricity Board.

Mercury arc rectifiers, which were mentioned by the second speaker, were not at the moment cheaper than rotary converters, and while they were a very efficient piece of apparatus, that again was a point which would be determined by the Central Electricity Board on the principle that he who pays the piper calls the tune.

Mr. SMART said the thing that worried him most about this change-over was the time that would elapse when getting power units converted. It was all very well when having motors running there were spares available, but what was to happen when waiting for rewinds, etc., to be done and no spares at hand to carry on with?

Mr. FRANK BECKETT in thanking Mr. Laird for his very interesting paper, said there was certainly a great deal of useful and interesting information in it, which he was quite sure the colliery electricians would be very pleased to get. He, himself, fortunately, was not very much directly concerned with the change-over, but it seemed to him that when the change was taking place at the colliery there was going to be a big loss of output; he could not quite see how it would be possible to change over a large number of motors at a pit without loss of output.

Mr. HASTINGS, speaking as an assistant colliery electrician, wondered, when the change was actually to be made at the collieries, who would have this thing to consider. Would it be the colliery electricians? In the generality of cases he did not think that would be so: he did not think they would have much to do with it. But if a man had to consider these problems as a colliery electrician, surely his remuneration would be much more than is now general. The man would have to take up work of the type dealt with in the paper, and would be above the present-day standards of colliery electricians' remuneration. The author had said that the status of the colliery electrician was rising through the efforts of the Association, and that his reward was sure to come. Did Mr. Laird mean that the improvement would be in mental status only or also in financial status?

Mr. JAMES COWAN said he had listened to the paper with great interest, and it had been of great benefit to him. Mr. Dixon and Mr. Robertson had made the statement that the Central Electricity Board would be responsible for the entire change-over. Mr. Cowan left the mines perhaps a year ago, and still had very strong recollections of some of the difficulties. There was one point, and that was that the Central Electricity Board may theoretically do the work; but he expected the C.E.B. would do so only as far as the surface switchboard. The colliery electrician, however, would be required to do everything from there inbye, and that could only be done, not in a weekend, and perhaps not in six months' time. It meant hours, very many hours, of overtime with the consequential cost. Perhaps the Central Electricity Board would bear that cost; he did not know, but it seemed that the mining company and the colliery electrician in general would have to bear most of the inconvenience and work. It was his impression that the work of the Electricity Supply Authorities in any case ended about the switchboard, and the mining electrical engineer starts from there onwards.

Mr. A. P. ROBERTSON.—An important point that had not been brought forward with sufficient prominence was the time available for changing. It was imperative that the whole change-over must go to a programme and that must not be lost sight of. Six months and a year have been mentioned as times in which to get one job changed over. Well, many of them would have to be changed over in one week-end. The jobs must be changed over when not required by the Central Electricity Board; they could not wait, and the Central Electricity Board would make the time. He, however, did not wish any of the colliery electricians to get the idea that the Central Electricity Board were autocratic. The Board wanted to work in a thoroughly helpful co-operation with all the engineers, but the time would have to be considered, and these jobs, as had been mentioned, would be done on overtime mostly. All the material must be got to specified dates, and the change-over must also take place up to time. There must be no six months in it, otherwise the work would never be put through.

Mr. JAMES COWAN.—Perhaps six months was a maximum estimate. In some types of mines, there are a large number of motors and one line of cable to supply practically the lot. It seemed obvious in cases of that kind if one motor is changed, the whole lot will have to be changed at the same time. The substations in the majority of medium-sized mines, were not suitable for isolating parts of the mines, installing 50 cycles, and maintaining 25 cycles, so that if the change had to be done in holiday time, a week normally was the time that must be allotted, and most of the individual collieries would not be able to cope with that at all. They would require outside assistance: and where it might come from was not very plain, unless it be from other collieries. It may mean loss of output and certainly inconvenience, but it stood to reason that in a medium sized colliery in Scotland, most of the change-over must be done at any one time. In some of the larger and more modern mines, however, with fairly wide areas, and various feeders from the pit bottom, the minimum of inconvenience, and cost might be caused.

Mr. ARTHUR DIXON said there seemed to be a good deal of doubt as to what was to happen and he confessed that he, too, felt doubtful. He had had occasion to look into more than one case of how certain collieries were to be changed over, and so far as he could see it would mean that before a start could be made all the new motors and new plant would need to be on the job, and the ordinary normal colliery would have to be tackled in sections.

The last speaker had mentioned that it had all got to be done in a week-end, but by using frequency changers it was possible to do say a branch cable at a time or start near the coal face and work back, or if there was a ring main that could be worked in too, and done in sections without shutting down the colliery. In one case of a fair sized colliery, if he remembered aright, it was estimated that the change-over could be done in six weeks. That would depend upon all the new plant being there, and a frequency changer of perhaps a couple of hundred kilowatts. The vital parts would be done during week-ends so as not to interfere any more than necessary with output. For a colliery of say 1000 horse power with perhaps 50 motors, he could not see how it could possibly be done under say six weeks. As far as incidental expenses were concerned it would seem that the labour, or the cost of labour (and possibly also the cost of preparing a scheme for the change-over) was a charge against the frequency change, but no consequential damages or compensation for loss of output were allowed. That was expressly prohibited by the Act.

Mr. LAIRD (in reply) said he would leave the matter of loss of output at the pit, which Mr. Holmes was worrying about, to the C.E.B. and the Supply Authorities and the colliery owners and managers. The sole object of the paper was to give the colliery man a lead so that he could size up a machine and say how he could change it for 50 cycle operation. As to the time required for changing over a motor or re grouping, one day would be sufficient for a motor up to 100 h.p.

Mr. Robertson was critical regarding the changing of transformers from Delta to Star, and so on, and said that the transformer could be used on 50 cycles if designed for 25 cycles. Then, if that be so, why not design all transformers for a universal range between 25 and 50 cycles? In fact, a transformer is particularly designed for a definite load on 25 cycles, or it may be particularly designed for a definite load on 50 cycles. The reason for mentioning that the transformer could be used on the mercury vapour rectifier was because a transformer rectifies current which is supplied to d.c. apparatus which has no varying power factor. About the change-over in the colliery, Mr. Robertson had said that the time would be definitely given by the Central Electricity Board, but a number of men might make up their minds that they would start to build Diesel engines, and the first thing they would have to do would be to find the personnel to establish their works and offices; they would have to find craftsmen who could build Diesel engines. To send a man belonging either to the Central Electricity Board or to the Supply Authorities down the pit (without pit experience) would be rather like manslaughter. The colliery engineer or mining electrical engineer from early training are the only men who realise what is required underground. Mr. Laird mentioned the case of a very badly conditioned colliery that came under his observation, and he had a works staff which he took one week-end down that pit to clean it up. Some of those men were laid up for weeks after it, and many of them never got into where their jobs were; yet they were ordinarily good tradesmen. Engineers frained on the surface have not the pit instinct. In the paper, mention was made of frequency changers, and saying that they would be paralleled on either side; the object of introducing that subject at all was that these would be used by the Central Electricity Board and also by the Supply Companies.

STOKE-ON-TRENT SUB-BRANCH.

Chairman's Address.

J. F. AUST.

The opportunity and privilege of airing one's personal opinions and views on non-technical matters fall among the advantages of being elected chairman or president of a Branch. Mr. Aust, at the beginning of last session, used this advantage effectively in his inaugural address from the Chair. The part filled by the A.M.E.E. in educating and developing the engineer of the mines—and other manual workers—was brought prominently forward in a clever historical narration comparing the evils that once were, with the better that is, and the sure promise of the future. It is not possible to give a full report of addresses of this kind in these pages. We can, however, give the speaker his due credit and support it by a few pointed abstracts from his speech such as follow.

"It is now some twenty years since the formation of the Association of Mining Electrical Engineers, for it was on the 17th December, 1909, that the inaugural meeting was held at the Midland Hotel, Manchester. The reason for the formation was to improve the status of those engaged in electrical work in and about collieries. The meaning of the word 'status' as defined by the first President, Mr. William Maurice, is 'that condition of society in which a man's career is determined for him by the social system into which he is born'. Mr. Maurice went on to say, 'You do not elevate your status by the mere fact of joining this Association, it is you who must first raise the Association'. Has this been accomplished? The function of the Association was to consider means for minimising the risk attending the application of electricity to the industry of mining; to facilitate the exchange of information and ideas on this subject amongst its members; and generally to extend the experience, increase the efficiency, and elevate the status of those engaged in such applications. Have we succeeded?"

"We enter into a desire for knowledge sometimes from a natural curiosity and inquisitiveness, sometimes to entertain our minds with variety and delight, sometimes for ornament and reputation, sometimes to give us the victory of wit and contradiction, and most times for money and profession, and seldom to give a true account of our gift of reason for the benefit and use of man."

"In my opinion," said Mr. Aust, "the true value of learning is in direct proportion to one's ability to impart it to his fellows."

"Character and personality will develop cleanliness; clean machinery, the replacement of a missing bolt, the alignment of bearings, the tightening of a belt. It eliminates the 'that is near enough'; it lessens waste—waste of material, waste by friction, waste of design, waste of effort—in a word it defeats inefficiency."

"What the watersheds are to other countries so are the coal measures of this country to us, and in the course of a few years it will be a punishable offence to burn 'green' coal. The immediate problem to be solved is to distil every ounce of coal raised, extract the by-products instead of sending them up the chimney, and give consumers a fuel super-rich in thermal units, but of a smokeless nature."

Speaking of the education of juveniles, Mr. Aust said, "I would have the children sceptical to a degree: they should be taught to enquire why and wherefore; I would have them taught discontent—discontent with the ugly and dirty, with unwholesome surroundings, with their cramped and insanitary homes. I would have them cultivate a love of beauty—beautiful pictures, works of art, the love of flowers, I would have them taught the lessons to be learned from the rocks, the sea, the air, the infinitely tiny electron, and the gigantic star depths which we measure in light years. Let this be our goal and we need not fear the future, for experience has established the fact that in proportion as the people are instructed, so do they form their habits of prudence, thrift, love of freedom, and justice.

Mines Managers' Electrical Questions.

At the May Examinations for Mines Managers' Certificates of Competency, the Electrical Questions set were:

What is meant by "power factor" in electrical power applications? How can the power factor be raised and what are the advantages of raising it?

The neutral point of a three-phase electrical system may be "earthed" or "insulated." What is meant by these terms? What are the advantages and disadvantages of an earthed neutral?

The brake horse-power of an electric haulage is 75. The mechanical efficiency of the haulage gear is 0.8 and the efficiency of the motor is 0.88. The electric power is three-phase, 50 cycle, 400 volt, at a power factor of 0.8. What will be the current in amperes?

Describe the mechanical parts of an electric motor-driven pump suitable for placing in an inbye pump-house to raise about 60 g.p.m. of water to a head of 300 ft.

What dangers may be apprehended when coal-cutting and conveying machinery is extensively employed in a dry and dusty mine yielding firedamp? What special precautions should be taken (*a*) When using compressed air, (*b*) when using electricity?

What steps have to be taken before electrical apparatus can be introduced or re-introduced into a mine?

What are the differences between a three-phase induction motor with wound rotor and a direct current shunt wound motor?

What are the General Regulations regarding the use of electricity for working coalcutting machines?

Quote, as nearly as you can, the definitions of the following expressions relating to Electricity as given in the General Regulations; (*a*) "Medium Pressure:" (*b*) "Apparatus:" (*c*) "Open sparking:" (*d*) "Electrician."

Working of Direct Current Generators.

F. MAWSON.

(This is the eleventh of a series of Articles intended more particularly to help Students and Junior Engineers: the preceding article appeared in the March number.)

A POWER station usually contains a number of individual sets or generating units, each consisting of a generator and its prime mover which may be a steam or gas engine, or a steam or water turbine. This division of the generating plant into units ensures a continuity of supply, for should one of the units break down the others are not affected, the faulty unit can be shut down and a spare one run up to take its place. This method has also the advantage that, during certain periods of the day, the total load may be very heavy and therefore nearly all the sets will be in operation; at other times the load demand may be low and require only one set; thus each set according to the power demand may be practically running at full load, i.e., at the maximum efficiency during its operating period. This improves the efficiency of the whole plant and, moreover, the arrangement permits of further extensions to be made by adding another unit when required, provided that sufficient space has been allowed for these extensions. The units added can be of the same type as already installed, thus giving uniformity of operating gear, with the advantages of interchangeable and few spares being needed.

Generators in Series.

Direct current generators are seldom run in series except to produce a high pressure for transmitting the current over long distances. The generators in this case are series wound and connected in series, their pressures added in the same way as the voltage of two or more cells in series, but the current output is not increased. Small series dynamos are sometimes placed in series with the outgoing mains or feeders to raise, or "boost," the voltage. The "booster" in this case is known as a "feeder booster" and is driven at constant speed, so that whenever no current is flowing in the line, the "booster," being series wound, generates no e.m.f.; when, however, a large current is flowing, the "booster" has a strong field and hence generates an e.m.f. which is added to that of the main generator. The e.m.f. generated by the "booster" thus depends upon the current flowing through the line and it therefore automatically compensates for the greater voltage drop under load and maintains a constant voltage at the far end of the line.

Generators may be run in series with very little difficulty whether series, shunt, or compound-wound; in the latter case, the compound coils must, of course, be in series with the line.

In most cases, however, the demand is for a large current output rather than high voltage, hence plain series running with main generators is not common.

Generators in Parallel.

Direct current dynamos are much more frequently operated in parallel than in series, and the simple connections are shewn in Fig. 1. In this case, to make the diagram as simple as possible, no field windings are shewn. Each machine generates the same voltage and the pressure between the lines is the same as if only a single machine were in use, but the current delivered to the feeders is the sum of the currents in the separate machines. Each machine delivers current through its double pole switch to the busbars as shewn, like terminals (polarity) of each machine must be connected to the same busbar.

In practice, both shunt and compound generators are run in parallel, but the compound machine is most common. Series machines are seldom run in parallel, in fact they are now hardly met with, except in some very old plants. They will however be first briefly explained because the compound machine is a combination of the series and shunt machines.

Series Dynamos in Parallel.

Two series dynamos, No. 1 and No. 2, are connected in parallel as shewn in Fig. 2, and each generates its proportion of the current required by a certain load; so long as the two machines generate the same voltage, they will continue to share the load in the proper proportion. If, however, the voltage of No. 1 drops slightly, owing to a reduction of speed or other cause, that machine will at once cease to furnish its full share of the load. Both machines being series wound the field in No. 1 will be weakened, thus further reducing its voltage, and the field of No. 2 will be strengthened, until finally No. 1 will be overpowered and it will run as a motor, with its direction of rotation reversed, this may result in considerable damage.

This unstable condition may be remedied by connecting the inner ends of the series coils of the two machines by a low resistance conductor as shewn at a.b. (commonly called an "equalizer"). If for some reason No. 2 at any time delivers a greater proportion of the current than No. 1, current will flow through the coil b.d., and part through the path b.a.c., that is, through the series windings of No. 1. The result being that the current delivered by one machine helps to keep up the field excitation of the other machine. Double pole switches should be arranged at F and G, and a single pole switch in a.b., so that each machine may be run independently.

Shunt Machines in Parallel.

The connections for two shunt dynamos in parallel are shewn in Fig. 3. If, owing to drop of speed or other cause No. 1 should reduce its voltage and fail to supply its proportion, more load would fall on No. 2. As the load in a shunt dynamo falls, the voltage increases, and, as the load increases, the voltage falls; therefore the tendency would be for the voltage of No. 1 to increase and for No. 2 to decrease until the two were again equal. Shunt dynamos are, therefore, well adapted for parallel operations.

When starting, all switches should be open and the machines brought up to the desired speed. One machine, say No. 1, is first excited and thrown into the circuit. The shunt field switch A closed and the field strength adjusted by means of the rheostat r_1 until the voltmeter v_1 indicates the proper e.m.f. The main switch M is then closed and the rheostat again adjusted to give the required e.m.f. To put No. 2 in parallel, it is run up to

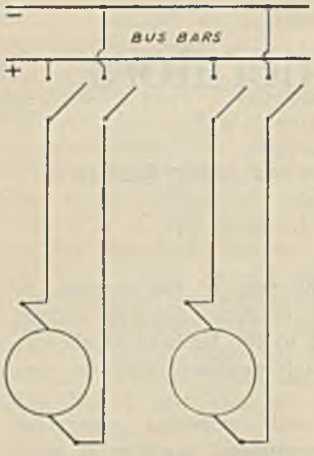


Fig. 1.

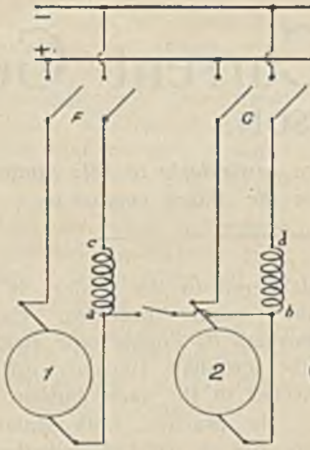


Fig. 2.

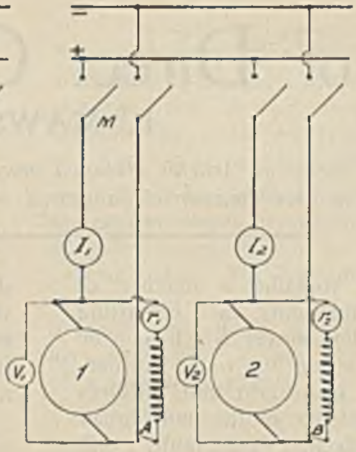


Fig. 3.

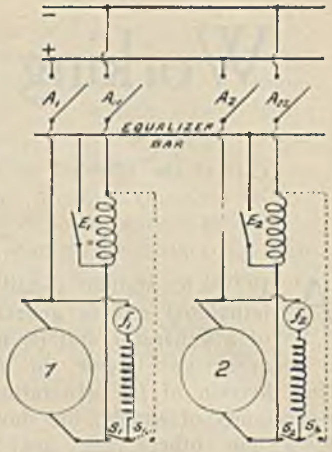


Fig. 4

speed, the shunt switch B closed and the rheostat r_2 adjusted until the voltmeter v_2 gives a reading one or two per cent. higher than v_1. The main switch N is then closed, the two machines should then each supply their proper proportion of the current as shewn by ammeters I_1 and I_2. The division of the load may be made as desired by adjusting one or both of the rheostats r_1 and r_2. Any number of shunt machines may be operated in parallel, each succeeding one started and thrown into circuit by the process described.

Compound Dynamos in Parallel.

The arrangement for parallel running of compound machines is a combination of the arrangements of series and shunt machines. The connections are shewn at Fig. 4. The switches E_1 and E_2 are connected to the equalising bar. The illustration shews two alternative methods of connecting the shunt field, the "short shunt" directly across the brushes as shewn in full lines, and the "long shunt" across the machine terminals as shewn in dotted lines. It makes little difference which method is used.

The general method of starting up a compound machine and connecting it in parallel with one already running can be explained by reference to Fig. 4. Suppose that No. 2 machine is running, its field circuit is closed through the switch S_2 and the regulator f_2, its armature being connected to the busbars, and that it is desired to run up and connect No. 1 machine. All switches of No. 1 should be open as shewn, and the machine run up to speed, then the equalising switches E_1 and E_2, the + switch A_1, and the shunt switch S_1 closed. A current will flow from No. 2 machine through the series coil of No. 1 and the machine will build up its voltage rapidly. The voltage is then adjusted by the shunt rheostat f_1 until the voltage is equal to or a little higher than that of the busbars, the negative switch A_{11} is then closed. After the machine has been thus thrown into parallel, its load is adjusted by varying the shunt field excitation.

If the machine is provided with a circuit breaker, as is the case on modern switchboards, this should be closed before the main switch. Should the main switch be a double-pole one, so that both the positive and negative connections are made at the same time, it will be necessary to run the machine up to speed, close the switches E_1 and f_1, adjust the voltage by the rheostat f_1, the main switch should then be closed.

In connecting machines to the switchboard, the cables should be of ample capacity, and the equaliser bar should be the same size as the main cables.

Standard Specification for Miners' Handlamp Bulbs.

The B.E.S.A. Miners' Handlamp Bulbs Specification provides for the ordinary class of two-volt bulb with a nominal rating of two watts, used underground in collieries. The terms of the specification have been determined after a series of tests which are probably unique. Batches of lamps were manufactured under normal conditions, having filaments designed to operate at different efficiencies.

All these lamps were carefully measured and a proportion of each design tested, in the manner defined in the specification, at several test stations, including those at the National Physical Laboratory, and the Mines Department, Sheffield.

Lamps of each design were also sent to six coal mines, chosen to represent the widely varying conditions normal to the industry, and details of their performance were carefully logged.

The data so obtained from both laboratory tests and experience in the mines, have been used in framing the specification, and its utility in defining a lamp satisfactory to the industry is thereby guaranteed.

Association of Special Libraries and Information Bureaux.

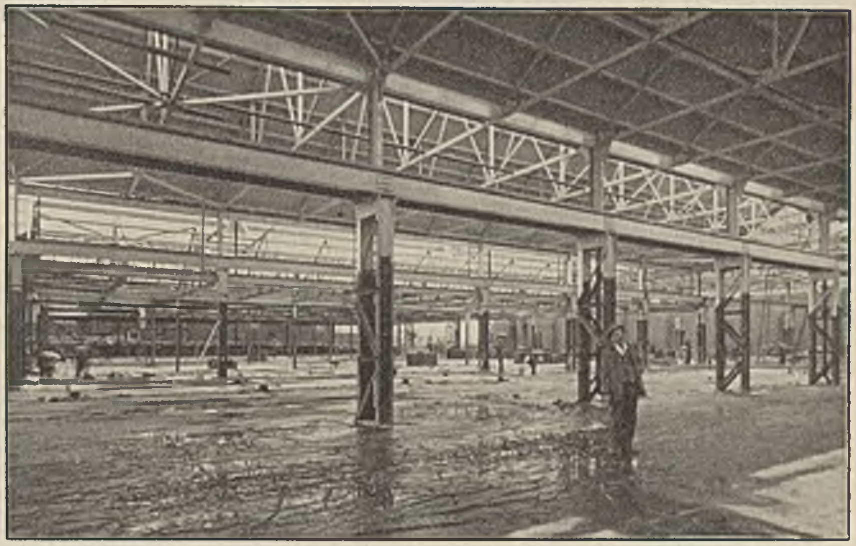
Mr. H. T. Tizard, C.B., F.R.S., Rector of the Imperial College of Science and Technology is to be President of the Association of Special Libraries and Information Bureaux for the year 1930-1931 in succession to Sir Joseph J. Thomson. His year of office dates from the Annual Conference of the Association to be held at New College, Oxford, in September. Mr. Tizard retired from the post of Permanent Secretary of the Department of Scientific and Industrial Research in September, 1929.

Overhead Lines Association.

The Council of the Overhead Lines Association have selected Friday, October 31st, 1930, as the date for their next Annual Conversazione. As was the case last time, the Conversazione will include a supper-dance and up-to-date exhibits relating to the activities of the Association.

Manufacturers' Specialities.

The New Works of J. H. Holmes & Co., Ltd.

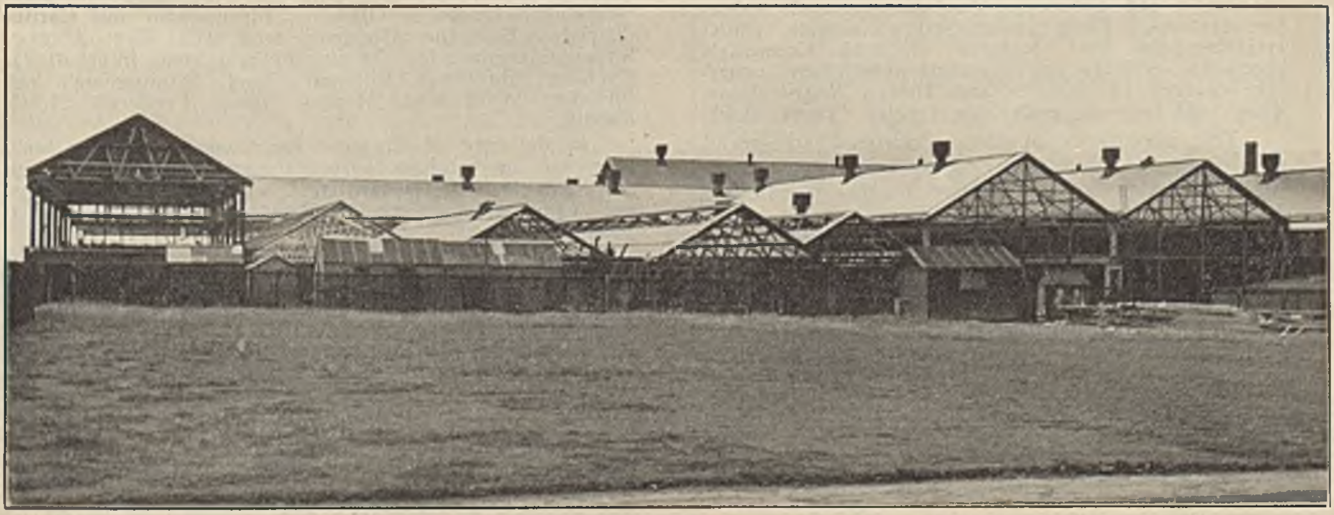


Holmes' Works under construction.

The history of J. H. Holmes & Co. carries back to the earliest days of industrial electricity. The company began in 1883, with temporary premises until the present factory in Portland Road, Newcastle-on-Tyne, was built in 1887. Its first dynamo was built in 1885, a year after Mr. J. H. Holmes had invented the quick-break switch: the parent of all quick-break switches now common throughout the world. It is related that, at the opening ceremony of an early installation of electric light, someone told Mr. Holmes that he had succeeded in turning down the light, a thing supposed to be impossible with the electric light. It was found that the switch had been put into an intermediate position between "on" and "off", and was drawing out an arc, which would of course in time have burnt the switch away. The lights were dimmed, but it was by an expensive destructive method. The quick-break switch was devised by Mr. Holmes to prevent the possibility of such damage in future, and so one element of modern switchgear came into being.

Messrs. Holmes turned their attention largely to the manufacture of electric motors and dynamos, and their work developed in a number of special directions. They soon became recognised as foremost experts in the driving of printing machinery, and in 1898 they patented the Holmes-Clatworthy System of driving rotary web printing presses for newspaper production. Special motor-generators for electro-plating and electro-deposition were also amongst their products, and excellent results were obtained in this far from easy line. Electric welding equipments were another of their manufactures, and other machines of special design were devised as customers' requirements demanded them. In addition they made as standard products a very excellent line of industrial direct-current and alternating-current motors with first-class characteristics. Ammeters, voltmeters, and other measuring instruments, were also made in considerable quantities.

When the firm was reorganised as J. H. Holmes & Co., Ltd., in 1928, work was continued on the old site in Portland Road, Newcastle-on-Tyne, and many important developments have taken place there during the last two years. Newspaper printing press driving equipments have been built with motors of the alternating-current commutator type, and incidentally this has provided a variable-speed efficient alternating-current motor applicable to many ordinary industrial purposes. The design of electro-plating generators was improved, and many new features have been introduced into the electric welding equipments, all tending to give greater perfection in the resultant welds, combined with ease in working. A further interesting and important development is that



The new works of J. H. Holmes & Co., Ltd., Hebburn-on-Tyne.

Messrs. Holmes have begun the manufacture of automatic electric street traffic control equipment, and are thus supplying all-British apparatus for this increasingly useful public service.

The next two or three months will see an important forward step in the Company's history, namely, the removal of the works and foundry to sites adjoining the works of A. Reyrolle & Co., Ltd., at Hebburn-on-Tyne. Entirely new works are now being built, and the most modern and up-to-date machinery and appliances will be available in place of the existing older tools and apparatus in Newcastle, for the continuation and enlargement of Messrs. Holmes's present manufactures. The records of nearly half-a-century's work will be available; and the Company, under the new conditions, will be able to enhance still further its reputation for quality in design and construction. The layout of the new works at Hebburn will be such as to give every facility for rapid and efficient manufacture, and fresh developments in the Company's activities may be looked for.

NEW CATALOGUES.

GENERAL ELECTRIC Co. Ltd., Magnet House, Kingsway, W.C. 2—The installation leaflet No. 21 is a valuable technical description, with many illustrations, of the generating plant and high tension switchgear installed by this Company for the Oxford Electricity Supply.

A. REYROLLE & Co. Ltd., Hebburn-on-Tyne.—A full range of the metal-clad draw-out pillar-type switchgear in which Messrs. Reyrolle specialise is dealt with in detail in the catalogue No. 808. Much of this apparatus is designed specifically for underground mining service and it has received the certificates of Sheffield University for compliance with safety in mines regulations.

METROPOLITAN-VICKERS ELECTRICAL Co. Ltd., Trafford Park, Manchester.—An interesting publication is the descriptive leaflet No. 13 0-1 which reprints a valuable article from the *Metropolitan-Vickers Gazette*, concerning technical enquiry and tests into Noise Problems in electrical plant and apparatus.. The author of the article is Mr. B. G. Churcher, and this publication will be received as one dealing authoritively with an important subject not often approached in such detail.

W. T. HENLEY'S TELEGRAPH WORKS Co. Ltd., Holborn Viaduct, London, E.C. 1.—A batch of three new catalogues and a separate trade price list give full details of the several Henley Wiring Systems. These are issued in connection with the Standardisation of Wiring Systems whereby seven of the leading cable makers have combined to secure uniformity in details and accessories for their several respective systems. These standarised accessories, whilst retaining the best features of each Company's speciality, embody improvements which are generally covered by Patents and Design Registrations. They will be sold under the "C.R." Trade Mark.

The advantages of these improved accessories are briefly as follows:—

Metal Sheathed Wiring, without Bonding Conductor:

1. The Joint Boxes are of substantial construction, are easily fitted together and consits only of the base, cover and bonding clamp.
2. The Clamps are arranged inside the box and are of a novel form, ensuring ease and speed in inserting the wires.
3. The Covers are held in position without introducing centre screws or other devices which tend to restrict the free wiring space inside the box.
4. The Joints and Bonding can be readily inspected by simply removing the cover without removing any screws or disturbing the bonding arrangements.
5. Alterations and additions to connections can be easily made.
6. The Boxes will take any size of cable from 1/.044 ins. to 7/.036 ins. inclusive.

Metal Sheathed Wiring, with Bonding Conductor:

The Joint Boxes possess the good features of the boxes described above, excepting that the internal bonding clamps are replaced by a terminal pillar for the reception of the copper bonding conductor. As the bonding is carried out by means of a copper conductor incorporated in the cable, no special bonding clamps are needed for this System.

Non-Metal Sheathed Wiring, Using C.T.S. or "Maconite" Cables.

1. The Joint Boxes are constructed from Bakelite and embody fixed terminals.
2. The entries are filleted in order that the space for a particular cable need not be made larger than necessary.
3. The contour of the lid has been modified to give a neat appearance.

Another Henley publication is a colour printed leaflet directing general attention to the green coloured porcelain insulators which the Company has devised for countryside transmission as being the least obtrusive and unsightly.

W. T. GLOVER & Co. Ltd., Trafford Park, Manchester.—The several standarised wiring systems of this Company are described in detail and priced in the new List No. 24.

HEYES & Co. Ltd., Water-Heyes Electrical Works, Wigan.—The *Wigan Review* for July is as interesting as ever. The technical subject of this issue is the effective lighting of colliery screens.

CROMPTON PARKINSON, Ltd., Guiseley, Leeds.—Several new catalogues have been issued recently by this Company. Among these might be mentioned the coloured folder illustrating the Company's motors as supplied for various "domestic" trades; and another dealing with the Cinema Installations. Technical catalogues include specifications covering respectively truck-type switchgear, "KRN" slip-ring motors, potential indicators, and ceiling fans.

LIVERPOOL ELECTRIC CABLE Co. Ltd., Linacre Lane, Bootle, Liverpool.—Single and multi-core cables of the low tension type, paper insulated, are covered in this new price list. The list gives a complete specification of each type and much technical detail in regard to dimensions, weights, etc.

New Addresses.

Bruce Peebles & Co. Ltd., have taken more commodious offices at Standard Buildings, Leeds, their telephone number now being 25816. Mr. Cecil C. Higgens, A.M.I.E.E. is in charge of the Leeds Office as hitherto.

New depots have been opened by Metropolitan-Vickers Electrical Co. Ltd., for the sale of their "Cosmos" Lamps in Glasgow, Birmingham and Cardiff districts. For the Glasgow area, 177 West George Street, Glasgow; for the Birmingham area, International Exchange Buildings, Edmund Street, Birmingham; and for the Cardiff area, Mervyn House, Frederick Street, Cardiff.

In the case of Glasgow the Company's meter business will be conducted from the same address.

Sales in the Swansea area will be conducted from the Company's existing offices at 62 Wind Street, Swansea.

Owing to the increased demand in Italy for the Tungsram products, this firm has found it necessary to open a new factory at Milan. Further details of this development can be obtained from the Tungsram Electric Lamp Works (Gt. Britain) Ltd., London.

Personal.

The Directors of Callenders Cable & Construction Co. Ltd., have appointed Mr. Theodor Peterson, M.I.E.E., one of the Joint Managers, who has been in the service of the Company for 35 years, Assistant Managing Director, with a seat on the Board.