The Mining Electrical Engineer.

OFFICIAL JOURNAL OF THE ASSOCIATION OF MINING ELECTRICAL ENGINEERS

EDITED BY E. DINSDALE PHILLIPS

Vol. X. APRIL, 1930. No. 115.

To Improve "The Fair."

Last February in these columns we recorded some general impressions of the last British Industries Fair, Birmingham, and suggested that in certain matters there was plainly room for improvement. In particular it was disappointing to notice the absence of exhibits of several of our largest national engineering industries, and to regret the great opportunities thus neglected by the makers of the heavier classes of engineering plant such as for mining, iron and steel works, transport and shipping, power engineering, etc. Great force has now been added to this contention by the Electrical Section Advisory Committee of the Fair in the form of a memorandum recently submitted by them to the Government Committee of enquiry as to the future of the Fair. It may be taken for granted that the memorandum is based upon the results of enquiries and the opinions of exhibitors and buyers; and in view of the authoritative character of the Committee it will doubtless influence for the better the organisation and conduct of the Fair.

The Advisory Committee deprecate the fact that the Fair is not sufficiently representative of British Industry; that the grouping of engineering exhibits should be increased to include various other sections of engineering, specific mention being made of the industries of mining and transport. Of very serious importance is the strong protest which the Committee has found it necessary to lodge against certain trade organisations which ban their members from participating as exhibitors, and it is urged that special efforts should be made to combat the deliberate refusals of associated traders to take part in this great co-operative scheme conceived as, and so far successfully proved to be, a powerful stimulant to British Industry.

It really does seem incredible that there are societies of traders and manufacturers which exist presumably for the development of their respective trades but which can be so out of date and so obviously at variance with one of the most generally accepted modern principles of successful sales' working; and who it is here alleged are, above all, opposed to this commendable effort on the part of well-informed influential business men working together in loyal co-operation. The Committee suggest that trade associations might be invited or encouraged to undertake the organisation of sections to deal with their respective industries. It would, indeed, be a wonderful conversion if, by further peaceful persuasion, the principle of deliberate boycott were to be ousted in favour of active and enthusiastic support! Invitations and words of encouragement have however, been lavishly used already without achieving the desired good effect: obviously there must be some sort of reason why they have not prevailed.

In our previous notes we suggested several possible deterrent factors and hinted that perhaps the Fair would be favourably considered by the absentee industries if, for example, it were to be held alternately in other national trade centres as greatly important as is Birmingham, or perhaps an alternative date would be more conducive to exhibitors and visitors. It is the fact that with a permanent location in Birmingham, that city must inevitably largely monopolise the benefits of the Fair at the least cost to themselves. Furthermore, bleak weather neither helps the transport and erection of machinery exhibits nor does it encourage buyers from remote countries, particularly those enjoying salubrious climes, to brave the conditions of the hard dying English winter.

The memorandum of the Committee supports this point of view by definitely expressing the opinion that the present date is wrong: that whilst much home trade is done, the overseas buyers will not visit this country in February. According to travel statistics the end of May and early June is the most popular period for visitors to this country from abroad.

Other opinions contained in the memorandum are that the cost of exhibiting is too high; that exhibitions abroad and travelling exhibitions are not likely to be useful or practicable. The greatest emphasis is given to the point that the classification and grouping of exhibits should be extended—with the introduction of sections for those typical national engineering works which seek the world-market and yet have, so far, apparently not been convinced that the Fair can be of help to them.

Mining electrical engineering is a special branch of this country's industrial activity; it is great in scope and importance; it is, moreover, one in which this country excels. There is sufficient time, if the start be made now, for the Fair of next spring to have a representative section of British mining electrical exhibits.

The A.M.E.E. Convention.

Great credit is due to the organising committee of the London Branch of the Association of Mining Electrical Engineers for the excellent arrangements devised for this year's Summer Meeting and Convention. The Programme, of which the essential details are published on this page indicates that leading manufacturers continue to show genuine and generous recognition of the helpful nature of the work done by the Association; the several works to be visited during the convention cover a very pleasing range of electrical and mechanical products. The diversity of apparatus and material to be shown in the making—heavy power plant, cables, instruments, switchgear, wireless plants and accessory appliances—guarantees sustained interest and, no doubt, much instruction for the visitors. Then again, to be privileged to visit the modern colliery in Kent will be highly appreciated by everyone.

Last month we pointed out the usefulness of these conventions and suggested that, in view of the valuable experience to be gained, expenses and leave of absence might be readily arranged between the mines' managements and the mining electrical men. The prices given in the published abstract of the programme will enable the would-be visitor to form a close estimate of his total expenses. It will be noted that they would be very modest indeed: for which powerful help in smoothing out one of the greatest difficulties of the mining electrical men who are planning to travel up from the more remote provinces, thanks must be given to the many good friends of the Association and to the hard work and personal understanding of the organising committee.

The true appreciation of the good services devised by a host is, after all, best expressed by the attendance of his invited guests: and particularly so by the promptitude of acceptance of invitation.

Will members therefore, please drop a note at once to the secretary; early acceptances do more than gladden the heart of the secretary, they simplify his arduous work and relieve him of much of the harassing worry which always to some greater or less extent is the inevitable lot of those who undertake voluntary services of this kind.

Association of Mining Electrical Engineers.

Annual Convention: London, Tuesday, 24th June to Saturday, 28th June, 1930.

Headquarters—Midland Grand Hotel, St. Pancras, N.W.1.

HOTELS.

Midland Grand Hotel, St. Pancras, N.W. 1.
Royal Hotel, Woburn Place, Russell Square, W.C. 1.

Charges.

Midland Grand Hotel ...	Single Bedroom from	8/6
	Breakfast	4/-
	Double Bedroom from	15/-
	Breakfast	8/-
Royal Hotel	Single Bedroom ...	6/6
	Breakfast	2/-
	Double Bedroom ...	13/-
	Breakfast	4/-

TUESDAY—June 24th, 1930.

Assemble in the evening at Midland Grand Hotel for issue of Badges, Tickets, etc.

WEDNESDAY—June 25th, 1930.

Visit to Chelmsford to inspect the following works.
Messrs. Crompton Parkinson, Ltd.
Messrs. Marconi's Wireless Telegraph Co., Ltd.
Messrs. Hoffmann Manufacturing Co., Ltd.

Luncheon will be provided by the combined Firms.

Route.—By Motor Coach. Leave Midland Grand Hotel at 9-15 a.m. Cost 5/-.

THURSDAY.—June 26th, 1930.

Visit to The Tilmanstone Colliery Co., Ltd., Kent. Light Refreshments will be served at the Colliery.

Route.—By Motor Coach. Leave Midland Grand Hotel at 9-15 a.m. Cost 7/-. Tea on the return journey as guests of the London Branch and the Kent Sub-Branch.

FRIDAY.—June 27th, 1930.

Morning.—Visit to Messrs. Evershed & Vignoles, Ltd., Acton Lane Works, London, N. 4.

Route.—Underground Piccadilly Railway from Kings Cross. Change Hammersmith for District Railway to Chiswick Park. Cost 2/-.

(*Alternative*)

Visit to Messrs. Metropolitan Cable Co., Ltd., Chadwell Heath, Essex. Luncheon as guests of the Firm.

Route.—Leave Liverpool Street Station (L. & N. E. Rly.) 9-44 a.m. Cost 2/-.

Afternoon.—General Council Meeting, Midland Grand Hotel, 2-30 p.m.

General Meeting, 3-30 p.m.

Resumption of Council Meeting, if necessary.

Dinner at Midland Grand Hotel, 7-30 p.m. Ticket 9/-.

SATURDAY.—June 28th, 1930.

Visit to Messrs. Allen West & Co., Ltd., Brighton. Luncheon as guests of the Firm.

Route.—Southern Railway. Leave Victoria Station 9-20 a.m. Cost 6/6.

Those proposing to attend should apply as early as possible for an Acceptance Form to the London Branch Secretary,

Mr. J. R. Cowie, c/o A. Reyrolle & Co., Ltd., 57/59 Victoria Street, London, S.W. 1.

Note.—The Official Hotels will only reserve accommodation on instructions from the London Secretary.

THE "MET-VICK" GIRL.

The sixteenth of the series of "Girl" Calendars issued by the Metropolitan-Vickers Co., Ltd., is a worthy addition to the galaxy of beauty adapted by the Company as an advertising speciality. The subject of the 1930-1931 portrait plate is Miss Helen Gilliland.

Development Tests on Trailing Cables.

P. DUNSHEATH, O.B.E., M.A., B Sc.

IT has been felt for some time, both by cable users and cable makers, that there are too many types of trailing cables in use for mining work. For years past a considerable amount of thought has been expended in producing variants on existing types with a view to effecting improvements, real or imaginary, in the design from the standpoint of safety or length of life in service or, on occasion, to meet the whims of individual users. A reaction from this point of view has now set in and, rather than extend the number of types, interested parties are concerned in the elimination of inefficient and redundant types so as to increase the quantities of each type made, to reduce and simplify stocks and repairs, and to raise the general level of service given by this important item of colliery equipment.

Certain cable makers, fully alive to the need for some action along these lines, have instituted extensive researches in order to compare the relative merits of various types of construction and material employed.

One of the first steps in any investigation of this kind is to adopt some standard for assessing the quality of the cable and this in turn involves new methods of test. Experience in the pit though the ultimate criterion of suitability, is too cumbrous, expensive, and uncertain a method to be of much service in the scientific elimination of undesirable features in design or the development of desirable characteristics. For this purpose controlled tests which can be carried out quickly are required and if possible they should be of such a nature that the comparison between types is given in a numerical form not calling for judgment, nor susceptible to different interpretations by different investigators.

It is possible that at some future date tests of trailing cables may be standardised for general use in the industry, but at present each maker is at liberty to devise his own forms of test, imitating as nearly as he can the condition under which the cable may have to work. The photographs illustrate a series of tests which have been developed in the Research Laboratories of Messrs. W. T. Henley's Telegraph Works Co., for this purpose, and as a good deal of thought has been expended on them they are described for the benefit of others who may be engaged on the same problem.

With a view to stimulating and emphasising practical pit conditions, four tests have been standardised as follows :—

1. Flexing.
2. Steady Crushing.
3. Crushing by Impact.
4. Cutting by Impact.

In the flexing test, illustrated in Fig. 1, the sample of cable is passed over grooved wooden pulleys whose diameters are three times the diameter of the cable. To one end of the sample is attached a disc weight of one hundredweight and the other end is attached through a driving chain to a long crank, which is rotated by suitable gearing at a speed of one revolution per second. The travel of the cable is three feet. In the actual outfit illustrated, two samples undergo test simultaneously

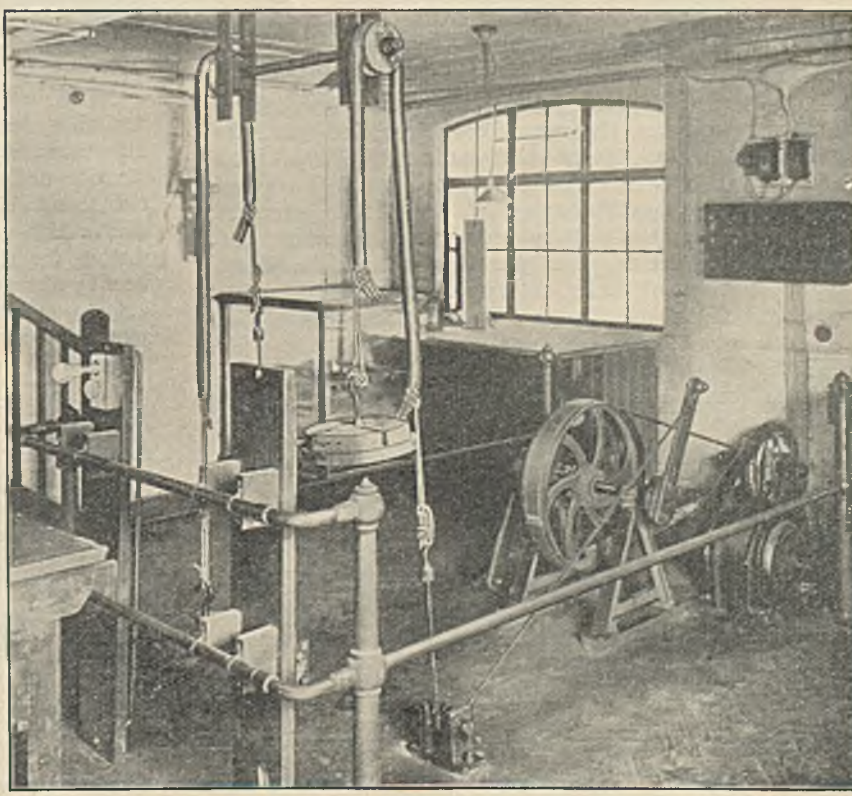


Fig. 1.—The Flexing Test.

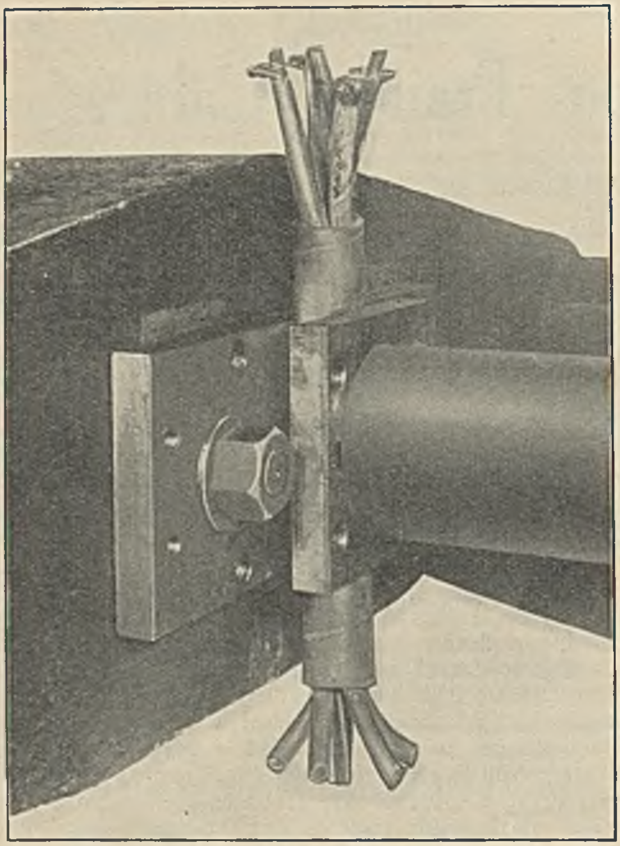
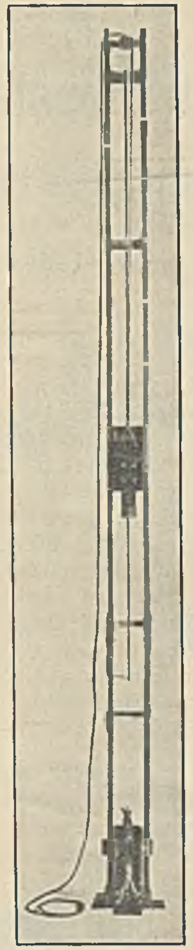


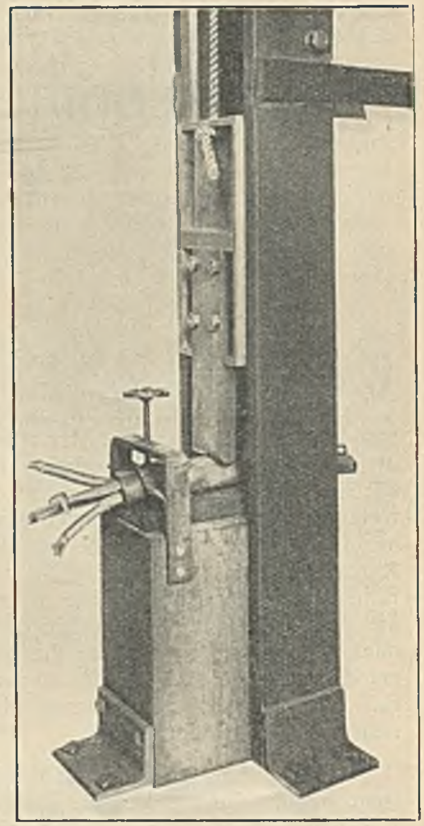
Fig. 2.—The Steady Crushing Test.

resulting in a speeding-up of the work and, incidentally, a balancing of the driving crank.

The criterion of failure in the flexing test depends to some extent on the form of cable under test. Electrical tests are not altogether satisfactory and generally visual examination is the best indication. Where the failure of an internal component is in question it may be necessary to subject a range of samples to different numbers of cycles, and by subsequent dissection and examination to decide which number represents the "life". Actual numbers of cycles determined for different cable constructions on the flexing test vary from about four thousand to well over a hundred thousand and it is quite usual for the weakest component in the make up of the cable to announce its defects quite unmistakeably, in the appearance of the cable after this test.

The second illustration, Fig. 2 shows a sample of cable subjected to the steady crushing test. Only quite a short piece, say six or eight inches long is required for this test, and it is placed between the jaws of a hydraulic press capable of giving any compression up to one hundred tons. The method of test is to apply a test voltage to the cable, and to increase the mechanical compression at the rate of half a ton per minute until electrical failure occurs when the amount of the pressure finally attained is the measure of the quality of the sample. The usual voltage employed for this test is one thousand alternating, either between cores or, where present, between earthing or concentric conductors and main conductors.





Figs. 3 and 4.—
The Crushing by Impact Test.

This test is found to be very useful in indicating desirable features in a trailing cable, quite large differences being found between different types. Cables of poor design will fail at compressive loads as low as two tons, while others will stand up to loads as high as twelve and even fifteen tons. It is interesting to note that in the steady crushing test very considerable reduction in diameter can take place in certain forms of cable before electrical failure takes place. In some cases, samples required to be compressed to half their original diameter in order to produce breakdown.

It is found in any research on the mechanical properties of trailing cables that static tests must be supplemented by impact tests in order to give the whole story, and the apparatus shown in Fig. 3 has been designed for this purpose. The cable sample, clamped to an anvil on the floor, is subjected to repeated blows from a twenty-two pound weight hauled up to various heights by rope and pulley and then released. During the test the cable has a thousand volts continuously applied.

Two different types of impact blow are employed, crushing and cutting. Fig. 4 gives a closer view of the sample on its anvil and shows the form of steel tool employed for crushing. The thickness of the tool is one inch and the lower face is machined to a semi-cylindrical form with a radius of half an inch. In this test the blow is delivered with a drop of ten feet and is repeated at the same point in the sample until breakdown occurs. The number of blows required is taken as the measure of quality on this test, and is found to vary from one or two for the worst samples to over thirty for the best. This test, again, gives excellent information on the desirable features in a trailing cable in order to produce resistance to failure from crushing by impact.

Cutting by impact is produced in this series of tests by the same apparatus as for impact crushing already shown in Fig. 3, but the arrangements for holding the sample and the form of strike are different. In this case, as shown in Fig. 5, the sample is held at an angle of 45 degrees with the horizontal and the striker or "knife" has a rectangular lower face with a sharp square edge. Here again the cable is subjected to a voltage of one thousand volts during the test, but a fresh point in the sample is selected for every blow. The height of fall is gradually increased up to the point where cutting of the sheath occurs, and this height is taken as the measure of the resistance of the particular cable to cutting. It is found in this test that the poorer types of cable fail under drops of four feet while it is not unusual for other types to withstand the full drop of the machine, which is ten feet.

In the impact tests described it is of course important to adopt some convention in selecting the position of the blow relative to that of the underlying cores and a useful one is to take the worst condition in which the cable may be struck, that is on the top of one of the cores.

No attempt has, of course, been made in this article to discuss the question of trailing cable design *per se*, but having adopted some such range of tests and criteria as indicated herein, it is important to note that the results obtained on testing a given sample depend on two distinct characteristics:

(a) the Design, i.e., the assembly of parts,
(b) the Nature of the Materials employed.

In comparing samples, therefore, care should be taken to avoid confusing these two points: it is quite possible for a particular construction to give good results when one particular kind of material is employed and bad results with material of a different kind. While it is not claimed that the tests described provide means for anticipating every contingency which a trailing cable may meet in service, it is quite clear that they constitute a valuable tool in the elimination of unsuitable types and the development of a more consistent and reliable product.

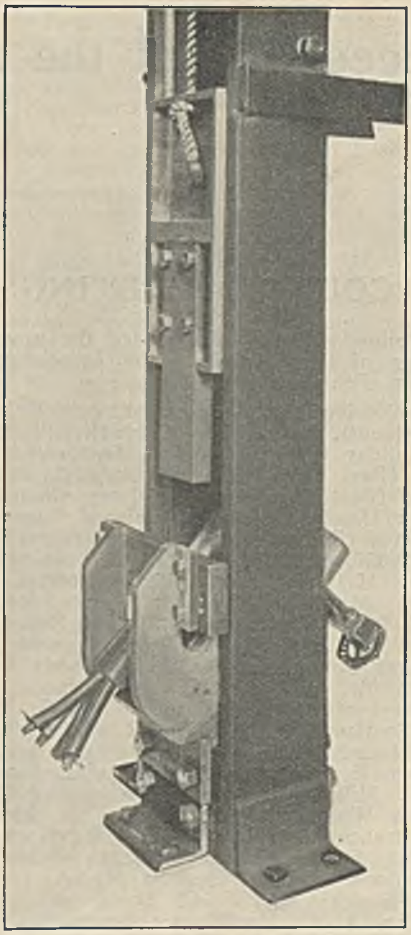


Fig. 5.—The Cutting by Impact Test.

Beryllium.

Writing in *The Electrical Times*, Mr. W. E. Rogers directs attention to the properties of the metal Beryllium and suggests that it may be found serviceable to the electrical engineer. The metal, also known as Glucinium, has been identified for about 130 years. It is widely distributed throughout the world, and, hitherto regarded as a waste by-product, now seems likely to be become a commercial metal of some appreciable potentiality within the British Empire. Just at present, outside America and Germany, it is little appreciated. Beryllium is usually found in company with alumina, aluminium, and particularly associated with beryl, the emerald, etc. Until quite recently, though not in demand, it was usually reduced from its chloride by means of sodium or potassium. Its chemical symbol is Be. Its atomic weight is given by various authors at 9.3, 9.5, or more, and its specific gravity is now shewn to be approximately 2.1 though the very latest figure is only 1.81 against that of aluminium of 2.56, i.e., a little more than half the weight of aluminium.

It has a melting point of 1,280° C., corresponding to 2,336° F., the corresponding figures for aluminium being 659° C. and 1267° F. In many respects beryllium resembles magnesium.

To-day beryllium is being produced electrolytically outside England. The metal has an elasticity far in excess of aluminium and quite twenty times that of steel. It can be forged, welded, rolled or drawn into wire.

It seems quite feasible, says Mr. Rogers, that ultimately the new "grid" may require an outer coating of beryllium, which is far better capable of withstanding atmospheric corrosion than is aluminium, as to a remarkable degree beryllium is proof against corrosion. He raises future visions by mentioning that as beryllium is being produced electrolytically outside England, an electrolytic load of 24 hours' duration would favour our old friend: "A cheap and abundant supply of electricity", and might appreciably assist the base load selected station of the future; particularly as beryllium is receiving the attention and blessing of the aeroplane industry and, if rumour is to be trusted, the motor car industry are also becoming interested.

Proceedings of the Association of Mining Electrical Engineers.

A.M.E.E.
COUNCIL MEETING.

The following is an abstract of the proceedings at the meeting of the Council of the Association, held in Preston, on February 22nd last.

The following members were present: Mr. F. Anslow (Past President), Publications Committee, in the Chair; Mr. R. Holiday (Past President), Treasurer; Mr. A. B. Muirhead (Past President), Advisory Committee; Mr. D. Martin (Past President), Advisory Committee; Mr. T. Stretton (Past President), Advisory Committee; Mr. G. M. Harvey (Past President), Examinations Committee; Mr. J. W. Gibson (Vice-President), Examinations Committee; Mr. H. J. Fisher, Certification and Examinations Committees; Mr. T. H. Williams, Certification, Examinations, and Prizes Committees; Mr. F. Beckett, Finance Committee; Mr. J. R. Cowie, Prizes Committee; Mr. A. Dixon, Prizes Committee; Mr. S. H. Morris, Publications Committee; Mr. J. Walker, Lothians Branch; Mr. J. A. Brown, West of Scotland Branch; Mr. G. N. Holmes, West of Scotland Branch; Mr. R. Rogerson, West of Scotland Branch; Mr. T. McGlashan, Ayrshire Sub-Branch; Mr. E. E. Shatford, North of England Branch; Mr. A. R. Hill, Cumberland Sub-Branch; Mr. A. M. Bell, North Western Branch; Mr. A. V. Heyes, North Western Branch; Mr. I. Mackintosh, North Western Branch; Mr. F. H. Williamson, North Western Branch; Mr. R. Wilson, Midland Branch; Mr. A. Hulme, Warwickshire Branch; Mr. W. G. Thompson, Warwickshire Branch; Mr. A. C. MacWhirter, South Wales Branch; Mr. H. J. Norton, South Wales Branch; Mr. E. D. C. Owens, South Wales; Mr. A. C. Sparks, London Branch; Mr. C. C. H. Smith, Kent Sub-Branch; Mr. C. St. C. Saunders, Secretary.

Letters of apology for absence were received from Capt. S. Walton-Brown, President; Major E. Ivor David, Vice-President; Messrs. G. Raw, Past President and Certification Committee; A. W. Williams Advisory and Publications Committees; T. H. Elliott, Certification Committee; J. A. B. Horsley, Examinations Committee; G. Henderson, Papers Committee; R. Ainsworth, Publications Committee; W. T. Mittell, Lothians; W. G. Gibb, West of Scotland; S. A. Simon, North of England; F. Mawson, Yorkshire; and W. Bolton Shaw, North Western.

The Minutes of the Council Meeting held on October 19th, 1929, having been distributed, were confirmed and signed by the Chairman.

Membership and Finance.

Reports were submitted with regard to the Membership of the Association at December 31st, 1929, resignations, deletions, and transfers, the bank balances of the General Fund and Publications Account, the receipts and Disbursements and Branch Balances. A statement was communicated regarding the position of outstanding subscriptions at December 31st, 1929. Whilst the number of members in arrear was considerable, some of the Branch Secretaries informed the Council that many subscriptions had been received subsequent to the report now presented to the Meeting.

The Quarterly Reports of the Branches regarding Membership, Finance, and District Meetings, were communicated to the Meeting. A special vote of thanks was passed to all those who had taken part in, and were proceeding with, the work of developing the East of Scotland Branch.

Advisory Committee.

Mr. Muirhead reported the publication of a new edition of the Handbook with Explanatory Notes by H.M. Electrical Inspector of Mines on the General Regulations governing the Installation and Use of Electricity in Mines, and the Coal Mines Act 1911, and drew attention to the notes of developments in practice since the previous edition issued in 1924.

A letter from Mr. J. A. B. Horsley, H.M. Electrical Inspector of Mines, was communicated to the meeting with regard to the Daily Log Book; and in which he called attention to the new editions of Forms 10 and 11, and conveyed the thanks of the Secretary for Mines for the help and advice the Association had rendered in this matter. A vote of thanks was unanimously passed to Mr. Fisher for his valuable assistance in connection with the preparation of specimen forms.

Examinations.

Mr. Harvey reported that the revision of the Syllabus had been receiving the Committee's attention, and that the final draft awaited the return of the Chief Examiner who was at present in India.

It was decided that the dates for the next Examinations should be April 26th and May 3rd, 1930.

Mr. Harvey also reported that Mr. Henderson had been co-opted upon the Committee, and this was agreed.

A resolution submitted by the Western Sub-Branch of the South Wales Branch, suggesting that in connection with the Association's Certificate Examination, a question on First Aid for cases of electrical shock should be set. Resolved that this suggestion be agreed to, and that Professor Statham should confer with the Examinations Committee on the matter with a view to including this subject in next year's Examination Questions.

Prizes.

It was resolved that the Prizes for Papers Committee be instructed to prepare a Report upon the papers contributed during the Session 1929-30 for presentation to the next Council and Annual General Meetings.

Annual Convention, 1930.

Mr. Cowie reported upon the suggested arrangements for the Annual Convention to be held in London, and it was decided that the Convention should commence on Tuesday, June 24th, 1930. It was resolved that the completion of the final arrangements be left to the London Branch and the Advisory Committee.

Election of Officers.

It was resolved that the following nominations be made for the principal officers for 1930-1931.

President: Mr. J. W. Gibson.
Vice-Presidents: Major E. Ivor David and Mr. F. Beckett.
Treasurer: Mr. Roslyn Holiday.

In case of further nominations, notification should be sent to the General Secretary at least five or six weeks prior to the Convention, in order that the notices and other papers relating to the Annual Convention may be issued, and the requisite arrangements completed.

Annual Report of the Council, 1929-30.

It was resolved that the form of the Council's Report be in accordance with those of previous years.

B.E.S.A. Committees.

It was reported that Mr. A. B. Muirhead and Mr. G. Raw would continue to represent the Association on Panel CO/38/5/8 Flameproof Motors for Coal Cutters and Conveyors. This was confirmed. It was resolved that if either Mr. Muirhead or Mr. Raw were unable to attend some of the meetings that, if permissible, the Association be represented by the two following substitutes. Mr. Theodore Stretton as substitute for Mr. Muirhead; and Mr. F. Anslow as substitute for Mr. Raw.

Mr. Stretton reported with regard to the proposed Standardisation of Trailing Cables, Bulbs for Miners' Hand Lamps, and Testing for Flameproof Apparatus.

Other Business.

In consequence of the ordinary business having finished in good time, the Members of the Council and Branches had a useful discussion upon several points of interest.

EAST OF SCOTLAND BRANCH.

A meeting of this branch was held at Kirkcaldy, on Friday, 6th December, 1929. Mr. Alfred T. Patterson Branch President, occupied the chair.

After the minutes of the previous meeting had been read the meeting was addressed by the Branch President. The discussion of points raised in the address was adjourned to the next meeting.

Presidential Address.

ALFRED T. PATTERSON.

A presidential address after what we decided upon at our last meeting must be unexpected The principles however, for which we have long contended and the objects of our Association for which we have long stood are just as vital as ever they were. Considering these things, I think it my duty to precede our further meetings with a short paper.

An attempt has been made to include only what may prove useful to the ordinary work-a-day student and colliery electrician. To do this, I think it unnecessary to do more than place on record, some of the thoughts that have passed through my mind since last we met.

To prepare a paper is an education in itself, and it is the person who writes the paper that profits most. Nevertheless, I am driven to confess that apparently it is just this time and energy expended, this concentration of mind, this testing and proving of statements, that the majority of members of this and other technical associations are not willing to give, that is responsible for much of the general apathy that prevails.

Yet withal I am convinced that but for the Association, conditions in our pits from an electrical point of view, would have been a great deal worse than they are to-day. Colliery officials who have entered with fervour into the discussions very naturally felt it incumbent upon them to provide the wherewithal to carry into practice their own suggestions in the interests of efficiency.

Again, what better education could student members have than that afforded by the discussions on a Paper? As one has said: "Discussion and argument, even though it reaches no definite conclusion, does ensure that a point is viewed in a variety of ways; generally speaking, a good discussion means that a problem is attacked from every possible angle." I used to think at one time that intelligence and good workmanship need not necessarily go together: that we would always have the technical man and the practical man, and that seldom the two were combined. Nevertheless, time and experience have proved it otherwise, the educated mind always tending to augment practical ability. The young men who find pleasure in evening classes or any source from which knowledge can be acquired are those most likely to succeed in their profession.

Often we have heard the statement, that "the inducements afforded by the coal industry are insufficient to compensate for the time and labour sacrificed in qualifying for them." Well, it is true that the conditions under which we work, call for great patience and endurance; but hope is a wonderful sustainer, and even though we do not get what we seek, I am prepared to say this much, that electrical men trained under colliery conditions are far more superior workmen than those trained elsewhere. During my time here, a large number of young men trained under the most adverse conditions, educationally and physically, are to-day filling posts of great importance in other countries.

It is most unfortunate that conditions are such that we cannot prevent these men going abroad; but surely the tables will be turned one of these days, and the coal industry will not always be at such a low ebb. Until that change does take place it behoves every one of us, therein engaged, to strive together for the salvation of the industry, "You in your small corner and I in mine."

Manufacturers and Coal Companies realise that every worker must be made to feel that he is an essential link in the chain of the industry to which he belongs; all sorts of schemes are devised to create in the worker the necessary interest, and to encourage suggestions of improving means and ways of doing things; many in high positions to-day realise that in the interests of efficiency and economy, workers must be paid according to the value of their work, and increased remuneration has been given in many cases.

PRESSURES UNDERGROUND.

I believe that in the near future, much higher electrical pressures than that of medium, will be the rule underground, not only from the point of view of economy, but of safety also, especially with regard to cables.

In a certain place known to the speaker no less than three 37/.083 D.W.A.D.C. cables, a total of 2100 yards in length, are in use. The difficulties of maintenance have been almost insurmountable in mining and electrical departments alike; to brush the roof above, or carry out any repairs on these cables, is such a laborious job that neither is ever done correctly.

A little forethought, and the question of installing only one H.T. Cable with converting plant at the receiving end, instead of three medium pressure cables of much larger dimensions, would have overcome the difficulties of accommodating so many cables of the lower voltage in such unsuitable conditions.

What might have proved a serious accident occurred recently on these cables; it demonstrated the value of the extra precautionary measures that we are compelled to take with H.P. and, incidentally, the value of a simple diagram of circuits which at a glance would guide a person unfamiliar with the apparatus.

An electrician in search of a fault opened up a joint box (without compound for certain reasons) under the impression that it was part of a cable which he had made dead. Had the box been H.T. it would have been solid filled and would not have been interfered with, until other tests had been carried out.

It is being borne in upon us more and more, that the use of H.T. in our pits is safer because of the precautions essential for greater potency. The case referred to above, is also one demonstrating the limits of medium pressure, especially for D.C. circuits, and the greater flexibility of high electromotive force in the long-distance transmission of power below-ground.

In the case of medium pressure very large and expensive cables must be used, or the loss of power in the cables will be excessive; with H.T. comparatively small and less costly cables may be used. In many pits to-day it is no uncommon thing to lose in the supply cables anything up to 30 per cent. of the power delivered, in many coal sections such a percentage loss represents no mean figure per working week. Unfortunately C^2R losses very often fail to appeal to us simply because the losses represent only a small percentage of the overall costs.

Perhaps a third disadvantage of medium pressure might be mentioned, and that is the difficulty in manipulating and connecting the cable ends to the apparatus. They are of large powers such as motors of 300 h.p to 500 h.p.

It must be remembered, too, that the current capacity of a large cable will decrease under the I.E.E. rules, as compared with the current density of 1000 amperes per square inch. For instance, a 450 h.p., three-phase, 550 volt. motor will require a 0.6 sq. in. cable under the I.E.E. rules. A cable of such dimensions, even though it has flexible armour and cores, cannot be bent into the space available between the floor and the terminal box of the apparatus.

In nearly every case in the speaker's experience, the makers' terminal boxes have had to be enlarged to allow the cable to enter the side or tops in the event of it entering by the top of the box, the armour of cable has to be fixed to the flange of a wrought iron bend through which the tails pass into the terminal box. We could, of course, use cables of smaller section in parallel, but that would mean the expense of extra material and time.

On a 380 h.p. pumping set now being installed, extensive alterations had to be made to terminal boxes on the L.T. side of the transformer and motor to accommodate a 0.4 sq. in., three-core, V.I.R., D.W.A., cable, even though both cores and armour were flexible.

The installing of the cable under the circumstances proved so difficult and costly, and considering that cables of larger diameters were yet to be installed, that we began to wonder if we were on the right lines, and if it would not have been better to have installed H.T. motors. Prices procured showed that a 450 h.p., 1475 r.p.m., 6600 volt, three-phase, protected type, slip-ring motor, would cost no more than what was paid for a medium pressure motor of the same H.P., plus the transformer. Less than half the time and cost would be expended in installing it, to say nothing of a much more compact arrangement occupying a minimum space, with efficiency and power factor not one whit behind that of the medium pressure motor.

With regard to the medium pressure cables, we now know that manufacturers can supply C.T.S. cables of 0.6 sq. in., having flexible armour of 75% conductivity, which can be handled easier than the 0.4 referred to above. I had expected before this meeting to have received prices of a 20,000 volt cable, that it might be compared with two 6,600 volt cables, each of 0.075 sq. in. now being installed.

A question of interest to me in this connection is: would it be essential to use switchgear between the H.T. side of the two transformers, one in the power station and the other in the pit bottom?

I do not wish to convey the idea that H.T. apparatus can be used with advantage at the coal face, or for motors of small h.p. Indeed Reg. (126) (a) forbids such; nevertheless when installing three-phase motors of 300 h.p. and upwards, it will be worth while to consider the advantage of E.H.T.

PLIABLE ARMOURED CABLES.

Much has been said of late about trailing cables in use at the coal face and considering that 26% of accidents are due to faulty cables and plugs, they cannot be discussed too often. Many have referred to the preference of the Electrical Inspector of Mines for pliable armoured cables and as the future of this type will be determined by experience gained by those using it, it may be of interest to mention here that we have been using such cables since 1925. At that time H.M. Inspector of Mines informed us that Reg. (130) B. for portable machines only applied to coalcutters, and that conveyors, loaders, and even a pump following water down a dook, were not portable machinery, and all cable in use therewith should comply with Reg. (129) (e). We set about complying with his suggestions, by specifying that all future apparatus would provide for armour glands in place of the usual housing of trailing cable plug. In the meantime we purchased and put into use two core 0.025 sq. in. V.I.R., cable, armoured with a double layer of seven 0.029 steel wire; but within three months 250 yards found its way to the scrap heap. We then installed a still more flexible cable. (Mr. Patterson referred to samples (1) and (2) as exhibited; on one the armour is braided copper, and the other braided galvanised steel; the conductivity of the armour is never less than 50%.)

An experience that we had with this kind of cable completely destroyed any hope we may have entertained of its being able to overcome our difficulties. One of the workers in a conveyor section complained of slight shock from the gate-end loader. A conductivity test of that particular circuit showed the armour resistance to be much higher than was permissible. An examination of joint boxes and several lengths of cable revealed no apparent cause for low conductivity and it was not until the armour glands of the pliable cable were removed that the cause was discovered, the braided flex armour fell away in fine particles the moment the glands were disturbed.

We again installed the same kind of cable but with an extra core as an earth conductor, over and above the flex armour; although it provided absolute immunity from danger of shock it failed to stand up to the abuse it was subjected to at the coal face.

We are now trying two types of C.T.S. cable, the only difference of the two lies in the armour; it is braided in one case, and in the other it is stranded. The braided armour is easily broken and too fragile to be gripped by the armour glands; it might easily be rendered useless when preparing the ends should the knife cut too deeply when removing the outer cover. This kind will be discontinued and only the stranded armour will be favoured meantime. It is strong and will stand a lot of abuse, the earth core being of the same section as the live cores, i.e., 0.0225 sq. in., and made up of 91/0.018 wires insulated with rubber, C.T.S. over the cores, 7/0.029 strand steel wire armour, with a layer of C.T.S. ¼ inch thick overall; the flexible armour is 68 per cent. of the section of the main conductors. One length has been in use for six months and is in better condition to-day than any previous type after being in use as many weeks. Should the cores, however, receive any damage it may be advisable to replace by a new length rather than to attempt repairs; to repair, however, would be no contravention of Reg. (131) (1) providing the armour complies with Reg. (125) (G). Personally, I am of the opinion that pliable armoured cable rarely if ever gets anything like fair treatment. Until conditions below ground and maintenance, the all-important thing in our pits, are more highly organised, our experience with the pliable armoured cable, financially at any rate, is not likely to be a pleasant one.

Light bogies provided with a double bollard upon which the cable can be coiled up in the figure eight, or even the drum with its sliprings, will get very little respect shown them, until workers at the coal face can be made to feel their responsibility. In that direction we are not making very rapid progress, a challenge has been thrown out to our Association to provide the necessary education, and to the manufacturers of the goods. Judging by discussions published in *The Mining Electrical Engineer* and the fact that makers have spent thousands of pounds installing machinery for this particular cable, the challenge has been accepted, and I have misgivings about the result.

In my estimation one thing is certain, and that is that soon we will be forbidden to use unarmoured cable, and it is just as certain that when that does take place, the percentage of accidents recorded in the report of 1928 will be considerably reduced.

I have spoken of the development of this particular piece of apparatus; its life's story when told on some future date will undoubtedly tell of travail, but the better part of its history will be one of triumph.

SOUTH WALES BRANCH.

Annual Dinner.

The Annual Dinner of the South Wales Branch was held at Cox's Café, Cardiff, on the 18th January. About a hundred members and guests spent a very enjoyable evening under the chairmanship of Mr. W. W. Hannah, President of the Branch. Unfortunately the date clashed with that of other important functions with the result that there were a number of absentees; amongst those who sent letters of regret were Mr. Budge, President of the South Wales Institute of Engineers; Mr. Martin Price, Secretary of the South Wales Institute of Engineers; Mr. Finlay Gibson, Secretary of the Monmouthshire and South Wales Coalowners' Association; Sir A. Whitten Brown, Vice Branch President; Capt. Carey, Divisional Inspector of Mines; Mr. C. T. Allan, Secretary, Western Centre, Institution Electrical Engineers; Capt. Talisien E. Richards, Secretary, Colliery Managers' Association; and Mr. E. D. C. Owens, Western Sub-Branch.

The loyal toast, proposed by the Chairman, having been duly honoured, Mr. W. Pugh was called upon.

Mr. W. PUGH, Branch President of National Association of Colliery Managers, in submitting the toast of "The Association of Mining Electrical Engineers," said he noticed that the Association was incorporated in 1911. That was some six years after the institution of the first official regulations for the use of electricity in colliery work. The pioneers of the Association, no doubt, had vision; they saw what was in the future, and they were inspired to form this Association which had been so successful.

He, Mr. Pugh, said he believed the total membership now stood at 2000 or more, of which South Wales claimed some 420 members. The result of the efforts of the founders had been that the status of the position of an electrical official at a colliery was now very much greater. In these days it had come to be accepted that at most, if not all, collieries the main consideration is the electrical equipment of their collieries. All these advances in electricity call for highly technical knowledge, skill, and experience in its supervision as well as in its installation. It is true that the use of electricity—method of transmission and use of power—is not desirable in every case, and Mr. Pugh said he had in mind places where collieries are working very successfully without electricity. He recollected how, about 25 years ago, viewing some electrical equipment at a certain colliery, he had been struck by the crude attempts of British manufacturers and that they were then utterly unable to compete with foreign rivals. He was acquainted with the development of electrical power and the leeway since fully made up.

Continuing, Mr. Pugh referred humourously to the responsibility of the colliery manager. The colliery manager has to be many things. He had attended the football match that day—an unusual thing—but it took him back to the time when one of his fellow players used to sing something about Crawshay Bailey's engine, and a description of the colliery manager—"he is a gaffer and surveyor, a bit of haulier and platelayer". Traditionally, the colliery manager is a jack-of-all-trades; to-day some may prefer to call him a superman, but he thought that if he were to revise the couplet it would run—"a colliery manager is a servant and employer, a bit of a doctor and a lawyer". The colliery manager had to have his eyes open to many things although not actually taking part. That was one of the qualifications of a colliery manager. This Association and the Association which he represented could do much, and he believed they would, to improve and benefit the industry both in regard to safety and to the economic working of the collieries. The coal industry was passing through a period of depression, and he believed that if they were only left to work out their own destiny there was nothing in the future of the coal industry to be despondent about.

Capt. S. WALTON-BROWN, President of the Association, in response, said it was his privilege and their penalty to receive a visit from the President of their Association. He had looked forward very keenly to coming to South Wales, having the feeling that, coming from the N.E. Coast, there was a sort of unity of interest between the two districts. South Wales in the past and still on occasion, took men from the north-east where, in return they had received a certain number from the Welsh field. He expressed his pleasure at the cordiality of his reception and the arrangements made. He took it as a personal and very delightful tribute to have been enabled to come and see an international match, and it showed a sort of super-organisation by the Branch that they, on the occasion of the visit of an English Born President, should kindly arrange for England to win. Mr. Pugh, in his remarks, said that he had not made very much use of electricity yet but, Capt. Walton-Brown said he was quite sure that no member wished to ram the application of electricity down the mouth of any colliery unless the use of electricity in that particular case would clearly be on an economic basis. It may be that up to the present such a basis has not been put before Mr. Pugh, but if matters progress as they have done during the past few years, it should be possible before long to put a proposition to Mr. Pugh that, on a cash basis, he could not well refuse.

Capt. Walton-Brown said that as president he had to be careful in his references to the coal trade, and his remarks in that connection should be considered as altogether of a personal character and the Association not held responsible for them. He had the feeling that in the coal trade they were coming to the turning point of the ways. Wages have always been dependent on the price of coal and some of them are hoping—he was one—that in the future the opposite would be the case and that there will be more regard given to the wages received by officials and workmen and an endeavour made to see that everyone in the trade, both owners and employees, is adequately remunerated; as a result it would be possible to determine what the price of coal should and shall be.

It seemed to him that in doing this the coal industry would only be taking a leaf out of everybody else's book. When one reads the parliamentary notes and finds propositions to raise what one might call the miserable pittance that some Ministers receive of about £2000 a year, one is assured how essential it is to raise it to £5000 a year at the earliest possible date! But—when there is talk of raising the price of coal, not to an exorbitant figure, but to a figure which would ensure the employees adequate wages and the owners reasonable profits, we are at once assailed by the cry "dear coal". We can have low wages so long as coal is cheap, the owners can do without profits, in fact they can incur losses, all so long as coal is cheap! Prices of materials can be up but—coal must be cheap! As a result we cannot attract capital to develop and maintain our industry as easily as other industries. In 1913 we had an output of 287 million tons of coal. We have not to-day. We ought to have more! All these things are said to be alright just so long as coal is cheap. It is time that was altered. The consumer should not be asked to pay an exorbitant price, but such a minimum price as would ensure the men and officials wages of similar value to those which our country pays its employees in other similar occupations, and the owners adequate profits.

In referring briefly to the legislation which is to the forefront at the moment, Capt. Walton-Brown said that while he would have preferred to see the industry left to work out its own salvation, it was possible that part of it would be for the good of the industry as it would place within reach some of those ideals which he had just expressed; he regretted therefore that there was to be an alteration in the hours of work, an alteration which could not fail to mean a rise in the price of coal to the consumer and which at the same time would surely diminish the wages beneath the higher figure which it could have been if the hours had remained the same. He, Capt. Walton-Brown, had not a full knowledge of what the ideas of his colleagues in South Wales were, but he was sure that in his district (the N.E. Coast)—owners, management, and workmen would welcome a continuance of the same hours provided there was an increase in remuneration. One other point he wished to allude to, one which is not popular in every district, but which he believed some in that South Wales district would receive with favour, was the subsidising of the export trade. The cry is always raised that the foreigner is going to get our coal cheaper than it can be got by the home user in this country. Yet many of those who cry the loudest adopt similar methods in their own industries. They of the N.E. and, he believed of the South Wales area, realised that they could not command in the foreign markets the prices which they would like to have. They could only get the world's price and if they were to keep out of the the markets in this country for the benefit of what might be called the "inland districts", it was only fair that the inland districts in return should see that each export district gets some financial assistance so as to ensure that the men, managements, and owners are placed at least on a wages' basis reasonably comparable with that received in the inland districts, particularly if such export districts worked rather longer hours than the inland districts as their contribution. He did not wish to say very much about the mining industry as a whole because there were other speakers to follow; but in these few remarks he had given his friends material which they could tear to pieces, or help along, or perhaps, as is sometimes done when these points are on the tapis, to maintain a discreet silence.

Captain Walton-Brown then turned to Association matters and urged that it was the duty of members to see that electricity is applied underground on the most up-to-date methods. There are various points of view of the work of electricians in collieries. Ask some manager or engineer—"How many electricians work at your colliery?" Some reply 20, or some say 100, some perhaps 50, and others, perhaps—"half of them only". He hoped that with regard to members of the Association it would always be answered that they were workers. The prospects in the coal industry are that a great deal more money than has been spent in the past will be spent in the near future, and it was highly probable that electrical development would take a great proportion of it. They must be cautious spenders—the money must give a proper return—but not too cautious. Not like the Scotsman who was walking silently with his wife who asked him what he was thinking about. In reply he said he was thinking of how he would spend Christmas. His good lady rebuked him for always thinking of spending!

All members must keep abreast of the times, attend the meetings, read the journal, and be fully alive: not like the man who could never answer any question the foreman asked. On one occasion, four or five questions elicited no reply; in desperation the foreman said "I suppose you have'nt even heard of the Flood—you know, Mount Ararat, the Ark, etc." That brought the answer: "I came out in such a hurry this morning that I had no time to see the newspaper."

One of the last qualifications and one of the most important qualifications that a man must have in this Association is that he must be what might well be called a protectionist. The Association stood, in a way for a policy of protection, for all members must pay a tax in the form of hard work and attendance at classes, reading books and practical work; after which they are allowed to go before the examiner's desk, and supposing that they have paid this tax in sufficient quantity they will receive from him a receipt in the form ot a Certificate of the Association which will enable them to enter a very strongly protected body of qualified men, and which will not only be for their own benefit but for the benefit of the mining industry and the country as a whole. Captain Walton-Brown urged all young enough, who had not got the certificate, to work for and obtain it at the earliest possible moment. It was true some would say it is not absolutely necessary that all electricians should be certificated at the present time, but he could assure them that the electrical industry was not going to stand still and the Certificate valuable now would become ever more valuable in the future. To quote one example of the value of it; relationships with what I call the coal owners are very happy. They cannot do more for us than they have done. They have entertained us when we have asked, and entertained us even when we have not asked! They have always taken an interest and recognised us as a useful body, and he, Capt. Walton-Brown, was very proud to receive the other day, a request that he should submit the names of any of the members whom he considered suitable for a good opening which was available at that time. It showed at least that the Association is getting into the position of being recognised, as having in its ranks the best men for the jobs that offer.

Mr. W. W. HANNAH (Branch President), in presenting the toast of "The Mining Industry," said he knew remarkably little about the coal trade, but seeing that he had been appointed in writing to this duty he would try to feel as competent as any colliery electrician who had received a certificate of competency from his colliery manager. He did consider himself an expert on the subject of the colliery manager, but there were too many managers present for safety, including the President of the Association, and another who was due to speak later. Mr. Hannah, however, felt it his duty to say that there was no truth in the rumour going round that the increasing numbers of doctors engaged by South Wales Coalowners were petitioning the Government and the British Medical Association asking that their degrees of M.B., F.R.S., etc., should in future be conferred on them by colliery managers. They did not understand why only mining electrical engineers should receive certificates of competancy at the manager's hands.

He would confine his remarks to mining electrical engineers each one of whom—according to his respective colliery manager—has been, is, and will be responsible for huge losses of output. To which failings of the electrical engineers must be added the troubles caused by geological faults, manager's faults, indifferent faces (not the managers'), undercut coal and undercut prices, then South Wales does appear to be one vast piece of barren ground.

How are those troubles to be overcome? The Chairman of the Western Centre of the I.E.E. in his presidential address talked about rationalisation. The subject was rather out of his, Mr. Hannah's, depth until the outgoing chairman defined it as being rather like an elephant a thing much easier to imagine than to describe. The discussion which ensued on that address was chiefly centred on the Rationalisation of German Industries which had taken place since the war. Mr. Hannah had pondered over the question a great deal because he had been in previous days unfortunate enough to spend some seven years in Germany, and again had seen some little more of it with the army of occupation. He thought he ought to know some characteristics of German mind and trend of thought: but mining electrical engineers, as any colliery manager will tell, are not blessed with supreme intelligence, and perhaps that was why it was not until some weeks later that he, Mr. Hannah, began to understand this problem. His subconscious mind had been at work and at last he knew exactly what Rationalisation was. It was in very truth an elephant—but it was a white one.

Rationalisation of the Coal Industry was no patent medicine with a secret formula. Neither amalgamations, coal marketing schemes nor the efforts of any political party could put the industry on its feet.

In former days at any rate the Germans were working long hours at low wages. Mr. Hannah had spent many months at German collieries where whenever it was possible to employ a gang of men in one position above ground, on rubbish tips or picking belts, on ground where material for hydraulic storage was picked up, convicts were employed for whose services the government paid sixpence per man per day. In the Silesian mines cheap male and female labour was imported from Galicia and Russian Poland and housed in barracks. The engineering staffs consisted of highly-trained hard-working technical men, and education is very cheap in Germany. The boards of directors of German Industrial

Concerns consist chiefly of men who manage and control some portion or department of the business. We, in this country do not want to copy these methods, but surely rationalisation consists wholly in the exercise of common sense. If we are to compete against cheap labour then it behoves us to get every man to do as much useful work as possible.

Our colliery managers have been carrying the whole of the burden of administering a colliery on their own shoulders. They are obsessed with the idea that if two men are to ride on one horse one man must ride in front. Nowadays five people ride in the front seat of a char-a-banc and that one feature of rationalising the Coal Industry is to get more than one mind to lead the work in each particular pit. Share out the responsibilities.

Let the colliery manager co-ordinate the work by all means, but why impose on him responsibility for matters in which he is not an expert and, worse than that, why deny him the relief which could be afforded him by having a certificated electrical engineer. If the German idea of a board of working directors each responsible for a department is feasible, then it is possible for us to run a colliery in that way too.

Mining is becoming, especially in the English and Scottish coalfields, very largely a question of using machinery and Mr. Hannah suggested that the Mechanical and Electrical Engineer must be let in. That was one direction in which the Coal Industry could be benefitted.

Mr. F. Ll. JACOB, responding to the toast of "The Mining Industry," remarked that since he had been closely connected with the coal industry for a good many years, a much more interesting speech would have been forthcoming had the reply been left with someone who had never seen a pit. He had been impressed by an expression in the papers recently, attributed to the Civil Lord of the Admiralty, who said: "That prosperity could not be expected in the Mining Industry until more money was placed into it." If that were true, how could it be expected that more money would be placed into an industry which was not paying its way: and when the Government of the land was endeavouring to force upon the industry measures which would make it even less possible.

Mr. Jacob said he felt convinced that the Labour Party gave their pledge during the election either in ignorance of the effect of carrying out such a pledge, or that they never expected to be given the opportunity to carry out such a pledge. They have had the opportunity of investigating the true position and effect of such legislature and they can now see the disastrous results bound to follow, such innovations as they propose; yet they persist by a mistaken sense of honour to carry out a pledge given either in ignorance or the expediency of an election although it would in effect inevitably hurt those that they sought to help.

Mr. Jacob said he believed the coal trade was quietly getting back to a more prosperous condition, but the struggle had been hard and consequently very slow; the reason for this long hard fight was not far to seek when one examined the productions of the coalfields of Europe outside the United Kingdom.

Changes might be needed in the marketing of coal—Mr. Jacob could not say. He was a mining man and a wise shoemaker sticks to his last, so he was loth to express any opinion on the commercial aspects, but he was convinced that whatever was necessary to be done to get back to that prosperity which everybody so anxiously desired, could only be done by voluntary means within the industry itself, and Government interference could not in any way assist. The coal trade wanted to be free from all bickering or outside interference if it was going to fulfil the function of being one of the mainstays of this country.

It seemed more than a pity that after all the work that had been done by Sales Agents, Colliery Managers and Officials, including Electricians, Mining Engineers and in many cases by the workmen themselves, in the combined effort to produce coal at a cost which would enable us to compete with the foreigner, and get back the trade lost by strike and interference, just when we were nearing the goal, further legislative interference enters to upset all the good work done.

Mr. Jacob, in concluding, said he could not speak too highly of the work of the engineers and that carried with it the President of the Association and a full appreciation of the work which the Association is doing in endeavouring to maintain and raise the standard of efficiency in the electrical branch of mining which becomes of greater importance every day in the whole industry. He thanked the company for the manner in which they had received the toast of the Mining Industry and was sure that if the industry alone were left alone to work out its own salvation, they would be calling on him or someone more able to respond to this same toast in a more cheerful atmosphere in years to come.

Mr. S. T. RICHARDS (Chairman, Western Sub-Branch), proposed "Our Guests: The Kindred Associations." He expressed his indebtedness to the coalowners for the encouragement they had given the Association. They were now recognising the Certificate of the Association, and it was hoped they would continue that support until eventually the goal of Home Office recognition was reached. He said they were very pleased to welcome Mr. Pugh, and must congratulate the Association of Colliery Managers on his good work. There is more co-operation between the management and engineers than previously: he could assure Mr. Pugh that the Association is out to assist the colliery management in every possible direction.

Referring to Mr. Haslam, a very prominent member of the Association, Mr. Richards said they were proud to know that the Institution of Electrical Engineers has him as its local President this year. He had the assurance of every good wish of his colleagues in the A.M.E.E. for a really successful and bumper year.

Mr. Richards congratulated Mr. D. Brynmor Morgan with regard to the progress of mining education in Monmouth, and suggested that he might consider the inclusion in his course for mining electrical engineering, a syllabus of the A.M.E.E. Certificate Examination. The experiment was tried in the county of Carmarthen and the most successful class was the A.M.E.E. and it was still a great success.

Mr. Richards expressed the hope that Swansea might might be honoured with occasional visits, in particular a visit from Capt. Walton-Brown would be most helpful.

Mr. S. B. HASLAM in reply, said their common aim and object was towards making happier, healthier and better lives for their fellow men. He believed that membership of these Associations should be honoured and guarded very jealously. He would offer the suggestion that the Association of Mining Electrical Engineers might take up with the Institute of Electrical Engineers the question of the A.M.E.E. Certificate being accepted in lieu of the I.E.E. Examinations: the standard set by the A.M.E.E. was high and the candidate would be relieved of a second examination. He would also suggest to the A.M.E.E. Branch Council that they should try to get the details of their meetings included in a combined programme with the I.E.E.: it would be a step in co-operation, and unity is strength.

Major E. IVOR DAVID, prior to submitting the toast of "The Chairman," mentioned that the eight hour day did not apply to the colliery electrician and certainly not to the mining staff. There had been issued only that week a most momentuous document to the electrical engineers of South Wales; from which it would seem that the colliery is to be the tin can tied to the tail of the electrical industry. The collieries of South Wales had been pioneering for several more years than some people seemed to think: their work dated back to the early eighties: they had the first high pressure electricity station in the country. The idea to be gathered from this document was that the collieries should quickly rush into the arms of the Supply Companies, but they had long stood firmly on their own feet and would continue to do so. They were not going to have the standards of safety lowered. They had carried on big industries with small staffs and few salaried men and the costs of the power to the industry rose at the very time when they should be reduced. The figures given in the document referred to, intended to appeal to potential consumers, would not attract any colliery at the present moment.

Submitting the name of the Chairman, or rather the Branch President, Major David said this branch of the A.M.E.E. had the gift of bringing out the good points of its presidents. They had only to think of those who had held the chair, and it was at once appreciated that it was a training ground for chairmanships in higher offices.

THE CHAIRMAN happily acknowledged the compliment, and the remainder of a most successful evening was carried to an all-too-soon conclusion by community singing and the individual good offices of an excellent group of entertainers.

LOTHIANS BRANCH.

Social Evening.

Lothians Branch held their Annual Social Evening in the Albyn Rooms, Edinburgh, on Saturday, the 8th of February. In the unavoidable absence of the Branch President, Mr. Perritt, due to illness, Mr. G. Henderson occupied the chair and presided over an attendance of fully a hundred members and friends.

The principal guests of the evening were Capt. S. Walton-Brown, B.Sc., President of the Association; Mr. J. Masterton, Divisional Inspector of Mines; Mr. Sneddon, of the Scottish Oil Agency, and several General Managers of local collieries.

Capt. WALTON-BROWN in his remarks emphasised the necessity for all connected with the electrical industry in the coal mines, of joining this Association. He pointed out that the lectures given throughout the session and also the various visits to collieries, public works, and power stations, were of a most interesting nature and exceedingly helpful to those in the industry.

Mr. MASTERTON, in an address, made special mention of the fact that electrical apparatus was making great strides since the first days in which he had anything to do with it. Because of this fact it was really necessary that the members keep themselves up-to-date with modern appliances as they came on to the market.

Mr. SNEDDON, although in the oil industry himself, stated that there was no reason whatever why both the coal and the oil industries could not be organised to work in harmony for the benefit of the country as a whole.

During the evening a musical programme was carried out by artistes who contributed songs, violin and concertina solos. The usual votes of thanks and the singing of "Auld Lang Syne" brought a most successful and enjoyable evening to a close.

WESTERN DISTRICT SUB-BRANCH.

Mines Electrical Accidents and their Treatment.

G. STANLEY PHILLIPS,

M.R.C.S. (Eng), L.R.C.P. (London).

(*Paper read 14th December,* 1929.)

Electrical accidents in collieries are fortunately of rare occurrence. The Annual Reports of H.M. Inspectors give the average figure of 5 fatal accidents and 48 notifiable non-fatal accidents per annum for the whole United Kingdom. The comparative infrequency of accident and the severity of the accident when it does occur supply the strongest reason for a thorough knowledge of the methods of dealing with cases when they do arise.

Electrical accidents are a far greater economic loss both to employer and employee than any other type of accident. Dr. Bede Harrison, Radiologist to Vincent's Hospital, Sydney, in a paper on Electrical Accidents in the Australian Medical Journal for 1927, gives some very interesting and striking figures in proof of this from statistics of the Insull Electrical Organisation. This organisation employs about 50,000 employees, practically all engaged in the production and distribution of electricity. They state that 93 per cent. of the accidents which cause damage to employees are due to mechanical causes, such as falling over a case, nail in foot, etc. In only 7 per cent. of the cases was the personal injury due to the particular energy (electrical) which was being handled. But when one looks at the financial side of the personal injury the tale is a very different one, and its significance cannot be too forcibly emphasised. The 93 per cent. of cases only accounted for 25 per cent. of the Company's compensation costs, while the 7 per cent. accounted for. 75 per cent. of these costs. In other words the average electrical accident cost both employer and employee 160 times as much as the average mechanical accident.

Let us now consider the causes of electrical accident. Like any other type of accident, they are dependent on two factors:

(a) The Mechanical Factor, and
(b) The Human Factor.

(a) The Mechanical Factor, as far as colliery electrical accidents are concerned, consists of

(1) Faulty equipment;
(2) Faults other than in actual equipment, e.g. falls of roof, etc.

(b) The Human Factor is dependent on several things:

(1) Unsuitability of the workman for the job in hand.
(2) Carelessness on the part of the injured employee or some other employee.
(3) Fatigue.
(4) Illness.
(5) Worry.
(6) Haste.
(7) Ignorance.
(8) Familiarity.

Possibly some will be inclined to disagree with the author in some of these conclusions and particularly in the matter of fatigue, worry, illness and haste, but those conditions have a close bearing on the incidence of accidents. They tend to produce lack of concentration and that renders a man more liable to accident. That workmen proceed to work when they are not as fit as they might be, the author from experience is wholly convinced. The economic conditions at present existing—low wages and high cost of living—tend to this.

The economic loss and the factors tending to produce accidents are thus stressed so that these notes shall start on the supposition that all accidents are avoidable and that every effort should go to prevent the occurrence of accidents.

Now let us consider the types of accident which do occur. Electrical workers are liable to two types of accident:

(a) Accidents due to Mechanical Causes; and
(b) Accidents due to the energy (electrical) being handled.

(a) It is not proposed to introduce a paper on general First Aid, but the author would like to say a little about two particular injuries due to Mechanical Causes:

(1) Cuts from wire with the possibility of septic poisoning. It is necessary to stress the importance of thoroughly cleansing such wounds and thorough application of whatever antiseptic you may be in the habit of using. It is better actually to pour the antiseptic into the wound so that it may react on the depth of the wound rather than rely on simply painting with a camel hair brush or cotton wool swab.

(2) Burns from acids. The importance of neutralisation of the acid cannot be too forcibly emphasised. Boric Lint soaked in a solution of Bicarbonate of Soda made with sterilised water forms the best dressing. Reference to this solution will be made later.

(b) Accidents due to the particular energy (electrical) being handled:

These occur in two main forms: (1) Accidental contact for a short time, the circuit being broken immediately either by the patient falling away from the conductor or the line fusing; (2) Contact for a longer period in which the patient grasps the conductor and, owing to muscular spasm, cannot free himself, or in which he falls across a live conductor or a live conductor falls on him and, as a consequence of the resulting unconsciousness, remains in contact.

It is of importance to recognise these two forms; in the former the question of freeing from contact does not arise, while in the latter it does. Suggestions as to freeing from contact are given at the end of the paper.

Passing on to the medical aspect of electrical accidents, the first question is: what voltage is dangerous to life? The answer depends on several factors:

(a) The nature of the contact;
(b) Wet hands or clothing;
(c) The earthing of the individual;
(d) Wet floor, particularly concrete;
(e) Nature of current—A.C. more dangerous than D.C.
(f) State of the patient's health;
(g) Path of the current, e.g., through both legs is not usually dangerous to life, but through both arms is.

In brief, given one or more of these factors, all voltages above 60 volts are dangerous.

The effects of electrical contact may be divided into two classes, from the Medical Standpoint: (1) Local Effects; and (2) General Effects.

Local Effects:

(a) The true electrical burn caused by contact with the conductor;
(b) Burns caused by the intense heat generated by short circuiting; the arc burn.
(c) Clothing burns caused by the ignition of clothing by the arcing.

The latter two are the ordinary burn and present the ordinary appearance of a burn. The first is a definite clinical entity and occurs at the points of entrance and exit. The amount of local injury is determined by the resistance of the skin and the degree of contact. The resistance of the skin varies from 3000 to 5000 ohms, but may be as low as 1000 ohms. It is dependent on the thickness of the skin and its state of cleanliness and dryness. Wet and dirty skin is far less resistant. The electrical burn presents definite characteristics. It is more or less circular in shape, has raised edges and excavated centre as if caused by puncture by a red hot wire. It is pale yellow in colour, bloodless, cold and painless. There is no reddening around the burn.

General Effects:

Apparent death is the common general effect. This is brought about by

(a) Heart failure.
(b) Inhibition or paralysis of the vital centres in the brain, particularly the centres controlling respiration and the blood vessels.

In this condition of apparent death, the brain is inactive so that several of the usual signs of life are absent, such as objecting to the eye being touched. Death should not be assumed until *rigor mortis* (stiffening of the body) has set in. This takes from 6 to 12 hours In order the better to understand the treatment, the author suggests for this condition, he would deal briefly with the effects of the inhibition of the vital centres. Respiration ceases and the blood gets dammed back in the large veins of the abdomen. The result is asphyxia or lack of oxygen in the blood. There is evidence that the absence of the signs of life in a patient subject to an electric shock is not to be interpreted as indicating that death is instantaneous. Here are quotations of two cases which have been published recently:

(1) A patient whose head had come in contact with a live wire was found post-mortem to have a hole in his skull through which brain matter was oozing out. Similar brain matter was found in the lungs and stomach indicating that he had swallowed and breathed after the incidence of the fatal shock.

(2) A man was shocked and his companions ran away. They returned in a quarter of an hour and pulled him off. He was dead apparently, but subsequent microscopical examination of the arm showed a vital reaction. This must have occurred 15 minutes after the shock.

That there is a period of time between apparent and real death is undoubted. Some observers place it as long as 15 minutes, but whatever it is, it emphasises the necessity of immediate efforts of resuscitation.

Treatment.

Local Effects.—The burns having been caused by intense heat are aseptic and every effort should be made to prevent the entrance of sepsis. Clothing which is not adherent should be cut away; no attempt being made to loosen adherent clothing. Immediate covering of the burn should be made to prevent the entrance of germs. A dry clean antiseptic dressing such as boric lint is the best thing to use. The author would most strongly advise the avoidance of such things as ointments and lotions in colliery practice, as they only collect dust and dirt and are a very useful medium to introduce the sepsis which it is intended to avoid. As little interference as possible is the best thing and immediate exclusion of air.

Co-existent injuries such as wounds and fractures will be dealt with on First-aid principles. The only thing to be emphasised here is the careful watching of bleeding. The blood vessels are good conductors of electricity and are therefore prone to damage so that a slight hæmorrhage may in a short time become severe.

General Effects.—In view of the fact that there is a definite period between apparent and real death, efforts at resuscitation should be commenced forthwith. Many forms of apparatus for pumping oxygen into a patient's lungs have been devised, but there are objections to them, the chief being delay and delay is dangerous. Artificial respiration by Schafer's method still holds the field as the method which has had the greatest measure of success.

Schafer's Method.

(1) Lay the patient down on his belly with arms above his head.
(2) Bend his left arm at the elbow and lay his head on this, face to right to allow free access of air.
(3) Remove obstructions from mouth, e.g., false teeth, etc.
(4) Do not waste time to undo tight clothing. An assistant can do this while you are doing artificial respiration.
(5) Place yourself straddle across the patient with your knees opposite his hips (level of trousers pocket).
(6) Place your hands, fingers, and thumbs together over his lower ribs so that your little finger is on the 12th rib with the tips of fingers just out of sight at the sides of the chest.
(7) Have your arms stretched and tense.
(8) While counting 1—2, bring the body weight on to your arms.
(9) While counting 3, bring the body back.
(10) While counting 4—5, rest.
(11) Do this 15 to 18 times per minute.

The effect of this is to force the spleen and liver up against the diaphragm which rises as in expiration. The sqeezing also forces some of the stagnant blood from the abdomen into the heart. Eventually the brain will get oxygenated blood and this will tend to decrease and eventually clear the inhibition of the vital centres. When you take your weight off your arms the diaphragm falls as in inspiration. The process thus follows closely that of normal breathing. You can estimate the rate from your own breathing. Have relief ready as you may have to continue for three or four hours. Keep patient warm with blankets and hot water bottles. Transport after resuscitation in a prone position. If the patient sits up he is liable to serious Syncope owing to blood stagnating in abdomen.

(A practical demonstration of Schafer's Method of Resuscitation was given.)

Conclusions.

(1) Each power house should have some form of Emergency Box, the contents being:

Ebonite sticks of various lengths to draw patients from contact. Insulated wire cutters. Insulated gloves and shoes. Sal Volatile. Boric Lint, Cotton Wool and Bandages. Blankets and Hot Water Bottles. Iodine or other Antiseptic. Bicarbonate of Soda in ½ oz. tins or packets makes 1 pint of lotion for acid burns.

Some power stations have Insulated Fire Extinguishers.

(2) Unskilled men when employed should be made alive to the danger of contact with a live conductor.

(3) Frequent practice in methods of resuscitation is essential. As the tendency is to go too fast, practice at 10 times to the minute.

BIBLIOGRAPHY.

A. J. Jex. Blake, British Medical Journal, Mar./1-8-15-22/1913.
W. B. Cameron, Resuscitation Commission. Tr. Nat Elect. Light Association, 1913.
S. J. Metzler, Resuscitation Commission. Tr. Nat. Elect. Light Association, 1919.
Reports Accident Prevention Commission. Tr. Nat. Elect. Light Association, 1919.
C. K. Drinker. Tr. Amer. Gas Association, 1923.
E. A. Schäfer. Harvey List, 1907/08.
S. Jellinek. Arch Radiol and Elect. 1922-23. xxvii 316
T. M. Legge. Arch Radiol and Elect. 1922-23. xxvii 1
S. Ram. Arch Radiol and Elect. 1922-23 xxvii 4
Bede Harrison. Australian Med. Journal 24. 9. 29.
S. Jellinek International Clinics. Vol. 1, Mar. 1929.
R. E. Gaby. Canadian Med. Journal. Vol. 17, 1927
Wills MacLachlan. Canadian Med. Journal. Vol. 17, 1927

Discussion.

THE CHAIRMAN (Mr. S. T. Richards) said they were deeply indebted to Dr. Phillips for his interesting and instructive lecture. This was a subject on which very little information could be obtained, and should be brought more to the notice of persons operating electrical machinery, especially in mines, where plant is subject to more severe treatment than in other industries. They had always considered themselves fortunate in having so small a number of accidents, but the financial losses due to this small number of electrical accidents was staggering. He asked Dr. Phillips whether the human factors stated by him were in the actual order of frequence. He, Mr. Richards, would be inclined to put Ignorance first, Haste next, and Familiarity afterwards. Dr. Phillips had pointed out that the Schafer method is the most successful one. The Chairman said he had always understood that, apart from this, there is a method that has been as successful as the Schafer method, e.g. giving the patient another sort of shock, say for instance, a kick in the back. He thought it was a Scotch method. He asked whether there were any symptoms that would give the First Aid man an idea as to which method to employ. He quite agreed with Dr. Phillips' description of electrical burns, having suffered in this way himself, and likened the state of the skin to a roasted potato.

Mr. W. M. THOMAS thanked Dr. Phillips for his able and lucid paper on matters which particularly affect the colliery electrical man. Dr. Phillips himself has done a great deal of First Aid work in West Wales, and is one of the most prominent men in West Wales in this movement. He said that manufacturers are out to give them the best goods and thereby reduce the liability of accidents to a minimum. During his (Mr. Thomas') experience, he had nothing to record during the past 6½ years in the way of an electrical accident. He had made it his business, outside electrical accidents, of making an analysis of accidents during the past few years, to get at the real cause of accidents, and by that means was able to keep them down to the very minimum. He regarded most accidents as preventable, and that is the only basis on which to start. He attributed the comparative freedom from electrical accidents to periodic inspections and records, to the suitability of the men for the work in hand, to the cutting down of faulty material, and to the particular care taken by the head of the electrical department to see that his appartus is, as far as possible, safe.

He was in complete agreement with Dr. Phillips in his summary of the human factors, and it was really surprising how these factors have an influence on accidents. He referred to a case he knew of a man being worried by family illness and working on the night shift, forgetting to shackle the journey. Worry had a very important bearing on accidents of all kinds. He was glad Dr. Phillips had mentioned cuts: on looking into the records of his own electrical staff to ascertain how many cases of injury they had had due to cuts from wires, there was only one instance during the last 6½ years of a case of septic poisoning, a freedom due mainly to the care taken by the ambulance man.

With regard to Acid Burns, he said that Lime or Soda will make a convenient alkaline solution to neutralise the acid. Electrical shock had, of course, received most attention in this paper, and he would like to have from Dr. Phillips more information on the pathology of this condition, and enquired as to the relative effects of heart failure and respiratory failure. He quite agreed that the electrical man should have a thorough knowledge of First Aid principles, and he would endeavour to get his electrical staff to have a little training at an early date, although many of them were already qualified in that direction.

Referring to the Laborde and Sylvester methods of resuscitation, he asked how these differed from the Schafer method, and what were the relative merits of each. He asked whether there was any specific time between the vital reaction after an electric shock, as the lecturer had given an instance where this reaction took place fifteen minutes after the shock. He enquired further as to what exactly took place in the Blood vessels when there was a slight Hæmorrhage at first, but which increased afterwards.

Mr. A. REES said that Dr. Phillips' lecture was more than interesting to him as an old ambulance man. He asked if it was definitely possible for anybody to say within ten minutes after receiving a shock that that patient is dead, and it was useless to go on with artficial respiration. At the post mortem examination, would it be possible, he asked, by examination of the brain, to say whether death had been instantaneous from the electric shock.

He referred to the case of burns, and said that the yellow colouring was due to the effect of copper; in the case of steel conductors he had not had it. In the case of an electrical accident, or a short with an electric arc, some of those patent fire extinguishers had been used. He asked what would be the treatment for bringing round the apparently dead in that case. Should one then use the Sylvester method to try to get rid of the gas.

Mr. MacSHEEHY said it was most interesting to have a practical illustration of the treatment for shock. Of the ten causes of accidents in the author's schedule, one dealt with faulty equipment, and as far as design of equipment was concerned, a geat deal had already been done towards elimination of faults. The other nine causes were directly or indirectly dependent on the human factor. It was impracticable to cater for all the vagaries of human nature and for this reason it was impossible to prevent every accident and therefore all the more essential that the correct methods of curing the effects should be generally understood. With regard to septic cases his experience was that development of sepsis could be prevented if men strictly obeyed instructions and had the slightest wound dressed at the ambulance room immediately on its occurrence.

Mr. GRIFFITHS.—It would be quite a good thing if everybody understood, with regard to burns, that they should be more or less left alone, apart from the lint. Mr. Thomas had mentioned the qualifications of his staff as first-aid men, and he would like to see every man connected with collieries qualified in this respect. When appointments were made, preference should be given, other things being equal, to men with a First Aid Certificate. He suggested that Dr. Phillips' paper should be read in other districts so as to give it the widest possible scope.

Mr. T. MORGAN, Agent of the Amalgamated Anthracite Collieries Ltd., said that Dr. Phillips had read a paper of high standard, and he had listened to the lecture with a great deal of interest. Dr. Phillips could speak with authority on First Aid work in mines, and had done more work in that direction in the Amman Valley than any other doctor he knew of. His Ambulance Classes have been numerous and covering an extensive area. These classes were always well attended, and were continued over a number of years.

He, Mr. Morgan, had had a great deal to do with electricity during the last 26 years, he was in charge of one of the few first collieries in the Anthracite District to introduce electric power, and he was pleased to state that there was not a single accident due to electric shock. A few minor electrical shocks known to him were due to curiosity, or a case of little knowledge being dangerous.

He had his experience of the three months' National Strike in 1921 fresh in mind, when all persons in charge of electrical machinery, except the electricians in charge, left the mine, and were replaced by officials who were told exactly what to do, and what they should not do. During that anxious period, there was not a single breakdown, which went to prove how reliable electrical machinery was when properly treated.

Mr. Morgan wished to pay tribute to colliery engineers who were thoroughly well trained in these days, and who were doing their work well. The collieries depend largely on their electrical staff to keep going—breakdowns were very few, and he was glad of the opportunity of giving the electrical men their due.

He was pleased with the manner in which Dr. Phillips had read his paper, and agreed with Mr. Emrys Griffiths, that the lecture should be repeated in the various districts to those interested in First Aid work. It was an educative lecture, and would tend to obviate electrical accidents in mines.

Mr. ISAACS said he thought it would be helpful if the author could add some cases in which methods of artificial respiration had been successful. It would encourage a knowledge of the correct treatment and its prompt application. There was one type of accident very prevalent during his apprentice days, e.g., a shock to the eyes due to a flash in a comparatively dark place. The effect was that a man who had received such a shock was apparently no worse, but several hours later was in agony. If there was any first aid treatment he would be glad to hear of it.

Mr. JENKINS congratulated the Sub-Branch on the new ground it had broken in arranging for a lecture so totally different from the normal, and yet so vitally important. He did not think that any paper on the subject had been read during the last twenty years before any of the better known British engineering institutions and the only occasion on which he had listened to such a paper was at a pre-war meeting of the German Institution of Electrical Engineers. His recollection of that meeting was that the author said that muscular tissue was comparatively non-conducting and that the most highly conductive parts were the nerves and then the veins and arteries. He wondered whether Dr. Phillips could confirm that.

The demonstration of the Schafer method was extraordinarily interesting as he, for one, had never seen its actual application before. As electrical accidents occurred unexpectedly it was of the greatest importance that electrical men should not only be familiar with methods of artificial respiration, but should also be frequently drilled therein so that in the event of their services in this direction being called upon, they could deal with the situation with the promptness and self-confidence which were essential. For this reason he thought that mining electrical engineers should be compelled to become proficient in such first aid work as they might be called upon to undertake in the course of their duties.

Mr. Rees had raised the question of the discolouration of electric burns and wounds. Mr. Jenkins quite agreed that this discolouration must largely be caused by the vaporisation of the metal of the conductor with which the victim came into contact.

Mr. Jenkins asked whether anybody present had come across cases of shock or burns from industrial voltages which were accompanied by the peculiar body markings—the so-called arborescent markings—which it is said occasionally accompanied burns or shock from lightning.

Mr. C. E. YATES said that whilst listening to the paper, his conscience had pricked, and he was left with a sense of a duty neglected. The question which arose in his mind was: Is it not possible that we as mining electrical engineers, can take steps to ensure that any man who goes underground to carry out our instructions and repair and overhaul electrical machinery, shall have access to prompt and skilfull first aid treatment in the event of personal injury? If an accident occurs during the ordinary working shift there is usually an ambulance man available, but the greater part of our work is done at times outside the working shift, and in the majority of cases it would be difficult to get skilled attention without dangerous delay.

He would therefore suggest that the working electrical staff at our collieries should be encouraged to attend ambulance classes where they may at least become familiar with the approved methods of treating electric shock cases and also with the treatment of injuries due to mechanical causes.

The present system of having an emergency first-aid box in each underground district with the key in the keeping of the fireman would not meet such cases as he had in mind, and he suggested that in all districts where there is a permanent electrical installation, the first-aid box should be kept in the haulage or pump-house, with a key in charge of the electrician.

With the co-operation of the management, it should be possible to arrange for the electrical staff to receive the essential first-aid instruction on the collieries.

The working electricians are usually so poorly paid, that they cannot reasonably be expected to give their own time and money in order to gain a knowledge of ambulance work; and as no reasonable colliery manager can deny that the practice of skilled first-aid is of direct benefit to the colliery company, the company should be prepared to afford facilities for the training, not only of working electricians, but of other charge-hands, whose duties introduce the liability to accidents under circumstances such as those mentioned.

Mr. TANNER said that with regard to the comparative costs of electrical and other accidents, electrical accidents were nearly always fatal. There was no second chance with an electrical accident, and they must be prevented. The accident that is not fatal may be serious, may be expensive, and it may mean the ruin of a life. Some people, when they come near a live conductor, have an almost irresistible desire to touch it. Some of his assistants had told him that it had taken them years to get over the desire. It was only will power that prevented them doing so, and this may be a contributory cause of a large number of accidents.

As to the question of wet floors, particularly concrete, he asked why concrete should be singled out, and whether it had a higher conductivity than brickwork or masonry for instance.

With reference to a shock to the eyes, which is known as "flashing," it might be interesting to them to know a remedy for this: Epsom Salts in water for bathing the eyes, gives almost immediate relief.

He referred to the dearth of reliable information as to what actually occurs between the shock and death to the patient. He made a suggestion, which was afterwards proposed as a Resolution, that an examination question on First Aid should be incorporated in the Association's examinations.

Mr. TANNER proposed that this resolution should be forwarded to Headquarters.

Mr. ISAACS seconded the resolution, which was put to the meeting and carried unanimously.

THE CHAIRMAN referred to H.M. Electrical Inspector's Report, giving full details of the many and varied types of accidents occurring in mines, and he thought that each colliery electrician should have that Annual Report. They were fortunate last year in having a gentleman to present each member of the Sub-Branch with a copy. When Reports were sent to collieries, the Manager should see that it is handed to the electrician for his perusal and study.

Dr. PHILLIPS in reply to a vote of thanks, thanked the members for their kind references to his paper and the very helpful discussion they had had. In reply to the points raised, he said:

The treatment of electric shock by means of a counter shock as mentioned by the Chairman did not show good results and was now discountenanced.

The question of the relative effects of cardiac failure and respiratory failure was one on which there had been, and still existed, considerable discussion. There were two schools, one maintaining that 90% of deaths were due to cardiac fibrillation, while the other school maintained that failure of the respiratory centre accounted for the majority of deaths. It was said that cardiac fibrillation was more often present with low voltages, and respiratory centre failure, or inhibition with higher voltages.

The question of colouration of burns as described by Mr. Rees was interesting. Dr. Phillpis suggested that in steel conductors you get pelleting—small pellets of metal being driven into the skin—the strömarken described by German workers, and that this accounted for the black colour of the burns as opposed to the yellow colour when the conductor was of copper.

Dr. Phillips agreed with Mr. Rees that where the asphyxia was due to the use of a fire extinguisher the case was one of gassing and either Schafer's or Sylvester's method of artificial respiration could be used.

In reply to Mr. D. Jenkins as to the relative conductivity of various tissues of the body, Dr. Phillips stated that this was the order: Blood vessels and nerves, muscles, skin, tendons, fat, and bones.

With regard to "flashing," Dr. Phillips stated that he did not think it mattered what lotion was used to bathe the eyes. The important thing was complete rest for the eyes either by use of pads or a dark room.

The higher conductivity of concrete he suggested was due to its porosity and retention of moisture.

The question of differentiation between electric shock and ordinary shock in the case of a linesman found unconscious at the foot of a ladder would be the absence of breathing in the former, presence of breathing in the latter.

Finally, he agreed most emphatically with several of the speakers that a knowledge of First Aid was imperative for all electrical workers and that frequent practice in methods of resuscitation was essential.

DONCASTER SUB-BRANCH.

The Electrical Engineer at a Modern Colliery.

C. C. BLEACH, Wh. Ex.

(*Paper read 21st December* 1929.)

Most people have either read or heard of Kipling's "If," the first two lines of which run:—

"If you can keep your head when all about you
Are losing theirs, and blaming it on you"

These lines always remind the author of the present plight of the electrical engineer at a colliery—always being blamed, rightly or wrongly, for stoppages, and being the general scapegoat of the other departments, but in spite of all, in the majority of cases, keeping his head and getting things going again with the least possible delay.

In view of the great responsibilities of the electrical engineer at a modern colliery, he is entitled to as much respect as is accorded to the manager and the mechanical engineer, and it is with the idea of proving this contention that the author has put this paper together.

Great progress has been made in recent years in the application of electricity to mining, and whereas but a few years ago it was considered very daring to light by electricity the pit top in the immediate vicinity of the shafts, now it is fast becoming the standard practice to take E.H.T. cables down the shaft for actual use in the mines themselves. One has only to refer to the Annual Reports of H.M. Electrical Inspector of Mines to realise how rapid is the growth of the use of electrical energy in pits.

Such rapid advancements demand considerable scientific and technical knowledge on the part of the engineer who has to design, instal, test and maintain efficiently the electrical circuits as occasion requires, if economy, efficiency and safety are to be maintained. It may be taken for granted that most mining electrical engineers have little to do with the design of the generators and motors, and that, as the cost of the conductors of the electrical energy generally exceeds that of the generators and motors the transmission and distribution portion is in reality the most important element of the whole system of the supply of electrical energy—which includes generation, transmission, and utilisation; it is on the two last mentioned that the notes in this paper deal with more particularly. It will, however, be as well in the beginning to consider all these items individually, and examine them briefly.

Generation.

Most modern collieries will have their own generating plant, as with boilers installed originally for winding purposes, a certain amount of exhaust steam will be available for this purpose. At many collieries, however, electric winders will now have been installed, when, according to local conditions, the supply of electrical energy will either be generated on site, such as by the Metropolitan-Vickers S.P. system, or bought from some outside source.

Assuming first the colliery concerned is generating its own electrical energy—either by exhaust steam from the winding engines, fan engines, compressor engines, etc., or from high pressure steam, direct from boilers, or partly from each—it is surely essential for the electrical engineer to have a working knowledge of boiler plants, the firing of boilers, and a smattering of fuel knowledge, as well as a knowledge of the engines or turbines driving his generating plant, otherwise he is quite unable to formulate any intelligent idea as to his generating costs, or whether such costs are the best obtainable with the plant available.

It is not intended to suggest that the electrical engineer should control the mechanical engineer as regards boiler and steam plant; at the majority of collieries there is room and work in plenty for both electrical and mechanical engineers, but the electrical engineer should have knowledge of such things, and should collaborate freely with the mechanical engineer on such matters which affect his own department so closely. At the moment, generally speaking, there is a definite line of demarcation between what shall be deemed to be the province of the electrical man and that of the mechanical man. This is fundamentally wrong, and shews clearly that neither has had the requisite training and early tuition which would automatically eradicate this evil.

In the case of a colliery taking a supply of electrical energy from an outside source, the electrical engineer must be capable of negotiating with the Power Supply Company or Public Supply Company for the necessary supply, on such terms as shall be as advantageous to his own Company as possible, whilst at the same time recognising that the Supply Authority has to make a reasonable profit and has other obligations to meet, besides those immediately concerning his own Company. Also, if he be on a two part tariff scale, he must so arrange the running of his electrical energy consuming plant as not to raise to an excessive figure his maximum kva. Demand.

Transmission.

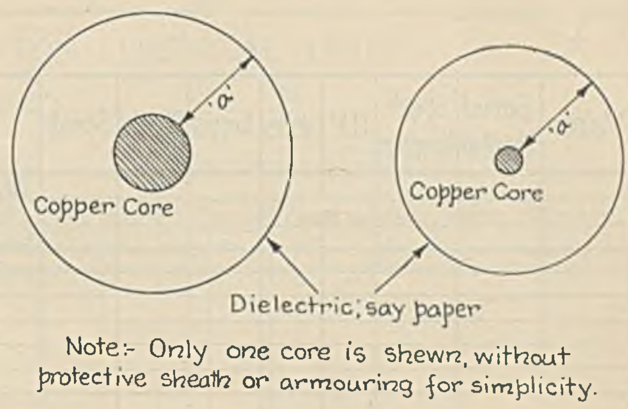
As previously stated, this will constitute the main theme of the electrical engineer's life at his Colliery. He has to know, when laying out schemes necessitating the use of electrical cables, the best type of cable to use under certain conditions; and also to remember that, although from an initial cost point of view, the smallest size of conductor to enable the required load to be carried must be chosen, yet the mechanical strength of such a cable may not always be compatible with safety, nor may the temperature rise obtained by working this small size conductor, due to its resistance and position always be found to be satisfactory. Perhaps the point as to mechanical strength may not be readily understood, so it might be elaborated a little.

In Fig. 1, "a" represents the dielectric thickness as recommended by B.E.S.A. for a certain voltage cable, say, of paper insulation with a core of size indicated by the black circle.

In Fig. 2 a very much smaller conductor is shewn, but the dielectric thickness "a" has to remain the same for a similar voltage though it will readily be seen that a cable made up of cores as shown in Fig. 2 will not be nearly so strong mechanically, that is, when handled and bent, as the cable made up of cores as in Fig. 1. It is therefore the author's opinion that it is entirely wrong to have too small a conductor in an E.H.T. cable for use below ground, where it is well known the amount of handling it has when being installed is usually none too gentle; and he would personally suggest on, say, 3300 volts the smallest size conductor which should be used underground on all long runs should be 0.04 sq. in. sectional area—in fact he is almost tempted to give 0.06 sq. in. as the limit.

It must, when considering E.H.T. cables, be also remembered that heat is generated in the dielectric by hysteresis, and also that "skin effect" will affect temperature rise in large conductors unless they are hollow cored.

Many electrical men will resort to a table of current carrying capacities, figures for which are given for single cored rubber insulated cable, in order to arrive at a suitable size cable for use on a three-phase a.c. circuit, with some entirely different dielectric (such as paper or bitumen); and will base their enquiries to manufacturers on such figures. That is, of course, a method to be condemned, and it is strongly advised that any electrical engineer who entertains the slightest doubt as to the most suitable type and size of cable to be used for certain working conditions should approach the engineer of one of the reputable manufacturing firms of cable makers, putting all the facts of the case before him. After all, why should mining electrical men be ashamed to make use of the manufacturers in this way—they spend thousands of pounds every year on research work and so surely should be in a position to know



Figs. 1 *and* 2.

more about cables than the ordinary hard working man who has quite enough to do with carrying out his own arduous duties without attempting to experiment seriously in this particular line.

In addition to transmitting the electrical energy from the generators to the points of utilisation, the colliery electrical engineer is often called upon to erect or supervise the erection of transmission lines, either overhead or underground in order to give supplies of electrical energy to small works, pumps, villages, etc. in the near vicinity of the colliery, when a knowledge is required a little more extensive than that required for the colliery distribution scheme, as he has to be conversant with the Rules and Regulations of the Electricity Commissioners and of the Local Authorities, etc.

He also has to have a working knowledge of various tariff charges for electrical energy, and has so to arrange agreements and prices with the would-be consumers as will enable him to shew to his management a reasonable profit on the undertaking, whilst at the same time keeping the prices to the consumers down to reasonable limits. Here it is necessary to impress upon him not to lose sight of the fact that the interest and depreciation on the capital cost of the cable and apparatus required to give such a supply is not the only factor to be considered, but that this item must be taken together with the cost of the energy dissipated in the cables and apparatus.

For instance, in the case of lighting a colliery village involving the use of a transformer it will be remembered that a transformer having a low iron loss at the expense of a trifle higher copper loss is advisable, as the "light load" hours of running far exceed the "heavy load" hours of running.

Utilisation.

Under this heading is included all the apparatus which converts the electrical energy as carried by the distributing cables to some other form of energy, which includes all motors, radiators, lamps, etc. Here again, the author considers that the electrical and mechanical engineers must work closely together, it not being sufficient for the latter to say, "Look here, we are putting down a haulage gear on the North West Plane and you had better get a motor of such and such a size and speed." How often do we find that on such a motor being installed it is hopelessly too small for the work it is called upon to do, or else it is much too large and runs with an atrocious Power Factor. The two engineers should collaborate, and on learning from the manager exactly what duties the haulage gear will have to fulfil, then carefully examine the job together and work out the size of gear and motor required, one checking the other's figures and deciding as a joint body the best type of gear and motor to employ to give as little trouble as possible to all concerned.

Another important point also, is that the electrical engineer must have an important "say" in the purchasing of all electrical equipment. There is so much more at stake than the initial capital cost of a new

MOTOR No 100

Maker	Serial Number	Specn Number	H.P.	Volts	Amps.	Phases	Speed	Type	Class	Diam of Shaft	Length Shaft Extension	Pulley Size	Megger Tests Stator	Megger Tests Rotor
								Slip Ring	Totally					
								—	Enclosed					
								Squirrel	—					
								Cage	Enclosed					
								—	Ventilated					
								etc.	—					
									Tube					
									Ventilated					
									—					
									etc.					

Fig. 3.

piece of electrical apparatus such as an oil circuit breaker, motor, or static transformer, and the author's experience proves that the loss accruing over a period of years through the installation and use of a relatively cheap article would often have justified the expenditure of much more capital in the first place and a rise in the electrical engineer's salary as well.

It is a great pity that at many collieries the purchasing of all materials is undertaken by a person having no technical knowledge whatsoever, but only a desire to approach his Chief every now and again and say, "Look how much money we have saved by buying from so and so", when, if the true facts of the case were known and presented, would probably entitle that person to instant dismissal for ruthlessly wasting his Company's money.

The only sane way in which to buy electrical apparatus is to weigh in the balance the relative maintenance costs over a period of years of the apparatus made by different manufacturers and to buy from the one shewing the least total cost, when it will be found nine times out of ten that the price of the article so bought may even be less but will certainly not exceed by a very appreciable amount the price of the inferior and shoddy article. This entails a certain amount of experience on the part of the electrical engineer, and correct early training.

THE WORK OF MAINTENANCE.

All the foregoing duties are but the preliminaries of the fully qualified electrical engineer's job, however, and by far the most important work constitutes the arranging of periodic inspections and tests on existing plant, in addition to maintenance, repairs and renewals, and this he must do :—

1. Comply with the requirements of the Coal Mines Regulations.
2. Ensure that all his plant is working in the most efficient manner, so cutting down his costs and minimising the risk of breakdowns.

As at a modern colliery the electrical engineer cannot hope to inspect personally all his plant himself even perhaps once per week, it is incumbent upon him to adopt some system whereby he can keep all matters pertaining to his job at his finger ends, and to this end the author presents some systems of recording, etc., which if adopted even to some limited extent will materially help in making the electrical engineer's task more pleasant and easier, while at the same time giving him means to answer any questions or solve problems regarding the plant, men, and work.

Records.

In the first place every electrical engineer at a colliery will have some form of log book in his Power House (i.e. Generating Station) for logging details relative to the generation of electrical energy, and to the consumption at and around the colliery premises, the main items which should appear on such a book are :—

Time./Date./H.P. Steam./L.P. Steam/Amps./Volts./K.W. Cycles./Power Factor./Watt Meter Readings./Exciter amps./Exciter volts./Lubrication details./No. and size of Set(s) running./Stores used./Station Attendant./Testing of Tripping Circuits for Feeder Switches/Testing of Emergency Lights/and any other information considered necessary according to local conditions.

................COLLIERY

MOTOR No 100

Date Installed ....19 ...Where Installed ....

Date	Locality of Motor	Cleaned or Blown out	Repairs, if any	Rotor Clearance	Remarks	Examiner
March 17/29	P.T. Sawmill	Examined	New pulley end	30/100	Winding Dry	
			bearing fitted	28/100 — 38/100	Condition	C.R. Smith
			(Ball bearing		generally good	
			'Skefco' No.)	25/100		

Fig. 4.

WEEKLY REPORT OF TESTS FROM ELECTRICAL PLANT.

at ________________ Colliery ______________ 19 __

SURFACE ____________ Electrician

Particulars of APPARATUS	Insulation Resistance to Earth						Insulation Res. between Phases						State whether higher or lower than last test, and cause
	Megs.	Ohms	Megs.	Ohms	Megs.	Ohms	Megs	Ohms	Megs.	Ohms	Megs	Ohms	
Generator No. 1.													
Stator													
Rotor													
Generator No. 2													
Stator													
Rotor													
Transformer No. 1													
Transformer No. 2													
etc													
No. 1 Cable													
No. 2 Cable													
No. 3 Cable													
etc.													

Note:- For cables, locality of same must be written on report sheet by examiner.

Suitable space for Remarks

Countersigned :- ____________ Electrical Engineer.

Fig. 5.

WEEKLY REPORT OF TESTS FROM ELECTRICAL PLANT.

at ________________ Colliery ____________ 19 __

UNDERGROUND ________________ Electrician

Particulars of APPARATUS	Insulation Resistance to Earth						Insulation Res. between Phases						State whether higher or lower than last test, and cause
	Megs.	Ohms	Megs.	Ohms	Megs.	Ohms	Megs.	Ohms	Megs.	Ohms	Megs	Ohms	
Substation													
H.T. Switchgear													
M.T. "													
H.T. Transformer No. 1.													
H.T. " No. 2.													
M.T. " No. 1.													
M.T. " No. 2.													
L.T. Transformer													
Lighting Circuits													
Drift Sub. Switchgear													
etc.													
No. 1 Cable													
No. 2 Cable													
No. 3 Cable													
etc.													

Note:- For cables, locality of same must be written on report sheet by examiner.

Suitable space for remarks.

Countersigned :- ______ __________ Electrical Engineer

Fig. 6.

WEEKLY REPORT OF TESTS FROM ELECTRICAL PLANT.

at.................... Colliery .... 19..

MOTORS .... Electrician

MOTOR, Particulars of	Insulation Resistance				State whether higher or lower than last test and cause
	Stator		Rotor		
	Megs.	Ohms.	Megs.	Ohms.	
Nº 1 Nº 2 Nº 3 Nº 4 Nº 5 Nº 6 etc stating locality of motor in each case.					
	Suitable Space for Remarks		Countersigned - .... Electrical Engineer		

Fig. 7.

Details should also be kept daily of the energy consumption of all important jobs, such as electric ventilating fan, air compressor, washery and screening plant, motor generator and supplies to outside consumers; also, if interconnected electrically with other collieries or Power Supply Undertakings, a daily record of "incoming" and "outgoing" units, together with a note of the "Maximum Demand" recorded (if fitted), and any other information that may be considered necessary.

Next we come to the electrical plant about the colliery premises. Here it is well to instal and keep up regularly an efficient filing system; for instance, a new motor arriving in the stores should immediately have a number allocated to it, which number will remain so long as that motor is in existence at that particular colliery. This number should be painted or stencilled on the motor in a conspicuous position. For example, should this motor be the 100th which has arrived at this colliery, give it the number 100. Full particulars of the motor should then be entered on a sheet or card in the filing system giving the particulars as shewn in Fig. 3.

In addition to the above, a note should be made of the clearances between rotor and stator taken at four equally spaced points around the circumference of the rotor. This is most important, as after the motor has been working some time, any alteration in these clearances will usually indicate wear in the bearings, which if not taken in time might mean disaster to the motor and time wasted in a "stoppage". The taking of these clearances should therefore be done regularly and carefully logged, together with the usual megger and bridge tests, and periodic inspections of sliprings.

One set of such files should be kept for apparatus actually in service and one for apparatus in stock. Another point worthy of mention is that it is desirable, if a quantity of motors of various sizes are in use at the colliery, that all should be carefully measured and notes made in the files indicating which of the motors in service can be replaced by those in stock without any or very little alteration. In this way it is sometimes found that a 15 h.p. motor will stand spare to some 10 h.p. motors as well as for motors of its own size, and so on; thus economising in spares.

A similar set of filing sheets or cards should be adopted with static transformers, motor starters, resistances and line switches. Such sheets or cards facilitate the ordering of spares and save much time and labour in the long run.

Another set of sheets, preferably in book form, should be kept in which can be entered the dates on which all of the above apparatus was put into service and where, and also the results of the periodic tests and examinations, and any parts renewed, and for what causes, see Figs. 4, 5, 6, and 7. Thus a complete history and, if considered necessary, cost, of each item of electrical apparatus about a colliery can be kept. Such a system helps in no small measure to find where a little extra attention would pay, where one make of apparatus is better than another on maintenance costs, and where extra heavy working conditions are experienced, and will altogether prove most interesting and instructive to the engineer in charge.

Frequency of Inspection.

We are now brought to another point on which no definite ruling is laid down in the C.M. Regulations, namely, as to how often electrical apparatus shall be inspected, and the author would suggest the following as meeting the needs of most collieries, taking the periods given as being the maximum permissible and subject to alteration according to local conditions of the items concerned:—

YEARLY.

Power House Switchgear.
Power House Transformers.
Transformers other than those in Power House.
Underground Sub-station Switchgear.
Village Sub-station Apparatus.
Joint Boxes on Shaft Cables.

Note.—Oil should be changed in all switches where switching operations are frequent, and transformer oil should be tested, and if possible filtered.

..............................COLLIERY.

REPORT ON ELECTRICAL PLANT UNDERGROUND

Shift.................. Date ....19....

	Medium Tension			Low Tension			Wattmeter Units
Leakage Indicator	A	B	C	A	B	C	
Voltmeters	E.H.T.			L.T.			
	M.T.			Signal Battery			
Cables							
Earth Conductor							
Switchgear							
Motors & Transformers							
Lighting							
Signals							

Suitable space for Remarks.

Signed:- .... Assistant Electrician

Fig. 8.

SIX MONTHLY.

All Medium Tension Distribution Boards.
All Lighting Distribution Boards.
Stores, Cranes, etc.
Overhaul all Lighting fittings.

Note.—All fuses should be renewed at least once per year as they "age" considerably.

QUARTERLY.

All Motors (which should have a thorough examination).
All Switches and Starters not mentioned above.
Shaft Signalling Apparatus.
All Earth Bonds.
Leakage Relays, etc.

MONTHLY.

All Leclanché Batteries.
Screens, Washery, and Signal Apparatus.
Motor Clutch Pulleys.
Liquid Starters.
Sand Buckets, Fire Extinguishers, etc.
Motor Couplings.
Shaft Pumplodge Apparatus (i.e., water level recorder, etc., if any).

In addition to the above the following tests should be made:

YEARLY. Bridge test of all cables.

MONTHLY. Resistance test of cable joint box bonds.

WEEKLY. Insulation tests of all apparatus.

The foregoing are purely suggestions and must be altered or revised to suit the needs of the Colliery under review.

Records of all such tests should be kept: they will definitely reduce the risk of breakdowns to a minimum and enable the mining electrical engineer to run at least his department at the Colliery much more efficiently than without any such system.

One of the most interesting records it is possible to keep is that of the size, position, and number of lamps used at a colliery. Such a record gives definite comparative information as to where the most lamps are consumed (perhaps through pilfering or excessive vibration, when the necessary steps to overcome the trouble can be taken), and enables one to keep stocks at such an economic level that a rush can be catered for and yet without being overstocked. In the same way full particulars of all fuses installed should be kept.

The next matter to be considered is the filling up of the daily report sheets by the electrical engineer of the colliery as required by the C.M.R. This form or report sheet is at present in a totally inadequate form, but the author understands it is to be revised very shortly.

The filling of this form absolutely binds the electrical engineer and makes him irrevocably responsible for the safe working condition of all the electrical apparatus in and about the colliery. At a large modern colliery it is a physical impossibility for this one person to examine or even visit all the electrical plant once in every twenty-four hours, and it is therefore incumbent on him so to arrange the working of his staff as to ensure that all the plant is visited by a competant electrician who shall report to him at the end of his shift in writing, thus enabling him to fill in the form conscientiously and with confidence.

Regarding the underground staff, the author would suggest that there should be a foreman electrician who should work "days" only and be responsible for finding employment for all electricians and mates on all

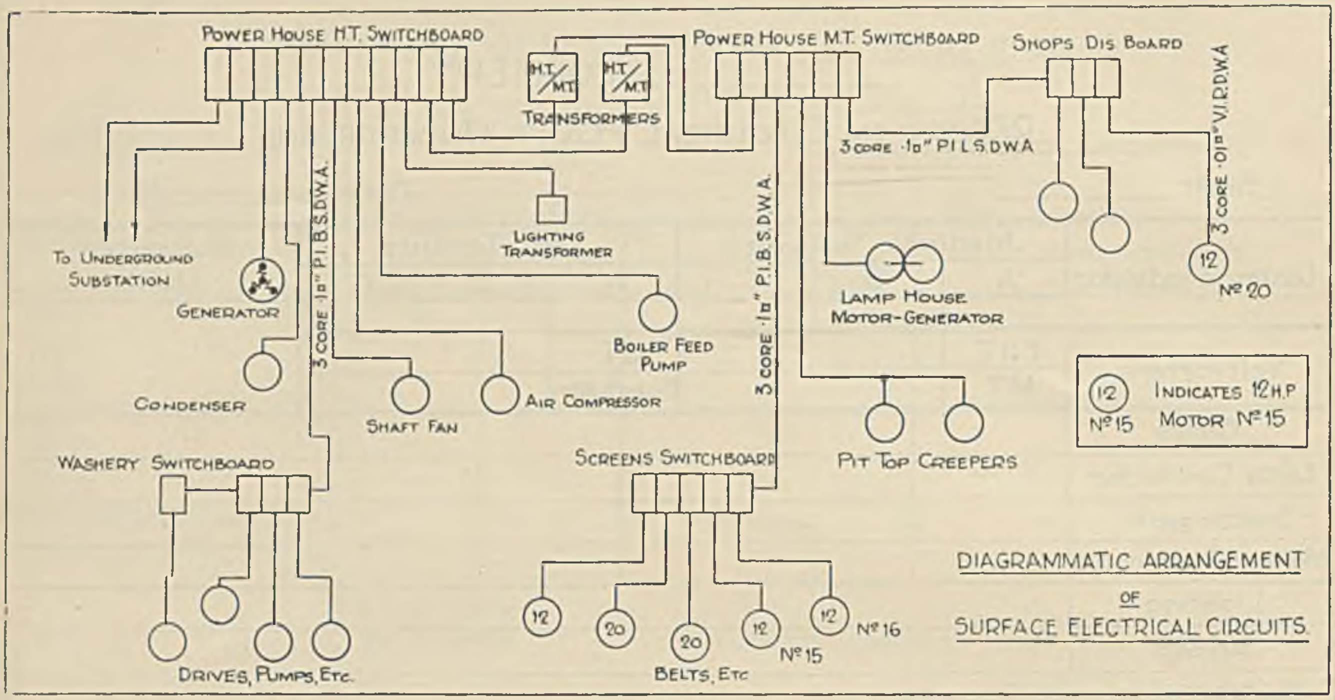


Fig. 9.

shifts, allocating their duties, and seeing that they carried them out. Each electrical man working below ground should be required to fill in and hand to the shift electrician a report sheet similar to Fig. 8 which is passed on to the electrical engineer, so enabling him to keep his filing system up to date and to cover him for signing the statutory form.

A great number of pits have a very small underground electrical staff, which is supplemented for the purpose of examining and erecting plane signals and telephones, by a number of semi-skilled men known as "Bellmen" or "Wiremen" who usually come under the jurisdiction of the undermanager. This is, the author considers, entirely wrong and the whole of the electrical apparatus both below and above ground should come under the direct control, both as regards erection and maintenance, of the electrical engineer. The majority of managers and mining people generally seem to think that signalling is a "mugs" game, and that there is no need for experienced men to work on such things, but as doubtless most members are aware, various experiments have recently been carried out at the Mines Department Experimental Research Station at Sheffield, and startling results declared which have brought to all electrical men's notice the extreme importance of signalling in the pit. In this connection the author might add that his Company have been experimenting and designing apparatus (in conjunction with a manufacturing firm in this connection) and a system of underground signalling has been devised by one of the Company's staff, which the author ventures to suggest is the only safe signalling system in use for fiery mines, and which will, he hopes, form the subject of a paper shortly.

Regarding the surface, the electrical engineer will personally be able to supervise most of the work, but he should have an able "first lieutenant" to relieve him without anxiety in cases of need, such as illness or holiday.

Many of the larger groups of collieries have been interlinked electrically for various reasons, and in some instances a chief electrical engineer appointed, but the author maintains that in all cases of emergency such as breakdowns, the colliery management, to avoid delay, are compelled to rely on their permanent staff engineers who are on the spot and so reduce the inevitable money loss to the colliery.

Qualifications.

Thus it is ever becoming more important that there should be laid down some definite standard of technical knowledge and experience for the qualification of a colliery electrical engineer. There can be no doubt that before the passing of many years this will have been brought about, and the mining electrical engineer will have to hold some recognised certificate before appointment. This will undoubtedly be better for the industry as a whole; in the meantime it is essential that the training of youths entering service in the electrical department at any colliery should be carefully considered and carried out in order to qualify them for the posts of responsibility as they fall vacant.

Criticism will, no doubt, be levelled at the author for suggesting that colliery electrical engineers should be capable of and expected to do so much recording work, but he feels confident that any such system will make for the betterment of the coal trade, the profession, and the individual, and merely necessitates the correct training of the young men.

Regarding the older and more established electrical engineer, it is suggested that he adopt some part of such a scheme, and so discover for himself how much easier and more interesting it tends to make his task. An hour a day at records will see most of them correctly entered—but do be sure that all systems are kept up to date day by day. Should any records be left but a day the obstacles arising to prevent making up the lost time will be found to be legion, and the system will then probably be blamed.

Plans of Installations.

There is just one other matter to be mentioned and that is the making and keeping up to date of plans of the electrical installation at collieries. There should be "line" diagrams for both surface and underground equipment shewing the size and type of each cable, so that it can easily be checked how any particular cable is loaded, see Fig. 9 and Fig. 10 for the principle of this idea.

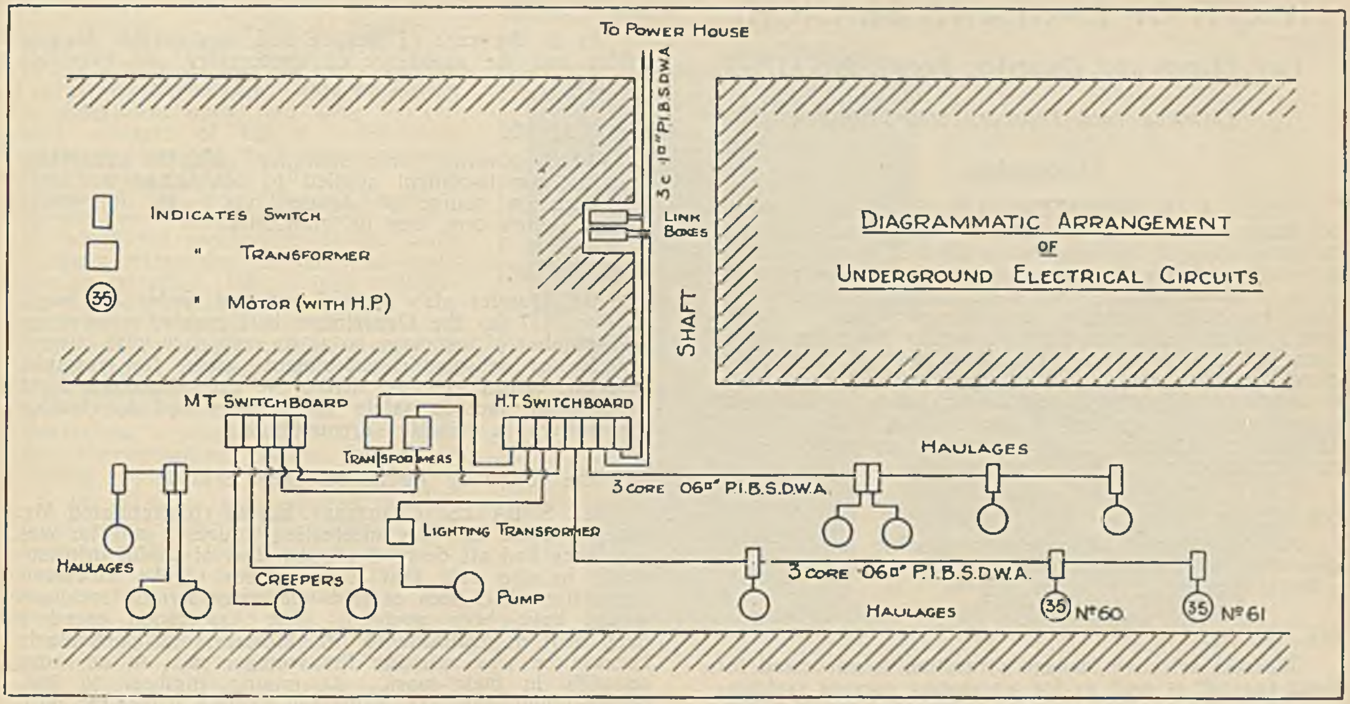


Fig. 10.

In General.

It will have been noticed that throughout this paper the author has referred to the electricial engineer of a colliery and not to the "electrician." This has been done purposely as surely with the ever-growing importance of the applications of electricity to mining, a bellman or wireman is not sufficiently educated in the science of electricity to carry out all the many duties at a colliery with efficiency and celerity. A fully qualified technical engineer in the fullest sense of the word is required and as managements gradually awaken to this fact, so will the status of the electrical engineer at a colliery be raised. It is the duty of each and every mining electrical engineer to keep himself up to date in all matters electrical, to make himself indispensable to the colliery management; even to the extent of a little "trumpet blowing" occasionally, and to take part in the training of youths and young men in the right manner.

In conclusion the author would like to revert to the opening sentence of this paper, with its reference to Kipling's "If" and merely say that the ending to that poem may, as applied to the colliery electrical engineer be held as true as the beginning, for Kipling says:—

"If you can fill the unforgiving minute,
With sixty seconds worth of distance run,
Yours is the earth, and everything that's in it,
And which is more—you'll be a man, my son."

Discussion.

THE CHAIRMAN in opening the discussion thanked Mr. Bleach for his excellent paper and considered the diagrams particularly interesting. He considered he had defined the duties of an electrical engineer at a modern colliery very clearly. The diagrams in his opinion were vary useful, and well worth the extra work it entailed in making them up . They would perhaps require modification to suit individual cases. He was not quite in agreement with the periods fixed for examination of switchgear being of the opinion that no switchgear whether being operated or not should go twelve months without being opened out. Six months he thought was quite long enough.

With regard to motors particularly of the ball bearing type, it was better that the same be not opened out too frequently as dirt and grit were apt to get into the bearings and as a matter of fact if the housing was packed with grease when the motor was built up, no further grease was required except in cases where the bearing caps were worn.

Turning to the matter of earth bonds the Chairman said this to his mind would be quite often enough if done every six months, as to test more frequently would probably entail an increase in staff; and, generally speaking, a properly bonded box or gear should not give any cause for trouble for a number of years except in extreme cases, but he agreed that systematic supervision was essential.

Mr. BLUNT was of the opinion that records should be kept of every part of an installation from its inception as he had found from experience that much time could be saved by the man in charge if he adopted record keeping in a systematic manner. In fact stores could be ordered without carrying a large amount of surplus gear and material and so save a fair amount in capital each year that may otherwise be wasted.

Mr. MORRIS proposed a vote of thanks to Mr. Bleach for his paper and considered that the paper would be an asset to the Proceedings of the Association.

Mr. MANN seconded the vote of thanks and pointed out that it was rather difficult to take all the tests which should be taken at a large colliery, as much of the apparatus was in constant use. He also asked Mr. Bleach if he would supply him with copies of his record sheets.

Mr. BLEACH in his reply said it was not intended to lay down any hard and fast rules regarding what should be the practice at each colliery but to endeavour to adopt a system of record keeping that would keep the electrical engineer in touch with the whole of the plant under his charge and also comply with the Mining Regulations. Modification would perhaps be necessary, particularly in the smaller collieries, but he felt that any effort and time spent on record keeping and testing would be time well spent.

NORTH OF ENGLAND BRANCH.

The Mines and Quarries Form, No 11.*

(*Meeting held February 8th,* 1930.)

Discussion.

Mr. J. A. B. HORSLEY, H.M. Electrical Inspector for Mines, opened the discussion. He pointed out that the last edition of this book was published in 1924 and that in the new edition the comments were no longer referred to as a Memorandum, but were entitled "Explanatory Notes by H.M. Electrical Inspector of Mines". While these "Notes" did not differ materially from the advice given in the previous Memorandum the opportunity afforded by the necessity for reprinting, had been taken to emphasise slightly certain requirements in the light of the experience gained in the interval. He directed attention in particular to the comments upon the following Regulations :

Reg. 125 (*a*)

As to degree of safety obtainable by earthing apparatus and the need for prompt automatic isolation of a faulty circuit, in relation thereto.

Reg. 128 (*c*).

Wherein selective leakage protection is advocated for direct current as well as for alternating current systems; split conductor protection being suggested for duplicate shaft feeder cables.

Reg. 130 (*a*).

In which types of flexible cable for portable and semi-portable apparatus were discussed and the desirability of a British Standard Specification is suggested.

Reg. 130 (*b*).

Where the application of mechanical and electrical interlocks with plug connectors is referred to.

Reg. 131 (*c*).

In which, at the special request of this Association, the position as to Section 66 of the Coal Mines Act, 1911, is explained and detailed suggestions are made as to the frequency with which the detailed examination and test of electrical equipment should be made under the terms of Reg. 131 (c).

Reg. 131 (*d*).

Refers to the Log Book and Mr. Horsley explained that it had not been found practicable to prepare a book that would meet all needs but that, as an experiment, H.M. Stationery Office had printed an alternative book in which double the space had been provided for the entries, and the heading for remarks had been restored, as desired by this Association.

Reg. 131 (*g*).

Wherein the importance is stressed of making structural provision for earthing the conductors of a circuit before handling them and in which it is suggested that this earthing should always be made through the medium of a suitably adapted switch or circuit breaker and never by dangerous improvised methods, such as by "flicking" conductors that are presumed to be dead.

Reg. 131 (*i*).

As to the care of flexible and semi-flexible trailing cables and the avoidance of unnecessary and excessive lengths.

Reg. 132 (*l*).

Which governs "open sparking" and the suggestion that by remote-control applied to coalcutting machines one common source of danger, viz. :—an improperly closed switch box, can be eliminated.

Reg. 137 (*a*).

Mr. Horsley also pointed out that under the terms of Reg. 137 (a) the Department had granted exemptions in a number of instances, so as to keep pace with current practice or reasonable experiment; such, for example, as small cables for coal drills, the use of electric light at the coal face in safety lamp mines and for trolley locomotives in suitable surroundings.

The following discussion then ensued.

Mr. S. BATES (Chairman), having congratulated Mr. Horsley upon his very interesting address, said he was sure they had all derived a good deal of useful information ; he also said that it was clear if Mr. Horsley's suggestions had been carried out many serious accidents would have been avoided. The Association owed a deep debt of gratitude to Mr. Horsley, and particularly because he was assisting the younger men to be more scientific in their work. As mining engineer to four colliery companies, Mr. Bates had become acquainted with the type of man engaged in colliery electrical work thirty years ago and knew the better type of man employed to-day, amongst whom were some of the best brains. To-day, the work was almost entirely electrical; he could not recall a single instance for many years where they had had to send an urgent call to the mechanical engineer, but he had in mind many cases when the electrical engineer's services had been essential.

Mr. T. GREENLAND DAVIES, speaking as a Divisional Inspector of Mines, said he would just like to say how very pleased he was to see Mr. Horsley at the meeting and to hear him explain certain points arising from the new Edition of the Electrical Regulations. He, himself, did not propose to say anything as to those Regulations but he did hope the members would take the opportunity of getting all the information they could from the electrical expert so that they would have a clear understanding of the Departmental point of view.

Continuing, Mr. Greenland Davies thanked the members for their kind invitation to the meeting; he congratulated them on the very live body the Association appeared to be, and wished it every success.

Mr. H. W. CLOTHIER.—When Mr. Horsley first picked up his revised book of recommendations he said we would notice it had a "stiff-backed" cover. Mr. Clothier did not know whether that remark might possibly be construed as indicative in some way of the contents of the book, but he considered there was nothing stiff-backed, impossible or difficult, in the recommendations made therein. Some of the developments pioneered in this district, for instance, the old core balance leakage protection, flame-proof flange enclosure, and electrical interlocking, were now well established in colliery practice, and the British Standard Plug, Spec. No. 279, and flitting connections were rapidly following suit. Split conductors for duplicate pit shaft cables were recommended.

Mr. Clothier believed Mr. Horsley was very wise in earthing all parts irrespective of the voltage. As Dr. Thornton had indicated, the resistance of a man's body was mainly on the surface or skin, and Mr. Clothier thought Dr. Thornton ran some risk when he experimented with 360 volts because if the skin had happened to break down he would not be alive to tell the story. In this connection there was a very interesting paper in

* *General Regulations as to the Installation and Use of Electricity* (*in Mines*), with Explanatory Notes by H.M. Electrical Inspector of Mines. Mines and Quarries Form No. 11. Mines Department, H.M. Stationery Office Price 6d.

the January, 1930, Journal of the American Institute of Electrical Engineers, reporting the results of an investigation of the effects of electric shock on the central nervous system. Rats were used to experiment upon, and were shocked with voltages of 110 to 1000, both alternating current and direct current, for varying lengths of time. The effects of the two different kinds of circuit were very marked, and shewed an interesting cross-over; at the lower voltages alternating current was deadlier in its effect, but at high voltages the opposite relation was found. The same paper recorded that in the United States approximately 50 per cent. of the electrical accidents were fatal, and the death rate from electricity was 0.9 per 100,000 population. It would be interesting to compare this figure with the corresponding figure for Great Britain.

Mr. Horsley had referred to electrical interlocking. Mr. Clothier said he considered it to be right to make the apparatus which controls the trailer in such a form that when the plug was removed at the load end the contacts inside the plug became dead. This was effected by interlocking with the circuit breaker. The electrical interlock system was suggested by Mr. Fisher in 1908 and at that time several sets were made for controlling coalcutters, but there was no market because they were too expensive. Now, largely owing to the greater appreciation of the operating requirements of electricity brought about by these Regulations and by the work of the Association of Mining Electrical Engineers, there was a different state of affairs existing and it was more realised that the higher first cost was justifiable.

As regards earthing cables when men are to work on them nobody on any ordinary power supply system would allow work to be done on a cable without a visible earth on the actual conductor upon which the men were working. The further earthing of that conductor by closing the circuit breakers at both ends through a properly designed earth connection also seemed essential for safety. Such a design made many years ago was being used by a number of collieries, but it must be admitted it was by no means in universal use. Perhaps it was a little troublesome to put the apparatus on to the circuit breaker, but it could be done if tried as a regular job.

Fig. 1 shews a standard switch unit with the circuit breaker withdrawn in the ordinary way, and indicates the limits of the withdrawal set by stops on the circuit breaker and the standard slide-bars. Fig. 2 shews a similar switch unit with extension slide-bars fitted, so that the circuit breaker may be withdrawn to a greater extent than the normal. This allows the fitting of a row of special extension plugs, and, when the other row of plugs, left at their ordinary length, have been connected to earth, the pushing-in of the circuit breaker prepares the cable for being earthed on the closing of the circuit breaker contacts.

There was one point about which he would like to question Mr. Horsley. Given this apparatus on the circuit breaker so that the cable to be worked upon could be earthed through the circuit breaker, remembering that in addition the earth could be made also on the cable where men were working, is it necessary to lock-off the tripping apparatus to prevent the circuit breaker tripping out accidentally? It was rather inviting mal-operation to have a lock-out device fitted, because the breaker might be locked out at the wrong time on account of forgetfulness. If it were thought to be too great a risk to allow the automatic function to remain on the switch when in the earthing position, an alternative would be to take the circuit breaker off the panel and substitute for it a non-automatic earth circuit maker.

A design of one such earth circuit maker is shewn in Figs. 3 and 4, one of which is an elevation, and the

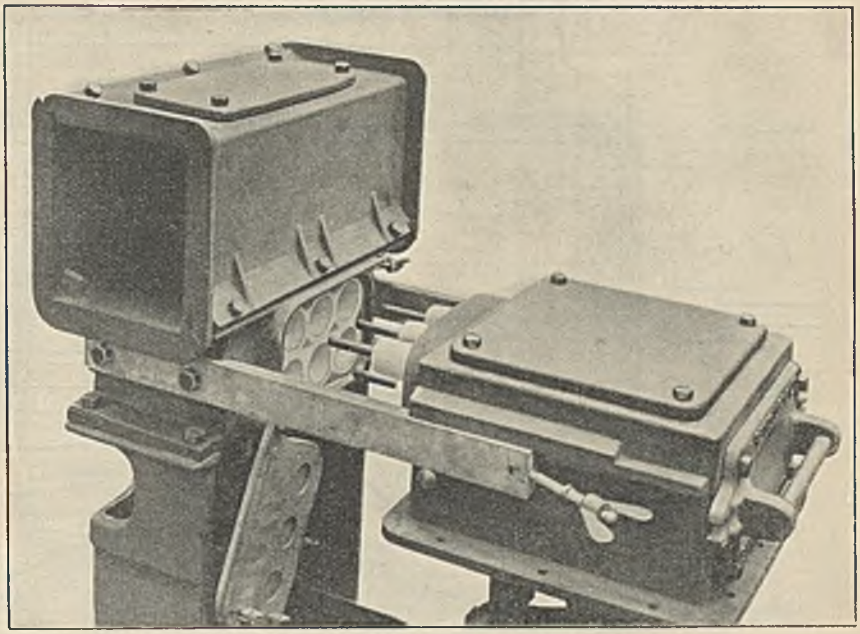


Fig. 1.

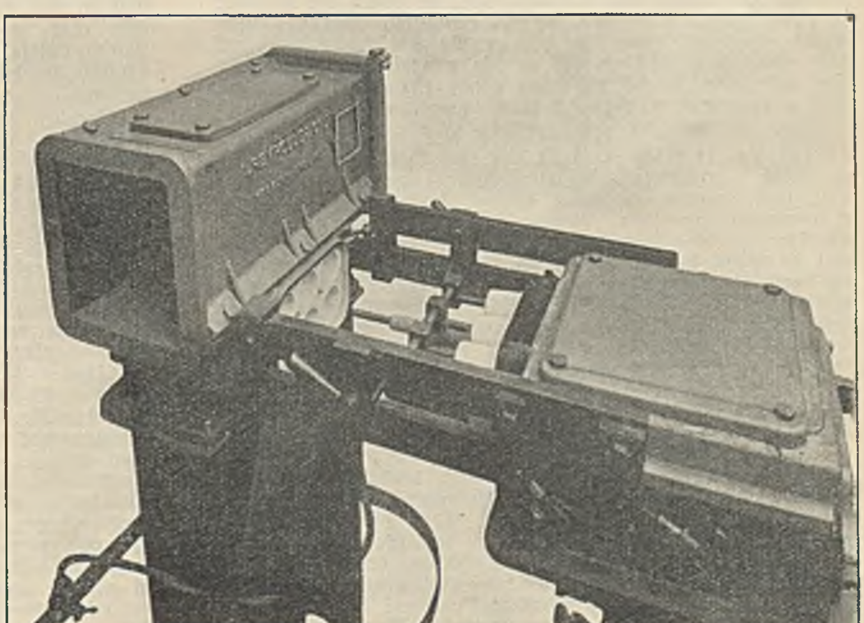


Fig. 2.

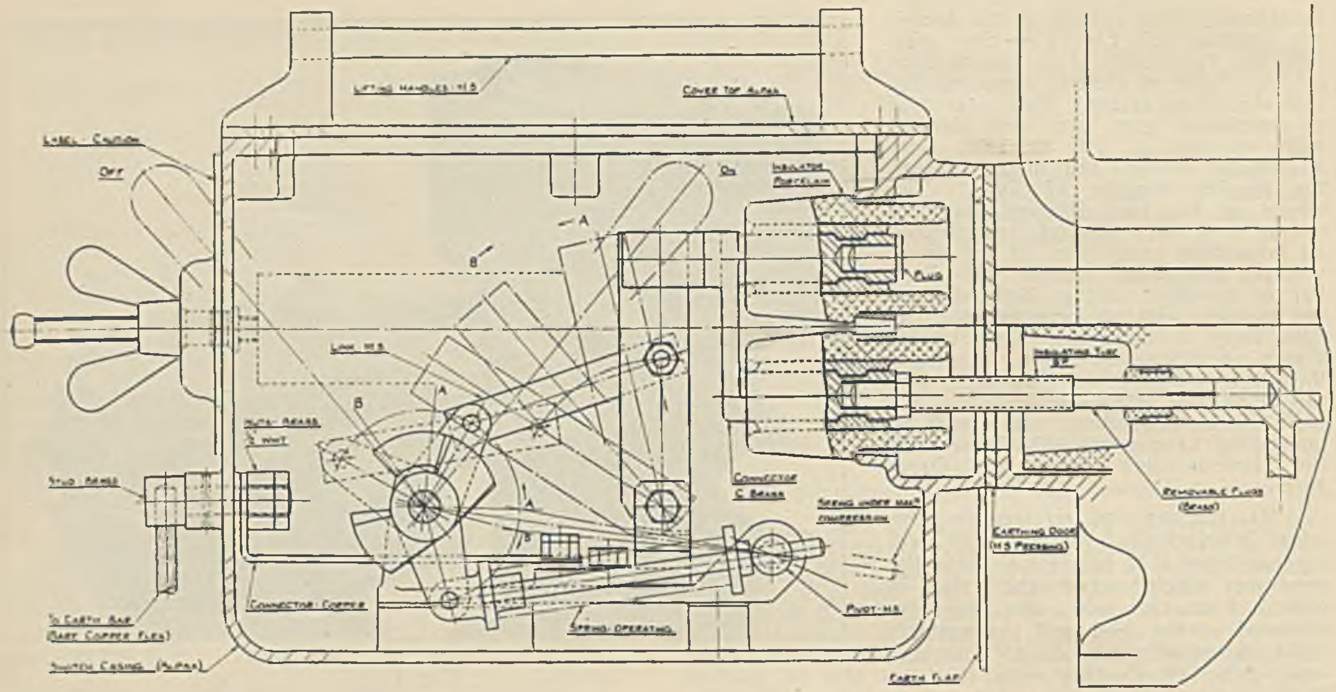


Fig. 3.

other a plan view of the switch. The putting in place of this earth circuit maker does not involve the addition of any lengthening pieces to the ordinary slide-bars, and when the switch is plugged home, the long plug, clearly seen in the elevation, makes contact at one end with the socket of the fixed portion of the switch unit, and at the other end is connected to the top contact of the switch blade. The hinges of the three switch blades of the earth circuit maker are connected together, and from the common connection a strip is taken across to the casing of the switch, from which a further connection is taken to the earth bar. Thus the closing of the earth circuit maker earths the cable.

In conclusion, Mr. Clothier said he could see nothing in the "Explanatory Notes" as explained by the author which was not eminently serviceable for convenient and safe operation, and so far as his experience went there did not seem to be anything other than initial expense that a practical man could take exception to.

Mr. R. W. MANN.—Under the heading of Reg. 125 (a) Mr. Horsley stressed the fact that earthing is not of itself a complete safeguard against dangerous shocks, and that prompt isolation by an Automatic Cut-out is a necessary corollary. While, in view of the very large number of fuse equipments in use, it is unlikely that this is meant to indicate that a fuse is unacceptable under the act, Mr. Mann said that he would be very glad to hear Mr. Horsley say that this is meant as a strong indication that Automatic Equipment, in the accepted sense of the word, is an essential, rather than Fuse Gear.

Under 128 (c) the application of leakage protection is more definitely emphasised, and it would be interesting to know whether Mr. Horsley had in mind the application of leakage tripping to every single switch. While the addition of graded time lags made it possible to secure a measure of selectivity with leakage trips, Mr. Mann considered the use of such complicated apparatus below ground was not justified, and, personally, preferred to accept a wider range on leakage tripping than was indicated by Mr. Horsley, commencing from 25 to 30 per cent. for shaft feeders and graded down to, say, 15 per cent. on Distribution Feeders; and finally, if necessary, to 5 per cent. on Portable Face Equipment. Whilst appreciating that it is not generally accepted, it was found in practice that leakage trips graded in percentage did tend to give a certain amount of selectivity between the various circuits.

Under the same heading Mr. Horsley had dealt with the split conductor system of shaft cables and it might be as well to bear in mind, in view of the frequency change in this area, that arrangements might be possible whereby the duplicate put in for the purpose of the change-over might be left with the Colliery Company, with the result that an improved system of protection might well be adopted at the same time.

Under Reg. 130 (a), under the heading of "Pliable Armoured Cable," Mr. Horsley commenced with "For apparatus that is not locomotive," and Mr. Mann thought that in this connection he would be right in the assumption that, provided the pliable armoured cable had a fourth official earth core, it could be used for the connection to face equipment, portable or otherwise, under the act.

Under the same heading Mr. Horsley had dealt with the necessity of bolting a plug and socket together where used as a unit for uncoupling in connection with pliable armoured cable. The unfortunate part of such an arrangement, said Mr. Mann, was that it prevented the manufacturer's adhering to the standard B.E.S.A. plug which they were now adapting to suit their apparatus, and one would like to have Mr. Horsley's confirmation that, provided the apparatus is arranged with an earth continuity circuit, which uses an additional pilot core and earth return, that the necessity for bolting the plug portion is obviated.

Under Reg. 131 (g) Mr. Mann was particularly interested to note that Mr. Horsley laid stress on M.D. Circular No. 23 dated the 24/6/27, which calls for an arrangement whereby a feeder might be earthed to its own switch; and while the Company which Mr. Mann represented, and other manufacturers have so modified switchgear, it was rarely that the necessary modifications even where offered as an alternative, were accepted by the collieries.

Under Reg. 131 (i), Mr. Horsley referred to the use of pliable armoured cable, and especially to its use in reducing the length of trailing cable. This has been advocated by Mr. Mann for very many years, and had been adopted in almost every extensive machine mining layout for which he had been responsible for some

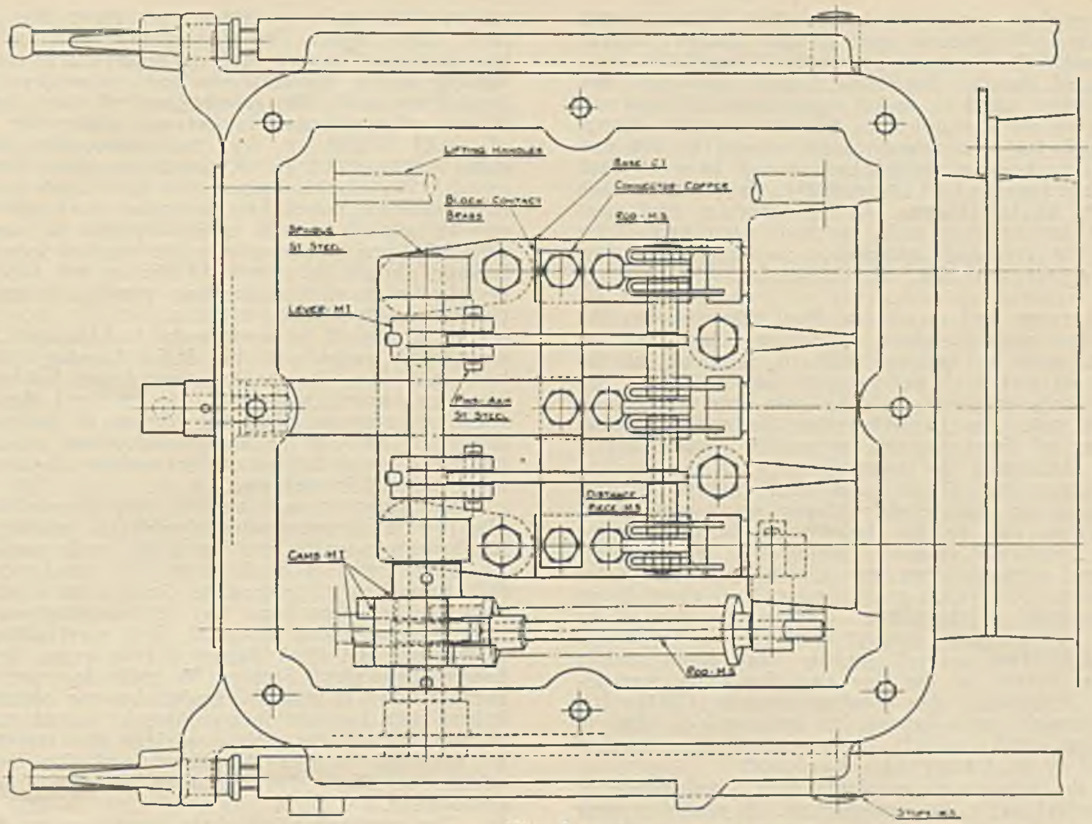


Fig. 4.

considerable time back. It was, however, desirable to draw attention to the possibility of using one more or less expensive automatic gate end box and interconnecting a number of small plug distribution boxes of the non-automatic type, by pliable armoured cable so that, particularly with arc wall working, a large number of plug-in points are available to the coalcutter operator, and the length of trailing cable can still further be cut down. A large number of equipments were in operation under this system.

Under 132 (i), Mr. Horsley called attention to the remote control of coalcutters, and after the six years in which Mr. Mann's Company had been intimately connected with the development of this class of apparatus, they could accept the fact that at last the use of this equipment was tending to become general, particularly on the North East Coast.

Under Reg. 132 (iv.), Mr. Horsley referred to the possibilities of obtaining permission for face lighting, and as it had been suggested to Mr. Mann that, apart from the question of actual permission, definite requirements were laid down for the class of apparatus which shall be used, and which lays the onus on the user, perhaps, therefore, Mr. Horsley would be so good as to indicate the class of apparatus which he had in mind as being most suitable for this class of work.

Finally, and whilst expressing his appreciation to Mr. Horsley for the extremely clear way in which the modifications to the explanatory notes had been made, Mr. Mann said he would like to suggest, for the benefit of users of the notes in general, that for the first year there should be available a separate appendix calling attention definitely to the modifications of the new notes as compared with the old notes. Failing which, it was to be feared that, for a very large number of years the new modifications would not, in general, be appreciated.

Mr. T. CARTER said he had formed the impression that Mr. Horsley had in mind the possibility of using, for semi-portable apparatus, a bolted plug and socket not capable of being taken apart except by an electrician possessed of a suitable tool for unbolting them. This, Mr. Carter understood, would enable permission to be given to use the armouring of the cable as the earthing conductor. Could not the British Standard Plug and Socket (British Standard Specification No. 279) be adapted for this purpose? If the wing-nut at present used for drawing in the plug were removed, and replaced by a head that could not be manipulated except with the proper tool, the object would, he suggested, be achieved. Earthing would be secured both through the earth-ring, which forms a very adequate connection, and through the contact between the plug and the socket brought about by screwing the plug home. Facilities for an electrical interlock would also be provided if the British Standard Plug and Socket were used in this way.

Mr. S. A. SIMON enquired of Mr. Horsley as to what is the meaning of "Conductivity" as used in the Regulations. How does the Mines Department interpret Conductivity at all parts and at all joints"? According to scientific textbooks and more authoritively to the British Standard Glossary, "Conductivity" is defined as "The reciprocal of volume resistivity (specific resistance)" which in turn is defined as "The direct current resistance between opposite faces of a unit cube of a given material at a given temperature." Resistance is defined as that property of a substance or body by virtue of which it resists the flow of electricity through it, causing a dissipation of electrical energy as heat. (Note. If a steady current flows through a conductor the ratio of applied voltage to the current flowing is a measure of the resistance. The ratio so obtained with a steady current is preferably known as the Direct Current Resistance.) As the specific resistance of iron used in armouring is about eight times that of copper, it is evident that the word "Conductivity" is not used in its scientific or standard British sense. It is therefore interesting and important to know what is the correct interpretation. Mr. Simon said he had always thought that it meant "Conductivity per unit of length."

In regard to the log book, some time ago this Association was asked to make suggestions for improvements, and in the discussion in this Branch, Mr. Simon had proposed that the present form should be retained but that a blank page should be inserted between each pair of printed pages, or alternatively, one side of each page should be left blank. As Mr. Horsley had mentioned that anyone may make up their own book form (provided the required information is given) he, Mr. Simon, now repeated his suggestion for what it may be worth.

Dr. Thornton had mentioned that 360 volts was the maximum that could be stood by human beings, but he, Mr. Simon, said he believed that in Scotland, in the early days of electrical development, about 360 to 380 volts was fairly commonly adopted, possibly on account of the fact stated by Dr. Thornton: he could not say whether any of these systems were still extant, but it would be interesting to ascertain.

Continuing, Mr. Simon said that highly sensitive leakage protection had disadvantages on a widely extended system, due to the liability of interruption of supply by temporary causes. During the heavy storms last Autumn, a small strap was blown across an extra high pressure (5000 volts) transmission line, close to an insulator support. Intermittent earths were caused by the strap swaying into contact with the metal work. It was only after several serious shuts-down and a very careful survey of the line that the cause was located and remedied. On another system (2000 volts) so much trouble was caused by interruptions due to birds making earth contacts that eventually the earthed neutral had to be temporarily abandoned.

From the reports of accidents which had happened due to contact with live conductors, it would appear that very short exposure to the pressure was sufficient to prove fatal or cause severe shock (unconsciousness). He would like to ask Mr. Horsley if there was any leakage protection sufficiently sensitive and quick in action to ensure that in the event of a man actually touching a live conductor, it would come into action and trip the circuit quickly enough to prevent fatal consequences.

Mr. A. HEPBURN referring to the pending change of frequency in the district, suggested that those who had not got their plant exactly according to regulation might take advantage of the opportunity to get into line.

Mr. Horsley had said that complete protection was not offered by earthing, and ought to be supplemented by the fitting of earth leakage protection devices, and he, Mr. Hepburn, must say that experience over a number of years caused him to support that contention. He had an example where a man received a very slight shock which did'nt put him out of action. The man was operating an electrical haulage gear driven by belt and in order to change the clutch on the haulage gear had to lift the clutch lever with one hand and with the other operate the reversing controller: during this process the man got a shock. It was quite easy to see how he got the shock. The current took the path of least resistance and of the several paths, in this particular case a part of the current found its way to earth along the haulage rope through the man. Where there are pieces of machinery they ought to be electrically connected together in order to safeguard absolutely the operator. There was nothing in the Act which called for this but it was a point which people would be well advised to take notice of.

In connection with earth leakage protection, Mr. Hepburn said that within the past few years he had had at least two cases of breakdown on the stator of a coalcutting machine in wet conditions. The water got into the stator and some of the coils went to earth, and the earth leakage protection—12½ per cent.—was so good that the operator never felt any shock at all although he was lying in among the water operating the machine.

At this point he wished to say that he was a great advocate of remote control of coalcutters; whilst he agreed that it was difficult to meet the expense in these days where rigid economies are called for, in his opinion it would not only safeguard the operators against shock, but the machines were less subject to breakdown with the remote control than without, and it was of particular importance where the seam was of small height: it was not reasonable to expect a man to travel 60 or 70 yards to close the gate end switch. He would suggest that the remote control might be simplified more by discarding such things in the remote control box as earth leakage, etc., which might safely be omitted to reduce the expense; but the earth leakage should be fitted to the switch which controls the feeder to the coalcutting equipment and only the electrician should re-set them.

With regard to semi-flexible cables and Mr. Mann's point with respect to the B.E.S.A. plug: Mr. Horsley had said that the halves should be bolted, and Mr. Hepburn agreed with him. He noticed the Mines Department recommended the figure 8 coiling, but he, personally, would recommend doubling it rather than putting it on a bollard. The method of connecting this cable was of importance.

Mr. Hepburn said he was very pleased to note that Mr. Horsley recommended electrically interlocking plugs: he had, personally, put in many such equipments.

There was a much contested point, especially in this Branch, with regard to Section 66 which calls for the weekly inspection. A lot of members contended that this was not essential, but surely they were to to observe the Coal Mines Act in every Section. The Electricity Rules, Section 66 calls for the weekly inspection, and it must be made; he was pleased to know it had been brought forward in the recent memorandum. In this respect the person making the inspection would be required to sign the Mines and Quarries Form 44 which has been looked upon as the Enginewright's prerogative.

The responsibilities of the electrician are more clearly defined in the new Regulations, and he was very pleased to notice that thereby another point has been cleared up.

Mr. R. G. MILLBURN said that with regard to leakage protection he had been a user of the system for many years and with excellent results. Mr. Horsley had mentioned that if they provided a feeder with overload and leakage protection they would be fully protected. Mr. Millburn drew attention to a case which occurred a few weeks ago. When these switches were supplied it was generally recognised that if a switch were provided with two overloads and leakage protection it would be quite in order. The particular switches he had in mind were so fitted. The case in question was as follows: The operating circuit for the leakage trip actually failed, the failure being discovered during routine testing. If the switch had been called upon to clear an earth fault on the particular phase on which there was no overload, the switch would not have operated and there might have been disastrous results. So he was inclined to think that for full protection it was necessary to have three overloads, one on each phase, together with the core balance.

Mr. Milburn then referred to a point regarding pliable armoured cables and the B.E.S.A. plugs. Mr. Horsley had suggested that this plug should be bolted to the carcase on semi-portable machinery. Mr. Milburn quite agreed, but wondered whether a slight alteration in the B.E.S.A. plug could be made to meet this. Instead of leaving the butterfly nut fixed, could it not be made removable so that the electrician could take charge of same after having inserted the plug into its socket?

Mr. T. HUGHES asked for Mr. Horsley's opinion on the fact, where Rule 132 applies, whether the use of jointless, rustless, unbreakable resistances would meet the Act in conjunction with flame-proof control. There were manufacturers offering these to meet that rule.

Dr. THORNTON, who said he had not come prepared to make any comments on this most interesting address, remarked that it had been his rule for a number of years to use this Memorandum as a standard text book in discussing questions of electricity in mines with his mining degree students. It tells exactly what the rules mean and how to charry them out, and they were under a great debt of gratitude for the very clear way in which it sets forth these regulations. He was quite sure that the new edition would enhance the value of the memorandum.

There were however, one or two comments which had occurred to him whilst listening to Mr. Horsley.

With regard to isolation of direct current cables from the point of view of shock. If they were isolated at both ends and had been under pressure any length of time there was the possibility of a much higher pressure than the original pressure rising in the conductors, due to the soaking out of charge in the insulation.

At the beginning of his notes, Mr. Horsley had said that a man of normal health had been killed at 60 volts. The degree of effect depended upon where the man took the shock. It was quite certain that no man living could bear even 25 volts if taken in the mouth. There was an occasion some time ago where an experiment was carried out, and a man took 25 volts in the mouth (such as a pony might who bit at the signalling wires) and it could not be borne. It was worse than 400 volts across dry hands. Dr. Thornton said that he, many years ago, experimented as to what a man could carry, and had a machine run up with himself across its terminals. He knew he would probably be unable to speak, and said "If you see me nod, you must break the circuit." The voltage was run up to 360, and he managed to nod. he concluded that it was not possible to bear more than 360 volts even in the best of health. When some wiring was being done at Armstrong College, a workman took hold of the 480 volt live terminals with both hands and stood there for some minutes unable to speak or move; the foreman found him waiting for the end. He recovered, but even now, 25 years later, there is a numbness in his fingers every now and again. A pressure of 60 volts is certainly, said Dr. Thornton, not too low for a man on occasion to be killed by it.

If in drawing the hand away one cuts through the flesh, there is the liability to sustain a most dangerous shock. The danger was a matter of the current taken not of the voltage applied. About 15 milliamperes was, Dr. Thornton believed, as much as a person could stand and he had always understood that a third of an ampere passing through the body from hand to hand was invariably fatal.

Mr. J. A. B. HORSLEY (in reply).—Referring to Reg. 131 (g), Mr. Clothier asked whether it is considered necessary to make the circuit breaker, through which the earth connection is applied, non-automatic after closing it, lest it should be tripped while the work is in progress and so remove the earth connection.

The risk indicated varies with the circumstances, and as an alternative to locking off the automatic feature or substituting, for the time being, a non-automatic switch the risk could be reduced to small proportions by applying a direct earth connection to the conductors, after earthing them through the circuit breaker.

The greater danger lies in attempting to apply an earth by hand instead of through a suitable switch, or in omitting to earth altogether.

In any case effective precautions are necessary to prevent other persons from applying pressure to the line, e.g., by locking the switch out. It is not sufficient to rely upon a danger board hung upon the switch. Where possible the conductors should also be earthed at the place where they are to be handled before they are touched, but this local earthing should not be applied until it is known that the line has been put to earth at its origin.

It is surprising that so little use is made of "potential indicators" of the vacuum tube type. There are designs suitable, for medium and for high pressure, that can be carried in the pocket.

Referring to Reg. 125 (a), Mr. Mann asks whether fuses may be regarded as a satisfactory means of ensuring the prompt isolation of a faulty circuit, for the prevention of dangerous shock from the earthed apparatus. Mr. Horsley said he certainly had leakage protection in mind when writing that comment, and did not see how fuses could be relied upon in all cases to effect the necessary automatic isolation. The fault current may be limited to a value below that at which the fuses would blow.

Mr. Mann also asks whether it is suggested that leakage trips should be applied to every switch, under the terms of Reg. 128 (c). That is not necessary but such trips might be applied advantageously at the origin of all branch feeders.

With regard to pliable armoured cable used with portable or semi-portable equipment, provided there is an earthing core in the cable an ordinary plug and socket union may be used.

If it is desired to use the stranded steel armour as the earthing conductor, then, as is pointed out in the comment upon Reg. 130 (a), the union should be a bolted one. Alternatively, an electrical interlock, for which a pilot conductor would be required in the cable, may be used to ensure the continuity of the earthing connections at each extremity of the cable.

Mr. Mann also refers to the general neglect to make constructive provision in switchgear to facilitate compliance with Reg. 131 (g), and it is much to be regretted that this should be the case.

As Mr. Clothier has pointed out, on no Power Supply System would men be permitted to work upon lines without the precautions called for by this Regulation; and yet every year there are accidents in collieries resulting from the lack of means to enable the circuit to be earthed without danger.

As to face lighting, it is true that somewhat onerous conditions are imposed at present as precautions against the risks that are, with our limited experience, difficult to estimate. The cable must be free from the risk of "open-sparking" as far as possible, and the fittings must also be designed to minimise that risk. Danger from shock is perhaps best guarded against by insistence upon low pressure, such as 125 volts with the mid-voltage point earthed. We don't know what type of cable will be best, and in the absence of a British Standard Specification based upon research, we have to take the slow road and gather experience.

Where consent to face lighting in a safety lamp mine has been given the conditions have been so drawn up as to leave scope for alternative types of cable and fittings, as experience or judgment may suggest.

Mr. Carter, discussing the issues as to the type of plug that may be used with a pliable armoured cable where it is desired to use the armour as the earth conductor, suggests that the retaining bolt of the British Standard plug would serve, with modification, as constituting a bolted union. Unfortunately, this would not meet all requirements, for one object of bolted union is to prevent withdrawal of the plug by men without technical knowledge. An electrical interlock, however, embracing the earthing circuit will, as was previously said, satisfy the practical needs of the case.

Mr. Simon wants a definition of "conductivity", where that word is used, as in Reg. 125 (b), to indicate what is to be understood by that electrical property as applied to the description of an earthing conductor in comparison with a working conductor. What is intended is clearly the reciprocal of resistance. "Conductivity" as used in the Regulations does not mean the specific conductivity of the metal. It means that the resistance per yard run of the earthing conductor shall not exceed the resistance per two yards run of the working conductor with which it is associated.

"Conductance" would be the more correct term to employ, for "conductivity", in the scientific sense, means the reciprocal of "resistivity" which means "specific resistance".

"Conductivity", if applied in the text book sense, would prescribe, not the resistance of the earthing conductor, but the metal to be used and that, as the context shews, was not the intention of the Regulation. Mr. Horsley said he had noted the point for future amendment.

Regarding ultra sensitive leakage protective trips, there was certainly the Winhey device, employing a very sensitive relay, for which it was claimed that it would operate on the leakage, at medium pressure, through a man's body. It was not a selective system, however, and it was not, therefore, generally applicable.

The object of Mr. Horsley's comment upon Reg. 125 (a) was, however, to suggest that earthing the apparatus is to be regarded as a means to an end, and that the end to be kept in view is the prompt and automatic isolation of the circuit in which a failure of insulation occurs. This end can be achieved by earthing coupled with leakage protection. If the pressure is not cut off when a fault develops, then the potential drop over the earthing conductor may suffice to give a dangerous shock.

Mr. Hepburn refers to this point and suggests that adjacent metal structures should also be connected to the earthing conductor, although the Regulations do not require it. This precaution, however, will not remove the danger due to drop of potential over the earthing conductor, for persons standing on the ground would get a shock from the haulage rope, in his example, unless the faulty circuit was immediately cut off. It would only safeguard the operator, in his example, and then only so long as he did not touch the general body of earth.

Mr. Hepburn supports, from his experience, the advocacy of leakage protection as a safeguard against electric shock.

Mr. Milburn suggests that the British Standard plug, if provided with a removable head for the retaining screw, would be equivalent to a bolted union on the assumption that the electrician alone would be allowed to attach and detach the plug. Where that procedure is practicable it would suffice, but an objection is raised to that proposal when he, Mr. Horsley, has made it, that it is impracticable to forbid the conveyor shifters to remove and attach the plug.

The only safe arrangement under those conditions is to employ an electrical interlock.

Dr. Thornton points out that an electrostatic charge soaking out slowly would recharge the conductor even after it had been discharged. That phenomenon is well-known to engineers who have experience of working with high pressure cables, and it is observed with alternating current cables. The remedy is to keep the conductor connected to earth so long as work is in progress.

If the conductor is merely "flicked" to discharge it, it may again attain dangerous pressure. The remedy is covered by the comment upon Reg. 131 (g).

WEST OF SCOTLAND BRANCH and AYRSHIRE SUB-BRANCH.

Joint Meeting with the Scottish Branch of the National Association of Colliery Managers.

A Joint Meeting of the West of Scotland Branch and the Ayrshire Sub-Branch of the Association of Mining Electrical Engineers together with the Scottish Branch of the National Association of Colliery Managers was held in the Royal Technical College, Glasgow, on the 23rd of November last, when a paper on "Heading Work with a Versatile Machine" (a new development in coal-cutter design) was read by Mr. Forrest S. Anderson, B.Sc.

Mr. G. N. Holmes, President of the West of Scotland Branch, occupied the chair, and there was a very gratifying attendance of the members of both Associations. The Secretary, Mr. W. G. Gibb, having read the minutes of the previous meeting of the West of Scotland Branch, they were approved and signed by the Chairman.

Apologies for absence were intimated from Messrs. Hart, Martin, John A. Brown, and W. G. Crawford.

THE CHAIRMAN, in his introductory remarks, on behalf of the Association of Mining Electrical Engineers, extended a very hearty welcome to the National Association of Colliery Managers. The members of the A.M.E.E. always looked forward to these annual gatherings because of the considerable benefit to be obtained from the mutual expression of goodwill and interchange of ideas. It had become a common opinion that the coal industry is condemned, but Mr. Holmes was reassured in the presence of a gathering like this and seeing the number of men who had given up an afternoon's leisure in the interests of mining, to learn and to teach. There was no question that the coal industry had suffered a very serious setback, but the study of its past history would shew that it had a good deal of its own way in the past, and was only now realising the menace of fierce competition. Mr. Holmes had the feeling that keen competition had been a good thing, and had kindled a live interest in the coal industry more than anything else could have done.

Associations like those met together that afternoon were doing a great deal to assist the coal trade and he was sure all our members were ready and willing to continue to further the interests of the industry. The shock which the coal industry had sustained might in one sense, possibly be one of the best things that could have happened; there was now the opportunity for a rejuvenated industry arising out of the troublous old past.

Mr. Holmes then suitably introduced Mr. Forrest S. Anderson, who was to give them a paper on "Heading Work with a Versatile Machine". Whilst many of the audience might not know Mr. Anderson intimately, they would all be familiar with the Company he was so closely connected with, and which everyone accepted as one representative of modern improvements in coalcutting methods and machinery. It was pleasing to know that Mr. Anderson as a junior was following closely in the footsteps of other members of his family whose names had been for so long intimately linked with the coal industry.

In addition, and supplementary, to the paper there would be a cinematograph illustration of coalcutting in operation below ground. Mr. Holmes humourously remarked that incidentally he had heard that the language was rather "striking" when this film was being taken, and it was hinted that one of the regrets of Messrs. Anderson Boyes was that the film was not a "talkie" instead of a mere silent picture. It was to be regretted for the interest would have been still greater had the the film, as a "talkie", combined education and entertainment in a most original manner.

Mr. Anderson then read his paper, which was illustrated with lantern slides and was followed by the exhibition of the cinematograph film shewing the machine in actual operation underground.

(This paper was published in the January number of this journal. It is here repeated—amplified by illustrations and a report of the meeting and discussion.)

Heading Work with a Versatile Machine: A New Development in Coal-Cutter Design.

FORREST S. ANDERSON, B.Sc.

The problem of heading work is one which has to be faced by every mining engineer at some time, and since the early days of coalcutters the application of machines to this work has received a considerable amount of attention. Many different classes of machines have been tried with greater or less success, but at the present stage of development, the Arcwall type of machine, working under suitable conditions, has undoubtedly proved of the greatest advantage. Its application to stoop and room working has revolutionised production costs to such an extent that, whereas formerly the coal won in the narrow work was the most expensive to get, it has now frequently become the cheapest.

This aspect of the case has also opened wider possibilities with regard to longwall retreating, panel systems, and other modified methods of working where the expense of doing the narrow work has hitherto proved a serious factor to place against the advantages likely to be derived. That the success of Arcwall machines is no illusion is amply demonstrated by the extent to which they are now employed by those colliery companies who have adopted them where suitable conditions prevail.

The Arcwall machine as originally applied in this country consisted simply of a longwall machine mounted on a suitable truck on which it could be readily transported or travelled by its own power from place to place. The saving in time of keeping the machine mounted while cutting proved to be considerable; but in order to get fuller advantage from the system, modifications in design were made to facilitate the work and make the machine suitable for a wider sphere of operation.

In this connection, one of the points which had to receive consideration was the question of cutting position. The early machines were arranged to cut at from 15 ins. to 20 ins. above floor level and this proved quite suitable in many cases, but as fresh subjects were tackled, the question of adjustment to a different cutting position inevitably arose. When the holing position was higher, the case was easily met by packing up the machine on the tram, but this lead to trouble in some instances as it did not leave sufficient headroom for the machine.

The difficulties have now been mostly overcome by designing different arrangements of gearhead and fitting the type most suitable for the particular holding position desired and the general conditions of the subject, though this may sometimes entail fitting a new gearhead to the machine when transferring it from one seam to another.

It frequently happens, however, that the cutting position has to be adjusted by a matter of a few inches only, and for such a purpose, the use of packing pieces between the machine body and the truck can usually be resorted to. Such a case might arise, for instance, after passing through a fault due to a slight alteration in the position of a dirt band in which the cut is being made.

In some instances the cutting position varies from place to place : for example, when holing in a band the position of which is not constant thoughout the seam, when cutting to a parting, or when holing at the bottom of a seam and working with a pavement brushing. Under these circumstances, the variation is frequently overcome by laying the rails so as to adjust the machine to its proper cutting level, but the difficulty is to ensure that the road is properly laid and it requires strict supervision to secure this and avoid delays with the machine which would be otherwise inevitable.

Another limitation of the standard Arcwall machine is that it is not practicable with it to hole at floor level.

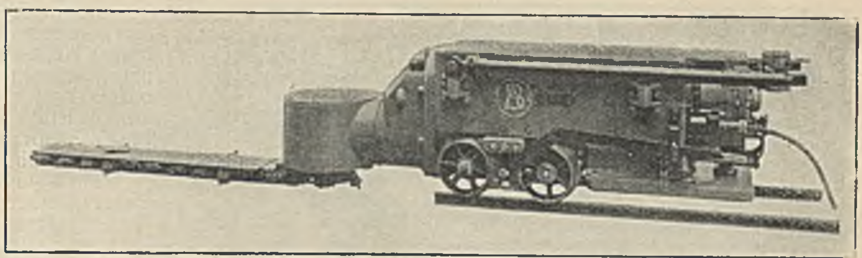


Fig. 1.—Jib in Lowest Position for Holing.

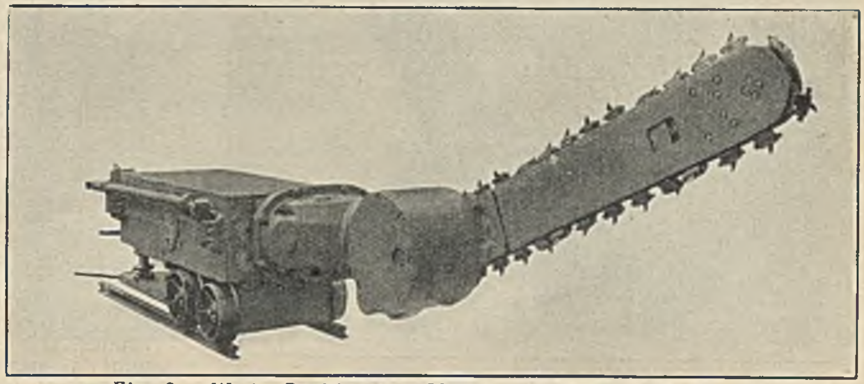


Fig. 2.—Jib in Position for Shearing at Side of Machine.

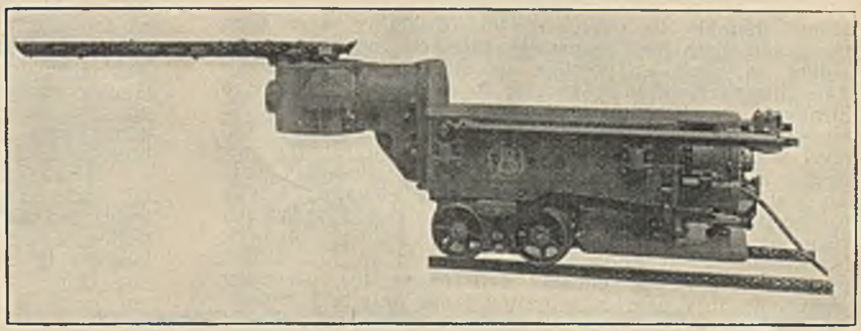


Fig. 3.—Jib in Highest Position for Holing.

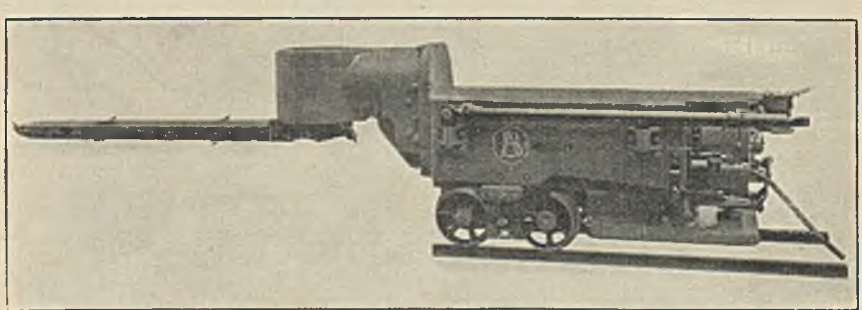


Fig. 4.—Jib in Highest Position for Holing as an Undercutter.

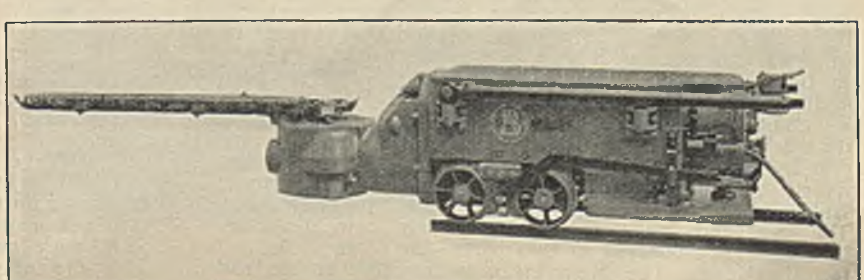


Fig. 5.—Jib in Highest Position for Holing as an Overcutter.

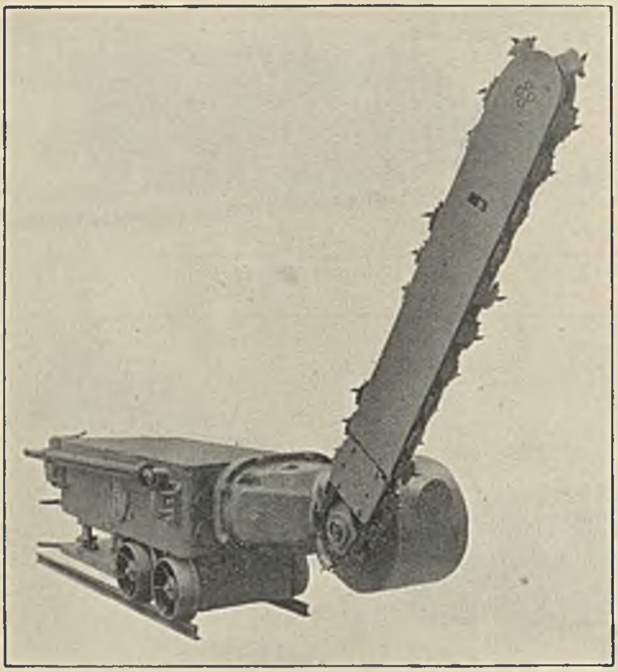


Fig. 6.—Jib in Position for Shearing on Centre Line of Machine.

Many attempts to overcome this disability have been tried, but they have generally resolved themselves into holing as close as possible to the top of rail level. This, however, often gives rise to a serious difficulty in flitting. It will be readily appreciated that with a machine carrying a 6 ft. or 7 ft. jib about 1 in. above rail level it is not an easy matter matter to flit rapidly over even what would normally be termed a good flat road. This problem has been met by fitting elevating screws to the machine so that the jib may be raised sufficiently clear of the rails when flitting. Screws have likewise been adopted to allow for a variation in the cutting position, but while entirely satisfactory for particular conditions, they provide a limited range only and increase the cost of the machine considerably.

Bearing in mind the limitations, some of which have been briefly sketched, and in view of the success attained by Arcwall machines generally, and consequent increased demand for such machines to suit more widely varied conditions, it was felt by the coalcutter manufacturing firm, Messrs. Anderson, Boyes & Co., Ltd., that development in design on broader lines than hitherto was called for. In addition, there has been an insistent demand for a machine which would be capable of putting in a shearing cut over and above the usual holing cut, and it was decided to explore the possibilities of incorporating this feature in the new development.

Shearing cuts by machines have been practised at several collieries but, while the advantages have been proved, the system had been handicapped in the past for want of an entirely suitable tool. The main features specified for the proposed design were that the machine should be capable of holing in any position from floor level to a reasonable maximum height; that it should be capable of putting in a shearing; and that it must be of a size suitable for British mining practice. A machine to this specification has now been successfully designed and put to work and, by its performance at the coalface, its ability to meet the requirements has been effectively demonstrated.

This unique machine is of the chain type and makes its cut in a similar way to the usual Arcwall machine, which it resembles somewhat in general appearance. The gearhead, however, is an entirely new departure in design, and consists of two parts—the Main Head and the Jib Head. The Main Head is mounted at the end of the machine and is capable of rotation about an axis in line with the motor shaft. The Jib Head, which carries the jib and cutting chain, is supported by the Main Head and is capable of rotation about an axis parallel with the axis of rotation of the Main Head, but eccentric to it. The construction may be likened to an overhung crank with the Main Head representing the web of the crank and the Jib Head mounted on the crank pin.

The possibilities with this construction will be clearly understood if we refer back to our comparison with the crank, and, in order to assist you to visualise it, a few slides of the machine with the heads in various positions will now be shewn. Suppose the crank is at bottom dead centre, with the jib at floor level. Assume in the first instance that the Jib Head is firmly fixed to the crank pin and that the crank shaft is rotated. In the starting position the jib can make an arcing cut holing at floor level (see Fig. 1). When the crank has rotated through 90 degrees, the jib will be in a position to put in a shearing (see Fig. 2); at 180 degrees another holing cut may be made—this time an overcut which, in the case of the machine under review, would at a height of about 4 ft. from floor level (see Fig. 3); at 270 degrees another shearing cut may be made—this time on the opposite side of the machine from the first; and at 360 degrees the cycle is complete (see Fig. 1).

In the second instance, assume that the Jib Head is quite free on the crank pin so that the jib will arc in a horizontal plane in all positions and we will again start from bottom dead centre. As the crank shaft rotates the cutting position will gradually be raised until a maximum of about 2 ft. from floor level is reached at top dead centre (see Fig. 4). Assume now that the crank shaft is held stationary and the Jib Head rotated through 180 degrees. The jib will now be up on top and the machine, working as an overcutter, may make a holing cut at a height of about 4 ft. from floor level (see Fig. 3). If the rotation of the crank shaft is now continued with the Jib Head free on the crank pin, the holing position will gradually be lowered until a minimum of about 2 ft. from floor level is reached at bottom dead centre (see Fig. 5).

It will thus be understood that a holing cut may be made at any position up to above 4 ft. from floor level, and in the same way shearing cuts may be made within a similar horizontal range (see Fig. 6). The motions described are all practicable with this machine, and either head may be locked for cutting purposes at any point in its rotation.

The drives and controls are so arranged that the Jib Head may be rotated with the Main Head stationary; the Main Head may be rotated with the Jib Head locked; and both heads may be operated simultaneously to adjust the jib into a cutting plane parallel to the cutting plane from which it has been moved. The motions are carried out by power from the motor, and the controls allow of rapid adjustment. The machine as a whole has been designed for heading work and embodies the features which a long experience in Arcwall work has proved to be desirable. The machine is of a very compact design, the overall dimensions being approximately 9′ 9″ long × 3′ 0″ wide × 2′ 6″ high to the top of the body.

The actual working of the machine is on similar lines to that of a standard Arcwall machine, except that when necessary the jib can be adjusted to its proper cutting positon after it has been flitted into the face. For example, if the machine were required to hole close to rail level, it would be flitted into the face with the jib well clear of the rails; the jib would then be swung round in the usual way and the machine driven forward until the head was close to the coal. The jib would now be lowered until the proper position was reached, the machine stalled in position and the cut made.

A film of the machine at work will be shewn when you will have an opportunity of observing an operation of this nature being carried out (see Fig. 7). In the case demonstrated the place being driven was only about 12 ft. wide and the full arc could not therefore be cut. This precluded the possibility of holing at floor level since the jib had to be kept above the rail to allow it to be brought to the cut, but it it clearly illustrates one method of driving places narrower than that given by a full arc.

After the place has been holed a shearing cut may be put in. The position of the shearing is a matter of choice, but it will generally be found most convenient to put the shearing in the centre of the place. For places up to about 10 ft. wide with the track close to one side the shearing may be put in at that side, but for wider places it would be necessary to lay a double track to get the shearing in that position and, as a rule, any advantage gained would not justify the extra work. With a shearing in the centre and the holing at the bottom, two comparatively light shots will bring all the coal. The shots usually do their work best when the holes are bored close to the sides and parallel with them, and with this arrangement a saving of about 50 per cent. on explosives will frequently be effected. In addition, the place will be well squared and rounder coal obtained.

The method of putting in the shearing as as follows. When the holing cut is finished, the machine is driven back until the jib is clear of the coal. The heads are then adjusted to bring the jib into position for shearing in the position desired and the jib swung up until the picks at the point of the jib are just clear of the roof. The machine is then driven forward by means of the track wheels and the jib cuts its way into the coal until the gearhead is up to the face. An arcing cut is then made until the point of the jib is down to the floor, when the arcing is stopped and the machine driven back with the jib cutting its way out, thus completing the shearing (see Fig. 8).

The time spent in a place to complete the two operations of holing and shearing where the conditions are such as to allow the work to be carried on with freedom is about 25 to 30 mins. on the average: the holing taking about 16 mins. and the shearing about 12 mins. As a further example, two holings and a shearing in one place can be put in in 45 to 50 mins. These are not record figures, but they clearly indicate the suitability and adaptability of this machine for its work and the convenience with which it can be handled.

In the early part of this paper, attention was drawn to some of the limitations of the standard type of Arcwall machine, and now with the brief description given of the construction and work of the Anderson Boyes Universal Heading Machine, it may be understood how these difficulties can be overcome. Briefly stated the claims for this new design are that it facilitates the work when cutting close to rail level or when taking a pavement brushing, allows a holing to be made at floor level, provides for adjustment to a variable cutting position and, further, combines a holing and a shearing machine in one compact unit. Like all machines of the Arcwall type its application is in practice limited to fairly flat workings but, while there may be few suitable conditions in Scotland, there are large areas in other parts of our coalfields where it could be successfully and advantageously employed.

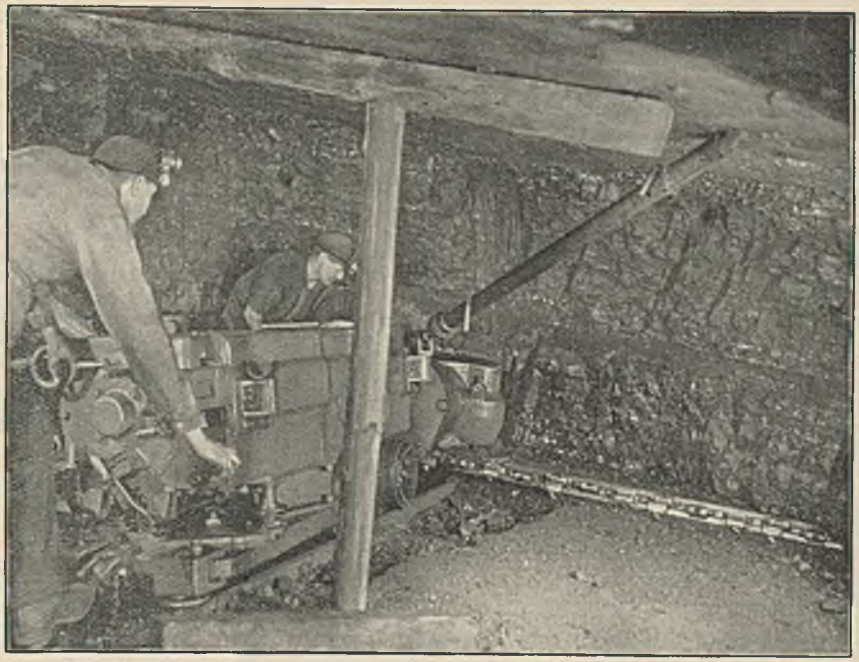


Fig. 7.—Holing close to Rail Level.

Discussion.

Mr. FRANK ANSLOW (Past President) said the technicalities of the subject introduced in the paper would doubtless be best dealt with by the many mining friends present. He would however like to echo the remarks of the Chairman in welcoming the Colliery Managers' Association. It was very gratifying to him as Past President of the Association, and a Past Branch President too, to find that the good relationships which were established many years ago between the A.M.E.E. and kindred Associations, particularly the National Asso-

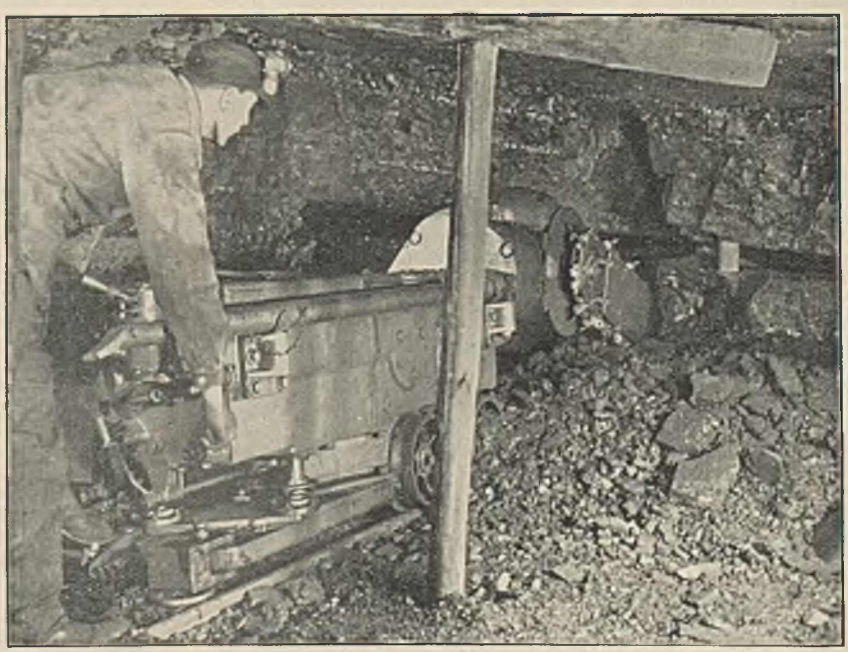


Fig. 8.—Shearing in Centre of Place.

ciation of Colliery Managers, had been followed up in other districts and was being continued and extended in the West of Scotland.

Mr. Anslow agreed with the Chairman's remarks about the trouble through which the coal industry had passed, and was particularly struck with the relationship of what was said in the paper and what had been exhibited on the screen in regard to that phase. Mr. Anslow recalled a talk with a colliery friend in the South who said that the proposed alteration in the hours of working would not materially affect his cost of coal getting at the coal face in view of the extended and improved machinery which he had put in for getting coal. Of course, he qualified that remark so far as the selling price of coal was concerned by saying that there were many other things which affected the cost besides the actual coal getting at the face. Mr. Anslow said he believed it to be the fact that mining electrical people have produced machinery which, notwithstanding the increased wages and reduced hours, could produce coal at less increase in cost than would have been possible had it not been for these developments. He wished to congratulate Mr. Anderson on the very concise way in which he had put his paper together, and on the excellence of the lantern slides which shewed so clearly the different operations which the machine could perform; and he would like also to congratulate Mr. Anderson on the successful film. The cinema film was very realistic and the West of Scotland Branch were favoured in the fact that this was the first time the film had been shewn in public.

Mr. WILLIAM WILLIAMSON (Hamilton), having been for some time out of the line of coalcutting, said he was therefore not quite abreast of the times, but was very interested to come back and see the developments that had been made. The paper had been a very interesting one; it was very technical and well put together: so that those who read it would not have much difficulty in following the action of the machine its method of working, and its intricacies. Of course, when one came to handle the machine in practice there was a good deal more to learn of its actual working.

There were one or two points in the paper that he might refer to. First of all there was that point about the weight of the machine. In view of the fact that it is really a duplicate machine, two machines in one, it must be a heavy machine, and that itself must add considerably to trouble in transit and shifting from one part to another, but Mr. Williamson believed even that difficulty had been got over, and the result was that on the whole that it was a very complete machine and very well adapted for its duplicate work. With its two-fold action it must form a very convenient machine.

In one place Mr. Anderson had said that the cost in working the solid seemed to be less even than longwall. Now, that statement surely should be modified in some way as to what height etc. is referred to in the working. In a 2½ foot seam there would not be a chance of it doing very much in working longwall in comparison with a good longwall working face. Those were points that have to be taken into account by comparison, and some of them who now had this machine working in their collieries might be able to give a paper later on and give the actual costs in comparison with those of other machines in longwall working. Such a paper would form a very good complement to the the present paper.

The cinematograph views helped to make the paper more interesting. It was not often possible to get illustrations from below ground of actual working at the face. There were several reasons for that: photos could only be taken where it was possible to get electric light in to such an extent as to give sufficient light but it must be extremely difficult to take a cinematograph picture of views underground because of the dark surroundings. To look at the picture, however, one would think that mining was a very comfortable and easy job, and it would appear from the picture that the only man who had any working to do there was the man who put the coal into the hutch and took it away to the haulage, or wherever it had to go. Mr. Williamson wondered if Messrs. Anderson Boyes & Company could not manage now to put a supplement on to it and show it passing the coals on to travelling belts or conveyors, and being transported on to the main filling place; that would more nearly complete the working operations, and men would be very little used so far as the hard work was concerned; they would just supervise the different machines working and see them digging the coal and transporting it right on.

Mr. Williamson was reminded of the Wembley Exhibition where aproximately £10,000 was spent on the colliery show, with its two shafts and connections showing the actual working underground; it was quite a common remark made at the time by visitors that it seemed quite a comfortable job working down below; they had even ponies down beside them, which made it more interesting. People seemed to think that the men were not so badly off as they had read about.

Mr. D. C. GEMMEL (Blantyre) said Mr. Anderson had that day very ably kept up the reputation of his family and firm, a family and a firm who had done so very much to help forward machine mining in Scotland. In the closing part of Mr. Anderson's paper the author lamented that in Scotland there was now very little opportunity of using this machine. That would not prevent many of them from dreaming of the great things they might have been able to do had the Lanarkshire ell main and splint seams been still available, and had they had such a tool they could then have beaten the Americans and held up their heads in the matter of coal production.

Mr. Anderson had said this machine would be useful in cutting out panels and making roads for retreating longwall. Some time ago, Mr. Gemmell had an opportunity of seeing such a system in operation in a four feet seam. The costs were given as being in the the proportion for narrow work of 2 to 1: that was to say, for every 3s. spent on producing the coal, 2s. per ton had been spent on narrow work and 1s. on retreating work. He would like to know whether Mr. Anderson had any figures in that connection that had been got through the working of his machine. In the particular case referred to by Mr. Gemmell, about 10 or 12 inches of the floor had to be lifted to allow the machine to cut on the floor level.

Mr. Gemmell said he had no criticism to offer on the machine described in the paper. In watching the movements of the machine depicted on the film they were most uncanny, and he thought Mr. Anderson was justified in describing it as a "robot."

The point occurred to Mr. Gemmell which had already been mentioned by Mr. Williamson. The cutting of the coal occupied a comparatively short time, only a few minutes; he would suggest to the mechanical friends that they now turn their attention to the clearing away of the cut coal; he could see no serious difficulty; nothing to prevent them devising a machine to clear away that coal so very quickly that they would have no notion of fitting the machine away from that place; that it would be quicker to put it aside and wait until the coal had been cleared. Then it could be claimed that we have intensive mining as a really established fact. Mr. Gemmell's memory took him back to seeing as a boy almost the first heading machine that was introduced, the old Stanley heading machine. That machine cut and completed a circle. One of the great objections to that method was the difficulty in securing the roadways. There was no longer that difficulty in these days of steel. That machine was doing well when it cut 3 feet of heading.

Mr. Anderson had spoken about two cuts in one place, and Mr. Gemmell wondered why he had two holing cuts in one place. Then, on the question of shearing, he did not think the author was quite safe in generalising on the production of round and small coal, and questioned very much if there would be much advantage in this respect by putting in a shearing in a place 14 or 15 feet wide. In a place of that width, by skilfully placed and well balanced shots, there should not be a great amount of coal produced.

Mr. ARTHUR DIXON said he would like to put a question to Mr. Anderson from a mechanical point of view. Mr. Anderson apparently introduced by putting in two heads, another link between the motor and the jib. That would mean that the wear would be multiplied by two, and any wear in either of these heads would of course be cumulative; Mr. Dixon wondered what was likely to be the life of the machine, and whether its efficiency and usefulness would be lasting. He would like to know if there had been machines working long enough to establish this fact.

Mr. FORREST ANDERSON, in replying to the discussion said he would try to reply in sequence to the various points raised. Mr. Williamson had asked about tthe weight of the machine. The machine weighs about four tons, and instead of being a disadvantage, the weight is more inclined to be an advantage for arcwall working. Of course, it is understood that the machine must have a road to stand the weight, but given that, it is an advantage to have the weight, for the cutting particularly.

Mr. Williamson mentioned the matter of cost and Mr. Gemmell had also raised that point. The reference in the paper to the cost was not to the cost of doing the narrow work as compared with longwall work, but to the cost of the stooping as compared with narrow work in stoop and room working; Mr. Anderson said he had been credibly informed by several colliery managers who were going in for arcwall machine work on a fairly large scale, that that had been their experience. Mr. Anderson would not say it was always done, but in some instances they had found that they were geting their coal from the narrow places cheaper than they were from the stoops. Of course, when it came to a question of panel working it was to be expected that the longwall coal would be got cheaper than that from the narrow places. Mr. Anderson regretted he had no actual costs to give; colliery managers guarded these points very carefully indeed; he would be very pleased if anyone present could give figures of costs.

Mr. Gemmell had mentioned the point about keeping the machine in one place. As a matter of fact he, Mr. Anderson, knew of one colliery where they were working that way with arcwall machines. The machine was not mounted on wheels at all but simply worked on the skids and was kept in the one place all the time. The coal was loaded off into a conveyor after being cut.

As to the question regarding the two cuts in the one place: there were two cuts in the one place shewn on the film, but that was only done to indicate the effectiveness of the machine. At the same time, Mr. Anderson said, there were places of which he knew where two cuts were desirable; for example, where two dirt bands come into the seam, and it was desired to cut these out and get the coal clean.

With regard to the point made by Mr. Gemmel about holing and shearing, he wished to point out that the machine did not produce so many cuttings from the shearing as from the holing. In the holing the machine was taking out, say, a six inch cut for the whole width of the place. In the shearing it was taking out that six inch cut for the height of the coal only. That is to say, when working a six foot seam it means taking six inches in the holing from the six feet; if driving a place fourteen feet wide it means taking away six inches only, with the shearing from fourteen feet, so that in that respect the holing is the bigger sinner.

With regard to the life of the machine, it is not dead yet: that was all he could say, excepting that there was no sign of any wear at all really. The gearing was designed to stand the strain, and whilst any additional gear must mean extra wear, it was not possible to give any close indication of how long it was likely to last.

Mr. GEMMEL.—In the actual holing the cutting is in line with the stratification, in the shearing it is at right angles to it. Had Mr. Anderson taken any note of the comparative power required in the two operations?

Mr. ANDERSON said he had done so, but could not quote the figures from memory; the shearing took less power than the holing. He accounted for that largely by the fact that in the shearing cut the holings were cleared much more easily, there was no jamming of the chain. He had always felt that a very large part of the power consumption in coal cutting was due to the holings and not to the actual cutting. Of course, one could not dogmatise on that: there were places where the actual cutting did consume a lot of power, but in this instance the shearing took less power than the holing.

Mr. JOHN GEORGE (Secretary, National Association of Colliery Managers, Scottish Branch): on behalf of the National Association of Colliery Managers, said he would like to say how grateful they were to have this annual invitation to join the A.M.E.E. in a joint meeting, and speaking on behalf of his colleagues, said he believed that there had been no joint meeting that they had enjoyed more than this one. The A.M.E.E. always saw to it that they had a splendid paper to offer when the Colliery Managers came to join them. To-day he thought they had surpassed themselves in having a splendid paper, a splendid reader of the paper, and a splendid cinematograph film to show illustrating the paper. He was sure that the mining community of Scotland was very grateful indeed for the high prestige and the high altitude in machine mining that had been reached by Messrs. Anderson, Boyes & Company, which they were all proud to claim as of Scotch origin. They were glad to have such a progressive firm in the Lanarkshire and Scottish coalfields. The joint meeting had been a very great pleasure and he trusted that his Association would in turn, be able to provide as interesting and useful a paper when they returned the compliment of arranging a joint visit with the A.M.E.E.

Mr. George proposed a vote of thanks to the Chairman, Mr. Holmes: the West of Scotland Branch was to be congratulated on having a President such as he. Mr. George confessed to feeling a little envious when he heared Mr. Gibb, the Secretary, read those names of new members joining up. He was afraid it was not every Association could show a balance sheet like the one they had heard; he was sure the A.M.E.E. could also be congratulated on having such an able Secretary as Mr. Gibb.

SOUTH WALES BRANCH.

Electrical Measuring Instruments.

ROWLAND H. MORGAN.

(*Continued from page* 336.)

POWER FACTOR INSTRUMENTS.

Power factor indicators differ from the instruments already dealt with in that a measurement of quantity is not involved but that of a ratio of two quantities, whose magnitude must not affect the correct indication of their ratio. A controlling force such as that provided by gravity or a spiral spring must not, therefore, be provided. A dynamometer type of instrument is readily adapted for power factor indicating. Fig. 35 shews the connections and arrangement of a single phase indicator which consists of two moving pressure coils and a stationary current coil. The two pressure coils are permanently fixed at right angles to each other, in the form of a cross, upon a spindle which also carries the indicating pointer. These two coils are mounted inside the stationary current coil so that they are capable of rotating. A phase difference of almost 90 deg. is obtained between the currents in the moving coil A and the moving coil B by a phase splitting device consisting of a non-inductive resistance and a choking coil which is highly inductive. The conditions are such that the two moving coils produce a rotating field and the coils will take up a position in relation to the current in the fixed coil. This position will be such that at the moment of maximum field due to the moving coils, the maximum field of the fixed coil will coincide with that of the moving coils. When unity power factor obtains, the maximum field due to the moving coils will be that due to the coil A alone and will coincide with the maximum field in the fixed coil, for the current in the fixed coil is in phase with the current in the moving coil A, but practically 90 deg. out of phase with the current in the moving coil B which therefore exerts no torque.

As long as the power factor remains unity the moving coils will maintain the position of coil A lying coincidently to the fixed coil, for at each reversal of the current in the latter, a reversal also takes place in the moving coil A. Should the current lag 90 deg. behind the pressure, the current in the pressure coil B will be almost in phase with the current in the fixed coil and these two coils will now lie in the same plane. Similarly the moving coils will take up certain positions for other power factors so that the maximum field of the fixed and moving coils coincide in time and position and give a deflection equal to the phase angle of the circuit involved.

The use of the necessary phase splitting device introduces errors, for the inductance does not remain constant with varying frequencies and pressures. A similar arrangement is suitable for a two-phase circuit except that the natural angle of 90 deg. between the phases is used instead of the phase splitting device and the frequency and voltage errors thus avoided.

For three-phase balanced circuits a single stationary current coil and two moving pressure coils (set at 120 degs.) may be used as shewn in Fig. 36. In this the lagging of the current in the fixed current coil causes that current to be more nearly 90 degs. out of phase with the current in one pressure coil and more nearly in phase with the current in the other pressure coil so that dissimilar forces are exerted on the moving coils and deflection results. For three-phase unbalanced circuits the moving system consists of three star-connected pressure coils spaced at 120 deg. apart and the fixed coils are three in number also set at 120 deg. apart, one being connected in each phase. Rotating fields are set up by both fixed and moving coils and the moving system will set itself so that the rotating fields are in time phase agreement, the deflection to do so being an exact indication of the phase displacement.

In all dynamometer indicators, connections to the moving coils are necessary. These usually take the form of thin gold or silver flexible threads which exert very little control upon the moving system. Such connections, however, prevent a complete rotating motion and may lead to false indication if the power factor reverses when the moving system is near the end of its motion for the pointer may hold against the stop and not reverse around the scale.

The induction or moving iron type indicator has a moving system capable of a complete circular rotation free from any control. Such indicators have no moving coils, the moving system consisting of soft iron vanes upon which acts the resultant field. The vanes are magnetised by a pressure coil and a rotating field is produced by current coils surrounding the inner pressure coil and moving vanes. The operation is similar to that of the dynamometer type excepting that the moving iron vanes now set themselves coincidently with the rotating field at the moment when maximum magnetisation of the moving iron occurs. With a change of phase angle the iron vanes are deflected to a similar degree and act as would a moving coil. Similarly, the centre magnetising coil may be a current coil and the rotating field produced by pressure coils. The general arrangement of such an instrument is given in Fig. 37.

The chief objection to this class of indicator is the rotational drag exerted upon the moving system by the rotating field, while the rather high inductance of the centre coil introduces a liability to frequency error. Their accurate use on unbalanced load is prevented by the influence of one coil on an adjoining coil's vane.

The arrangement of an instrument suitable for three-phase unbalanced load is given in Fig. 38.

Three iron vanes, set at 120 degs. apart, are magnetised by a pair of coils which have similar poles adjacent, one vane lying between each pair of coils. The three pairs are star-connected with each pair in series and are almost non-inductive. Stray field interference with adjoining vanes is avoided, the frequency error is considerably reduced, the concentrated field provides increased torque and rotational drag reduced.

Another indicator introduces, in place of the rotating field, an alternating or oscillating field and so completely eliminates rotational drag. This is arranged by the use of a pair of current coils connected in series and in one phase, with one coil on each side of the pressure coils and vanes as shewn in Fig. 39 which gives the internal diagram of a single-phase instrument. A similar arrangement but with an increase in the number of vanes and pressure coils only, is suitable for balanced three-phase circuits, and for unbalanced three-phase circuits with additional current coils also, the latter being set with their axes parallel to each other and in separate parallel planes on each side of the pressure coils and vanes.

FREQUENCY INDICATORS.

A frequency indicator of simple design is the vibrating reed type. It consists of a number of thin steel strips arranged in a row or other convenient manner, the reeds possessing a natural frequency of a range suitable to the desired range of the instrument. An electro-magnet is energised by the circuit whose frequency it is desired to measure, so that magnetic impulses are applied to the reeds and agitate them to a degree comparable with their natural frequency. That reed which has a natural frequency corresponding to the impulses of the circuit vibrates violently, and the others in a less degree according to their respective fre-

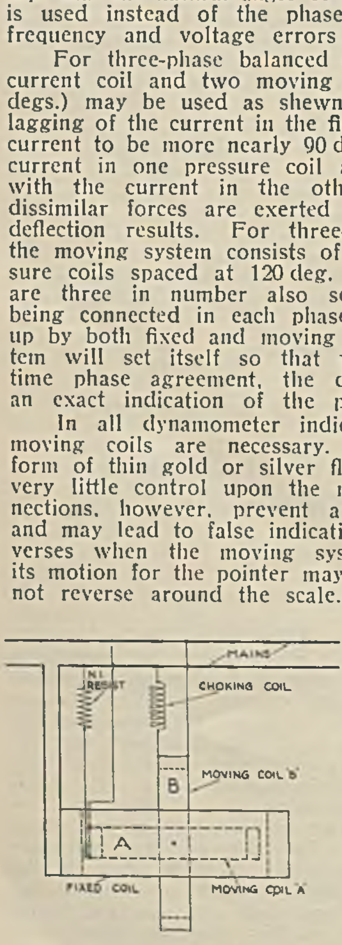


Fig. 35.

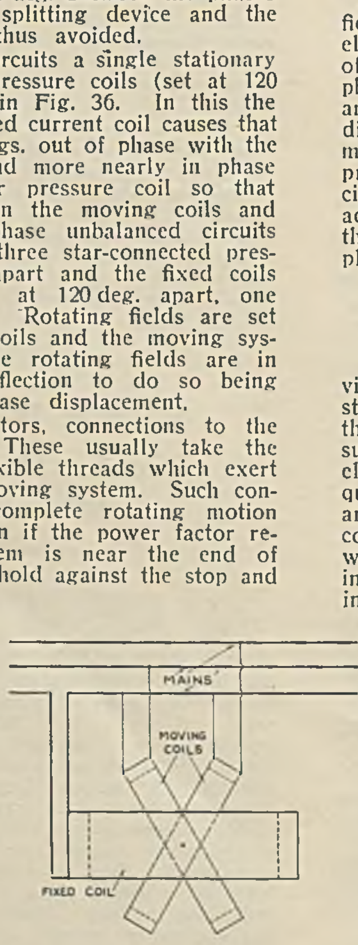


Fig. 36.

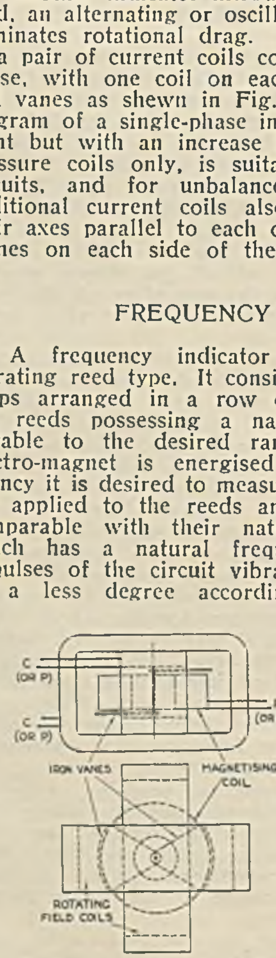


Fig. 37.

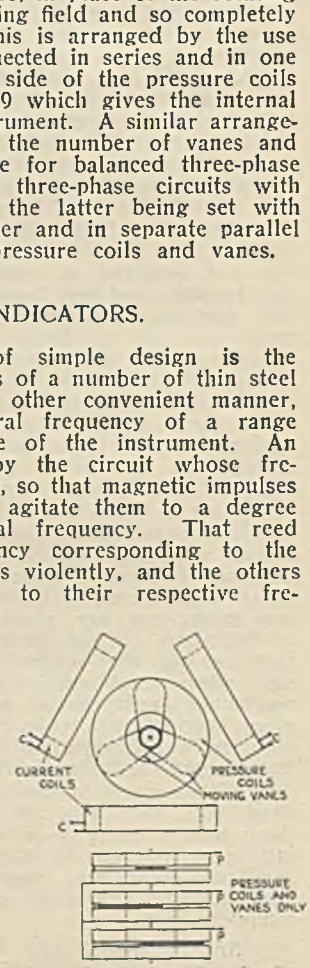


Fig. 38.

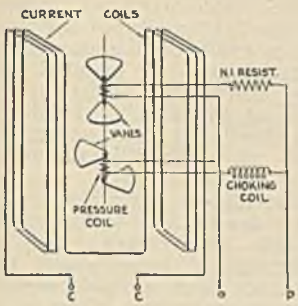


Fig. 39.

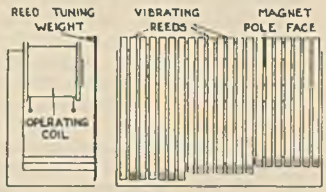


Fig. 40.

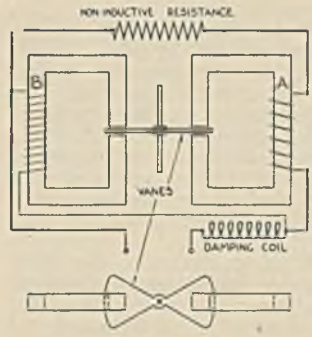


Fig. 41.

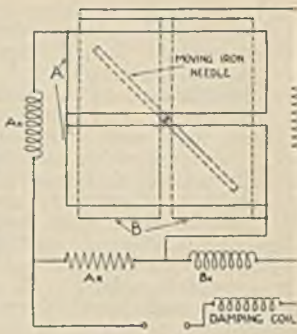


Fig. 42.

quencies. The general arrangement of such an instrument is given in Fig. 40. The natural frequency of the centre reed usually corresponds to the normal impulses obtaining in the circuit, with lower and higher frequency reeds, differing by a quarter or half frequency, on each side respectively. In some instruments of this type the support to which the reeds are attached is magnetically vibrated, which results in a precisely similar functioning of the reeds.

Another class of frequency indicator depends for its action upon the increase of inductive reactance with an increase of frequency, and gives a deflection indication permitting of greater accuracy than is afforded by the vibrating reed type. The general arrangement of such an instrument which involves the induction principle is depicted in Fig. 41. The inductance of the electromagnet A is almost unaffected by frequency variation, its winding being in series with a high non-inductive resistance whereas the inductance of the electro-magnet B varies inversely as the frequency. An additional choking coil is incorporated to render the instrument independent of wave form by damping out the higher harmonics. The two electro-magnets are so arranged that at normal frequency their tendency to urge the vanes in opposite directions is balanced. The torques exerted by A being constant, while that due to B varies with change of frequency, provides a deflection of the needle proportional to the frequency of the circuit.

A similar class of instrument in which a moving, thin, soft iron needle is caused to deflect with the resultant field of two current carrying coils is depicted in Fig. 42. Ax and Bx are inductances and Ar and Br non-inductive resistances, Ar and Bx being connected in series across the instrument terminals, with the inductance Ax and coil A, and the resistance Br and coil B, shunted across each respectively. A uniform and strong field is provided by the two operating coils, which are fixed at right angles, along which resultant fields the moving iron needle lies. With an increase of frequency an increased current flows in circuit B due to an increase in inductance in Bx, whilst Ar remains unaltered, and the increased inductance of Ax decreases the current in the circuit A. The moving iron needle now takes up a position along the resultant field of the two coils which will vary according to the current flowing in each coil as dependent upon the frequency.

Other instruments depending upon the same principle of increase in reactance with frequency, but with various moving and energising arrangements such as an oppositely faced pair of coils each attracting a soft iron armature in opposite directions around a common spindle are also used, while another distinct type makes use of the change of capacity with a variation in frequency.

RECORDING INSTRUMENTS.

Recording instruments have not been separately dealt with as they are in general but a mechanical development of indicating instruments in which the spear head of the pointer is replaced by an inked nib. This nib rests on and marks a roll (or disc) of suitably scaled paper which is kept passing under the nib by being wound off one drum on to another, rotation being provided by a hand or electrically wound clock or small motor.

In conclusion, the author wishes to acknowledge with thanks his indebtedness to the many British firms who so successfully specialise in the manufacture of electrical instruments and who have so willingly provided the matter essential to the preparation of a paper of this character.

LONDON BRANCH.

Oil-Filled Electric Cables.*

Discussion.

Mr. S. AUSTEN STIGANT, discussing means for coping with cable expansion, said he had noted, from a photograph, shewn by Mr. Horley, of six joints on 66 k.v. oil-filled cables in London, each joint being in a separate concrete container, that there were three bolts fitted to each container to hold the cable rigidly on each side of the joint in order to relieve the latter of the stresses set up by cable expansion. He asked what provision was made for taking care of the expansion set up in the cable itself as the result of variations of load. Further, he said he had not yet seen any references to the application of the oil-filled system to multi-core cables, and he asked whether there were any inherent difficulties in applying it to such cables.

Mr. Stigant also asked to what extent the introduction of the hollow-core oil-filled cable increased the current-carrying capacity, and to what extent, if any, the dielectric stress on the cable insulation could be increased by virtue of the larger diameter of the central core.

Finally, he asked if Mr. Horley had experienced difficulties arising from the sludging of the oil in the hollow core. Sludging was a possibility in all mineral oils; but he appreciated that the internal temperature in an oil-filled cable was considerably lower than that in transformers for instance.

Mr. F. HEPPENSTALL suggested that, in referring to the oil-filled cable as something of a novelty, Mr. Horley had not gone far enough; it was really an epoch-making innovation, as important in electrical science as was the invention of the steam turbine by Mr.—now Sir Charles—Parsons. Scientific progress was so rapid, he said, that there was a tendency to overlook such facts, but when one considered that it was possible, by means of oil-filled cables, to transmit large blocks of power at 220,000 volts with perfect safety, one must admit that the invention was one of the very first importance.

* See *The Mining Electrical Engineer*, March 1930, p. 351.

Discussing the problem from the users' point of view, Mr. Heppenstall referred first to the reliability of the oil-filled cables. It had been mentioned by Mr. Horley, he said, that the oil-filled cables in America would carry 100,000 k.w. at 132,000 volts, but it was well to add that these were the largest cables in the world at the time they were put into operation, and that the power company which had installed them were liable to a penalty of 400 dollars (£80) for every minute during any cessation of current, and that there was no spare cable. Those facts were sufficient testimony to the reliability of 132,000 volt oil-filled cables.

Another attribute of oil-filled cables was that they were extremely robust. All cable engineers in England had in the past been extremely careful in the handling of high-tension cables in cold weather, particularly if they happened to be 33,000 volt cables. They did not bend them at too sharp an angle, and they did not bend them twice if they could avoid it.

On the other hand, referring to the laying of a 132,000 volt oil-filled cable in America, he recalled that Mr. Emanueli, the inventor of the system, had read a paper with regard to it before the Institution of Electrical Engineers about two years previously, and had exhibited a cinematograph film showing the installation of a 132,000 volt cable. It was being installed by means of a Ford tractor, which travelled along the street surface pulling a rope through a manhole, the cable being attached to the end of the rope, and being pulled into ducts under the street. He (Mr. Heppenstall) did not know what was the temperature at that time, but the driver of the tractor was clad in furs, and there was snow and ice on the ground. It had been a great surprise to him to see the handling of a 132,000 volt cable during weather in which we in this country would hesitate to handle 11,000 volt cables.

Another point which had impressed Mr. Heppenstall was that of the extreme care with which the details of the system had been thought out. Some few years ago the fluid oil-filled cable system was tried in this country, but was not successful, for reasons given by Mr. Horley. The particular cable he (Mr. Heppenstall) had in mind was a three-core cable to transmit current at 66,000 volts pressure. It had no fillings, and the lead was in the form of a "triangular helix". The oil ducts were the space between the cores and the triangular spaces between cores and lead sheath. The cable was installed with no breathing appliances; the end of it was coupled to three single-core cables, each of the latter being coupled up to an ordinary tank at the top of the transmission line poles. It must be borne in mind, of course, that when a cable was being heated up under load something like an irresistible force was being introduced; the oil must expand, and, in expanding, it had to go somewhere. In this cable, however, no space was provided into which the oil could expand, and there was no supply of any magnitude from which oil could be drawn to fill up the cable when the oil contracted, due to decrease of the load and reduction of temperature. As a result, two difficulties arose. In one part of the cable a partial vacuum was formed, and eventually the cable broke down electrically at that particular place. In another part of the cable the mechanical pressure of the oil when trying to find a way out of the cable was so great that, although the cable was a very strongly built and substantial one, with heavy armouring, it had burst.

The up-to-date cables and accessories Mr. Horley had exhibited, however, were the result of the exercise of meticulous care by experts in such matters as the expansion of oil with increase of temperature and the friction of oil in the ducts in which the expansion has to take place, and the provision of sufficient facilities for the accommodation of the increasing quantity of oil expelled from the cables as the temperature rises. He believed there was no reason why oil-filled cables should not operate at any temperature up to 80 degs. C., or possibly 100 degs. C. He had seen the system in operation, and congratulated the patentees upon having catered for every known point connected with the technique of cable making for extremely high voltages.

Mr. A. F. W. RICHARDS, after paying a tribute to Mr. Horley, asked what type or quality of oil was used for the cables, and whether any provision was made for the heating of the oil containers. He pointed out that even in this country we experienced variations of temperature from zero Fahrenheit to probably 140 degs. Fahrenheit in the sun, and asked whether those variations affected the viscosity of the oil sufficiently to upset the balance.

He also enquired as to what lengths the cables could be made, and whether special drums had to be made for them. Commenting on Mr. Heppenstall's remark that the cables could be operated at temperatures up to 100 degs. C., he said he did not think anybody in the world was operating three-core super-tension cables at a temperature higher than 60 degs. C.

Finally, he congratulated the Association of Mining Electrical Engineers upon having secured from Mr. Horley a paper containing so much valuable information which, he believed, had not been published before in this country.

Mr. J. R. COWIE (Branch Hon. Secretary), referring to the pressures at the terminal ends of transmission lines, said that the pressures exerted on a terminal sealing bell or an ordinary end box could be surprisingly high. Figures put before him had shewn that the pressures on terminal end boxes varied from 80 lbs. to as much as 400 lbs. per square inch. It seemed to him that there was some limiting head to which Mr. Horley was working, and it was just possible that, towards the terminal ends, he was putting in diaphragm sealing joints. In any case he asked Mr. Horley to make the point clear, because it was becoming of increasing importance in various sections of industry.

Mr. Cowie said he believed it was no secret that high-voltage cables, carrying current at even 220,000 volts, were being taken right into the middle of big cities, and the problem of the ways and means of handling and distributing the power there had been solved; but one of the main problems was what would be the pressure on the end joints or end boxes or sealing bells at the points at which the cables were joined up with other apparatus.

With regard to the oils to be used, Mr. Cowie said that a certain amount of research was being conducted, and it had been found that an oil which was shewn to possess a reasonably high dielectric value when tested by the well known methods might yet contain a dangerous percentage of moisture. He asked Mr. Horley if special precautions were taken to ensure that the oil used was reasonably free from moisture.

Mr. R. E. HORLEY, replying to Mr. Stigant's question as to the means adopted for taking care of expansion in the cables themselves in the London installation of oil-filled cables, said that those cables were laid in the familiar triangular formation, but they did not remain in the same relative positions throughout the whole of the length between joints. Over part of the route the top cable was laid over against the bottom cable, and was then brought back to the original relative position before the next joint was reached. Each cable was treated in that way, so that there was a definite amount of slack between any two joints, allowing scope for expansion. At the same time, he, personally, did not consider that that precaution was really necessary.

There was no reason at all why multi-cored cables of the oil-filled type should not be made. In fact, there was a 60,000 volt cil-filled three-core cable working in Milan. This was an ordinary belted type cable, but the oil channels were formed in the lead sheath itself, between the belt and the lead. The joints were of the ordinary straight-through Pirelli type. It was working quite satisfactorily, and no trouble had been experienced. So far the attention of his Company had been concentrated upon 66,000 and 132,000 volt cables, and if cables of that type were made with three cores, the diameters would be too great, the lengths of cable which could be handled would be shorter, so that the number of joints would be increased. As the voltages at which oil filling was used decreased, he had no doubt we should adopt oil-filled three-core cables. In America three-core cables of the oil-filled type were used even down to 11,000 volts.

Dealing with the question as to the extent to which oil filling increased the carrying capacity of cables, Mr. Horley said that obviously it varied with the size of conductor, but he mentioned, as a guide, that in the normal type cable the temperature rise accepted was usually about 30 deg. C., starting at 15 deg. and rising to a maximum of 45 deg., some makers claiming that they could deal with a temperature of 50 deg.; but an oil-filled cable could deal with a temperature rise up to about 60 deg., so that there was a wide margin. The specification for the London installation had demanded heat cycles up to 100 deg. C. on cable laid in the ground. His Company had carried out those cycles without trouble, and had demonstrated that the cable was just as good afterwards as it was before. They were then requested to carry the heat cycles as far as they could, but with the apparatus at their disposal they could only go to 135 deg. C., and after that it was demonstrated that the cable was just as good as before.

It might be asked why the oil containers were not maintained at a temperature of 100 deg. C. The answer was that if large temperature ranges such as that were to be used, obviously, the pressures to be dealt with would increase and that would mean either the provision of very much more apparatus or else the strengthening of the cable to a very large extent.

Further, a certain amount of trouble would probably be occasioned in the joints. The joints had to be wiped, and the jointers of oil-filled cables were given special training. The average jointer could not wipe a joint really properly, but the defect was not noticed because in the normal type of cable the compound was so viscous that trouble did not arise. When an average jointer wiped an oil-filled cable joint one began to appreciate that he was not so skilled as one had imagined him to be. Therefore, it was found advisable to give jointers a short course of training in the jointing of oil-filled cables.

There was no danger of sludging of the oil; sludging was caused by oxygen in the air, but all the air was carefully removed from the oil-filled type of cables before they were laid, and they were hermetically sealed. Further, the oil used for the cables was a high-grade transformer type of oil, it was just a little more viscous than the ordinary transformer oil.

With regard to dielectric stresses, Mr. Horley said that in connection with oil-filled cables, if we had erred at all, we had erred too much in the direction of safety. For oil-filled cables his Company were using only half the amount of insulation used on the normal type cables. For a 66,000 volt cable they were using only 8½ mm. of insulation. Such a cable, working at 66,000 volts, had a pressure to earth of about 38,000 volts. They had carried out life tests, at 160,000 volts, for 500 hours, and the cable had been totally unaffected thereby, so that the factor of safety was enormous. Life tests had been carried out on the 132,000 volt cable at 350,000 volts, and there had been long period tests also up to 400,000 volts, so that there again the margin of safety was very great.

They were also making a 33,000 volt oil-filled cable in which they were using 5 mm. of insulation, which contrasted with the 8½ mm. in the normal type of cable. The pressure to earth in that case was 19,000 volts. After life tests had been carried out at 90,000 volts, the cable was unaffected.

The type of oil used had a freezing point below minus 30 degs. C., so that difficulties in regard to the oil would not arise when laying the cables during winter.

With regard to the bending of the cables, he said that because the oil was so fluid they could be bent to sharper angles than could the normal type of cable. The cables were full of oil when wound on the drums finally and when being laid, and there was no fear as to the effects of bending. There was no heating of the containers, because the oil was not too viscous even in cold weather. The viscosity of the oil increased as the temperature dropped, so in calculating the size of tanks and the pressure they examined the oil at all temperatures at which the cables were likely to operate, and at temperatures beyond the operating temperatures, and took into account the viscosity, because there was a moment during the cycle in which the pressures rose to a maximum. This was not at full load, but when switching on at about one-third full load.

Replying to Mr. Cowie, Mr. Horley said that with the oil-filled cables there was no difficulty in maintaining the terminals fully impregnated. If a terminal were anywhere a large change in the profile of the line, so that there was likely to be a big pressure, they could put in a stop joint and a small pressure tank to take the pressure on the terminal. With regard to connections to overhead lines, he said that in America, where very bad storms were experienced, experiments were carried out in which two or three lengths of oil-filled cable were connected to an experimental overhead line. These were shocked with voltages of 500,000 several times, and the cable was then dissected in order to ascertain if it had suffered, but it had not, and it was concluded that the factor of safety was enormous.

The "drying" of oil, of course, was done in steam-heated containers under vacuum in the ordinary way, and the oil was tested in the normal way between a standard gap. A breakdown figure of 50,000 volts had to be obtained before the oil was accepted, and that was a fairly high figure.

WARWICKSHIRE & SOUTH STAFFS. BRANCH.

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

The fifth branch meeting of the session was in the form of a visit to the Witton Works of the General Electric Co. Ltd. on January 23rd. last. Members assembled outside the Company's Offices in the early afternoon and were later escorted by guides through the shops. Much interest was found in observing modern practice in the construction of motive, generating and transforming equipment from units of fractional form to the titanic ratings which requirements have made it necessary to develop. The switchgear aisles proved no less interesting, and in the few minutes spent inside the h.t. test laboratory it was demonstrated that pressure tests up to 1,000,000 volts could be made and frequency tests of similar magnitude.

The party took tea at the Magnet Club at the very kind invitation of the management, and Mr. Whitford speaking for the Company mentioned his regrets that it was not possible for the promised paper to be given or the tests carried out on Flame-proof Apparatus owing to the unavoidable absence of the Author, but that Mr. H. J. Coates would describe the apparatus which was under construction for the grid scheme of the Electricity Commissioners.

Mr. Coates produced a model of the steel terminal structures, which previously had been seen in course of assembly and outlined the general features. He very ably drew attention to the many difficulties which it was necessary to surmount in the design of super-tension apparatus and readily dealt with the questions addressed to him.

Mr. A. HULME, the President, tendered to the Management the very sincere thanks of the Branch for the excellent entertainment during their visit, and to Mr. Coates for his interesting paper.

Mr. WHITFORD in response said that it was the pleasure of the Company to be of service, and expressed regret that the time available was insufficient to enable them to conduct an extensive tour, but that they may have the opportunity at some later date of being again able to assist in a similar manner.

Postal Addresses.

It often happens that members of the Association of Mining Electrical Engineers on making a Change of Address neglect to send notification to their Branch Secretaries; the result is confusion, complaint, and disappointment at non-delivery of "The Mining Electrical Engineer". Will members kindly note this reminder—and remember also that the publishers cannot accept responsibility for the provision of back numbers consequential upon failure to advise new and correct addresses.

Obituary: Mr. James Perritt.

The Lothians Branch of the Association of Mining Electrical Engineers sustained a great loss by the recent death of the President, Mr. James Perritt. Mr. Perritt was a very active and valuable member of the Association. He devoted considerable time to the interests and affairs of the A.M.E.E. and was held in the highest esteem by his colleagues and many friends.

The Care of Power Plant.

At a recent meeting of the Electrical Power Engineers' Association, Messrs. W. J. Oswald and E. W. Greenway read a paper entitled "Some Notes on the Maintenance of Station Plant."

The supreme importance of cleanliness in every direction was emphasised, as was the necessity for general and periodical inspection of switchgear, time-limit fuses, switch contacts, instruments, cables, and cable boxes.

Turbo-generators should be thoroughly warmed through before starting up, and should be brought up to speed gradually, except when passing through the critical speed which, when reached, should be passed as quickly as possible. There was a tendency on the part of the running staff to have the pressure of brushes on sliprings or commutators much greater than was necessary.

For the joint between the bottom and top halves of turbine casings a mixture of 50 per cent. manganese and 50 per cent. foliac was recommended; where there was an unevenness in the surface due to distortion, particularly at the high-pressure end, asbestos string with a copper-wire core should be inserted.

When cleaning condenser tubes, it was asserted that some cleaners used under-sized brushes, which made the work easier, but was practically useless. A brass-wire brush was more effective than a steel-wire brush.

Daily tests should be made of samples taken from the water entering the boilers, and the condition of the water should be such that the results obtained showed a hardness of 0.5 deg., with a phenol test of 0.5, and a total alkalinity of 1.0. The authors had proved conclusively that if such conditions were maintained in the feed water, the amount of scale in the tubes after 12 months' steaming would not be more than egg-shell thickness, and a 50,000 lb. boiler could be cleaned out in four days. It was necessary also that the density of the water in the boiler should not exceed 600 grains per gallon, and to achieve that it was recommended that the water should be changed once a month rather than daily to blow down the boiler, say, 3 or 4 inches. When a new tube was installed, it was a good practice to paint the inside with a graphite paint, which assisted considerably in keeping the tube in a clean condition. Incidentally, it was recommended that a coat of similar paint applied to the turbine blades would assist in preventing corrosion and in keeping the blades clean.

With regard to mechanical stokers, the authors strongly advocated the practice of making one man responsible for maintaining the lubricating system in an efficient condition. It was a mistake to allow a grate to run after it had commenced to bind on the sides, as considerable damage might be done to the driving gear, and, in running, frequent stoppages would occur, causing difficulty in maintaining proper steam pressure.

In connection with steam-turbine-driven feed pumps, the importance of fine clearances was emphasised, and the necessity for having a system whereby the essential clearances were checked at regular and frequent intervals was advocated.

Dealing with the maintenance generally of centrifugal pumps, surprise was expressed that a number of manufacturers supplied a design of gland in which the end of the neck bush and the end of the gland were square with the shaft. It was necessary that those parts should be chanpherred, so that when the gland was tightened up the packing would be pressed down on to the spindle.

The view was also expressed that it should be the responsibility of one man to keep the motors of auxiliary plant in a clean and reliable condition, it being pointed out that the breakdown of even a small part of the auxiliary plant might place a torbo-alternator or a boiler unit out of commission, or considerably restrict its duties.

On superheated-steam pipe lines, brass joint rings should not be used; a cuprous-nickel ring of 80 per cent. copper and 20 per cent. nickel had been found the best to withstand superheat. The use of ordinary screwed and socketed joints, however small, for steam pressure pipes was strongly deprecated, while in the smaller-sized pipes the use of adaptable unions was recommended.

Special emphasis was laid upon the need for close attention to valves. A frequent cause of valve spindles being hard to operate was their being allowed to get into a dirty condition, and that particularly applied to valves fixed in a horizontal position.

Personal.

Mr. R. W. Glass and Mr. Frank Lee, M.P., have been appointed members of the Safety in Mines Research Board to fill the vacancies caused by the retirement from the Board, under the rotational scheme of retirement, of Sir John Cadman, G.C.M.G., D.Sc., F.G.S., M.Inst.C.E., and Mr. A. M. Henshaw, J.P., F.G.S., M.Inst.C.E., M.I.M.E.

Mr. William Whiteman has been presented by his colleagues with a silver chain and medallion on his retirement after forty-seven years' service with the Ocean Colliery Co. Ltd., Treharris, Glam. Mr. Whiteman was a member of the electrical staff.

Capt. H. G. Bell, M.Sc. (Tech.) has been appointed by the Central Electricity Board to be Technical Assistant to Mr. Robert Blackmore, Chief Engineer for the North Western Section of the Grid. Capt. Bell received his technical training at the Manchester College of Technology, including a post-graduate course of research work on commutator problems at heavy overloads, for which he received his M.Sc. degree. During the war he was commissioned to the Lancashire Fusiliers and served with the 42nd Div. Signal Company on Gallipoli. Afterwards he was in charge of the officers' and cadets' technical school in the R.E. Signal Service Training Centre, and was later seconded to the Admiralty for research work in connection with submarine detection. Since the war he has had a variety of interesting experiences with the Metropolitan-Vickers Electrical Company. For two years he was the Company's liaison engineer with the Westinghouse Company in America and on his return was made responsible under Mr. A. P. M. Fleming for the design and operation of a broadcasting station which was set up in the Company's Research laboratories at Trafford Park. This was the second broadcasting station in the country to run a regular daily service of programmes. Subsequently Capt. Bell was chief assistant designer of the radio apparatus developed by the Metropolitan-Vickers Company. For the last four years he has been engaged on the design and application of protective equipment for power transmission systems.