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Concerning The Association of Mining Electrical Engineers.

We are much indebted to those prominent members, several of whom were amongst the foremost in creating the Association of Mining Electrical Engineers, for the series of interesting reminiscences which they have so kindly contributed to add suitable distinction to this the A.M.E.E. 21st Birthday Number. It is hardly necessary to couple with this acknowledgment the fact that there were many other hard-working enthusiasts engaged in putting the new scheme into running order. A few have passed away and an occasion of this kind awakens regretful memories. Some, not many, have dropped out and no longer take an active part in the work of the Association. There are, however, quite a considerable number of those pioneers who, happily, still retain an active and enthusiastic interest in the organisation, which they have for twenty-one years helped to foster and develop. To those in the last category we may tender a sincere appreciation of their services whilst regretting that they fought shy of putting their Association impressions into print.

FOUNDERS OF THE ASSOCIATION.

As might only have been expected it is not possible in fairness to credit any one individual, or even a small group of men, with the invention of the Association. The recollections of founder members and a careful perusal of the records of those early days, tend to indicate that the A.M.E.E. "just grew" as a natural outcome or by-product of that active industrial period, which saw the innovation of electricity applied effectively to mining services.

Mr. William Maurice, who was at that time the manager of Hucknall Torkard Colliery and a trained electrical engineer, was the man of the moment to foster the germ of the movement. Upon him, with his strong and forceful personality, combined with the right kind of professional experience, the leadership devolved; he became the first president and continued as such to organise and guide the infant association for three years. He was indefatigable in carrying the message of the new association into every colliery district; he devised the routine by which the affairs of this novel kind of technico-industrial society should be conducted. The Association was definitely launched in April, 1909, and Mr. Maurice must have felt greatly satisfied when he was able in 1912 to leave a thriving society in the hands of those competent men who had associated with him in laying so well and truly the foundations.

Mr. J. H. C. Brooking was another great worker who applied an ardent personality and sound business sense to consolidating the work. He tells us in this number how the A.M.E.E. came into being. It is hardly possible, nor would it be discreet to attempt to mention the names of all who took part. Several have put together a few modest notes for this number. They speak inadequately for themselves; and we will be content with re-echoing their just appreciation of their colleagues.

One cannot help feeling some disappointment that the minutes of proceedings of those early meetings are so cut and dried—that they are, as is not unusual in such documents, of the clipped and curt variety. In this case they are remarkably devoid of references to those romantic personal touches which enlivened the early conferences of men who were as keen prospectors in a land of promise and which would to-day have provided fascinating reading. We are, therefore, the more indebted to those contributors who have committed some of their memories to paper for our benefit. Which is not to suggest for one moment that all the said founder members were pleased to recollect and send along to us is here perpetuated in print. After all, twenty-one years of age presumes discretion: and in regard to publishing an historical record of this character, and of so recent a period, one must be particularly circumspect.

A SOUND POLICY.

It would appear that the secret of the success of the Association centres round the fact that it started off with a simple and definite policy to which, so wise was the pre-vision of its founders, it has been able to conform ever since and in the pursuance of which it has year by year gained greater weight and prestige. The Association was founded to further two great causes in progress; there was the impersonal one of promoting the industrial development of electricity in mining; the other was to help in the making of men best able to force ahead electrical mining interests.

It was realised, therefore, from the very beginning that to achieve these objects the Association should have a very wide door. Not the technical electrical man, the mine owner, the electrical manufacturer, the scientific professor—not any one of these alone, in all their existing respective closely limited conclaves of specialists, could do the effective work which the Association undertook as its leading interest. The aim was to provide an organised society to bring these several experts into regular conference on common ground.

There have been occasions when the voice of semi-hostile criticism has been raised respecting this diversity of membership. Opposition of that kind is quite out of countenance to-day. It is conceded in all circles connected with mining and electrical work that the policy of the Association in regard to its breadth of membership has been fully justified and, moreover, that it has been largely responsible for the enviable strong position which the A.M.E.E. has gradually assumed. The meetings of the Association are distinguished by a liveliness and vigour not found in other technical societies. There is plenty of colour in the varying and often diametrically conflicting opinions of the members to give tone to the discussions, making them always interesting and useful.

ORGANISATION AND METHOD.

Consider then, briefly, the actual doings of the Association and incidentally compare its administrative methods and organisation with those of other electro-engineering and mining societies. The headquarters of the Association are not at any one centre. There are ten branches and seven sub-branches. The branches are each self-controlling. Their respective Presidents and Committees direct the programmes of the branches' activities, and control the finances. Thus the whole of the British mining fields are effectively and equally covered by the activities of the Association.

The collaboration of these several branches in regard to the general administration of the affairs of the Association as a National Body, is covered by the General Council with a number of national sub-committees as a part of its organisation; the whole working under a National President. The General Council meets normally twice or three times a year; the place of meeting being selected from time to time to meet the exigencies of the immediate interests of the Association. Once a year all members are called to the Annual General Meeting, which takes the form of a Summer Convention and which is held in turn in one or other of the greater mining centres of the Kingdom.

It is at the Summer Conventions that the Association comes officially under public notice—and with the gratification of considerable pomp and ceremony. These are the occasions when civic and public authorities and leading men in political national and industrial circles have extended unstinted hospitality to the Association. Their kindly tributes have stimulated and encouraged the members to greater effort and been the means of smoothing out many obstacles from the progressive path of the Association.

GOOD WORKS.

It would be difficult to condense into reasonable space an adequate account of all the work done by the Association. Perhaps the best insight into this is to be gained by a mental comparison of the condition of mining electrical engineering in 1899 with the position to-day. In this mental review it becomes immediately clear that there is no necessity to stress the opinion that the Association has played an invaluable and unique part in the general development and progress of these great industries. Consider, for example, such phases of modern progress as Mines' Research, Miners' Education, National Testing Stations, Standardisation, Government Rules and Regulations, Miners' Welfare, Mines Safety, Competence of Engineers, Mines Inspectorate, and so on. In all these progressive moves the Association has materially assisted.

That this voluntary work of the Association is far from finished (in fact one might say it has hardly yet begun, so much is there still to do) is shewn by at least two outstanding developments of the past few months. The appointment of a deputy Electrical Inspector of Mines and four district Electrical Inspectors to assist the one Inspector, who has for several years past done what would now appear to be six men's work, marks a salient point in the route of progress. Then there is the Report of the special Committee appointed by the Government to inquire into the qualifications of mines' officials and published only a few weeks ago. In that report it is recommended that the duties and responsibilities of the electrical engineer in mines shall be closely defined and there is the further tentative promise that it may be deemed necessary as the next official step in this direction to have the mining electrical engineer legally qualified and rigorously tied by a Certificate of Competency. It is obvious that in these two measures there is a great deal of vital interest to the Association and that they will inevitably involve much of the highest importance in the future deliberations and work of the members individually and as a body.

ECONOMY IN FINANCE.

The notable beneficial results gained by the A.M.E.E. are the more greatly to its credit in that it has grown to sturdy maturity and thrived on an extremely meagre financial diet. There can only be wonderfully good management and a severe tax on voluntary personal services, where a member's subscription of only one guinea a year can do so much and yield such an abundant return. The full member pays a yearly subscription of one guinea; the associate member 17s. 6d.; and the student member only 12s. 6d.

ROLL OF MEMBERS.

The membership of the Association is not nearly so large as it should be. The present roll contains about 2000 names, whereas a conservative estimate of men eligible for membership throughout the country would probably increase that figure by three times. We have already indicated briefly the services which members render to the Association, that is to say the value they put into it. In the hope that the interest of eligible men may be kindled, a few remarks as to what the Association gives back to its members in return might be useful.

For one guinea a year, or less according to grade of membership, each member receives post free a copy of *The Mining Electrical Engineer* every month.

To the fully fledged mining electrician, and to his junior, there is the advantage of an improved status implied by reason of the fact that he has been accepted as qualified for membership.

The regular routine work undertaken by every branch consists of the reading of original papers; discussions and debates; technical lectures; visits of inspection to mines, engineering works etc. Nor is the social side neglected, for it is customary to leaven the sessional work of serious technical character with a modicum of social evenings, dinners, etc.

The value derived from the meetings of the A.M.E.E. rests very largely in the fact that the membership covers such a broad field in the respective mining and electrical businesses. Here, are brought together mining electricians, mine owners and managers, apprentices, college students, consulting engineers, scholastic professors, manufacturers sales engineers and designers, and even government mining officials. To meet these men in friendly conference is surely an advantage and, what is more, it is an advantage which can only be gained in this way by many of those who ought to be members.

INDIVIDUAL GAIN.

There is no disputing the fact that no man who is to make his way in the business world, can afford to dispense with self-advertisement. This term is used not as descriptive of the bombast with the trumpet. It more truly describes the man who keeps himself in the broad, swift running industrial stream, there to be ready to perceive, and seize as they pass, the opportunities for advancement. Persistence in personal retirement within a narrow environment has prevented many a good man from attaining and enjoying the social position warranted by his abilities.

At the meetings members gain proficiency in the art of vocal and literary expression: without the ability or disposition to speak and write coherently, however gifted and expert the engineer may otherwise be, he cannot fully utilise his talents nor gain the ultimate credit or reward commensurate with his technical knowledge and business acumen. These regular meetings keep members in touch with progress, they broaden the field of the general mental outlook—a virtue characteristic of every man successful in a responsible position. The general knowledge of the industrial, commercial, scientific, and social worlds always to be gained by joining actively in the affairs of men is here supplemented by specific information arising out of practical difficulties and concerning particular subjects in which always some of the members are weak.

Members who take part in the inspection of mines and works are privileged visitors and guests: they, being technical men, are entertained and instructed with facts, demonstrations and explanations by staff experts: and thus, aided by conference amongst themselves with process and equipment before them, acquire exactitude of knowledge.

FACTS AND DETAILS.

In connection with the Examinations, which the Association conducts annually as a test for Certificates of Competency for its members, it is interesting to note that in all there have been 662 candidates, of these 13 gained Honours Certificates, 264 First Class Certificates, and 174 Second Class Certificates. It is customary for the Association to give special recognition to any candidate who shews exceptional proficiency in the examinations: in this connection there have been seven Gold Medal awards. The Association offers regularly each year a number of prizes for the best papers submitted during the session: the premier award takes the form of a Gold Medal. Most of the Branches, also, present prizes for papers contributed by their own members.

It will be well here to acknowledge the services so generously given by the chief examiners, who from time to time were Dr. W. M. Thornton, Prof. Ellis H. Crapper, Prof. Magnus Maclean, Prof. Daniel Burns, and Prof. I. C. F. Statham, who is the present examiner.

Various committees deliberate in regard to specific matters entering into the Association's interests and operations. The Association has rendered considerable assistance to the British Engineering Standards Association by considering Standard Specifications and making suggestions; amongst others in this series of activities are those dealing with the following subjects:—Rails, Steel Arching, Tubs, Ropes, Transformers, Switchgear, Cast Steel Wheels and Pedestals and Miners' Lamp Bulbs.

A Committee of the Association also considered in detail questions referred to them upon the Qualifications for Colliery Electrical Engineers, and evidence was given before the Government Committee of Enquiry appointed to consider and submit a Report upon this matter.

Some of the branches have made arrangements with local Technical Societies, for the formation of Joint Libraries, and have valuable collections of scientific books available for home study.

Many colliery owners and other firms have joined the Association as patrons and donors, thus shewing the interest and value which the mining and electrical fields in general attach to the Association.

These notes give but a suggestion of some of the good things which attach to membership of the A.M.E.E. and all of which are enjoyed by all grades of members. Full members, associates, students, and also patrons and donors will perceive that there are many other phases of the Association activities which, whilst useful to all, are of exceptional value to particular classes of member.

Another point of view, often overlooked by those who may be considering the why and the wherefor of becoming a member is this: every name added to the roll adds the weight of an interested, qualified, and responsible man to the bulk effort of the Association towards securing and upholding the industrial status and amenities of mining electrical engineering. The greater the membership and the more fully representative it is, the stronger and more effective is the work which it is enabled to do for the development of the associated national industries and the men and concerns dependent thereon.

Twenty-One Years with the A.M.E.E.

A series of reminiscent reviews by some of those members who have come to be looked upon as more closely identified with the growth of the Association. These writers are only a representative few of the many zealous workers who reared the Association to maturity.

In response to the invitation to tell us something of the youthful days of the A.M.E.E. there were others of these ardent supporters who pleaded that they were ('tis passing strange to-day!) too busy to write; some were even shy of print (which also seems a curious trait in those whose names are as household words); others again begged to be excused for this or that definite or indefinite, mainly indefinite, reason. But one and all were cordially agreed in congratulatory sentiments and wishes that their Association should ever increase in strength with passing years. To which kindliness it will, we trust, not be counted amiss if we, for all the other members, here give many thanks.—*Editor.*

A Word from the President.

Mr. J. W. GIBSON: President of the Association.

IT is a great pleasure to send to all members of the Association hearty greetings on the occasion of its coming of age. Twenty-one years ago some far-seeing engineers perceived the pressing necessity for putting mining electrical practice into definite shape and they, being men of action as well as intuition, set themselves to work and brought into existence the Association of Mining Electrical Engineers. Those pioneers, possessed of great energy and enthusiastic in their enterprise, engaged whole-heartedly in the new venture without a thought of self or personal gain. They saw the need for the spreading of knowledge and the interchange of experience: as much for the advancement of the great industries concerned as for greater reliability and greater safety in the application of electricity to mining.

It is fitting that we should use this opportunity to express our appreciation and gratitude to those who have given their time and efforts for the benefit of mining electrical engineers in general, and the members of our Association in particular.

Great Opportunities await Young Members.

The next few years will see a greatly enhanced rate of development in the use of electricity in all industries and particularly in the more general mechanisation of mining, for which industry electric driving offers overwhelming advantages as the best form of power. The future cannot but hold out encouraging prospects for young men, for the students and apprentices who are obtaining their training and experience under present conditions. To-day, they have a vast fund of knowledge to hand for the mere asking, knowledge which has been gained in the hard school of necessity and experience.

I would urge the younger members of the Association to make full use of their opportunities in the way of technical instruction, in order to qualify for the important posts which are bound to offer in the future. The results of examinations may not always be a true indication of the degree of knowledge gained, but they serve as an indication that the student has achieved some success in applying himself to the task before him. A certificate may, moreover, be a very useful adjunct to a candidate for a possible post.

A lifetime of association with mining has brought me into contact with this industry in all parts of the world, where I have found British trained engineers, both mechanical and electrical holding positions of trust and responsibility.

It is about nineteen years since Mr. W. H. Maurice invited me to become a member of the Association, an opportunity of which I readily took advantage. Since that time the status of the mining electrical engineer has grown in importance, and it will continue to do so as the electrification of mines becomes more complete.

The pioneers of the Association built well. The technical society they visualised and created has attained full age and the strength of maturity. It is to the younger members that we will have to look in future to take the lead and help in carrying forward the praiseworthy objects for which it exists. The best service they can at present render to the Association is to use every possible effort to increase its membership.

Dr. W. M. THORNTON: President, 1921

Formerly Chief Examiner.

MY first direct association with mining electrical engineering was in 1898 when the colliery engineers of the North-East coalfield expressed a wish to have instruction in electrical engineering and formed a class of a hundred or so held on Saturday afternoons: this was a part of a most effective educational scheme for miners at that time active in our district, and recently revived.

Men came to these classes from as far afield as Cumberland, and they were all keen; questions were asked and discussions frequently arose after the classes were over. Three-phase working was just coming in. It was hailed then as a panacea, as indeed it has nearly proved to be, but few at that time realised the problems of safety that were to arise from the extensive use of electricity underground. A succession of incidents brought these problems to the fore, the interest of the electrical profession was aroused and on every hand one heard of the need for a Society to deal specially with mining electrical problems.

There were two distinct movements. One originating in Whitehaven desired a Society on Trade Union lines for the protection of the colliery electrical engineers whose responsibilities were being so much widened. The other, guided by the vision of Mr. William Maurice, then of Nottingham, saw an association as we have it to-day, a technical society pooling its knowledge, one in which every problem of electrical engineering as applied to mining would find a place.

I was present at the meeting in Manchester when the question had to be decided as to which of these two directions we were to take. After a full discussion the latter won the vote. There was then the discussion as to the title of the new society. "The Institution of Mining Electrical Engineers" was favoured, but seemed to cut out the working members. A telegram to me from the Institution of Electrical Engineers suggested "Association" rather than "Institution"—to avoid any possible clashing of title and interest, and as clearly indicating the purpose of the new Society. There were other organisations connected with the coal industry in which the word "Association" was already used as a title. The Coal Owners' Associations, The National Association of Colliery Managers, and the various miners' Associations. The suggestion was adopted by the meeting and the Association of Mining Electrical Engineers came into being.

The details of the early meetings are in our records but the history of the Association during the last 21 years has shewn the wisdom of the early choice of direction. The best judgment and widest experience of those connected with electricity in mines in any capacity have been at the service of the Association.

One of the original purposes, that of raising the status of the colliery electrical engineer, has been constantly in view; but in this as in all such organisations, the pressure must come from the members themselves. To foster this vital activity, by discussions, by the Journal, by favourable consideration on the part of colliery management, no effort on the part of those in responsible positions in the Association has been spared.

Some of The Builders.

Mr. A. B. MUIRHEAD: President, 1922-1923.

THE publication of a special number commemorative of the twenty-first Anniversary of the Association of Mining Electrical Engineers provides a suitable opportunity to place on record the indebtedness of the Association to some of the men who have taken a prominent part in building up the Association. In this connection, we think first of all of our Secretary—Mr. C. St. C. Saunders—who throughout the life of the Association has rendered valuable and ungrudging service. His wise counsel and the good humour with which he deals with the many difficult problems arising out of his duties have contributed largely to the smooth working of the organisation.

The Treasurer comes next in the natural sequence of builders. Mr. C. F. Jackson was our first Treasurer and fulfilled his duties with marked efficiency. For business reasons he was compelled to relinquish his active connection with the Council in 1918, and he was followed by Mr. Alexander Anderson, who had been President of the Association for the Session 1913-1914.

Mr. Anderson occupied this position until 1929. He was always the first to claim that his treasurer's duties were light, but perhaps that, not unfairly, can be accounted as due to his particular ability to fulfil them. His foresight, coupled with outstanding engineering experience, added strength and stability to our Council. Mr. Anderson acted as President of the Association during the years 1913-1914 with distinction, and the new, as well as the old, builders are no doubt glad that the supreme civic honour which has fallen to Mr. Anderson (Provost of Motherwell and Wishaw) in recent years is not likely to deprive us permanently of his help.

At the inception of the Association, Mr. J. H. C. Brooking became the honorary editor; he was succeeded by Mr. E. Kilburn Scott who continued in that responsible position until the Session 1915-16, when demands upon his time in connection with his scientific work compelled him reluctantly to relinquish the office. Mr. Kilburn Scott devoted much time and enthusiasm to the editorial work and laid a foundation for the records of our technical activities which have withstood the test of criticism. We are glad that he is still with us as a member of the London Branch.

The present editor took over from Mr. Kilburn Scott in 1918, and in the year 1920 produced for the Association its own monthly journal *The Mining Electrical Engineer.*

The yearly examination inaugurated by the Council has proved a valuable feature of the activities of our Association. Prof. Daniel Burns of the Royal Technical College, Glasgow, acted as chief examiner for several years and rendered great service during this period in setting up a standard examination which brought out the theoretical and practical attainments of the candidate. He was followed by Prof. I. C. F. Statham of the Mining Department of the Sheffield University, who has added a notable contribution to the standard aimed at.

The name of Mr. J. H. C. Brooking has already been referred to. His name is specially worthy to be included among the builders of the Association. There came a time when it was revealed that the financial foundations on which the Association rested were not too secure. Experience was proving that we gave value to our members out of proportion to what we received from them for the financial support of the Association; as an inevitable result the structure began to shew signs of crumbling. Mr. Brooking brought a particularly keen business mind to bear on this problem and in 1915, in response to his recommendation, an Investigation Committee was appointed to examine the affairs of the Association and to submit a report to Council on steps which should be taken to put matters right. Mr. S. H. Lee and Mr. Chris. Jones joined Mr. Brooking on this Committee and we are grateful to them for the services they rendered at that time.

As an outcome of the work of this Investigation Committee, a Central Committee was formed and appointed to keep in touch with essential matters of administration; this became a Management Committee in 1917, and was thereafter constituted as the Advisory Committee which continues to-day.

Mr. Maurice, our first President, and Mr. Theodore Stretton served with me on the Central Committee. After the formation of the Management Committee, Mr. Maurice dropped out and the late Mr. R. H. Willis took his place. That gallant spirit and good comrade continued to serve the Association until the state of his health made it impossible for him to carry on. He passed from us in 1921.

I may be permitted a word about some of the Past Presidents. In pursuance of a wise policy the Presidents have been drawn alternately from the engineering and coal-producing interests of our Membership. I would probably not be allowed space, and in any case have not the ability to deal adequately with the merits of the various men who have passed through the President's Chair with distinction; therefore, readers will perhaps pardon me if I confine my reference more particularly to those who have come from the Colliery Owners and Officials side of our membership. Of the engineers who have occupied the Chair I would only mention Mr. Wm. C. Mountain and Mr. G. Stephen Corlett, who are no longer with us. I am glad that I had the privilege of knowing them. The helpful influence which they exercised on their colleagues remains with us to this day.

Of those who came from the Coal Owners side of our membership, we have Mr. William Maurice, to whose efforts as an individual it may be said that we owe the existence of our Association. Next in rotation comes Mr. Roslyn Holiday. It is a matter for gratification that

Mr. Roslyn Holiday has undertaken the duties of Treasurer and thus continued to maintain his close connection with the Council. Following in the line of succession, from the Mining side, we have Mr. Matthew Brown, Mr. C. Augustus Carlow, Mr. George Raw, and Mr. Walton-Brown. One and all have brought their own individuality and great business ability into the service of the Association, and during their respective terms of office they gave a strong lead to the Council and to the Association in the building up of its strength; and, moreover, of equal importance, is the invaluable contribution they made in forging the connecting link between the A.M.E.E. and kindred Associations in the Mining Industry.

Now that our Association has attained its majority it is for every member to see that the work of the builders is maintained and developed so that it will be able to continue its effective contribution to the efficiency of the mining industry.

Mr. W. T. ANDERSON: President, 1924.

I AM one of those original members of the Association who hold the opinion that it should never have been allowed to come into being. In a country less insular in its prejudicies the great body of men who a generation ago were becoming interested in electricity as applied to mining would have been accepted gladly as a national branch of one of the great Institutions interested in those respective and closely allied Industries. Happily, no thought of similar though possibly glorious isolation actuated those in whose hands lay the moulding of the Association's fortunes. The key-note of its success lay in the cosmopolitan nature of its membership, and the entry of all responsible men whether Mining Electricians, Consultants, or Manufacturers, who had a direct interest in the use of electricity as a means of developing the mining industry with a greater margin of safety, made such success assured from the outset. An immediately apparent result of this breadth of membership was reflected in the Transactions of the Association and caused them to become of the greatest practical value. They appealed with great force not only to the laboratory and higher research man, but particularly to the practical electrician engaged in mining of whatever nature, whether underground or on the surface.

In its history the Association has had its periods of travail. Some would have used it as a means to better their financial outlook with a leaning towards trades unionism ; but wiser counsels—and the well formulated Articles of the Association—prevailed, and gradually the Association settled firmly into its intended position as one of the learned or technological bodies with the consequent ever-increasing weight and prestige.

As a natural part in this progress it was soon evident that the possibility of the compulsory certification of mining electrical engineers had to be anticipated and the Association has endeavoured to mould, by its educational efforts and system of voluntary examinations, a type of man for the pits, who, prior say to 1912, was comparatively rare. In respect to these efforts the coal mining industry is especially indebted to the Association.

Two other main factors may also be indicated as largely contributory to the Association's success: the wise policy which has always allowed the widest possible representation on Council, coupled with astute business management. What other highly technical Association could supply its members every month with a Journal the production of which costs per annum per member more than the member's annual subscription ?

The mention of the Journal carries one's thoughts back to memories of more personal nature. The great development of the Association coupled with war-time restrictions had rendered it increasingly difficult for the *Iron and Coal Trades Review* to continue the hospitality of its Journal for Transactions which were extending rapidly in volume. Moreover it was felt that the time had come when the Association's needs could only be met by the provision of its own publication. I well remember the anxious hours spent with that stalwart founder of our Journal, the late R. H. Willis, when the task of making bricks with little or no straw, devolved upon us. The long initial spade work put in at that time by some of us, under the able chairmanship of Frank Anslow, was ultimately justified by the advent of *The Mining Electrical Engineer* which became an instant success.

Personal too are the writers' recollections of other and more domestic phases such as the development of the North Western Branch with its widely dispersed membership and the establishment of Sub-Branches in Stafford and North Wales: work in which W. Bolton Shaw played a part which will always make the Association his debtor.

Later, and on a wider stage, are personal memories of the campaign to enlist the great body of colliery electricians, the efforts to gain recognition of our certificated members by the coal owner, the formation of the Cumberland Sub-Branch with A. R. Hill doing yeoman service, and the resuscitation of the London Branch and the Kent Sub-Branch under the efforts of J. R. Cowie.

Looking back on the shadows of those pioneer days the most outstanding impression is, I think, that of valued friendships made: the very disputations in Committee and in Council, even the occasional tilts with that august but patient and canny body the Advisory Committee, all contributed to a robust and breezy healthiness, which, in spite of awful trade and weird politics, has united the Association into a forceful and homogeneous whole.

Mr. THEODORE STRETTON: President, 1926.

MY earliest recollection of the Association, which I joined in 1911, is of attending a Meeting in one of the Cardiff hotels and being impressed by the enthusiastic way in which Mr. Sidney F. Walker, the President of the Branch, conducted the Meeting. It is said that speech is golden. It might have been rare as platinum or pearls, so reluctant were members to enter freely into discussion; the average contribution at that time appeared to be rather a series of spasmodic utterances than coherent speeches. Today, as a result of the encouragement and assistance given to the members by the Association our Papers and our Discussions are at least equal to those of any of the senior Institutions.

In those days there were only comparatively few who realised that the Association was a purely technical association, and consequently it was often looked at askance and was not therefore assisted by other bodies, nor were its members likely to be selected with any preference when there was a situation to be filled. All that has been lived and worn down, until today we receive and enjoy as our due the assistance and support of most of those who are in the best position to give that help and support.

Writing from South Wales I would like to take the opportunity—more especially in view of the possibility that the Association will hold its Annual Convention in Cardiff next year—of acknowledging the great indebtedness which the South Wales Branch—the largest in the Association—owes to the South Wales Institute of Engineers which has placed its handsome premises at the disposal of the Branch for its Meetings, through the kindness of the President, the Council and the ever-helpful Secretary, Mr. Martin Price.

The South Wales Branch can look for and does receive moral and material assistance from the Monmouthshire and South Wales Coalowners Association through its Chairman; the Secretary, Mr. Finlay Gibson, and his Assistant, Mr. Iestyn Williams.

Without the hospitality and help of these Associations and gentlemen our Association could not have made such great strides in this part of the country; they, like many others, realise that there is mutual benefit to be gained with the advanced status of our members, and they have put that belief to the proof of active support and the tangible encouragement of our interests.

Nor must I overlook the very material assistance given to the Association by the staffs of manufacturing firms. Their help in the way of permitting and organising works' visits, providing technical matter for lectures, demonstrations and papers are plainly in evidence to be appreciated by all members: but not so obvious, and apt to be overlooked, is the secretarial assistance which they provide without which it would be difficult if not impossible, to carry on the routine work of a large and active technical society. And lastly, but not least, we have to thank the Press for its active support.

May our Association go on from strength to strength.

Mr. DAVID MARTIN: President, 1927.

I JOINED the newly formed Association before there was a branch in Glasgow, for several reasons. There was an obstinate prejudice against the use of electricity below ground: and there was a shortage of qualified men to look after the electrical plant in mines. Along with many others, I expected that the new Association would help, by example and precept, to remove these disabilities. Again, many of the men already in the mining electrical industry were not considered as qualified to join the Institution of Electrical Engineers. There was considerable opposition to the formation of the new body. The older Institutions objected to the use of the name "Institution", hence the adoption of the title "Association of Mining Electrical Engineers."

Ingenious as the older methods were for transmitting power below ground, such as long lengths of steam piping, longer lengths of compressed air piping and the very dangerous endless rope haulages all dangling side by side with the cages in the shaft, we felt convinced that electricity provided a safer and more economical method of getting power below to the pumps, haulages, and for machine cutting. Many of the older mining engineers looked upon electricity as an untried weapon, and progress against this opposition was very slow. The educational value of an Association such as proposed promised a way to accomplish much. It helped to remove the prejudices and, by the interchange of opinions of men with such diverse interests as professors, consultants, users and manufacturers, did in fact succeed. It gradually wore down the opposition, until now, in Scotland at any rate, there is not a colliery without its electrical plant. The dissemination of knowledge through the aid of the Association was the cause of this progress. I shall never forget the early debates on "Compressed air versus Electricity," which for many a day provided a star turn at our earlier meetings.

Two years after the formation of our Association saw the new Coal Mines Act of 1911 and instead of electricity being banned as a menace to be greatly feared, the famous "Memorandum" came out with the rules and regulations concerning the use of electricity in collieries. In it the colliery electrical engineer was called a "competent person," but not quite so definitely as that, with the result that there was much legal argument and no little profit to expert witnesses and the legal fraternity. However, in passing this would appear to be an inherent weakness of legislation which apparently finds it impossible to call a spade a spade and not a shovel, to the bewilderment of the lay mind.

After the founding of the Association it soon became palpably apparent that there was not only unlimited room for its efforts but a real necessity for its services. At the inaugural meeting of the West of Scotland Branch on 17th September 1910, there were 46 enrolled members. By January, 1911, we had 100 members; in December, 1912, we reached 200; 1914 saw us at 300, and in 1921 we exceeded 400 members. Mr. Clothier of Newcastle presided at our first meeting, at which the following branch officials were elected:—

Branch President: Mr. Alexander Anderson of Motherwell.

Branch Vice-President: Mr. Matthew Brown, now Managing Director of Shotts Iron Co.

Branch Auditor: Mr. A. B. Muirhead, Consulting Engineer, Glasgow.

Branch Treasurer: Mr. D. L. Frew, Mining Surveyor, Glasgow.

and, as Secretary, the writer who is connected with the manufacturing side of the business. The Branch Council of twelve was composed of:—

Messrs. J. R. Benson of Banknock; Wm. Cairns of Burnbank; J. C. McCallum of Ayr; David Mowat of Summerlee; the late A. Power of Glasgow; R. Robertson of Glasgow; and the late J. B. Thomson of Earnock, who were "mining" members; Messrs. Frank Anslow; H. A. McGuffie, and R. Edwards represented consulting engineers: and Messrs. C. W. Holman and W. A. Wilson of Glasgow, representing the manufacturers' interests.

Before the year had expired there were three resignations from that Council. Mr. Mowat, of the Summerlee Iron Co., found it inconvenient to attend our meetings and was succeeded by Mr. James E. Sayers, consultant, of Glasgow, who also has the distinction of being one of the original founder members and signatories to the Articles of Association. Mr. Wilson was promoted to his Head Office and Works in Lancashire and was succeeded by Mr. W. H. Telfer, now Managing Director of the Coltness Iron Co. Mr. Edwards found himself too often from home to attend the business of the Association and was succeeded by Mr. Sydney A. Simon, now the electrical engineer of the Consett Iron Co.

There were thus nine members representing colliery interests, four consultants and four on the manufacturing side. The diverse interests blended very well and that principle still maintains in the Council of the Branch as throughout the Association. It was undoubtedly a factor in the success so soon established. The West of Scotland Branch rose in membership to the premier position which it retained until overtaken by South Wales in 1928. An outstanding fact, which the writer will be forgiven for mentioning, is that from this original Branch Council the Association drew five of its Presidents, quite a notable record in 21 years.

The recollections of those early days are bristling with incident. One relates to the first Examinations Committee. The Branch refused to recognise it until it was popularly elected (shades of the Covenanters!). Mr. Maurice, of Nottingham, the President, who attended our meetings for the first time on 17th February, 1911, must have been somewhat bewildered at the stand we made, which necessitated a special meeting of General Council in Nottingham on 25th February, 1911. The first Scottish member to receive a first class pass was Mr. Peters now chief engineer to the Lochgelly Iron & Coal Company.

It was at this Nottingham meeting also that a hearty invitation was given the President to hold the forthcoming annual meeting of the Association, the second in its career, in Glasgow in October 1911. Those who remember will have pleasant recollections of the notable reception and luncheon in the Great Exhibition then drawing to a close, and of the Corporation Reception in the magnificent municipal buildings in Glasgow. Thus was initiated that system of movable annual meetings in different centres which have done so much by social intercourse to amalgamate and consolidate the Association's work.

We invited the ladies to participate in our annual dinners and other social functions, an innovation then but now become a universal custom.

An interesting analysis of the West of Scotland Branch membership by occupation was made in January 1912 and disclosed that 64 per cent. were connected with collieries, 30 per cent. were of the manufacturing element and 6 per cent. were consultants.

Another item was that Professor D. Burns for many years Chief Examiner was elected by the Branch in 1910 as local examiner.

The late Mr. R. H. Willis first came among us on 19th June, 1911, and proved a considerable source of strength. Many will remember him as one of the Committee who initiated our journal, *The Mining Electrical Engineer.*

In November 1911 the Branch determined to hold district propaganda meetings in Larbert, Hamilton and Kilmarnock. These proved successful and led to a considerable increase in our strength. They were followed by others.

Among the War Honours for our members was the K.B.E. for Sir Adam Nimmo. Among the many War casualties was the late Campbell King whose paper in 1913 "The Electrification of a Group of Small Collieries" is historic.

So much for the branch of which I was the first Secretary.

In the wider sphere of the Association as a whole, ex-officio I was a member of the governing body—the General Council—from 1910 to date. Time with his scythe has been busy among the earlier members. Happily Mr. Maurice, the first President is still with us; likewise, Provost Alexander Anderson and many others. Among those who have gone were such giants as the late Mr. W. C. Mountain, of Scott and Mountain, one of the pioneers of electricity in mines; Messrs. Hood Haggie, Stephen Corlett, Sydney Walker, and Michael Longridge; all men of mature age, ripe experience and of enormous help in those early days.

We also had as our first Honorary Member the late David Graham, a co-worker with the late Lord Kelvin, the contractor for the first electrical installation of any kind in the world so far as mining work was concerned. In his later years he was tremendously rejuvenated by the progress electricity was making in the coalfields. He frequently informed me that such progress was inevitable.

Our Association still retains the elements which make for and merit success, and I trust it will still continue to develop and flourish.

Prof. DANIEL BURNS: Formerly Chief Examiner.

TWENTY-ONE years ago when the Association of Mining Electrical Engineers was formed, the use of electrical power for mining purposes was only beginning, and it required both courage and foresight on the part of the small band of enthusiasts who pioneered the early growth of the Association. That these qualities were in no way lacking has been amply proved by the progress the Association has made. In many respects, although working in a somewhat limited sphere, the Association has shewn a width of outlook and a broad sympathy with its members that has undoubtedly fostered industrial progress in the mining electrical field. It is not proposed in this short article to go into elaborate details of what the writer considers has been done by the Association in the way of advancing design ; the provision of greater safety ; and the raising of the standard of electrical knowledge regarding mining electrical apparatus on the part of those whose duty it is to maintain the electrical installations now found at most mines; he would however, desire to say a word on the educational aspect of the Association's work, the side with which he, as Examiner for a good many years, was very closely connected.

From the outset it was recognised by the promoters of the Association that if safety and efficiency were to be secured it would be necessary to do something to raise the standard of technical knowledge possessed by the colliery electrician.

Towards attaining this object a journal was established in which the proceedings of the various branches of the Association were published; there was also a system of Examination for Membership instituted.

That the Journal of the Association has attained a high standard of merit will be admitted by those conversant with electrical matters, particularly in relation to their technical development in mining practice. Its contents must prove of great value to very many of its readers ; not only to the men engaged in responsible positions as colliery electricians, but also to those whose ambitions lie in that direction. There is no other publication where information relating to mining electrical development can be obtained in the same direct form.

Regarding the Examinations conducted by the Association, these have played an important part in raising the standard of technical attainment of the mine electrician, and although not taken by a large number of candidates are worthy of a much wider support. The questions set, while necessarily not entirely divorced from theory, have in general a direct bearing on mining practice, so that the candidate derives in his preparation educational as well as technical advantages. Many may be of opinion that the examinations are too searching for the ordinary practical man, as the percentage of failures is high: in the opinion of the writer, that is no reason for lowering the standard. Nor should it restrict the number of candidates if considered from the proper standpoint, for, although a candidate may fail to secure a pass, the mere fact of his having prepared with the examination in view, means that he has added to his knowledge.

The examination system is an incentive to progress and unsuccessful candidates should not feel discouraged but should press on in the knowledge that the further preparation will always add to what they have already attained, and will in the end enable them to reach their goal.

Examinations are not in themselves an absolute test of a man's ability but, in a world of imperfections, they form one of the best practicable tests that can be devised for general use. The outlook of those responsible for the Association's Examinations has all along been focussed on the benefits of the study entailed, and less stress has been laid on the pass list than on the educational value of the preparation.

At the present time the insistence by the Mines Department for technical knowledge, on the part of responsible mine officials and the necessity for Certificates of Competency for mine managers, undermanagers, firemen, and mine surveyors, indicates, in the opinion of the writer, that sooner or later a like examination will have to be passed by the mining electrical engineer before the Mines Department will accept him as a Competent Person.

Should such conditions materialise, then it becomes evident that those who have voluntarily prepared for the Association's Examinations will be the more favourably situated for undertaking the Official Examination which will be the method adopted to qualify a man as the Competent Person.

For these reasons my advice to the young colliery electrician is: attend classes where possible, especially classes where laboratory work can be obtained, read the various articles and papers in *The Mining Electrical Engineer*, and prepare for the Association's Examination. These are always safe stepping stones to greater knowledge and advancement.

The Genesis of The Association.

Mr. J. H. C. BROOKING.

IT was a leading article in *The Electrical Review* of December 11th, 1908, that started the A.M.E.E. The closing paragraph entitled, Electrical Fatalities in Collieries, is perhaps worth recording in view of this:—

"There is one thing, however, which we venture to suggest might be done as a step towards what we believe is what every colliery engineer in the country would gladly welcome, and that is, for all mechanical and electrical engineers to form themselves into an "Association of Colliery Engineers," similar to the "Colliery Managers' Association," for their mutual benefit and protection, and quietly but firmly to agitate for their rights. As there must be many amongst our readers interested in this question, we will gladly throw our columns open to them so that they may state their views upon what we believe to be a most important and pressing question."

In *The Electrical Review* of December 25th, 1908, Mr. P. D. Coates, of Burnley, took up the matter as follows:—

"Reading your leading article in THE ELECTRICAL REVIEW of December 11th on "Electrical Fataiities in Collieries," I quite agree with you that we colliery electrical engineers should have a society to protect and further our interests, and the sooner we get 'incorporated' the better. I myself, having 10 years' experience as a colliery electrician, shall be pleased to assist any association that might be formed as much as possible."

It was, however, the letter from Mr. J. Glynn Williams in *The Electrical Review*, of February 12th, 1909, that dealt rather more definitely with the possibility of forming a Society of competent Mining Electrical Engineers, and which really got the matter going:—

"Referring to Mr. Sydney F. Walker's letter in your current issue of the REVIEW, I think that the moral to be drawn from it is the competency of the electrician in charge, as I presume Mr. Walker is thoroughly acquainted with Rule 11, Sec. 1, of the Coal Mines Regulations Acts, relating to Electricity in Mines, which states that a competent person shall be in charge of the electrical plant whilst in use.

"There have been several letters in your paper from various readers, suggesting that the charge electricians of collieries shall form a society amongst themselves with a view to assisting the managers of collieries to have thoroughly competent men to take charge of this responsible and dangerous work. It would certainly be as well if the Board of Trade issued certificates as they do to marine engineers, and in the meantime it would, no doubt, help matters considerably if a society was formed of competent men, framing the rules so as to ensure that they shall be thoroughly experienced and hold a certificate as a guarantee of competency.

"I do not wish to take up your valuable space by relating what I have met with during my colliery experience as to men who have had a sublime cheek to take charge of a colliery plant, also as to the work done, but would suggest a few rules for the new society, if it is formed, as follows:

"1. That each member must have been in charge of a colliery electrical plant for at least 12 months, or have worked as assistant for at least two years previous to joining.

"2. That each member shall be prepared to give a satisfactory reference or testimonial from present or past managers.

"3. That each member shall be thoroughly acquainted with the Rules and Regulations of the Coal Mines Acts relating to Electricity in Mines.

"4. That each member must be prepared to pass a practical examination in order to obtain a certificate of competency, and after the society has been fairly established, that no new members shall be admitted without having gained this certificate.

"Should any of your readers be of the same opinion as myself, I shall be pleased to hear from them with a view to carrying out the formation of a society of colliery electricians, and so minimising as far as ever possible the subject of this letter."

On seeing this letter I wrote Mr. Williams approving his views and asking if I could help him in his efforts to realise the outcome. The result of my letter was a visit to him at Whitehaven, where he was employed as electrician at a local colliery; my impression of Mr. Williams was of a man with some excellent ideas, who thought ahead of his time and put energy into whatever he took up. I was able to give him some help in dealing with the correspondence that followed the publication of his letter, and was struck by the wholehearted way in which he tackled the job of forming the Association.

Most of his correspondents on the subject were useless for his purpose. As I had to point out to him, they were really worse than useless as only causing a waste of his time in futile correspondence with them. On my part I put the matter before a number of my friends in the North Country and Scottish Coalfields, with whom it was my business and pleasure to deal at that time, but I was unable to get some of those, who should have been most closely interested, to do anything constructively on account of their being too busily engaged on their own jobs.

Eventually Mr. William Maurice, the then Manager of Hucknall Torkard Colliery, was interested enough to take a hand. The project soon became a reality under his able direction, and with the assistance given by *The Electrical Review* and *The Iron & Coal Trades Review*, the latter becoming the official journal, with Mr. Kilburn Scott as Editor.

At the first meeting in 1909 at Newcastle-on-Tyne, Mr. Maurice was elected President and he carried on the good work by introducing many able and influential men to the Association, not the least of these being the Secretary, who is still with us, and whose records might be culled for matters of interest to members who may only dimly remember the happenings of those early days, and others who have more recently become enthusiastic members.

Naturally in those early years there were some very important episodes, not all of which, however, were of the kind usually recorded; notably one of these was a very heated argument after the first Council Meeting in Newcastle as to whether the funds of the Association might be drawn upon for a certain object—an argument which settled itself in a peculiar manner during the same evening. On another occasion an argument in a certain official's office between the writer and another nearly ended in blows, so thoroughly were we interested in all matters connected with the new Society.

My best wishes for the success of the now mature Association.

Mr. P. D. COATES.

We had hoped to be able to include a suitable contribution from Mr. P. D. Coates, who was one of the very first to take a live interest in the suggestion of forming the new society. He became a founder member of the Association of Mining Electrical Engineers and still retains an active interest in its affairs. It is, however, with the greatest regret that we learn of the recent death of his wife, who was interred on the 1st of this month. In these tragic circumstances all his friends, including those in the Association, will unite in extending to Mr. Coates their deepest sympathy.

Notes from the Minutes of Proceedings.

It was in Manchester on April 24th, 1909, that the Association was established. Mr. William Maurice, who presided at the meeting, proposed, and Mr. E. Ivor David seconded, that an Institution be formed under the title of "Institution of Mining Electrical Engineers". The proposition was carried unanimously and local representatives were elected as follows:—Messrs. Jas. E. Sayers (Scotland); H. J. Fisher (Northumberland and Durham); R. J. Frost (Yorkshire); P. D. Coates (Lancashire); J. Kirkby (Derbyshire); H. Cusworth (Nottingham); Sydney H. Bell (Staffordshire); H. J. F. Stewart (South of England); J. A. Bosher (North Wales); E. Ivor David (South Wales); and J. G. Williams (Cumberland), who was elected Honorary Secretary and Treasurer.

At the next meeting, held in Sheffield on May 22nd, 1909, the task of preparing Articles of Association, Rules and Byelaws was entrusted to a sub-committee of three, Messrs. William Maurice, J. H. C. Brooking, and J. G. Williams. During that year meetings were also held in Cardiff on May 22nd, Nottingham on June 5th, Newcastle on June 24th, Glasgow on July 3rd, and Manchester on July 10th.

Apparently the "Institution" had got well into its stride by December 1909, for at a Council Meeting on the 17th of that month held in Manchester, the following principal officers were elected:—President, Mr. William Maurice; Vice-Presidents, Mr. W. C. Mountain and Prof. William Robinson; Honorary Editor of Transactions, Mr. J. H. C. Brooking; Treasurer, Mr. J. Glynn Williams; Secretary, Mr. C. St. C. Saunders.

It is interesting to note that at this meeting the difficulty raised in regard to the title of the new "Institution" was mentioned. At the following meeting (June 1910) in Derby the Council resolved that "inasmuch as the Registrar of Joint Stock Companies was unable to register the title previously used, the Institution be known henceforth as "The Association of Mining Electrical Engineers."

The appointment of Mr. E. Kilburn Scott as Editor of Transactions dated from July 1st, 1910.

Soon after the outbreak of the Great War, it was resolved that members with the imperial forces be allowed to retain their membership without payment of subscriptions. In 1915 when dealing with the financial position it was observed that strict economy was essential consequent upon the effects of the War, which had made the publication of Transactions very expensive; a trouble aggravated by the very large number of subscriptions in arrears.

The financial weakness had reached an acute form when a special committee consisting of Mr. J. H. C. Brooking, Mr. S. H. Lee and Mr. C. Jones was appointed in 1915 to analyse the position and report. As a result of this committee's very able work, the Association has ever since enjoyed sound financial security.

Mr. E. Kilburn Scott, on proceeding to America, resigned the position of Editor. He was accorded very hearty thanks for his services by the Council on February 9th, 1918. At the same meeting the present Editor was appointed.

On October 24th, 1919, the Council considered the scheme submitted by the Editor in regard to the possibility of the Association publishing its own proceedings. It was resolved that the Advisory Committee should confer with the Editor regarding the suggestions and report to the next meeting. That meeting was held in Manchester on February 14th, 1920, and Mr. A. B. Muirhead submitted the report on behalf of the Advisory Committee as requested. It was resolved that the scheme be accepted in principle and a Committee consisting of the Advisory Committee with Mr. G. S. Corlett, Mr. W. T. Anderson, Mr. Frank Anslow and Mr. R. H. Willis consider the scheme in detail. Matters progressed through the usual routine and in October, 1920, the first issue of "The Mining Electrical Engineer" appeared. It was well received and a permanent publications Commttee was formed to direct its publication. The first Publications Committee included Messrs. R. H. Willis, W. T. Anderson, and Frank Anslow. It is with regret that we note the record of the death of Mr. Willis very soon after. Mr. W. T. Anderson and Mr. Frank Anslow both served in turn as the Chairman of the Publications Committee and, in turn, relinquished that position to assume the highest office in the Association, that of President.

Proceedings of the Association of Mining Electrical Engineers.

KENT SUB-BRANCH.

(P) Earthing as a Means of Minimising the Risk of Shock.

S. FORD.

(*Paper read 5th March,* 1930.)

From time to time there have been innumerable papers and discussions on the above subject, giving various methods and opinions, but all with one object, i.e., so arranging the frames of generators, motors, transformers, switchgear and cable armouring, etc., that they are connected with the general mass of earth so as to minimise the risk of electric shock in the event of an insulation breakdown on any of the above apparatus.

The author proposes to deal first of all with a brief description of a colliery earthing system with which he is familiar, and which operates on a three-phase direct earth neutral system.

Installing an Earthing System.

There are several points to be considered when installing an earthing system. First, to comply with Rule 125 of the Mining Regulations, the actual connection to earth must be at the surface. Secondly, the most suitable position to provide an efficient earth. Thirdly, the method of connection to earth, whether by means plates or pipes.

Although the above official rule does not compel the use of two earth connections it is recommended in the Memorandum.

With regard to the most suitable position, this can be selected by testing at various points. This site selection becomes rather a difficult proposition in ground which has chalk to a depth of something like 600 feet. However, as the water at the pit in question is pumped into ponds situated approximately 500 yards from the power house—and from these ponds the water soaks away through the earth—it appeared to the author that one of the pond beds would be the most suitable position for the installation of the earthing connections.

The next step was the question of insulated cable necessary for connecting the earthing system to the test board in the power house. This was rather easily overcome, as with the reorganisation of the colliery in 1925 by the present owners, the then existing two power cables, three-core, 0.3 sq. in., P.I.B.S. D.W.A., low tension, installed in the shaft from the surface to the 1500 feet level, had to be taken out to make room for the present high tension cables.

One of these low tension cables was used for connecting the earthing system to the power house test board.

It was decided to put in a duplicate earthing system each at 20 yards apart and consisting of three cast iron pipes, 10 ft. long by 9 ins. diameter, buried upright in a straight line, at 3 ft. centres, to a depth of 8 ft. in

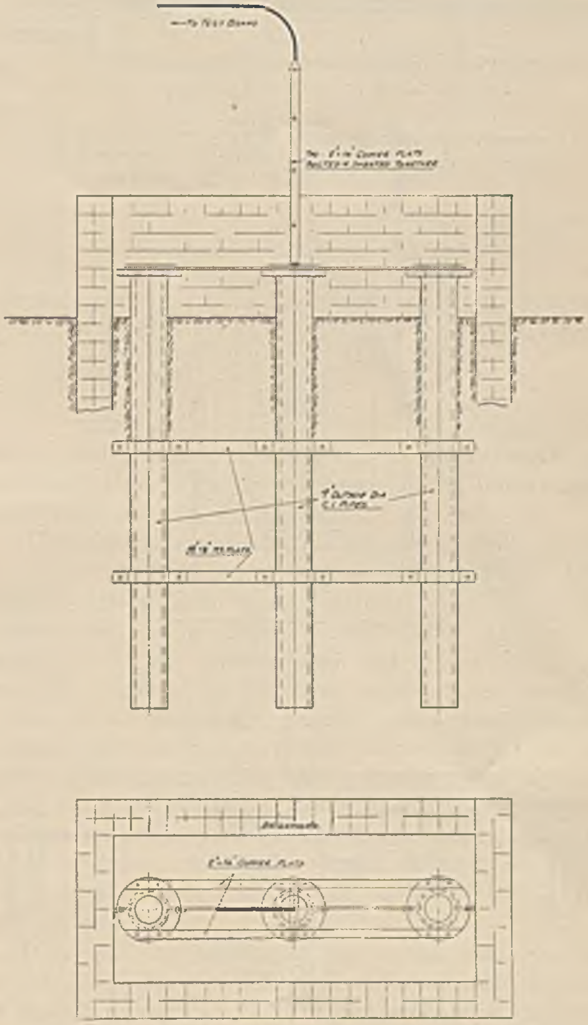

Fig. 1.

coke breeze. Each set was bonded by iron straps 3 ins. by $\frac{5}{8}$ ins. (See Fig. 1.)

The top flanges of the three pipes were thoroughly cleaned. Two tinned copper bars, 2 ins. by $\frac{1}{4}$ in. were placed across the top flanges and each bar was bolted with two $\frac{5}{8}$ in. bolts on to each flange. Two lengths of tinned copper strap, each 4 ft. long of 2 ins. by $\frac{1}{4}$ in. section, were bolted and sweated on to the top flange bonding bars to make provision for the bolting and sweating of the insulated cable to the system. This length of 4 feet was required, owing to the depth of water in the pond at the end of each pumping shift which completely immersed the system to a depth of 2 ft. 6 ins. This length of connecting strap gave ample clearance above the water for the attachment of the insulated cables. Within 24 hours this water is practically gone.

The same method was repeated for system No. 2. Each system has a 9 in. brick wall around it, 9 ft. by 3 ft. by 3 ft.

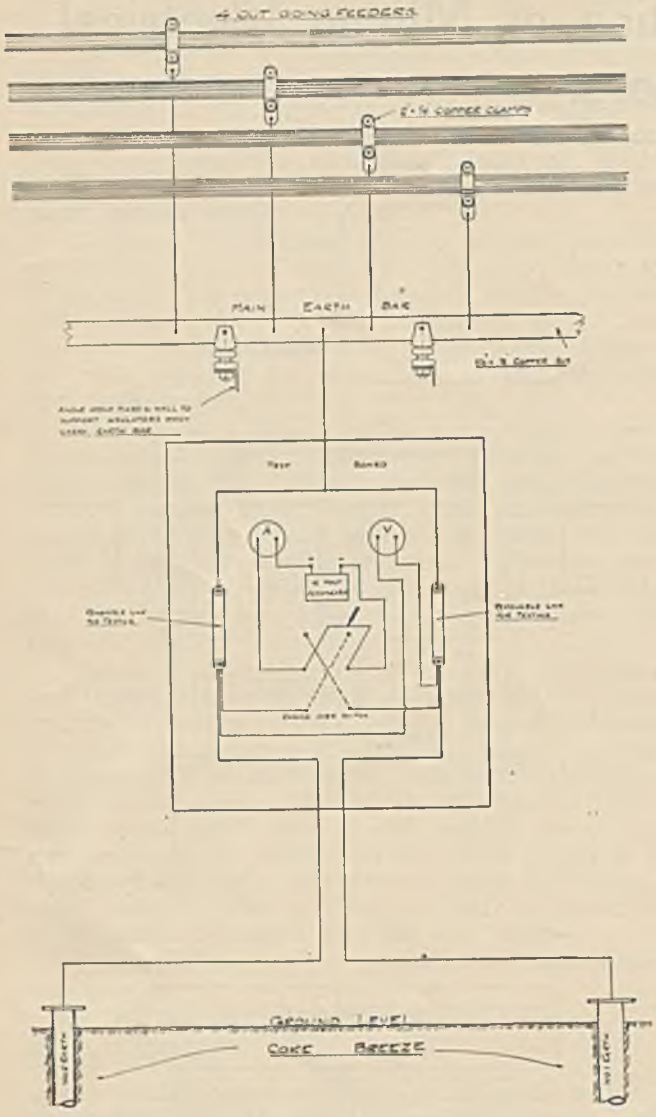

Fig. 2.

The main earth bar, of 2½ ins. by ½ in. copper, was mounted on bus bar insulators supported by 2 ins. by 2ins. angle irons fixed into the wall at every 3 ft. intervals. This bar runs practically the whole length of the power house sub-way. Holes were drilled in the earth bar as and where required for the bonding of all generators, motor, and incoming and outgoing feeder cables. The insulation test taken of this bar alone, when mounted, showed 30 megohms.

Testing the Earth System.

Recent test figures, taken at a time when no water was in the pond, will give some idea of the contact resistance of each set of earthing pipes with the general mass of earth.

Figure 2 shows a general arrangement of the earthing system.

When these tests were made the plant was shut down so that the earth provided by the apparatus of the plant in contact with the earth could be used as a third system to find actually the contact resistance of each earthing system with the general mass of earth.

TEST No. 1.

Insulation resistance of 0.3 cable.

Between A and B: Infinity	A to earth: 40 megs.
„ A and C „	B to earth: Infinity.
„ B and C „	C to earth: 40 megs. (not in use.)

TEST No. 2.

Test between + –	*Volts*	*Amps*	*Resistance in ohms*	*Resistance of leads*	*Resistance between any two systems through earth*
E_1 and E_2	4.2	2.4	1.75	0.08	1.67 ohms $= R_1$
E_1 and E_3	4	3.4	1.176	0.04	1.136 ohms $= R_2$
E_2 and E_3	3.8	3.1	1.226	0.04	1.186 ohms $= R_3$

Resistance of E_1, E_2 and E_3 may now be found by the use of the following formula:—

$$E_1 = \frac{R_1 + R_2 - R_3}{2}$$

When R_1 = the resistance between E_1 and E_2
R_2 = „ „ „ E_1 and E_3
R_3 = „ „ „ E_2 and E_3

$$\therefore E_1 = \frac{1.67 + 1.136 - 1.186}{2} = 0.81 = \text{Resistance of } E_1$$

$$E_2 = \frac{1.67 + 1.186 - 1.136}{2} = 0.86 = \text{Resistance of } E_2$$

$$E_3 = \frac{1.136 + 1.186 - 1.67}{2} = 0.326 = \text{Resistance of } E_3$$
(or Plant Earth.)

TEST No. 3.

Test between – +	*Volts*	*Amps*	*Resistance in ohms*	*Resistance of leads*	*Resistance between any two systems through earth*
E_1 and E_2	3.8	2.2	1.727	0.08	1.647 ohms $= R_1$
E_1 and E_3	4	3.4	1.176	0.04	1.136 ohms $= R_2$
E_2 and E_3	4.2	3.5	1.2	0.04	1.16 ohms $= R_3$

With the formula used in Test No. 2 we may now find the new values of E_1, E_2 and E_3:—

$$E_1 = \frac{R_1 + R_2 - R_3}{2}$$

$$\therefore E_1 = \frac{1.647 + 1.136 - 1.16}{2} = 0.8115 = \text{Resistance of } E_1$$

$$E_2 = \frac{1.647 + 1.16 - 1.136}{2} = 0.8355 = \text{Resistance of } E_2$$

$$E_3 = \frac{1.136 + 1.16 - 1.647}{2} = 0.324 = \text{Resistance of } E_3$$
(or Plant Earth.)

Another test similar to the above was now taken but with the current reversed.

Referring to Tests No. 2 and No. 3 it will be seen that there is a variation of readings in two cases when the current is reversed, which, in turn, alters the final reading of each earth.

E_2 appears to have the highest contact resistance with the general mass of earth, and it is E_2 which shows a potential of 0.2 volts which assists in one test and opposes in the other.

This method can only be said to give an approximate idea of the earth system conditions, because of the effects of electrolyte action, polarisation and stray currents which are more pronounced in some cases than in the above. Nevertheless, it shows the necessity of taking a test with the current flowing first in one direction and then in the opposite.

In earlier methods alternating current was used for the above tests, as alternating current cancels out all electrolytic and stray currents, but this was only reliable in the hands of highly skilled men, as the readings were not direct. They needed balancing adjustments and even then required three separate measurements for one result. This method had further disadvantages in bulky apparatus and considerable supply of power.

Messrs. Evershed & Vignoles have now placed upon the market a Megger Earth Tester with which they claim to have overcome all the troubles due to electrolytic action, etc.

It is a combined ohmmeter and generator, so designed that alternating current is supplied to the ground section of the testing circuit to overcome difficulties due to electrolysis, 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 ohmmeter embodies two coils, one called a control coil and the other a deflecting coil, mounted at a fixed angle to one another on a common axle and swinging in the field of a permanent magnet. The axle carries a pointer moving over a scale marked in ohms.

The current proportional to the total current flowing in the testing circuit passes through the control coil while the deflecting coil carries a current proportional to the potential drop across the resistance under test. The coils are wound to oppose each other.

The final position of the moving coils, and hence that of the pointer, depends on the ratio of the potential drop to the total current, and the instrument is therefore a true ohmmeter, giving readings, in ohms, which are independant of applied volts.

It is claimed by the makers of this testing set that the accuracy of the readings obtained is not affected by capacity or induction; nor by the frequency of the stray alternating currents encountered in the soil.

If the stray currents have the same frequency as that of the Earth Tester when the handle is turned at a normal speed the pointer will waver, but when this occurs it is only necessary to alter the rate of turning and a steady reading will again be obtained.

Requirements of Rule 125.

Having given a brief outline of an earth system and method of testing, we will now deal with the further requirements of Rule 125. This rule compels the earthing of all metallic sheaths, coverings, handles, joint boxes, switch and fuse boxes, motors (including portable motors), to an earthing system at the surface of the mine, if the voltage exceeds low pressure D.C. or 125 volts A.C.; also that all conductors of the earthing system shall have a conductivity at all parts and at all joints at least equal to 50 per cent. of that of the largest conductor used solely to supply the apparatus a part of which it is desired to earth. This means

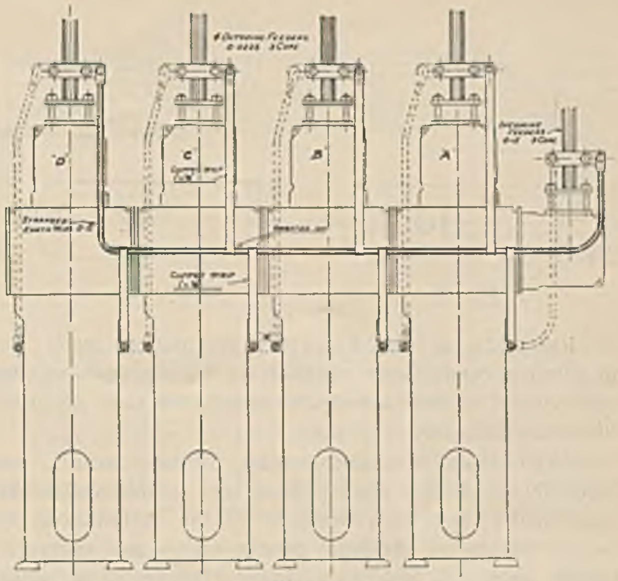

Fig. 3.

that the said metallic sheaths, etc., of cables must not have more than twice the resistance of the largest core supplying power to the apparatus.

The author's experience has led him to bond across every point at which the armour has been cut. For instance, across joint boxes, starters, switches, transformers, etc.. using tinned copper clamps 2 ins. wide clamped on to the cable at each end of the joint box, etc. The position on the cable where the clamp fits is first of all thoroughly cleaned and a tinned copper stranded wire with a sweating lug on each end is bolted to the clamps. The author uses a minimum bond of 0.1 sq. in. on apparatus underground, for mechanical reasons, in addition to which, it increases the earth circuit efficiency; for cables larger than 0.1 in. The size of bond used is equal to the section of the largest core enclosed.

It is also the opinion of the author that the best method of bonding switchgear, starters, and other apparatus housed together, is to have one common earth bond upon which are sweated strips of copper, forming flag terminals for direct bolting on to each piece of apparatus to be earthed.

The bonding of one piece of apparatus to another, forming a series of connections as shown by dotted lines in Fig. 3, is unreliable, because if one bolt (marked "X" Fig. 3) becomes loose, panels "C" and "D" and the cables attached have their earthing efficiency reduced; whereas with the continuous bond, if the same bolt becomes loose, only panel "D" would have its earthing efficiency impaired.

There are several methods used for bonding. Figs. 4 and 5 show two types used by the author. These are made to fit the cable armour, allowing a grip in proportion to the diameter of the cable; also, the thickness of the copper used for the clamps is selected, depending upon the size of the cable; machined bolts and washers are advocated.

Testing Conductivity of Armour.

After dealing with the method of bonding we will now deal with the method of testing the armour conductivity.

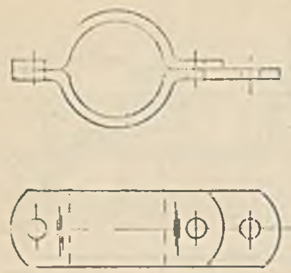

Fig. 4.

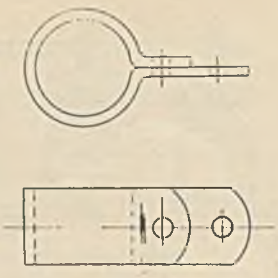

Fig. 5.

Rule 125 of the Electricity Regulations calls for an armour conductivity of at least 50 per cent. of the conductivity of the largest live conductor core enclosed within the armour.

First of all, it is not possible to test, usefully, the conductivity of the armour from one point whilst the cable under test is connected to the installation, as the various earths produced by the cables and apparatus (pump stock in particular) have a tendency to assist the conductivity of the armour.

The only way to get the correct conductivity of the armour is to isolate the cable and disconnect both the armour and the cores at both ends from the switchgear or other apparatus. Then, with the Bridge Megger, we can test for core resistance, first of all taking an insulation test to earth and also between cores. Then short circuit two cores at the far end of the cable with a good connection, leaving the other cores and armour isolated. Now take a resistance test across the two open ends of the cores at near end of cable. (This method saves the necessity of measuring the cable.) The result of this test will be equal to twice the resistance of one core plus the resistance of the test leads.

If the connection between the cores is now broken, and one of the cores now bonded to the armouring with a good connection, and a reading taken again—this time across the bonded core and armour, this result will be equal to the resistance of one core plus armour and test leads. By deducting the core resistance obtained in the first test, and also test leads resistance, we have now the resistance of the armour.

If any joint boxes were in the length of cable under test it would be necessary, before taking the above armour resistance test, to see if the conductivity across each box, or boxes, was at least equivalent to the resistance of a relative length of the unbroken cable armour, as it is possible to get a 50 per cent. conductivity test of the armour circuit with a relatively high resistance across a joint box as will be seen from the following example taken from test figures of cables issued by the makers at the time of purchase.

TEST FIGURES OF
THREE-CORE D.W.A. CABLES.

Size of Conductors	*Length in yards*	*A.C. Pressure between conductor and earth*		*Conductor Resistance in ohms*		*Resistance of Armour in ohms Per 1000 yards*	*Item*
		volts	*mins.*	*length*	*1000 yards*		
7/0.064	206	2500	15	0.670 in series	1.083	0.44	1
7/0.044	516	2500	15	3.48 in series	2.250	0.620	2

From this test sheet it will be seen that the conductor resistance of Item 1 is 1.083 ohms per 1000 yards, whilst the armour resistance of the same item is 0.44 ohms per 1000 yards. Therefore from this we see that the resistance of the conductor is 2.46 times the resistance of armour. In other words, the armour has a conductivity of approximately 250 per cent. of the conductor.

As already stated, Rule 125 states that the armour shall have at least 50 per cent. conductivity of the largest core enclosed in the cable. Taking this literally, we could say that if the armour resistance were twice that of the conductor resistance we should be in order; that being the case, from the above test figures we are allowed an armour resistance of twice 1.083 for 1000 yards which equals 2.116 ohms.

Assume there is a joint box on the cable. We could have a resistance across the joint box of 1.726 ohms and still have 50 per cent. conductivity for the whole armour circuit relative to the core.

It is also possible with the figures given in Item 1 on test sheet to have a resistance across the joint box equal to 400 per cent. of the resistance of the core and still have 240 per cent. conductivity for the total armour circuit. But in neither case of the above would it comply with Rule 125, because we have not 50 per cent. conductivity across the box.

This goes to prove that when taking a test of this description it is most essential first of all to take a conductivity test across every point of junction of one appliance with another to prove that the requirements of the Rule are met at every part of the installation.

Rule 125 states that the conductivity over joint boxes, etc., shall have at least 50 per cent. conductivity of the largest core they contain. Even in this case it is possible to have a higher resistance across a joint box than the resistance of a corresponding length of unbroken cable armour. Again referring to Item 1 on test sheet, we have 1.083 ohms per 1000 yards for the core, therefore the resistance of 1 yard equals 0.001083 ohm. This, again, means that the armour resistance must not exceed twice this amount to have 50 per cent. conductivity. If we now assume that the length occupied by the joint box equals 1 yard we are allowed 0.002166 ohms and have 50 per cent. conductivity, thereby complying with Rule 125.

But even in this case the resistance across the box is five times that of the armour for a corresponding length. This again goes to prove that it is essential when testing for armour conductivity to see that the conductivity across any point of junction is at least equal to the conductivity of a corresponding length of cable armour. This at the same time increases the efficiency of the armour circuit.

The above armour conductivity test is not advocated by the Author as it necessitates cutting off the power and disconnecting both the armour and cores at each end of the length to be tested, or satisfying oneself that the armour under test does not receive any outside assistance (to any part of its length) to carry the testing current, this being impossible in the case where cables have been installed for some time in very wet places, such as some pit shafts.

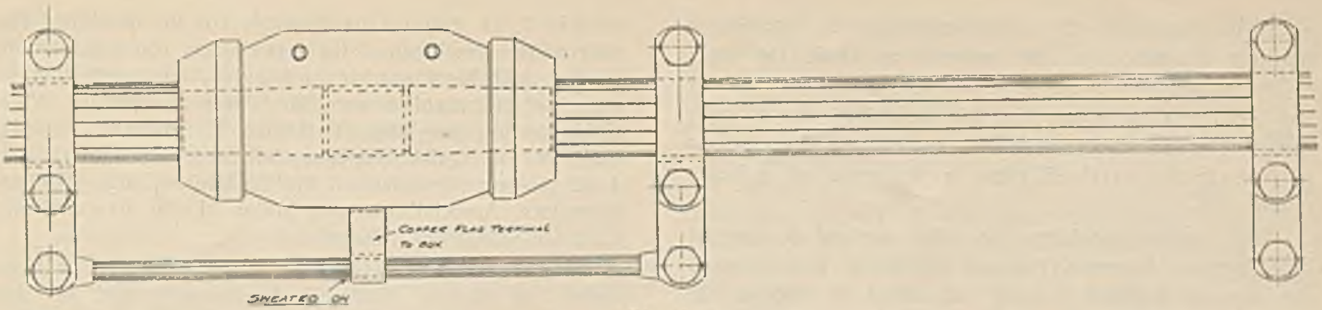

Fig. 6.

By using the Continuity Tester the resistance can be measured across joint boxes, junctions, switchgear, etc. whilst the power is on the apparatus under test, and therefore can be carried out during ordinary routine work.

Continuity Testing.

The continuity test appears to be by far the best and most satisfactory method as the armour is not likely to deteriorate unless situated in wet places where the water contains acids, in which case it would be necessary to take periodic tests for conductivity across various lengths of the armour to see how the resistance compared with its resistance when purchased.

Also the resistance across a box or other apparatus may be compared with the resistance of a corresponding length of cable by fixing another bonding clamp on the cable at a position along its length equal to that required by the box or other apparatus (See Fig. 6).

These tests should be taken periodically and records kept.

It should always be borne in mind when ordering armoured cables to insist on being supplied with a certificate of test of the cable so that figures may be compared if a doubt arises.

Reducing Severity of Shocks at point of fault.

Perhaps the size of bonding wires and armour clamps etc., advocated herein may be considered by some to be somewhat excessive, but, in addition to mechanical reasons, the author is of the opinion that the lower the resistance of the armour, the less is the severity of a shock should a person come into contact with apparatus at the moment a fault develops.

It is common knowledge that although the resistance of the armour is such as to comply with the requirements of Rule 125, it is possible to get a shock on long lengths of a cable if a fault has developed at some considerable distance away on its length. Therefore it is quite apparent that the resistance of the armour is too high.

The severity of this shock can be greatly reduced by several methods, viz., earthing the cable at several points along its length inserting a limiting resistance in the neutral, or fitting core balance protection.

Fig. 7 gives some idea of how the installation of earth plates at several points along its length reduces the shock.

As already mentioned, this is generally experienced at the end of long lengths of cable. Suppose we take for example a 1000 yards of cable similar to Item 1 on the Cable Test Certificates.

There are 1000 yards 0.0225 cable, three-core, D.W.A., having an armour resistance of 0.44 ohms per 1000 yards, and a core resistance of 1.083 ohms per 1000 yards. If at the far end, one of these cores came into contact with the armour, we should now have a resistance of 0.44 plus 1.083 in series, making a total of 1.523 ohms. Suppose this cable was operating on a 500 volt, three-phase, direct earth neutral system. We should have between phase and neutral a voltage equal to 58 per cent. of the line voltage, namely 290 volts. Neglecting any impedance, we would now get a current of 190 amperes. This would in turn give us a potential at the point of fault of $190 \times 0.44 = 83.6$ volts, and a person coming into contact with the cable at that point would receive a shock to the extent of 83.6 volts. If this cable had been earthed at the point marked "M" on Fig. 7, approximately midway of its length, the shock would have been reduced to the extent of 50 per cent. Again, if the cable had been earthed at "J" then the shock would have been reduced in proportion. Thus it can be seen that the severity of the shock would then be only 25 per cent. of what it would be in the first case.

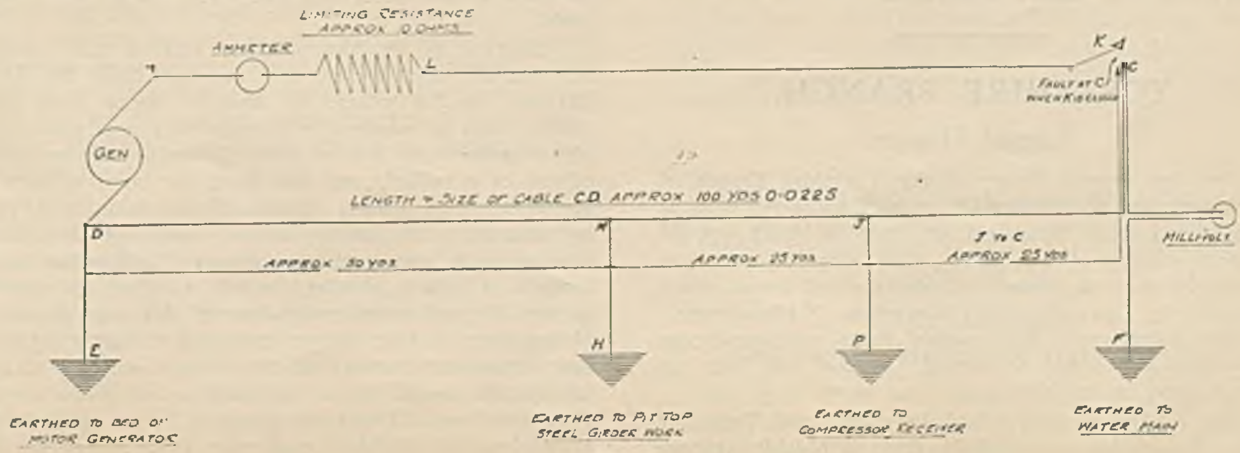

Fig. 7.

With regard to the second method, i.e., inserting a limiting resistance in the neutral to limit the flow of current in the event of a leakage, great care would have to be taken to see that the resistance was of such capacity as to allow sufficient current to flow so as to operate the overload trips in the event of a faulty phase.

The author considers the third method to be the best because it would cut out the faulty section when the current reached a value of either 5, 10, or 20 per cent. whichever setting was required, of the full load current of the switch.

It is not the intention of this paper to deal with the various methods of protection as this could be subject matter for a paper alone, but the core balance protection was mentioned just to show that by cutting down the leakage current to a minimum we at once reduce the severity of the shock.

At the same time, with the use of core balance, the state of the insulation of the system must be kept in a high state of efficiency; and, in addition to reduced danger from shock, the dangers of fire and the ignition of gas or coal dust would be reduced to a minimum, as it would isolate the faulty section with a small leakage current.

From the figures given in the Table, together with reference to Fig. 7, of several tests which have been made it is very clearly illustrated how the shock is reduced by the earthing of a cable at several points along its length.

TABLE.

Test Number.	Amps.	Applied Volts.	Volts drop across Cable.	Resistance of whole length of Cable in ohms.	Potential at Point of Fault.	Point of Cable earthed on Fig. 7.	Size and length of Cable under test.
							100 yds
1	20	220	1.8	.09	1.8	D.	.0225
2	20	220	.9	.09	.9	D.M.	,,
3	20	220	.45	.09	.45	D.M.J.	,,
4	14	220	1.26	.09	1.26	D.	,,
5	14	220	.63	.09	.63	D.M.	,,
6	14	220	.315	.09	.315	D.M.J.	,,

In conclusion, the author would emphasise the point that it is of little use having an elaborate earthing system unless the paramount importance of obtaining and keeping an efficient earth is appreciated by the management and acted upon. If this is not done the endeavour to ensure safety in working by earthing becomes greatly impaired, if not entirely neutralised.

YORKSHIRE BRANCH.

Annual Dinner.

The first annual dinner of the Yorkshire Branch of the Association of Mining Electrical Engineers, held at the Strafford Arms, Wakefield, on the 15th March, proved a great success. The large attendance of members thoroughly enjoyed themselves, an excellent repast being followed by several very interesting "after-dinner" speeches, interspersed with musical items, and one began to wonder why such an annual function had been so long delayed in its inception.

Mr. Roslyn Holiday, Past President and Treasurer of the Association, presided in the unavoidable absence of Mr. T. H. Elliott, the President of the Branch. The visit of the President of the Association, Captain Walton-Brown, had been eagerly anticipated, and with him as guests of the evening were Mr. Percy C. Greaves (Vice-Chairman of the West Yorkshire Coalowners' Association), Mr. T. Quick (Carlton Collieries Association), Mr. J. A. Jackson (President of the Yorkshire Colliery Under-Managers' Association), and Major H. G. Fraser (City Electrical Engineer, Wakefield).

Mr. T. QUICK, proposing the toast of the "Association of Mining Electrical Engineers," said he had been connected with the engineering side of the mining industry for a good number of years, and had had opportunities of noticing and admiring the very splendid service given by the mining electrical engineer, whose work differed very considerably from what the man-in-street understood as electrical engineering, inasmuch as they were called upon to instal and maintain electrical plant in positions which made the job arduous and very difficult. They had to contend with electric motors and switchgear working in dust-laden or damp atmospheres, or atmospheres containing acid fumes, and such unusual conditions placed a very great responsibility on the mining electrical engineer.

It did not matter how clever the manufacturers' designer might be, or how robust or efficient the machine itself might be, the success of the plant depended very largely on maintenance, and without skilful and careful supervision of their installations he was sure that electrical machinery in mines would not have reached that safe and efficient state they knew it to be in at the present day.

The colliery owners were alive to the very fine work the Association was doing in raising the standard of knowledge and ability of its members. He would like to see the day when all young men starting out as mining electrical engineers were compelled to take a scholastic technical course, and he believed that if the colliery owners got together and formulated some scheme it could be made quite workable.

He thanked the Yorkshire Branch for the hospitality shewn him that evening and he wished the Association every success in the future.

Captain WALTON-BROWN, responding, spoke of the great pleasure he had derived in visiting Branches of the Association in various parts of the country. As President of that Association it was very difficult indeed for him to speak on the subject of the legislation which was pending, and if he did it was only from the technical point of view. The technical man at the colliery did not always see eye-to-eye with the owners nor, necessarily, with the workmen. He was called upon to produce the most efficiently run show he possibly could.

Situated as he, the speaker, was at that moment between Mr. Holiday on the one hand and Mr. Percy Greaves on the other, he had to speak with great caution, and in mentioning "compulsory amalgamations" and "quotas" he did so from the point of view of an official of a colliery and not from the point of view of the trade as a whole. Some officials had spent years in attempting to bring success, and one might say happiness, to one particular concern, and after having reached a certain standard which enabled the concern to sell its coal consistently day by day, one could not blame them if they rather hesitated to enter into any new arrangement under which a large number of their workpeople would have the number of their working days cut down. He lived, possibly, in an old-fashioned atmosphere, at a colliery employing about fifteen hundred people, and they took a great interest in their men in every way. A lot of the changes being effected in these days might be for the benefit of the industry as a whole, but one could not see much benefit, for instance, to the people at the pit where he worked, because it would be impossible to pay them the same remuneration on a partly-worked place or a reduced output.

Compulsory amalgamations did not seem to Capt. Walton-Brown to be in the best interests of the particular units, and he doubted very much if they would prove to be for the best interests of the country as a whole. If they had a successful concern, and they suddenly made it a present of a "dud" show, he did not see how it was possible to do other than harm, and it would be still more alarming if the control of the new management were handed over to those people who had mismanaged the "dud" partner.

Returning to the work of the Association, Captain Walton-Brown said their duty was the succesful application of electricity to the coal mining industry in Great Britain, and coupled with that was the duty of supplying the right kind of man, and the properly trained man. He urged all young mining electrical engineers who had not yet secured the Certificate of the Association to do so at the earliest possible date. Certification of electricians connected with mining had not yet been dealt with by legislation, but there was no doubt that that would come about in due course. Every mining electrical engineer who became a member of their Association was assuredly joining the right train, and the best ticket for his journey was the ticket of the Association in the form of the Certificate of Proficiency. He thanked them all for the way he had been received that evening, and he thanked Mr. Quick for his appreciation of the Association's activities.

Mr. ROSLYN HOLIDAY, proposing "The Coalowners," said the Association appreciated very greatly the interest which the Owners took in the electricians' part in connection with the working of the pits but, if he might suggest it, there was one very practical way in which that interest on the part of the Coalowners could be signified, and that was by becoming Patron Members of the Association. The subscription entailed was merely nominal, and he hoped that Mr. Percy Greaves, whom they were delighted to have with them that evening, would be an apostle in the cause amongst his friends.

Everyone knew the Owners had been going through a very trying time; it had in fact recently been a trying time not only for the owners but for the officials and the miners themselves. There was all the difference in the world in working for a concern that was successfully facing the problems of the industry, as compared with a struggle where, do what they would, they could not make profits. He could therefore truthfully and sincerely say that that Association would welcome better times for the Coalowners, knowing that if better times came it would be to the advantage of everybody concerned in the trade.

Mr. PERCY C. GREAVES made a very happy speech in responding. His reminiscences touching on his experience with electricity underground caused much amusement, particularly as he would insist, with great frankness, that he knew absolutely nothing whatever about electricity. He was, however, very interested in the application of electricity to mining and mentioned the problem of face lighting, asking the Association to apply their minds to inventing something that would give 50 volts d.c. at the face without the necessity of putting in a rotary generator. He had consulted many eminent electrical engineers, who said that it could not be done, but he nevertheless left the problem with them because he himself felt confident that some apparatus would ultimately be brought out to achieve the object they had in mind.

At present they had only a poor light at the coal face, no matter what lamp they used, and if face lighting could be improved they would not only get cleaner coal but they would reduce very considerably the number of accidents. He was perfectly sure it was possible to do it but, as a non-electrical engineer, he had not the faintest notion how.

With regard to the coal trade in general, they had been undergoing a trial different from anything that ever happened to them before. He had been a great believer in low costs; but was that quite the whole position today? They could have what low costs they liked, but if the market was not there, no matter how low their costs, they could not sell an increased quantity as conditions were today. It was the market whch controlled the selling, and they could not get over the fact that so far as coal was concerned, and so far as cotton and textiles and other things were concerned, the production was beyond the market capacity. He did not like the quota, because he had been a free man for a great many years, but he was absolutely certain that without the quota system in some form or other they woud never get a proper marketing scheme.

Mr. C. C. HIGGENS proposed "Kindred Associations," and regretted to announce that Colonel H. Cecil Fraser, the Secretary of the Yorkshire Section of the Institution of Electrical Engineers, had looked forward to being present with them but at the last moment had found himself unable to attend because of indisposition. They were pleased however, to welcome Mr. J. A. Jackson, President of the Yorkshire Colliery Under-Managers' Association, because they were always glad to learn something of the other man's point of view.

Mr. J. A. JACKSON, in replying, said that in common with the Association of Mining Electrical Engineers his organisation had always had before it in various forms their everyday problems appertaining to the practical application of scientific knowledge to the business of coal mining. He himself appreciated very greatly what had been done by the introduction of electricity for lighting and power in the mine, and he joined with Mr. Greaves in hoping that it would be applied more and more successfully. If they could get face lighting by electricity it would reveal more clearly the state of the roof and so prevent accidents; it would also minimise cases of miners' nystagmus and in many other ways improve conditions underground.

The toast of "Our Visitors" proposed by Mr. T. H. Williams was suitably acknowledged by Major H. G. Fraser (City Electrical Engineer, Wakefield), and brought to a close a thoroughly successful and enjoyable function.

MIDLAND BRANCH and WARWICKSHIRE & SOUTH STAFFS. BRANCH.

Joint Meeting.
Visit to the Macintosh Cable Works.

On May 22nd last about eighty members of the Midland and the Warwickshire & South Staffs. Branches of the Association paid a visit to the new works of the

Macintosh Cable Co., Ltd., in Derby. The party was divided into small groups and conducted round the works by members of the staff.

Wire Drawing.

The copper is delivered to the works direct from the rolling mills in the form of black rod approximately ¼ in. in diameter. The first operation is to remove the black oxide by immersing the rod in dilute acid. The copper is then reduced in diameter by being drawn through a series of dies, these getting smaller as the process proceeds. In the initial operation the dies are in line on the machine. Smaller sizes are dealt with by the wire being passed round two cones having grooves of increasing diameter, the dies being fixed between the cones. This latter operation employs diamond dies whereas in the former chilled iron or steel dies are usual.

The drawing process increases the tensile strength of the copper considerably, but it also reduces the electrical conductivity. To regain this, and also to make the copper suitable for use in the average type of cable, where tensile strength is not of such importance as voltage drop, it requires to be softened or annealed. This process is carried out by passing the copper through a water seal into an electrically heated chamber, the temperature of which is controlled to approximately 500 degs. C. After a predetermined period has elapsed the copper is removed, when it is apparently unchanged in outside appearance but has become soft and pliable.

Tinning.

To ensure that the sulphur, which is an essential constituent of every vulcanised rubber compound, does not chemically attack the copper, a coating of tin is next applied. In this process the copper is thoroughly cleaned by immersing in a cleansing agent, polished with a soft abrasive and passed through a bath of pure molten tin. The surplus tin is wiped off and the tinned copper wire run off into convenient coils.

Stranding.

Dependent on the ultimate working conditions of the cable, i.e., current carrying capacity, tensile strength, flexibility, etc., the conductors have to be built up of a number of wires twisted together. To attain this end the requisite number of single wires are placed in a stranding machine and twisted together, this operation continuing until the requisite cross sectional area is obtained. It should be noted that in order to preserve the cleanliness of the wire in the uninsulated state operatives wear gloves.

Rubber Mixing.

Raw rubber is delivered to the works in two forms in which it comes from the plantations, smoked and crepe. The rubber mixing process is carried out by placing the raw rubber between two heated horizontal rollers, which each revolve inwardly, the various dry fillers being added and milled into the rubber. After the rubber has been so mixed it is known as compound rubber. For the longitudinal method of insulating wire, as described later, the rubber compound is rolled out into thin sheets on a calender and placed in stock for an ageing period.

Insulating.

By the longitudinal method the conductors, together with two strips of the calendered compounded rubber, are passed between a pair of horizontal revolving rollers each of which has a series of half circles formed on its surface. The edges of these half circles effectively "weld" the rubber strip round the wire, the joint so formed disappearing in the subsequent vulcanising operation.

In the extruding process the conductors are fed into a machine having a steam heated chamber, inside which a screw revolves. The rubber strip is fed into this screw which forces the compound on to the wire and through a die of definite size, the insulated conductor is then cooled in water to prevent decentralisation.

Vulcanising.

The vulcanising chamber comprises a steam jacketed pan similar to a boiler, the insulated wires are packed in french chalk (to prevent sticking of adjacent layers) placed in this chamber and subjected to a heat treatment varying in duration according to the size and type of the cable. It is noticed that after the vulcanising process the rubber is much stronger physically and is very elastic, whereas before it was soft and had the consistency (when warm) of putty.

Laying up.

The next process to which the insulated conductor is subjected depends upon the design of the finished cable. A twin, three-core, or multi-core cable is made up in the following manner. Each core is lapped with either a coloured or numbered tape for identification purposes and run off on to a drum; the drums are placed on a rotary machine which revolves and lays up the cores in the same way as the wires are stranded together. It is usual to introduce fillings of tanned jute or rubber cords into the interstices between the cores, to make the cable circular. The cable may then be sheathed, which is carried out on an extruding machine in a similar manner to the extruding process; or it may be armoured after first applying a layer of jute as a bedding for the armour. The galvanised steel armour wires are applied spirally to the cable, and, in the case of double wire armouring, the second layer is applied in the reverse direction on a machine which is in fact a large stranding machine.

Braiding and Finishing.

A large percentage of the total output of rubber cables are finished off by means of a cotton braid which usually comprises sixteen threads of cotton, half of these revolve in one direction and half in the other. The braid thus formed is then impregnated with waxes and weather proofing materials as a protection against climatic and surrounding conditions.

Tests.

Each consignment of raw material, for whatever purpose it is intended, is carefully checked and tested in the laboratory for quality. This ensures an absolutely uniform product. The various stages of cable manufacture are also strictly supervised, daily examinations and tests being made on the copper, tinning, rubber, etc., as well as the processes to which the materials are subjected. The cables are tested after each stage of manufacture, the main test room being equipped with transformers capable of providing 100 Kilo-volts for pressure tests. Insulation and capacity tests are also carried out, and various methods of copper conductivity, etc., tests are made.

General.

In the manufacture of rubber cables, cleanliness is absolutely essential. To ensure the absence of dust and dirt the whole factory is provided with floors of of maple wood. The factory has its own private railway sidings, and is arranged on the progression system so that the raw material enters at the starting end of the works, and the finished goods are placed on rail at the other, or finishing end.

Mr. C. D. WILKINSON.—After the inspection had taken place, the party were entertained to tea in the works canteen, and a vote of thanks was proposed by Mr. C. D. Wilkinson (President of the Midland Branch), who said that it always gave the user of an article a little more respect for that article when he had seen the process of manufacture. They had seen that afternoon every stage of cable manufacture, and were all impressed with the modern methods used by the Macintosh Cable Co. The firm, with their associated companies, should be experts and their products should be the best obtainable. He hoped that Mr. Morris would convey to his Directors the best thanks of the Association for the opportunity of visiting the works. Mr. Wilkinson said it also gave him great pleasure to meet their fellow members from the Warwickshire and South Staffs. Branch. He would like also to thank the guides who had shewn them round the works.

Mr. DIXON President of the Warwickshire & South Staffs Branch) said he had great pleasure in seconding the vote of thanks to the Company for their kindness in permitting the visit and for the hospitality extended to them. Their guides had been very efficient and had explained various points of interest in a very able manner.

Mr. H. MORRIS, in responding for the Macintosh Cable Co., said he was glad to have been the means of arranging this visit; he thought it would be a good thing for the members of the two Branches to meet on common ground. The visit had been mooted previously, but had to be put off until a suitable time came. On behalf of the Directors of the Company he would like to say that they always welcomed anyone connected with electrical engineering because, as Mr. Wilkinson had said, it gave the users greater confidence in British manufacture, and gave them the opportunity of making any suggestions or criticisms of the articles manufactured which might be helpful to the firm. He hoped those present had found the inspection instructive, and that they would repeat the visit on another convenient occasion in the future.

MIDLAND BRANCH.

Visit to the G.E.C. Works, Witton.

On Wednesday, July 23rd, a party of thirty-five members of the Midland Branch visited the works of the General Electric Company Ltd. at Witton, and spent the greater part of the day inspecting several of the principal departments of the works and witnessing specially arranged demonstrations in the laboratories. Amongst the many interesting examples of the manufacture of the very largest type of modern electrical gear which the visitors were enabled to see were the equipment for the 132,000 volt outdoor substations for the "Grid" electrification scheme; one of the largest high speed turbo alternators yet built in this country; and large motors for colliery winding and rolling mill equipments. Of considerable interest too was the construction of railway and tramway motors, and marine type motors. The High Tension Laboratory is equipped with extra high tension testing apparatus for carrying out super-voltage tests. The plant is capable of giving one million volts, and the visitors were much impressed with the striking and remarkable effects produced when insulators were subjected to tests at this tremendous voltage.

Luncheon was served in the "Magnet" Club, one of the most spacious social clubs associated with an industrial undertaking in this country. Here the party were joined by members of the Derby branch of the Electrical Contractors' Association who had spent the morning at the G.E.C. "Magnet" Works at Landor Street.

Dr. GARRARD, chief switchgear engineer of the Company, presided over the gathering and extended a cordial welcome to all. He said that it was a great pleasure to preside over such a party and hoped that the mining industry would soon turn the corner, particularly as it had such far reaching effects on national trade as a whole. Turning to the electrical contractors he said that without them the G.E.C. would not exist and he was pleased that they had seen some portion of the Company's vast activities. He pointed out that the present electrification schemes tended to reduce work for manufacturers and contractors, as the units built were so large that comparatively few of them were required. It was, therefore, important for electrical contractors to endeavour to increase the use of electricity not so much for lighting as this was already fairly well established, but for heating, cooking, cleaning and other domestic purposes. The advantages of electricity in these directions were too well known to need any elaboration from him.

Mr. C. D. WILKINSON, President of the Midland Branch of the Association of Mining Electrical Engineers then proposed a hearty vote of thanks to the Company. He said he was speaking for all the visitors when he expressed thanks for the interesting and instructive visit. He was particularly impressed by the large amount of money spent by the G.E.C. on research and development work, which was a true indication of the Company's progressive policy. The exchange of ideas, he said, made visits of this nature beneficial both to the visiting engineers and to the manufacturers. The vote of thanks was seconded by Mr. Ames of the Derby Section of the E.C.A.

SOUTH WALES BRANCH.

Visit to the Pirelli-General Cable Works.

On August 14th last fifty members of the South Wales Branch journeyed by special saloon from Cardiff to Southampton to inspect the Pirelli-General cable works where all the wires and cables sold by the General Electric Co., Ltd., are made. Favoured by a perfect summer's day and the most hospitable hosts the visit will long rank as memorable in the annals of the Branch. On arrival at the Docks station about mid-day the party were met by representatives of Messrs. Pirelli's, and after lunch at the South-Western Hotel were conducted over the works on the Western Shore in Southampton before going on to Eastleigh.

The Branch President (Sir Arthur Whitten Brown) was unfortunately unable to be present, and Major E. Ivor David, national vice-president, was prevented from attending. Amongst those heading the party were Mr. W. W. Hannah (Tredegar), immediate Past President of the Branch; Mr. H. J. Norton (hon. secretary); Mr. Theodore Stretton (Past President of the A.M.E.E.); Messrs. J. H. Bates, F. A. Brock, J. B. J. Higham, and W. A. Hutchins (members of Council); Mr. M. Hughes (H.M. Inspector of Mines); Messrs. W. E. Hobbs, J. Ducé, and A. Morgan (G.E.C., Cardiff), and Mr. S. Wilson (Pirelli's, Cardiff).

Southampton Works.

Though this factory is much the older of the two works it is none the less modern in equipment and

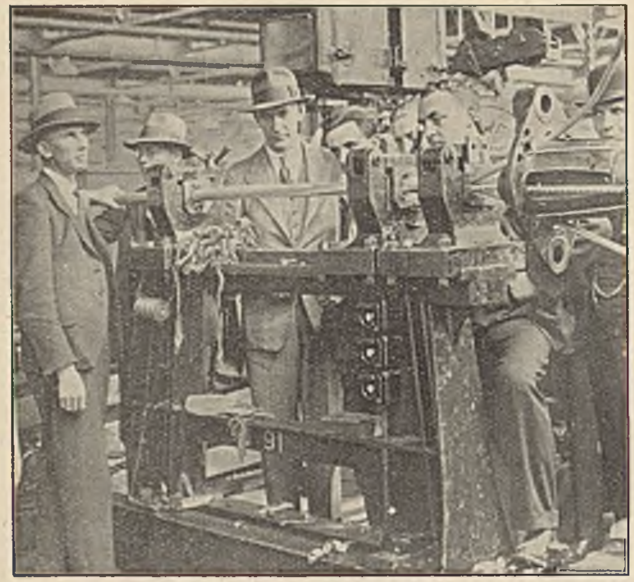

Fig. 1.—Cores and Packings passing through dies on a Laying-up Machine.

working process. Constructed of brick and reinforced concrete, the buildings are divided into thirty-one bays and have a frontage of approximately two thousand feet. They are solely devoted to the manufacture of rubber insulated cables and flexibles and silk and cotton covered wires and constitute one of the best equipped factories in the kingdom for the production of these classes of wires and cables. Of particular interest to the visitors was the range of "Sotonite" cables and wires.

The word "Sotonite" is the registered name of a tough resilient non-hygroscopic material of the rubber compound insulation class. It was developed in the research department of the works and introduced to provide a flexible, easily installed cable possessing the necessary physical and electrical qualities to enable it to be laid direct anywhere with impunity. "Sotonite" cables are impervious to water, resist osmotic action and are unaffected by contact with oil, acids or alkalis. Thus they are peculiarly suitable for collieries, mines and railway work and have found much favour both for shaft and in-bye cables. Owing to the toughness and resilient qualities of "Sotonite", wires insulated with this compound are suitable for use in ordinary cases without further protection, but it will be appreciated that in the case of many permanent installations additional protective finish is desirable. As a guide to the type of finish recommended by the makers to meet the exigencies of various circumstances, the following notes are useful:

(a) For mains cables in power houses plain lead covered or lead covered and armoured, with an additional protection if necessary.

(b) If the cables are required to be drawn into ducts, taped and braided finished, compounded overall is suitable. The taped and braided finish prevents abrasion of the cable during the drawing-in process. Should there be any danger, however, of the cable within the ducts being damaged, single wire armour left bright should be used.

(c) For connecting up low tension apparatus in damp situations or for positions in which the cable is liable to be submerged in water, and where for other reasons paper cables are impracticable, "Sotonite" cables may be installed without further protection, or they may be lead covered, which of course gives an additional and more permanent protection.

(d) For in-bye cables in collieries when a pressure of 250 volts is not exceeded, cables with a taped and braided finish are suitable, provided they are properly secured to efficient insulators.

(e) For in-bye cables where the pressure used exceeds 250 volts or where there may be risk of ignition of coal dust, or other inflammable material, cables with a metallic braid protection and an overall finish of jute or hemp serving may be used. If desired, however, the metallic braid protection may be coated with a layer of "Sotonite" in which case the "Sotonite" may be left bare, or further protected by a taped and braided finish, or a serving of jute or hemp.

(f) "Sotonite" cables for in-bye purposes in collieries may also be protected by steel tape, single or double wire armour, if required.

(g) For cables to be laid along railway tracks cables with braided finish and compounded overall are suitable, unless liable to mechanical damage; when they should be further protected by single wire armour, either left bright or compound jute served overall. For cables which will be laid along the wall of railway tunnels, an anti-sulphuric finish is desirable such as tape or braid, compounded overall with anti-sulphuric compound.

Fig. 2.—Group of Visitors at entrance to the Southampton Works.

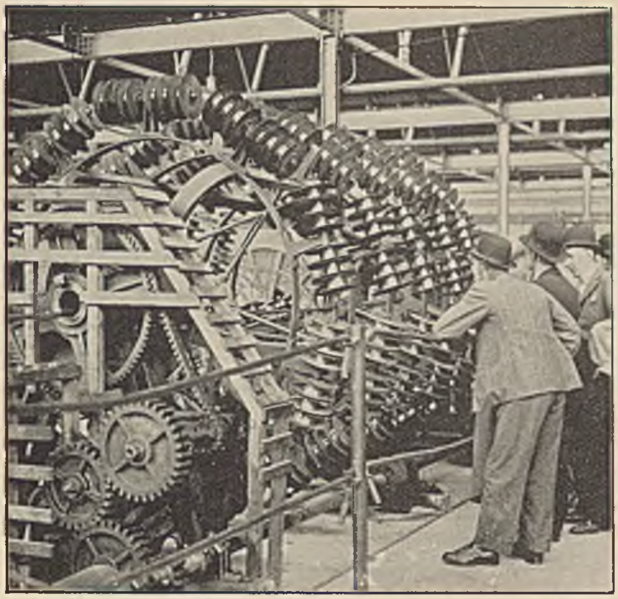

Fig. 3.—The revolving carriage of a large Stranding Machine.

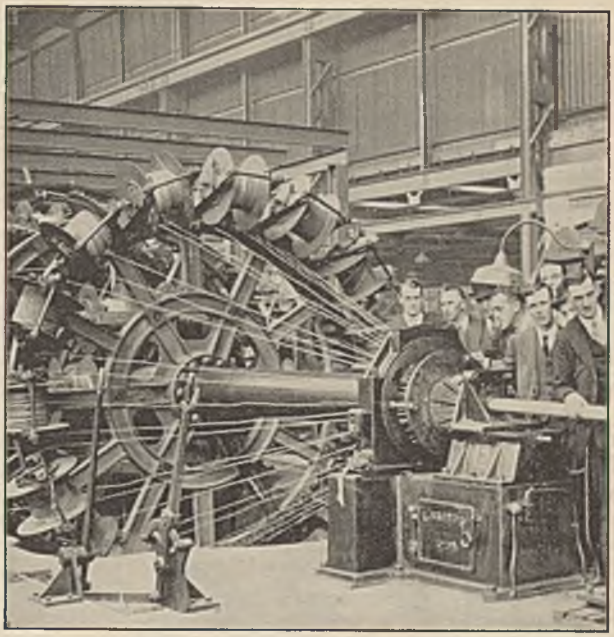

Fig. 4.—Wire Armouring Machine.

Eastleigh Works.

The Eastleigh factory covers an area of about twenty acres and, being some six miles from Southampton, the party enjoyed the rural refresher of a chara. ride thereto.

Paper insulated power cables and telegraph and telephone cables are the staple products at Eastleigh. Quite the most interesting part of the works is the extensive plant required for making the super-tension oil filled cables for which the Company are world famous. A very complete description in detail and with many illustrations, of the Pirelli oil-filled cables as built for working pressures up to 220,000 volts was given in a Paper read by Mr. R. E. Horley before the London Branch of the Association last January and published in full in *The Mining Electrical Engineer* for March this year. The visitors were extremely interested in seeing the several processes and the remarkable plant used for putting together, treating and testing this super-product of scientific cable design. In the Pirelli oil-filled cable system single-core cables are used so that the internal stresses are radial. The impregnating medium is a mineral oil of low viscosity so that when the oil expands due to the increase in the cable temperature, the extra volume instead of distending and permanently damaging the lead sheath, is accommodated by means of external reservoirs which return the oil to the cable when it contracts during periods of lighter loading. The cable is thus maintained full of oil under pressure for all working conditions.

The oil is fed into the cable through a central tube formed by standing the conductors around a plain narrow single spiral of metal strip so making a hollow core cable. This core is kept completely filled with oil by means of feeding and pressure tanks at a pressure which is never allowed to drop below atmospheric at any point of the cable.

In the manufacture of the cable the normal drying of the paper is only preliminary and the impregnation of the paper is effected after the lead sheathing process. By this means much more perfect impregnation is possible because the vacuum that can be established in the lead covered core is more complete than can be established in impregnating tanks. As the tank in which the core is placed for the vacuum and impregnating operation is maintained at a temperature of 100 degs. C., the lead sheath must be perfectly sound or the vacuum cannot be established. This constitutes a check on the soundness of the lead sheath.

The oil used for impregnating the cable is clarified by passing it through a centrifugal machine and degasified. The degasifying of the oil is a most important point: one of the root causes of the failure of other e.h.t. cables has been proved to be the ionisation of gases occluded in the dielectric. Owing to this preparatory treatment of the oil and the method of impregnating the cable, the stress per m.m. of insulation that can be used with safety, is much higher than the maximum stress that may be safely employed in cables of ordinary construction. The thickness of dielectric in oil-filled cables is thus considerably less

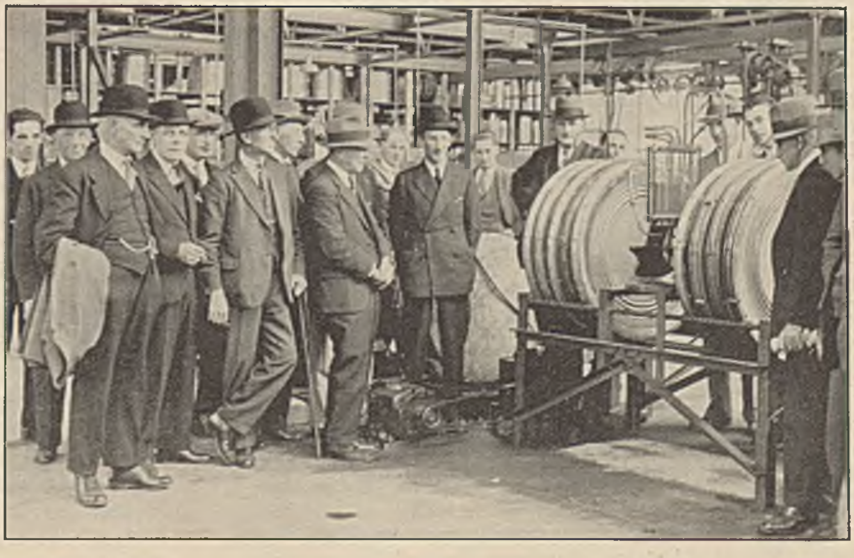

Fig. 5.—Testing Feeding Tank Cells under Vacuum.

than that of normal type cables for an equivalent voltage.

Around the first lead sheath a reinforcing armour of plain brass tape is wrapped between two layers of impregnated cloth and one of insulating paper. This prevents the lead from being stretched when subjected to increased pressure owing to the expansion of the oil, the total extra volume of oil flows instead along the hollow conductor core and into an expansiple closed reservoir designed to accommodate it. A second lead sheath is applied to protect the brass tape against the chemical action of the ground. This also gives a smooth surface for pulling into ducts, but where the cable is laid direct in the ground, a suitable waterproof covering is employed.

The reservoir tank for dealing with the expanding or contracting oil is connected to the cable and placed at a height above it in order to obtain necessary hydrostatic pressure according to the profile of the line. It will be appreciated that the oil in the reservoir shall not be in contact with the surrounding air in order to maintain it in its degasified condition and, further, it must be kept practically at atmospheric pressure independent of the quantity of oil in the reservoir. These conditions have been fulfilled by constructing the reservoir in the form of flexible walled cells made of corrugated nickel plates, the number and size of cells depending upon the amount of oil required for the operating conditions in the cable at the particular point.

Obviously with this system the design of cable terminals and joint boxes presented unusual problems. Full particulars of these were given in the paper by Mr. Horley and need not be repeated here. The construction of these details and the principles successfully adopted were clearly explained to the visitors.

On their return from Eastleigh the members assembled at the hotel and over a cup of tea heartily endorsed the speeches of thanks tendered by Mr. Hannah, Mr. Stretton, and other Branch Officials to the Pirelli-General Company and their Staff for all their kindness through a whole long day. The which was suitably acknowledged as usual.

WESTERN DISTRICT SUB-BRANCH.

Some Considerations Governing Power Costs at Collieries.*

Discussion.

J. B. J. HIGHAM, referring to the question of meters, said that money spent on the installation of accurate meters was well spent. He asked if the meters in general use were of the recording or integrating type, and if simple flow meters were used to any great extent. In referring to flow meters he described an idea of his own. By carefully measuring the difference of pressure between the outside and inside of a bend the quantity flowing through the bend could be calculated. Corrections for temperature and pressure were of course necessary, and the constant for the meter could be determined from the dimensions of the bend and the physical properties of the fluid. He explained some experiments which had proved that the pressure difference was sufficiently large, in the order of 6 ins. to 12 ins., to allow an accurate reading and estimation of the quantity.

* *The Mining Electrical Engineer*, Sept. 1930, page 79.

He would like Mr. Richards to try this method and suggested that, if the idea proved of any value, a series of bends could be made up—using standard pipe bends—and these could be calibrated by the National Physical Laboratory. These could be connected if necessary to a recording meter provided with a suitable scale and the cost would be practically negligible.

Mr. A. REES, of the Swansea Corporation.—It was necessary to costing that reasonably correct records should be kept, and a lot could be done with meters. He referred to the burning of anthracite duff and the prevalent idea of forcing up the rating of the boiler and not allowing the coal time to burn. He referred to the grate area as compared with the heating surface of the boiler and the secret was that the coal was allowed time to burn.

Regarding the load factor, he thought this had a lot to do with the engineer on the job. He thought if it was worth considering where a colliery was taking outside supplies, it was certainly worth considering where they were providing their own power. Likewise with regard to the diversity factor, a lot could be done in that direction. As regards the power factor, they were up against the same trouble.

In reference to the period of costs, the Government had definitely specified monthly costs, and for a calendar month, not four weeks. They arranged to take three checkings in a week, and he would like to have daily checkings to see how they were going on each day, but the weekly check was very useful and very important. Repairs and renewals were adjusted quarterly or yearly.

Mr. McSHEEHY referred to the question of meters, and said it was instructive to see the arrangements at Great Mountain Colliery with regard to this matter. He said that at one of their works recently they found one department consuming about half the coal, whereas it was being charged by rule of thumb at 30 per cent. to each department. It was not until suitable meters had been installed that this particular plant was charged with its due proportion. He asked if it was not wise to include an amortisation charge in their costs in view of some seams having a limited life

Referring to mixed pressure turbines, he did not think the charge should be in proportion to the full thermal value. Incidentally, he expressed the opinion that there were very few cases where a mixed pressure turbine could be justified at all. In nine cases out of ten it paid to put in high pressure sets.

Referring to Power Companies and their charges, and the extra charge on the price of coal, he thought a fairly general charge was proportionate to the burning of 3 lbs. of coal per unit. He would suggest that 2½ lbs. of coal per unit delivered to consumers would be quite high enough.

With regard to the time lag on maximum demand, he was interested to see that half an hour was definitely mentioned. It occurred to him that if they charged on a half-hour basis as between the super power stations and the distributors, private consumers should surely be allowed an hour. In many cases a great deal could be done towards grading the power factor, by choosing the correct size and type of meters.

Mr. W. M. THOMAS offered congratulations to Mr. Richards for his valuable contribution, and thanked the Amalgamated Anthracite Company for the facilities afforded them that day for examining plant at the Great Mountain colliery. He said that cheap power was the basis of successful colliery engineering, and Mr. Richards had chosen a subject of paramount importance to colliery engineers and managers. He had referred to the burning of anthracite duff, the lowest grade of fuel produced, which, subject to a moistening process, would give an efficiency comparable to the best washed coals. In this respect Mr. Farr Davies had made a remarkable advance in the anthracite district, in his experimental work during the last few years, and to-day he had the able assistance of Mr. Richards and Mr. Veater. All steam generating plants at collieries should be burning their lowest grade fuel.

Referring to costs, Mr. Thomas favoured a comparative monthly sheet showing total evaporation, total tons used, percentage of total output, evaporation of lbs. of water per lb. of fuel, and the cost per ton of output. This would enable the engineer and the manager to see at a glance the cost of coal supplied and to what extent the output was effected, and what the boiler plant had been doing during the month.

He would like Mr. Richards to give them the proportions to be allocated to fuel, labour, and other charges. Would he recommend weekly or monthly costs? Mr. Thomas thought weekly costs were somewhat irregular, and a better comparative figure would be obtained monthly. He asked what figure Mr. Richards would recommend for interest and depreciation. He agreed that the cost of meters was high, but the expense was fully justified on most plants, as one could get at the inefficient units more easily. He certainly thought every manager should be supplied with a weekly Compressed Air cost.

Mr. H. M. TAYLOR, speaking as a Power Company engineer, said they had seen the burning of anthracite duff that day, and his company had done the same, but in their case it was not refuse at a colliery, they had to pay carriage on it, and therefore a higher grade coal was justified. Referring to the question of Rates Assessment, he said the Power Supply Company's plant was for the production of electricity for sale, and, rightly, or wrongly, colliery plants were assessed at 50 per cent. or so below them.

Their costs were standardised and prepared monthly. Extraordinary repairs and renewals should be allocated over a reasonable period of time, and not on one month.

As to the question of supplying collieries at a particular price, if 100 per cent. load factor was taken for a proportion of the plant, he asked how much they were going to pay for the lighting. The Electricity Board would probably take the maximum demand at an average of three maximum demands per hour of any supply authority.

Major IVOR DAVID said that the subject of costs from the engineering point of view, resolved itself into consideration of how far the engineer could go, and where the Accountant came in. Engineers had to be accountants to a certain extent, because they had to use these costs, and had to prepare them for their particular uses. The object of costs was for comparison between various power stations, so that they might be certain they were only running their most efficient stations, or all their stations as efficiently as they could. There were published at intervals, Costs based on the public supply stations in the country. These costs give detailed figures per unit for practically all the items Mr. Richards had mentioned, but they excluded Capital Charges. They referred to them as "Loan Charges", but they carefully excluded them from the details of unit costs. This exclusion of Capital Charges made these published costs valueless from the colliery engineer's point of view.

In collieries, twice as much coal was used as in Public Supply Companies for generating electricity, yet we hear more in the Press of the Public Supply difficulties than we do of the Colliery Engineer and his efficiency: the latter was sadly lacking in self-advertising instincts.

Referring to Mr. Richards' statement that all power charges balanced and no profit was to be made, Major David said he could not quite agree. If Interest were paid on Capital outlay, that interest should be considered as profit. There were very few collieries at present paying any dividend on their ordinary shares. Some of them were paying Debenture Interest, but some were in default in this. If interest on Capital were charged against cost, we were paying a profit on our venture. If the plant was purchased by the raising of Debentures, then Interest on the Debentures had to be paid, which was a profit. When new plant had to be purchased the engineer had to shew not only the rate of depreciation on that plant, but also interest on the capital value. They had always to consider the Power Station as a profit-earning portion of the plant, separate from the colliery.

Referring to the question of Repairs and Renewals, Major David said that brought up the point as to the period over which these should be charged. A monthly period may be calendar or lunar, and some colliery companies ask for a thirteen month year, but they had difficulty in adjusting accounts. Where the charges came forward in large lumps, it was difficult to distribute them, and he would like to hear opinions on that question.

As to Rates and Taxes, Major David said he had estimated these items on many of the Power Stations in Glamorgan during the last few years, and colliery companies paid one-third to one-half of what was paid by Municipal Supply stations. For instance, Cardiff Municipal supply station was assessed at £15,900, while a similar colliery supply station was assessed at £7500.

When it is required to distribute costs between various types of power, electricity, compressed air, and steam, the steam should be calculated per 1000 gallons, and then the allocation of costs was an easy matter.

Regarding inter-connections between individual collieries, they had found, by running quite a small number of cheap inter-connections, that they could reduce the maximum demand by nearly forty per cent. Colliery Companies should do this, both from the point of view of safety, and for the benefits which would result. As to the question of Maximum Demand, they had found in one instance that it paid to run certain large units for a quarter of an hour and shut down for the remaining period. The question of maximum demand would certainly arise, because the Electricity Board's rule was that the maximum demand should be twice the maximum demand for thirty minutes over a twelve months' period. It was very difficult in some cases to get the maximum demand down when they had such a short period as that. Mr. Richards made a good point when he said that when colliery companies shut down certain plant and took supplies from outside, the capital charges must still be charged to the job. He also referred to the idea of running the colliery plant at a high load factor, and that was advisable where low grade fuel was available.

Mr. Richards referred to the difference in various parts of the country in the unit consumption per ton of coal raised. In a paper read before the I.E.E., Major David said the point came up that in the Midlands the steam winder had persisted longer than in other parts of the country, because the exhaust steam was exactly the amount required to supply the other units of the colliery.

Mr. C. E. YATES said the paper dealt with a subject of very great interest to him personally, for he had been struggling for the past ten years in an attempt to produce a comprehensive and accurate generating cost account for his central station. The measure of success which he had achieved in that direction was due to the increased interest in this subject which had been taken during recent years by the colliery management.

Mr. Richards had quoted Mr. R. Nelson as saying, with reference to the average colliery: "It is unusual for any records to be kept", and whilst Mr. Yates said his experience forced him to agree with the statement, he would submit that the fault lay in many cases not with the electrical engineer, but to the lack of facilities being provided in the equipment of steam-generating plant and power stations which would enable the electrical engineer to ascertain the essential figures for his generating costs.

The first difficulty usually arose when one attempted to find out the quantity of steam supplied for generation of electricity from a boiler-plant working on a mixed load. Unless the power-house had its own steam generating plant, a steam-meter was necessary and, unfortunately, many of these were not so truthful as their makers would have the users believe. But, if lucky, a steam meter in conjunction with a water meter, and an accurate system of coal weighing would suffice to give data as to the quantity of steam supplied and its cost, and also the percentage of total steam generated which was supplied to the power-house. This figure was necessary as items such as the wages of stokers and other men employed in connection with the boiler-plant must be taken in the same proportion to arrive at the figure to be included under labour charges.

It would be instructive if Mr. Richards could give, for the generating station visited that day, the percentage of the total generating cost represented by each item. The figures from the speaker's power-station were as follows:

Fuel	33%
Labour	17%
Stores	0.47%
Rates and Taxes	8%
Interest and Depreciation	34%
Home Consumption	6%

The fixed charges amounted to 42% of the total generating cost, and Mr. Yates would suggest that an important consideration affecting colliery generating costs ot-day was the overvaluation of colliery property.

Mr. Richards had rightly emphasised the importance of attention to "peaks" in order to prevent excessive maximum demand charges when taking Bulk Supply. It was a common error to have too high a rope speed on underground haulages. Mr. Yates had in mind a case where a 120 h.p. haulage was working with a peak demand of 210 amperes: he had plotted a curve to shew the performance of this haulage during the day-shift and found that the idle periods amounted to more than the actual working time. Altering the rope speed by alteration of gear ratios brought the peak demand down to 110 amperes, and the haulage still handled the same quantity of coal.

The effect of load factor upon generating cost was well illustrated by the figures published of the costs of a public supply station, with a capacity of 351 million units per annum. At 25% load factor the cost per unit was 0.3314d., and improving the load factor to 50% brought the unit cost down to 0.2232d. Had it been possible to obtain 100% load factor, the cost per unit would have been reduced to 0.1653d.

In conclusion, Mr. Yates thanked Mr. Richards not only for an interesting paper, but for arranging the visit to the Great Mountain Station.

Note.—Mr. S. T. Richards, the author, indicates two errors in the printing of his paper. On page 81, left hand column, eighth line, the cost of compressed air is given as 2¼d. instead of 1½d. per 1000 cu. ft. of free air. On the same page, right hand column, line 32, the words "line incidence" should read "time incidence."

KENT SUB-BRANCH.

Summer Meeting in Dover.

The summer meeting of the Kent Sub-Branch was held on Saturday July 12th, when some forty members visited Dover. The party assembled outside the Dover Town Hall and proceeded to the Corporation Electric Power Station where they were cordially received by Mr. Harper, the borough electrical engineer, and his staff. An interesting hour was spent in examining the rather unique collection of old and new generating plant, the guides being busily employed in explaining the various combinations of a.c., d.c., and frequency changing gear which had to be adopted to deal with the different types of load.

At the close of the visit, the President of the Branch, Mr. A. R. Cooper, after welcoming Mr. Gibson, the President of the Association, who had come down especially for the visit, asked Mr. Gibson to propose a vote of thanks to Mr. Harper and his colleagues.

Mr. Gibson complied with a brief speech and the party returned to Dover Town Hall. Here they boarded a special tramcar kindly supplied by the Dover Corporation and journeyed to the Marine Station of the Southern Railway. After traversing with some little difficulty the intricate maze of platforms and stairways the party eventually found themselves on the quayside and went aboard the S.S. "Canterbury." This boat has been built for first-class cross channel passenger traffic and is one of the best equipped vessels of its kind. The boilers are oil fired, the screws are driven through gearing by steam turbines, and the electric supply for radiators, fans, lights, etc., is obtained from two Diesel driven d.c. generators. A very interesting hour and a half was spent in exploring the boat from the engine room, through the magnificent state apartments to the chart room; particular interest was evinced in the signalling arrangements and the bulkhead closing gear. Interesting comparisons were drawn between the duties of ships' engineers and colliery workers, the visit proving to be something of a revelation to many members.

After arrangements had been made for thanks of the Branch to be conveyed to Messrs. Gates and Wood of the Southern Railway for the facilities which had been given, the members dispersed, after having enjoyed an exceedingly entertaining afternoon. The unqualified success of this Summer Visit, the first of its kind for the Kent Sub-Branch, was due to many things—the attendance of Mr. Gibson, the President, and his cheery good fellowship; the admirable transport arrangements made by Mr. Pollard; and lastly, but by no means least, the enthusiastic response of the Branch Members, the attendance being over 70% of the membership.

WEST OF SCOTLAND BRANCH.

Visit to the Albion Motor Car Works.

Over seventy members took part in the visit on September 10th to the works of the Albion Motor Car Co., Ltd., Scotstoun, Glasgow. They were received at the works by Mr. Pate, works manager. Thereafter the members were split up into parties of eight and, under capable guides, were taken through the various departments where everything was very fully explained. On the conclusion of the visit the members were entertained to tea by the Albion Motor Car Co., at which Mr. R. Rogerson, President of the Branch, took occasion to convey to the Albion people the thanks of the Branch for their kindness. Special thanks were due to Mr. Pate, Mr. Arthur the Employment Superintendent, and other members of the staff, who had made the visit such an enjoyable one. Mr. Pate, in replying, stated that at any future time facilities would be given for a repeat visit.

Mr. James R. Laird afterwards entertained the assembled company with a reading which was greatly appreciated.

THE ALBION MOTOR CAR COMPANY.

The history of the Albion Motor Car Company is not without its romantic elements. To go back to 1899 is a long way in affairs of motoring, and it was in that year that this firm had its beginning. Two men, the late Mr. T. Blackwood Murray and Mr. Norman O. Fulton (now the Chairman of the Company), with a staff of five workmen and two clerks managed to turn out one motor car by the end of 1900. It is not surprising in view of the great success which subsequently attended the firm, that this car embodied engineering features in regard to ignition altogether in advance of its date. Without entering into detail regarding the progressive steps to date, it is interesting to know that the activities of this Company now extend into practically every part of Britain overseas; moreover, there are more than thirty different governments who use Albion cars for their transport services.

Needless to say, the inspection of a works of this description, replete with the most modern tools, appliances and methods, provided an extremely interesting and valuable lesson to the visiting members. No modern works is complete without its research or experimental department. In this case, the section devoted to work of a research character is equipped with the most accurate type of engine-testing appliances. All engines built at the works are submitted to a non-stop run of 100 hours at full power, tests of temperatures, etc., being read every 30 minutes during the run. Very valuable too are the road tests to which all the first examples of improved or modified chassis designs are subjected. In this case protracted loads are imposed; the trials being equivalent to 3000 miles of road service in each case.

So it is all through the story of the construction of Albion vehicles, from minor but essential details, such as magnetos and carburetters, up to the finished product. In regard to purely research work, chemical and physical tests of all materials are part of the regular routine. The instruments and apparatus used in the research department are of the most accurate and modern description. Motor car engineering may appear to be some distance removed from mining electrical engineering but it offers examples of modern processes and developments of which a knowledge is extremely useful. This visit will long be considered by the West of Scotland members as a day well used.

Association of Mining Electrical Engineers Examination Papers, 1930.

CERTIFICATE EXAMINATION.

1.—*Direct Current.*

(1) Define the terms "Insulation Resistance," "Resistivity" and "Electromotive Force." Explain how the temperature of a conductor effects its electrical resistance.

What is "Joule's Law" and what is Joule's equivalent?

(2) Discuss the various factors which have to be considered when determining the efficiency of a d.c. generator.

Explain how you would proceed to determine the efficiency of a 10 h.p., d.c. motor.

(3) Find the speed and horsepower of a d.c. motor to drive a three-throw ram pump which is required to raise 150 gallons of water per minute to a height of 300 yards. The following data is available:—

Diameter of rams	= 5 inches.
Stroke	= 10 inches.
Allowance for slip	= 15%.
Allowance for pipe friction	= 5% on static head.
Gear ratio	= 10 to 1.
Overall efficiency of pump and motor	= 78%.

(4) For what purposes is a "field regulator used in conjunction with a shunt motor? Draw a diagram to illustrate the principle of such a regulator.

(5) A motor has an output of 25 b.h.p. at 500 volts. If the efficiency of the motor is 85% and the resistance of the supply cable is 0.5 ohm., find:—

(a) the power used by the motor.
(b) the current taken by the motor.
(c) the power lost in the cables.
and (d) the required voltage at the generator.

(6) Describe the construction of an ammeter suitable for use in a d.c. circuit. Shew by diagrams how an ammeter and voltmeter are connected.

(7) Give a brief description of the construction and action of one type of primary cell.

What is meant by the term "polarisation"? Explain clearly the difference between a primary cell and an accumulator.

(8) A d.c. generator, with self-excited field, when running at its correct speed, will not build up its voltage to the normal rating. If the windings are not faulty, what other possible causes would you look for?

Give a brief description of the main types of d.c. motors.

2.—*Alternating Current.*

(1) Explain what is meant by the "Effective Value" of an alternating current. If the maximum value of the voltage in an a.c. circuit is 100 volts, what will be the reading on a voltmeter in the circuit?

What is "form factor" and what is its value for a true sine wave?

(2) State what type of motor you would instal for an endless rope haulage, if three-phase current at 500 volts were available. Give reasons for your choice.

If the motor is one of 60 b.h.p. with an efficiency of 86%, find the full load current per phase taken by the motor, assuming a power factor of 0.88.

(3) What is the difference between "core type" and "shell type" transformers? Draw sketches of the two types shewing the arrangement of the windings.

Explain the various methods of connecting two three-phase transformers in parallel.

(4) For an underground station, the power requirements are 750 k.w. at a power factor of 0.8. If three-phase current at 3000 volts is available and the distance from the surface power station is 1000 yards, find the size of cables required. Assume that the power lost in transmission is 2% of the load and neglect inductive effects.

(5) Describe, with the aid of a diagram, the construction of a frequency meter.

Explain the relationship between the speed of rotation of an alternator and the frequency of the current generated.

(6) Give a short description of an induction motor and describe the various methods of starting such motors.

(7) Explain what is meant by "voltage regulation" of alternators.

Describe one type of device for automatically regulating voltage within permissible limits.

(8) Describe a protective system which can be incorporated in the circuit of a three-phase electrical coalcutter, the protection to include both the coalcutter motor and the trailing cables.

3.—*Electric Lighting and Signalling.*

(1) What are the requirements of the Coal Mines Act and General Regulations with respect to electric lighting underground?

Sketch and describe a typical layout for an underground lighting system commencing from the shaft cable giving details of cables, fittings, lamps, etc.

(2) What is the maximum voltage permissible for signalling purposes? Explain why such a maximum voltage is specified. Give details of the type tests which have to be made on electric bells and relays which are to be used for bare wire signalling.

What limitations are imposed upon the use of approved bells?

(3). Describe the arrangements necessary for charging electric safety lamp accumulators where such lamps, say to the number of 1000, are in daily use.

Enumerate essential points to be considered in connection with the maintenance of electric safety lamps?

(4) Sketch and describe a system of signalling other than by the use of bare wires.

Enumerate the advantages and disadvantages of such a system for various purposes.

(5) Describe any system of electrical signalling suitable for use in mine shafts. Illustrate your description with sketches and indicate how the provisions of the Coal Mines Act are complied with.

(6) What type of battery would you adopt for use in a mine signalling system? Give reasons for your choice and give a detailed description of a single cell of the type chosen, stating the capacity of the same. Show by a sketch how the various cells would be connected in a battery for use on a long haulage plane so as to give the best result.

(7) Sketch and describe a fixed lighting fitting suitable for use underground, indicating what precautions are necessary to ensure safety.

(8) What are the objections to the use of an auto-transformer for underground lighting?

Describe the concentric system of wiring and state what precautions have to be taken with respect to the use of switches and fuses in this system.

4.—*Electrical Rules and Regulations and Special Paper.*

(1) Why is it necessary to earth electrical apparatus?

State the requirements of the General Regulations with respect to earthing.

Under what circumstances may accidental recharging of apparatus occur and what precautions must be taken against it?

(2) Explain clearly the meaning of the terms "open sparking," "medium-pressure," and "authorised person," as laid down in the General Regulations.

Describe briefly the essential features of design of a "flame-proof enclosure" to be used for mining electrical apparatus.

(3) Describe, with the aid of diagrams, either of the following :—

(a) A construction of a plug and socket connector which is safe for use in a fiery mine.

(b) Two safe methods of releasing the pressure developed within a casing as a result of an explosion of firedamp and air.

(4) What are the provisions of the General Regulations respecting :—

(a) The appointment and duties of the electrician.

(b) The notices which must be exhibited at a mine and the positions of such notices.

(5) State what precautions must be taken with respect to the protection of cables underground and also with respect to an overhead transmission line.

Describe the methods of securing a cable in a mine shaft 600 yards in depth.

(6) Enumerate the potential dangers arising from the use of electricity in mines and explain briefly the means which can be used to overcome these dangers.

What are the limitations imposed by the Coal Mines Act, 1911, and the General Regulations upon the use of electricity in gassy pits?

(7) Describe a method of locating the position of an earth fault in a three-core feeder cable of considerable length, giving a diagram of the test connections.

(8) Define the term "load factor" and state what type of plant contributes largely to maintaining a good load factor at a colliery.

If the yearly output from a colliery generating station is 3.08×10^6 B.O.T. units and the maximum demand on the station at any time during the year is 1000 k.w., determine the load factor.

HONOURS EXAMINATION.

Paper No. 1.

(1) Discuss the causes and effect of "armature reaction" in d.c. machines, and describe the methods adopted to overcome the effect of such reaction.

(2) What is the "efficiency characteristic" of a d.c. generator?

A 500 volt shunt dynamo has an armature resistance of 0.06 ohm. and field resistance 125 ohms. and its full load current is 200 amperes. If the stray losses in the machine are 2000 watts, determine the h.p. of its prime mover when it is delivering full load. Find also the load at which its efficiency is a maximum.

(3) Explain fully the economic factors which have to be considered in connection with the distribution of electrical energy. State the laws which govern the size of conductors in general and the distribution of currents in networks.

(4) State the requirements of the General Regulations with respect to automatic protection of circuits.

Sketch and describe a system of leakage protection for either

(a) a d.c. system; or

(b) an a.c. system.

(5) Discuss the relative advantage and disadvantages of electric winding and steam winding. Give a brief outline of the main available types of electric winding systems.

(6) Explain what is meant by the "rupturing capacity" of a circuit-breaker.

What special points would you take into consideration in deciding between air-break or oil-break circuit-breakers for use underground.

(7) Describe, with the aid of a diagram, a typical layout for the use of an electrical coalcutter. Give details of the protective devices which can be used on such a circuit.

Paper No. 2

(1) Explain clearly the methods of connecting individual phases for three-phase working. Compare the methods of connection with respect to line and phase voltages and currents.

How would you take a measurement of the power in a three-phase balanced system?

A 100 h.p. three-phase star-connected motor has an efficiency of 90% and power factor .92. If the supply voltage is 500, calculate the line current.

(2) Define the terms "power factor," "load factor," and "diversity factor." Discuss fully the importance of these factors with reference to the supply of electrical power to a colliery.

(3) Sketch and describe a type of reverse power relay and explain how this instrument is used for protecting an alternator.

(4) What is the principle of a synchronous induction motor? Under what circumstances is such a machine used?

A synchronous motor is used in conjunction with an induction motor in order to improve the power factor of the system. If the induction motor has an input of 20 k.w. at 0.8 power factor and the power taken by the synchronous motor is 5 k.w., determine the power factor of the synchronous motor when the combined power factor is unity. The supply voltage is 500 volts.

(5) Discuss the important points to be considered in connection with either :—

(a) Electric lighting underground (including coal face lighting); or

(b) Storage battery locomotives for mine use.

(6) Describe the methods of starting a rotary converter and draw a diagram to shew the arrangements for one method.

(7) What are the requirements of the General Regulations respecting danger from "open sparking"? Explain fully the manner in which these requirements are met, giving details of the various features of design to which you would pay special attention when examining electrical apparatus for use underground in a gassy mine.

FULLAGAR ENGINES.

The English Electric Co., Ltd. report an increasing demand for their Fullagar opposed-piston oil engine sets, the value of recent orders totalling over £92,000. A tribute to the satisfaction given by these prime movers is the fact that no less than 42 per cent. of the total horse-power of the Fullagar engines supplied by this Company represents repeat orders.

The recent contracts comprise :—Karachi Electric Supply Corporation: 1500 b.h.p. engine and tandem generators. The Admiralty: Two 1125 b.h.p. engines and 750 k.w. d.c. generators. Delhi Electric Supply Co. : 1125 b.h.p. engine and 750 k.w. a.c. generator. Dubbo (Australia): 750 b.h.p. engine and 500 k.w. a.c. generator. Zanzibar (Crown Agents for the Colonies): 750 b.h.p. unit.

Earlier in the year other important orders received for Fullagar engine sets included:— Sudan Light and Power Company: 1125 b.h.p. engine and alternator. Bermuda Electric Light, Power and Traction Company Ltd.: 1500 b.h.p. engine and alternator.

The manufacture of straight 4-cycle Diesel engines, which has been carried on at the Rugby Works of the English Electric Co. for the last 23 years, is still continued, and an order has recently been received from Colombo for a 335 b.h.p. unit to a 225 k.w. generator.

TUNGSTONE BATTERY FEATURES.

It is claimed by the makers of the Tungstone battery that it is the only battery in the world which is sold under a nine months' guarantee of plates and component parts, even to corrosion of the plate terminals. The firm is able to give this guarantee, not only because of the quality of material, workmanship, and plate reliability, but because their batteries are sent out partially first charged. This ensures that the risk of damage during the first charge is almost entirely eliminated. The partial first charging of the cells also possesses another advantage. Instead of the plates having to be soaked for twelve hours, it is sufficient if they be soaked for from two to eight hours according to the type. For example, instead of the first charge of a motorcar battery taking 98 continuous hours at 4 amps., or 70 continuous hours at 6 amps., the battery can be fully charged in from four to ten hours. Not only is the risk of injury, and subsequent inefficiency, obviated, but the cost of the first charge is considerably reduced.

Among the many special features incorporated in the Tungstone batteries, are the easy accessibility of the plates, which can be renewed as occasion arises, more plates per cell, meaning bigger starting power; the paste is interlocked into the plate grids; the grids are specially strengthened to resist buckling; permanent sulphation is impossible; the ebonite containers are of high grade; and all batteries are built to standard sizes which cover practically all replacement requirements.

A LARGE CABLE CONTRACT.

In connection with the South East England Electricity Scheme, the Central Electricity Board has placed a contract with Messrs. W. T. Henley's Telegraph Works Co. Ltd., through Messrs. Merz & McLellan, for the supply and installation of cables for pressures of 3000 to 33,000 volts, together with auxiliaries, in various towns in the South East England area. This follows a contract from the same source, placed with Henley's a few months ago, for the supply and erection in the same area of a large quantity of steel-cored aluminium conductors on lattice steel towers for 33,000 volts pressure.

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.—OUTPUT AND EMPLOYMENT AT METALLIFEROUS MINES, QUARRIES, etc., during the Quarter ended 31st March, 1930. Price 4d. nett.

Mines Department.—THE EXPLOSIVES IN COAL MINES ORDER of the 26th August, 1930 (for official use). Price 2d. nett.

Mines Department.—REPORTS OF H.M. INSPECTORS OF MINES under the Coal Mines Act, 1911, for the Year 1929. Price, each report, 1s. nett.

1.—Scotland Division: Report by Mr. J. Masherton.

2.—Northern Division: Report by Mr. T. Greenland Davies.

3.—Yorkshire Division: Report by Mr. E. H. Frazer.

4.—North Midland Division: Report by Mr. J. R. Felton.

5.—North Western Division: Report by Mr. W. J. Charlton.

6.—Cardiff and Forest of Dean Division: Report by Mr. Macleod Carey.

7.—Swansea Division: Report by Mr. T. Ashley.

8.—Midland and Southern Division: Report by Mr. W. E. T. Hartley.

also—Reports by H.M. Inspectors of Mines and Quarries under the Quarries and Metalliferous Mines Acts: in one volume, price 1s. nett.

Mines Department.—LIST OF MINES in Great Britain and the Isle of Man. Prepared by H.M. Inspectors of Mines. Price 5s. 6d. nett.

The List includes sections as follow:

(1) Divisional Lists (a) of Mines under the Coal Mines Act, and (b) of Mines under the Metalliferous Mines Regulation Acts, arranged according to the name of owner, and giving the name and postal address of the owner, the name and situation of the mine, the names of manager and under-manager, number employed, minerals worked, etc.

(2) A General Index of all Mines.

(3) An Index of all Owners of Mines.

(4) A separate Index of all Mines producing minerals other than coal, arranged according to the mineral obtained.

(5) A County Index which precedes the Divisional Lists.

PITMAN'S ELECTRICAL EDUCATOR, edited by Sir Ambrose Fleming, M.A., D.Sc., F.R.S. In Fortnightly Parts, Part 1 published Oct. 4th, 1930 (about 28 parts in all). London: Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, W.C. 2. Price, per part, 1s. 3d. nett.

The strongest recommendation of this book is that, having proved its value when first produced, it now appears in a new edition. The work has been brought right up to date, and the sections re-arranged to give greater facility of reference. It is expressly planned to form a complete guide to the first principles of practical electrical work and to present a broad view of the industry as a whole. In its complete form it will comprise nearly 1500 large pages of information, instruction, explanatory diagrams and photographs, and includes practically every electrical subject. The contents have been compiled by some fifty experts and specialists, and cover the whole field of heavy current electrical engineering, with special sections on wireless subjects. The book will be found a valuable help by the electrical worker and the student. It is a practical work of reference to the things that most closely concern the worker in electrical industry. The method of issuing a voluminous technical book at the small cost of 1/3 for each part, at fortnightly intervals, puts it within easy reach of the pockets of those for whom it is primarily intended and to whom it is of the greatest value.

THE PRINCIPLES OF ELECTRIC POWER TRANSMISSION BY ALTERNATING CURRENTS: H. Waddicor, B.Sc., A.M.I.E.E., Mem. Amer. I.E.E. London, Chapman & Hall, 11 Henrietta Street, Covent Garden, W.C. 2. Price 21s. nett.

This book was first published in February, 1928, and in this second edition the work has been thoroughly revised and brought up-to-dtae. The subject is treated in the form of a text-book for college students in electric power transmission.

The author states that he has taken full advantage of widely diffused information given in original papers, to the more important of which references are given, so that the reader can follow up his interests further. The subject is one which is of first importance to a rapidly increasing circle of engineers, and the fact that this book has run through its first edition in two years augurs well for the success and popularity of this new and revised edition.

Particular attention may be directed to the thorough manner in which the book deals with the protection of circuits and the design of automatic apparatus for these purposes. It is notable that, throughout, the respective subjects are treated with the industrial requirements and. the manufacturer's work in view: the book is therefore more than a student's text-book, it is one which will be found extremely useful by the practical electrical power engineer.

TECHNICAL REPORT of the British Engine Boiler and Electrical Insurance Co., Ltd., for the Year 1929. Published by the Company from the Head Office, 24 Fennel Street, Manchester. Price 7s. 6d.

These annual reports have long been favourite books of reference. This edition is an exceptionally useful one: it deals exhaustively as usual with a series of machinery and plant failures and accidents and, in addition, gives a full account of the Company's investigations in regard to Fusion Welding. Running to more than 200 pages of letterpress and over 150 illustrations and plates, all produced in the very best form of print, it represents wonderful value.

A.M.E.E. Annual Convention : 1931.

At the Council Meeting held in Preston on October 18th, it was resolved that next year the Annual General Meeting and Summer Convention of the Association of Mining Electrical Engineers would be held in Cardiff during June. The actual dates were not fixed because it was hoped that by giving early notice in the press, other similar societies would follow suit and eventually by mutual arrangement come to decisions which would prevent clashing of the dates of meetings.

Council Meeting.

The next meeting of the Council of the A.M.E.E. will be held in Stratford-on-Avon on Saturday, 21st February, 1931. The date and place being convenient for those members who may wish to visit the British Industries Fair in Birmingham.

Motor Controlling Apparatus.

F. MAWSON.

(This is the Eleventh of a series of Articles intended more particularly to help Students and Junior Engineers.)

FOR the purpose of starting up a direct current motor which is operated from a constant voltage circuit, it is necessary to provide some form of apparatus for reducing the voltage at the motor terminals. The usual method is to insert a resistance in series with the armature; the resistance is decreased gradually as the motor gains speed, and it is finally cut out altogether when the motor has reached its running speed. The resistance of the armature is very small, and if the machine, while standing still, were to be connected directly to the supply line, there would be an enormous rush of current, because the motor cannot generate its normal back e.m.f. except when running at normal speed. When at rest, of course, the motor cannot set up any e.m.f. For example, a certain shunt motor has an armature resistance of 0.1 ohms. If this armature be connected directly across a 200 volt supply while the armature is stationary, a current of 2000 amperes would flow through the windings. From Ohm's Law,

$$E = IR, \text{ i.e., } 200 = I \times 0.1. \quad I = 2000 \text{ ohms.}$$

A motor starter usually consists of a resistance divided up into a number of sections, combined with a multiple contact switch. The sections of the resistance are connected up to the contacts in such a manner that the sections can be cut out step by step as the motor increases its speed, as shewn in Fig. 1. When the motor has gained its normal speed the resistance is completely cut out and the full voltage is then applied to the armature terminals.

The materials which compose the resistance vary considerably, the most common type comprise materials which are metallic, built up in sections and connected to the multiple switch. Another form of resistance is the liquid starter, a variable resistance is brought about by immersing the metallic plates in a liquid and the amount by which the plates are immersed determines the resistance.

The materials for metallic starters vary considerably according to the requirements, such as the amount of current to be carried and the number of times the starter has to be operated in a given time. For heavy currents, iron castings in grid form or plain or galvanised iron is used. For lighter duties, and for windings of high resistance, choice may be made between German silver wire, and wires of special alloys, such as platinoid manganin, etc.

The simplest form of metallic starter is shewn at S in Fig. 1. The switch is mounted on the front of a slate base and the resistance sections in a ventilated iron box at the back. The sections of the resistance are connected in series, tappings being connected from the junctions between the sections to the buttons a a_1 a_2, etc. The terminal screws are connected respectively to the arm e and the contact b. When the arm is turned so that the contact rests on a, all the resistance is in circuit. As the handle is turned to the right, the arm e passes over successive contacts cutting out corresponding sections of the resistance; when, finally, the arm rests on b the whole of the resistance is cut out.

Liquid starters generally consist of a metallic box or trough containing an acid or saline solution into which a metallic cone or plate is immersed. By controlling the depth of immersion in the liquid, the length of the path of the current through the liquid, and therefore the resistance in the armature can be reduced gradually as the speed of the motor increases.

The liquid resistance has an advantage over the metallic in that it permits of smoothness in control, there being no spasmodic step by step changes. The risk of spilling the liquid and the difficulty of maintaining a constant resistance are disadvantages of the liquid type, especially in the case of movable machinery such as a crane.

Shunt Motor Connections.

The common method of connecting a shunt motor and starter to a constant potential supply is shewn in Fig. 1. The wires leading to the motor are connected to the mains through the fuses D from which they are led to the switch B. The latter is usually of the double-pole type. The positive side of the switch is connected to one end of the shunt field F through the terminal 2 and to the starter arm terminal M. The terminal N is connected to the last stop b of the starter and is coupled to the armature terminal 3. The opposite end of the field and the negative brush and coupled together and connected to the negative side of the double-pole switch.

The field of the motor should be fully excited before the armature circuit is closed, so that the full starting effort of the motor can be exerted as soon as the current passes into the armature. It is therefore usual to provide the starter with an extra, or dummy, contact, forming an "off" position on which the switch arm can rest and then to connect the first section of the resistance to the second and third contact as shewn at a and a_1. It is evident from the diagram Fig. 1, that as soon as the main switch B is closed current will flow through the field F and excitation will immediately take place. When the starter arm is moved to the second and successive contacts, current will flow through the armature and the motor starts. The handle is then moved slowly over the remaining contacts until the motor has attained its full speed and the whole of the resistance of the starter S is out of circuit.

Compound Motor Connections.

The connections for compound motors are similar to those for shunt motors with the exception that the series field windings are connected between the armature terminal on the motor and the armature terminal on the starter; that is, the series winding is simply connected as a part of the armature circuit between the terminals 3 and N.

Series Motor Connections.

These are very simple, N through series winding to 3, and 1 to the negative terminal of the switch B.

In the foregoing notes only the simplest form of metallic starter has been described in order to make the connections as clear as possible. Except for the smallest size of motors, the simple starter is seldom used for the following reasons. In the case of a motor arranged as in Fig. 1, suppose that it is stopped by merely opening the switch B, without the starter arm being moved back to its starting position. If the main switch is closed in order to start the motor again, while the whole of the starter resistance is out of circuit, the armature will be subjected to the full line voltage and a rush of current will take place which may seriously damage the motor. Similarly, if the supply fails while the motor is running and, with the standing motor still connected to the mains, should the supply be restarted exactly the same conditions will prevail as in the case of opening the main switch.

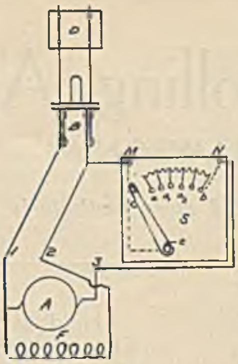

Fig. 1.

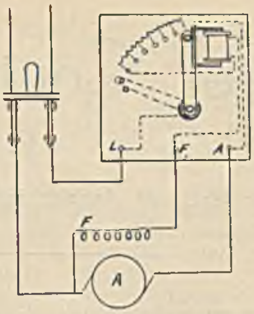

Fig. 2.

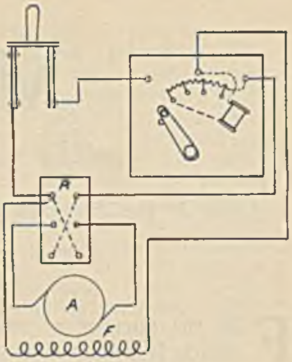

Fig. 3.

No-Volt Release.

To prevent risks of this kind it is therefore usual to incorporate a no-volt release in the starter. The starter arm is fitted with a spring which tends to make it fly back automatically to the "off" position. The arm is held in the running position against this spring, by an electro-magnet. So long as the current is flowing through the machine the magnet exerts a pull which overcomes the force of the spring, but should the supply be cut off, the magnet ceases to operate and the arm is thrown back to the "off" position.

The method of connecting the no-volt release starter in a motor circuit and the external connections are shewn in Fig. 2. The terminal L is connected to the positive side of the switch, F is connected to the field coil and A to the armature terminal. As will be seen from the diagram, when the starting resistance is cut out the motor field windings and the release coil in series with it, are connected across the armature terminals. If the current be interrupted the current ceases to flow in the release coil and the arm flies back to the "off" position, shewn dotted. The release coil is always connected in the field circuit of a shunt motor because it protects the motor in case of a broken field circuit. In some motors an overload coil is incorporated: this is of the simple solenoid type and when in action breaks the circuit in the no-volt release coil.

Reversing the Direction of a Motor.

If the current in either the field or the armature of a motor be reversed the direction of rotation will be reversed. It is the common practice to reverse the direction of the current in the armature and not that of the field. It will easily be seen that this is the best method as reversing the field current would mean reversing the polarity of the field magnets. Fig 3 shews the method of reversing a shunt motor, the reversing switch is shewn at P. The connections are very simple, and will be easily followed from the diagram.

The reversing of a series motor is a very simple matter and is effected by changing over the armature connections.

Speed Control.

Speed control of a shunt motor can be obtained by two methods or by a combination of the two, i.e., by placing a resistance in the main circuit or by regulating the resistance in the shunt field. The former method simply means that the voltage at the machine is reduced to cause a corresponding reduction in speed. This is not an efficient method owing to the wastage of current in the form of heating of the resistance. In the latter method, for controlling the shunt field an adjustable rheostat is placed in the shunt field circuit and is sometimes incorporated with the starter. It must be remembered that the weaker the field the greater will be the armature speed to give the necessary back e.m.f. The slowest speed of the machine will be when the shunt resistance is cut out. Only a limited speed range can be obtained, it is usually about 25 per cent. from normal upwards, but if interpoles are used this can be greatly increased sometimes up to the ratio of four or five to one.

Speed control of a series machine is obtained by placing a variable resistance in the circuit, this resistance has to be of sufficient conductor area to carry the full current taken by the motor. Another method is by the use of a diverter or variable resistance in parallel with the field coil, but this is not a common method.

AN AMALGAMATION.

David Brown & Sons (Huddersfield) Ltd. in announcing their amalgamation with P. R. Jackson & Co., Ltd., Salford, state that, for some time past it was felt that this combination would be beneficial and be the means of effecting important economies. The policy of the joint companies will be to operate entirely independently as regards the execution of orders, but design will be standardised and the technical and research work will be available to both. It is believed that this union of interests probably represents the largest and most completely equipped organisation in the world for dealing with machine-cut and machine-moulded gearing.

THE INSTITUTE OF FUEL.

The Annual Dinner and Dance of the Institute of Fuel will be held at the Connaught Rooms, Great Queen Street, London, W.C. 2, on Wednesday, October 22nd. The President, Sir David Milne-Watson, LL.D., D.L., and Lady Milne-Watson will receive the members and guests at 6-45, and dinner will be served at 7-15 p.m. Many distinguished guests will be present. The toast of "The Fuel Industries" will be proposed by The Most Hon. The Marquess of Londonderry, K.G., M.V.O., and responded to by the President. The Dinner will be followed by a dance, and cabaret performance continued until 1-30 a.m.

The Electrical Equipment at Lydney and Crump Meadow Colliery.

IN connection with the development of the Arthur and Edward Colliery of the Lydney & Crump Meadow Collieries Co., Ltd., a considerable amount of electrical apparatus has been installed, comprising 33,000 volt transformer outdoor sub-station equipment; truck cubicle switchboard on the surface; and pedestal oil-immersed switchboards, haulage-gear motors and motor control gear, motor driven turbine pumps, etc., below ground. The contract for this plant and apparatus was placed with the General Electric Co., Ltd., the gear being manufactured at the Company's Witton Works, Birmingham.

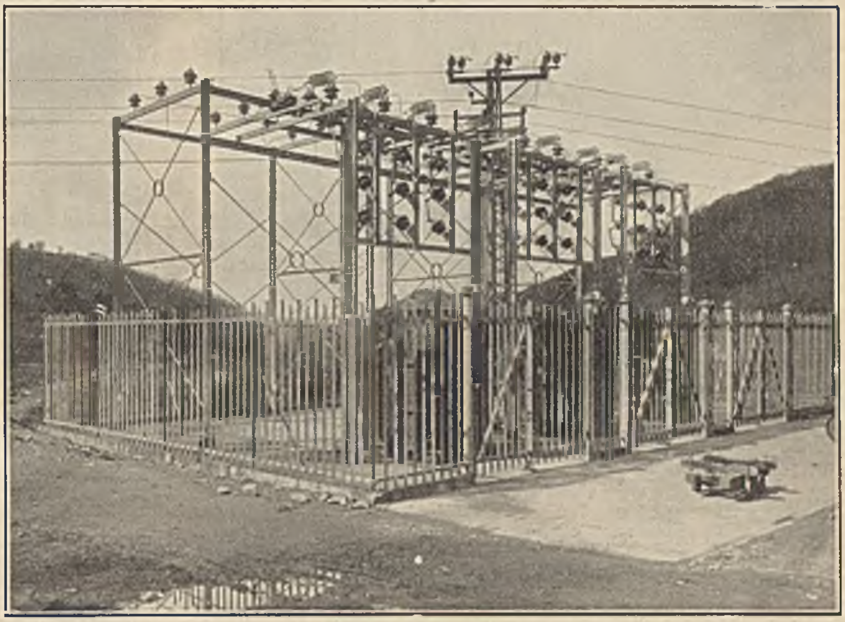

Fig. 2.—The 33,000 *volt Outdoor Sub-station.*

Two views of the outdoor sub-station are shewn in Figs. 1 and 2. The incoming power is taken from the 33,000 volt, 50 cycle, overhead lines of the West Gloucestershire Power Co., and transformed down to 3300 volts. The equipment on the high tension side of each transformer consists of a triple pole horn break switch with choke coils, and a triple pole isolating link with fuses. The structure which carries this switchgear is built up of H stanchions with channel and angle members.

The transformers are each of 500 kva output 31,500/3300 volts, 50 cycles, with primary tappings at plus and minus 2½% and 5%. The connections are arranged star-star. The transformers are of the G.E.C. standard three-phase oil-immersed self-cooled core type, and of the outdoor pattern enclosed in a sheet steel tank fitted with radiating and circulating tubes. Standard outdoor shed-type porcelain terminals are fitted on the high voltage side, and on the secondary side straight through porcelain bushes are fitted, these being protected by cowls. Each transformer tank is complete with oil drain, oil level gauge, thermometer pocket, earthing device, and rollers. The primary winding is wound with cross-over coils, while the secondary side is of the spiral type. Both windings are vacuum impregnated and treated for shrinkage before assembly. Pure pressboard, suitably treated is used for the major insulation.

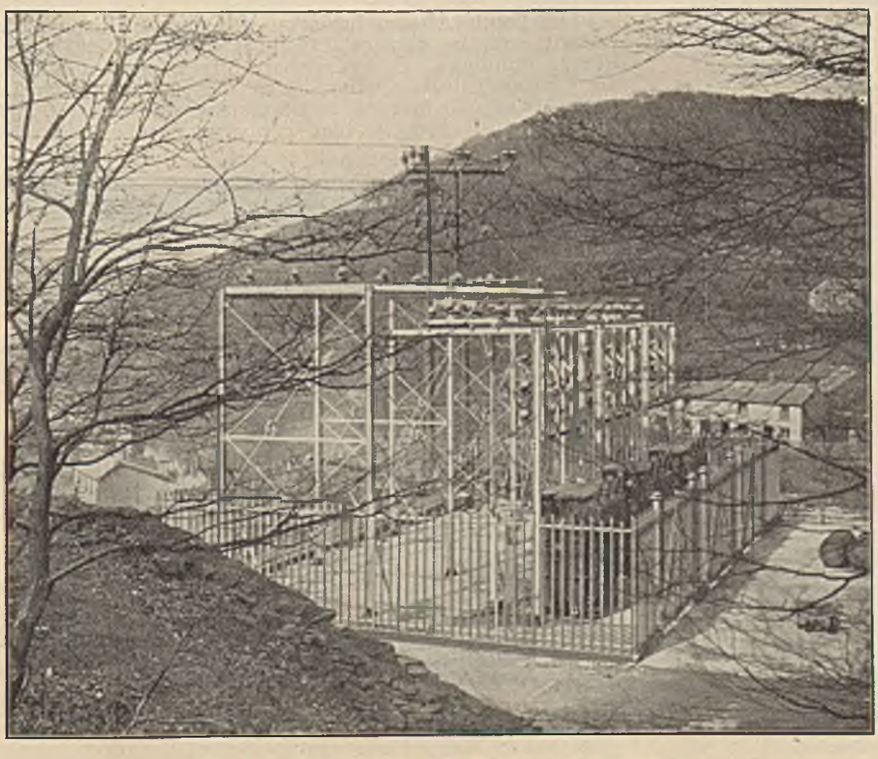

Fig. 1.—The 33,000 *volt Outdoor Sub-station.*

The power from the low tension side of the transformers is controlled by the 3,300 volt G.E.C. truck cubicle switchboard situated in the switchgear house closely adjoining the sub-station The complete switchboard is shewn in Fig. 3. Apart from the three cubicles controlling the low tension side of the transformers, there are two metering cubicles and two cubicles for controlling outgoing feeders. The pedestal oil-immersed pillars on either side of the truck switchboard control the lighting circuits.

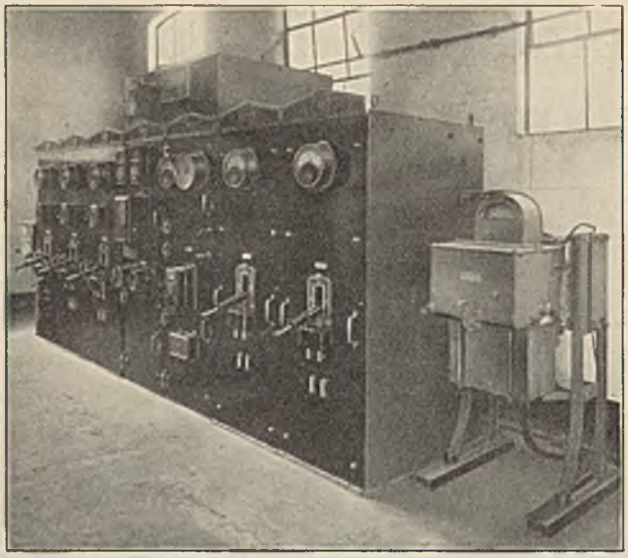

Fig. 3.—3300 *volt Truck Cubicle Switchboard and Oil-immersed Pillar.*

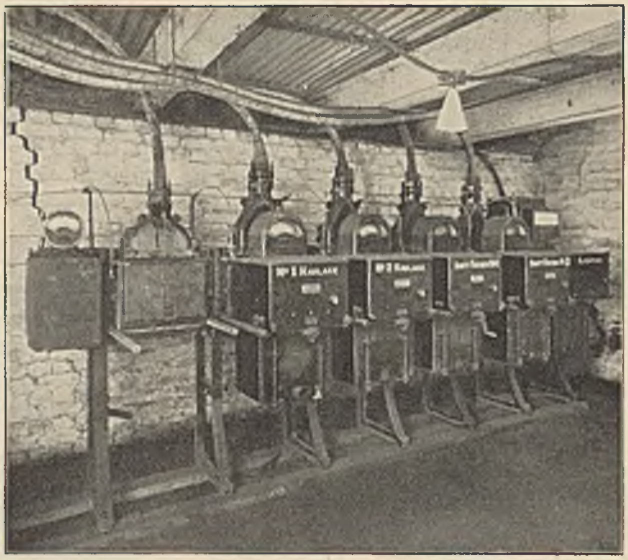

Fig. 4.—3300 *volt Oil-immersed Pedestal Switchboard, Underground.*

The pit bottom switchboard, illustrated in Fig. 4, is of the pedestal oil-immersed draw-out type, comprising six units. Two of these control the incoming shaft feeders, two control the circuits supplying power for haulages, the fifth is for lighting, while the sixth controls the feeder to a pumping station. Metering equipment is attached to the unit controlling the lighting. The G.E.C. oil-immersed pedestal type of board is particularly suitable for colliery service, being of very robust construction, and providing maximum safety in operation, due to the draw-out feature.

The electrically driven equipment below ground includes two main haulages, each driven by a 130 h.p. 3,300 volt three-phase "Witton" induction motor. One of the haulages is shewn in Fig. 5. The control gear for each motor consists of three items of apparatus: a main oil-immersed draw-out pillar, as described above; an oil-immersed stator reversing contactor; and a horizontal oil-immersed drum type controller. The first two of these sections of the control gear are to be seen in part in the background of the illustration Fig. 5. The oil-immersed stator reversing contactor is provided with a potential transformer and high tension fuses, while an electrical interlock prevents the tank being lowered while the switch is closed. A feature of this contactor unit is that all three phases are broken when reversing, thus making the motor dead.

The horizontal oil-immersed drum type controller presents many special features of design. Thus, the drum section is fixed to end-brackets on the lid of the controller so that it is very accessible when the lid is open. Further, the lid can only be opened or closed when the operating handle is in the "off" position. Also when the controller is in the "off" position, the motor is completely isolated from the line, all three phases being broken by the controller.

In conclusion, indebtedness must be expressed to the Proprietors and Manager of the Lydney & Crump Meadow Collieries for the kindness in allowing the information contained in this article to be published, also for permission to take the photographs reproduced herein.

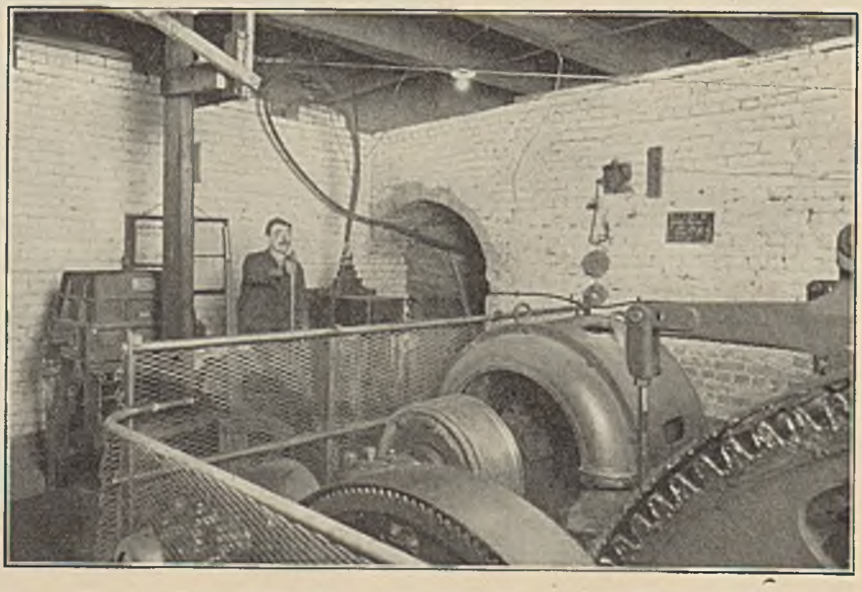

Fig. 5.—*One of the* 130 *h.p. Haulage Motors and Control Gear.*

DELEGATES VISIT CANADIAN MINES.

As a result of arrangements made by the Tourist Department of the Canadian National Railways, more than 100 delegates attending the annual meeting of the Canadian Chamber of Commerce at Toronto last month made an extensive tour of the mining areas of Northern Ontario. They travelled by special train to Timmins, Iroquois Falls, Swastika, and the famous Rouyn copper copper mining area of Central Ontario. They also visited Cobalt and Sudbury, the world-famous nickel centre.

PERSONAL.

Mr. George Ellison, Jr.

The South African business of George Ellison Ltd. is dealt with by George Ellison (S.A.) Ltd., at North British Buildings, Commissioner Street, Johannesburg. Mr. George Ellison, junior, is at present on a tour in South Africa with a view to developing the trade of this leading British firm in that important market.

Knocking in Steam Engines.

EDWARD INGHAM, A.M.I.Mech.E.

KNOCKING in any type of engine should always be regarded as a serious trouble, for a knock is an indication that some part or parts of the engine are being repeatedly subjected to suddenly-applied forces, which, as is well known, induce stresses far in excess of those induced by gradually-applied forces of the same magnitude. Such forces will quickly lead to fatigue and weakening of the parts concerned, involving serious risk of breakdown. It is indeed wise to take a knock as a warning against impending breakdown. There is little doubt that large numbers of breakdowns might have been prevented had the engineer-in-charge taken the warning given by a knock in some part of his engine.

There are a great many causes of knocking, but, in most cases, the source of the trouble is easily discovered. Occasionally, however, it is a most difficult matter to find the cause, and in some instances, engines have been dismantled, but all to no purpose.

In probably nine cases out of ten, knocking is the result of lost motion or "play" between parts which have become considerably worn. The most common case perhaps, is knocking at the connecting rod brasses. Thus the brasses at either the crank or the crosshead end gradually become worn as time goes on, with the result that, at the ends of the stroke, when the direction of motion of the piston has to be reversed, a certain amount of lost motion has to be taken up, and this causes the engine to knock at each end of the stroke.

Similar trouble may occur at numerous other parts of the engine, i.e., at all places where there are bearing brasses, but of a less pronounced character. In all these cases, the trouble is as a rule easily located, when the remedy, i.e., adjustment or renewal of the brasses can be made.

Many cases of knocking occur through round pins or bushes wearing oval. Occasionally an eccentric will wear slightly oval, and cause a knock which may prove difficult to locate because the noise may be manifested not at the seat of the trouble, but at some point a considerable distance away.

Sometimes, knocking is the result of badly fitting flywheel keys, and the cause in such cases may be difficult to discover because the noise appears to come from several places at the same time.

Knocks frequently develop in the engine cylinders and the valve chests. The most common cause of these internal knocks is probably water in the cylinders; the trouble is then generally relieved by the mere opening of the drain taps, but the proper remedy is of course to prevent water from entering the cylinders.

Knocks in the cylinder and valve chest are sometimes due to the combined effects of wear and readjustment. Thus, the piston in course of time wears the cylinder and, if the cylinder is not bell-mouthed, leaves a ridge at each end of the stroke. This alone cannot of course give rise to a knock, but if the connecting rod brasses be taken up for wear, the centres may be very slightly altered, so that the piston strikes against one of the ridges (see accompanying figure) with each revolution of the engine, causing a more or less serious knock. The remedy is to remove the ridge. A similar trouble may occur in the valve chest through the valve wearing the facing until ridges are formed at the ends of the valve stroke.

A like trouble, but of a more serious nature occurs when, owing to unsatisfactory readjustment, the piston is made to strike the cylinder at one end, or the slide valve the end of the valve chest. Such a knock may easily lead to fracture of the cylinder end or the valve chest.

Many cases of heavy knocking are the result of parts having worked loose or broken off. In one instance a nut worked off the valve spindle of a Meyer expansion valve of a fan engine at a colliery, and falling down one of the steam ports, found its way into the cylinder, eventually becoming trapped between the cylinder cover and the piston. A tremendous banging was heard for a moment or two, and then a smash, the breaking of the cylinder cover.

Occasionally, the piston will work loose on the rod, giving rise to a heavy knock. This particular trouble will sometimes cause an intermittent knocking of a very elusive character. Thus, the piston, instead of repeatedly banging at the ends of the stroke, the result of the backlash being taken up, will at intervals remain on the taper of the rod for a few moments, so that the noise ceases for a short time; or it may remain on the taper for a considerable time, giving the impression that the trouble has ceased.

The following is a striking instance of the great trouble which is at times experienced in finding out the cause of a knock. The engine was of the vertical high-speed type. The knock was of only a comparatively light kind, but for an unusually long time, its cause could not be ascertained. All sorts of adjustments and certain renewals were made, and the engine was dismantled to a large extent on two occasions, but still the problem remained unsolved. Eventually it was found that there was a little slackness between the end of the piston rod and the crosshead, and this was evidently responsible for the trouble, because after the slackness had been taken up, no further annoyance was experienced.

A factor which has an important bearing on the trouble under consideration is the amount of the compression in the engine cylinders at the ends of the stroke. If there is a reasonable amount of compression, as is the case when the exhaust valves are arranged to close a little before the ends of the stroke, the moving parts are cushioned and brought gradually to rest, so that the tendency to knocking, if there is any slackness of the parts, is very much less than when there is practically no compression.

A reasonable amount of compression is always advisable, for it helps greatly towards smooth running of the engine.

Whilst compression generally tends to minimise knocking troubles, it may, if too great, actually bring about knocking. If for example, the exhaust closes so early that the steam is compressed to a higher pressure than that in the valve chest, it is possible for the valve in certain cases to lift slightly off its seat, and, in falling back, it gives rise to a more or less heavy knocking.

It will be seen that correct setting of the valves is a factor of importance in the prevention of knocking; and also that the application of the indicator may often be of considerable help in trying to find out the cause of a knock.

We have seen that most cases of knocking are due to lost motion caused by wear. It follows that the greater the tendency to wear, the more likelihood there is for knocks to develop.

If wear and the tendency to trouble from knocking are to be reduced to the minimum, it is imperative that the engine should be maintained in perfect alignment, and that it should not be overloaded.

All sorts of trouble are liable to arise if the engine is allowed to get out of alignment, such as excessive friction and overheated bearings, fractures, and eventually breakdown. Since want of alignment is often manifested by knocking, it is well when a knock develops gradually, to suspect that the engine is getting out of line. The cause may be uneven wear of the main bearings, or slight settlement of some part of the foundation.

It is an excellent plan to have the engine thoroughly tested for alignment from time to time. To do this satisfactorily requires the use of stretched lines and plumb bobs, and perhaps a theodolite or dumpy level, and takes a considerable time, but it is desirable, and, in the case where the engine is giving trouble from knocking, very necessary.

Some steam users appear to have a decided objection against having their engines lined up. We have in mind the case of a tandem compound engine which developed a severe knock in the high-pressure cylinder. On examination, it was found that the trouble was caused by a piece of metal which had broken off one of the piston rings. It was also found that a ridge had formed on the bottom of the cylinder at the outer end of the stroke, and another ridge on the upper side of the cylinder at the inner end of the stroke, clearly shewing that the cylinder had been badly out of line. The nature of the wear in the low-pressure cylinder shewed that this cylinder also had been out of line.

The ridges, which were at parts as much as ⅛ inch high, were removed by grinding wheels, new piston rings fitted, and other alterations carried out, but, strange to say, no attempt was made to line up the engine. Immediately the engine was set to work again, it knocked badly, and it was not long before it had to be put out of commission entirely.

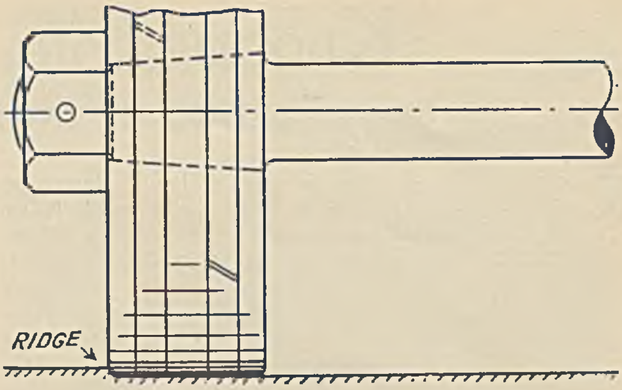

Diagram shewing wear in engine cylinder.

Overloading is, in numerous instances, largely responsible for knocking. It is a feature of the steam engine that it will carry an overload for a prolonged period without apparent difficulty, whereas other types of engine will not. The consequence is that the average steam user looks upon his engine as a willing horse, and therefore does not hesitate to add more and more load until eventually the engine is made to drive a load far in excess of that for which it was designed. In many cases, the engine shews clearly by the way it pants and groans that it is being subjected to unusual strains which are certain to cause heavy wear and tear, and sooner or later, knocking and other troubles.

To sum up briefly, we may say that if knocking is to be prevented, and generally, if the engine is to run smoothly and well, and to have a long working life, it should be operated at the load for which it was designed, maintained in proper alignment, tested regularly for tightness and security of the various parts, whilst any wear which takes place at bearings or other parts due to the rubbing of one surface upon another should be taken up before any appreciable amount of lost motion results. Since the wear which takes place between two surfaces rubbing together can be reduced to within exceedingly small limits by efficient lubrication, the lubrication of the engine should always receive the closest attention.

HOW TO KILL AN ORGANISATION.

Don't go to the meetings.
If you go, go late.
If the weather doesn't suit you, don't think of going.
If you attend a meeting, find fault with the work of the officers and members.
Never accept office, as it is easier to criticise than to do things.
Get sore if you are not appointed on committees; but if you are, do not attend committee meetings. If asked by the Chairman to give your opinion on some matter, tell him you have nothing to say. After the meeting tell everyone how things should be done.
Do nothing more than absolutely necessary, but when the members use their ability to help matters along, howl that the institution is run by a clique.
Hold back your "subs" or don't pay at all.
Don't bother about getting new members—"let George do it."

"LEWBESTITE" CABLES.

The Liverpool Electric Cable Co., Ltd., have published particulars of a new fire-resisting and self-extinguishing cable which they have devised after extended research and trial. The great value of this "Lewbestite" cable for switchboard wiring and similar services is obvious. The general particulars of the cable are: tinned H.C. soft copper conductors insulated with "Lecite" V.I.R., specially treated with asbestos, cotton braided in colours, and finally served with a transparent finish. It is suitable for pressures up to 660 volts. Remarkable illustrations of tests with bunsen and blow-lamp flames on single wires and groups bunched closely together shew that the covering is really self-extinguishing: the only damage done is at the confined small area of the one cable on which the flame actually impinges.

CHANGES OF ADDRESS.

The Macintosh Cable Co., Ltd., have now taken up the London Address of Bank Buildings, 20 Kingsway, W.C. 2. Telephone: Holborn 7387-8.

The Metropolitan-Vickers Electrical Co., Ltd., have transferred their Bristol office to 22 Victoria Street, Bristol, at which address is also their Cosmos Lamp depot. Telephone 6860-1.

Manufacturers' Specialities.

New Mining Electrical Control Gear.

Interesting developments in electrical control gear for use in mines made by the Metropolitan Vickers Electrical Company include a new self-contained controller, mining switch units that are also supplied as gate-end boxes and mining transformer units, and plug distribution boxes. All these types are supplied with flameproof enclosure, suitable for use in mines where Regulation No. 132 applies. The welded boiler-plate cases adopted have undergone extensive investigations with special apparatus for testing flame-proofness, constructed and used in the Company's research department.

A feature of interest is that in the self-contained controller and in the mining switch units and gate-end boxes, air-break switchgear is employed.

Air-break gear has been adopted because the apparatus is liable to operate several hundred times in a single day. It is well known that when an electric circuit is broken under oil, a small quantity of carbon is set free, and that in course of time this carbon tends to form conducting films over the surface of the oil and other insulated parts across which short circuits might occur.

In oil-filled gear this risk can only be avoided by renewals of clean oil at regular intervals.

In ordinary service, in which circuit breakers may operate only once or twice a day, periodical inspection may shew that it is unnecessary to change the oil more frequently than once a year, but for apparatus liable to operate several hundred times a day, if oil were used, it would require to be changed very much more frequently.

Consequently, in the new apparatus, risk of flashing across and considerable trouble and expense are avoided by using air-break gear. Furthermore, because of the absence of oil, it has been found possible to make all the parts more readily accessible and convenient for inspection and adjustment. The absence of oil and greater accessibility make for appreciable reductions in maintenance charges.

Mining Self-contained Controllers.

These are designed for the complete control and protection of alternating current motors of sizes up to 60 horsepower and for circuits up to 650 volts. They are supplied either with an external resistance to control variable speed slipring motors, or for use with three-phase squirrel-cage motors when star-delta starting and reversing are arranged for. Similar controllers can also be supplied for direct current service.

A typical self-contained controller is illustrated in Fig. 1, as supplied in a heavy boiler-plate welded case with wide rough machined flanges for flame-proof enclosure, but it may be added that welded cases of water-tight construction are also supplied and are recommended for service underground where flame-proof enclosure is not essential. The illustration shews that mounted in one case are a six-notch reversing controller, a three-pole contactor switch, two overcurrent relays, and an externally operated isolating switch, while on the top of the case is mounted a flame-proof ammeter The controller is of the Company's standard design ; interlocks ensure that the circuit is always made and broken by the contactor, and so the service required from the controller is very light and thus the drum contacts and fingers have very long life.

The contactor is fitted with magnetic blow-outs and has renewable contacts which open and close rapidly with a rolling and sliding action. All three phases are broken, so that when the contactor is open the motor is completely isolated. Over-current protection on all three phases is given by the two over-current relays, one of which is fitted with a double winding. Under-voltage release protection is given by the contactor, which opens when the supply voltage falls below a set value. No-volt no-close protection is given by the contactor, and also by an electrical interlock which compels the return of the controller to the off position after a shut-down before the contactor can be reclosed. The isolating switch is electrically interlocked, so that it cannot be opened until after the circuit has been broken by the contactor.

Inside the controller case a cover, not shewn in the illustration, is fitted over the isolating switch and the live terminals, so that when the cover of the controller case is removed all contacts which are still alive are protected against accidental contact. The external handle of the isolating switch is arranged so that it can be padlocked in the open position. A flame-proof ammeter can be fitted as shewn in the illustration.

Important savings obtained by the use of the self-contained controller are the cost of cable and trifurcating boxes necessary where a separate circuit breaker to control the stator circuit is installed, and also the expenses that would be incurred in their installation.

Mining Switch Units and Gate-end Boxes.

These are illustrated in Fig. 2 which shews a two-unit combination, while Figs. 3 and 4 shew respectively detail views of a typical switch panel and of three thermal relays.

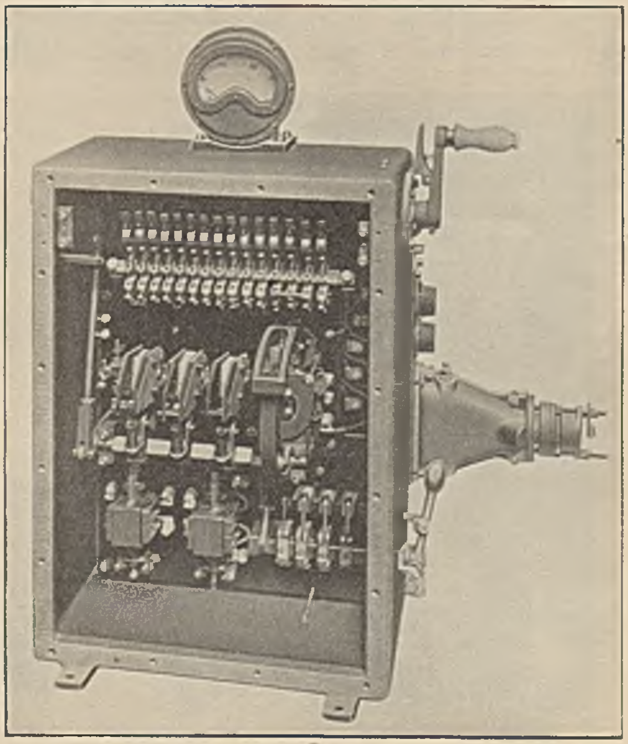

Fig. 1.—Mining self-contained Controller with Boiler Plate Flame-proof Case.

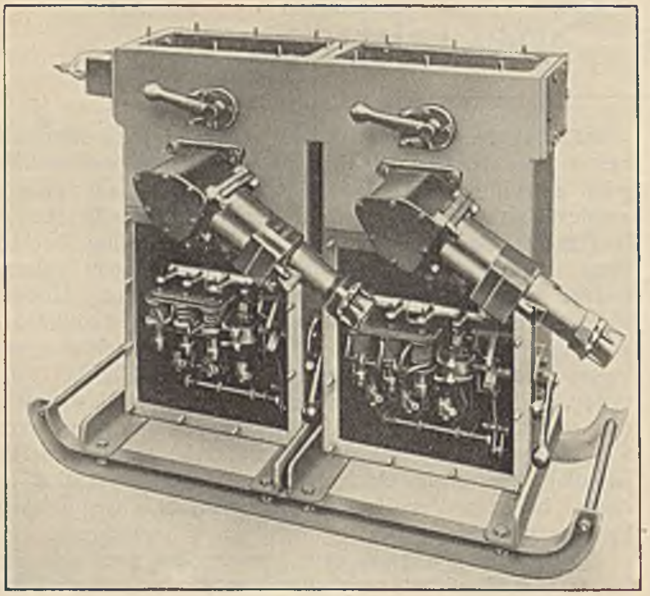

Fig. 2.—A double Mining Switch Unit.

The mining switch units are designed for the complete control and protection of squirrel-cage motors, of sizes up to 40 h.p., on circuits up to 650 volts, as for driving portable and semi-portable machinery, such as coalcutters, conveyors, small pumps, etc., at the coal face.

The new mining gate-end box has been developed to replace the well known Metrovick gate-end box that was introduced a few years ago for the automatic protection of coalcutters, coal conveyors, and trailing cables.

While the service given by the older design has been widely appreciated, the new gate-end box has the important advantage of being sold at a lower price, and moreover, includes various improvements based on the extensive experience gained with the older type.

As shewn in the illustration each unit is contained in a welded case of heavy boiler-plate provided with wide machined flanges so as to be flame-proof. The units are supplied either singly or in combinations of two, three, or four units, comprising switch or transformer units or gate-end boxes, as required ; either single units or any desired combination being mounted on skids, as illustrated, for convenience in movement as the working face is advanced.

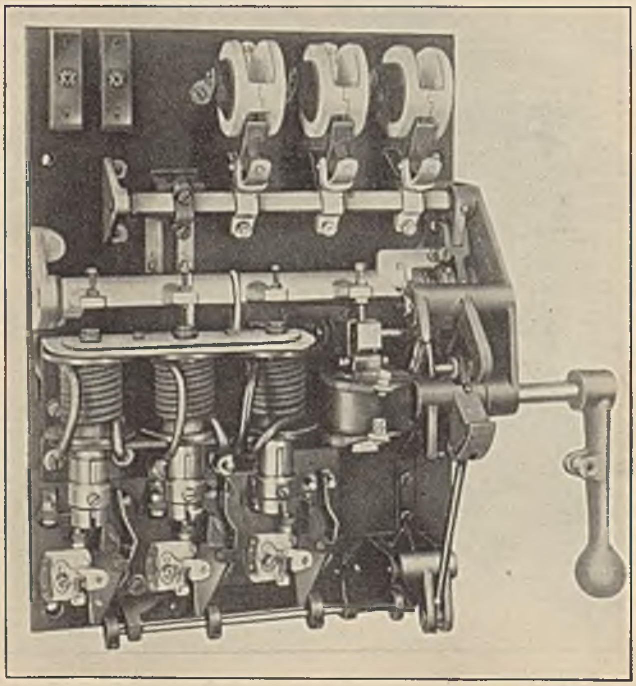

Fig. 3.—The Switch Panel of a Mining Switch Unit.

The detailed view given in Fig. 3 shews a panel as included in the mining switch unit, fitted with a three-pole contactor, which is provided with an external operating handle and a combined no-volt, no-close and under-voltage release mechanism. In the top left-hand corner may be seen two enclosed type re-wirable fuses which protect the under-voltage coil. Immediately below the contactor are the three instantaneous pattern trip coils, and below these again may be seen three thermal overload relays that are further illustrated in Fig. 4.

In the gate-end box the switch panel is similar to that shewn in Fig. 3, but with the hand operated contactor switch replaced by a contactor switch having a closing coil which makes the switch suitable for remote electrical control.

The contactor is fitted with powerful magnetic blow-outs and incombustible arc shields. It has three poles so that with the contactor open the motor is completely disconnected from the line. The contacts close with a rolling and sliding action and are easily and cheaply renewable. The external handle (as fitted to the mining switch units) is arranged to be in the up position when the contactor is closed, so that anything falling on the handle would tend to open the contactor.

Overload protection on all three phases is given by the instantaneous trip coils and by the thermal relays. Three trip coils are provided to guard against short circuits, and are set to trip at from seven to ten times the normal full load current, i.e., above the standstill short-circuit current of the motor.

The thermal type relays give the ideal inverse ratio time current protection against normal or small sustained overloads on all three phases. They are adjustable and can be set to guard against prolonged overloads only just above the normal rated output of the motor. As the action of the relays is based on temperature rise and not on mere excess of current, they are not actuated by the short current rushes that occur when a squirrel-cage motor is switched on the line. The thermal relays are automatically reset on all three phases when the contactor is brought to the off position.

Under-voltage release is given by the contactor, which opens when the supply voltage falls below a set value. No-volt and no-close protection is given by a laminated magnet no-volt no-close device, incorporated in the under-voltage release mechanism. In certain cases both the no-volt and no-close protective features may not be required, and in such cases they can be omitted, and under-voltage release and overload protection only provided.

In the top part of each unit is a separate flame-proof chamber in which busbars and an isolating switch can be provided if required. The isolating switch is operated by an external lever handle, which can be fitted with a padlock to prevent unauthorised use.

For incoming cables a trifurcating box can be fitted to either end of the busbar chamber. Provision for the outgoing cable is made just above the removable front cover ; this provision may consist either of a trifurcating box for flexible armoured cable, or of a BESA. four-pin mining type plug and socket for a trailing cable. An ammeter in a flame-proof case can be fitted to each unit.

Special protective features that can be incorporated include provision for either earth continuity protection

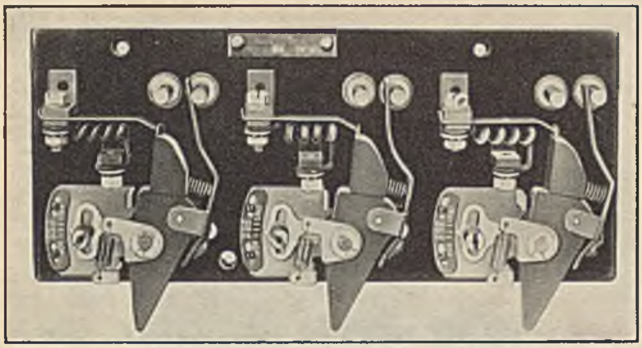

Fig. 4.—The Thermal Relay Panel.

or earth leakage protection. Where earth continuity protection is required a small potential transformer is included to give a pilot circuit pressure of 20 volts, as required by the Mines Regulations, and this circuit is taken through a pilot core of the trailing cable and earthed in the plug and socket at the motor end of the cable.

Where earth leakage protection is required a three-phase core-balance transformer and a flame-proof leakage trip relay, set to operate at 5% primary leakage, are included. In this instance the main case is made of increased width but it may still be bolted up with other switch units to form a multi-unit combination.

Mining Transformer Units.

The mining transformer units consist of a standard case having a transformer with fuses for primary and secondary circuits mounted in the main compartment and in all instances including the busbar chamber with its isolating switch, the latter being used to switch the transformer on or off.

The transformers may be single-phase up to 3 k.v.a. in capacity, or three-phase up to 2 k.v.a. capacity, with the primary winding for 440/650 volts as required and the secondary for any voltage that may be desired. Mining transformer units can be assembled in combination with switch type units and gate-end boxes and are useful to supply lighting circuits at the coal face or to supply power for small motors driving drills, etc.

Mining Plug Distribution Boxes.

The mining type plug distribution boxes have been designed mainly for use in connection with electric coal-cutters working a long face. They are inexpensive and easily portable. When connected to the gate-end box in series with each other, and spaced out along the working face, they provide convenient points at which the trailing cable from the coalcutter may be plugged in, as the machine travels along the face. A typical mining plug distribution box is illustrated with all covers off and with a trailing cable plug in position in Fig. 5.

The distribution box is of strong welded steel plate, and contains four four-way terminals designed for use with four-core cables. The example illustrated is designed with two branches for a through cable but provision can easily be made for a third branch. Each terminal box contains four terminals each of which has

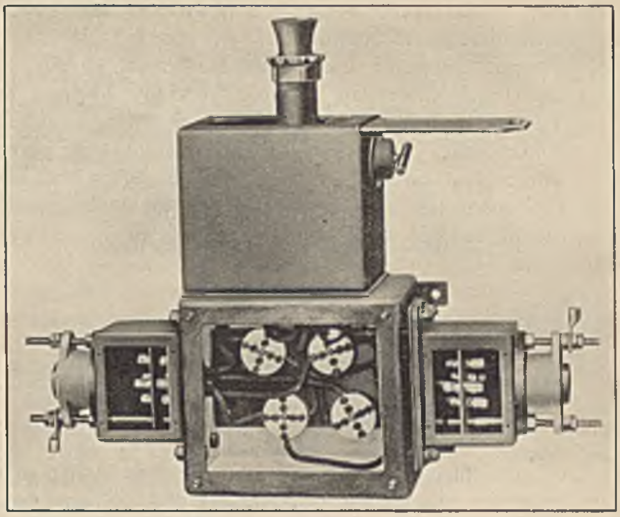

Fig. 5.—Plug Distribution Box with covers removed.

two pinch screws to receive incoming connections. The inner chamber of each terminal box is sealed with compound before despatch. The plug chamber in each box is fitted with a socket to receive a four-pin 100 ampere, B.E.S.A. mining type plug. It is provided with a sliding door fitted with a lock; when the sliding door is open the key cannot be withdrawn and thus, as only one key would be supplied for use at each working face, only one of the distribution boxes can be in use at one time.

Of the four sets of terminals provided, three are intended for the three-phase power conductors and the fourth is intended for the pilot circuit. For continuity of the earth circuit reliance is placed on the armouring of the interconnecting cable, armour clamps being fitted on each terminal box as shewn in the illustrations.

It may be added that while mainly designed for the special purpose described above, Metrovick plug distribution boxes can also be adapted and are in extensive use for other purposes where a flexible system of plug-in points is found to be desirable.

Mining Joint Box.

The illustration herewith shews a mining type straight through compound filled joint box for three-core wire armoured cables as made by Callender's Cable and

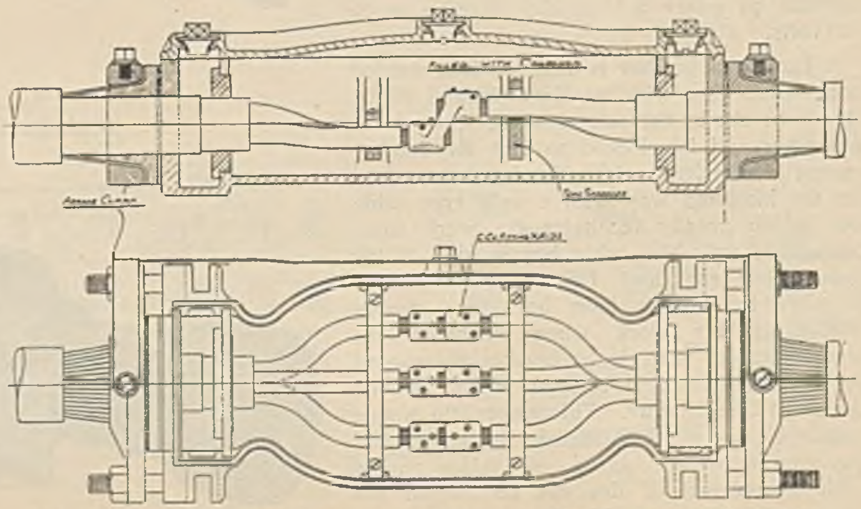

Fig. 1.—Callender Joint Box for Three-core Wire Armoured Cables.

Construction Co., Ltd. A notable feature of this design to which particular attention is directed is the type of conductor connector used; this is stepped so that a core from each cable can be brought right through its own jointing socket. Where cables are jointed in the pit with ordinary connectors of the straight type there is a danger that one of the cores may be taken too far into the connector at the expense of the other core. The use of stepped connectors helps to ensure a sound cable joint.

Anderson Boyes Circuit Breaker Gate-End Box.

A more efficient means of protection than switch and fuse gear for electrical apparatus at the colliery face has been called for, and it is generally recognised that an automatic circuit breaker meets the need. For the

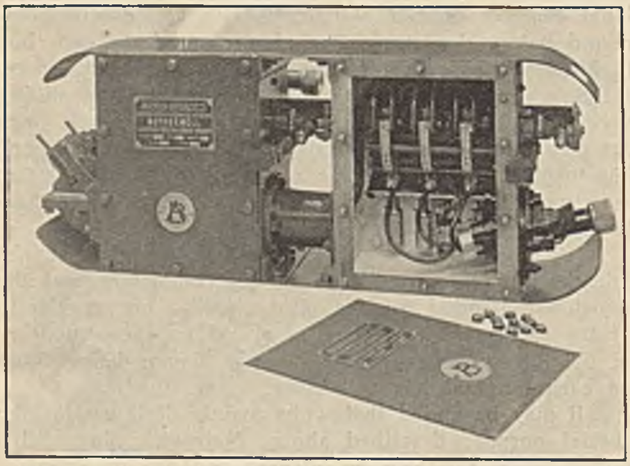

Fig. 1.

protection of coalcutters and other portable electrical mining apparatus, Anderson Boyes & Co., Ltd., have designed and manufacture a robust form of circuit breaker gate-end box to withstand the hard usage to which underground apparatus is subjected under these services. These circuit breakers are suitable for use on either a.c. or d.c. circuits up to 660 volts.

The circuit breaker is mounted in a welded boiler plate case with machined flanged joints. It can be set to the safe working load of the coalcutter and interlocked so that the breaker cannot be interfered with. The box is arranged on the incoming way with a split type cable box which greatly facilitates the work when connecting up. The cable box is also of the detachable type and two can be jointed together to form a joint box, thus greatly minimising the work when extending the machine cable. The circuit breaker is mounted on a frame which is secured in the box by means of three screws. This makes it a simple matter to remove the complete breaker should any alterations be required. All minor repairs such as renewal of tips can be carried out with the breaker in position.

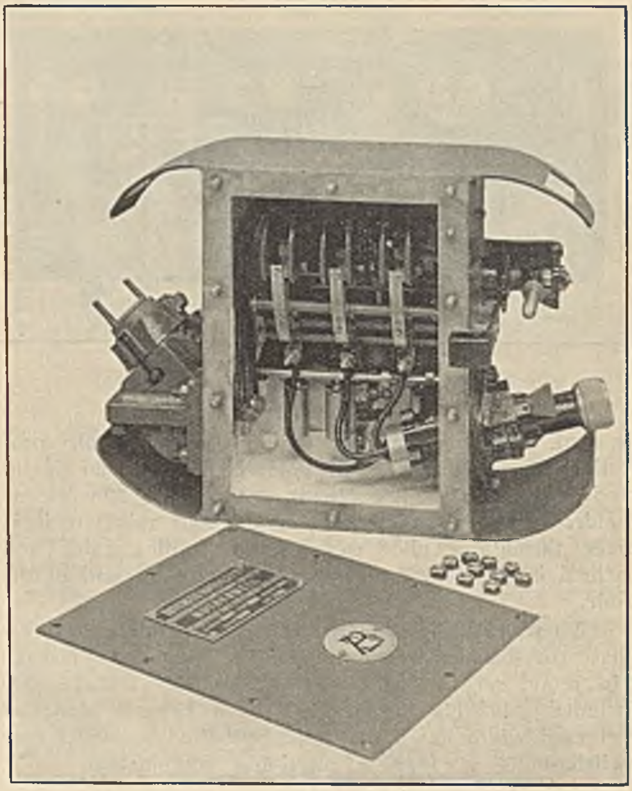

Fig. 2.

The breaker is fitted with magnetic blow-out coils overload trips with time lags, and a no-volt trip is fitted when required. The blades are of laminated phosphor bronze of liberal dimensions; arc shields are provided and ample space is left in the box to prevent flashing to earth, and also to allow of ease in connecting. One handle is used for closing and opening the breaker this being of the free-handle type on auto-

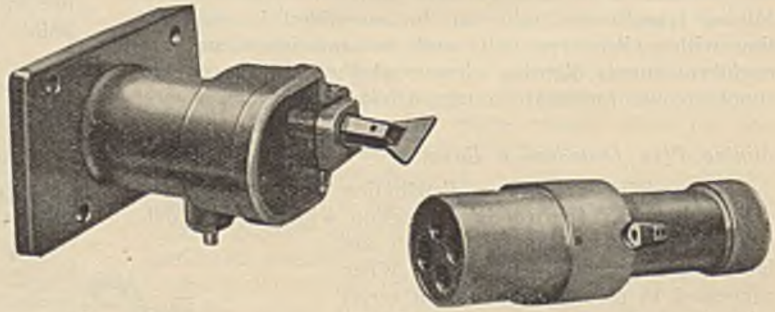

Fig. 3.

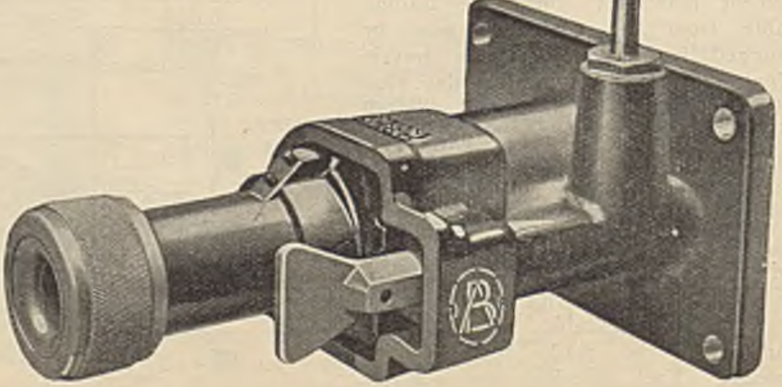

Fig. 4.

matic release. Stops are provided for the handle and these are clearly marked "off" and "on." The contacts and terminals are mounted on round insulated steel rods. The trip adjustment and time lags are all inside the box and cannot be interfered with by unauthorised persons.

The box is of unit construction and two or more can be bolted together to form a board; the illustration Fig. 2 shews a two-way board. This Circuit breaker gate-end box is of flame-proof construction and complies with the Coal Mines Act and the General Regulations regarding the installation and use of electricity in mines.

The circuit breaker is fitted on the outgoing way with a BESA 100 ampere flame-proof type plug and socket for heavy duty as this is now recognised as the standard connector for trailing cables and has the approval of H.M. Chief Inspector of Mines. The A.B. BESA plug and socket has been designed for efficient working and possesses many novel features of construction. All parts comprising the plug and socket are manufactured to limit gauges to ensure interchangeability and the A.B. BESA sockets will fit any other make of plug made in accordance with BESA Specification No. 279-1927.

The A.B. BESA, Plug and Socket.

The plug and socket, shewn in illustrations Figs. 3 and 4, is fully interlocked and it is not possible to withdraw the plug unless the switch is in the "off" position. The plug is arranged with a visible earth, and the arrangement is such that the earth circuit is made first in inserting the plug and broken last in withdrawal. The plug is inserted and withdrawn by means of a screw and it is so arranged that, if the line circuits are broken with the screw in operation, the combination of plug and socket will be flame-proof. The A.B. plug and socket is manufactured with the minimum number of component parts, and as these parts are all manufactured to limit gauges interchangeability is assured. The sockets are made with a number of standard flanges, but special flanges and adapters are also supplied to suit customers' own requirements.

Some J. & P. Improvements.

Link Box for Bitumen Cables.

The illustrations (Fig. 1) reproduced here from scale drawings are of the newest pattern of Johnson & Phillips' straight through link disconnecting box for use with bitumen cables up to 0.15 sq. in., three-core, and for 3300 volts working pressure. The armouring is securely clamped by gunmetal grips to which a continuity copper bond is sweated. The ends of the cable can be made away from the main disconnecting chamber and, by the special type of connector, can easily be connected up. The end boxes have large plates for compound filling and have machined faces. The main chamber has a wide machined face fitted with gunmetal swing bolts. The disc links are mounted on heavy porcelain insulators, and every part can be easily replaced.

"Rough Service" Switchgear.

The Johnson & Phillips' latest design of ironclad switchgear for use above or below ground is well illustrated in Fig. 2 which is a view of an underground installation consisting of five units on pedestals.

This gear, which covers all ranges up to 3300 volts, is suitable for installation in almost any position, however cramped, exposed or awkward. Legs of different sizes can be provided to suit uneven floor levels and low

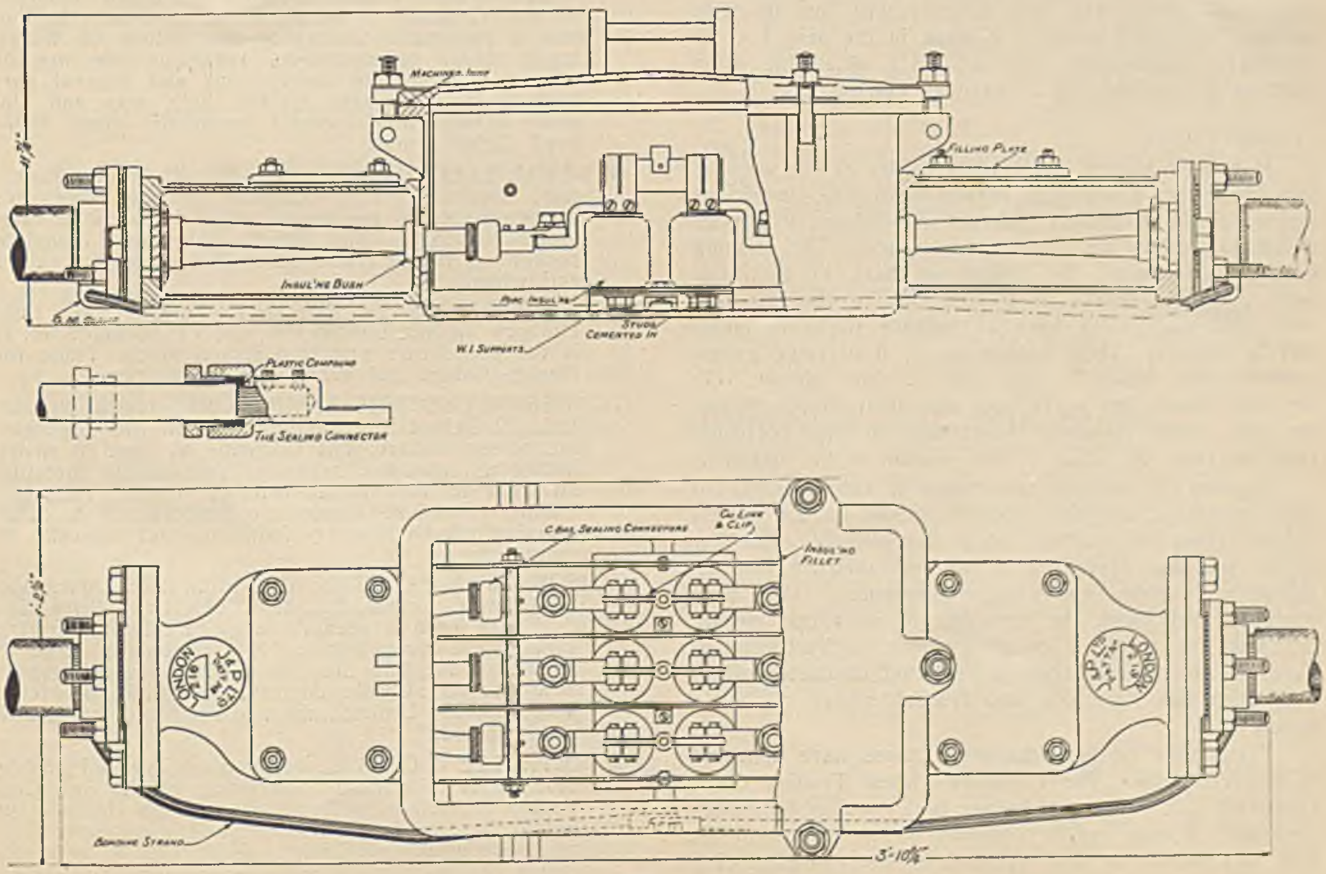

Fig. 1.

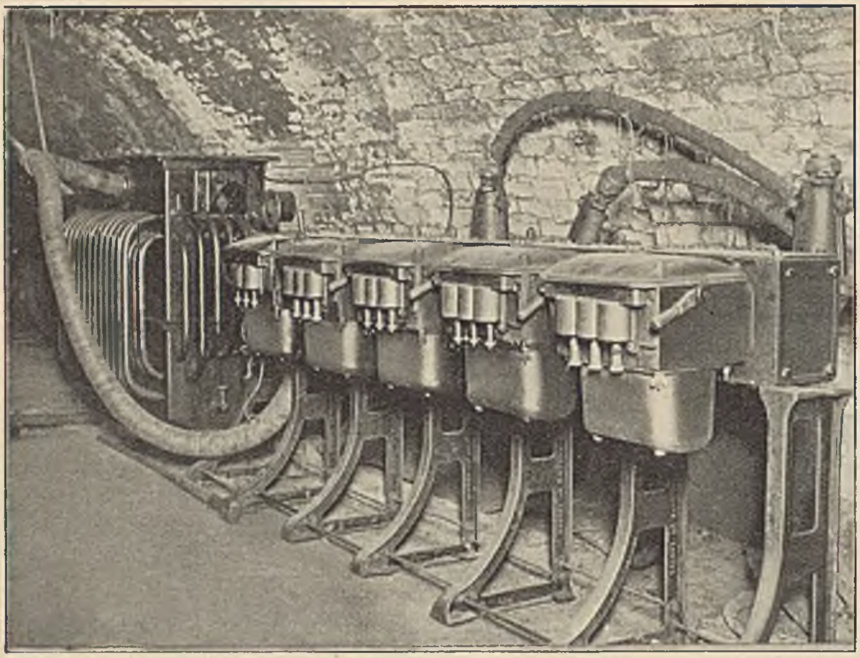

Fig. 2.

roofs. Universal cable boxes are fitted when required, which will accommodate cables incoming at practically any angle.

In addition to being very robustly protected mechanically, the oil circuit breakers are of liberal electrical design, being capable of handling the rated currents continuously, and making and breaking the circuits frequently without damage.

The unit construction facilitates additions and alterations. All listed sizes and patterns will line up with one another. Full details are given in the new J. & P. Switchgear publication, List I.C.a 1/1 obtainable from Johnson & Phillips, Ltd., Charlton, London, S.E. 7.

Trailing Cables.

It is well known that trailing cables at the working face are always a source of anxiety to colliery electricians owing to the extremely onerous conditions of service which such cables are called upon to meet. The earthing screens surrounding the conductors have in particular been a prolific source of trouble due to the fact that their individual wires have a tendency to break under certain stresses. These broken wires, if of large gauge, penetrate the insulation and cause a short circuit. On the other hand, fine wires have also their disadvantages, amongst which is early destruction by the corrosion resulting from the action of free sulphur in the dielectric.

Johnson & Phillips have made a special study of these problems, and have recently placed on the market several types of trailing cables respectively applicable to the practices prevailing in different districts and designed to overcome the troubles mentioned. They have dealt not only with the screening of individual phases, but also the tendency of pilot cores to fracture, and have introduced a specially constructed conductor which overcomes this very old and fruitful source of breakdown.

From time to time details of these have appeared in these columns. The Company's latest Trailing Cable Leaflet, T.C.1., issued in August last, contains full specifications. A copy can be obtained on application to the firm and should be kept at hand by every mining electrical man.

NEW CATALOGUES.

ELLISON INSULATIONS Ltd., Perry Barr, Birmingham.—An attractive illustrated booklet which deals with the speciality "Tufnol." This is an insulating material of the paper and resin variety though, in this case, after considerable research and trial, the product is claimed as having exceptionally valuable properties. It is stocked in tubes and rods of various sections, washers, bobbins and moulded detailed parts, also as a fabric for the building up of silent gears.

HANS RENOLD Ltd., Manchester.—The Renold price list for 1930 will, as usual, be kept at hand as a continuous book of reference for the engineer who has to plan and estimate for mechanical drives. This book as well as being a price list is largely of a technical character, as will be gathered from the fact that it occupies over 100 pages of letterpress.

CROMPTON PARKINSON, Ltd., Guiseley, Leeds.—The recent entry of this Company into the sphere of makers of electric lamps is further signalised by the issue of an attractive colour printed price list of Crompton Lamps.

Other Crompton Parkinson specifications to hand include No. A101 referring to Induction Motors of the "L.S." Range and No. A505 dealing with Kiosk Type Substations.

ENGLISH ELECTRIC Co., Ltd., Queen's House, Kingsway, London, W.C. 2.—The publication M 35 is a useful technical treatise with diagrams concerning the English Electric design of Oil-immersed Switch Fuses.

HEYES & Co., Ltd., Water-Heyes Electrical Works, Wigan.—The "Wigan" Review published monthly by this Company is as attractive as usual. In this case a paragraph concerning the history of Wigan lends colour to statements regarding the use of "Wigan" fittings in dairy farms and general particulars of water-tight electric bell gear and the newly-introduced "Lacent" prismatic glass bulkhead lighting unit.

GENERAL ELECTRIC Co., Ltd., Magnet House, Kingsway, London, W.C. 2.—Bakelite lighting accessories is the subject of the very complete illustrated catalogue No. 5537. The G.E.C. have also issued a pocket size bound trade list of Pirelli General cables and wires.

W. T. HENLEY'S TELEGRAPH WORKS Co., Ltd., Holborn Viaduct, London, E.C. 1.—N.P. Booklet No. 22 is the pocket size price list issued to the Trade for Henley Cables and Wires and accessories.

TUNGSRAM ELECTRIC LAMP WORKS (Great Britain) Ltd., 72 Oxford Street, London.—Now that the lighting season is here, this Company as usual is distributing an attractive series of publications directing attention to the special features of the Tungsram Lamps. Standard Lamps are produced in a range covering effectively every industrial and domestic requirement.

EDISON SWAN ELECTRIC Co., Ltd., 123-5 Queen Victoria Street, London, E.C. 4.—Booklets and Price Lists deal with the new season's range of Ediswan Electric Fires. The range covered is exceptionally large by reason of the fact that the Edison Swan Company now markets also the domestic specialities of Metro-Vick Supplies, Limited; the two companies being now amalgamated.

A. REYROLLE & Co., Ltd., Hebburn-on-Tyne.—Pamphlet No. 182 is a technical description of the Split-Conductor Protection methods and systems devised and adopted as standard by the Reyrolle Company. This is an important publication, which should be in the hands of all interested in the problems of modern electric transmission and distribution.