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Generate Power at the Coal Source.

Once a water-power station is established, the cost of its current output is practically irreducible because of its being so intimately based upon the initial cost of the scheme, whereas the price of current from heat-electric stations responds to the price of fuel and, above all, to such economies in its use and improvements from time to time as can reasonably be anticipated. This in effect epitomises a lucid argument by "The Colliery Guardian" against any precipitate action of the Electricity Commissioners and similar authorities to sanction certain hydro-electric power schemes for Scotland. Several examples of established hydro-electric systems in Great Britain, South Africa, the United States and the Continent are cited as showing that already it has frequently happened that steam-power electric stations have proved to be the more economical generators of current within the areas covered by the respective hydro-electric systems. These are cases in actual existence and tend to pin the arguments down to hard irrefutable facts. It would, therefore, appear to be fairly obvious that in this country where cheap coal abounds, ready to hand and on the spot, every proposal to establish hydro-electric plant for bulk power generation must, to say the least, be viewed with the closest circumspection.

Whenever expression is given to the commercially disinterested opinion, one which is so clearly founded on a basic truth, that the best place in which to generate electricity is at the coal pit, the interested dissentients almost invariably raise the point that an ocean of water for condensing is much more important than cheap fuel. It is, however, none the less true that there are very large steam stations which show strikingly low costs without having unlimited water resources. In the article mentioned attention is directed to the notable success of at least two large colliery steam-electric power stations in this country which manage with the water raised from the pits. Moreover, it must surely be generally agreed that British collieries, as a rule, have more than sufficient water available: in many cases water in such overwhelming profusion as to be a perpetual menace to their very existence and which, at great expense has to be got rid of in order that the pits may continue in work at all.

Coal using power stations of large capacities are, generally speaking, cheaper in first cost than the equivalent large power hydro-electric stations. The charges on dead capital sunk in civil engineering works and in special plant are so proportionately great with the hydro system that it is permanently handicapped in regard to the market-price of the K.W. hour. On the other hand the electric power station is readily adaptable to the economic developments of heat and electrical engineering which are still coming so rapidly forward: in fact, from this point of view, it might be said that the capital of the steam-electric station is mainly in liquid condition, the design and structural features of the plant are in accordance with common standards, and pre-eminently suitable for adaptation or financial realisation at the dictates of technical and economic progress.

Then there is the question of the expense of electrical transmission. This is in some cases the item which has finally put the hydro-electric system out of the running in favour of the modern steam-power station in the same territory. It has also been another of the leading opposing arguments advanced against the economic practicability of establishing the electric generating works at the pit top.

Bring Industries to Labour, Coal and Power.

Rather than pursue this particular phase of the subject on the lines upon which it has so often been discussed, may we now lead the subject of electric generation and transmission into an unusual channel, generally overlooked, and mention "transference of labour"? As a feasible remedial measure against unemployment it has been accepted that the redundant labour of the colliery districts shall be transferred to other industrial centres. Behind the acceptance of this policy is the settled conviction (and look at it as one will it would appear inevitable under present mining methods) that even when the coal mining industry has been restored to its full activity there will still be very many miners without work. This is not to say that the coal industry, when modernised to that extent which the early future promises and which would carry its methods and processes beyond the mere getting of coal, will not in time demand more and more labour. Such changes can, however, only come gradually and some principle bringing immediate relief is being sought. But surely the transference of surplus mining men to industrial pastures new is a remedy entirely dependent upon the expansion of other industries, the extension of present works and the institution of new ones—which also rests with the future, which is gradual, doubtful and slow.

So it is that one is faced with the question: whether is it better to apply the method of transferring men from the collieries to non-colliery industrial centres, or to bring industries to the collieries? The latter alternative means that labour, cheapest power, fullest transport services in and out, cheap land and plenty, are all in existence on the spot and immediately available. Furthermore, whatever great developments in regard to industry are most likely to eventuate and mature in the near future and to assume large labour extent, the surest to happen so far as can reasonably be foreseen are those based upon the refinements and fuller utilisation of the wealth hidden in coal. This is but to touch upon some of the strong economic reasons which show that to establish and build up a permanently prosperous industrial condition in this country the best policy is to urge and encourage the concentration of manufacture around the collieries. The essentials of coal, heat, electricity and labour are there available in the readiest profusion. They are there, rooted by nature, and deliberately to waste their substance in expensive attempts to transplant or transfer them to other fields not more, but usually less, favourable to their growth and effective use is savouring of folly.

The North-East Coast Exhibition.

In view of the fact that Newcastle-on-Tyne is this year to be the rendezvous of their Annual Convention, members of the Association of Mining Electrical Engineers will read with interest of the plans and progress of the North-East Coast Exhibition. Especially is this so because the Exhibition authorities are kindly extending the A.M.E.E. every facility and hospitality. Constructional work on the buildings and ground is proceeding very rapidly: as a matter of fact the architect and contractors are in advance of the schedule time with regard to the two main buildings—the Palace of Industries and the Palace of Engineering. These are now ready, practically a month before the stipulated time and already the exhibits have begun to arrive.

The Exhibition is to be opened on Tuesday, the 14th May, provisionally fixed by His Royal Highness the Prince of Wales. The event will be a red-letter day for Tyneside and the presence of His Royal Highness should give the Exhibition a most enthusiastic send off.

It may be said without exaggeration that the Exhibition will be one of the largest and best that has ever been held outside of London. The primary object of the promoters is the stimulation of industry on the north-east coast. This area, like many more industrial centres, has suffered very badly as a result of the extraordinary economic conditions of past years. The number of workmen on the dole has been unusually large, and it is hoped that the coming Exhibition will be of the greatest assistance in bringing about a general revival of industry in the district.

Practically two months remain now before the Exhibition will be opened, and all is bustle on the site to get the finishing touches put in. Good progress is being made with the Stadium, the Amusement Park and the various erections on the grounds in which will be housed special exhibits.

The extent of the ground taken over for the purpose of the Exhibition amounts to over 100 acres. It is situated on the Town Moor, within easy reach of the heart of the city and the principal railway station of the London & North Eastern Railway Company. The lay-out of the buildings and grounds has been most favourably commented upon, and visitors will be more than delighted with the setting as a whole.

The combined floor space of the Palace of Industries and the Palace of Engineering amounts to two hundred and sixty thousand square feet, every inch of which has been fully booked. The exhibits will be largely representative of the numerous industries which have made the north-east coast of England known throughout the world.

The shipbuilding and marine engineering; electrical as well as mining engineering; and iron and steel exhibits will constitute one of the finest displays of British engineering manufacture and method ever brought together. All the exhibits will be British or Colonial.

Arrangements have been made for the grounds and exterior of the buildings being beautifully illuminated at night. Two searchlights will be in operation at the top of the two principal towers; while a magnificent illuminated fountain will add to the brilliance of the scene.

Hints for Examination Candidates.

By an Instructor in Mining-Electrics.

THE best preparation for a technical examination is got by attending definite courses of instruction such as are held at Technical Institutes and Colleges. In many instances, notably those of the evening, the classes are arranged exactly on the lines of the examinations held by the Association of Mining Electrical Engineers, the City and Guilds Institute, and the National Certificate in Electrical Engineering. The lecturers and teachers are necessarily approved by the Board of Education and often by the examining authorities, which affords the student the best assurance of suitability.

Occasionally the candidate has been prepared by private study. However earnest this may be, it must suffer more or less from limitations and defects which do not enter into the courses of study carried on at a Technical Institute.

The student would be well advised to consult the lecturer or teacher with regard to suitable text books. To gain the greatest advantage from the study of a text book it should be used as a work of reference; that is to say, when studying a given subject, the student should refer to it in his text book, to aid and elucidate and extend his lecture or laboratory notes already in hand. In this way he will perfect each branch of his work as he goes along. The student who reads a text book as if it were a novel, by devouring each successive page from the preface to the last full stop, tends to gain little beyond a headache.

Most Technical Institutes are now equipped with the necessary machines, instruments, and apparatus for demonstrating the principles underlying the subject, and students should wherever possible make personal experiments to support the theory of the subject. Records should be kept of all experiments and all inferences and details should be noted in full.

One year, at least, should be allowed for preparation for each stage or grade. Where evening work alone is possible, and in the more advanced grades, two years is often requisite.

The average evening student would considerably enhance his prospects of success in examinations if he would seek the advice of his lecturer or teacher (and heed it) before setting out on his work of preparation. Such advice is always to be had, it costs nothing, and may often prove invaluable.

The student's chance of passing his examination depends not only on his knowledge of the subject, but also to a very considerable extent on the way in which he sets about to tackle the examination paper when the fateful moment arrives. As in all other competitions, success is largely dependent on strategy, forethought, and carefulness.

Cases are not infrequent of students possessing sufficient knowledge to enable them to qualify, but who nevertheless fail at the examination simply through inability to tackle the examination paper in a reasonably skilful manner.

In most examinations it is usual for the candidate to be allowed the choice of a certain number of questions; as, for instance, a paper may be set with fourteen questions, and instructions given that the student may answer any eight. The writer once met a very enthusiastic student who had religiously worked through a complete paper and many days afterwards discovered that the explicit instructions printed on the questions paper were that not more than eight questions had to be attempted. He felt strongly of the opinion that he had passed, but the writer's prediction of a reverse order was, unfortunately, the only thing that came to pass.

It is usual to find certain instructions at the head of almost any examination paper, and these should be carefully read and mentally noted. The candidate would be then well advised to read through the questions noting, as he does so, the ones of which he feels perfectly sure with the answers, and also those of which he feels he has a fairly good chance of giving the correct answers. Small distinctive marks in pencil may perhaps be made alongside the respective questions in this connection.

It is usually found that the different questions carry different numbers of marks awarded, there being shown printed in brackets at the end of each question. It is clearly not necessary or advisable to limit one's selection to those questions which are the highest marked. Obviously these will contain the most difficult, and such a selection might seriously hamper one's chance of a pass. Nor, on the other hand, is it wise to pick all the lowest marked. In some cases a question may be low-marked because it is simple, but it may take a long time to work it out and put an intelligent answer together.

In a paper for which the usual three hours is allowed, 10 to 15 minutes occupied in a careful perusal and study of the various questions is time well and profitably spent.

In the answers it is most essential to stick rigidly to the essence of the question—that is to say, to avoid wandering off to points which do not most closely belong to the question as set. The answers should be clear, exact, and concise and, whilst giving fully the information asked for, should be as short as possible in length. In a recent report on one examination it was remarked that "in all grades a tendency to give rambling answers was noticeable," and that this should be discouraged in favour of conciseness.

Another report read: "The candidates showed weakness in the setting out of their workings which was frequently in a slovenly manner, leading to arithmetical slips." This is of great importance, as the object of the candidate is to show the examiner that he is perfectly familiar with the subject, and therefore if the mathematical side is not arranged in such a manner that the examiner can follow the steps taken, marks are lost. In many examinations a scheme of marking is adopted and very often more marks are given for the method in which the question is "tackled" than for the arithmetical or mathematical result.

Recent reports of examiners also show that candidates display a weakness in sketching, diagrams being poor and difficult to follow. Sketching should be assiduously practised by every candidate and, wherever possible, the student is advised to use sketches as being always preferable to long essays. Moreover, it often happens that a student has not sufficient command of language and composition to give a clearly understandable description, and it is far better for him to be able to make a really good sketch.

Students of any subject, or candidates for any examination, are strongly advised to read books other than their text book. There are free libraries in nearly every town and village, from which good sound literature can be borrowed. The general reading of books if perused with that definite object, give a student a wider knowledge and surer command of speech and writing.

There is still another method of gaining knowledge so as to be able to answer questions, and in the writer's opinion it is probably the best of all, that is, to write a paper on some subject for an Association or Society. Nearly all young members are afraid of showing how little they know, and fear they may incur something like ridicule at the meeting should they dare to present a paper. There is not the slightest evidence that anything of that kind ever occurs. The older and more experienced members are always prepared to help the beginner in every way possible: after all the start must be made by everyone, and the same experiences which appear difficult to the junior member have been met with and overcome by the older ones. Students, take an old member's advice: read a paper, however short it may be, on some difficulty you have experienced or any special occurrence you have noticed, and you will not only gain self-confidence, but some useful addition to your stock of knowledge.

The modern tendency in examinations is to increase the percentage of marks given for the *viva voce* portion, if any. Candidates are usually very nervous when before the examiner; there is no need for this if the candidate has a thorough knowledge of his subject. The examiners are not there to "plough" the candidate, but to see if he has sufficient practical knowledge. Often the questions asked by the examiner have some bearing on the questions set at the written examination, and the candidate who may have made a poor showing in his written answers, is given the chance of recovering lost ground by means of the oral questions.

Much more notice is now being taken of the work done by students during their attendance at the classes of the Technical Institutes and Colleges. Laboratory and experimental work is essential in all cases and laboratory note books should be well kept. The writer had a case a little while ago, where a student on the examination figures was a few marks below the pass standard; the examiner asked to see his laboratory note books, with the satisfactory result that the student passed the examination.

As a final hint, but by no means an unimportant one, the writer would strongly advise all students of mining electrical engineering to join the Association of Mining Electrical Engineers, attend the meetings and, if possible, take part in the discussions and visits. He will be agreeably surprised at the mass of useful information which he has gained in this manner. It is also as well to mention that much knowledge is available from the systematic perusal of suitable technical journals.

(*To be continued*).

Bristol Power Scheme.

The electrical equipment for the extensions to the large power station which the Bristol Corporation is constructing at Portishead is to be extended by the addition of a 50,000 K.W. turbo-alternator set which, together with important extensions to the boiler plant, switchgear and transformer equipment, is under construction by the Metropolitan-Vickers Electrical Company. The initial plant of this power station was put down in 1927 by Vickers Ltd., and later by the Metropolitan-Vickers Electrical Company as main contractors; the generating equipment then consisting of two 20,000 K.W., 3000 r.p.m. turbo-alternator sets, condensers, switchgear and transformers all being of Metropolitan-Vickers manufacture.

The new generating plant consists of a 51,250 K.W. turbine driving at 1,500 r.p.m. a main alternator of 62,500 K.V.A. and a house-service alternator of 1,560 K.V.A. The turbine is a two-cylinder machine designed for the existing steam conditions of the station, viz., 300lb. per sq. inch gauge pressure at the turbine stop valve and from 800 deg. F. to 830 deg. F. total temperature. The condenser is of the Metropolitan-Vickers central flow type divided to permit one half of the tubes to be withdrawn for cleaning while the other half is in operation under light load.

The supply of circulating water will be taken from the existing system, which is one of the most interesting features of the station. The water is taken from the River Severn by means of four culverts 7ft. 6ins. in diameter and 700ft. long, which have been constructed to be adequate for the ultimate capacity of the station. The circulating pumps are arranged in a pit 97ft. below the floor level of the station so as to be below the lowest recorded tide level, and are driven by motors on the turbine basement about 80ft. above the pumps. The condenser is mounted at such a height as to take full advantage of syphonic action. The equipment of the set includes steam-operated air-ejectors, feed-water heaters and double effect evaporators, all of Metropolitan-Vickers manufacture.

The new steam raising plant for the extensions includes two water-tube boilers each of 80,000lb. per hour normal capacity, together with stokers, forced and induced draught plant, economisers, air heaters and steam and water pipe-work.

The contract also includes extensions to the switchgear and transformer equipment both at the Portishead Station and at the Feeder Road Station at the other end of the 33,000 volt transmission lines. The switchgear to be installed will be similar to the metal-clad gear already in service at both stations. The new transformers for Portishead will consist of a 62,500 K.V.A., 11,000/33,000 volts, three-phase bank of single-phase units, and three 1800 K.V.A. three-phase units for station lighting. The new transformer equipment for Feeder Road will consist of a 25,000 K.V.A., 33,000/6,600 volts, three-phase bank in single-phase units. The new equipment at both stations will include oil-cooling and handling plant. The whole of the equipment is being supplied to the specification of Mr. H. Faraday Proctor, the Chief Engineer and General Manager of the Corporation Electricity Department.

Proceedings of the Association of Mining Electrical Engineers.

COUNCIL MEETING.

A meeting of the Council of the Association was held in Preston on February 16th last. A summary of the proceedings is as follows.

Members Present.

Mr. F. Anslow, President, in the Chair; Messrs. G. M. Harvey, Past President, Examinations Committee: A. B. Muirhead, Past President, Advisory Committee: D. Martin, Past President, Advisory Committee, T. Stretton, Past President, Advisory Committee: W. T. Anderson, Past President, Certification Committee: G. Raw, Past President, Certification Committee: R. Holiday, Past President, Examinations Committee: J. W. Gibson, Vice-President, Examinations Committee: H. J. Fisher, Certification and Examinations Committees; T. H. Williams, Certification and Examinations Committees; R. Ainsworth, Publications Committee; S. H. Morris, Publications Committee: J. R. Cowie, Prizes Committee and London Branch: A. Dixon, Prizes Committee: J. Dawkins, East of Scotland Branch: J. Walker, Lothians Branch: F. Beckett, West of Scotland Branch: J. A. Brown, West of Scotland Branch: G. N. Holmes, West of Scotland Branch: E. E. Shatford, North of England Branch; A. R. Hill, Cumberland Sub-Branch; R. Wilson, Midland Branch: and H. J. Norton, South Wales Branch. Also Mr. C. St. C. Saunders, Secretary.

Letters of apology for absence were received from Messrs. C. A. Carlow, Past President; A. Anderson, Past President and Treasurer; A. W. Williams, Advisory and Publications Committees; S. Walton-Brown, Vice-President; J. A. B. Horsley, Examinations Committee; T. J. Nelson, Examinations Committee; Dawson Thomas, Certification Committee; A. C. MacWhirter, Papers Committee; W. T. Mittell, Lothians Branch; W. G. Gibb, West of Scotland Branch; S. A. Simon, North of England Branch; T. H. Elliott, Yorkshire Branch; A. M. Bell, North Western Branch; A. V. Heyes, North Western Branch; W. Bolton Shaw, North Western Branch; E. R. Hudson, Midland Branch; F. J. Hopley, Warwickshire Branch; and J. W. Robinson, London Branch.

Minutes.

The Minutes of the Council Meeting held on October 20th, 1928, were duly confirmed and signed by the Chairman.

Finance.

The General Secretary reported upon the Bank Balances of the General Fund and Publications Account, and also with regard to the number of Members on the roll, and the analysis of the Branch Statements for the Quarters ended September 30th and December 31st, 1928.

Lists of Arrears of Subscriptions from the various Branches were laid before the Meeting, but further consideration was deferred until after the end of the Financial Year.

A letter was read from Mr. Alexander Anderson, the Treasurer of the Association, conveying an intimation that he wished to be relieved of the duties as Treasurer in consequence of his having undertaken important public work. Members from the West of Scotland Branch explained that probably this intimation from Mr. Anderson was due to his having been elected Provost of the Burgh of Motherwell and Wishaw, and that the appointment was for three years.

Great regret was unanimously expressed at Mr. Anderson's resignation, but knowing that Mr. Anderson would not have arrived at this decision excepting for the call of greater public duties, the resignation was reluctantly accepted.

It was resolved that any formal vote of thanks be delayed to the Annual General Meeting in July.

Branches of the Association.

The representatives of the various Branches submitted the usual Quarterly Reports.

A vote of thanks was unanimously passed to Mr. James Dawkins for his exceptional and valuable services in maintaining the interests and operations of the East of Scotland Branch.

"The Mining Electrical Engineer."

Mr. R. Ainsworth reported upon the financial and general position of the Journal, and also upon the special issue of the Journal in January, 1929.

Advisory Committee.

Mr. Muirhead explained that the Mines and Quarries Form No. 10 had received attention, and that Mr. H. J. Fisher had drawn up a Memorandum on the subject. It was resolved that this matter be left to Mr. Fisher, in consultation with the Advisory Committee, with full powers to present the Association's views to the Mines Department on the subject.

After discussion it was resolved that the constitution of the Advisory Committee be not altered; that it shall consist of four elected Members, and the two elected Vice-Presidents, together with the President and Treasurer as ex-officio members.

Examinations.

Mr. Harvey, on behalf of the Examinations Committee, suggested that the dates of the next Examinations should be April 27th and May 4th, 1929, and it was resolved that the Chief Examiner be asked to confirm these dates, if convenient.

Mr. Harvey introduced the subject of Service Certificates and explained the suggestion that Members of the Association, not less than 30 years of age, having been full Members of the Association for five years, and in continuous occupation at a Colliery for at least five years, should be allowed to undergo an Oral Examination with a view to obtaining a Service Certificate. After careful consideration it was resolved that the proposed Examination for Service Certificates should be proceeded with, and that the subject be left to the Examinations Committee with full powers to settle details.

Prizes for Papers.

It was resolved that the Prizes Committee be instructed to prepare the usual Annual Report for presentation to the Council and Annual Meetings in July, 1929.

Annual Meeting 1929 *and the next Council Meeting.*

Mr. Shatford, on behalf of the North of England Branch, presented particulars of the suggested arrangements for these functions, of which the following is a short summary.

Tuesday, July 2nd, 1929.—7 p.m. to 10-30 p.m.—Informal Re-Union at the Central Station Hotel.

Wednesday, July 3rd, 1929, Morning.—Visit to Derwenthaugh Coke Works of the Consett Iron Co., Ltd. Alternative, an Excursion to the Roman Wall.
Afternoon, 2-30 to 5-30. Visit to the works of Messrs. Reyrolle & Co., Ltd., Hebburn-on-Tyne.
Evening, 7 p.m. to 11 p.m.—Dinner followed by Dancing.

Thursday, July 4th, 1929.—Morning, 9-30 to 12-30.—Visit to Dunston Power Station of the Newcastle-on-Tyne Electric Supply Co., Ltd.

Afternoon, 2-30 to 5-30.—Visit to Seghill Colliery.

Evening, 7 to 11.—Civic Reception by the Lord Mayor of Newcastle and the Sheriff, followed by Dancing.

Friday, July 5th, 1929.—Morning, Council Meeting at 10 a.m.

Afternoon, Annual General Meeting.

Evening, Annual Dinner at the Central Station Hotel.

Gratification was expressed at the very satisfactory arrangements which had been provisionally made by the North of England Branch.

Office Bearers for 1929-30.

It was unanimously resolved to nominate Mr. S. Walton-Brown as President for the Session 1929-30, Mr. J. W. Gibson and Major E. Ivor David as Vice-Presidents, and Mr. R. Holiday as Treasurer.

Qualifications of Colliery Officials, Departmental Committee.

Mr. Raw reported upon the deliberations of the Joint Committees upon this matter, and also that Mr. R. Wilson of the Midland Branch had been co-opted on the Certification Committee in place of Mr. E. R. Hudson resigned. This was confirmed.

Mr. Raw also reported that the statement of the Association's views had been practically completed, and would be presented to the Departmental Committee in due course.

Special Educational Facilities.

Various particulars had been received from the Branches regarding the Local Educational Facilities, and it was resolved that this matter be referred to Mr. H. J. Fisher to compile the Report upon the Association's behalf.

British Engineering Standards Association.

Mr. Theodore Stretton spoke upon the various matters which had received the attention of this organisation.

WEST OF SCOTLAND BRANCH.

Visit to the Works of Mavor & Coulson, Ltd.

Through the courtesy of Messrs. Mavor & Coulson, Ltd., Glasgow, about eighty members of the West of Scotland Branch visited this firm's works in Mile-end, Glasgow, on December 1st last. They were received by Mr. Davies, one of the Directors, and members of the staff, by whom they were conducted through the various departments.

On the test bed the visitors saw an M. & C. coalcutter equipped with remote control gear; and also a distribution board for the coal face embodying the control gear for the coalcutter face conveyor and gate end loader.

Several examples of belt conveyor equipments were also on view. In the coalcutter section examples of the various types of machines made by the firm were seen in varying stages of construction. Some of these machines were fitted with compressed air turbines, and the members had the opportunity of examining the details of these machines in course of manufacture.

Some thirty members also visited the Company's new conveyor works at East Kilbride, where the pans and framework for the jigger conveyors are manufactured. Here they were conducted by Mr. Rutherford and other members of the staff. On their return to the main works, they joined the remainder of the party and were entertained to tea in the canteen.

Afterwards the Branch President, Mr. Beckett, on behalf of the Branch thanked the firm for their kindness in throwing their works open for inspection by the members. He pointed out that the firm was one of the first in the country to take a special interest in the application of electricity to mining, and that the Association were much indebted to them for repeatedly entertaining them in this manner. They were pioneers in the industry, and the members always found something new and interesting to engage their attention.

Major Mavor on behalf of the Directors and Staff acknowledged the vote of thanks, and said they were always pleased to show what they had of interest to the members, either collectively or individually at any time.

The Annual Dinner.

After visiting the Mavor & Coulson works, the members and friends reassembled at the Grosvenor Restaurant in Glasgow for the Annual Dinner of the Branch, at which Mr. Frank Beckett, Branch President, occupied the Chair.

Prof. G. W. O. HOWE, of Glasgow University, in proposing the toast of "The Association," said that the members of their organisation had important problems to face in the care and oversight of the electrical equipment in mines. Electricity provided a means of conveying unlimited power from above-ground to the remotest point of the mine, silently efficiently, economically, and safely. Having got the electricity to the farthest point of the mine they could then convert it into mechanical power for coal cutting, hauling, and all the other activities of the pit.

They might even have ultra violet lights fitted near the coal face, so that the men could work in artificial sunlight, and perhaps they could also have loud-speakers which would enable the men to hear, above the noise of machinery, a Beethoven symphony, or, perhaps, a talk elaborating the details of the latest Government scheme for old-age pensions for everybody at the age of 21.

One of the most important duties of their Association was to strive to raise the status of the mining electrical engineer. Engineers in this and other countries had not the status comparable with their importance in the community. He, personally, was mainly concerned with the educational aspect of engineering, which was very closely associated with the question of the status of the engineer.

One of the disturbing factors about mining at present was that the mining departments of their colleges and universities had so few students. Even in Glasgow, the centre of a very large mining industry, the number of students attending the mining classes at the University and Technical College was lamentably small compared with the importance of the industry, indicating that those in charge of the industry did not show a proper appreciation of higher technical education. Of course, he quite realised that the reply would be that the industry at present was under a cloud, and that the colliery owners were simply marking time. Nevertheless, every organisation such as theirs should consider this problem, and endeavour to ascertain why there should be so few students in the mining departments of the universities and technical colleges.

Mr. F. ANSLOW, President of the Association, in his reply, said he was pleased to hear Professor Howe humourously describe the Association as a "Dining Society," because he feared that the speaker might have used the expression "Mutual Admiration Society" which some years ago had been used as a term of disparagement: but taken seriously, it really did not appear too bad. If by its activities the Association could help colliery electrical engineers so to improve their education, training and status as to join in the chorus of mutual admiration, that was surely evidence of sound progress towards achieving the objects the Association sought to attain.

He was also pleased with Professor Howe's reference to the improvement in the status of the colliery electrical engineer, and in the suggestion that there should be a greater co-operation amongst educational authorities with a view to providing better facilities for technical education in the mining districts; because, that subject having been broached, it enabled him, Mr. Anslow, to maintain that the Association had already taken active steps in this direction. It had been invited by "The Departmental Committee of Inquiry into the Qualifications of Colliery Officials" to submit evidence in regard to the training and qualifications necessary for Colliery Electrical Engineers, and also to make suggestions for better facilities for education in the districts to which Professor Howe had referred.

Previous to this the General Council of the Association had already taken up measures bringing it into closer touch with the appropriate educational authorities, and there was every reason to believe that there were great possibilities in this direction.

With regard to the affairs of the West of Scotland Branch, Mr. Anslow congratulated the members on the fact that the Premier Honours of the Association had this year fallen to their lot, and that he would have the signal honour of presenting the Gold Medal of the Association and other awards at a later stage in the evening's proceedings.

Mr. Anslow, whilst regretting that the Branch had lost the honour it held for so many years of having the largest membership, indicated that it was a matter which could be remedied; and he was sure the energetic Branch Council would do everything possible to restore the Branch to that first position. Notwithstanding this "fall from grace", they were still the Premier Branch so far as financial matters were concerned and held the largest branch funds in the Association.

At various branch meetings which he had had the pleasure of attending he had spoken at some length on what the Association was doing for the colliery electrician and thus for the coal industry, and he would on this occasion content himself with dealing with that aspect of the case which refers to the importance of the economic use of electric power.*

*See "The Association" by Frank Anslow, *The Mining Electrical Engineer*, January 1929, page 216.

The importance of the economic use of power and coal is not yet sufficiently well recognised in this country: recently he heard of the case of a works where it was proposed to instal plant capable of reducing the consumption of coal required for power purposes by some 30% or 40%, but this did not particularly appeal to the management because the total consumption represented only some 5% or 6% of the total works costs. Such a point of view in regard to the use of coal may be good for the coal industry, but does not help the cause of economic production. There was also much said about the reduction of the quantity of coal used for the production of electric power in large generating stations, but there again the cost of coal was only a proportion of the total cost, and it was not at all clear that the reduction would effect any corresponding reduction in the cost at which electric power could be produced. The point he wished to make at the moment was not the cost at which power could be produced or generated, but to emphasise the necessity for its economic use—and that was nowhere of greater importance than underground.

The Association in giving facilities for the higher education of colliery electricians was not only assisting in improving the status of these engineers but, in helping them to a greater appreciation of the need for economy in the use of power, was directly helping the coal industry in educating a body of men able and willing to appreciate the importance of having and maintaining the installation under their charge in the highest state of efficiency.

Without being influenced by un-informed criticism of the methods of coal production and handling, they would agree that many of our colliery installations were capable of improvement in regard to economy, and that careful attention to losses in main cables, in transmission systems, in efficiency of individual motors and in the gearing of the plant, could be improved. If the gain be only 1% or 2% here and there, the accumulated effect would be considerable and have an appreciable effect upon the cost of power per ton of coal used.

Annual Dinner of the West of Scotland Branch.

Mr. G. N. HOLMES proposed the toast "Our Guests," to which Mr. D. S. Munro responded. Other speakers were Mr. R. Rogerson, who expressed thanks to the artistes who had added so much to the enjoyment of the party, and Mr. C. E. Hart who voiced the thanks due to the chairman.

Presentation of Prizes.

In the course of the evening, Mr. Anslow presented prizes as follows:

A Gold Medal, the Premier Award of the Association, to Mr. R. Rogerson, for the paper on "The Economic Use of Public Power Supply."

The First Prize of the Association to Mr. Robert Wilson for the paper on "The Running of Generators in Parallel—A.C. and D.C." The Second Prize of the Association to Mr. James Comrie for the paper on "Modernising Colliery Plant."

The Branch Prizes were awarded: First Prize to Mr. R. Rogerson, and the Second Prize to Mr. J. N Gardner for the paper on "Electrical Conversions."

STOKE SUB-BRANCH.

(P) Practice with Dynamo-Electric Machines.

J. H. AUST.

(*Meeting held 9th November,* 1928).

The theoretical study of electrical engineering in general has given us the confidence to apply practically the knowledge gained. Without this general knowledge it would be impossible for anyone to administrate successfully the application of electrical plant for industrial purposes. Practical experience so gained is, perhaps, more useful to the maintenance engineer than is merely theoretical study; and upon the combination of both depends the success of any electrical undertaking.

The following are a few of the most important causes of the unsatisfactory behaviour of electrical machines: Overloading; wrongly connected; short circuits internally in any winding; loose connections; open circuits; defective insulation; poles not properly spaced; decentralisation including end-play; out-of-balance; faulty polarity; and earths.

From a general survey of the above causes the following conclusions may be drawn.

Overloading.

The primary cause of overloading is mechanical, but the electrical results are destructive and may consist of a combination of the defects previously mentioned. A logical consideration determines that the performances of machines in general working under such conditions are most unsatisfactory, uneconomical and dangerous. A short review of the situation, based on abnormal running, will be useful.

In the case of D.C. generators by increasing the speed of machines of constant field strength it is necessary, if the voltage is to remain constant, to decrease the strength of the field. The field current of any system is naturally a loss under any conditions. Therefore this loss would be reduced but the armature copper losses under loaded conditions remain the same. We can neglect the iron loss, friction and windage, which are bound to be higher in any case; the conclusion is that the full load current has to be commutated in a weakened field, resulting in possible destructive commutator sparking: in addition to which the mechanical stresses imposed upon the generator and prime mover are much greater.

The effect of decreasing the speed naturally is entirely opposite to the preceeding; mechanical stresses and unsatisfactory commutation are avoided, but if the speed is lowered very much below the normal it may be impossible to keep the voltage up to its designed value although the field has been strengthened to its greatest density by cutting out all external resistance. Excessive heating of the field may result. It should be borne in mind that no useful work can be performed by the field beyond saturation point.

Raising the voltage will result from increasing the field strength and again overheating of the shunt field takes place. It is assumed that the speed is kept constant to reduce the mechanical stresses previously mentioned. Then it follows that the field C^2R losses are increased and the armature C^2R losses remain the same. The limiting factors are again heat and saturation values of the shunt field and, up to a certain point, a slight efficiency might be gained. Lowering the voltage will have the opposite effect to raising the voltage, due to the weakened field and commutation.

It is obvious that the output is in direct proportion to the amperes. If the ampere output increases above designed conditions, overheating, bad commutation, and extra mechanical stresses result; both as far as the prime mover and the generator are concerned. A lowered output eases the above conditions but is not a condition to be sought because the machine is not registering its designed load and, as previously stated, any conditions other than those for which any machine is designed should not obtain.

With D.C. motors and following a similar line of thought, it is obvious that if an increase in speed is obtained and if the loaded conditions were normal previously, an increase in torque results which means an increase in the motor output. The field is weakened to allow for the speed increase. Therefore it follows that the increase in load takes place in a weakened field and again mechanical stresses, commutation sparking and heat limit the extent to which this condition may be taken. The results of lowering the speed are opposite in character.

The effect of raising the voltage is an increase in field strength with a resultant greater armature current: the increase being in proportion to the increase in voltage. A greater torque would be exerted at the armature shaft and the speed would increase, which would increase the back E.M.F., again tending to lower the armature current. When the machine then settles to the new conditions the armature amperes would be equal to

$$\frac{E - E_1}{R}$$

Where E = Impressed E.M.F.
E_1 = Back E.M.F.
R = Arm. Resistance.

Note that the field strength would be limited by the total saturation of field iron which, under normal conditions, is practically at its highest value. Therefore from an increase in voltage no material benefit is derived. A decrease in voltage lowers all values, mechanical and electrical.

With A.C. generators, raising the speed increases the frequency. It follows for a level voltage a lower exciting current is needed. Neglecting friction windage and iron loss, an increase in efficiency would result for the same rated output. Lowering the speed would have the opposite effect. The field strength would have to be increased to keep the voltage level. The remarks under the D.C. heading may be applied to this case.

Raising the voltage increases the excitation and again iron saturation restricts any possible increase in efficiency because it is impossible to over-saturate the field iron (exciter or rotor) and any further increase in exciting amperes will only result in general heat. The effect of lowering the voltage is to interfere with the regulation if taken below a certain value, and if the amperes are increased to maintain the output there is little or no advantage to be gained. In regard to output the conditions are similar with A.C. as D.C. motors.

Increasing the power factor is about the only change to better the running conditions of any class of A.C. machine.

In the case of induction motors, increasing the voltage increases all known losses with the exception of copper loss at the same output so that there is little or no change for the better, but here again increased speed means greater torque, consequently the machine deals with a greater output. Decreasing the voltage has the opposite effect and the results in general are similar to those which obtain for the D.C. class. The only exception being the power factor which of course is always present and cannot be changed, except by a change in the conditions of supply.

Wrong Connections.

These are always a possibility.

Shorts.

External and internal faults which may consist of crosses in any winding, increase the voltage stress between the turns and break down the insulation, which in many instances is only sufficient to withstand a pressure difference of a few volts. Again, insulation may be destroyed by the heat generated from overloaded conditions.

Loose Connections.

These are commonly caused by faulty repairs, overheating, vibration or the magnetic effect of an alternating field or current.

Open Circuits.

These are usually due to overheating, vibration and overload.

Defective Insulation.

Due to dampness and dirt, age, overload, overheating.

Poles not Properly Spaced.

The probability of this defect is extremely remote.

Decentralisation (including end play).

This may be due to magnetic effects or uneven field, and the results are worn bushes and possible destructive commutation. If the air gap is uneven, bad commutation and poor starting torque are usual effects. Properly graded brushes result in good commutation. The conductivity strips between brush holder and brush must be electrically connected, to prevent sparking between holder and brush and also to reduce the resistance between box and brush. The current density in the brushes for a given armature current is obtained by dividing the armature current by the area of half the brushes, that is, the area of number of brushes in parallel. Brush tension must be graded according to the size of the machine and, as a maximum, about 1½lbs. per sq. inch of brush surface is a fairly good figure.

Out of balance is caused usually by the commutator or slip rings being out of truth or the windings unsymmetrical. Wrong polarity is due to faulty connections.

Earths.

Earth faults may be due to any of several causes, or the combination of one or more faults as outlined and here must be included voltage rise due to inductive effects, which if not taken proper care of may be responsible for such faults as internal short circuits, breakdown of slot and bush insulation; and not only locally, but the effects may also be felt on some other part of the system.

The only conclusion one can draw from the foregoing is that the effect of overloading and its subsequent bearing upon the condition of machines forms a very undesirable factor to contend with. Even under the best of conditions machines will not run indefinitely. It is often necessary to take a machine out of commission for complete overhaul, bearing renewals, re-insulation, new commutators or slip rings, and rectifying any other fault common to electrical machines.

Fortunately a complete burn out is rare, but it does come along sometimes. It is not intended to discuss here the methods adopted in effecting any repair work. It is, however, proposed to deal with common tests which can easily be performed to determine the correctness of the repairs.

Tests.

In all probability no matter how well a colliery electrical workshop and stores is equipped elaborate electrical tests are out of the question. More often the repair is urgently needed, and in many instances only a light-load run can be taken after the overall resistances, insulation resistances, etc., have been checked, but if time permits and a load run can be taken this course should be adopted, because in the majority of cases any of the causes mentioned previously will be found. Therefore to overcome any elaborate arrangement the writer in many cases has successfully employed the use of a brake pulley; in several instances belt pulleys have been used by flanging the sides and allowing the flange plates to overhang the pulley boss, thus preventing the cooling water from being sprayed about. The water supply can be taken from any convenient source. A nozzle is mounted and so adjusted that sufficient water is used for cooling purposes. The flange plates that overhang externally prevent the brake rope from sliding off the pulley. For the rope successful results have been given by a ⅜in. flexible wire rope on which brass shoes were clamped, grease being used as a lubricant (see Fig. 1).

It should be clearly understood that the main object the writer had in view was an arrangement whereby current under running conditions could be forced around the machine circuits.

An ordinary spring-balance and pan and electrical instruments and thermometers complete the gear. The electrical instruments used depend upon the completeness of the test. For all practical purposes the following results are of the most importance.

Before the load run test the insulation, polarity, and resistance of all circuits: during the run take temperatures, speeds and operations: after the run take temperatures, insulation resistance, and resistance of all circuits hot.

The above is submitted on the assumption that all machines of to-day's manufacture are capable of dealing with the designed conditions satisfactorily. With one or two exceptions the writer has invariably found this to be the case.

It is not recommended that machines be subjected to abnormal tests such as 25% overload for two hours or 50% overload for half an hour, etc. If it is necessary for a machine to withstand such conditions let it be rated accordingly. Overloads have to be carried at times, and if this condition is unforeseen it is very unfortunate for all concerned, but to expect machines of rated output to function normally under overload conditions is not by any means reasonable.

Before the commencement of either a light or loaded run it is most important that insulation, resistances, polarities, air gaps, etc., should be checked so that in the case of unsatisfactory running many of the possible sources of trouble can be readily eliminated.

The polarity can be tested by passing a weakened D.C. current around the circuit to be tested and using an ordinary compass needle. It is advisable to record the changes of polarity, particularly in the case of D.C. compound interpole machines, by the aid of a diagram representing the number of machine poles, and remembering that the series poles are generally cumulative (wound in the same direction as the shunt field, thereby possessing the same pole polarity) and that the commutating poles are of opposite polarity to the main preceding poles.

The insulation tests should be general; it is also advisable to circuit test both to earth and between windings where necessary.

A complete record of all conductor circuits resistances should be taken, as far as an A.C. machine is concerned, of all phases stator and rotor, and these readings should balance for each circuit. For the D.C. type, the total resistance of all circuits is taken and then the resistance of each pole field taken. The addition of the later readings for each circuit considered should balance and one pole should balance the other. If there is any discrepancy it should immediately be traced and remedied.

As far as D.C. armatures are concerned the resistance of the armature is taken between brush and brush. If the armature is multiple-wound the armature is set so that the brushes connect as near as possible with a pair of balancing rings. The brushes are evenly spaced and are ground to the commutator surface. The resistance is taken across the adjacent brush arms. Three or four readings are taken with the armature in different positions and the mean reading calculated. The resistance tests may be taken by means of the bridge or with the aid of a suitable voltmeter, ammeter, and battery with an adjustable rheostat.

It is advisable to run the motor light before attempting to "load up." A light load reading is taken when satisfied as to the general condition of the machine. Note the direction of rotation which determines the method of attaching the rope. This is placed in position so that a downward pull is registered on the balance. The necessary instruments having been connected in circuit, the machine is speeded up and the pan loaded until the ampere reading registers full load.

The following readings will be sufficient to indicate the general performance of the machine:

1. Voltage.
2. Amps. per phase (Total amps. = Mean $\sqrt{3}$).
3. Wattmeter reading.
4. Lbs. weight in pan.
5. Scale reading = Back Pull in lbs.
6. Speed, effective radius of pulley plus rope must be calculated.
7. Temperatures.

From the readings taken can be calculated: Apparent H.P. $= \dfrac{\text{Amps. per phase} \times \text{Terminal Volts} \times \sqrt{3}}{746}$

Real H.P. = from Watt Meter Readings (since the current is balanced) and the machine star connected, the pressure coil is then tapped across line and neutral. The Watt Meter Reading $\times$ 3 = total watts. If the neutral point is unavailable or the machine is mesh connected use two wattmeter method.

Syn. Speed = number pairs poles $\times$ r.p.m. = 60 $\times$ cycles per second.

$$\%\text{ slip} = \frac{\text{Syn. Speed} - \text{Motor Speed}}{\text{Syn. Speed}} \times \frac{100}{1}$$

Motor Speed= R.P.M. of Shaft.

B.H.P. is found from Speed and Torque and $\dfrac{2\pi}{33{,}000}$

P.F. = Ratio of Real Input to apparent Input.

Apparent Efficiency = Ratio of Brake Output and Apparent Input.

Real Efficiency = Ratio of Brake Output and Real Input.

Torque in lbs. ft. = Effective Weight in lbs. $\times$ (Radius of Pulley + Radius of Rope, in feet).

The Effective Weight in lbs. = lbs. weight in pan + weight of pan — back-pull.

The Losses may be classified as follows:—

Stator Copper Loss.—Obtained by measurement of Resistance of Windings $\dfrac{C^2R}{2}$

Iron Friction and Windage.—Found by reading Real Watts at No Load and Full Voltage and subtracting Stator Copper Loss under same conditions.

Rotor Input is equal to Real Input—the total Stator Losses (sum of above two).

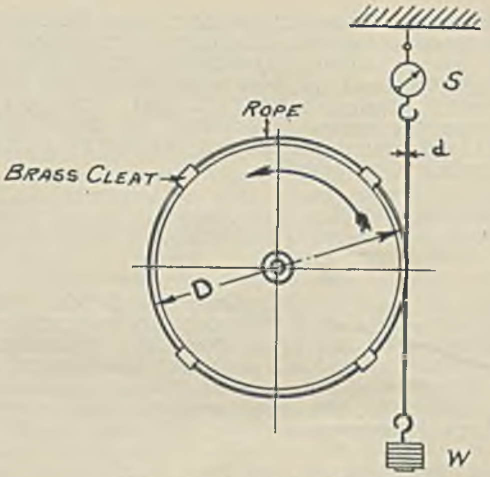


Fig. 1.—Brake Pulley.

$$\text{B.H.P.} = \frac{(W - S) \times \pi (D + d) \times N}{33{,}000}$$

where D, d = feet.
W, S = lbs.
N = r.p.m.

Rotor Copper Loss is the difference between the Rotor Input and the Brake Output (since there is practically no loss in rotor).

In cases of wound rotors the rotor current may be measured and brake H.P. will be found by subtracting all losses from real H.P. Input. The tests applied to variable speed machines having wound rotors are practically similar to constant speed machines. The Rotor Phase Current may be checked and if necessary the Induced Voltage. It should also be borne in mind that the starting torque can be taken under varying conditions and also the pull-out torque, which is taken to ascertain the maximum torque at which the motor begins to slow down without any further increase in the back pull as indicated by the scale reading. The pan is steadily loaded to procure the above results.

Compound Wound D.C. Machines.

The methods of checking machine polarities, resistances and insulation tests and the method used to secure a temperature run have been described. As a check against the first method of determining the polarity of machines of this type, first run the machines purely as a shunt and then as a series machine, noting the direction of rotation. It may be of interest to note that when a shunt motor is loaded the speed drops Also when a compound wound machine is connected so that the series field assists the shunt, the drop in speed will be greater as the machine is loaded because the field is strengthened by the series field. In the case of a compound motor differentially wound, series against the shunt, the speed may be made constant or with a higher speed at full load than at no load. This will again serve as a polarity check, although it is generally used as a regulation test, with the object of ascertaining the relation between change in speed from no-load to full-load speeds: the shunt current and the terminal voltage being held constant throughout.

When current flows through an armature it exerts a demagnetising effect on the main pole system, whilst the remaining conductors under the poles tend to demagnetise the field: these conductors are termed armature back ampere turns. This condition then has to be rectified to enable us to commutate in a sparkless position. In other words a commutating neutral position has to be found. A little consideration will show that a backward lead is given in cases of motors and forward lead is given in cases of generators in respect to direction of rotation (see Fig. 2).

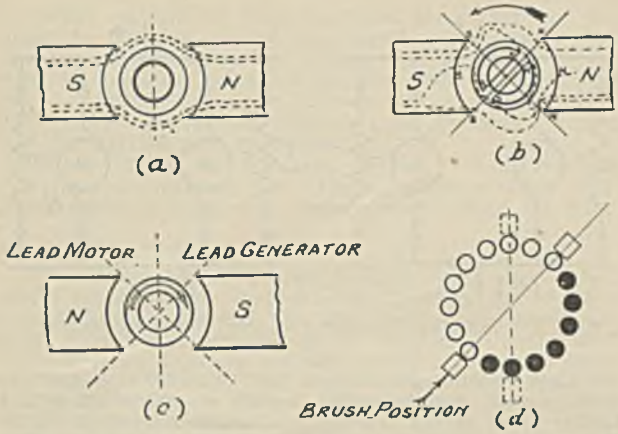


Fig. 2.—(a) *Field Undistorted.*
(b) *Generator Distorted Field.*
(c) *Brush Leads for Generator and Motor.*
(d) *Correct Brush Position.*

The effect of self-induction is to prevent a current from dropping down instantly from any value to zero and also to prevent an E.M.F. from bringing a current from zero up to any value. Some interval of time must elapse and the time interval during which these processes are carried out is whilst the armature coil is under the action of the brush. The commutating poles are of opposite polarity to the main preceding poles and their inclusion in D.C. machines tends to improve commutation. The moment before the coil is commutated, current is flowing through the coil in one direction. By the time this coil has left the brush the same current has to be flowing in the coil in the opposite direction and this has to be carried out whilst the brush has been bridging the commutator segments connected to the coil.

Due to this reversal or the effect of self induction some times elapses before the current is changed from one direction to another. Sufficient time has to be allowed or sparkless commutation cannot be obtained. This is why a wider brush is sometimes necessary, also carbon offers a certain resistance and this resistance is made use of to obtain sparkless commutation. The commutating poles produce in the coil under commutation the reversal of the current when that particular coil is passing under the brush, also the magnetic action of the commutating pole tends to correct the distorted field.

In an alternating machine the distortion is due to the armature ampere turns: the results are similar to the D.C. class as far as the shifting field is concerned and are also similarly variable, depending upon the amperes flowing. If the armature current is in phase with the voltage, the field is distorted, and if the armature current either leads or lags as far as generators are concerned, it either weakens or strengthens the field as well as the distortion which is bound to take place under any conditions.

Summary of Tests.

The general tests having been discussed, there is no necessity to cover the ground again. The following is a summary of the readings taken and classified. The brake H.P. is calculated in exactly a similar manner to that described.

Arm. CR Loss = Full Load Amps. × Arm. Resistance.
Com. Pole CR Loss = Arm. Amps. × C. P. Resistance.
Series CR Loss = Arm. Amps. × Series Resistance.
Shunt Loss = Shunt Amps. × Shunt Volts.
Brush Loss = 1.5 to 2 × Full Load Amps.
Friction and Windage = Light Amps. × Volts.

$$\text{Efficiency} = \frac{\text{Full load amps.} \times \text{volts}}{(\text{Full load amps.} \times \text{volts}) + \text{losses}}$$

Arm. Amps. = Full Load Amps. — Shunt Amps.

An armature revolving in a magnetic field and supplied with a definite E.M.F. will so adjust its speed that its back E.M.F. reduces the current passing through it in proportion to the work performed at that speed.

Let E = applied voltage,
C = current,
R = armature resistance,
E_1 = back E.M.F.,

Then $\dfrac{E - E_1}{R} = C$,

$\therefore E - E_1 = CR$.

Multiply by C = $EC - E_1C = C^2R$

EC = power supplied C^2R = power lost.

E_1C = difference between EC and C^2R

$\therefore EC$ = output of armature in power,

and $\dfrac{E_1C}{EC}$ or $\dfrac{E_1}{E}$ = Efficiency of Armature.

Temperature Rise.

It may also be of interest to note that the electrical heat generated in any circuit depends upon the total current squared multiplied by the time of flow in secs. $= C^2Rt$.

One Joule = 10^7 ergs and 1 calorie = 42,000,000 ergs.

$$\therefore 1 \text{ calorie} = \frac{42{,}000{,}000}{10^7} = 4.2 \text{ joules},$$

and the Joule is the work done or energy transformed between two points when the P.D. between the points is One Volt and One Coulomb of electricity passes.

$$1 \text{ — B.T.U.} = \frac{5}{9} \times \frac{453.6}{1} = 252 \text{ calories},$$

and if the following calculation be made $\dfrac{.24\, C^2R\, t}{252}$, the amount of B.T.Us. generated will be established.

Therefore for any particular machine this heat has to be dissipated.

As far as colliery engineering is concerned the machines in common use are of the enclosed or protected type. Naturally the conditions do not allow for free windage and the cooling is forced. Consequently the temperature rise must be checked electrically. A general figure of, say, between 50 to 60 deg. C. final temperature is sufficiently high enough for any class of machine to be allowed to develop.

Parallel Running.

A.C. generating plant generally runs well in parallel, providing that the machines are similar in design: that is the wave form or shape of the wave, voltage, and phase are respectively alike. About the only other factor which may be taken into account is the smoothness of the running of the prime movers. After synchronism the load is generally apportioned by adjusting the turbine speeds.

Variation of excitation alone will have little or no effect on the load carried as the machine is locked at synchronous speed. This is why the turbine governors are given an artificial setting so that the steam supply is opened by an amount necessary to enable the alternator to pick up load as soon as paralleling has been performed, after which speed control is used. The adjustment of the load is practically automatic and the machines will take or drop the load simultaneously because they are loaded in step.

Again referring to smoothness of running, supersensitive governors may cause a large variation of speed picking up as the load drops off and dropping back to normal as the load increases. This might cause fluctuations electrically and upset the good running of the system. Sluggish governing will have the same effect possibly in a more jerky manner. The only other factor

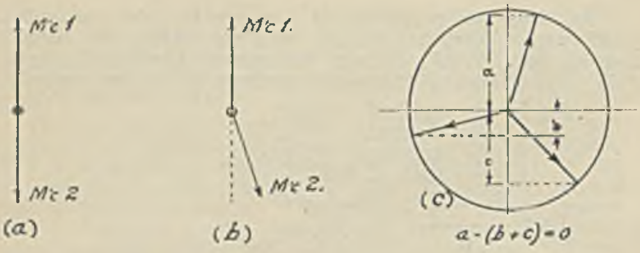


Fig. 3.—(a) *A.C. machines in parallel.*
(b) *Angle of machine behind synchronising point.*
(c) *Current Flow in windings.*

to affect the good running is that the power factors of the various machines must be similar, otherwise circulating currents between the machines are bound to follow.

The pressure waves can be represented vectorily by two lines 180 deg. apart for complete phase coincidence. If a difference exists the resultant voltage is that across the local circuit. The diagram Fig. 3 is self-explanatory and shows the directions of the flow in the windings of an A.C. machine at any instant. When machines run in parallel, complete phase coincidence is established before synchronisation takes place.

D.C. Generators.

By the aid of the simple diagrams Figs. 4, 5 and 6, some idea of the current exchanges that take place between machines when operating in parallel will be obtained. The effect of running in parallel is repulsive in character. Before attempting to review the action of these machines when under load the following remarks may be of service to us.

In the case of series machines, Fig. 4, the field is in series with the armature and carries the amperes generated. This being so it follows that the field density is greatest when the full load current is passing. If the load begins to move from one machine to the other owing to a slight drop in speed, the excitation of

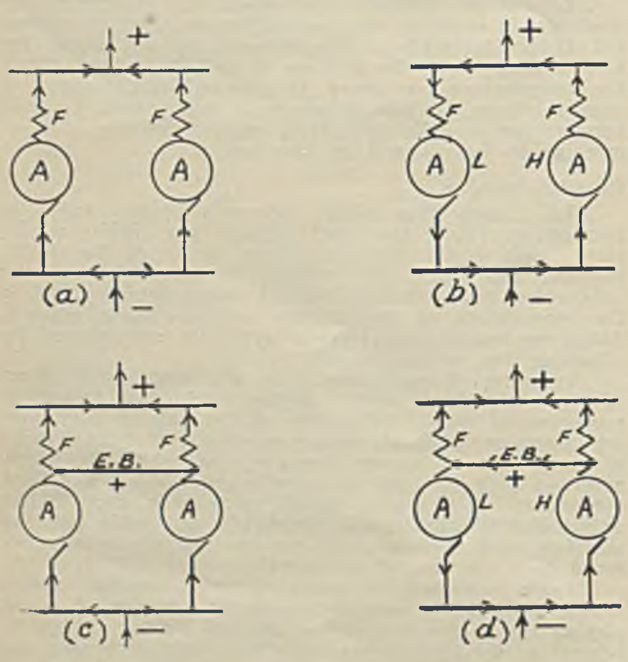


Fig. 4.—*Showing Current Flow in Series Generators, and necessity of the Equalising Bar.*

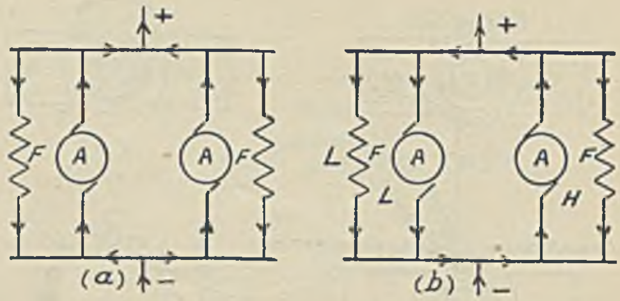


Fig. 5.—*Showing Current Flow in Shunt Generators.*

the slow running machine at once weakens. A drop in speed causes simultaneously a drop in excitation and a further drop in the internal voltage, which again affects the current. If the voltage falls below a certain value, the current will be reversed in the slow running machine. But this is not all, the slow running machine begins to be driven as a motor but in the reverse direction to that previous. Therefore to overcome the possibility of such a happening, an equalising bar is used which conveys the reversed current through the armature and strengthens the series field of the slow running machine in the right direction.

In the case of shunt-wound generators, Fig. 5, if one machine is giving the proper external voltage, both fields are excited in the proper direction: so that in case a drop in speed takes place with one machine, the voltage generated and the current drop automatically, and if the current in this armature is reversed the machine becomes a motor but does not reverse its direction of rotation. Before this occurs the chances are that the speed will pick up, due to the automatic unloading. The speed will again become normal and an equal division of the load will result. This explains why there is no necessity to instal equalising bars when running shunt machines in parallel.

Fig. 6 illustrates the parallel running conditions of compound-wound generators. The behaviour of these machines combines the virtues of the series and shunt class without their defects. Although reversals are possible, the current flow through the machines helps automatically to settle any differences which may occur.

The two sketches, Fig. 6, show two methods of connecting compound machines to the bus bars. In traction work where the negative pole is earthed, No. 1 method is used: the series turns being placed on the positive side and then connected direct to the positive feeder. No. 2 method is the usual form. In both cases it follows that the series turns strengthen the field and tend to build up the voltage. From the diagram it appears that the series flow is against the shunt. The shunt flow is from positive to negative because it is a pressure winding. The series flow is a current flow being in series with the return to the generator. To make these separate fields cumulative for each field pole each separate winding is connected in the opposite direction.

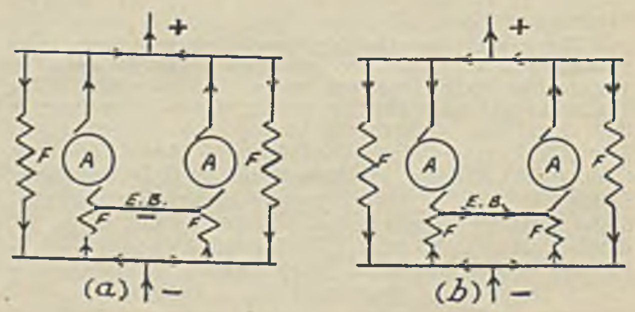


Fig. 6.—*Showing Current Flow in Compound Generators.* (a) *Parallel*; (b) *Reversal.*

When paralleling D.C. machines, the voltage of the incoming machine should be slightly lower than the machine on the bars. The voltage and the speed of the incoming machine being correct, the order of switching and load adjustment is as follows: close negative main switch; close equalising switch; close breakers; adjust load by varying the excitation.

When taking the machines off the bars the reverse operations are carried out. The ammeter readings indicating when to break the machine circuit from the bars.

Notable Occurrences.

Before concluding a brief description of one or two events remarkable in their way will perhaps be of more than ordinary interest. The first refers to a burn out. A 60 H.P. motor coupled direct to a centrifugal pump received more than an ordinary wetting due to a blow hole which perforated the pump casing. The armature was shorted between turns and in several instances had blown itself clear, destroying the conductors. The armature had to be stripped. In turn the commutator tests were apparently satisfactory. When the re-wind was completed the commutator was subjected to the final examination. Low readings had developed between adjacent commutator bars and fortunately these readings were not improved. Therefore it was decided to strip the commutator. It was found that the heat developed due to the primary cause had run a film of solder between the back end mica ring and segments. The risers although rivetted into the bars had also been soldered.

In the second case an intermittent earth was traced to a 25 H.P. motor which was driving a three-throw pump through gearing. The motor was mounted on a cast steel bed which formed part of the pump bed casting. A raw hide pinion which was shrouded formed the first reduction. At intervals flashes were seen between the pinion and spur wheel as the armature oscillated between the bearings. The set was efficiently earthed, being bonded over and connected to the main earthing system. The earth return consisted of the feeder D.W.A. and the pipe line. The only explanation the author can suggest is that the balance of the armature at full load and the evenness of the field allowed the armature to float. Consequently a film of oil was formed between the bearings and shaft so that the armature was insulated from ground. Oil wipers or shaft wipers have been used to eliminate the above and have been incorporated in motor design, but in how many cases is the true rotating position established?

The third peculiar occurrence proved to be purely mechanical. It is worth recording and the events as they happened are duly set forth. This pumping set consists of a 75 H.P. motor, 1000 r.p.m., coupled direct to a centrifugal pump. The pump is equipped with an extension bracket carrying a bearing through which the pump shaft passes. Two collars fit the shaft, one on either side of the bearing. The collars are held in position by two set pins which are tapped into the shaft. The inner side of the front end motor bearing had run hot and this was the first intimation that anything was out of order. Eventually the front end bearing ran cool, the machine being kept under load. The next happening of note occurred some hours later—the pump thrust bearing and the front end motor bearing became hot. The pump was shut down and an external examination revealed nothing. Decentralisation of the impeller was suspected and as an expedient the thrust collars were moved. The back end pump inspection covers were taken off and again a blank was drawn. The pump was again placed on load and in a very short time the heating of the bearings took place. The set had been subjected to end play and the lift was apparently in order. It was then decided to strip the pump and the impeller shaft was found to be broken in such a way that it acted similar to a clutch: it was held in position by tightening on the extreme bearings. The author has seen many breaks but none similar to this.

The fourth instance was an electrical failure and in its way may be termed a "classic." A separate circuit from the main board fed a 160 H.P. compound motor, which was operated by a reversible tramway type controller and a suitable bank of resistances. The motor control board consisted of a D.P. contactor panel and D.P. switch combined. Owing to certain circumstances it was necessary to trip the circuit. As soon as the breaker was tripped the visual earth lamps burst. This was the first intimation that any fault had developed.

The circuit was made dead and I.R. tests made throughout. A straight through test gave a 3.5 meg. reading. The circuit was again closed. Running tests were again conducted under power at the motor end. The shunt discharge was suspected but this proved to be in order. The results outlined occurred again when the breaker was tripped from the feeder end. Further tests were made and with no evidence it was decided to dismantle the resistances, a new temporary batch displacing those already in use. On completion the circuit operated in a normal manner. The old resistance batches were stripped and no faults were found. The resistances were of the grid pattern supported on four insulated rods and mounted between end plates which bushed where the supporting rods pass through the plates. When the resistance was rebuilt it was decided to increase the insulation from 1¼in. to 2½in. at the rod ends. The rods themselves being grounded to the frame, these resistances have again been placed in circuit and have given every satisfaction.

In conclusion, it was evident that an inductive discharge took place, but where the author would not venture to say. He has seen faults similar but not so destructive in character. In such cases sparking took place and was soon evident either visually or through a ground test. The inductive discharge in this case was no more than 1000 volts and was taken care of by the buffer previously referred to. The moral of this episode is that too much faith can be placed in I.R. tests.

SOUTH WALES BRANCH.

Joint Meeting with Colliery Managers Association.

(*Continued from page* 257).

To the meeting of this Branch held on 8th December last, the Colliery Managers Association were specially invited. The Paper by Mr. H. H. Broughton was read, and an unusually interesting and valuable discussion ensued. The subject of bulk handling of coal, ore, grain, etc., was recognised as of supreme importance to Cardiff and the South Wales district in general. As will be gathered from the tenor of the discussion, the lessons and suggestions brought forward by Mr. Broughton were highly appreciated by a critical meeting.

Bulk Handling of Ore, Coal and Grain.*

Discussion.

Mr. D. FARR DAVIES, Branch President Colliery Managers' Association.—Speaking as one who has been very interested in the shipping of coal to Montreal, and one who knows a little of the difficulties of the trade, Mr. Davies said he had seen the coal shipped at this side and seen it at Montreal. He knew the state of the coal leaving the collieries on this side, and could tell Mr. Broughton some of our difficulties.

The chief trouble is to get the coal to the steamer at Montreal, or to the wharf at Montreal, with as little deterioration as possible, and if this could be done there is no doubt we would be in an excellent position to compete with the anthracite mines of Pennsylvania but, due to deterioration, the problem is very difficult.

* See *The Mining Electrical Engineer*, June 1928, p. 478.

Our coal is prepared most carefully at the collieries, it is loaded into wagons with a maximum drop of 12 to 18 eighteen inches, and it is taken to the dock on this side and dropped into the ships a matter of from 16 to 25 feet. The deterioration begins at once and continues during transit in the ship itself. When it gets over to the other side, and the big grabs which Mr. Broughton has mentioned in his lecture are used, the prospect of getting large coal into Montreal, in the state in which we would like to, is very remote indeed. Several people from America and Canada have watched the shipping of coal at the docks in this country; the remark of one of them was that "It was suicidal," and it is up to the railway companies to improve so as to increase the possibility of our trading with Canada. We have been able to compete, up to a point, very successfully in Montreal itself and possibly as far as Ottawa, but beyond that it has been impossible. Even in the small boats as far as Toronto, it is very difficult to compete with the Pennsylvania trade.

If Mr. Broughton can tell us how we can overcome the difficulties of deterioration in transit we shall go a very long way to competing with the Americans and actually beat them, because we have a better quality coal with a much lower percentage of inherent ash and extraneous ash, because we prepare our coal much better than they do on the other side. If we send the coal out with 1% of extraneous ash there is a great row, but in Pennsylvania they are allowed a much higher percentage. Mr. Davies had said to an American colliery proprietor, "You do not wash or treat your coal as well as we do"; and he replied, "Why should we, when we are allowed a certain percentage of ash?"

That, Mr. Broughton, is the difficulty in South Wales as expressed by one who has produced coal on this side, shipped it to Montreal, and seen it discharged at Montreal; Mr. Davies could assure Mr. Broughton that the coal as sent away by himself at South Wales he did not recognise at Montreal. If Mr. Broughton can tell him how he could get over this deterioration in transit and get the coal safely discharged with those grabs at Montreal, he would be delighted.

Mr. Davies said he was pleased to hear the reference to Montreal as the greatest grain export port in the world. He happened to have been at Montreal when one of these grain elevators was built in 1923-24. Prior to that year New York was looked upon as the greatest port of grain. As a Britisher he was delighted to know that we had for once beaten the United States.

MAJOR E. IVOR DAVID criticised the remark by Mr. Broughton that the colliery was not the place to generate electrical power. The collieries had in fact been the pioneers in every power direction: high pressure and high temperature steam had been developed by colliery companies. In the whole country there were some 17,000,000 tons of coal used at collieries raising 270,000,000 tons a year. They were supposed to be burning coal wastefully, yet they were actually producing more power for that 17,000,000 tons than the whole of the electrical undertakings.

There was one question he would like to ask Mr. Broughton. In one of the photographs the hopper bottom wagons were shown handling ore, and side tipping wagons for coal. It was a question of importance when they considered the revival of their trade. In the North the hopper bottom wagon was extensively used, but in the South various types were in use, mostly end tippers: which type does Mr. Broughton recommend?

Mr. C. BILLINGHAM (communicated) congratulated the author on the very excellent paper with reference to the handling of ore, coal and grain. The compiling of a paper of this description involved a very considerable amount of work. Having been associated with appliances handling material at the South Wales ports for over 35 years, Mr. Billingham said he felt somewhat justified in having something to say about the methods and appliances in use at some of the South Wales ports, and thought that claims could be made for some progress in the application of modern electrical gear to improve the handling of material at these ports.

He was afraid he could not entirely agree with the Author, some of Mr. Broughton's remarks were much too severe on the South Wales business men who have been responsible for the facilities and business arrangements in connection with the marketing of coal in particular.

Taking then the statement that the spending of money on privately owned wagons was a wrong principle, Mr. Billingham would ask how else could this have been done, having regard to the conditions prevailing, because if the Railway Company provided the wagons, the Colliery Company would have to pay for the use of these wagons, as they do on the North-East Coast. Where the Railway Companies do provide wagons they have much siding accommodation at the Collieries. In South Wales, siding accommodation at the collieries is mostly out of the question; the geographical conditions would not allow of extensive siding accommodation. Of course, if one had faith enough, mountains could be removed. The South Wales colliery business men do not live by faith alone. The 150 miles of wagon tracks provided at the docks is explained by the fact that it is impossible to provide siding accommodation at the collieries, and it makes no difference whatever whether they were connected with half-a-dozen railway systems or with one of the big Railway Groups.

To describe briefly what takes place with the handling of coal at any one of the South Wales ports, it is necessary to review the principle on which the trade of the South Wales ports was built up. No doubt they were all aware that Welsh Coal has enjoyed a world-wide reputation second to none, and it was built up by a demand for a very highly scientific blending of the various grades of coal in order to obtain the best results from a calorific point of view, as well as the other constituent contents, and it is only necessary to glance at a Shipping Order to realise the importance of mixing the various grades of coal. Typical Shipping Orders are as follows:

GREAT WESTERN RAILWAY.

Cardiff,

11-50 a.m. August 18th.

Please tip at 1/2 tip, Roath Dock, for the *S.S. Pencarrow*.
Shipper: Chellow.

BUNKERS.

500 tons U.N. Co. Bute Myr large.
300 tons U.N. Co. Risca Sirhowy large.
200 tons U.N. Co. Risca nuts.
500 tons U.N. Co. National Standard small.

Mix 6 wagons Risca Sirhowy large or nuts to 6 wagons Bute Myr large.
Mix at shipment: 20 tons large or nuts to 10 tons small.

100 tons nuts to be shipped in the sides and 100 tons in the thwartship. IMPORTANT.

Retare.

GREAT WESTERN RAILWAY.

Cardiff,

10-15 a.m. August 17th, 1928.

Please tip at No. 4/6 Tip, Roath, for the *S.S. Pencarrow*.
Shipper: G.L.M.

CARGO.

1500 tons G. Keen Dowlais small ex T.V.R. Red X Labels
800 tons Ocean small ex R.R.8 and 10 labels only.
850 tons Troedyrhiw C. Cos. large.
3550 tons Tredegar I. Cos. large, labelled A.
330 tons D. Davis & Son, Ferndale small.

Mix 9 wagons Troedyrhiw to 30 wagons Tredegar.
Mix cargo: 90 tons small to 180 tons large.
Commence each hold with small.
Do not ship coal on beams.
More orders to follow for small.
Do not exceed 2180 of small. *Retare.*

GREAT WESTERN RAILWAY.

Dock Supt.'s Office, Cardiff Docks,
10-45 a.m. August 27th, 1928.

Please tip at No. 3/4 Tip, E.S.R. Bsn., for the *S.S. Briere*
Shipper: Cory Bros. & Co.

BUNKERS.

130 tons Cory Bros. Blue Star large.
145 tons Cory Bros. Pentre large.
60 tons Cory Bros. Red Star small.
140 tons Cory Bros. Gelli White Label small.
75 tons Cory Bros. Wyndham small.

Mix 10 tons Pentre large to 10 tons small.
And 10 tons Blue Star large to 10 tons small, alternately throughout.

Retare.

For Docks Superintendent. W.F.J.

GREAT WESTERN RAILWAY.

Dock Supt.'s Office, Cardiff Docks,
11-40 a.m. August 18th, 1928.

Please tip at No. 1/2 tip, Roath Dock, for the *S.S. Daybeam*
Shipper: Cory Bros.

CARGO.

400 tons Cory Bros. Letter P, large.
500 tons P.D.R.V. large.
300 tons Cory Bros. Gelli White Label large.
600 tons „ „ Wyndham Pgwent large.
200 tons „ „ Pentre/Tynybedw large
740 tons „ „ Gelli large blue label.
250 tons „ „ Gelli small white label.
350 tons „ „ Gelli small blue label.
350 tons „ „ Pentre/Tynybedw small
450 tons „ „ Wyndham/Pgwent small.
50 tons „ „ Tydraw large.

Mix on road: 18 wagons letter P/R.V./Gelli white label Wyndham/Pgwent large to 10 wagons Pentre/Tynybedw/Gelli Blue large.
Mix the smalls: 9 wagons Gelli white/Wyndham Pgwent small to 9 wagons Pentre/Tynybedw Gelli Blue Label small.
Mix at shipment 90 tons small to 180 tons large
Commence with small, and finishing with large
Remove all beams before commencing loading.

Retare.

These are examples taken at random of these Shipping Orders.

Compare this state of affairs with the possibility of a port handling such as the author has referred to. We may now turn to a careful investigation of the American methods as to how far their adoption would apply to our own needs.

Within the last three or four years, the general manager of the Great Western Railway, Sir Felix Pole, and several of the leading officials, with the enterprising motive to do all that is possible in connection with the handling of material, visited America, and saw for themselves the operations in existence in that country; so it can be said that personal acquaintance with American principles has received practical attention, and those intimately acquainted with the facilities in South Wales are fully aware how far the American principles are applicable to our particular requirements.

Our markets for Welsh coal have been affected by several conditions, e.g., the post war developments have brought about a diversion of the buying by foreign countries particularly Italy, France, Norway, Sweden, Denmark and Spain. Then again the coal strikes, particularly the long one in 1926 lasting eight months: during that period, all the foreign countries referred to had to resort to alternative means of burning their own local coal supplies, and having altered their boilers for this purpose they have not considered it worth while to revert to the consumption of Welsh coal on account of the expense and the need for some guarantee by labour of industrial stability for at least five years. The Spanish Government has made severe restrictions on the importation of Welsh coal in order to benefit their own coal producing areas. A large quantity of coal is being sent from the Ruhr (reparation coal). All this directly affects the business in this country, and it is not due to the lack of modern methods, nor to the mismanagement by business men. We have to consider that labour troubles are so much in evidence in this country as compared say, with America. On the Continent the rate of wages is lower, making competition almost impossible. In short, it does not seem fair to lay the charge to business men of South Wales for the present depression in trade.

With regard to the matter of spending money on what the author terms legitimate mining enterprise, the author does not state how colliery companies could have proceeded on more up-to-date lines, and certainly the idea that the privately owned wagons are of little use to them is somewhat beside the mark. Further, the capacity of wagons might be somewhat modified, because it is a fact that not a single eight-ton wagon exists today for coal traffic; the ten-ton wagons are fast disappearing and all new wagons to-day are twelve-ton.

We have provided fifty tips at the South Wales ports capable of dealing with twenty-ton wagons, and these have been in existence for at least two or three years; we have at present about 1,000 twenty-ton wagons in traffic, and it is well known that a rebate is offered for the introduction of these wagons, a rebate on the rail charges, and also a rebate on shipping charges; but on account of the other conditions prevailing trade has not been what it might have been, and therefore capital has not been forthcoming to encourage colliery owners to adopt the twenty-ton or higher capacity wagons.

Referring to the capacity of appliances which have been introduced at the South Wales ports, there are tips at Cardiff Docks which are capable of shipping at the rate of 1200 tons per hour, and that rate of shipment is comparable with some of the statistics referred to by the author; in fact, if we take the loading of grain—12,000 tons in ten hours—the figures are identical with the example given.

Briefly, to summarise the position with regard to facilities at South Wales, it will be seen that having regard to the requirements of South Wales coal, the bulk handling principles existing in America cannot be applied because mixing could not possibly be dealt with and again, the nature of the Welsh coal being extremely friable, the matter of handling it in large bins would entail excessive breakage. It is well known that customers of Welsh coal pay a higher price willingly for large coal, and the percentage of small which would result from the handling of the coal in a manner similar to that which is in existence in America would result in such a large percentage of small coal that our markets would soon dwindle.

The author mentioned that he visited Cardiff a number of years ago, and was somewhat surprised at the number of power stations at Cardiff Docks. Mr. Billingham said that when he joined the old Cardiff Railway Co. in 1911, this matter was gone into, and in 1914 a large triple expansion pumping station was installed, and it was claimed that the station could pump water for hydraulic purposes as cheap as any in the country. Several power station problems were discussed, and in 1925 an electrically driven pumping station was installed, and the number of stations reduced from ten to four, which is considered an ideal arrangement for the conditions prevailing at Cardiff Docks, so that it would seem the author had been somewhat anticipated in this matter.

With regard to anti-breakage appliances, considerable progress has been made with such appliances; Mr. Billingham had experience of all types of the anti-breakage appliances used in the Bristol Channel Ports, and with the more recent type coal shipping could be proceeded with at a very rapid rate consistent with the minimum breakage. He could assure the author that they were ready at all times to receive suggestions or to put any proposed appliance to the test when anyone cared to put a proposal forward.

Mr. C. F. FREEBORN (communicated).—It would not be out of place to draw one or two comparisons between the area dealt with in the paper and our own district of South Wales, in which the G.W.R. Co. says there exists the world's largest dock system. The dock acreage of the South Wales ports is over 900 acres, of which Swansea contributes 280 and Cardiff 165, and out of the 41 million tons of coal shipped in the record year of 1913, Cardiff sent out 10½ millions, Barry 11, Newport 6 and Swansea 4½. Last year Cardiff shipped 6 millions out of a total of 25 millions, and Swansea 3.

There are 172 coal hoists in South Wales, 49 being suitable for 20-ton wagons, and capable of lifts of 70 feet; eleven such hoists are at Cardiff, and of these four in the Queen Alexandra Dock are of special interest. These hoists are hydraulically operated so far as the hoisting and tipping of the wagons are concerned, but other motions are carried out electrically; two 35 H.P. motors operate the traversers, and at the full loading rate start and stop 250 times an hour; two 20 H.P. motors move the hoists themselves, which weigh 300 tons, for berthing purposes, at a rate of 30 feet per minute.

The tipping tables for bringing the full wagons in and the empty wagons out are also worked by motors, with electric brakes for holding the tables in each position. One is compelled to be conservative in giving outputs, but these hoists can handle fifty 20-ton wagons per hour quite easily, and no doubt a higher rate could be obtained if it was required.

Barry, however, apparently holds the record for coal loading, having completed a cargo of 4000 tons at 650 tons per hour with four hoists; a single hoist at the same port loaded 5000 tons at 450 tons per hour, and a belt conveyor loaded another cargo at 392 tons per hour.

Regarding other merchandise, South Wales imported last year nearly a million tons of ore, half of which came into Cardiff; at one port a cargo of about 3000 tons was off loaded in 17 hours. It is sad to relate that last year a million tons of iron and steel billets and blooms came into South Wales ports, chiefly to Newport, and two cranes are recorded to have off loaded 1454 tons of blooms in eight hours.

Last year 400,000 tons of grain came in, half coming to Cardiff, where there is a floating grain elevator at the Queen Alexandra Dock capable of dealing with 120 tons per hour, as well as two 80-tons per hour pneumatic elevators.

It is of interest to notice that in the South Wales ports there are 320 cranes, hydraulically operated, whereas only 45 so far are electrically operated, although in several centres, and especially in Cardiff, the hydraulic energy is generated electrically. As Mr. Broughton has said, the old steam stations have now been replaced largely by a central pumping station, the equipment of which, as well as that of the special hoists, was described in a paper read last year by Mr. Billingham before the Institution of Mechanical Engineers. The actual station consists of four 650 H.P. units, each unit having a capacity of 800 gallons per minute at 800lbs. per sq. inch; the Great Western Railway are to be congratulated on the liberal spacing and general lay-out of this plant, which has fully justified its installation.

Mr. H. H. BROUGHTON.—Replying to the discussion, Mr. Broughton emphasised the fact that in the paper he had not advocated the adoption of American methods of handling. What he had done, he said, was to suggest to them the desirability of studying those methods and of investigating the feasibility or otherwise of making Bristol Channel ports a great receiving centre for Canadian grain, taking Welsh coal and, or, anthracite to Canada as return cargo.

He was not prepared to discuss the shipping of coal from Cardiff. If, however, they thought all was well with the trade they could continue to use the large number of "toy" wagons that were employed at the time, and no doubt the shipping appliances would be found to be sufficiently large for the work they had to do. He was, however, of the opinion that the initiative and enterprise which had been shown in the past would be in evidence in the future in every branch of the coal trade, and if that were so the rational handling of coal was only a question of time.

He had seen Welsh anthracite unloaded at Montreal and was in full sympathy with the views expressed by Mr. Farr Davies. The only suggestion he had to offer was that they should examine the possibility of preparing their coal most carefully at Montreal instead of at the collieries. He thought that was a more logical thing to do than to drop prepared coal a matter of 16ft. to 25ft. into the holds of vessels and to expect arrival in good condition after such treatment.

Mr. Billingham's remarks, he said, were of particular interest to him, but he thought that for the most part they dealt with matters outside the scope of the paper. Unless they had wagons to feed large-capacity coal hoists he doubted the wisdom of providing such hoists. Nevertheless, as Mr. Billingham had said, there were fifty 20-ton hoists in South Wales and there were only a thousand 20-ton wagons in use.

As one interested in the handling of materials he would have been glad had Mr. Freeborn told him what proportion of the 320 hydraulic cranes referred to were economically operated.

He thought Major David had misunderstood his remark with regard to the generation of power at the collieries, because it was common knowledge that at some of the collieries in South Wales electrical power was generated as economically as in the so-called super power stations.

In expressing his thanks for the very cordial reception accorded to the paper he said it might be to the interest of South Wales to enquire into the feasibility or otherwise of shipping anthracite and soft coal to Montreal and Fort William and to the new port on Hudson Bay. The best time to make the enquiry was during the spring and summer months.

Subsequent to the meeting Mr. Broughton wrote the Secretary of the Branch as follows:—

Shipping Coal to Canada.

Lest the suggestion I made at the meeting last Saturday should be either misreported or misunderstood I beg to set out the suggestion briefly below.

"That the coal interests in South Wales should enquire into the feasibility of shipping anthracite and soft coal to Montreal, Vancouver, Fort William and to the new port on Hudson Bay.

"In connection with the latter, it is possible that important concessions for a coal dock could be obtained from the Canadian Government.

"The best time to make the investigation would be at the end of April or the beginning of May."

Mr. DAVID EVANS, on behalf of the Colliery Managers' Association, proposed a vote of thanks to the South Wales Branch of the Association of Mining Electrical Engineers for the invitation to attend the meeting.

Mr. C. H. McCALE seconded the vote of thanks, and said if the suggestions made by Mr. Broughton could be applied practically, and he knew of no reason why they should not be, he thought they would again see the coal industry in South Wales in the position it was some years ago. If they could make Cardiff a distributing centre for Canadian wheat and Montreal a distributing centre for South Wales coal they would have found one way out of the present difficulty and much work for our army of unemployed. It had been suggested only a few days ago that if we could find a market for 10,000,000 tons of coal the problem of unemployment would be solved. Mr. Broughton had referred to large capacity rolling stock. He, Councillor McCale, had had experience of rolling stock extending to 50 to 60 tons and if colliery companies would only consider the advantages to be derived from making use of larger units of rolling stock together with the railway company, they would be able considerably to reduce freightage charges.

WEST OF SCOTLAND BRANCH.

At the meeting of this Branch on February 20th last, Mr. H. H. Broughton was unable to be present for the reading and discussion of his paper, "Bulk Handling of Ore, Coal and Grain." The paper was read by Mr. F. Beckett, the Branch President, and an interesting discussion ensued. The main paper was published in *The Mining Electrical Engineer* last June. The following supplementary notes were sent forward by Mr. Broughton for this meeting.

Bulk Handling of Ore, Coal and Grain

(Supplementary Notes).

In a recent annual report of one of the large colliery companies there are two items of special interest. One of these deals with engineering and the other with finance. It appears that during the year a hundred 12 ton wagons were made by the colliery company's employees. Elsewhere in the report shareholders are informed that no dividend is to be declared.

The question arises: If it be more profitable for a colliery company to make wagons than to buy them from the professed wagon builder, might it not be more profitable for the colliery company to enter the wagon trade and to leave the winning of coal to the wagon builder? Is it not more logical for a man to attempt to do the work of his tailor?

An authority has given as a reason for the continued use of small wagons the fact that the gantry hoists and drops, constructed 50 years ago, are incapable of handling heavier loads. To the thoughtful the remedy appears to be an obvious one.

Records show that of the 2840 mines at work in Great Britain no less than 1263, or 45% of the total, can either afford not to use, or are compelled to do without, a supply of electrical energy. In consequence of this, the amount of fuel consumed at the mines in the uneconomical generation of power exceeds by many times the fuel consumed by the whole of the public electricity supply undertakings in Great Britain.

A Gilbertian situation has arisen owing to the indispensability of electric power supply. Briefly, on the one hand large power users cannot afford to use electrical energy owing to its high cost; and on the other hand power companies cannot afford to reduce the price owing to the limited demand for power.

A refreshing contrast is furnished by a big country which is a member of the brotherhood called the British Empire, a country larger than Europe and having a population something less than that of Greater London. It is Canada. There it has been found necessary to build a power station the annual output of which is about one-third that of the combined output of the whole of the public electricity supply stations in this country.

Imagine the opposition of the 600 vested interests to the rational development of the power supply at home. Is it in virtue of this opposition that this—The Association of Mining Electrical Engineers—cannot bring about the use of electrical energy at close upon 1300 mines It may be taken for granted that every member will agree that electrical energy is indispensable in mining enterprise. There is room for the suggestion that an industrial nation trying to work without an abundant supply of cheap power in the twentieth century is likely to result in factory chimneys emitting the sooty hell of mutiny, and savagery, and despair.

The professional half of the writer was in favour of a paper on Electric Winding—a subject with which he claims a certain amount of familiarity—but the unruly half, having been kept under subjection, would hear of no such thing. He, the unruly half, insisted on what he termed 'plain truths straight from the shoulder', and the other half, being essentially a man of peace, had to give way. Otherwise the writer would have said that expert opinion in various parts of the world is inclined to favour the use of electrical energy for the economical hoisting of minerals. The unruly half retorts—'That may be the reason why of nearly 3000 mines at home only 200 main shaft winders are electrically operated.' The possession of an unruly half is a grave responsibility and the professional element craves the indulgence of listeners.

As many are aware the steel trade of the country is kept alive by rolling plates and sections from foreign billets. It may not be so generally known that vested interests made it virtually impossible for the carriers and ironmasters to install plant for the rapid unloading and handling of iron ore when they were minded so to do. The said interests, when work can be found, obtain 7½d. for work which is done better by the machine for 2½d. Is this one of the reasons why, at the present time, it is found cheaper to roll British steel from foreign billets?

During the lifetime of most of those present at this meeting our competitors have reduced the cost of handling iron ore from 28d. to 2d.

While the machinery and methods whereby these results haves been achieved may not suit the conditions in this country it is thought that their examination cannot fail to be of interest. The psychologist can probably account for the enthusiasm aroused by the unloading of 10,000 tons of coal from a boat and the loading of a like amount of ore, or grain, and departure from the port on the same day. All the author can do is to vouch for the enthusiasm.

At this point the unruly half observes that the economist can probably reduce to a common denominator the effect of keeping boats waiting for days to be loaded or unloaded. He notes that the effects of delay begin at the port and end in the workhouse.

In the original paper reference is made to our struggle to pay the baker. This struggle may account for lack of interest in the subject of grain handling—a trade the magnitude of which makes many other trades appear insignificant in comparison. But if any have witnessed the tragedy of a grain dealer in Eastern Europe playing, as a cat plays with a mouse, with a peasant farmer concerning the quality and weight of grain which the one pretends to be unwilling to buy and the other is feverishly anxious to sell in order to keep body and soul together, they will welcome as a breath of fresh air an insight into a method of handling which gives a square deal both to buyer and seller, and which hall marks the product in the world's market places.

Special attention is directed to the following extract from a letter issued by the American Society of Mechanical Engineers last March.

"American industry is beginning to awaken to the seriousness of its annual loss due to inefficient material handling (in the United States), estimated by competent authorities to be in excess of 620 million sterling annually."

If, notwithstanding the labour-aiding appliances described, such a loss be possible one can vaguely predict the probable loss in industrial countries which still rely on brute force.

LONDON BRANCH.

Decking Plant.

L. B. CHILDE, A.C.G.I., B.Sc.

(*Paper read* 16*th January*, 1929).

The problem of transporting the coal won at the coal face to the screens at the pit top has to be considered in three distinct phases, relating respectively to the journey from the coal face to the shaft, the journey in the shaft and from the shaft top to the screens. It is frequently found that the shaft forms, in more senses than one, the "bottle neck" which is the limiting factor as regards the output of a pit. As the general opinion now is that winding speeds in modern colliery shafts have reached a practical maximum, other methods than increasing the speed of winding have to be exploited should it be desired to increase this output.

An increase in the number of decks of the cages in the shaft, perhaps the most obvious solution of this phase of the problem is, however, found on closer investigation to be an extremely expensive undertaking, as heavy capital outlay on equipment and structural work is inevitable. Further, three or four deck cages are the largest which experience has shown it to be economical to employ, whilst of multi-deck cages generally, those having two decks only are probably the most favoured at the present time.

The operations of decking the tubs, that is, of loading and unloading the cages at pit top and pit bottom, have not in the past received nearly so much attention as they deserve, since acceleration of these operations, by decreasing the time that the cages are stopped, results in an increased number of winds per hour being made. Thus the application of power to decking operations, by which this acceleration may most easily be obtained, forms the readiest method of increasing the output dealt with through an existing shaft, or of ensuring the maximum efficiency of a new one.

When it is further considered that the arduous manual labour inseparable from hand decking is almost entirely eliminated it will be realised that the advantages of power decking cannot be ignored in these days when efficiency of operation counts for so much towards the successful running of any colliery.

It may here be remarked that the speed of operation of a power decking plant has been equalled by hand decking for short spurts; but the effects of fatigue in the human element become quickly apparent in repeated delays, each small in itself but very considerable in the aggregate, which inevitably occur when high speed decking is attempted for long periods at a stretch. The efficiency of a power plant, however, remains unchanged throughout the whole shift, and it is by this elimination of numerous small delays between successive operations that the success of such a plant may be gauged.

Having thus mentioned the two outstanding advantages of employing power decking plant—namely, speed of operation and reduction in manual labour—it will be well to summarise the qualities which such a plant must necessarily possess to enable it to be a commercial success.

(1) *It must be absolutely safe in operation.*

There must be no possibility of a wrong move being made by the operator—the plant must be so interlocked that there is no danger of, for example, premature operation of the decking rams before the cage is in position.

(2) *It must be reliable.*

Obviously it is a waste of money to instal plant to increase the output of a pit if there is danger of repeated failures of the plant resulting in delays which may more than nullify the time gained while it is working. Safety and reliability are thus the first and most important essentials of a decking plant, as indeed they are with most other items of pit machinery.

(3) *Its running cost must be light.*

It is useless to save money in labour costs if the mechanical appliances which reduce the latter cost more to operate than did the labour they displace.

(4) *Construction must be of the sturdiest.*

The attention required to keep it in order must be reduced to a minimum. Colliery conditions, particularly underground, are totally unsuitable for delicate apparatus; and it is advantageous for all routine attention to be simple enough to be carried out by unskilled labour

Furthermore, it must be possible for the decking plant to be adapted to suit widely varying conditions. Pit top and pit bottom lay-outs vary so enormously even from shaft to shaft in one colliery that no standard plant can be evolved, but each plant has to be designed to suit an individual set of conditions, not only the track lay-out but such factors as rail gauge, size of tub, type of keps and many other factors, in regard to which there is wide divergence of practice, having to be taken into consideration.

Decking plant in which compressed air forms the motive power has now been employed in a number of collieries for sufficiently long for it to have been proved that this system possesses all these qualities.

These installations, whether they serve simple single deck cages, or whether two, three or even four deck cages are employed, all operate and are constructed on the same general principles, which will now be briefly described.

Rams and Skotch Blocks.

A pneumatic ram whose piston carries a crosshead and pushing arms designed to engage with the tub axles is installed for each line of tubs and pushes the empty tubs on to, and the full tubs off the cage at the pit top, and the full ones on and empty ones off the cage at the pit bottom. Skotch blocks, without which it is not considered advisable to operate power rams, are fixed close up to the cage on each track and hold back the tubs until decking is to commence. An air valve is opened through suitable operating mechanism by each cage when it arrives in line at the pit top or pit bottom and supplies air to remove the skotch blocks and operate the rams, so that the presence of the cage is necessary before any of the plant may be actuated. Thus the simplest possible plant consists of rams, skotch blocks and cage-in-line mechanism with, of course, suitable control valves for the regulation of the air supply to these units.

Control and Operation of Keps.

At the pit top and any other levels where keps support the cage during decking, these may advantageously be power-operated, a pneumatic cylinder being employed to move them under the cage and withdraw them. An air valve mechanism actuated by the keps is employed to feed air to the decking plant when the keps are inserted under the cage, so that this condition must obtain, in addition to the cage being in line, before decking can commence. The withdrawal of the keps is further interlocked with the decking plant by its being arranged that, until the skotch blocks have been replaced on the rails after decking is complete and the pushing arms of the ram have retracted clear of the cage, air cannot be supplied to the operating cylinder to withdraw the keps (Fig. 1).

Incidentally, there are two opinions as to the correct method of inserting the keps under the cage. The first method is to move the keps to the "under" position before the arrival of the cage at the pit top, and allow the cage, as it arrives in line, to knock the kep shoes aside, allowing them to fall back for the cage to be lowered on to them after the cage has been drawn above them. The second method is to wait until the cage has arrived and is above kep level before moving them to the "under" position.

It depends upon the design of the keps as to whether the first method is practicable; its adoption, though possibly saving an instant of time which would otherwise be spent whilst the keps were being inserted after the arrival of the cage, results in greater wear and tear on the kep mechanism. When power mechanism is added to existing hand-operated keps, it is usually arranged that the existing practice shall continue as regards which of these methods is employed. With a new installation, the second method would be recommended, as with power operation the time taken to insert the keps is negligible, since they are automatically put in on the arrival of the cage.

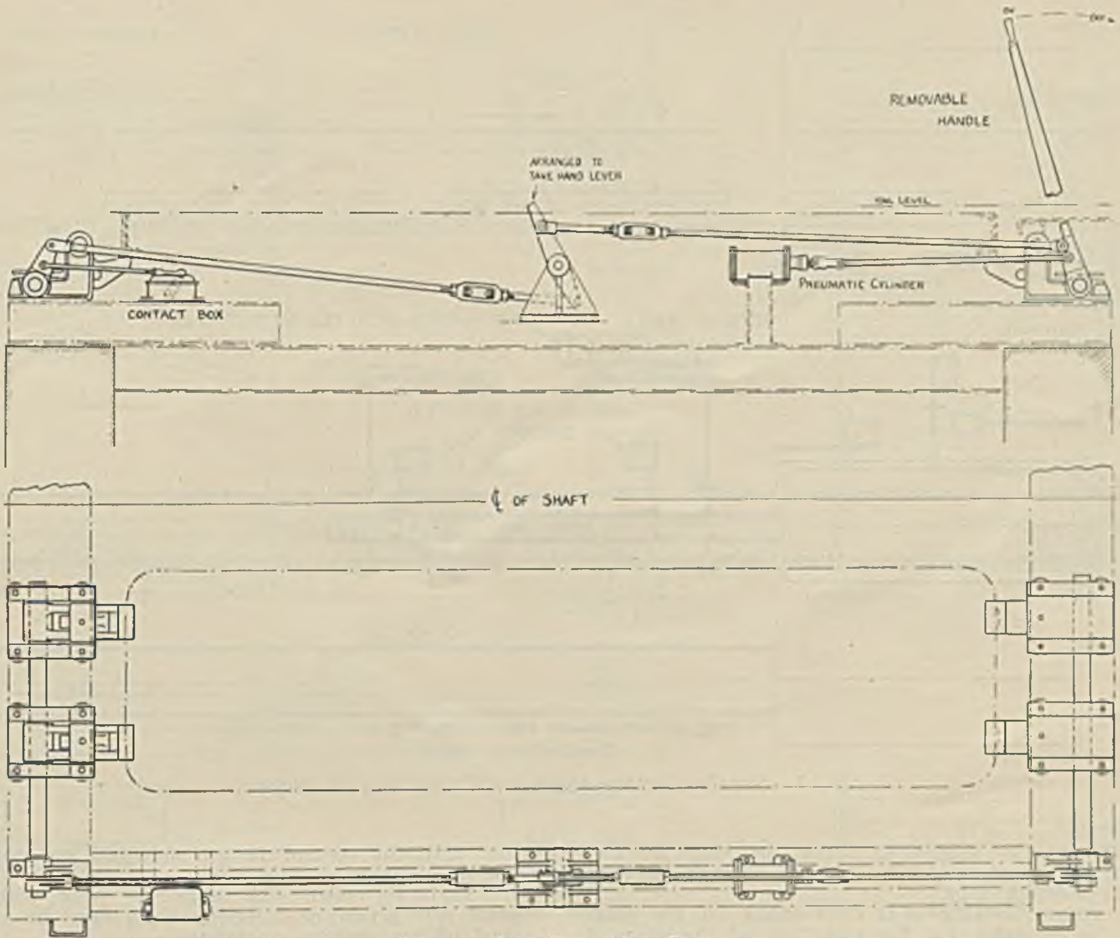


Fig. 1.—Kep Operating Gear.

Mining Plunger and Blinder.

There has unfortunately been a number of accidents in the past with hand decking caused by the cage being signalled away before the completion of decking.

To ensure that the cage is not signalled away until a power decking plant has completed its operations, the mining plunger by which the winding signals are transmitted is provided with a pneumatically operated blinder which is lowered to cover the mining plunger during the time that decking is in progress. In cases where keps are employed, this blinder is not raised to enable the cage to be signalled away until the keps are withdrawn, which, as described above, cannot take place until the decking is completed; where there are no keps, the skotch blocks must be on the rails and the arms of the rams clear of the cage before the blinder is raised. The blinder may be raised by hand should it be necessary to transmit any signals during the decking period; but that such a deliberate movement is necessary obviates the danger of a premature signal being inadvertently transmitted.

Rear Skotch Blocks.

Hitherto the usual method of stopping any tubs over and above those actually waiting for the next decking operation has been by "lockering" their wheels as they approach the pit bank. Now perhaps it is too much to say that "lockering" is a practice which should be absolutely ruled out in any modern pit, as it is undeniably the simplest means of bringing a tub fairly gently to rest, but it cannot be denied that it is bad for the track, bad for the tubs and not without danger to the man who has to push the sprag or locker into the spokes of the wheel.

A most convenient method of regulating the flow of tubs to the cages is afforded by the installation of a second set of skotch blocks some distance back from the shaft, these skotch blocks to be controlled by the banksman or onsetter, or if more convenient, an assistant.

Fig. 2 shows a simple decking plant with rear skotch blocks. It will be noticed that the rear skotch blocks are so placed as to allow a space between the tubs sufficient for a man to pass between them. A further advantage of these skotches is that a clear space may thereby be maintained in front of the cages when men are being wound.

Front Stops or Catches: Tub Controllers.

There are at present on the market probably some 56 different types of tub catches and controllers for use in the cages, most of them patented; in addition to these, some colliery companies use catches of their own design and manufacture. (Here is a good example of the wide divergence in pit practice previously mentioned). It will be appreciated that where power decking plant is used, the type of controller to be installed in the cage requires careful consideration.

The simplest type of front catch, known usually as the "jack stop" consists of a pair of levers lying between the track, carried on a horizontal pivot which allows their forward end to project upwards to engage with the tub axle; the levers are lowered, to allow tubs to pass, by a hand lever mechanism on the side or roof of the cage. The operator pulls the lever and lowers the stops at the commencement of decking, allowing the tubs on the cage to be pushed out, and at the correct instant, after the outgoing tubs have passed, he

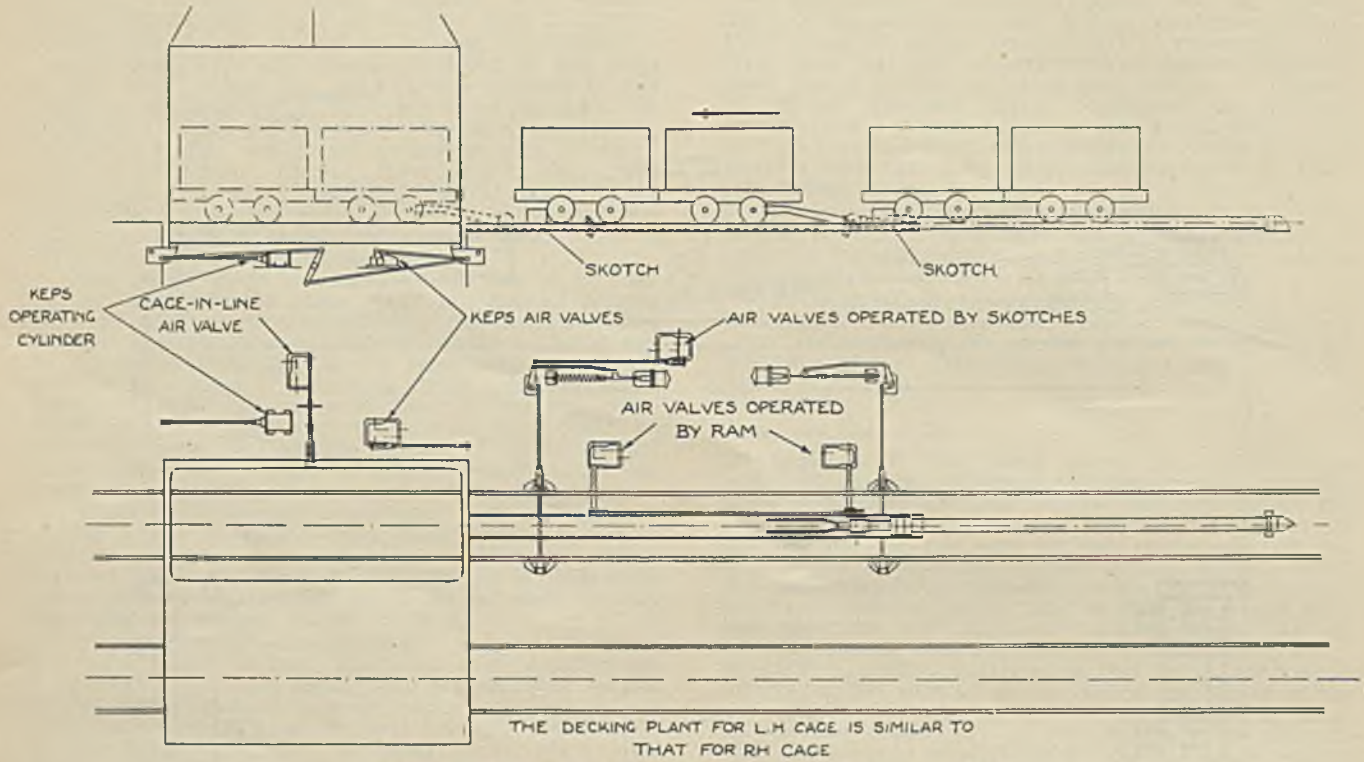


Fig. 2.—Simple Decking Plant with Rear Skotch Blocks.

has to release the handle to allow the stops to rise under the action of counterweights or springs, to hold back the incoming tubs.

This system, relying as it does solely on the judgment of the operator for the re-setting of the stops at the correct instant, is hardly suitable for use with high speed power decking, though it may be quite satisfactory when hand decking is employed, as the operators attain considerable skill in correctly re-setting the stops. It is, however, sometimes possible to incorporate some form of automatic tripping device, operated, for example, by the front axle of the first outgoing tub when it reaches a point the correct distance beyond the cage, to effect the re-setting of such jack stops, but this is not a system which lends itself to universal adoption, owing largely to structural considerations in the immediate neighbourhood of the shaft.

In place of these jack stops, tub controllers, that is stops of the rotary type, are now being increasingly adopted. The tub controller consists essentially of a star wheel carried in a fixed casting or body between the rails, at such a height that it engages with the axles of the tubs. The star wheel stands normally locked, thus forming a positive stop against the tub axles, but when unlocked the wheel is free to revolve, and is turned one star at a time by the axles passing over it. In the case of a tub controller on a cage, when either two or three tubs at a time have to be passed, the star wheels have either four or six stars, and are allowed to rotate once only, after which they automatically re-lock. These controllers are capable of operating very rapidly, and provided they are carefully installed in the cage, give remarkably trouble-free service.

These tub controllers may be operated by a hand lever mechanism on the cage, or through suitable striking mechanism by pneumatic power from the pit bank, and may be employed equally well in conjunction with manual decking as with power decking plant. Whether the controllers are power released or hand released, the act of unlocking them causes air to be supplied to the decking plant to start off the sequence of operations, so that until the controllers are unlocked no movement of the rams can take place.

Similarly, when jack stops are used with decking plant, the action of releasing them may be utilised to start off the decking operations.

Back Axle Stops.

Fig. 3 illustrates a main cage equipment: this diagram also shows a special type of back stops—known as detecting back axle stops—installed in the cage; their purpose is to ensure that all tubs are fully on to the cage before the latter is sent away, and are necessary when it is impossible for the banksman to see that this is the case. It is desirable wherever possible to arrange that the banksman shall be able actually to see the tubs running on to the cage on each deck, grid flooring being provided in the case of multi-deck plants for this purpose, so that should a tub be derailed or any other emergency arise there shall be no danger of his being unaware of the fact. But if for any reason it is not possible to arrange for this, these detecting back axle stops must be installed.

Their construction is not unlike that of the controllers; they have a star wheel which may be rotated by the axles of tubs passing over them. They are, however, never locked against forward rotation, so that the tubs run on to the cage unchecked, but they are permanently prevented from rotating in the opposite direction, and so stop the tubs from running backwards off the cage. An ordinary faller stop alongside the star wheel forms another safeguard against this danger.

The detection of the tubs is carried out by the star wheel, which when in other than its normal position displaces a pawl by cam action which in turn is caused to operate striking rods to actuate a valve mechanism on the pit bank, whereby a signal or indication is given to the banksman when the back stops are "normal," and until this indication is given after decking the cage must not be signalled away. In cases where the blinder previously mentioned is used in conjunction with the signalling plunger by which the cage is signalled away, it is

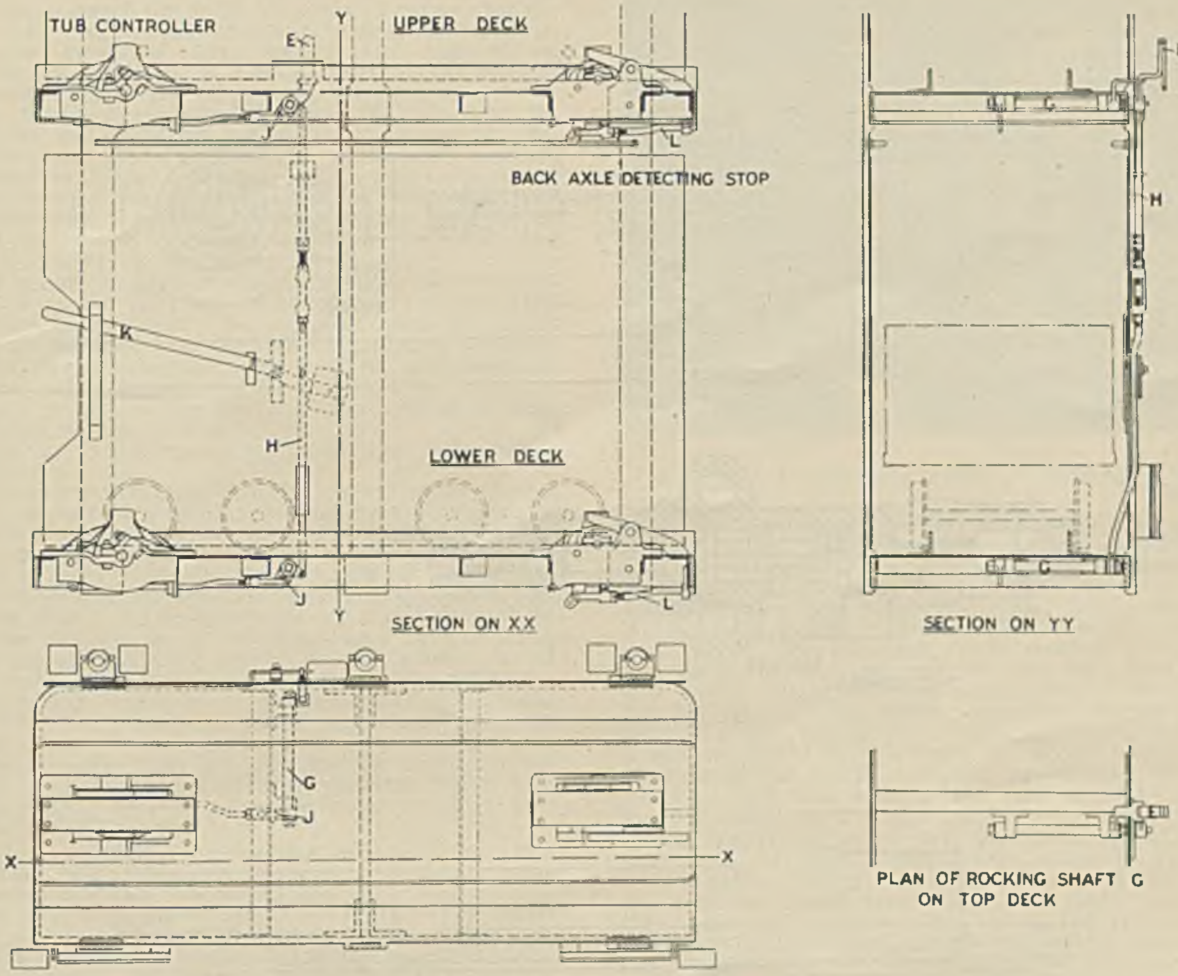


Fig. 3.—*A Main Cage Equipment.*

arranged that this blinder is not raised until the star wheel of each detecting back axle stop on the cage is "normal."

Method of Operation and Control of Decking Plant.

As regards the control of the plant, this may be carried out either by electro-pneumatic or by purely pneumatic means. In the case of electro-pneumatic control, contact makers and switches make and break electric circuits which energise electric magnetic valves, the latter in turn supplying air to operate the various parts of the plant.

As the volume of air which can be dealt with by these magnet valves is necessarily only small, an air relay valve, called an auxiliary valve, is used in conjunction with them. The magnet valve then feeds air when energised to open the auxiliary valve, the main supply of air then passing to the cylinder or ram until the magnet valve is again de-energised.

The contact makers, which are operated by the various units of the plant and regulate the correct sequence of operations, differ to some extent in detail construction, but are all alike in that they must be fully enclosed, to keep out dirt and water.

When used underground, the contact making mechanism, in addition to being dirt-proof and waterproof, has also to be flameproof. It is not proposed to go into the question now of the best designs of such flameproof apparatus.

The best method of carrying the electric circuits between the various pieces of apparatus is by armoured cored cable. It is essential that this should be of the finest quality and that the cables should be run from point to point in such a way that they are not liable to mechanical damage from, for example, a derailed tub, and of course as far as possible out of the way of mud or moisture. The cables must be fed into the contact boxes through properly designed gland connectors, by which the cable armouring is rigidly held and earthed, in accordance with the mining regulations, and in addition a watertight joint ensured.

In a pneumatically-controlled decking plant, these contact makers and electro-pneumatic magnet valves are replaced by mechanically operated air valves operated by the different units of the plant. It might be imagined that it is a very simple matter to cause a ram or a cage to open or close an air valve at a desired moment; actually the design of the operating mechanism required a great deal of care, since, as in the case of the contact box, allowance had to be made for a large amount of "over travel." For example, consider the air valve to be opened when the cage arrives in line; a cam on the cage operates a roller striker mechanism to open this valve, but although the cage is bound to swing and rock considerably while the tubs are running on to it and off it, the valve must be held fully open until the departure of the cage. Fig. 4 shows how by the use of a rotary cam operating mechanism, the air valve is held fully open in spite of any swing of the cage that may occur.

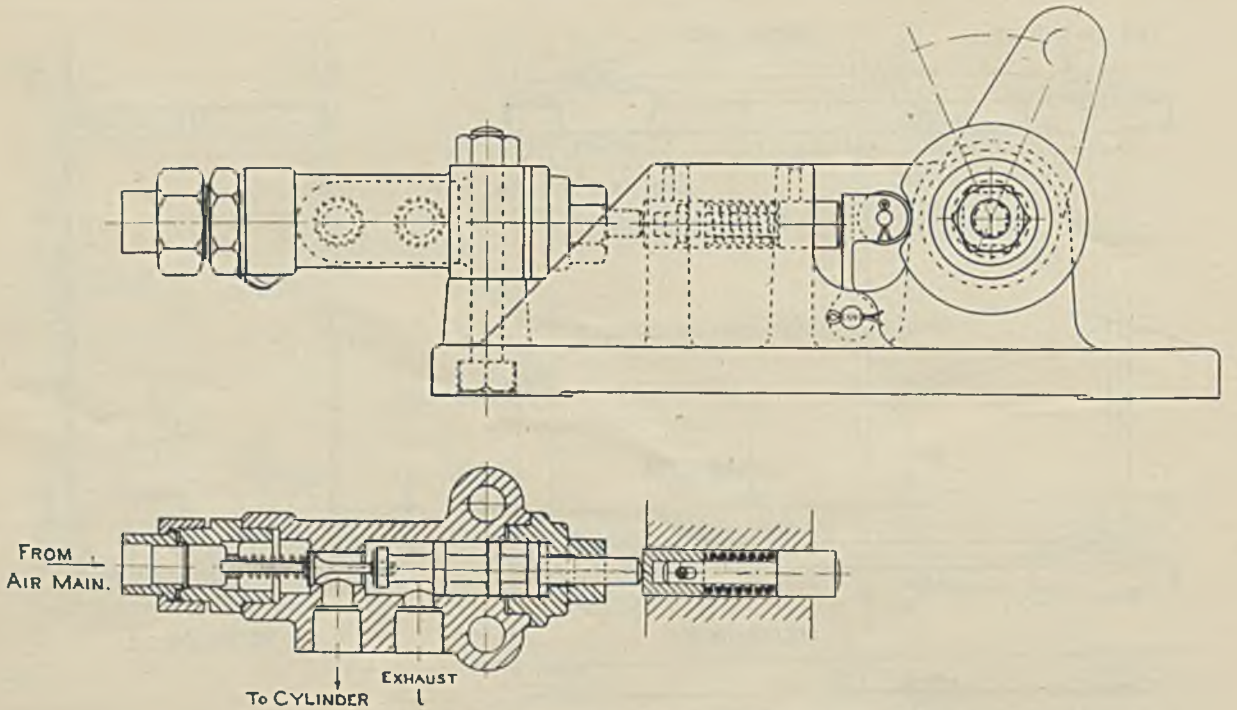


Fig. 4.—Mechanically Operated Air Valve.

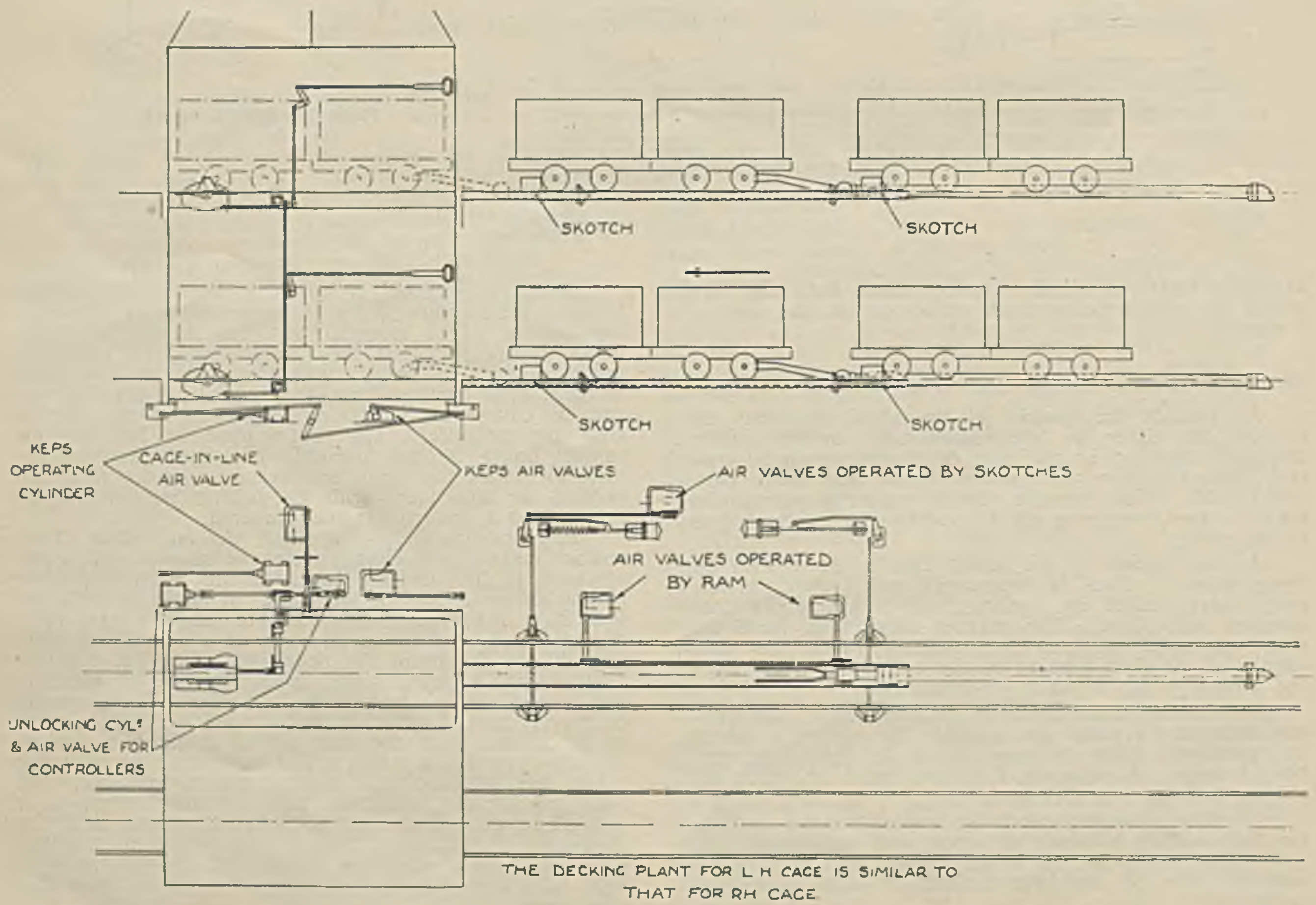


Fig. 5.—Decking Plant.

In addition to the cam which allows the necessary over travel, means has to be provided to ensure that the valve shall seat correctly even after some wear has taken place, for these air valves operate many hundreds of times in the course of a shift, and wear of the seatings and moving parts is bound to occur. The lift of the cam is therefore made greater than the movement required by the valve stem. Then when the cam is rotated, the valve is forced fully on to its seat, and the additional movement is taken up by a compression spring plunger device interposed between the cam roller and the valve stem. As wear becomes evident, more of the lift of the cam is employed in seating the valve, and less in compressing the spring plunger.

This type of mechanically operated air valve is used wherever an air valve has to be opened and closed by any parts of the plant; for example, when the skotch blocks are removed from the rails, an air valve is opened to feed air to bring the rams forward, and there are other air valves operated by the ram itself by which the automatic reversal of the ram is obtained. Both of these are shown on the next slide.

Now as to the relative merits of these two systems of control.

It sometimes happens that it is necessary to effect a control of part of a multi-deck plant from some apparatus such as an axle counter on a drop cage close to the main cage. In such circumstances it is much more convenient to carry a flexible electric cable on to the drop cage and arrange for the axle counter to operate a contact box than to let it operate an air valve and have to carry an air bag on to the drop cage. In this case, electro-pneumatic control would be the better. In all other cases, the all-pneumatic plant has the advantage in every way—experience has shown that it not only fulfils the four conditions which are necessary to the success of any plant equally well, if not better than, electro-pneumatic plant, but also has the additional advantage of slightly higher speed of working—that is with even less delay between successive movements than with electro-pneumatic control.

Before describing the sequence of operations which takes place when the plant operates, it should again be emphasised that this is a typical and not a standard layout, and that in individual cases there may be some departure from the procedure described. The principles involved are, however, similar in all cases.

A typical lay-out of a two-deck pneumatic decking plant is shown in Figure No. 5. It includes power operated tub controllers but there are no detecting back axle stops; as the banksman can see both decks, plain faller stops are employed on the running in side of the cage.

Here the cage is represented as just having arrived in line at the pit top carrying two full tubs on each deck, two empty tubs stand ready to be decked at each level, while further empty tubs awaiting their turn are held back by the rear sets of skotch blocks. It should be noted that the decking plant for the two cages is identical, but that for each cage is quite independent of the other.

Considering the plant shown, this would be controlled by the banksman by means of a pair of hand control valves and a foot plunger valve. Each of the hand control valves has three positins, and one would control the keps, its three positions representing respectively "keps under," "pressure cut off," and "keps out"; the other would be the decking control valve proper, its three positions being "deck," "safety," and "front skotch blocks," the significance of the latter position being explained later, whilst the foot plunger valve is a simple two-way valve used to feed air to unlock the controllers.

During normal decking the handle of the decking control valve would be left in the "deck" position, but no movement of the rams and skotch blocks could take place until the arrival of the cage in line. As soon as the cage arrived at the pit top, the banksman would insert the keps by means of his kep control valve and when the cage had settled on the keps he would depress his foot plunger valve; this would cause air to be supplied to the controllers-unlocking cylinder and both controllers would be unlocked; this in turn would supply air to start off the decking operations which would be carried out automatically as follows: the front skotch blocks would be removed from the rails and the rams would move forward, each pushing two empty tubs on to the cage and two full ones off. The banksman would release his foot plunger valve immediately the full tubs running off the cage had started to revolve the star wheels of the tub controllers, and the controllers would then be free to re-lock automatically as soon as the fourth axle had passed over the star wheel of each. As soon as the rams reached the full forward extent of the stroke they would automatically reverse and return to the fully back position and at the same time the front skotch blocks would be replaced on the rails. During the forward travel of the rams, the banksman would reverse his keps control valve to the "keps out" position, then when the arms of the rams were clear of the cage on the reverse stroke and the skotch blocks were replaced on the rails (and not till both these conditions were fulfilled), the keps would be withdrawn. The blinder, which would have been lowered over the banksman's signalling plunger at the start of the decking operations would now be raised and the banksman would signal the cage away.

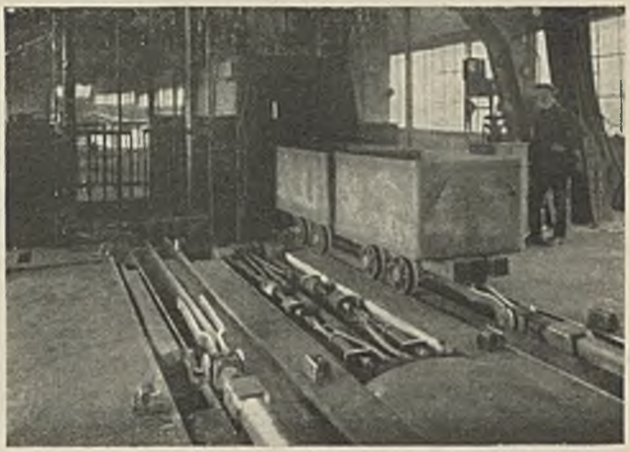


Fig. 6.—Pit Top Decking Plant: Snowdown Colliery.

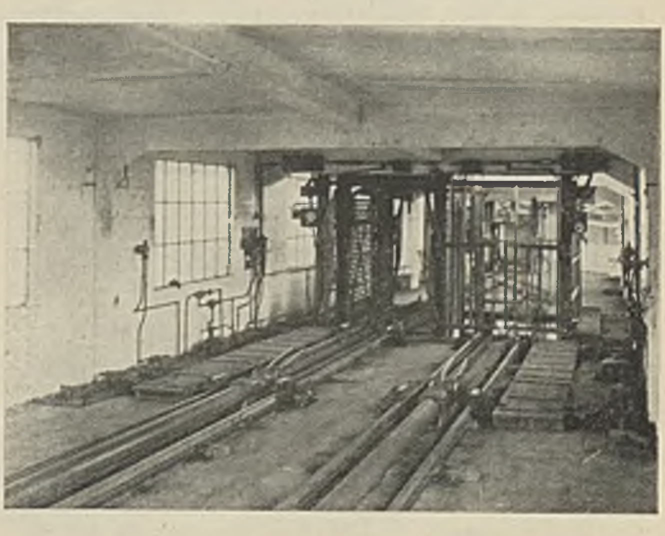


Fig. 7.—Pit Top Decking Plant: Baddesley Colliery.

As already mentioned, the decking control valve may normally be left in the "deck" position, but occasionally it is desirable to be able to push tubs on to the cage without using the rams, as when sending down timber or rails. To enable the skotch blocks to be removed without operating the rams, the decking control valve is reversed to the "front skotch block" position. Then when the cage arrives in line the skotch blocks will be removed, but in no case can they be removed unless the cage is in line.

When men are being wound the decking control valve is moved to the "safety" position, neither rams nor skotch blocks being then operated, but the keps are moved under and withdrawn by the kep control valve in the ordinary way, as when decking is taking place, and also the blinder is lowered whilst the keps are under the cage.

In an emergency during decking—for instance, should a tub leave the rails—the control valve is put to "safety." The skotch blocks will then be immediately placed on the rails and the rams will return to their normal position.

The control of the rear sets of skotch blocks is carried out independently of the rest of the plant, and can be arranged so that those on both decks are operated by the banksman or else with a separate control valve on each deck so that the banksman controls those on his deck only while an assistant controls those on the other deck. It depends entirely on local conditions which of these arrangements is the more convenient.

Automatic Gates.

Power operated gates, opening automatically on the arrival of the cage, are particularly suitable for use with power decking plant, when it is essential that no time should be lost after the arrival of the cage in line before decking commences.

Auxiliary Cages.

So far very little mention has been made of auxiliary cages. But in the case of multi-deck plants, the operation of drop cages is frequently very closely bound up with that of the decking plant, so that a brief reference must be made to both hoists and drop cages.

When creepers and creeper-retarders are used for transferring the tubs from one level to another, or where hoists and drop cages are in use well away from the shaft, their action need not be associated with the decking plant and does not concern us here. But in many instances there are hoists and/or drop cages in close proximity to the main cages—perhaps a hoist on the running-in side and a drop cage on the running-out side. In such a case it will be necessary for the rams to operate through the hoist cage; the hoist on the running-in side is interlocked with the decking plant so that the rams cannot be operated nor the front stops in the hoist be released until the hoist is fully raised. Such a hoist might be electrically, hydraulically or pneumatically worked.

The drop cage on the running-out side is controlled by a cataract oil cylinder and counterweights, and its action is fully automatic. It also is interlocked with the decking plant, and it must be in its fully "up" position before the rams can be operated or the tub controllers in the main cage released.

It will be appreciated that the presence of auxiliary cages in such conditions as these adds considerably to the complication of the interlocking of a plant, and wherever possible it is advisable for any auxiliary cages to be well behind the back of the rams on the running-in side, and sufficiently far away on the running-off side for there to be standage room for several journeys of tubs between the main cage and the auxiliary cage. Then should a temporary hitch occur in the operation of the auxiliary cages, decking will not have to be suspended owing to a shortage or superfluity of tubs.

Discussion.

A MEMBER, referring to an illustration of the decking plant at Snowdown Colliery, asked what was the capacity of the trams there.

Mr. CHILDE replied that each tram carried about one ton of coal, and the length of each tram was about 5 feet.

Mr. J. R. COWIE (Chairman) said that the subject of decking plant was one which would come more and more prominently to the attention of colliery owners in the future if coal winning were to be speeded up. The paper had reminded him of a problem he had had to solve some years ago in the north in connection with the equipment of a new colliery. It was known that a certain class of coal was available in the region of about 1200 fathoms, but it was not known at first that a very fine seam of coal was available in the region of 300 fathoms. When the electrical equipment was designed—it was one of the early electric winding equipments—a very high winding speed was called for in order to ensure the requisite output. There were certain old colliery workings in the area, which were known to be flooded, and the area available for shaft sinking was extremely limited, so that the only way to ensure speed of output was to adopt high-speed winding.

It was realised, however, that unless the marshalling roads were very good, or the team of men was very good, it was impossible to wind from a depth of 300 fathoms at the high speed originally anticipated. It would appear at first that the proper course was to instal decking plant at that level, but it was realised that the marshalling roads could not cope with it. At 1200 feet, however, the only proper means of handling was by means of adequate decking plant.

That experience served to emphasise Mr. Childe's point that no two sets of conditions were alike, and Mr. Childe had been very careful to point out the wide variations in conditions as between different collieries.

The speaker said he would have liked more information with regard to decking at the intermediate stages at collieries where it was necessary to wind from more than one level. It seemed to him that at the intermediate stage, if such existed, the electro-pneumatic plant was of most use. He had noted that in the electrical operation of the plant a valve was moved—not the main valve, but an auxiliary relay—and that auxiliary valve admitted air to the main valve before the decking cams and decking levers began to move. Presumably the primary relay was introduced with the idea of obtaining a little more speed, because there was no mechanical reason why a single operation should not be sufficient.

Mr. C. DAWSON, discussing the kep operating gear, called attention to the author's statement that there were two opinions as to the correct method of inserting the keps under the cage. The first method was to move the keps to the "under" position before the arrival of the cage at the pit top, and allow the cage, as it arrived in line, to knock the kep shoes aside, allowing them to fall back for the cage to be lowered on to them after the cage had been drawn above them; the second method was to wait until the cage had arrived and was above kep level before moving them to the "under" position.

The author appeared to favour the method of moving the keps to the "under" position after the cage had arrived at bank, and from his (Mr. Dawson's) experience, that would appear to be the wiser course. He recalled an accident which had occurred at a colliery at which it was the custom invariably to put the keps in position immediately the cage had descended below decking level, so that when the cage ascended again it passed through the keps and allowed them to fall back again after the cage had been drawn above them. After the plant had been in operation for some time it happened that, in the normal course of winding, a piece of the shoe or toe broke off when the cage came up through the keps, and the piece fell down the shaft, apparently due to the fact that the hundreds of blows administered by the cage as it ascended in the normal course of operation had fatigued the metal and had caused it to fail. A piece of metal weighing about half a hundredweight had fallen a quarter of a mile down the shaft fitted with air pipes, water mains and super-tension cables, and the fact that it had not caused damage in its fall was a fortunate circumstance. It was obvious, of course, that either of the other three or the other seven tongues of the keps might fail similarly if the method of operation adopted had been continued, and he had given instructions that from that time onwards the keps were to be kept out until the cage had ascended above the kep level.

Experience had shown that that arrangement had not resulted in decreased output; in fact, the number of winds per hour was greater after that arrangement was adopted than it was when the cage was allowed to pass through the keps.

Mr. Dawson asked if hand operation could be resorted to if the electrical or hydraulic power were not available. For instance, it was sometimes necessary to close down the plant at week-ends for examination and repair, and it might be that two or three individual winds were desired; and he asked if it were possible to by-pass the automatic devices so that the cages could be operated by hand.

Mr. CHILDE replied to the discussion. Commenting on the Chairman's remarks, he said there was quite a number of cases in which it appeared that the installation of decking plant at the early stages was not advisable; it might be that the output of the pit was not very great at first but was expected to increase, or that the lay-out of the roads was such that it would not be economical to instal the plant, and therefore it was obviously the proper course to wait until conditions were ripe for the installation of such plant. It helped, in such cases, to bear in mind—at the time the gantries were laid out at the pit top, and when the roads were put down—the future installation of decking plant, so that when the time arrived for the installation of rams, etc., the conditions were favourable. The design of the plant should be such that it could be adapted to any circumstances; obviously, from the point of view of cost alone, the simpler the arrangement of the plant the better for all concerned.

He agreed with the Chairman that the electro-pneumatic plant might be desirable in cases where winding had to be effected from intermediate levels, but each case had to be considered on its own merits, and in the case of intermediate levels, as in the case of pit top and pit bottom plant, one must consider all the circumstances in deciding whether the pneumatic or electro-pneumatic plant would be most suitable.

Replying to Mr. Dawson, he said that on the whole he favoured the practice of placing the keps in position after the cage had ascended above kep level, instead of allowing the cage to knock them aside in the course of its ascent. In the paper he had expressed the view that the latter practice resulted in greater wear and tear.

With regard to the operation of the winding plant when the decking plant was not available, he said it was quite possible to push the tubs on to the cage by hand. In special cases it might be arranged that the skotch blocks be mechanically withdrawn from the rails when power was not available, and the presence of the rams in any case would not interfere with the pushing of the tubs into the cage by hand. The decking plant could be put out of action without interfering with the cage at all, and the gates and skotch blocks could be manually operated or put into the "off" position.

NORTH WESTERN BRANCH.

A joint meeting of the members of this Branch and the members of the Wigan Past and Present Mining Students' Association was held on Monday, December 10th last, at the Wigan Mining and Technical College. Mr. A. M. Bell, the Branch President, was in the chair.

Mr. R. M. Chalmers, M.C., B.Sc. (Glas.), M.I.Min.E., read a paper on "Flameproof Enclosures." It was illustrated by lantern slides and demonstrations with apparatus.

Flameproof Enclosures.

R. M. CHALMERS, M.C., B.Sc.

The choice of subject may not seem to be particularly happy as so much has already been said and written on flameproof enclosure. Even after making this choice two papers have been read to two other branches of the Association of Mining Electrical Engineers. One might have chosen a subject which would have proved more interesting from the electro-technical point of view but certainly not one more vitally important to the members of both Associations under the auspices of which this meeting is held.

Without labouring the importance of preventing open sparking from electrical apparatus in mines, the perusal of the Mines Department Circular No. 31, recently issued on this matter and specially referred to coal cutting machines, is recommended. In that circular occurs: "During the last five years there have been thirteen such accidents (due to the ignition of firedamp attributable to the use of electrical power at or near the coal face) and they have resulted in the deaths of seventeen persons and injuries to fifty-two others."

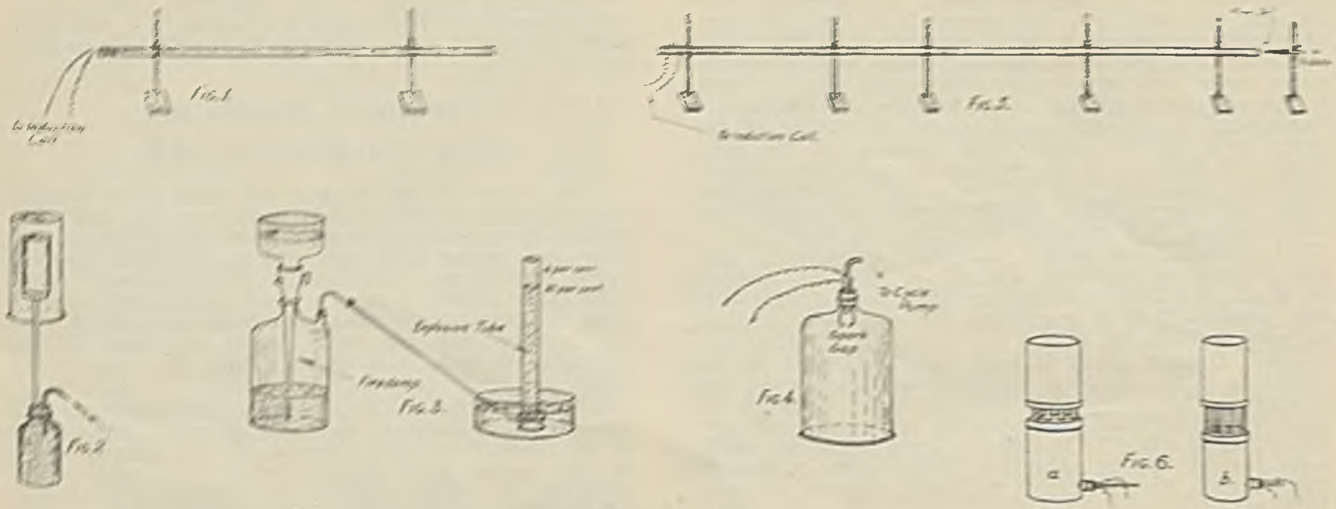
No other reason or excuse for preaching this text should therefore be necessary, but if any were to be given it would be found in the reply of the Electrical Inspector of Mines to a question relative to the lack of information amongst users on the subject of flameproof enclosure. His words were (*ref.* Transactions of the Institute of Mining Engineers, Vol. lxxv., p. 261): "I agree that there is ample scope for the instruction of colliery electricians and other officials at a colliery in this problem of flameproof maintenance. I am convinced that the best, if not the only way of teaching the men concerned is to give them actual demonstrations of the effect of omitting one or two bolts, and so forth. When I was in Germany last year I witnessed a demonstration devised for the instruction of colliers, to teach them why only 'permitted' explosives should be used for shot firing in coal and why stone dusting should be practised. Such instruction can be given quite simply; it is convincing and lasting in effect."

Certainly such instruction can be given and demonstratins carried out with simple improvised apparatus. This has been done throughout the major part of the Lancashire coalfield during the past year by members of the staff of the Mining Department of the Wigan College and under the auspices of the Lancashire Education Authority.

Now to the subject. Rule 127, Par. V. of the Electrical Special Rules states that "All parts shall be so protected as to prevent the occurrence of open sparking where firedamp is likely to occur." Apparatus on which sparking takes place must therefore be enclosed in flameproof enclosure which according to British Standard Specification No. 229 of 1926 is "one which will withstand without injury any explosion that may take place in practice within it under the conditions of operation within the rating of the apparatus enclosed by it (and recognised overloads if any associated therewith) and will prevent the passage of flame such as will ignite any inflammable mixture which may be present in the surrounding atmosphere."

Where firedamp is likely to occur such enclosure is necessary because electrical arcing or sparking or heated conductors may cause its ignition, which might result in a devastating explosion. (At this stage it was shown that electrical sparking would ignite an explosive mixture of firedamp and air. The apparatus used was simply a long glass tube closed at one end by a stopper through which the leads to a spark gap were taken. The apparatus is shown in Fig. 1).

The aim of the designers when electrical apparatus was first installed in mines was to make the necessary



Figs. 1—6.

enclosures "gas tight," and a packing was inserted between the flanges of cover and box. But they set themselves an impossible task; it is impossible to have an enclosure made and maintained gas tight. Firedamp, which is probably 96% to 98% Methane, is a gas which is lighter than air and is therefore found first near the roof, in the ripping, etc. It must not, however, be forgotten that it can travel downwards by the process of diffusion. By this process it can be shown to pass through porous pots.

The second experiment demonstrated this. The apparatus used is shown in Fig. 2, and when a jar containing firedamp was brought over the porous pot the increased pressure due to diffusion of the gas through the pot was clearly indicated by the appearance of the water jet indicated. From this experiment it would surely be impossible to prevent the passage of gas into electrical apparatus or enclosure between flanges and along operating spindles.

It was not long before this fact was recognised and accepted, and the designer was set the task of designing an enclosure without any effort to make it gas-tight—capable of withstanding the force of an explosion of firedamp and air taking place within it, and of preventing the passage of flame to the outer atmosphere. To design such an enclosure one must understand the characteristics of firedamp-air mixtures, the most explosive mixture of firedamp and air, the pressures that can be set up in enclosures by the ignition of such a mixture, the factors governing the intensities of pressures thus set up, and how such pressures can be safely released.

Characteristics of Firedamp-Air Mixtures.

Most underground workers are familiar with the method of testing for firedamp with the lowered flame of a safety lamp. When firedamp is present in small percentage it will be seen to burn, forming a cap over the oil flame of the lamp. With small percentages of firedamp in air combustion of the gas is confined to the surface of the flame, it cannot proceed throughout the mixture; there is insufficient gas present—insufficient being burned to raise the temperature of the adjoining layers of gas to the ignition temperature; or, in other words, to cause the propagation of flame throughout the mixture.

(This was demonstrated, a 4% mixture of firedamp in air being collected in the tube shown in Fig. 3 and a light applied to it. A rich mixture of gas and air, one with 80% firedamp was then collected in the tube and a light applied to it. The gas was immediately ignited but combustion was confined to the mouth of the tube. There was not sufficient oxygen present now to permit the flame proceeding throughout the mixture. Between these two extremes, however, there was a range of firedamp-air mixtures from 6% to 15% firedamp which might be called the explosive range, and if any mixture of this range is ignited the flame will travel rapidly through it. A 10% mixture was next collected in the explosion tube and a light applied to it; combustion proceeded rapidly up the tube thus demonstrating the effect of ignition of an explosive mixture. Two more experiments were made to emphasise the existence of this explosive range. The bell-jar shown in Fig. 4 was filled with firedamp and sparking at the spark gap arranged within the jar failed to ignite it, but when a light was put to the mouth of the jar the gas was ignited and it burned only at the opening. The jar was again filled with gas; sparking within the jar failed to ignite it, but after air had been slowly forced in through an opening in the stopper at the top by means of a cycle pump an explosive mixture was formed and ignition took place).

(In the next experiment demonstrating this point the long glass tube shown in Fig. 5 was used. A spark gap was arranged at one end of the tube and a small nozzle through which firedamp was made to pass was placed at the other end. When this small nozzle was placed within the end of the long tube the gas was ignited at the spark gap and combustion was confined to that end of the tube, but when the small nozzle was withdrawn a little from the tube to admit a greater amount of air with the gas the ignition which started at the spark gap proceeded rapidly along the tube towards the nozzle).

Pressures set up by Explosions of Firedamp-Air Mixtures.

The pressures set up by the explosion of various mixtures of firedamp and air have been thoroughly investigated by the Safety in Mines Research Board. Experiments were conducted with a spherical bomb. The spherical form was chosen as being that in which the maximum pressure would be developed. In any other shape of vessel, as for example a rectangular vessel, the flame will not reach the walls simultaneously, one part will reach one wall before another part reaches the other wall; some of the hot gases will be cooling off while combustion is proceeding in another part of the vessel. (Lantern slides showed successive positions of flame in a spherical bomb with central and ex-central ignition, whilst others showed successive positions of flame in a rectangular vessel and emphasised the point detailed above).

In consequence pressures developed in rectangular vessels are less than in spherical vessels and the greatest pressures are registered when explosions are produced in spherical vessels. The findings of the Safety in Mines Research Board as a result of experiments were:

(1) That the greatest pressures are produced by a 10% mixture of firedamp and air.

(2) That the greatest pressure developed is 102lbs. per square inch.

Investigations have also been carried out with different sized vessels, and the conclusion arrived at is that 102lbs. per square inch is the highest pressure that can be produced by firedamp explosions within a single enclosure, however big that enclosure may be.

Influence of Turbulence on Pressures.

Experiments have been conducted in order to determine the effect of turbulence on pressures set up, and on the time taken to develop these pressures. The spherical bomb previously shown had a fan fitted and tests were made with the fan running and with it stationary. It was shown that turbulence has no appreciable effect on the maximum pressure produced. With a 10% firedamp mixture a 5% increase of pressure may be noted. It was, however, shown that the time taken to reach the maximum pressure by ignition of samples of the same mixture is much shorter. (A lantern slide showed a graph of the times taken to reach maximum pressures in different firedamp-air turbulent mixtures).

Pressures Developed in Partitioned Casings.

In the Mines Department Circular No. 31 the suggestion is made that in flameproof enclosure there should be no connecting passages between separate parts of an enclosure. The reason for this may not at first be quite apparent, but a study of the results obtained by the Safety in Mines Research Board affords an explanation and it will be realised that the recommendation is completely justified.

Experiments were conducted in a large steel drum connected with a spherical bomb through a short pipe. Both drum and bomb were filled with an explosive mixture of firedamp and ignition commenced in the drum. It was found that the pressures developed in the bomb were much greater than the maximum of 102lbs. per sq. inch previously recorded. This phenomenon is referred to as "pressure piling." The reason would seem to be that the pressure developed in the drum is transmitted to the bomb, and when ignition actually takes place in the latter it does so at an increased initial pressure and then the final pressure attained is much greater. In all probability, turbulence is also set up in the bomb and this also influences the pressure set up. Partitioned casings are therefore undesirable unless each division of the enclosure is in itself flameproof.

A summary of the points demonstrated and referred to is as follows:

(1) An explosive mixture of firedamp and air is readily ignited by electrical sparking.

(2) It is impossible to prevent sparking on electrical plant.

(3) It is impossible to ensure that an explosive mixture of firedamp and air will not gain access to such plant no matter how it may be enclosed.

(4) It is therefore necessary to house apparatus on which sparking takes place in an enclosure which is capable of withstanding the force of an explosion taking place within it and this enclosure must be such as will prevent the passage of flame to the outside atmosphere of the mine.

(5) The most explosive mixtures of firedamp and air are those containing 9% to 11% firedamp.

(6) With such a mixture 102lbs. per square inch is the maximum pressure developed in the largest enclosures likely to be employed in housing electrical apparatus.

(7) Turbulence of the explosive gas mixture has no great material effect on the actual pressure developed, but it hastens the development of this pressure.

(8) Partitioned casings are undesirable on account of "pressure piling."

Application of These Points in the Design of Flameproof Enclsoure.

It would therefore seem necessary that enclosures should be capable of withstanding an internal pressure of probably 600lbs. per square inch to give an adequate factor of safety. Enclosures would thus be heavy and unwieldy. This pressure, however, need not be provided for if some means of releasing the pressure be instituted. But the function of the enclosure must not be lost sight of and the means adopted for pressure release must be such that the flame will not be permitted to pass from within the enclosure to the outside atmosphere.

The safety lamp gauze presents a solid wall to the passage of flame; when the lamp *flames* the gas burns within the gauze but the flame does not pass to the outer atmosphere. It might be thought therefore that the provision of gauze covered openings in the walls of an enclosure would allow of release of pressure and at the same time prevent the passage of flame. Such openings would certainly give the necessary release of pressure but their gauze coverings would not be so effective here as in the safety lamp. The speed of the flame as it reaches the gauze must be considered. (The tube shown in Fig. 1 was now filled with an explosive mixture and fired, ignition being made at the closed end. The tube was again filled and the explosive mixture again fired but ignition this time was made at the open end, the flame travelling towards the closed end. In both cases the increasing speed of the flame was noted. Photographic representations of the flame travelling in this explosive mixture were shown on lantern slides).

The gauze of the safety lamp prevents the passage of flame by its cooling action, but if the flame approaches the gauze at speed there is insufficient time for this cooling action and the flame passes. Experiments demonstrated this point clearly. An ordinary safety lamp gauze was fitted in the end of a glass tube held vertically over a bunsen burner. When the gauze was at the upper end of the tube and the gas ignited there the gauze held the flame, but with the tube inverted so that the gauze was at the end nearest the burner and the gas ignited again at the upper end the flame travelled rapidly down the tube, passed the gauze and lit the burner underneath).

A gauze covered opening cannot therefore be employed if an enclosure is to be flameproof. The principle of the gauze can, however, be made use of. If enclosures are provided with broad flanges and gaps are left between these the action of the metal of the flanges will be such as to lower the temperature of the flame to below the ignition point of the gas. (This principle was demonstrated in the tube shown in Fig. 1. A brass plug with a number of holes drilled in it was placed half-way along the tube, which was then filled with an explosive mixture of firedamp and air. The mixture was ignited at one end but the flame was arrested at the plug in spite of the presence of the explosive mixture on the other side of it).

The gaps provided between the flanges must not, however, be too wide or the flame may pass. The elementary apparatus shown in Fig. 6 may be employed to show this. The tins or compartments in (a) are connected by moderately wide tubes and in (b) by longer, more numerous and smaller diameter tubes. Spark gaps are arranged in the lower compartment in each case. (Each apparatus was then filled with an explosive firedamp-air mixteure and ignited by sparking. The inverted tins forming the upper compartments were blown upwards; in (b) no flame was apparent, but in (a) the flame passed upward.

The Safety in Mines Research Board have conducted numerous tests to find the dimensions of suitable flanges and gaps. These experiments were made by the use of a spherical bomb in which were means for fixing a gap. The bomb was placed in a large compartment to avoid disastrous pressures being set up, and an opening covered with oiled paper was provided. Both the bomb and the outer case in which the bomb was placed were filled with a 10% firedamp mixture which was ignited within the bomb. If the gap arranged between the flanges were too wide the flame of the explosion initiated within the bomb would travel through the gap and cause an explosion in the outer or containing compartment. (A lantern slide showed time-pressure curves for explosions in the bomb with the safe gaps of (a) 1/64th of an inch and (b) 1/32nd of an inch and, for comparison, a similar curve for explosion in the bomb without gaps was shown).

The release of pressure obtained could be noted. The pressure developed was between 25lbs. and 30lbs. per square inch as compared with 100lbs. per square inch, the actual limitation of pressure being determined by the gap area per unit volume of enclosure, and this was of course dependent on the shape of the enclosure.

Protection against passage of flame in this way is called flange protection, and there are various forms in which it may be applied according to the method of obtaining the necessary gap. These different forms are:

(a) With rough machined flanges.
(b) „ vented flanges obtained by machining the flanges down between the bolts.
(c) „ vented flanges obtained by providing washers round the bolts.
(d) „ with a corrugated relief device.
(e) „ spring relief bolts.

Forms of protection other than flange protection take the form of:

(a) Ring Relief Vents.
(b) Plate Relief Device.
(c) Spiral Release.
(d) Perforated Plate Release.
(e) Metal Sponge Release.

Discussion.

THE CHAIRMAN said from a student's point of view the practical demonstrations carried out by Mr. Chalmers must impress upon them the dangers which arose from explosive mixtures and the great care which must be taken in the design of flameproof apparatus. From a practical point of view it was necessary to keep in mind that plant has to be maintained, and therefore simplicity should be the key-note. Fortunately Mr. Chalmers had dwelt upon flange protection which, as the audience would have noticed from the illustrations on the screen, was simple, particularly the rough machined surfaces.

In research work hundreds of experiments had been carried out to establish many conclusions which Mr. Chalmers had put before them. One point was the subject of a special Mines Department Circular issued recently. That was, what happened when two chambers were within a flameproof enclosure? Mr. Chalmers put on the screen a chart which indicated most clearly that under such conditions there were found to exist pressures of two to three times the normal pressure due to explosion.

Mr. BOLTON SHAW asked whether Mr. Chalmers could explain how the photographs which had been shown were taken.

Mr. BUXTON asked whether it was possible for sparks from falling rock or stone dust to ignite the explosive mixture of firedamp and air.

Mr. THOMPSON said Mr. Chalmers had suggested the pressure would be higher where there were two enclosures communicating with each other. Had he any information as to what the effect would be if there were three, four, five, or any number of enclosures? How far had tests been made to prove what the highest pressure obtainable was under such conditions?

With a certain amount of diffidence, due to the fact that the electrical side of the mining industry was so largely represented in this meeting, he would like to say with regard to the men who were connected particularly with the pits rather than with the electrical side, that they did not want to be overwhelmed by these electrical people.

He remembered a tale that was told of the early days. A man went from a colliery to inspect at the manufacturers a motor which was to be totally enclosed. The motor was run and it looked a very nice job right away through. But this man must have been one of those inquiring people whom the Chairman had mentioned, and he wanted to know "Why?" So he looked about and found a big hole underneath. He asked the manufacturer, "What is this hole for?" "That is for ventilation," was the answer. The man said, "It has got to be hot if it has to have a hole that size!"

Mr. ROSEBLADE said he would like Mr. Chalmers to explain further about the pressure. Various methods had been shown. First of all Mr. Chalmers referred to the rough machine-faced surfaces, which gave almost a corrugation between the surfaces. Then he illustrated another method, with just a single corrugation, which he said was much more effective. As far as one could see they were practically the same.

Reference had been made to the pressures obtained by ignition extending from one chamber into another. He thought if ignition took place in a large enclosure and there was an opening into a smaller one the pressure in the latter would increase; but when the ignition was in the smaller chamber the pressure in the bigger chamber would be comparatively small.

THE CHAIRMAN.—Mr. Chalmers had described some dangers which arose in dealing with methane-air mixtures. For the benefit of the students he wished to say there were also explosion risks with electrical apparatus. Under all normal conditions the danger of such explosions should not arise, but they were largely due to the human element. One risk was the explosion which might arise from oil vapour. Another risk was the explosion which might arise from the vapour given off from bitumen compounds.

Mr. CHALMERS said he believed what he had shown were actual photographs; he remembered seeing the apparatus with which they were taken, but he did not see them actually taken.

If a spark failed to ignite a firedamp mixture it was possibly due either to a low temperature or to extremely short duration. Many people strongly believed in the ability of the sparks produced by falling rock or stone dust to ignite a firedamp mixture. Much work was being done at the present moment in different parts of the country upon that subject.

Mr. Thompson raised the question of the effect of more than one partition. He was afraid he had no information as to how far pressures could be built up in that way except that the pressure developed in a chamber adjoining and connected to that in which ignition actually commenced was always greater. He had only dealt with pressure going from one chamber into another.

He understood Mr. Roseblade's point was whether he considered the corrugated joint to be better than the rough machined joint. From the point of view of release of pressure it was better—there was a greater release of pressure—but both were effective in preventing the passage of flame. He would not say that one was better than the other in any other respect.

The next question was whether an increase of pressure occurred only when there was pressure set up in a small enclosure due to ignition in the larger chamber. He thought it was quite possible to get the same increase of pressure in the larger vessel by an ignition which started in the small vessel. It seemed to him that what happened was, the pressure set up by ignition in one chamber was immediately communicated to the second one and was followed by the propagation of flame through the opening. Could that pressure release itself back through there before ignition took place? He thought that was the governing factor.

CAPT. MACINTOSH said all would agree they had had a very instructive evening. The slides had shown how tests were carried out, but to his mind they were not the right tests. It was all very well to have a spark gap, but they knew that if they had a short circuit inside something on a power main very much higher pressure was set up by the short circuit. The short circuit itself might absorb all the metal. If he had been one of those people thirsting for knowledge who had been referred to, he might have asked Mr. Chalmers how many times greater pressure he would allow for those originating in a short circuited electric main. However, that was a point which could be left for the time; it went into a very wide field.

In Wigan they were very proud of their Technical School, and every year they saw the highly successful results which were got there: when it was possible to get really lucid lectures such as this one it was easy to understand why. He proposed a vote of thanks to Mr. Chalmers.

Mr. BUXTON, in seconding the vote of thanks, said the question he asked was whether continuous sparking was necessary to ignite the explosive mixture, and he took it that Mr. Chalmers' answer was in the affirmative. Experiments had been carried out by the Research Board under exactly the same conditions, namely, a continuous shower of sparks emitted by friction with stones, and they failed to ignite the mixture unless amongst the fragments which emitted the sparks there happened to be one of extra large size which was flung into the gas jet and remained hot for a sufficient length of time to ignite the gas.

With reference to the various devices which were adopted now for flameproof enclosure apparently the principle behind the whole thing was the gauze principle—dividing up the escaping gases into attenuated streams and cooling them by metallic contact. The gauze was made much thicker in order to deal with the greater pressures which were encountered inside the enclosed area, and afford greater cooling effects.

Mr. CHALMERS said a vote of thanks to him was not necessary; it was he who ought to thank the members of the Branch and of the Students' Association for their presence. He would complete his answer to the discussion by referring to the remarks made by Capt. Macintosh and Mr. Buxton. Capt. Macintosh asked about the pressures caused by a short circuit. That was a question for research—a problem of the mining industry to be solved in the future.

Mr. Buxton had gone wrong in his interpretation of the answer to his question if he thought the answer was that continuous sparking was necessary for the ignition of gas. No. The whole point seemed to be the temperature of the spark and the duration of the spark; and when speaking of the duration one had to think of very small periods of time. The length of time required for ignition might be very small indeed.

The Mining Research Board had made tests to ascertain whether sparks from falling stones could ignite gas. That research was difficult because one could not quite simulate the actual practical conditions that occurred when falling took place at the coal face, or in hard holing, or anything like that. In hard holing with coal cutters going one got prolonged sparking; a succession of sparks was produced and ignition might be caused.

In conclusion, he desired to express his indebtedness to the Safety in Mines Research Board for the use of the lantern slides which had been shown.

EAST OF SCOTLAND BRANCH.

Miners' Electric Lamps.

ALBERT V. REIS, B.Sc.

(*Paper read 25th January, 1929*).

The safety flame lamp for many years has been used to detect quantities of inflammable gas and atmospheres which will not support life, but as an illuminant in its present form, it has ceased to be of real value underground. Broadly speaking, a safety flame lamp gives from 0.5 to 1.25 candle power which, while it fulfils present regulations, does not afford an adequate light. For this reason, the electric lamp will entirely displace it as an illuminant unless a vastly improved light can be otherwise obtained. It is not suggested that the safety flame lamp will be eliminated entirely from mines, but its use will be simply as a gas detector; the electric lamp will be universal for lighting purposes.

Accumulators.

There are two general types of accumulators employed with the portable electric lamps for underground use:—

(1) The Lead Acid Cell.

(2) The Alkaline Cell:

(a) Nickel Iron; (b) Nickel Cadmium.

The lead cell has a positive plate of lead peroxide (PbO_2) and a negative of spongy lead (Pb) with sulphuric acid (H_2SO_4) as the electrolyte. The alkaline cells in both cases have nickelous hydroxide ($Ni(OH)_2$) as the positive electrodes with the active negative materials in (a) iron oxide; and in (b) cadmium oxide; in both cases, caustic potash (KOH) is the electrolyte.

The chemical reactions are reduction and oxidation in charging and discharging, the interchange taking place between the active materials comprising the electrodes. In the case of the alkaline accumulator, the electrolyte acts as an oxygen carrier or catalytic agent.

The chemical reactions in the lead acid cell cause deterioration of the plates which have, therefore, a definite life. In the use of the portable electric lamp, it is generally considered that a lead cell has a life of about 250 working shifts—about one-third that of an alkaline cell.

Alkaline cells have certain advantages, since they do not suffer on over-charge or from short circuits, and the electrodes do not deteriorate on standing.

The gelatination of the sulphuric acid, although it causes a small loss of efficiency in the cell, is an advantage in a portable lamp in that there is no spillage as compared to the alkaline cell. Caustic Potash causes burns which are considered in a serious aspect, although it has been stated by some that these burns are not so serious if properly treated in the early stages.

A great deal of information is available on the subject matter of accumulators and a very instructive communication was made to the Association by Mr. A. W. Bridges,* a copy of whose paper should be in the hands of everyone interested in lead acid accumulators.

There is a considerable divergence of opinion as to which class of cell has the greater claim for use in the miners lamp. Apparently there is room for both classes and certainly each type has its adherents.

The lead acid cell is probably more popular in this country than in the U.S.A., where the Edison nickel iron alkaline accumulator has been widely employed and was probably the forerunner of all cells of this class.

The drop in voltage in the alkaline cell is about 20% as compared to the 10% of the lead acid cell. This is an important factor, since the drop in voltage affects the candle power from the filament in the bulb.

Lamp Bulbs.

Since current and voltage are factors which influence the temperature of the bulb filament, the amount of illumination given out by a glowing filament will be increased or decreased corresponding to any change in voltage.

A small increase of volts will give proportionately greater illumination, whilst a small decrease will produce a somewhat greater loss in light or candle power.

* "Notes on Accumulators, Lead Acid Type," by A. W. Bridges, *The Mining Electrical Engineer*, pages 60-64, August 1927.

It is for this reason that all factors which go towards loss of voltage must be eliminated or reduced so far as practicable.

The life of the metal filament in a bulb is dependent on the temperature to which it is heated; its life, therefore, is shortened if the voltage is higher than that for which it was designed, but the amount of light given will be much better than that of the bulb used under normal conditions of voltage. A bulb which is used at a voltage greater than that of its normal life is called an over-run bulb.

Manufacturers make various claims in the matter of the life of bulbs which vary generally from 400 to 800 hours. The lower figure represents the over-run or high efficiency bulb. The danger in using the latter type underground is that of being suddenly bereft of a light with the attendant risk of inconvenience and possible danger, and also the additional cost in replacement and labour.

In the cap lamp, the accumulator has been cut down in weight and, therefore, in capacity, which in turn defines the current consumption of the bulb when the duration of the burning hours is known.

The two-volt cell may have a capacity of nine hours at a one-ampere rating which, on discharge at 0.9 ampere, will burn continuously for nearly ten hours. The voltage should not fall below 1.8.

An over-run bulb will give a brilliant light for the first hour or so with a gradual drop in candle power. Normally with an alkaline cell the voltage drop is much greater and the danger of defective bulbs arising will, therefore, be increased unless less efficient bulbs are used.

The drop in voltage in an alkaline cell may be from 1.25 to 1.00. After charging an alkaline cell, the makers insist—very wisely—on at least half-an-hour standage of the cell, as the danger is always present of burning out the bulb.

In new lamps, provision is made to have a two filament bulb with a two-way switch in case of failure of one of the filaments and also to use the high efficiency filament at the working face and the lower efficiency one in travelling to and from the working face. A bulb of the two filament type therefore eliminates the objection to the failure of a bulb with a single filament.

The possible range in improvement in candle power by employing over-run bulbs with the two-volt lead cell is limited, and the increased illumination obtainable may amount to between 15% and 20%. If the capacity of the accumulator, the burning hours and the voltage have been fixed, since candle power will be the dominant feature remaining for consideration, the increased candle power with an over-run bulb may not be considered worth the added cost and inconvenience.

Comparisons.

In comparing the electric lamp with the safety flame lamp, the following advantages are claimed for the former:—

(1) Adequate illumination. This applies to the two-volt cap; four-volt hand and cap; and alkaline cap lamps.

(2) No danger of igniting firedamp through defects or improper cleaning.

(3) Reduction of risk of gas and gas explosion.

(4) No products of combustion.

(5) Clean to handle. Requires no adjustment during the working shift—hence saving of time.

(6) Increased man power efficiency due to saving of time and better lighting.

(7) Fire damp detectors may be employed where necessary for making tests of gas.

(8) With cap lamps, both hands free.

(9) When used with rescue teams, can be employed in irrespirable atmosphere.

There are two main classes of electric lamps employed underground: (1) Hand lamps; (2) Cap lamps. The first class is one which is really confined to European practice and is practically unknown in the U.S.A. or Canada.

The two-volt and the alkaline hand lamps are on a par as far as illumination is concerned which, in the opinion of the writer, is so poor and inefficient that further consideration will not be given to these types.

The four-volt hand lamp weighs approximately 10½lbs., and gives a light of 3½ candle power. With a pillarless lamp and reflector dome, the candle power is tripled.

Cap Lamps.

There are many types of hand lamps on the market, sufficient indeed to meet the most diverse requirements and tastes, but it is believed that the future of lighting underground will be met by the cap lamp. It is not suggested that the hand lamp of suitable type is incapable of giving the necessary light, but the cap lamp has so many obvious advantages over the hand lamp that it is considered only a matter of time until it is universally adopted.

There are four types of cap lamps which have been found to be satisfactory for general conditions underground:—

(a) two-volt lamp; lead acid cell.
(b) four-volt; lead acid cell.
(c) 2.6 nickel iron alkaline.
(d) 2.6 nickel cadmium alkaline.

The two-volt cell gives a very soft and evenly distributed light.

The 2.6 volt nickel cadmium alkaline has a new headpiece which gives a very satisfactory light.

(Polar curves of these lamps were exhibited and demonstrated the light distribution and candle power which, it was to be noted, are somewhat similar).

The reflector and bulb are extremely important and it is satisfactory to observe that a great deal more attention has been paid to these points of late in order to provide an adequate and soft light free from glare.

The advantages of a suitable accumulator may be almost entirely lost if the headpiece of the cap lamp is not provided with a reflector of suitable design. The lamp should be provided with a switch, not for the purpose of conserving the light in the event of an explosion, but for the advantages it has otherwise.

In despatching lamps from the lamp room, a switch is useful since the lamp man may have to hand out from 200 to 300 lamps per shift where, in the case of no switch being furnished, the man would require to commence, say, half-an-hour before the shift to close the lamps, thereby extending the period of the burning hours whereas, with the lamp provided with a switch, the burning hours start from the time the light is turned on by means of the switch.

In making tests underground for fire damp, it is useful to have a switch so that the light may be extinguished to enable the test to be made under completely darkened conditions.

The introduction of the two filament bulb places the switch on the headpiece and makes it an essential part of the lamp.

Great care should be given to the proper selection of a suitable head cable. In addition to strong and efficient insulation, the choice of suitable copper strands is extremely important. The extremities of the cable should be carefully protected by rubber sheathing and fixed by metal binders which will not cut into the protecting hose.

Use of Photometer.

For the purpose of checking periodically the amount of light which is available from a lamp, a photometer of the direct reading type will be found to be of service in a lamp room. A candle power reading can very quickly be obtained without any special arrangement or corrections for its utilisation.

Gas Detection.

The recent application of electrical appliances for the detection of firedamp has been carefully dealt with by Professor MacMillan.* In this connection, reference might be made to a new form of the lamps of this type which are already on the market. It combines a good light with a form of safety flame lamp superimposed over the usual light furnished by the lamp. (A specimen lamp was exhibited).

Whilst the research work in connection with the application of electrical means to detect gas deserves every encouragement in fostering progressive ideas, still the simplicity of the safety flame lamp combined with its efficient results in gas testing and low cost—both capital and maintenance—remains the best simple method of detecting firedamp, with the additional value of its further use for detecting Carbon Dioxide or black damp.

Opinions will differ as to the practical value of the gas detecting electric lamp, and many will undoubtedly still continue to retain a simple good electric cap lamp for lighting purposes and, for the purpose of testing for gas, a safety flame hand lamp fitted with a self ignitor, in preference to any type of electric lamp which combines the properties of a good light and a gas detector.

NEW CATALOGUES.

W. T. HENLEY'S TELEGRAPH WORKS Co., Ltd., Holborn Viaduct, London, E.C. 1.—The "Vienna" and "Vinazo" Tough Rubber Sheathed Wires and Cables—Standard and Flexible Conductors—as made by Henley's are listed in the handsome catalogue Section BC/V. These cables and wires are insulated with vulcanised rubber without the use of a covering of pure rubber next to the metallic conductor. They are particularly suitable for conditions introducing high temperature and excessive humidity. There are some twenty classes of these cables listed in single, twin, three and four-core, all tough-rubber sheathed. Similar cables but not tough-rubber sheathed are dealt with in the companion catalogue Section BA/V—BB/V: in this case the cables are plain, braided, lead-covered, wire-armoured, etc.

A. REYROLLE & Co., Ltd., Hebburn-on-Tyne.—The 1929 Edition of the Reyrolle Accessories Catalogue is a substantial collection of price lists and descriptive books bound in a strong folder. Guide Cards facilitate reference to the several sections, which include Fuse Gear, Air Break Switches, Oil Break Switches, Plugs and Sockets, Cable Sealing Ends, etc. This catalogue is one of the most satisfying reference works which the estimating engineer or buyer could wish for.

BROOKHIRST SWITCHGEAR Ltd., Northgate Works, Chester.—Brookhirst Control Gear for Synchronous Motors is put forward in this reprint of an article showing in simple terms the savings to be effected by Power Factor Correction. It is intimated that the Brookhirst Company will issue, in the near future, a more comprehensive pamphlet on this subject.

CAMBRIDGE INSTRUMENT Co., Ltd., 45 Grosvenor Place, London, S.W. 1.—An attractive Postal Card directs attention to the Cambridge Dial Thermometers. There are six patterns of these, in 28 standard ranges, covering temperature indications from — 10 deg. F. to + 550 deg. F.

ENGLISH ELECTRIC Co., Ltd., Queen's House, Kingsway, London, W.C. 2.—Specification, dimensions and ratings of a range of Oil-Immersed Starters for S.C. motors up to 650 volts are given in the illustrated publication No. 940. The starters are of the iron-clad, totally-enclosed, weatherproof type, and interesting views of the internal construction are a feature of the new list.

L. MARSHALL & SONS, Ltd., Huddersfield.—Calorifiers and Feed Water Heaters of various capacities and types, boilers for central heating, etc., are specialities of this Company as mentioned on an illustrated card.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs. —The Bridge Scoring Pad is not strictly a Trade Catalogue, but it is an exceptionally happy way of keeping the B.I. name in mind. Every tear-off sheet shows a new and interesting illustration of a part of the plant and process in the Prescot Works.

CHLORIDE ELECTRICAL STORAGE Co., Ltd., Clifton Junction, near Manchester.—Entitled "The Lure of the Cotswolds," this art folder with its charming views of the 17th century Church Cottage, Witcombe, tells of its taking on the modern garb of electricity aided by the ubiquitous Chloride Battery.

GENT & Co., Ltd., Faraday Works, Leicester.—Book 1, Section B, is a very complete and well-arranged catalogue of the "Tangent" specialities including Iron-Case and Cast Metal Bells, Pushes, Relays, Indicators, Signal Keys, etc., as supplied for Mines, Railways, and the heavier industries.

GENERAL ELECTRIC Co., Ltd., Magnet House, Kingsway, London, W.C. 2.—Recent G.E.C. publications include a technical description of the Nuneaton Storm Water Pumping Plant (Installation Leaflet No. 6), of the G.E.C. Metal Clad Switchgear, compound or oil filled (Technical Description No. 290), and interesting particulars and illustrations of the new electric lighting system of the Thames Embankment, which is to be carried out for the L.C.C. by the Charing Cross Electricity Supply Co., Ltd., who have entrusted the work to the General Electric Company. The system will employ powerful Wembley lanterns suspended 30ft. high over the entire length of the road from Blackfriars to Westminster. These lanterns, which are designed at the Wembley Research Laboratories, are to be made in the G.E.C. factories in Birmingham, and will be suspended in pairs from ornamental standards at 140ft. intervals. Each lantern will house a 1500 watt Osram gas-filled lamp capable of enabling a person of average sight to stand erect and read a newspaper lying at his feet in the roadway. A flood of light will illuminate the whole width of roadway along its entire length: it is said that it will overcome the density of the thickest London fog.

TUNGSRAM ELECTRIC LAMP WORKS, Ltd., 72 Oxford Street, London, W. 1.—A colour printed leaflet gives ratings and prices the well-known Tungsram "D" Pearl Lamp.

MIDLAND ELECTRIC MFG. Co., Ltd., Barford Street, Birmingham.—An art illustrated folder gives particulars of the construction of the newest form of "Memset" switch. In one case it combines a double-pole main switch, and a two-way double-pole fuse-board; two sizes, 15 and 30 amperes, and for 250 volts and 500 volts, respectively, are standardised.

B.T.H. Magnetos in World's Car Speed Record.

In creating the remarkable new World's Speed Record of 231.36 miles per hour on 11th March with the All-British Irving-Napier car "Golden Arrow," which is fitted with Napier-Lion engines and B.T.H. Magnetos, Major H. O. D. Seagrave beat the previous record by nearly 24 miles per hour and thereby added considerably to British prestige throughout the world.

It is of further interest to note that B.T.H. Magnetos were used on the cars with which Capt. Malcolm Campbell and Major Seagrave obtained world's speed records in 1927 and 1928, and are fitted to the motor boat "Miss England," with which Major Seagraev is about to try to obtain the world's fastest water speed.

*See *The Mining Electrical Engineer*, June, 1928.

Manufacturers' Specialities.

The British Industries Fair, BIRMINGHAM.

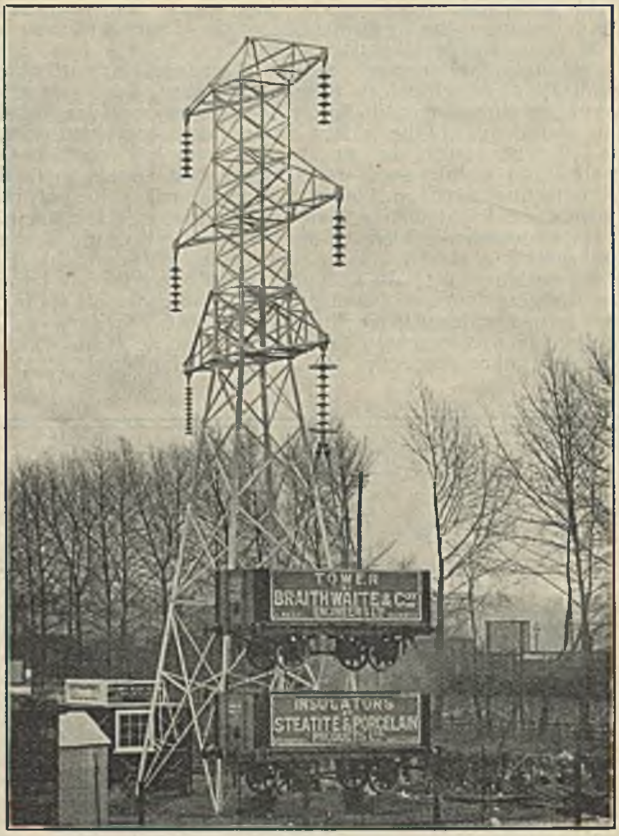
SOME NOTABLE EXHIBITS.

BRAITHWAITE & Co., Ltd., and STEATITE and PORCELAIN PRODUCTS, Ltd.

Messrs. Braithwaite and Company, Engineers, Limited, built a tower specially to show the design and means of construction, while the Steatite and Porcelain Products, Limited, have fitted up the tower with actual insulators of the type which are to be used. The shapely design of this tower is clearly evident from the illustration herewith. The structural merits were very graphically demonstrated by the fact that, suspended from the porcelain insulators, on one of the cable arms, were two railway goods wagons. It is particularly to be noted that the value of this test lies in the fact that the exhibit was arranged to show the load entirely out of balance, the whole of the weight being taken by one side of the tower: it is not evenly distributed as it would generally be when the tower is actually in normal service. This transmission line tower is of the type which will be used for the "grid" electrical transmission scheme in the South Eastern Counties.

The special feature of the insulators is that the pins are fixed by purely mechanical means and they have an extremely high mechanical strength, as was evident by the exhibit of suspending, on a single string of insulators, two full size railway trucks, 19ft. overall, the total weight of the two trucks being nearly 15 tons. The carrying capacity of each insulator is 20 tons.

One of the main difficulties of high tension transmission in the past has been the danger of interruption in the supply due to some failure on the line caused perhaps by a heavy lightning discharge. The mechanically fixed, spring ring, insulator protects the line from such troubles. A very large works with an area of over five acres has been erected at Stourport in Worcestershire for the production of these insulators, which have never previously been manufactured in the British Empire.



The Braithwaite Tower.

GEORGE ELLISON.

This exhibit included resistance starters and control panels for slip-ring induction motors; direct-on, star-delta and auto-transformer starters for squirrel-cage motors, automatic circuit breakers of various types; underground switchgear and cable couplings for mines; control equipment for cranes; and several examples of metal-clad distribution and main switchboards.

A new design shown is an improved totally-enclosed circuit breaker for power circuits up to 660 volts, having a higher than usual breaking capacity on short-circuits and accessory fittings which make the work of installing and connecting up very easy. This gear can be operated with safety by workmen without special knowledge.

A new type of switchboard also exhibited, consists of a group of small automatic circuit breakers mounted up on a bus-bar enclosure to form a distribution point for branch circuits. This is an alternative to switch-fuse gear which also is specially designed for operation with perfect safety by the average workman, as it is only necessary to move a handle to re-close a circuit.

The well-known Ellison circuit breaker for use at the coal face in mines is mounted on skids for portability and is a welded steel cased unit, certified flameproof, fitted with trailing cable plug connector and end coupling for the supply cable. The cable end coupling is a patented accessory which obviates the jointing of cables underground, as when the breaker is moved and another length of cable has to be laid, the new length of cable is readily connected up by bolting together the sealed end boxes, and connecting the cores by the links provided.

The high-pressure switchgear of which typical units were shown, comprises draw-out, drop-down, truck type and fixed cubicle metal-clad units all of standardised manufacture. All this switchgear is designed with good spacing of the live parts and made easy of access for maintenance. The sheet-steel enclosures are rigidly

The George Ellison Exhibit.

bolted and welded in jigs, and units of similar design are therefore interchangeable. Many other examples represented a range of switchgear and accessories for the control of electrically driven machinery for all industries, and switchgear for electric supply sub-stations up to 11,000 volts pressure.

Ellison switchgear was also to be seen in the Exhibition electric sub-station controlling the high-pressure supply from the Birmingham Corporation mains to the transformers, and from the transformers to the various circuits of the Fair.

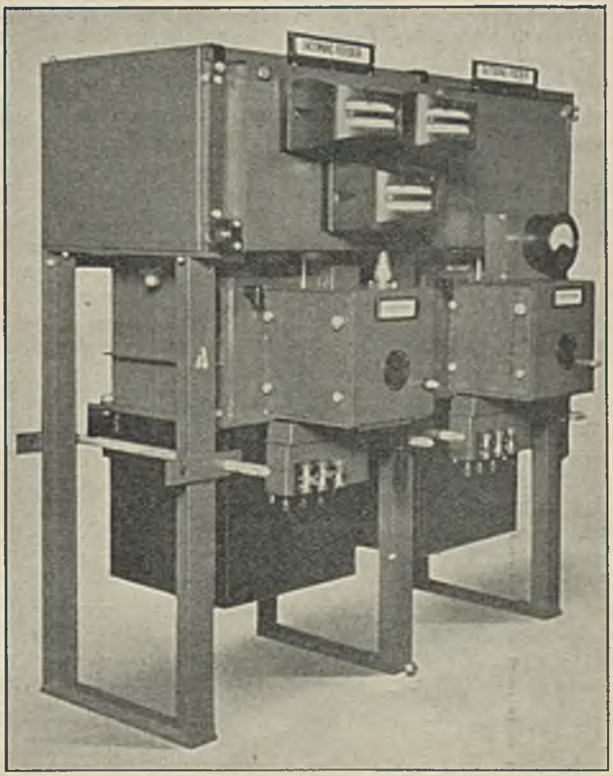
Particular attention should also be directed to the display of insulating material which is made in the Ellison factory for use in the various switchgear designs. This includes "Tufnol," shown in all kinds of shapes; and a plastic compound. "Tufnol" is a laminated synthetic resin material baked under pressure in moulds; it is extremely tough, can be readily machined, and has high dielectric qualities.

BRITISH THOMSON-HOUSTON Co., Ltd.

This exhibit was one of the most complete and attractive of the electrical displays. Much of the apparatus was shown in operation, particularly electric motors and control gear for industrial use. In addition to A.C. and D.C. motors of the more standard types the Company exhibited single phase reversing motors of the repulsion-induction type; vertical spindle motors; "built in" motors for the direct drive of machine tool cutters; motor-generators; "Fabroil" silent pinions; etc.

The B.T.H. single phase repulsion-induction motors are designed to start up as repulsion motors and when up to speed to run as induction motors, there being an external or primary winding on the rotor which gives a high starting torque, and an internal or squirrel cage winding which allows only a very small speed variation from "no-load" to "full-load"; no centrifugal mechanism, brush-raising gear, etc., is required. These machines have remarkably good starting, accelerating and running characteristics; they have a high efficiency and power-factor, and requiring only simple starting gear, they are particularly suitable for duties where high starting torque and good acceleration are required.

A notable range of equipments for the control of A.C. and D.C. reversing and non-reversing motors of various sizes were shown, these being of both the wall mounting type, and pillar type for floor mounting. The air-break, flame-proof controllers for A.C. and D.C. circuits were of particular interest to mining engineers. These controllers are suitable for starting and reversing polyphase slip-ring induction motors up to 75 H.P. at 550 volts; also D.C. shunt, series, or compound-wound motors up to 120 H.P. at 550 volts. They are provided with flanged joints and are fitted with pressure relief vents. They are designed and built with a view to compliance with British Standard Specification No. 229, 1926. The large number of starting points provided in each direction, in conjunction with the accurately graded



B.T.H. Vertical Plugging Switchgear.

resistance, ensures smooth acceleration of the motor at full speed. Both the forward and reverse motions are controlled by one operating handle having an off-position latch to prevent accidental reversal of the motor. This handle fits over a D-shaped shaft, to which it is fastened by a taper pin, but is removable so that the controller cannot be used by unauthorised persons. There is a knob on the handle which releases the latch, when pressed downward; only a slight pressure is required, and this can be adjusted to suit the operator. Any of these controllers can be fitted with interlocking contacts on the cylinder which connect with two pivoted fingers mounted on the main finger bar. They are used for electrically interlocking the controller with an oil circuit breaker, so as to prevent the motor being switched on to the line before the controller handle has been returned to the off-position.

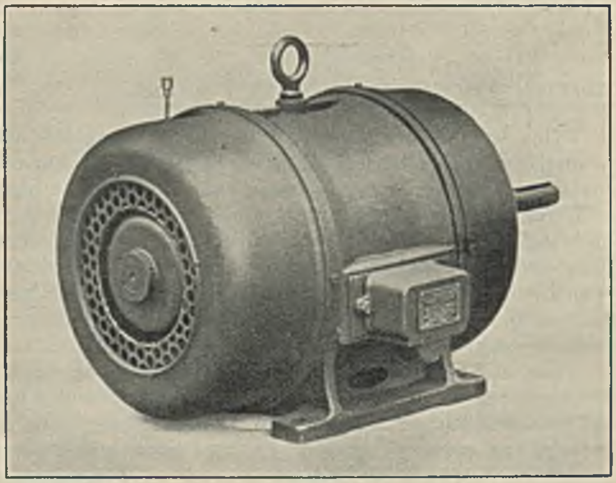
A valuable improvement is the new B.T.H. thermal type oil-immersed circuit breaker and A.C. motor starter which has been designed primarily for the direct starting of squirrel cage motors taking up to 100 amps. starting current on voltages up to 660. This circuit breaker gives full protection against every kind of fault on all phases. It measures only 8⅝in. high by 7⅜in. deep, by 6in. wide, has a dust and drip-proof enclosure, and is under push-button control, either local or remote. By the inclusion of such special features as thermal overload protection on each phase, instantaneous short-circuit trip, and low voltage release, a breaker of this type allows a motor to carry heavy overloads for short periods, but will disconnect it on sustained overload, as well as should any irregularity develop in connection with either the supply or the motor. The high momentary starting currents taken by squirrel cage motors when started by direct connection to the mains are safely carried without the breaker tripping, but no overload can persist for a sufficient time to cause injury to the motor insulation by overheating. Further, an open circuit on one phase will cause the breaker to trip before the motor can become over-heated by operating single-phase, and in the event of a short-circuit occurring in the motor windings or leads the motor is immediately disconnected, as it is also on failure of the supply. Thus maximum service can be obtained from the motor and full protection is given to the operator, for, should the motor shut down due to any of the causes mentioned, it cannot automatically restart on removal of the cause.

One of the exhibits made for the first time was that of the new B.T.H. metal-clad vertical plugging switchgear, of which an illustration is here given. This switchgear is suitable for service under adverse climatic and other conditions, and its introduction makes the metal-clad construction commercially applicable for small as well as large circuits. The utmost economy is achieved in the use of space and material; for example, the saving effected as compared with truck type switchgear of equivalent rating is 25 per cent. in the space necessary for installation and operation, and 43 per cent. in cubic content. The bus-bars are completely shut off from other chambers, but they can conveniently be rendered accessible. An automatically operated shutter closes the contact socket holes when the breaker is withdrawn, and guide holes are provided for accommodating the locating spears carried by the oil circuit breaker. Only one simple lifting carriage is required for a complete switchboard. The contacts are self-aligning; the current transformers are housed in the circuit breaker top casing and are readily accessible and interchangeable; a voltage transformer with protective fuses and limiting resistances is mounted, when required, on top of the fixed chamber. Contact is made with the circuit connections below, through the medium of spring pins carried on porcelain insulators in the bottom of the transformer tank. Withdrawal of the fuses through the top isolates the voltage transformer in complete safety, and the top cannot be raised until the transformer is dead from both primary and secondary sides, and the primary earthed. With regard to this switchgear, in general it can be said that the pedestals do not require precision alignment, and a full system of automatic interlocks prevents inadvertent mishandling of the equipments. The illustration depicts a two-equipment switchboard of this type for 600 amperes, 11,000 volts.

J. H. HOLMES & Co., Ltd.

J. H. Holmes & Co., Ltd., exhibited a direct current motor of a construction especially interesting because it can be easily adapted, without any essential change in the framework, for use as an enclosed-ventilated, a pipe ventilated, or a drip-proof machine. This firm also exhibited a 14 H.P., 770 r.p.m., 440-volt alternating current, squirrel-cage motor, totally enclosed with external fan ventilation (see illustration). This type of motor is particularly suitable for service in situations requiring complete enclosure of the windings and working parts together with efficient ventilation. Cooling is effected by means of an external fan which draws air over the outside of the machine proper, and not into it; and it is therefore immaterial whether the surrounding atmosphere is perfectly clean or not.

This arrangement of air circulation prevents dirt and moisture from settling on any of the working parts. The motor itself is completely enclosed by an inner casing, which is made dust-proof and weather-proof. In addition to the inner totally enclosing casing, an outer casing is also provided as part of the frame of the motor, and so there is an annular space between the



Holmes A.C., S.C., Totally Enclosed, Fan Ventilated Motor.

outside of the motor proper and the exterior of the frame. A fan mounted on the motor shaft blows air through the space between the two casings, and this air necessarily passes over the outer surface of the stator core plates. By a careful study of heat-paths and of relative values of heat-dissipating surfaces and by using a fan so constructed as to obtain the most effective draught, a machine has been produced, of the totally enclosed type, but comparable in price and size with one of the protected type. The machines are built to run with a minimum of attention, even in places where there is a damp or dusty atmosphere. The outer end-shields are of robust design to withstand rough usage, and are easily detachable for cleaning purposes. Ball or roller bearings are used throughout.

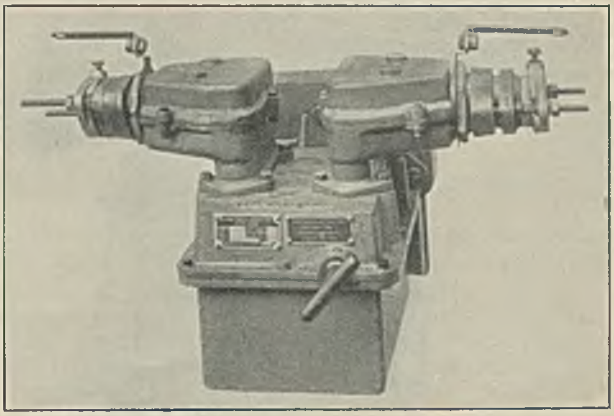


Fig. 2.

A. REYROLLE & Co., Ltd.

Messrs. Reyrolle exhibited many examples of their specialities in an extremely effective manner. Recent developments in mining switchgear included two "Mothergate" switchboards. These are virtually a very compact portable distribution centre consisting of a number of 60-ampere or 100-ampere circuit-breaker units built up into the form of a switchboard. A standard 60-ampere or 100-ampere plug is fitted on each unit for the trailing cable, and the dividing box is easily detachable so that cable re-jointing is obviated when the switchgear is moved to a new position. A complete system of interlocking is provided between the circuit-breaker and plug of each unit so that wrong working is impossible. The circuit-breakers are mounted on skids to provide portability and the enclosure is of the earthed metal flame-proof type. The units exhibited were of 60-ampere and 100-ampere capacity respectively, and the larger units are fitted with an electrical interlock to the coal-cutter. The illustration, Fig. 1, shows a three-unit class "M.K." "Mothergate" switchboard consisting of three 60-ampere circuit-breakers and 60-ampere plugs.

Other exhibits of particular mining interest included three examples of small oil-immersed three-phase circuit-breakers with a current carrying capacity of 60 amperes at 660 volts. One, of the quick-make-and-break type, is adaptable for either wall or pillar mounting. Another is of the flameproof type, and is similarly adaptable for wall or pillar mounting. It is of historical interest that the certificate issued by the Department of Applied Science of the University of Sheffield in connection with the flameproof tests on a circuit-breaker of this class was the first certificate of its particular series. The design is such that satisfactory working is obtained under the difficult conditions encountered in mines, and all the Regulations made under the Coal Mines Act, 1911, are fully complied with. The oil-tank is of welded boiler plate, and the circuit-breaker is thus exceptionally well fitted to work under the severest conditions. Two, or three, series overload trip-coils may be fitted, and either inverse time limit dash pots, or tubes for instantaneous tripping may be included, each adjustable to give a tripping range varying from normal to three times normal rating. If the duty is to control the supply to an A.C. squirrel-cage induction motor of a size suitable for switching direct on, a special starting dash-pot may be fitted, so arranged that the operation of closing the circuit-breaker lowers the trip-coil plungers and tripping does not take place under the influence of the heavy starting current, but the plungers return gradually to their normal position while the motor is running up to speed, and are thus ready for their ordinary operation under running conditions. Adequate provision is made for earthing the metal enclosure of the circuit-breaker, and a flameproof ammeter can be fitted on the top of the enclosure as may be required. The attachment of the dividing boxes is such that the complete circuit-breaker can be detached from them without the need of altering their position, and thus the cables need not be unsealed.

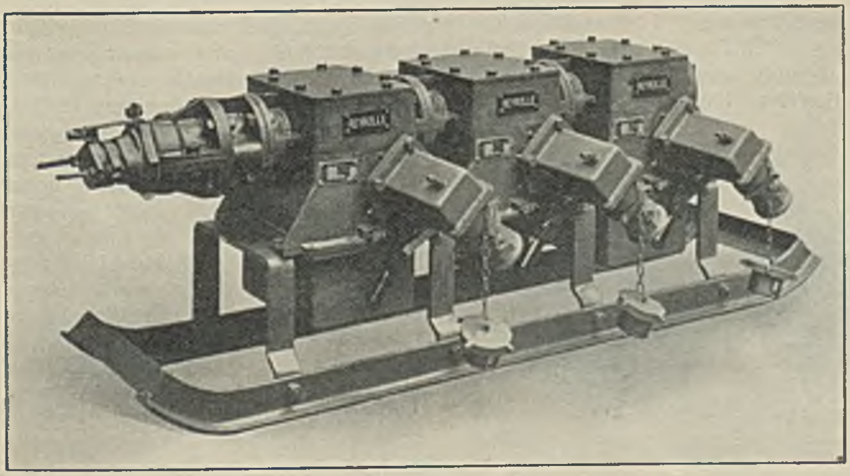


Fig. 1.

Fig. 2 is an illustration of a 60-ampere, 660-volt, three-phase, oil-immersed circuit breaker, with overload

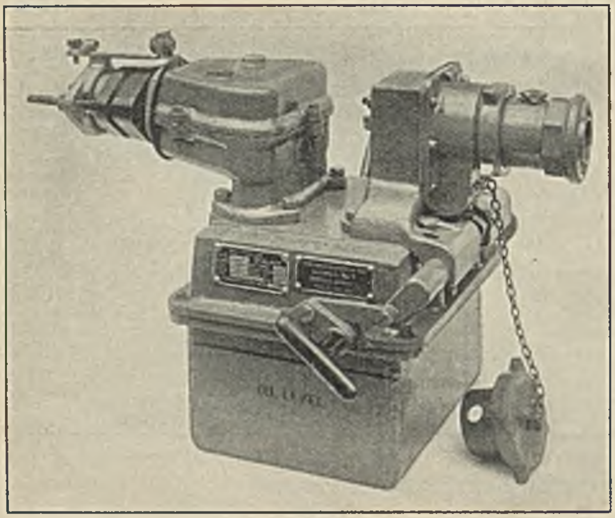


Fig. 3.

trips, fitted with two horizontal dividing boxes with glands for armoured cable.

The third example of these small circuit breakers as exhibited consists of one of the type just described adapted for use as a gate-end switch for the control of an electric supply to underground mining apparatus, such as a coal cutter or a portable conveyor. In one arrangement, a dividing box with a cone gland for an incoming cable is fitted on one side, and the other side is provided with an interlocked plug and socket to take a trailing cable. The interlocking is such that the plug cannot be withdrawn while the switch is in the "on" position, and the switch cannot be closed when the plug is withdrawn, unless the cap provided to cover the orifice of the socket is screwed right home. This means that it is impossible for any live contact to be exposed, and so safety in operation is ensured. If desired, an interlocking plug can be fitted on each side of the switch instead of a dividing box on one side and a plug on the other. Fig. 3 shows a 60-ampere, 660-volt, three-phase, oil-immersed circuit breaker, fitted with one dividing box and one interlocked plug, for use as a gate-end switch.

Plugs and Sockets.

Messrs. Reyrolle also exhibited a representative collection of plugs and sockets of their manufacture. The majority of the domestic plugs and sockets comply with the British Engineering Standards Specification No. 196, 1927, which is for reversible, protected-type, two-pin plugs and sockets with earthing connections. Since this specification deals with 5-amp., 15-amp., and 30-amp. sizes, it marks an important stage in development because it provides for metal-clad enclosure of these comparatively small plugs and sockets, and so introduces, for domestic apparatus, a safe connector for portable appliances. The metal earthing of the enclosure makes the plug and socket safe to handle and, further, prevents the possibility of shock from the framework of apparatus. There is an exceptionally robust and accurate fitting about these plugs which mark them as better and distinct from the usual qualities of domestic appliances. It was interesting, in this connection, to learn that Messrs. Reyrolle similarly bent upon making domestic electrical apparatus on soundly efficient "engineering" lines embodying standard B.E.S.A. features, are taking up the manufacture of electric heating and cooking appliances.

In addition to examples of their plugs and sockets actually mounted on domestic appliances such as a washer, a radiator, a kettle, a toaster and several irons, Messrs. Reyrolle are showing a number of plugs and sockets for other purposes, including a 15-ampere, 3-pin flameproof plug and socket with scraping earthing connection for use in mines; a 100-ampere, 3-pin and earth, flameproof mining plug and socket in accordance with British Standard Specification No. 279, 1927; a 150-ampere vehicle charging plug and receptacle, made in accordance with British Standard Specification No. 74, 1927, and with the recommendation of the British Electric Vehicle Committee and other industrial types, capable of application to many purposes. All are provided with metallic enclosures and adequate facilities for earthing. The illustration, Fig. 4, shows two 15-ampere, 440-volt, flameproof plugs and sockets, one of which has the plug withdrawn to show the contacts and socket interior.

DAVIDSON & Co., Ltd.

This Company exhibited a very complete range of their well known "Sirocco" fans, including fans for ventilation, dust removal, and for supplying high pressure blast to cupolas, furnaces and forge fires. Of exceptional interest was the example of a fan lined with ebonite, which protects the internal metal surfaces from the action of corrosive gases and consequently greatly increases the life of the fan. One of the most practical and efficient methods of grit collection was exemplified by the exhibit of the Davidson patent flue dust collector, of which a working model was shown in operation. These collectors have met with great success, it being stated that over 100 power stations have installed them. A similar collector for dealing with industrial dust was also to be seen at work. Popular attention was forcibly directed to this stand by a fascinating exhibit of the "Sirocco" aerostat, a rotating series of air nozzles and coloured balls, which was the source of much speculation on the part of the visitor as to how the rotating balls were maintained floating in the air.

(*To be continued*).

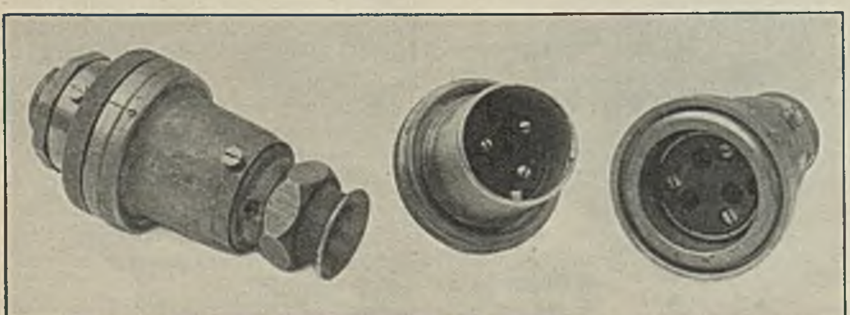


Fig. 4.