The Mining Electrical Engineer.

OFFICIAL JOURNAL OF THE ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

EDITED BY E. DINSDALE PHILLIPS.

Vol. XII. DECEMBER, 1931. No. 135.

Greetings to all our many good friends:

A Merry Christmas and

A Happy New Year.

Young Miners and Safety.

Having freshly in mind the notes we wrote here last month, and whilst still buoyant in the hope that the New Year would surely see still greater activity in providing the better methods and equipments for safety and economy in mines, such as were advocated in the Inspectors' Reports, the average reader will share with us a little twinge of irritation when he reads overleaf some of the remarks passed at the Safety in Mines Conference in Manchester. The account we give is but a short abstract of the voluminous whole-day-long proceedings: but this condensed version indicates the main channels through which effective progress can be made and, warningly, brings into bold relief some of the more formidable snags to be encountered by the way.

Electrical men will find it extremely hard to credit that there are still some mining people who do not believe in electricity: or, to put it less generally though with equal truth, who refuse to be convinced that electricity will ever be kept safely within bounds in a colliery. So long as there are those who, ranking as spokesmen for many, give utterance to views of that kind in a company of over two thousand mining men, there is still need for electrical "missionary" work.

There is, of course, not the least fear that any such casual sweeping and dogmatic condemnation of electricity as a perpetual danger in underground workings, is likely to stem the course of progress in the electrical equipment of collieries. Nor will the use of steel props, electric lamps and lighting, and other changes for the better in coal mining be appreciably checked. Such opinions cannot, however, be lightly waived aside and ignored as innocuous curiosities of unreason; and especially when these fear-instilling dicta are publicly proclaimed in a large meeting assembled for the express purpose of promoting safety in mines, and where other speakers seek to impress by the logical presentation of established fact and truly reasoned argument. Those who read the "pointers" we have printed will notice that they shew how flagrantly some mine workers neglect the simple opportunities offered to them for learning how to avoid danger.

In view of the still lingering presence of the hopeless gospel regarding electricity to which we have referred, it is no longer surprising to find that the smooth paths provided to lead the miner to safety and knowledge are deliberately avoided.

The pride with which most people accept and enjoy the amenities of this enlightened age of science gets a nasty little jolt when there is seen the necessity of pleading with the fathers to send their boys to the fount of learning. Instruction classes have died out for lack of pupils—and that in places where there are hundreds to whom instruction means the preservation of life and limb. It may be that human nature has an inseparable fatalistic element which, uncurbed, prompts some to preach the unwholesome doctrine that "such things ever were and always will be." Half the success in any laudable venture can usually be credited to the confidence and knowledge with which it is pursued. The miner is courage itself. His confidence is dependent upon knowledge. The creed of the fatalist would destroy confidence and when that goes gone too is the urge to knowledge.

The great evil done is the easy dissuasion of the young miners against yielding a few hours of their free time to trying to learn how to beat the (so called) inevitable. That would be too silly! The way to escape danger (alas for courage and confidence) is to run away from it! Let none under sixteen years of age be allowed to work underground! So would these dour antagonists to progress spoil good men. Our protest is not complete until we remark that whether the beginner be fourteen or sixteen, or even twenty, he is still an unlearned beginner—and, very often, the lad of fourteen is more teachable than the young man of twenty.

These notes are particularly addressed to the young miner. If to him they have initiated a train of thought, culminating in a healthful, safe and ambitious outlook and a wise resolve for the New Year their purpose is served.

"POINTERS" FROM THE SAFETY CONFERENCE.

The fifth of the series of Safety in Mines conferences to be held in the principal colliery centres of the country drew some 2500 mining men to Manchester on December 5th. Mr. Isaac Foot, M.P., Secretary for Mines, presided: he was supported on the platform by Sir Alfred Faulkner, Under-Secretary, Mr. E. G. Fudge and Mr. F. Mallinson of the Mines Department, and many of the mining and political leaders of the district.

The Lord Mayor of Manchester, Councillor Ellis Green, welcomed the conference to the city. The Chairman referred sympathetically to the Bentley disaster, and the courage and sacrifice of the brave men involved. One of his first duties in his new official capacity had been to decide whether these natural conferences should be continued: he considered that all the expense and labour of calling together the conferences was fully justified if they were the means of saving but one life. In respect of safety, science and statutory protection were unavailing without the co-operation and ready response of the men. In particular it was desired to impress the younger generation with the importance of maintaining the advantages of scientific achievements and the growth of all available knowledge.

Sir HENRY WALKER, H.M. Chief Inspector of Mines, referring to falls on roads said the natural successor to the cockered timbering was the steel arch, and so far as he was concerned, it was to the steel arch that we must look for greater safety on mine roads not only from falls but also from haulage accidents.

Referring to falls at the face, Sir Henry said that two essential needs were indicated : (1) the best possible packs ; and (2) the use of supports between the packs and the coal face of such a character that each support is of equal strength to its neighbour on either side. The first essential was a matter of supervision by skilled men, and the second was found in the use of steel props and steel bars.

The Chief Inspector said the figures in regard to haulage accidents underground were the least satisfactory. Many were attributable to want of care on the part of the persons killed or injured, but he always felt that the risks which were taken were the result of anxiety to get on with the job. He also felt risks would always be taken, and therefore, in order that the person taking them might have the best chance of success, the conditions should be for him and not against him. Boys and youths—and even older men—would not stop, look and listen, before they acted. The pits could not work if they were to. It might be that some of these accidents might be met by stricter discipline and better education and training; it might be that workmen should exercise greater care; but in the end he believed that the remedy which would have the greatest effect and be of benefit in other directions was the provision of roads of ample height and width, and the provision of better lights. The conditions under which haulage work had to be done could be improved by the use of steel arches for supports and the provision of better lighting.

Mr. W. J. CHARLTON, H.M. Divisional Inspector, dealt more closely with the particular conditions prevailing in the local districts, which were more difficult than those met with in some other coal fields. These conditions explained why Lancashire mine managers lagged behind in the adoption of mechanical methods of mining, and in the use of electric safety lamps. The ventilation of the collieries was in the forefront of the problems to be met. They must go on developing machine mining if they would live, but they must adopt means to the conditions. When the workmen in a fireman's district were much scattered, Lancashire managers had some diffidence in withdrawing the means of detection of the presence of firedamp which the flame safety lamp afforded. Concentration of workmen had removed the necessity for each workman to have a gas indicator with him. Moreover, concentration of output meant intensified production of dust and the need for improved lighting. Mr. Charlton anticipated that a development in the use of high candle-power electric safety lamps would follow the inevitable development in machine mining. In discussing the matter of falls Mr. Charlton mentioned that the use of the steel arch and camber girder form of support had made great headway. They were in use right up to the road face rippings in many instances. In the live ground near the face he regarded them as of great value : they acted as centres round which the roof adapted, and finally supported, itself. Mr. Charlton emphasised the great importance of team work amongst the men in regard to securing good ventilation, and immunity from falls of ground and haulage accidents.

Mr. P. L. WOOD (Manchester Collieries Ltd.) considered that in the use of steel roof supports probably more advance had been made during the last year or two than in any other branch of mining connected with safety. Steel arches originally were only used for roads which had taken their first crush, but now they were often used right in the ripping against the face. At the Manchester Collieries in one of the most difficult brows they had to rip four times before the roof settled, which meant four lots of timber being broken. Now they set arch girders 9 ft. high by 13 ft. wide placed on wooden stilts 5 ft. long protruding 3 ft. beyond the bottom of the arch girders. When these were first set the road was 12 ft. high and, under pressure, the stilts either telescoped or were partly pushed into the floor until the road was finally only 9 ft. high. That gave much greater safety than the original method. In addition to the wooden props for telescoping, which were now in common use, they were trying slotted fish-plates at the crown of the girders. At the moment they were experimenting with nearly 1000 of these. They were also trying an experiment in regard to cambered girders. It was generally agreed that cambered girders functioned better if they were made end tight, but where the side pressure was excessive, they were clamping timber on to one end of the girder and this telescoped in the same way the vertical props did at the foot of arch girders: that allowed the first squeeze to take place without buckling the girders and was answering very well. Steel face props were making headway but slowly, as experience was necessary to determine which design of prop was most suitable for each varying condition.

Although very large numbers of props of the plain steel joist or tube type were used in some parts of the country personally he did not like them. They had tried a number in a district with a bad roof where there was considerable weight, but found them impracticable on account of the difficulty and cost of withdrawng. If these props were not holding much weight, or taking much crush, they could be taken out without difficulty, but under those conditions was it necessary to use steel props at all? He would say that steel props should only be used where wooden ones were not giving satisfaction. In seams with a hard roof and a hard floor, where the roof would not break off but would bend, the rigid steel prop was not altogether satisfactory, because even when the bottom was pointed, it would not always sink into the hard floor. In that case, he considered a prop that would yield was preferable.

Mr. Wood had also pointed comments to make in regard to underground lighting. He asked: how could men avoid danger if they could not see it? In December last the Mines Department outlined proposals of suggested regulations. To those proposals the coal owners had to reply that the candle powers specified were too high, until the lamp makers could produce lamps to give improved lights, as no British lamp would give the candle power required. That state of things, however, was very quickly changing, and they were now offered electric lamps which would give an all-round light of 3 c.p. at the beginning of the shift and over 1½ c.p. at the end of the shift. Great improvements were being made in cap lamps. The adequate lighting of shunts and junctions was, he thought, a very important matter. They had portable lamps giving from 7 c.p.. to 10 c.p. for that purpose, but for important haulage junctions the compressed air driven electric lamp was a great advance on the accumulator type. At the Manchester Collieries they had a large number of those lamps and they gave from 50 c.p. to 100 c.p.

Mr. McGURK (President of the Lancashire and Cheshire Miners' Federation) could not agree with the recommended use of steel props at the coal face in every instance. Anything that was used at the coal face which would not give way, or give a warning to the miner, was an added peril. He would always hold that the use of electricity at the coal face was an added danger to the workmen, because it would never be made absolutely safe, although experts had tried to prove to the contrary. He suggested that the Mines Department should apply itself to that subject. They were getting reports of the tremendous amount of overtime worked in the county of Lancashire, and of the great number of accidents that took place during the overtime. There was too much overtime being worked, and accidents occurred when the men were tired.

Sir HENRY WALKER, in reply to a question, said the Mines Department were very seriously disturbed at the number of accidents occurring to boys. Efforts were being made to hold classes or meetings where boys could bring their difficulties to men who would tell them what to avoid. But there were two sides to the matter. The Department and the people who wanted to help were ready to play their part, but the parents must share the responsibility. At the present time a scheme was being carried out under the auspices of the West Riding County Council, and in some places it met with a very good response; but, at certain collieries where 3000 men and boys were employed it was difficult to get together a sufficient number to warrant the continuance of the classes. The parents must see to it that the boys attended.

Mr. H. RICHFORD, President of the Lancs. branch of the National Association of Colliery Managers, said an amazing number of accidents happened which ordinary care would have prevented. At the collieries where he was engaged they changed from the ordinary safety lamps to electric lamps and there had been a decided reduction in the number of accidents. The electrical engineer who gave them a better light without adding to the weight of the lamp would be conferring a great benefit on the underground worker. Throughout the county colliery managers were carrying out research work in some form or other. In his own case air samples were taken regularly on machine faces. The amount of gas given off from newly wrought coal was surprising; in several instances there had been a difference of 1 per cent. of firedamp at the back end of the cut, as compared with the general body of air.

Mr. F. EDMOND (Wigan Coal Corporation, Ltd.) discussing the question of protective equipment, said goggles had been tried, but he had serious doubts whether it would be wise to adopt them in mining to-day. With regard to the hard hat, he had used one, of British Make, for nearly two years. As a member of the council of the Manchester Geological and Mining Society, he wanted it to be known that after Christmas there would be a splendid series of lectures and discussions on practical mining subjects and the council would welcome everyone who wished to take an intimate interest in the technical side of mining, from all points of view.

CONVEYOR MOTORS AND CONTROL GEAR FOR MACHINE MINING.

R. W. MANN.

(Abstract from *The Metropolitan Vickers Gazette*, December, 1931).

Divided broadly, there are three classes of conveyors.

(1) The belt conveyor, by which the coal is conveyed on a continuous belt.

(2) The shaker conveyor, by which the coal is conveyed by an oscillating trough moving comparatively slowly in one direction of travel, with a quick return, which carries the coal forward in the desired direction in what may be termed a series of throws.

(3) The scraper conveyor, by which the coal is conveyed by a continuous scraper working in a fixed trough.

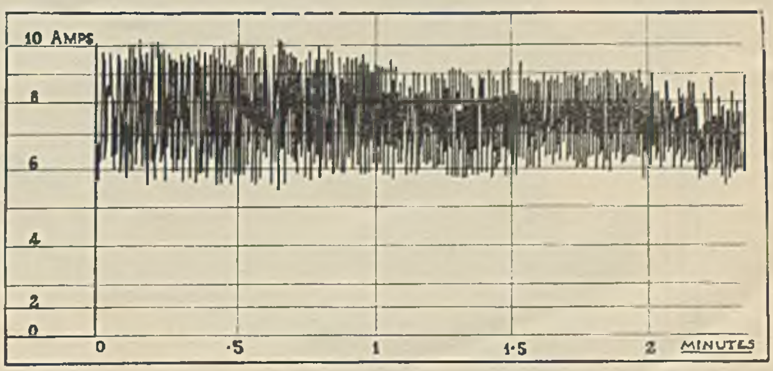


Fig. 1.—Fast speed graph for a shaker type conveyor.

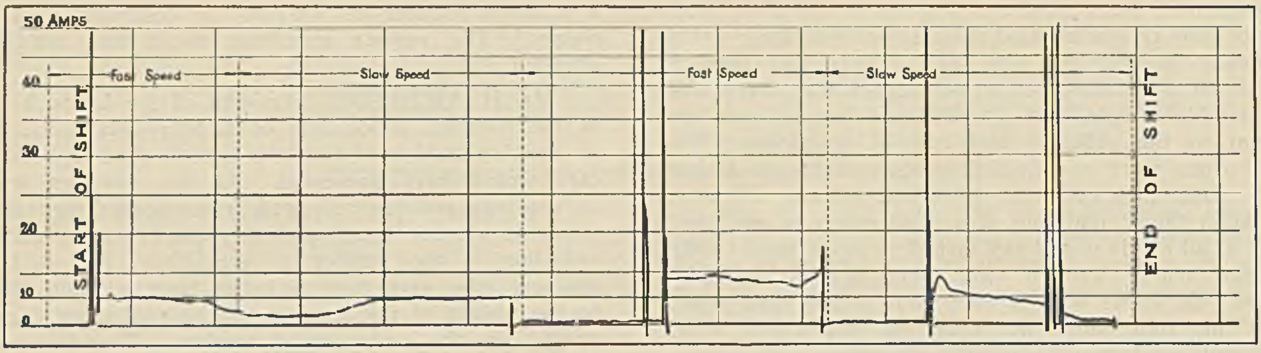


Fig. 2.—Fast and slow speed graph for a 10 h.p. belt type conveyor recorded over one shift.

Coming also within the scope of the conveyor motor, is the loader, comprising a short conveyor of the belt or scraper type, for raising coal from the height of the main conveyors to tub height for loading purposes.

The respective uses of the various types of conveyors are in the mining sense fairly well defined and do not come within the compass of this article. The duties required of the electrical motors, and more particularly the arrangements of the electrical control equipment, vary for each type of conveyor. The design of general purpose conveyor motors must therefore meet the requirements of all types of conveyors, and be adaptable to the varying control systems that are liable to be used.

Figs. 1 and 2, shewing the load graph of a shaker and belt conveyor respectively, are typical examples of a large number of tests of all types and makes of conveyors working under a variety of conditions. Fig. 2 records the whole of a working day for one particular type. The working shift commences with the fillers just starting work on the coal face. The load, apart from the initial kicks due to the conveyor lying idle over the preceding shift, is shewn to be light; as the fillers get into their stride the load is shewn to be increasing with the quantity of coal; then, in consequence of a shortage of tubs at the loading end due to rapid delivery of coal, the face conveyor is stopped for some minutes during which the fillers continue to load the belt, even in spite of instructions to the contrary, resulting in excessive starting and load conditions until the belt has regained its normal load of coal. This is followed by an overload trip caused by excessive coal at the gate-end, or the fouling of the guides and head by spillage; then the dropping off of the load as the face is cleared of coal, concluding with a number of stops and starts and fairly high load conditions representing the final clearance of the remains of coal on the face. All the changes of conditions indicated on the main graph were repeated with quick speed graphs to obtain the detailed information required in the design of the machines.

Apart from the electrical characteristics, the mechanical application of conveyor motors is such that the most careful thought has to be given to the length, diameter, and more particularly, the robustness of the machines, to enable them to withstand the rough usage inseparable from mining service. In addition the motors must comply with the requirements of the underground engineering staff from the point of view of interchangeability and maintenance, and finally with the requirements of the mining engineer in connection with the varying applications and methods of coal-getting as influenced by geological conditions.

The ideal mining conveyor motor, having in mind the foregoing considerations, should have the following essential characteristics:

Unbreakable steel carcase.

Steel end brackets.

A plain cylindrical yoke for rolling along the face.

Large dust-proof bearings.

Wide air-gap.

Interchangeability with various makes of conveyors.

High starting torque with small starting current.

Ability to work satisfactorily on a sub-normal supply voltage.

Indestructible rotor without brazed or welded bars.

Adaptability to various systems of starting and control.

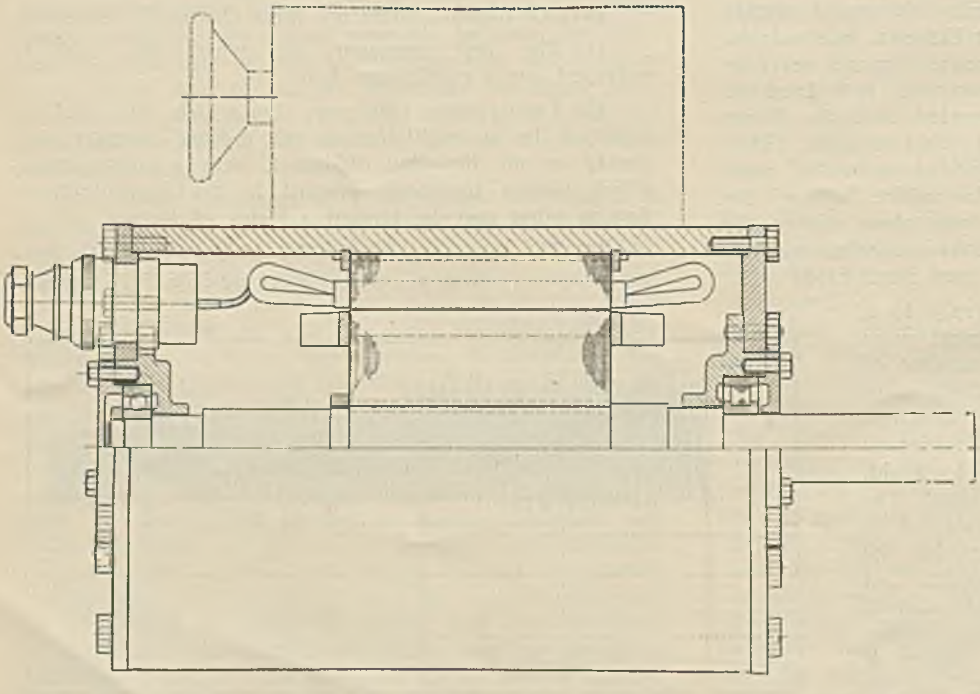
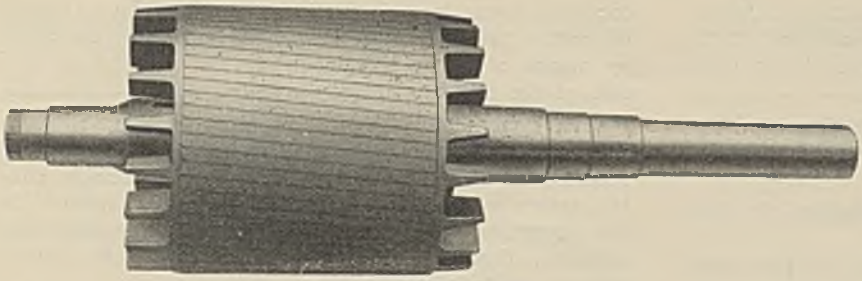


Fig. 3.—Cross section of a "KF" conveyor motor, position of control switch when mounted on motor shewn dotted.

Fig. 3 shews a sectional drawing of the Metropolitan-



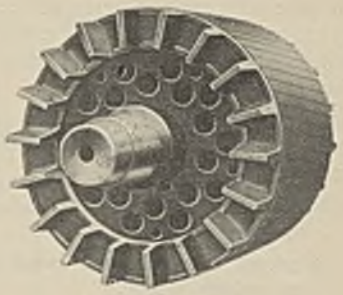


Fig. 4.—The rotor of the "KF" conveyor motor. The rotor bars, end ring and fan are cast in one solid piece in the rotor laminations.

Vickers type KF conveyor motor, and illustrates the boiler plate carcase and end brackets of exceptional thickness. The main feature of the external appearance of the motor is the cylindrical yoke enabling the motor to be rolled into position. The "offset" rotor will be noted, this arrangement providing ample accommodation for the connection of the stator leads either to a switch mounted on the side of the motor, or to an end bracket plug and socket as described later. When supplied to take a switch a special arrangement of terminal is provided, together with a closing piece, so that with the switch removed the closing piece can be inserted and the motor thus retain its original cylindrical form for rolling.

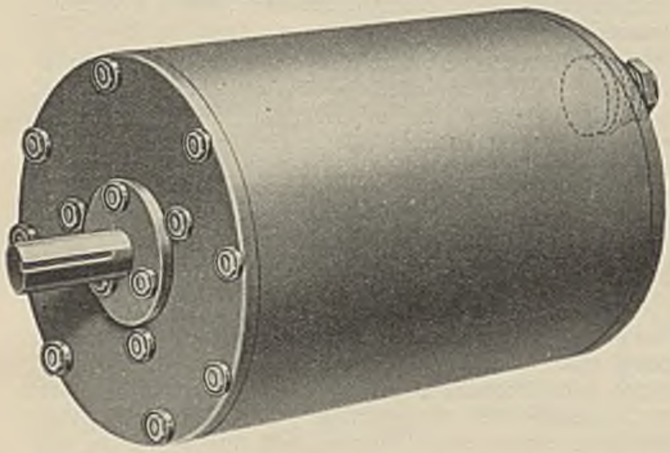


Fig. 5.—Exterior view of the "KF" motor shewing the cylindrical boiler-plate yoke.

The fixing of the motor is effected by means of movable feet. This arrangement has been adopted with a view to the speedy replacement of a motor in case of breakdown, and the standardisation of a given horsepower and speed to suit one or more types of conveyor heads, thus enabling the maximum use to be made of what standby plant is available. Alternatively to the movable feet, where a range of motors is required for a specific duty, steel feet are welded permanently to the motor in any desired position.

The electrical design of the motors has been given the same careful consideration as the mechanical construction. A stator winding is incorporated in semi-closed slots, and is specially impregnated so as to be practically waterproof.

All sizes of motor are direct started, and sufficient margin has been allowed in the design for the motor

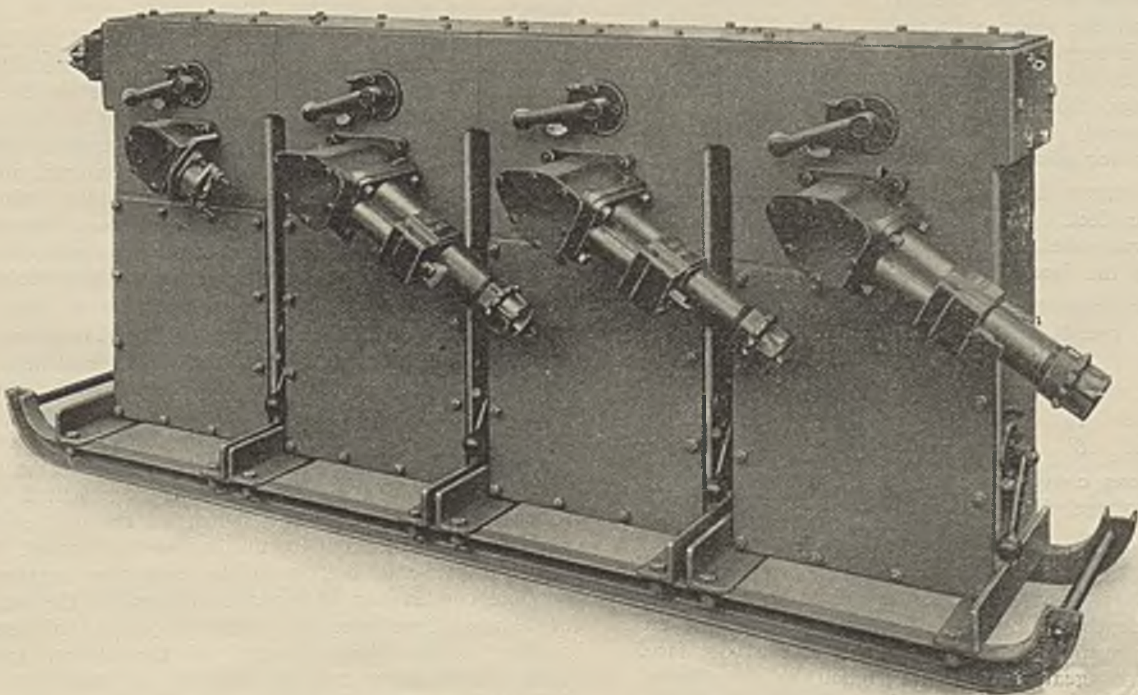


Fig. 6.—Combined conveyor and cutter panel.

to give its required performance with a voltage variation of 10 per cent. below normal, to compensate for actual working conditions as commonly met with at the coal face.

The rotor construction of conveyor motors has been one of the chief causes of failure, usually from one of three causes:—

Breaking of the rotor bars where attached to the end rings.

Working loose of the rotor laminations on the shaft or spider sleeve.

Failure of bearings.

Fig. 4 shews the patented construction of the rotor wherein the rotor bars, end rings, and fan, are cast in one solid piece in the rotor laminations. The special alloy used has characteristics which enable the motor to deal satisfactorily with all working variations in temperature, and to exert a starting torque of 2½ times full load torque.

Not only is this type of rotor indestructible, but the method of construction, with its inherent solidity, enables the bore to be machined to a smooth surface before being fitted to the shaft, thus obviating the loosening of laminations after severe service, and making the withdrawal of one shaft and the insertion of another a matter of an hour's work with the simplest of colliery tools.

The failure of bearings has been due to two main causes: either the incorporation of too small a bearing, together with the whipping of the shaft; or the ingress of stone dust due to the dismantling of the machine.

A comparison of the shaft diameters of the Metropolitan-Vickers K.F. motor shews that for 15 h.p., 1000 r.p.m., the K.F. shaft is 2½ ins. in diameter whereas other makes of motor of similar rating and supplied for conveyor drives have shaft diameters of only 1⅝ ins. to 2 ins.

As will be seen from Fig. 3, the roller bearing at the driving end, and the ball bearing at the opposite end, are both constructed in dust-proof cartridge type housings, the bearings remaining as a complete unit on the shaft when the end brackets of the machine are taken off and the rotor withdrawn. Only the complete renewal of a bearing necessitates exposure of the balls or rollers to the atmosphere. In addition to amply rated bearings, the machine has been arranged with an airgap practically double that found on most makes of machines for similar service.

Fig. 5 shews a completed motor without starting apparatus or feet. Transport is greatly facilitated by the cylindrical yoke which makes it possible to roll the motor along the face.

The K.F. motors are made with the range of horsepowers and speeds shewn in the following table.

R.P.M.	*H.P.*	*H.P.*	*H.P.*	*H.P.*
750	6½	9	12½	17
1000	7½	10	15	20
1500	8½	12	17½	23

Continuous conveyor rating, 50° C. temperature rise. Maximum voltage, 650 volts.

METHODS OF CONTROL.

No matter how good the conveyor motor, it is necessarily dependent upon the system of control, if the best overall results are to be obtained at the coal face. Special control gear has been designed by the Metropolitan-Vickers Company for use in conjunction with the conveyor motor for this particular service. Two systems of control are possible, viz.:—(A) ordinary operation by means of a direct starting switch mounted on the side of the motor; and (B) remote control.

The operation of both arcwall and longwall coal cutters by the remote control system is now widely accepted as the best practice, and a similar remote control system is likely to be accepted as the best method for the operation of coal conveyors. Remote control has certain indisputable advantages, which may be briefly outlined as follows:—

It entirely obviates the misuse of control gear at the face: it removes the making and breaking of power circuits from the region of the coal face: and it ensures that the connecting cables are only alive when the motor is actually running.

The control gear described here shews a great saving in costs for renewals of contacts; it enables a conveyor to be controlled from the most convenient place; and it provides inherent electrical interlocks to make the withdrawal of a live plug, or the trailing of a live cable impossible.

The incoming cable to the conveyor is taken to a plug and socket mounted in the end bracket at the non-driving end of the motor. The motor is started and stopped by a small pilot switch mounted on the end bracket, or in any convenient position on the conveyor head; or if desired, remote control can be arranged for a number of conveyors from a central point This latter arrangement is shewn in Fig. 9, and is only applicable where the conveyor need not be reversed.

Local control is effected in the ordinary way by a normal direct starting and reversing switch of the flameproof type, mounted on the side of the motor, and provided with incoming plug and socket, interlocked either mechanically with the starting switch handle so that the plug cannot be withdrawn with the switch in the on position; or, alternatively, electrically interlocked in conjunction with a system of earth continuity protection so that withdrawal of a live plug is impossible. The switch is particularly robust, with massive barrel, finger contacts having arc shield separators, and steel case.

The gate-end boxes for the protection of the motor, whether remotely or locally controlled, are specially designed for coalcutter and conveyor service on the unit system. Fig. 6 shews a four-panel board incorporating panels of the remote and local type mounted together. The board can be increased, or panels removed, at will, and provides a flexible arrangement, readily adaptable to changing conditions at the coal face. The range is completed by a unit of similar size and shape enclosing a transformer for electrical drilling of shot holes, or for face lighting.

In these panels special consideration has been given to the overload protection required by coalcutter and conveyor motors. Reference to Fig. 2 shews, besides overloads liable to occur under normal working conditions, peak currents of several times full load current occur during starting. A protective device of the single dash-pot type cannot possibly have sufficient range to prevent operation of the switch on starting, and also give ample protection to the motor on normal loads. In this gate-end box complete protection against all possible combination of loads is ensured by the inclusion of thermal type overload relays having a characteristic similar to the heating curve of the motor, together with instantaneous trip relays set at 8 to 10 times full load current for fault protection.

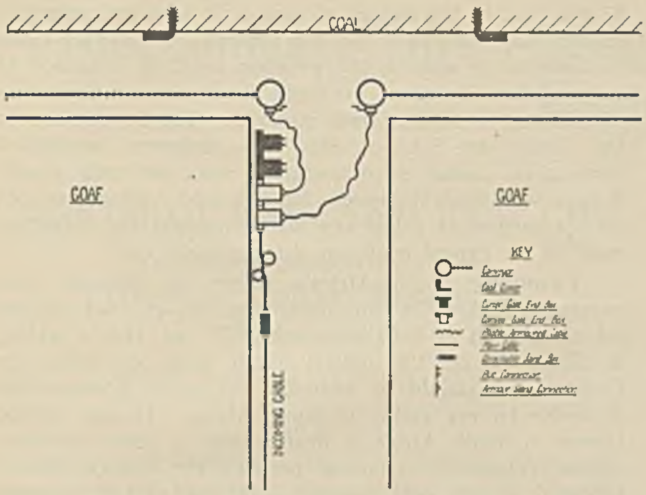


Fig. 7.—Double unit cutting and conveyor face.

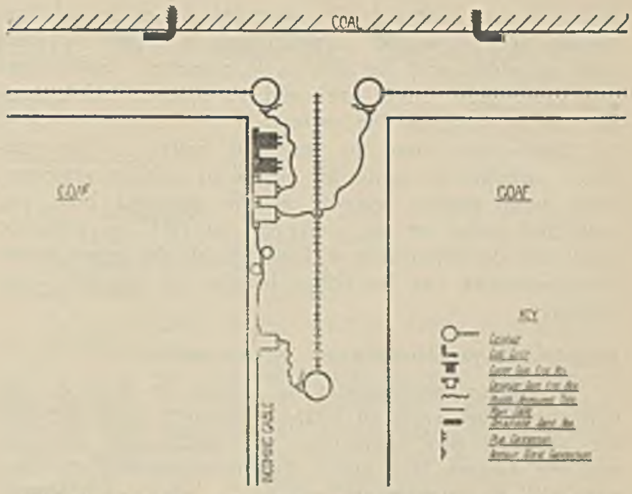


Fig. 8.—Double unit face with fixed loading point.

The air-break contactors are triple pole and, whether for remote or local control, are provided with substantial arc shields and blow-out coils. When remote control is used, an auxiliary transformer provides a secondary operating voltage of 25 volts, and the contactor is operated by a small relay in this circuit, which is completed by the operation of the master switch on the conveyor motor.

Provision is made, under patents, to ensure that in the event of the operating circuit being closed at any other point but the master switch, due to the failure of a cable consequent on a fall of stone or other cause, the gate-end box is locked out of circuit until the fault has been remedied, while in addition a test position is provided on the master switch so that the operation of the protective circuit can be tested from time to time.

Where it is desired to use a gate-end box alternatively for a coalcutter and a conveyor motor, the direct starting switch on the conveyor is fitted with thermal overload protection on two phases with setting suitable for the size of motor, and arranged to trip the gate-end switch in case of overloads. Protection is thus provided for two motors of different horse-powers from one piece of apparatus and without the necessity for adjustment by operator or electrician.

It is becoming more or less a recognised practice to use a pliable armoured cable for interconnection between the gate-end box and the conveyor motor in preference to a trailing cable, and when required provision is made for this arrangement either by a special gland on the cable plug, or by armour glands of the permanent type.

TYPICAL LAYOUTS.

Figs. 7 to 10 serve to illustrate a number of possible layouts for electrically operated machine mining.

Double unit cutting and conveyor face.

In Fig 7 the conveyors feed into tubs directly, or with a loader which follows the face, in which case another gate-end panel is added. Two cutter and two conveyor panels are provided as one 4-panel unit interconnected to the main mothergate cable by a 100 yard length of pliable armoured cable coiled in the form of a figure eight, and so arranged that a lap is taken off each cut, enabling the 4-panel board to follow

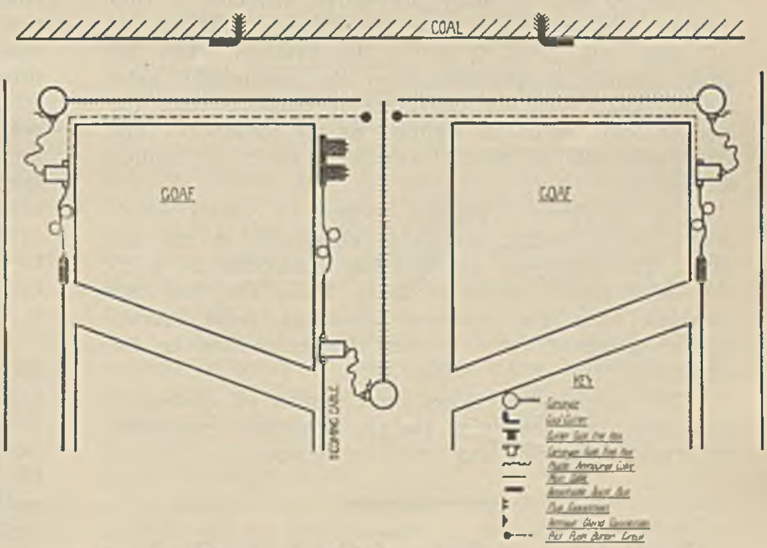


Fig. 9.—Double unit tail gate conveying. Power supply available from the mothergate only.

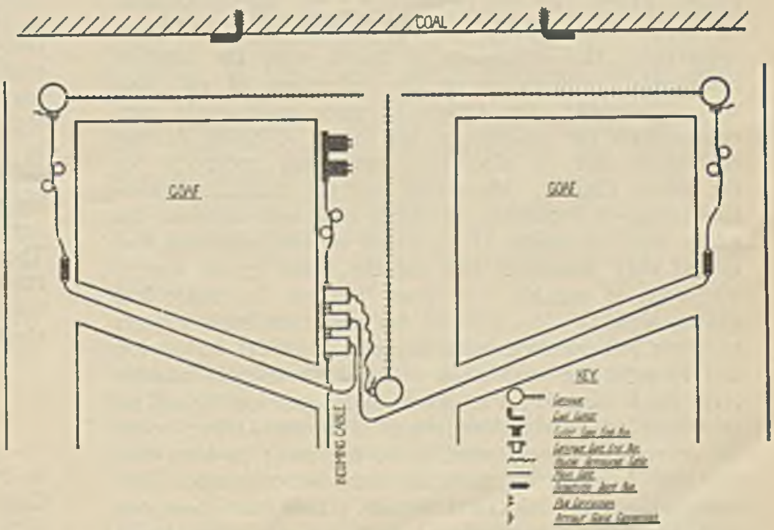


Fig. 10.—Double unit tail gate conveying with power available at the tail gate on a separate circuit. The conveyors are remote controlled.

the coal face without the necessity of cable jointing. At the end of a 100 yard advance a length of main cable is added and the process is repeated. Self-sealing detachable joint boxes are used so that all cable sealing can be done on the surface.

Connection from the gate-end boxes to the conveyor switches is made by means of pliable armoured cable with armour glands on the gate-end box, and plug and socket at the conveyor, so that the conveyor head may be withdrawn without trouble for canch work. The conveyors can be either locally, or remotely controlled.

Double unit face with fixed loading point.

A similar arrangement is shewn in Fig. 8, but with the figure eight of pliable armoured cable between the gate-end box controlling the mothergate conveyor and the 4-panel face unit. By interconnecting the face unit with the mothergate unit by a pilot cable operating on a 25 volt circuit, complete remote control of all three conveyors can be obtained from the loading point.

Tail gate conveyors.

Figs. 9 and 10 shew alternative methods of controlling face conveyors with the driving units at the tail gate end. Fig. 9 covers the situation when the power supply is available from the mothergate only. Manual control of the conveyors is obtained from the loading point, or by the switches on the conveyors. The same principle of pliable armoured cable is applied throughout.

Fig. 10 shews a possible method of control where power on a distinct circuit is obtainable at the tail gate. The conveyors are remotely controlled by a 25 volt pilot circuit which is taken along the face and operated from the conveyor discharge point. Again pliable armoured cable is used for connection to the conveyors.

This specially developed unit system of control is such that a combination of the above methods can easily be arranged to suit any conveyor lay-out.

Great Expectations of Oil from Coal.

To a writer in *The Mining and Industrial Magazine* (South Africa), we are indebted for the golden promise of great developments in the British coal and iron industries. His enthusiasm is based upon the pending commercial exploitation of the extraction of oil from coal. Naturally, the author is more particularly concerned with the relation of his theme to South African conditions, but he also visualises great prospects for the whole Empire. He states that the profitable industrialisation of extracting oil from coal had occupied the public mind in South Africa a few months ago, but that it had only waned of late for the good reason that it was time, to use his expression, "to cut the cackle and get on with the 'osses." In the meantime local experts by close collaboration with Imperial Chemical Industries, had brought the realisation of an oil-from-coal industry very much nearer. Far from hydrogenation being inapplicable to certain descriptions of South African coals, the reverse has been found to be the case; in fact, they are now held to be more suitable for conversion into petrol than those of Great Britain. This contention has been proved by hundreds of tests recently carried out at an experimental plant of the Bergius type in Johannesburg: it is said that the demonstrations shew that fully 55 per cent. of the classes of coal dealt with are amenable to profitable treatment by this means. Should this claim continue to be upheld, the problem must be regarded as solved, since it makes available for treatment thousands of millions of tons of raw material. The importance to the Union of S.A. of this new industry, should it materialise, cannot be over-stated; since not only would it supply all domestic needs, but it would render available such a surplus at a low cost as to warrant the establishment of an export trade on a large scale.

Favouring South Africa's chance in domestic and overseas markets is the cheapness of its coal at the pit mouth. It is held that, while 7d. or 7½d. a gallon is likely to be the official retail price of petrol in England, oil should be available for public consumption at under 1s. per gallon in South Africa. Though skilled labour in South Africa is dearer than in other coal-producing countries, excepting perhaps the United States, the coal is not only cheaper, but the unskilled native labour is the cheapest in the world.

Experiments have proved that an extraction of 300 gallons of petrol per ton will be the yield of South African coal by the Bergius process, depending on the class of coal treated. In other words, stated a local engineer, we might theoretically convert our present coal output into almost 4,000,000,000 gallons of oil per year, or fifty times as much as we now consume. But providing market conditions proved favourable, there is no reason why the annual output of 13,000,000 tons of coal should not be doubled to meet the export demand for oil. It must, however, be remembered that, far from synthetic petrol being likely to prove the ruin of the great existing oil interests, which are partly owned by Great Britain, the Bergius process is actually used to convert low-grade "offal" oil into high-grade spirit. Competition between the natural and synthetic oil product is, therefore, likely to be keen.

For the past three years large-scale experiments in the liquefaction of coal have been in progress at Billingham (England). The solid results accruing from these investigations are of such a favourable nature as to justify tentative plans for the general conversion of the coal output of England into liquid fuels, thereby making the nation independent of imports. In fact, it looks as if Great Britain's two great basic industries—coal and iron—are to take on a new lease of life, the one by finding new uses for its raw commodity and the other by amalgamation of all the important steel interests.

It would be a red-letter day for the Empire if large-scale commercial exploitation in the Old Country synchronised, as well it may, with South Africa's embarkation on a similar project, as connoting a great step forward in the struggle to become self-supporting in the matter of oil-fuels. Canada, with her vast resources in coal, would then seriously have to consider the expediency of coming into line with this epoch-making development of commercial and industrial evolution. There can be no doubt that the world will soon be running entirely on oil, either directly in traffic and transport, or indirectly as the fuel used to generate electricity.

Change of Address.

Mr. Thomas T. D. Geesin has transferred his offices to Commercial Chambers, 132 Renfrew Street, Glasgow, C. 2. The principal firms represented by Mr. Geesin are: Richardsons, Westgarth & Co. Ltd.; Samuel Hodge & Sons Ltd.; Strachan & Henshaw Ltd.; Yorkshire Switchgear & Engineering Co. Ltd.; S. Hodgson & Co. Ltd.; Croydon Cable Works Ltd.

Proceedings of the Association of Mining Electrical Engineers.

NORTH OF ENGLAND BRANCH.

Frequency Standardisation: Notes for Colliery Engineers.

J. E. LAMBERT.

(*Paper read 14th November*, 1931).

PART I.

These notes relate to the organisation which has been set up by the Newcastle-upon-Tyne Electric Supply Company, Ltd., as Authorised Undertakers acting on behalf of the Central Electricity Board, to carry into effect the Frequency Standardisation requirements of the North East England Scheme on the premises of Consumers of the Associated North East Coast Power Companies. In particular they relate to Changeover procedure on Colliery Premises.

The Area served by these Power Companies has been divided into "zones," to each of which it is proposed to afford electrical energy supplies at 40 cycles and 50 cycles simultaneously. These "zones" will be dealt with in sequence and, incidentally, this accounts for the fact that some of our colliery friends are already familiar with changeover methods whilst others, whose plants are situated in "zones" which will not be changed over for three or four years, have not yet been approached in regard to this matter individually.

Consumers' Reference Numbers.

After determining the position and extent of the numerous "zones," a form of reference—taking account of the name of the Consumer's Colliery or Works, the name of the area or Zone and the Substation Number—was found to be necessary so that various departmental operations in relation to the zone might be co-ordinated. As a result there are the Change of Frequency Reference Numbers with which many are now familiar; for example, ABC/NS. 6 signifies :— The A.B.C. Coal Company Limited/Northern Area—Sample Colliery—No. 6 Substation. It follows that all plant and work in connection with the Sample Colliery will bear the ABC/NS. 6 reference.

Motor Detail Card.

The method of scheduling motor particulars was given very careful consideration and a motor detail card was evolved which would be suitable for use for all types of machines likely to be met with in the area. A reproduction of the front of this card is shewn in Figure 1, and it will be seen that at the top of the card provision is made for the change of frequency Reference Number. It will also be seen that the card is sub-divided to give particulars of:—

(1) The motor.
(2) Starting Gear.
(3) Type of Drive.
(4) Coupling.
(5) Pulley.
(6) Gear Drive.
(7) Chain Drive.
(8) Fan.
(9) Pump.
(10) Compressor.
(11) Particulars of actual speeds.
(12) Space for remarks.
(13) Space for Head Office.

The other side of the card is shewn in Figure 2 and it will be noted that provision is made for the dimensions of the existing motor, together with dimensions shewing the nearest obstruction. Space is also given for gear and chain drive particulars, together with a plain section of squared card which is to be used for sketches of the machine under consideration so as to shew up points of difficulty, or to give additional information to that contained in the printed portion of the card.

The card itself is fairly stiff and good to work on and it should be noted that special attention has been paid to the size with a view to an easy filing system. The cards are printed in two colours, namely, black and red; the black card being used for 40 cycle particulars and the red card to give particulars of the proposed 50 cycle replacement plant for that particular drive

It was realised that definite rules would be necessary to ensure that the various engineers who had to work with these cards all adopted the same procedure and having this in mind a system was drawn up and has been satisfactorily followed. With a view to illustrating the necessity of this a few typical rules are given below:—

1. *Terminal Box Positions*: These should be expressed in terms of clock hours when looking on the shaft end of the machine, e.g., right hand and left hand on the centre line will be described as 3 o'clock and 9 o'clock respectively. Direction of the cable or tubing entry should be shewn.

2. *Direction of Rotation*: This should be expressed as clockwise or anti-clockwise as the case may be when looking on the shaft end of the machine. If the machine is arranged to run in either direction, the direction of rotation should be given as reversible.

3. *Diameters of Rope Pulleys*: The overall diameter to the top of groove is to be measured and also a profile of the groove taken with the special tool provided.

4. *Resistances*: State type and whether separate unit. State trifurcating box or tubing and give size of cable or tubing.

5. *Remarks*: A description should be given here of the main switch protecting the motor, stating particulars of overload coils: time lags: no-volt coils: meters, etc.

A reproduction of the front of a completed black card for a typical colliery drive is shewn in Figure 3, which illustrates clearly the method followed in filling in the card. Similarly, Figure 4 is a view of the back of the same card which shews how use is made of the space reserved for sketches.

A copy of this card, together with two blank red cards, will eventually be sent to the selected Manufacturer, who will fill in on the red cards all dimensions and details of the proposed 50 cycle replacement motor and will return one red card while retaining for his

C. F.

DETAILS SHEET

Consumer's Reference and Motor No. ......

Consumer ......

Address ......

Area ......

Section ......

Date ......

Inspected by ......

Consumer's Engineer ......

40 CYCLE MOTOR.
Location ......
Horse Power ...... Rating ......
Voltage ...... Phase ......
Speed (Nameplate) ......
Winding ......
Type ......
Maker ......
Address ......
Serial No. ......
Frame No. ......
Position of Terminal Box (Stator) ......
" " " (Rotor) ......
Type of Terminal Box (Stator) ......
" " " (Rotor) ......

STARTER.
Type ......
Class ......
Maker ......
Serial Number ......
Protection ......
Resistances ......

MACHINE DRIVEN ......
Maker ......
Address ......
Serial No. ......
Is Motor integral part of Machine? ......
Drive Belt, Chain or Rope ......
" Direct or Gear Coupled ......
" Clutch ......

COUPLING
Type ......
Material ......
Maker ......

PULLEYS — Driver. — Driven.
Belt Type ......
Diameter ......
Face ......
Flat or Crowned ......
Rope. Type ......
Diameter ......
Width ......
Number of Grooves ......
Diameter of Rope ......

GEARS — Driver. — Driven.
Type ......
Material ......
No. of Teeth ......
Width ......
Maker ......

SPROCKETS — Driver. — Driven.
Type ......
Material ......
No. of Teeth ......
Face ......

CHAIN.
Type (Inverted tooth or roller) ......
Breadth ......
Pitch ......
Serial Number ......
Maker ......

FAN.
Type ......
Maker ......
Serial Number ......
Cubic feet air per minute ......
Water Gauge ......
Standby ......
Normal Working hours ......

PUMP
Type ......
Maker ......
Serial Number ......
Head ......
Gallons per Minute ......
Suction and Delivery Diameters ......
Suction and Delivery Positions ......
Number of Stages ......
Standby ......
Normal Working hours ......

COMPRESSOR
Type ......
Maker ......
Serial Number ......
Pressure ......
Cubic feet air per minute ......
Standby ......
No. of Starts per hour ......
Starting Loaded or Unloaded ......
Normal Working hours ......

HEAD OFFICE
Entered by ...... Checked by ......
Specifications sent to Manufacturers ......
Date Quotations received ...... / ...... / ......
Motor ordered: Date ...... / ...... / ......
Motor Order No. ......
Starter Order No. ......
Mechanical Order No. ......
Delivery promised: Date ...... / ...... / ......
Delivered: Date ...... / ...... / ......
Approved: — ......

Actual speed of motor ......
Direction of Rotation ......
Actual speed of first motion ......

REMARKS:—

Fig. 1.

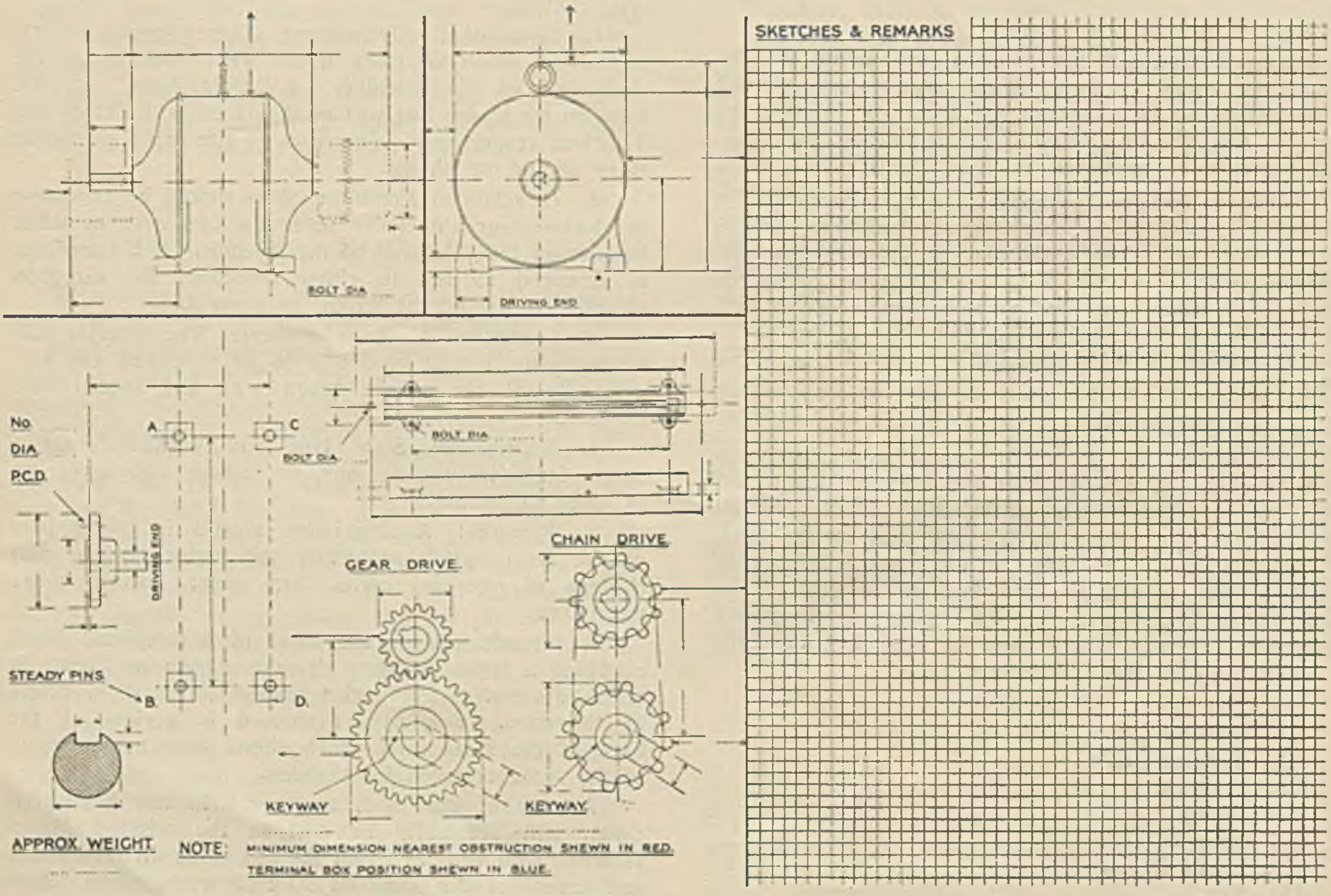


Fig. 2

Consumer's Reference and Motor No. ABC/NSI

Consumer ABC Coal Co. Ltd.

Address Sample Colliery Northumberland

C. F.

Area Northern

Section 1

Date —

DETAILS SHEET

Inspected by — Consumer's Engineer

40 CYCLE MOTOR. S.
Location Main fan house
Horse Power 360 Rating
Voltage 3300 Phase 3
Speed (Nameplate) 194
Winding Slipring
Type Open pedestal
Maker Westinghouse
Address Trafford Park Manchester
Serial No. 64[illegible]
Frame No.
Position of Terminal Box (Stator) 8 o.c.
" " " (Rotor) 6 o.c.
Type of Terminal Box (Stator)
" " " (Rotor)

STARTER.
Type Liquid
Class
Maker Westinghouse
Serial Number No ref.
Protection
Resistances

MACHINE DRIVEN Ventilating fan
Maker Walker
Address No ref.
Serial No. "
Is Motor integral part of Machine? No
Drive Belt, Chain or Rope
" Direct or Gear Coupled Direct
" Clutch

COUPLING.
Type Flexible steel springs Vennel coster patent
Maker Made by the Bond Engng Co. 19 Dickinson Street. Manchester

PULLEYS. Driver. Driven.
Belt. Type
Diameter
Face
Flat or Crowned
Rope. Type
Diameter
Width
Number of Grooves
Diameter of Rope

GEARS Driver. Driven.
Type
Material
No. of Teeth
Width
Maker

SPROCKETS Driver. Driven.
Type
Material
No. of Teeth
Face

CHAIN.
Type (Inverted tooth or roller)
Breadth
Pitch
Serial Number
Maker

FAN.
Type Centrifugal Ventilating
Maker Walker
Serial Number No ref.
Cubic feet air per minute 240,000
Water Gauge 5.5 to 6.7
Standby Steam driven (too small)
Normal Working hours Continuous

PUMP.
Type
Maker
Serial Number
Head
Gallons per Minute
Suction and Delivery Diameters
Suction and Delivery Positions
Number of Stages
Standby
Normal Working hours

COMPRESSOR.
Type
Maker
Serial Number
Pressure
Cubic feet air per minute
Standby
No. of Starts per hour
Starting Loaded or Unloaded
Normal Working hours

Head Office.
Entered by E.L.R. Checked by [illegible]
Specifications sent to Manufacturers
Date Quotations received
Motor ordered: Date
Motor Order No.
Starter Order No.
Mechanical Order No.
Delivery promised: Date
Delivered: Date
Approved:—

Actual speed of motor 186
Direction of Rotation Anti-clockwise
Actual speed of driven machine 186

REMARKS:—

Controlled by Metro-Vick S type oil switch.
Style No33629
Serial No634530
O/L coils 60A
N/Y " 110 Y
Ammeter 0-100 A No664956
Normal load 62 amps.

Mounted on hollow C.I. bed bolted to brick foundation pillar. Lifting girder fixed but no lifting tackle.
Motor would have to be stripped and door frame dismantled for new motor. Railway & tramway 3 yards from fan house.

Fan. Inlet & Outlet Diameters:- 9'. 12' x 9
Inlet & Outlet Positions:- centre. 12 o.c.

Starter T.B.P. Back Bottom.

Drive. Direct coupled to fan.

Fig. 3.

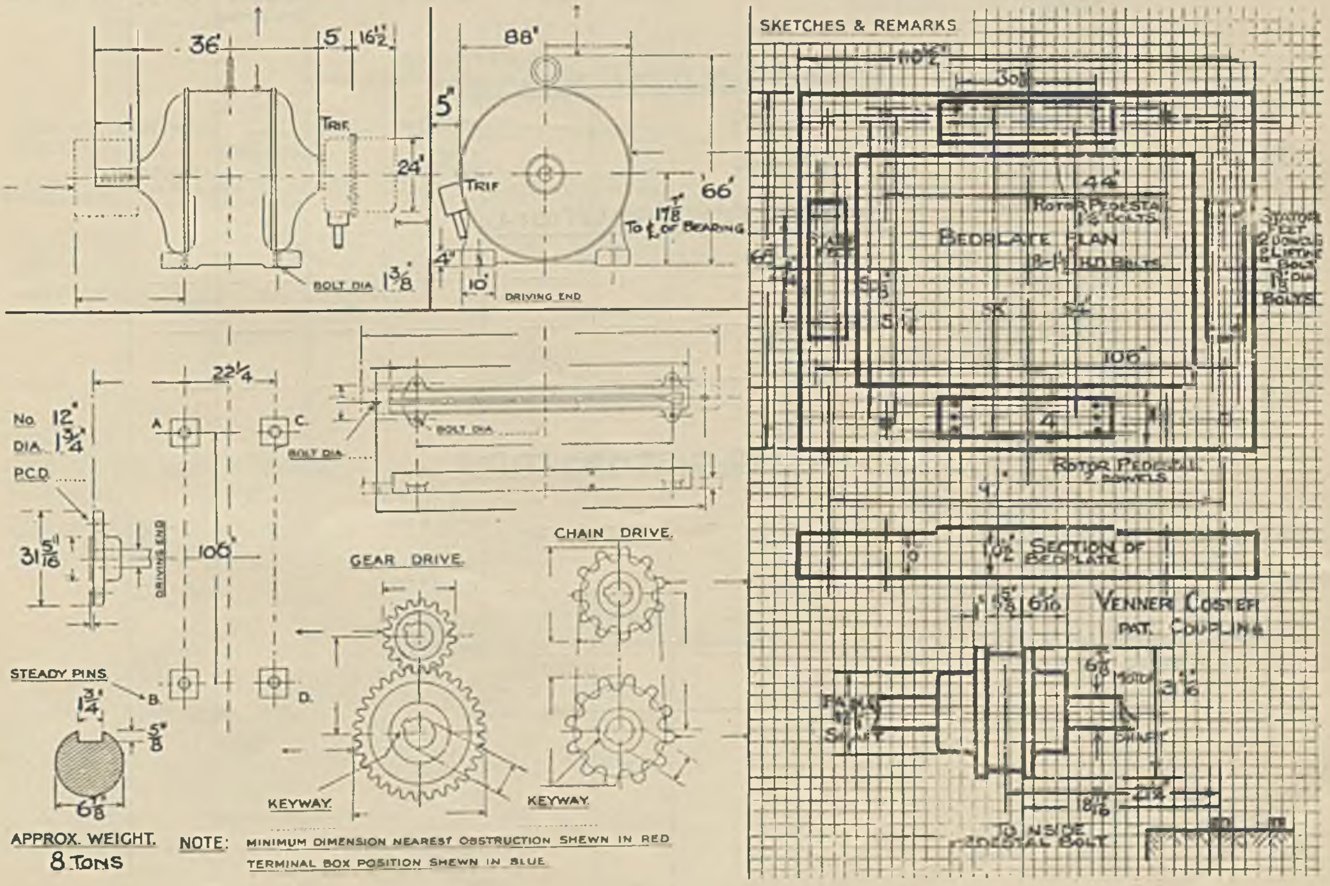


Fig. 4.

own use and records the black card and the remaining red card.

Feeders and Sub-Feeders.

Feeder and sub-feeder switches may or may not be affected by a change of frequency and it was decided to schedule these on a separate schedule of switchgear, instruments and meters, so as to enable them to be submitted to the various manufacturers for their recommendations as to the modifications (if any) that may be necessary. Figures 5a and 5b shew an example of a typical switchgear schedule.

Consumer A.B.C. COAL CO. LTD Consumer's Reference A.B.C./N.S.1.

Address SAMPLE COLLIERY

SCHEDULE OF SWITCHGEAR ON FEEDERS AND SUB-FEEDERS.

Situation and Name Plate	Makers	Type and Serial No.	Volts	Amps	Protection	Normal Current O.L. Coils and Settings	No Volt Coil No.	Earth Leakage Protection	Ammeter Type and No.	Voltmeter Type and No.	Wattmeter Type and No.	Ammeter Readings	Remarks
					SURFACE SUBSTATION CONSUMERS CHAMBER								
TRANSFORMER No1	REYROLLE	TYPE D-ORD No900	3000	300	OL COILS		—	—	197798	—	—	0-350	CT RATIO 250/5
TRANSFORMER No2	REYROLLE	TYPE D-ORD No901	3000	300	OL COILS		—	—	197799	—	—	0-350	CT RATIO 250/5
WINDER FEEDER	REYROLLE	TYPE D-ORD No902	3000	300	OL COILS		—	—	197800	MI 197880	—	0-350	CT RATIO 250/5
SHAFT FEEDER No1	REYROLLE	TYPE D-ORD No903	3000	300	OL COILS		—	—	197801		—	0-350	CT RATIO 250/5
SHAFT FEEDER No2	REYROLLE	TYPE D-ORD No904	3000	300	OL COILS		—	—	197802		—	0-350	CT RATIO 250/5
					H.T. DISTRIBUTION BOARD								
UPCAST WINDER	REYROLLE	TYPE F No1680	3000	300	OL COILS		—	—	156801		MET VICK TYPE N	0-250	CT RATIO 100/5A
FAN	REYROLLE	TYPE F No1681	3000	300	OL COILS	NO VOLT COILS	—	—	156802		No446792 300V 100A	0-120	PT RATIO 3300/110V
TRANSFORMER	REYROLLE	TYPE F No1682	3000	300	OL COILS		—	—	156803		3 PHASE INTEGRATING	0-120	
					L.T. DISTRIBUTION BOARD								
SHOPS	MET VICK	TYPE SF No616867	625	150	3 OL COILS	60	—	—	MI No712514	—	—	0-120	
SCREENS & WASHER	MET VICK	TYPE SF No616868	625	150	3 OL COILS	60	—	—	MI No712515	—	—	0-120	
					SHOPS DISTRIBUTION.								
JOINER SHOP & SAWMILL	GEC	AIR BREAK & FUSES	625	75	FUSES	—	—	—	—	—	—	—	
FITTING & SMITHS SHOPS	GEC	AIR BREAK & FUSES	625	75	FUSES	—	—	—	—	—	—	—	
ELECTRICIANS SHOP	GEC	AIR BREAK & FUSES	625	50	FUSES	—	—	—	—	—	—	—	
					SCREENS DISTRIBUTION								
BELTS & CREEPER	FERGUSON & PARLIN	TYPE BDB No1850	625	80	—	—	—	—	MI No124771			0-100	
CONVEYOR	FERGUSON & PARLIN	TYPE BDB No1851	625	80	—	—	—	—	MI No124772			0-100	
WASHERY	FERGUSON & PARLIN	TYPE BDB No1852	625	100	—	—	—	—	MI No124773			0-120	

Fig. 5a.

Layout Diagrams.

As it will be absolutely necessary to have an accurate diagram of the existing cable layout in order to work out the duplicate supplies which will probably be necessary to carry out the installation of the replacement plant, a line diagram is made of the existing cable system and switchgear together with the various items of plant. Figures 6a, 6b, and 7a, 7b, shew typical line diagrams which are made for this purpose. (Note—It was thought advisable to use the Authorised Undertakers' existing symbols in preference to B.E.S.A. symbols so as to avoid confusion with other departments.)

Consumer A.B.C. COAL CO. LTD — Consumer's Reference A.B.C./N.S.L.

Address SAMPLE COLLIERY

SCHEDULE OF SWITCHGEAR ON FEEDERS AND SUB-FEEDERS.

Situation and Name Plate	Makers	Type and Serial No.	Volts	Amps	Protection	Normal Current O.L. Coils and Settings	No Volt Coil No.	Earth Leakage Protection	Ammeter Type and No.	Voltmeter Type and No.	Wattmeter Type and No.	Ammeter Readings	Remarks
					UNDERGROUND								
					SHAFT BOTTOM SUB STATION.								
No1 Feeder	Switch-Gear & Cowans	Type SG3 No5541	3000	300	3-OL coils	300 Amps	—	—	No253715 Scale 9/300	MI Type No24466	—	—	Potential Transformer 3300/110V 40 to 80 Cycles
No2 Feeder	Do	Type SG3 No5542	3000	300	3-OL coils	300 Amps	—	—	No253716 Scale 9/300		—	—	
No1 Pump	Do	Type SF2 No5543	3000	200	3-OL coils	60 Amps	No Volt Coil	—	—	—	—	—	
No2 Pump	Do	Type SF2 No5544	3000	200	3-OL coils	60 Amps	Do	—	—	—	—	—	
Shaft Haulage	Do.	Type SF2 No5545	3000	200	3-OL coils	50 Amps	Do	—	—	—	—	—	
Transformer	Do	Type SF2 No5546	3000	200	3-OL coils	150 Amps	—	—	—	—	—	—	
					LOW MAIN TRANSFORMER HOUSE								
Low Main Feeder	Union Electric	No119 L	650	150	2 OLs	150 Amps			MI No12613 Trans Ratio 150/5				
Plessey Feeder	Do	No120 L	650	150	2 OLs	150 Amps			MI No12614 Ratio 150/5				
Endless Haulage	Do	No121 L	650	150	2 OLs	80 Amps	No Volt Coil		M No 12615 Ratio 100/5				
					LOW MAIN HAULAGE HOUSE								
North Feeder	Gellison	No A53117 Oil Immersed	625	100	3-OL coils	100 Amps	—	—	—	—	—	—	
East Feeder	Gellison	Oil Immersed No A53118	625	100	3-OL coils	100 Amps	—	—	—	—	—	—	
Haulage	Gellison	Oil Immersec No A53119	625	100	3-OL coils	80 Amps	No Volt Coil	—	—	—	—	—	
Lighting Transformer	Gellison	Oil Immersed No A53120	625	20	—	20 Amps	—	—	—	—	—	—	
					NORTH DISTRICT								
North No1 Gate End Switch	Reyrolle	Type WK No6319	625	50	OL Coil	40 Amps	NV Coil	—	—	—	—	—	
North No2 Cutters	Metro-Vicks	Type MU75 No921643/1	625	50	Auto-thermal Relays	40 Amps	—	—	—	—	—	—	Remote Control
					EAST DISTRICT								
East No5 Gate End Switch	Mavor & Coulson	Air Break Switch & Fuses	625	50	Fuses	40 Amps	—	—	—	—	—	—	
East No6 Gate End Switch	Mavor & Coulson	Air Break Switch & Fuses	625	50	Fuses.	40 Amps	—	—	—	—	—	—	
East Cross Cuts Gate End Switch	Switch-Gear & Cowans	Williams Rowley No3933	625	50	Williams Rowley	40 Amps	—	—	—	—	—	—	
Straight East	Do.	No GE 5947	625	50	3 OLs	50 Amps		Earth Leakage Trans 50A	—	—	—	—	

Fig. 5b.

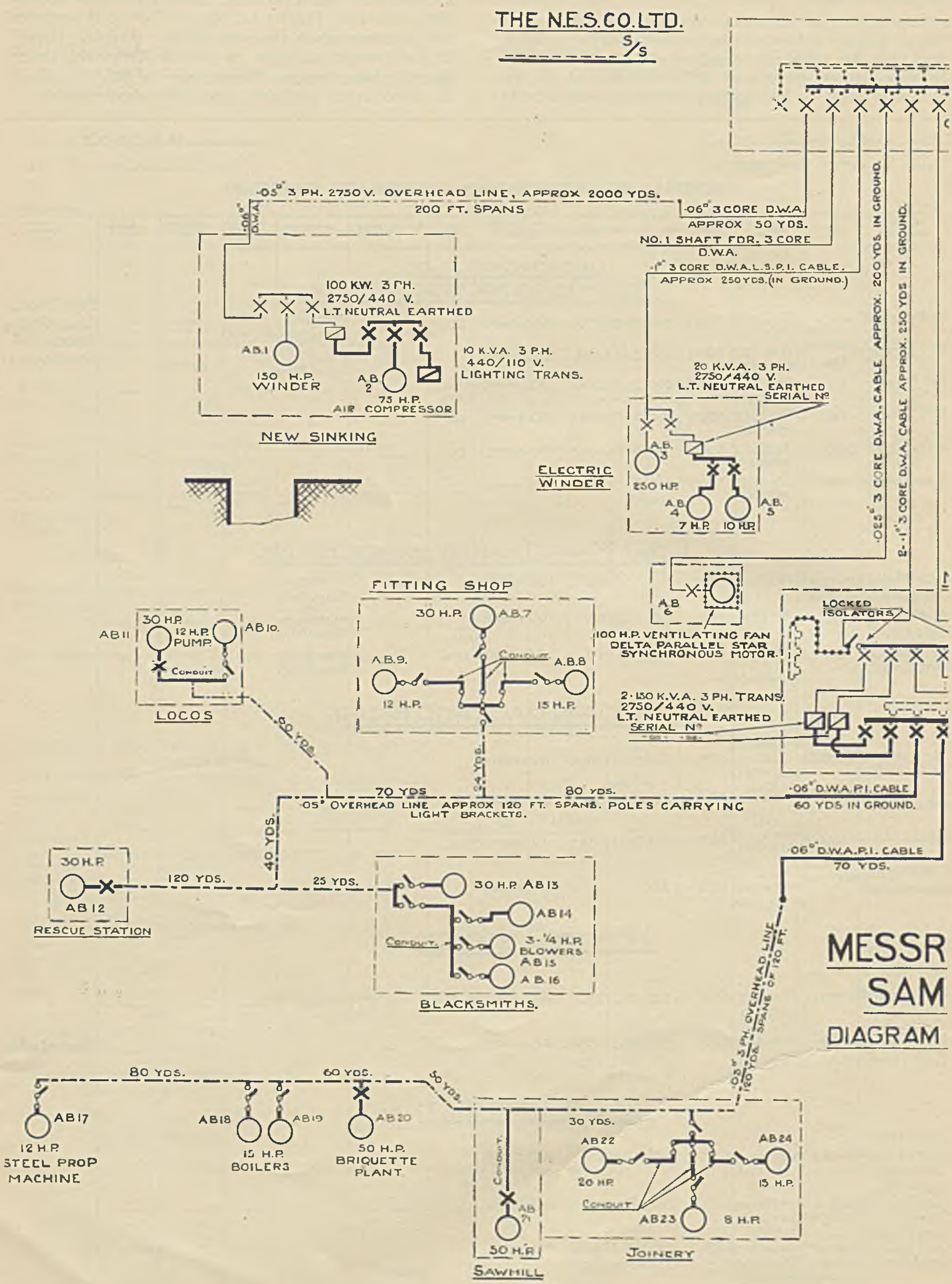
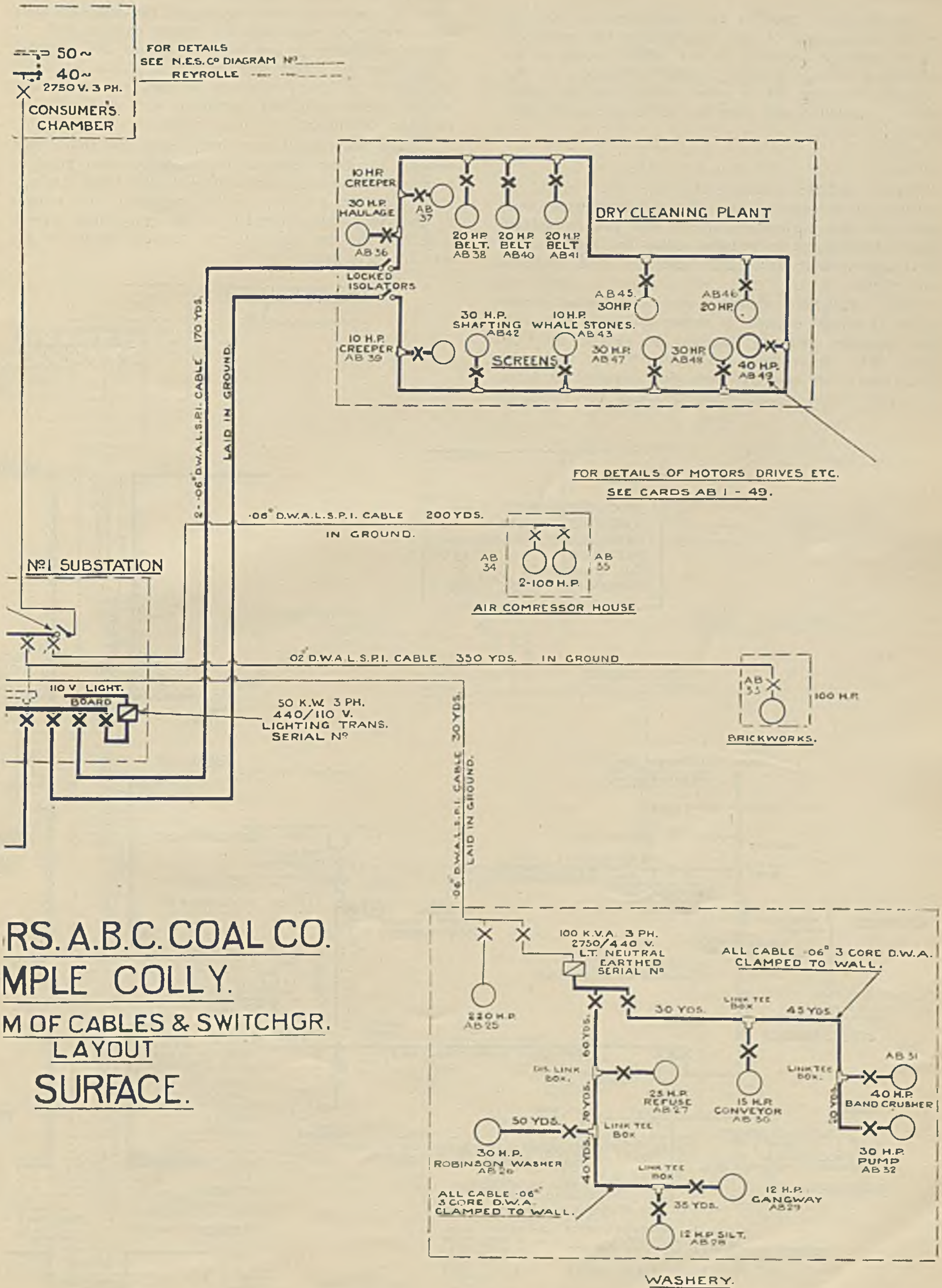

THE N.E.S.CO.LTD.
S/S
·05" 3 PH. 2750 V. OVERHEAD LINE, APPROX 2000 YDS.
200 FT. SPANS
·06" 3 CORE D.W.A.
APPROX 50 YDS.
NO. 1 SHAFT FDR. 3 CORE D.W.A.
·1" 3 CORE D.W.A.L.S.P.I. CABLE.
APPROX 250 YDS. (IN GROUND.)
·025" 3 CORE D.W.A. CABLE APPROX. 200 YDS. IN GROUND.
2-·1" 3 CORE D.W.A. CABLE APPROX. 250 YDS IN GROUND.
100 KW. 3 PH.
2750/440 V.
L.T. NEUTRAL EARTHED
AB.1
150 H.P. WINDER
AB 2
75 H.P. AIR COMPRESSOR
10 K.V.A. 3 P.H.
440/110 V.
LIGHTING TRANS.
NEW SINKING
20 K.V.A. 3 PH.
2750/440 V.
L.T. NEUTRAL EARTHED
SERIAL No
ELECTRIC WINDER
AB. 3
250 H.P.
AB. 4
7 H.P.
10 H.P.
AB. 5
AB 6
100 H.P. VENTILATING FAN
DELTA PARALLEL STAR
SYNCHRONOUS MOTOR.
LOCKED ISOLATORS
2·150 K.V.A. 3 PH. TRANS.
2750/440 V.
L.T. NEUTRAL EARTHED
SERIAL No
FITTING SHOP
30 H.P.
AB.7
A.B.9.
12 H.P.
A.B.8
15 H.P.
CONDUIT
30 H.P.
AB 11
12 H.P. PUMP.
AB 10.
CONDUIT
LOCOS
60 YDS.
24 YDS.
70 YDS
80 YDS.
·05" OVERHEAD LINE APPROX 120 FT. SPANS. POLES CARRYING LIGHT BRACKETS.
·06" D.W.A. P.I. CABLE
60 YDS IN GROUND.
·06" D.W.A. P.I. CABLE
70 YDS.
40 YDS.
30 H.P.
AB 12
RESCUE STATION
120 YDS.
25 YDS.
30 H.P. AB 13
AB 14
3-¼ H.P. BLOWERS AB 15
AB 16
CONDUIT.
BLACKSMITHS.
·05" 3 PH. OVERHEAD LINE 120 YDS. SPANS OF 120 FT.
MESSR
SAM
DIAGRAM
80 YDS.
60 YDS.
50 YDS.
AB 17
12 H.P.
STEEL PROP MACHINE
AB 18
AB 19
15 H.P. BOILERS
AB 20
50 H.P. BRIQUETTE PLANT
CONDUIT.
AB 21
50 H.P.
SAWMILL
30 YDS.
AB 22
20 H.P.
AB 24
15 H.P.
CONDUIT
AB 23
8 H.P.
JOINERY

Fig. 6a.



50~
40~
2750 V. 3 PH.
CONSUMER'S CHAMBER
FOR DETAILS SEE N.E.S.Co DIAGRAM No.
REYROLLE
10 HP. CREEPER
30 H.P. HAULAGE
AB 37
AB 36
20 HP BELT. AB 38
20 HP BELT AB40
20 HP BELT AB41
DRY CLEANING PLANT
LOCKED ISOLATORS
AB 45. 30HP.
AB46 20HP.
30 H.P. SHAFTING AB42
10 HP. WHALE STONES. AB 43
10 H.P. CREEPER AB 39
SCREENS
30 HP AB 47
30 HP AB48
40 H.P. AB 49
2-·06" D.W.A.L.S.P.I. CABLE 170 YDS.
LAID IN GROUND.
FOR DETAILS OF MOTORS DRIVES ETC.
SEE CARDS AB 1 - 49.
·06" D.W.A.L.S.P.I. CABLE 200 YDS.
IN GROUND.
AB 34
AB 35
2-100 H.P.
AIR COMRESSOR HOUSE
No.1 SUBSTATION
02" D.W.A.L.S.P.I. CABLE 350 YDS. IN GROUND
110 V LIGHT. BOARD
50 K.W. 3 PH. 440/110 V. LIGHTING TRANS. SERIAL No.
100 H.P.
BRICKWORKS.
·06" D.W.A.L.S.P.I. CABLE 30 YDS.
LAID IN GROUND.
RS. A.B.C. COAL CO.
MPLE COLLY.
M OF CABLES & SWITCHGR.
LAYOUT
SURFACE.
100 K.V.A 3 PH. 2750/440 V. L.T. NEUTRAL EARTHED SERIAL No.
ALL CABLE ·06" 3 CORE D.W.A. CLAMPED TO WALL.
220 H.P. AB 25
30 YDS.
45 YDS.
60 YDS.
LINK TEE BOX
AB 31
40 H.P. BAND CRUSHER
25 H.P. REFUSE AB 27
15 H.P. CONVEYOR AB 30
20 YDS.
50 YDS.
30 H.P. ROBINSON WASHER AB 26
30 H.P. PUMP AB 32
40 YDS.
12 H.P. GANGWAY AB 29
35 YDS.
ALL CABLE ·06" 3 CORE D.W.A CLAMPED TO WALL.
12 H.P. SILT. AB 28
WASHERY.

Fig. 6b.

Reports.

At the same time as the particulars are obtained for the preparation of line diagrams of the cable system, a report is compiled on any difficult points of the installation which require special attention as, for example, the case of a motor driven haulage which was first installed and then had its engine house built round it.

Summary.

After suitable arrangements have been made, inspecting engineers (who have all had mining experience) attend at the particular colliery and fill in a black detail card for every electrical motor and its incidental parts and prepare switchgear schedules, line diagrams and reports.

On completion, duplicate copies of motor survey sheets (a typical example is shewn in Figure 8) switchgear schedules and line diagrams are sent to the Consumer, who checks them and returns to the Authorised Undertakers one copy of each, duly certified as being a correct record of his plant, retaining the remaining copy of each for his own use. At the same time he is asked to specify the names of at least two and preferably three electrical manufacturers whose motors will be equally acceptable to him for all machines and to place a 'tick' on the survey sheet against any item for which he desires an exact repetition of the type and speed of the driven appliance, although not necessarily of the make of motor.

When negotiations have been completed and a final decision has been made as to the replacement plant to be supplied, duplicate copies of a 50 cycle Plant Replacement Schedule are sent to the consumer, who returns to the Authorised Undertakers one copy duly signed, signifying that he agrees to the items as shewn on the schedule (Fig 9).

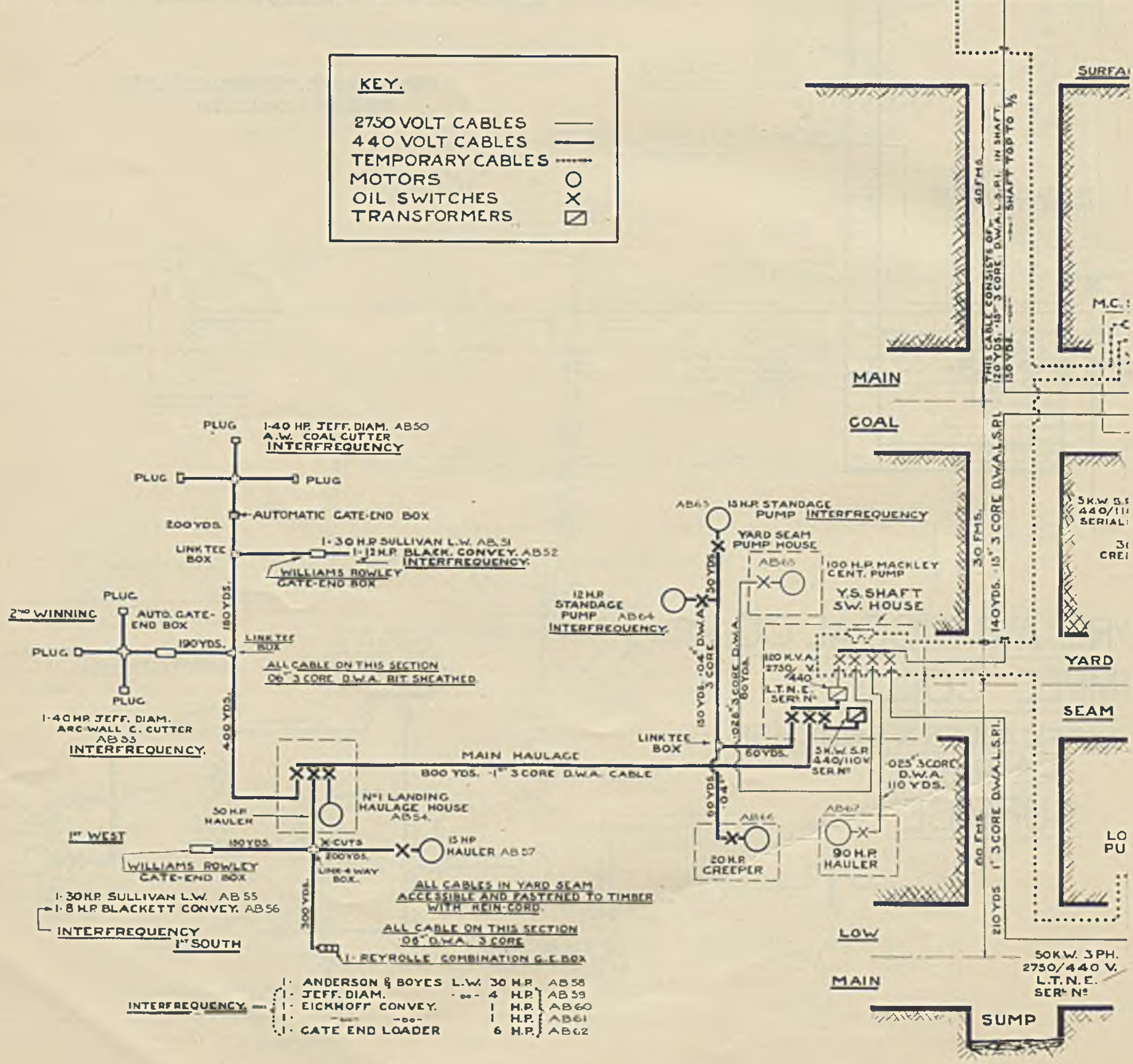



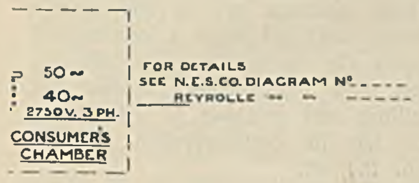
Fig. 7a.

PART II.

Table of Synchronous Speeds.

40 *Cycles.* Poles.	Speed.	50 *Cycles.* Poles.	Speed.
2	2400	2	3000
		4	1500
4	1200	4	1500
		6	1000
6	800	8	750
8	600	10	600
10	480	12	500
12	400	14	428
		16	375
14	342	18	333
16	300	20	300
18	264	22	272
20	240	24	250
22	218	26	230
24	200	28	214
		30	200
30	160	40	150
40	120	50	120
50	96	60	100

In Part I it has been shewn how the stage was reached when it had been definitely decided as to the replacement plant which had to be supplied to take the place of the existing plant; it is now proposed to give details of some of the plant which is, or will be, available with a view to simpifying the actual carrying out of the changeover.



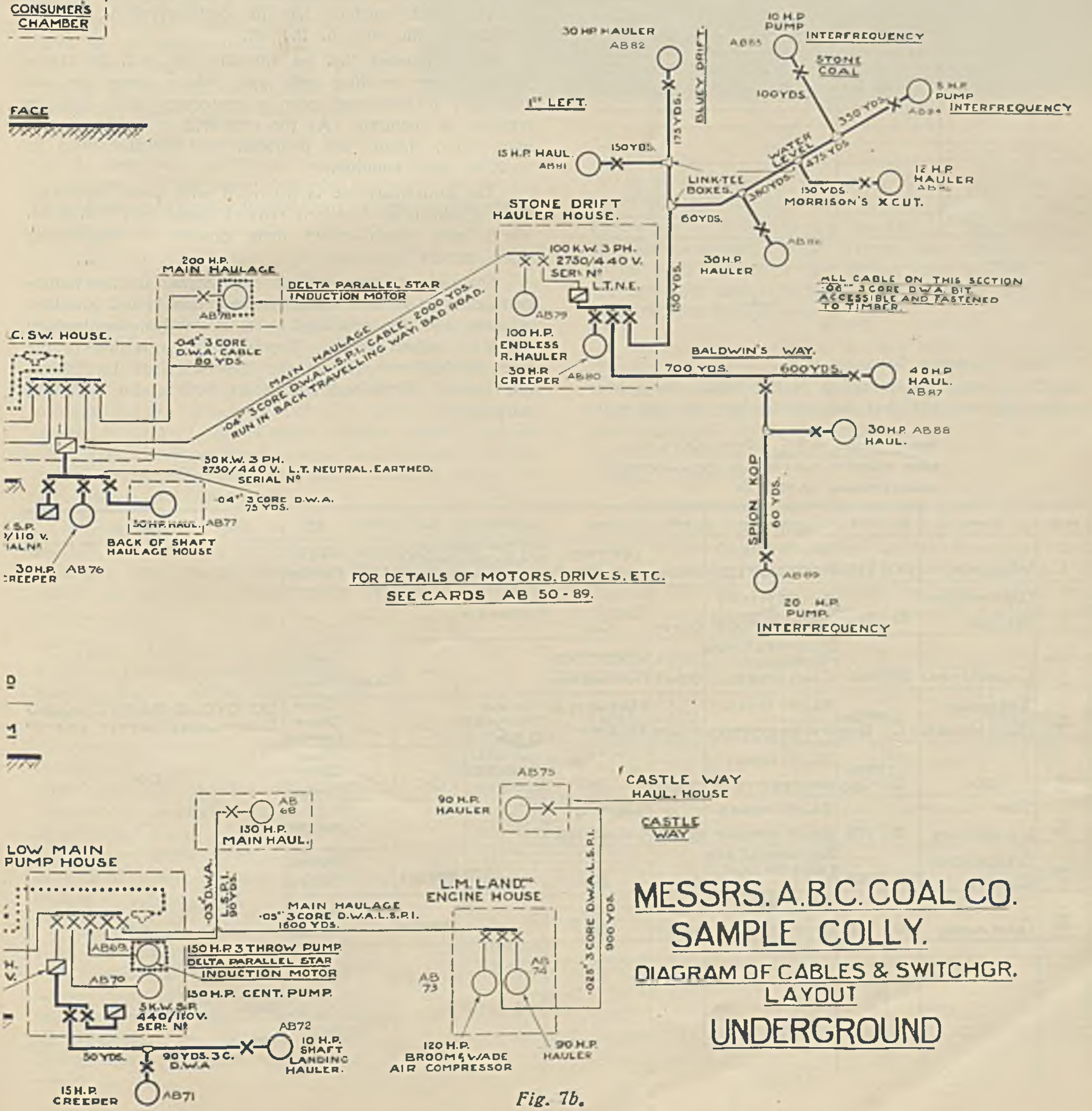


Fig. 7b.

OHANGE OF FREQUENCY.

Sheet No. 1

Newcastle-upon-Tyne Electric Supply Company, Limited,
CARLIOL HOUSE, NEWCASTLE-UPON-TYNE.

Consumer A.B.C. COAL CO. LTD
SAMPLE COLLIERY

Date 16-9-30

H.P.	SPEED	C.P. REF.	MAKER	SERIAL No.	LOCATION	REMARKS
		AB/CD18				
100	390	1	WESTINGHOUSE	642039	WINDER.	S
10	750	2	Do	E27TH.9211	COMPRESSOR	S
1·5	1160	3	-	12196	LAMP ROOM	S
15	1200 1140	4	MATHER & PLATT	20807	TURBINE PUMP HOUSE	U/G
15	1200 1140	5	Do.	20806	Do	U/G
10	800	6	BROWN BOVERI	1180	TOP LANDING	U/G
2	1200	7	Do	5695	ST. EAST PUMP	U/G
153·5						
			SPARE MOTORS			
8·5	770	8	J.H. HOLMES & CO	8219	GARAGE	

Other Appliances

Signature

Fig. 8.

Portable Frequency Changers.

After careful consideration of the actual changeover problem it was felt that use would have to be made of a limited number of portable frequency changers, these to be of a type which could be readily moved from one consumer's premises to another. It is not proposed to compare the relative merits of the different types of frequency changers but to give only a description of the type which was finally adopted as being the most suitable for the particular work in hand, after careful consideration had been given to the various advantages and disadvantages of the different sets offered.

The general construction of each set is as shewn in Figs. 10 and 11, the capacity being 500 k.w. The sets consist of a 40 cycle, 8-pole, stator and a 50 cycle, 10-pole, stator, mounted on a specially fabricated under-carriage. The rotors are of the salient pole type mounted in tandem on a solid one-piece shaft supported on two pedestal bearings. These bearings are of the marine type capable of retaining their oil with a longitudinal tilt of 15 degrees from the horizontal. In addition the bearings are fitted with felt washers around the shaft to check the spilling and creeping of oil during transit. Each machine has its own overhung exciter mounted at the ends of the set.

It is intended that on site the sets will be transportable over existing rails and, where these are not available, if necessary over a temporary track laid in sections as required. As the sets will probably remain upon rails, clamps are provided for securing them in position when running.

The under-carriage is provided with roller bearings, flanged wheels of standard railway gauge and 7 ft. 6 ins. wheel base which makes them capable of negotiating sharp curves.

Shackles are provided at each corner of the under-carriage for vertical slinging, and hooks and shackles at each end for coupling to a locomotive, hauling by winch, or other means. There is also provision in the form of hollow ends on the under-carriage for inserting baulks of timber to act as buffers for shunting purposes.

Name of Consumer: ABC COAL CO. LTD.
Address of Consumer: SAMPLE COLLIERY
Consumer's Reference: AB/C.D.

Date

Ref. No.	Location	H.P.	Speed	Winding and Type	Rating	Maker	Starter	Gears	Pulley	Mech Parts	Remarks
1	WINDER	100	375	SLIP RING PROTECTED	SPECIAL	METRO VICKERS	CONTACTOR COILS - BRK MAGNT COILS	PINION SHAFT & BEARINGS	—	HALF COUPLING	
2	COMPRESSOR HOUSE	10	720	SLIP RING DRIP PROOF	CONT	DO	STARTER	—	—	—	
3	LAMP ROOM	2½	960	SQUIRREL CAGE TOTALLY ENCLOSED	CONT.	CROMPTON PARKINSON	—	—	PULLEY	SLIDE-RAILS	
4	TURBINE PUMP HOUSE	15	1140/1430	SLIP RING PROTECTED	CONT	MATHER & PLATT	ROTOR STARTER N.V. COIL	—	—	PUMP UNIT COMPLETE	50 CYCLE PARTS ALSO SUPPLIED WITH PUMP
5	DO	15	1140/1430	SLIP RING PROTECTED.	CONT	DO	ROTOR STARTER N.V. COIL	—	—	PUMP UNIT COMPLETE	DO
6	TOP LANDING	10	720	SLIP RING DRIP PROOF	CONT	METRO VICKERS.	—	—	—	ADAPTOR	
7	STRAIGHT EAST	5	960	SQUIRREL CAGE DRIP PROOF	CONT	DO	—	PINION	—	PACKING PIECES	
8	GARAGE.	10	720	SLIP RING DRIP PROOF.	CONT.	DO	—	PINION	—	PACKING PIECES	

Certified

Date

Fig. 9.

The wheels at the 50 cycle end are fitted with brakes operated simultaneously by hand wheels at each side.

All the external connections are brought to a special covered terminal board mounted on the 40 cycle end of the under-carriage. This board is in two sections, one for the 40 cycle connections, outlined in black, and the other for the 50 cycle connections, outlined in red.

Both machines are star-wound alternators, rated at 625 k.v.a. when operating at a power factor of 0.85 at pressures of 440, 500, 550, or 650 volts. There is a wide range of variation between these specific voltages obtained by rheostatic control on the machine acting for the time being as an alternator. When pressures in the neighbourhood of 3000 volts are required the sets are coupled up through special 800 k.v.a. three-phase outdoor type transformers.

The sets are reversible, i.e., they can be run from a 40 cycle supply to deliver a three-phase 50 cycle four-wire supply (or single-phase supply up to 200 k.w.) at any of the above-mentioned voltages and *vice versa.*

Each set is started and controlled by two sets of switchgear in cubicles and an auto-transformer. The Input Cubicle consists of a starting switch, neutral switch and a running switch, all suitably interlocked mechanically with the cubicle doors and for correct sequence operation, the two former coupling the machine temporarily acting as a motor to the supply through the auto-transformer which is cut out when the running switch is closed. The Output Cubicle consists of an Oil Circuit Breaker Panel and a Control Panel containing a Tirrill Regulator and Field Control Gear for both Motor and Alternator.

To enable the sets to run in parallel with one another, or with an independent supply of the same frequency, the 10-pole stator is housed in a rocking cradle operated by a hand wheel at the side of the under-carriage.

[Note.—The sets will not be used to couple the Authorised Undertakers' existing 40 cycle system with the new 50 cycle system.]

Special sectional sheds constructed of steel angle iron covered with corrugated sheeting, fitted with storm-proof ventilators and louvres with bushed exits for cables, are provided for housing the sets and switchgear where existing accommodation is not available.

On soundly constructed level track the sets can be easily handled and require little effort to move them. The brakes are capable of holding the sets on an incline up to 10 degs.; on greater inclines chocks must be used under each wheel.

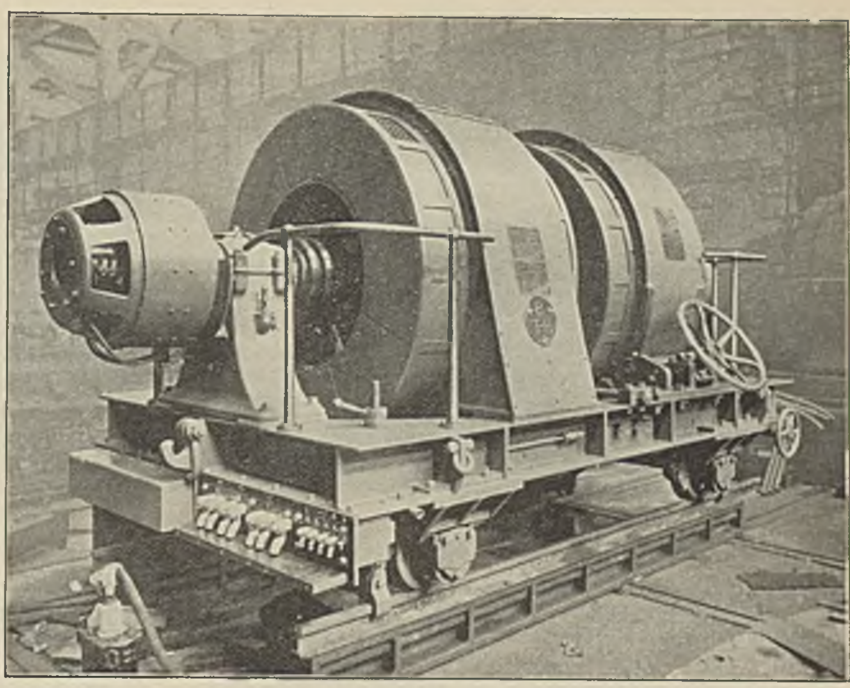


Fig. 10.

If it is necessary to jack-up a set, jacks are provided for this purpose. The complete sets can be lifted by means of four slinging shackles at the corners of the under-carriage. This feature has already proved to be useful insomuch that it has been adopted to lift the sets into awkward positions by making use of the L.N.E.R. breakdown crane.

The minimum opening through which the frequency changer will pass is 8 ft. 6 ins. in width by 7 ft. 6 ins. in height measured from the track rail top. It is essential that the Tirrill regulator should be disconnected and unshipped from the output cubicle to be transported separately and carefully handled to avoid any jolting or jarring.

The foundations for the sets can consist of a short section of rail track about 15 feet long which, if necessary, could be the tail-end section of the temporary track laid for moving the set into its running position. In general the site chosen should be fairly solid hard ground and preferably could be an old machine foun-

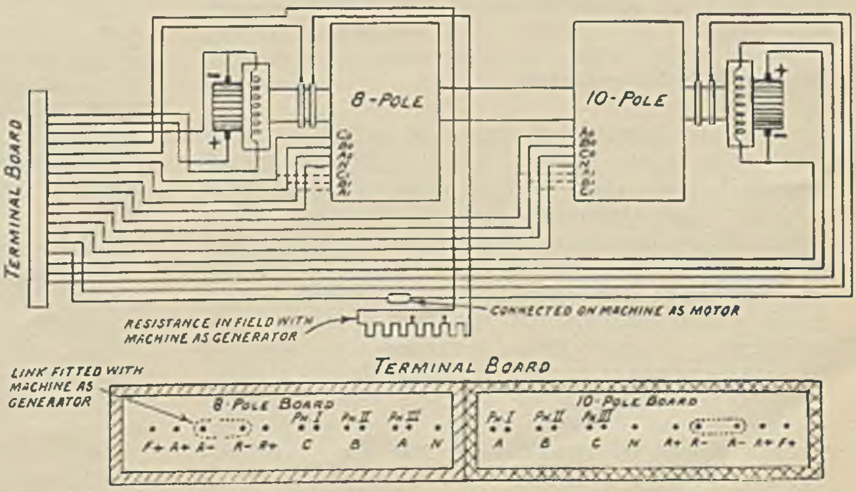


Fig. 11.

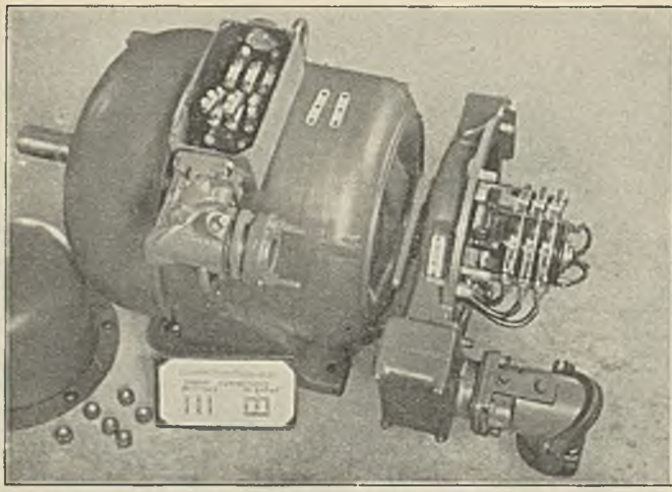


Fig. 12.

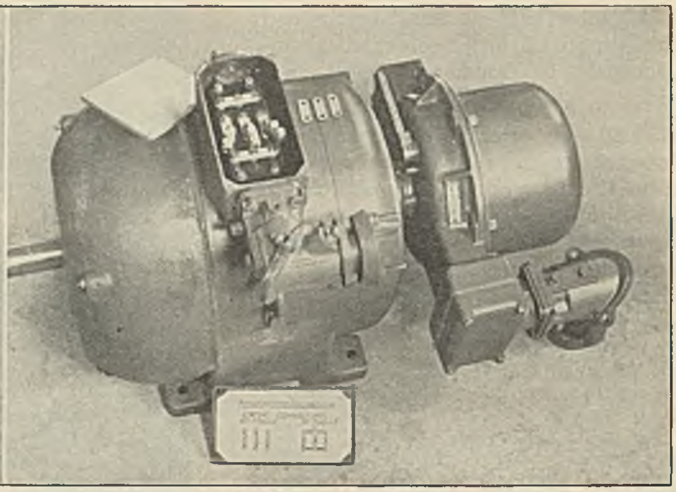


Fig. 13.

dation. It is essential that the set should be set level and if left on the rails all four wheels should be firmly in contact with the rails. Provision has been made on the terminal boards of the sets to enable the "phase rotation" and relationship to be maintained correctly.

The step-up and step-down transformers are suitable for 3000 to 2750/440 volts with tapping switches giving plus and minus 3% and 6% tap.

The neutral connection is brought out on both the high tension and low tension windings. The transformers themselves are of the outdoor type. Provision is made on the switchgear for metering the frequency changer losses; current and potential transformers are provided in the cubicles both on the input and output ends with separately mounted instruments.

Appendix A.

As many colliery engineers will no doubt in the course of the changeover operations at the various collieries have these sets installed on their premises, particulars of the starting up and putting on load of these sets have been included in the Appendix 'A' as a ready means of reference.

Standard Interfrequency Motors and A.C. Commutator Motors.

The definition of these types of motors together with particulars were given in a Paper read before the Association last Session and it is not proposed to add to these other than to state that use can be made of these types of motors to facilitate actual changeover operations.

Delta/Parallel Star Reconnect Interfrequency Motors.

After consideration had been given to typical colliery changeovers it was realised that it would be an advantage if certain 'key' machines could be changed over a week or two earlier that the main changeover operations. On further investigation it was established that there were quite a number of machines which could be allowed to run at 25% slower speeds for a period without any material effect on normal working conditions. To meet these conditions, i.e., where a reduced horse-power output is permissible on a motor while it is running on the 40 cycle supply equal to say 80% of the motor's aggregate horse-power on the 50 cycle supply, the Delta Parallel Star Reconnect Interfrequency Motor is available. This machine differs from the standard interfrequency motor insomuch as by employing a special arrangement of reconnection in the stator winding it is possible to arrange an interfrequency motor suitable for 80% of the 50 cycle output when operating on 40 cycles supply having characteristics approaching the ideal.

The standard 50 cycle machine is perfectly suitable for this service if provision is made to operate the machine connected Parallel Star on 50 periods supply and Delta on 40 cycle supply. Under these conditions the performance figures of efficiency and power factor are not less than the corresponding figures for a standard 40 cycle machine. The performance figures for efficiency and power factor on a 50 cycle supply are of course the same as those of a standard 50 cycle machine. The only disadvantage of the special Delta/Parallel Star Reconnect Interfrequency Machine is that of starting.

By virtue of the special arrangement of the stator winding this type of machine cannot be used for squirrel cage motors employing star delta starting, but it is a perfectly feasible proposition for all slipring motors and some squirrel cage motors, the latter employing either direct or auto-transformer starting.

It should be noted that the whole of the above considerations are based on low tension operation. A special reconnect motor is, in general, not permissible on a high tension supply on account of the complication introduced by a high tension delta connected winding. This latter statement is only to be taken in a general sense, as often cases arise when it is possible to design this type of machine irrespective of circuit voltage.

It is found in practice that the most satisfactory way of arranging for the change of connections on the Delta/Parallel Star Interfrequency Motor is to split each phase into two half phases and to bring all six half phase ends out to the terminal box. The two different schemes of connection are then effected by means of suitable copper links. This arrangement introduces twelve terminals into the motor terminal box but permits of a change from one connection to the other in an exceedingly short space of time (Figs. 12 and 13).

Where the machine is of comparatively small size mechanically, and the terminal box is not capable of carrying a special 12-terminal arrangement, an alternative scheme can be employed using a terminal box in the standard position for the incoming cables and a duplicate box on the opposite side of the machine carrying the phase end connections not required to be connected to the incoming lines. This latter arrangement admittedly duplicates four terminals but its great virtue is that it permits the three main incoming leads to be located in one terminal box.

There appears to be a field for this class of motor on haulages, where it is a distinct advantage to have the use of these machines at the main changeover operations to enable a machine to be available for the movement of 'inbye' plant. They can also be usefully applied to ram pumps and, if circumstances permit, to man-shaft winders.

Interfrequency Synchronous Machines.

These motors can be supplied on similar lines to the above with the additional advantage that they will develop the same horse-power on 40 cycles supply as on 50 cycles supply, the speed on 50 cycles being 25% higher than the 40 cycle speed and the voltage remaining the same.

Synchronous motors—both salient pole and of the synchronous induction type—can be designed to meet these requirements but may in some circumstances be somewhat larger than the standard machine for the same output.

The synchronous machine has, for this application, one definite advantage over the induction motor in that its torque is proportional to the flux and not to the square of the flux as in the case of the induction motor.

Since with the synchronous induction motor there is usually ample overload capacity as an induction motor, and the synchronous overload capacity is usually the limiting feature, the synchronous induction motor shares the above advantage with the salient pole machine to a certain extent. Where it is possible to change the connections, the interfrequency motor will be somewhat larger than the normal single frequency machine, but where it is possible to use Delta connection on 40 cycles and a 2-Parallel Star connection on 50 cycles, the machine would be no larger than the standard 50 period machine.

The exciter would need special consideration and would be designed for full output at the 40 period speed.

When running at 50 periods, approximately the same output would be required, which would necessitate the use of a permanent resistance or a larger shunt regulator on the exciter field. With the good commutating properties and excellent voltage stability of the modern exciter this could be arranged to work perfectly satisfactorily under the two conditions of speed unless an abnormal voltage range were required in addition.

(*To be continued.*)

WARWICKSHIRE & SOUTH STAFFS. BRANCH.

This Branch held its first meeting of the Session in Cannock on October 15th last. Three new members were elected: Messrs. G. S. Buckingham, Member; A. W. Dunn, Associate; and C. Deakin, Student.

Mr. G. J. Latham was complimented by the Chairman upon his being awarded a First Class Certificate at the Association's Examination.

Mr. I. T. DIXON, upon vacating the Chair and the office of Branch President, referred to the pleasure he had derived from serving that office and expressed his thanks to all who had supported him so freely during the year.

Mr. L. C. Gunnell, the President-Elect, was duly installed and addressed the meeting.

Speeches recording the thanks of the Branch to the retiring President and to the Speaker, were delivered by Messrs. Kingsbury, Hopley, and Dixon, and carried with enthusiasm.

Presidential Address.

L. C. GUNNELL.

Having thanked the members for the honour of their electing him to the premier office of the Branch, Mr. Gunnell paid tribute to Mr. Dixon for the excellent manner in which he had for the past year conducted the meetings.

Knowing that a Presidential Address would be required of him, Mr. Gunnell had been rather concerned to find a suitable topic upon which to discourse. Reference to back numbers of *The Mining Electrical Engineer* and, in particular, to the Presidential Addresses of past presidents had not been very fruitful. Some of his predecessors had chosen the political situation and its effect on the mining industry; others had dealt with the industrial side of coal mining, and with the marketing of coal; presidents of highly scientific attainments had spoken of research work, and so in all cases the addresses were the outcome of expert knowledge.

Referring to his personal interests in the general work of the Association, Mr. Gunnell mentioned that he had been a member for sixteen years. During that period he had, naturally, been in touch with progress, both as to the growth of the Association and also the development of the coal mining industry especially since the introduction of electricity into coal mines. When the Association of Mining Electrical Engineers was first formed, the use of electrical power for mining purposes was very limited. Apparatus in those days was of a very crude form. Open type switchgear and unarmoured cables were quite common, but it very soon became evident that before any great progress could be made something more substantial would have to be produced in order to withstand coal mining conditions. To this end the Association could justly and proudly claim to have accomplished much in advancing the design of mining electrical equipments and in developing the ideas and knowledge of the colliery electrician. It had raised the standard of electrical knowledge amongst its members.

Thanks to scientific research it had now become possible to take electrical power right to the coal face and to mechanise completely the coal mining industry. Coal is cut by electrical machinery, headings are driven forward electrically, coals are got and loaded into tubs by electrical plant, shot holes are drilled electrically, and in fact the whole of these and other operations necessitating the use of any power were now carried out freely by electrical appliances and, by the aid of electric lighting from the mains, with perfect safety. With this electrical development, the working conditions of the miner have grown more congenial, healthy, and safe.

Mr. Gunnell, continuing, said he must give credit to the official Journal of the Association (*The Mining Electrical Engineer*) for all it had done for the coal mining industry. It had undoubtedly fostered industrial advancement in electrical equipment more than any other electrical journal ever published. It had succeeded in raising the standard of electrical knowledge of engineers whose duty it was to maintain the electrical equipment of mines in a safe and efficient manner.

The status of the mining electricians had been considerably raised through the untiring efforts of the Association's Journal. It informed its readers of all matters of a technical character appertaining to the use of electricity in Mines and, in short, had come to be accepted as the finest journal of its character.

Mr. Gunnell then urged the necessity of increasing the membership of the Association. He could but sympathise with the less fortunate mining electricians who could not afford (due possibly to the general trade depression) to become members of the Association, but, on the other hand, considering the small annual subscription and the value of the journal, to which each member is entitled without charge, the cost only amounted to a few coppers per week.

Turning to the subject of education and the work of the Association in that matter, Mr. Gunnell referred to the Examinations held each year at each centre, upon the results of which candidates were awarded Certificates. The part which required the most careful consideration at present was the actual preparation of intending candidates. He would like to suggest that some understanding might be arrived at between the Association and the various Schools and Mining Centres, in putting forward the requirements of the standard of knowledge which should be possessed by the candidates. An arrangement of that kind would be of inestimable value to all concerned. It would be understood that the number of young mechanical and electrical engineers engaged at collieries was rapidly increasing and in the interests of these men, their employers and the industry in general, it was essential that this class of craftsmen should have a thoroughly technical training and be, in fact, competent to ensure the greatest advantages being secured from the costly machinery now necessary for the winning of coal. Moreover, it was quite evident that in the very near future a Statutory Examination for Mechanical and Electrical Engineers engaged in the Coal Mining Industry would be instituted. The educational authorities were realising the position with regard to the education of this class of men, and were already devising courses of study whereby the mechanical and electrical student could be prepared with a view to obtaining his National Certificate.

Being mindful of these developments, Mr. Gunnell said he felt that a great responsibility rested upon the shoulders of their members to exert their influence on all young colliery craftsmen to join the Association ; and with co-operation between the Association and the Educational Authorities, the students would have little difficulty in their final preparation to obtain their certificates.

SOUTH WALES BRANCH.

The first General Meeting of the session took place at Cardiff, on Saturday the 17th of October, 1931. In the beginning Mr. J. B. J. Higham occupied the chair. The following applications for membership were accepted: Mr. H. Manley Roberts, Ebbw Vale, and Mr. W. H. Tyce, Penarth (Members) ; Mr. Edward I. Taylor, Pontnewynydd (Associate) ; Mr. W. F. J. Twitt, Bristol, was transferred from student to associate. Messrs. Robert Jones and Gwynne Tanner, both of Penclawdd, were admitted as associates of the Western Sub-Branch.

Sir John W. Beynon Bart, C.B.E. past Chairman of The Monmouthshire & South Wales Coal Owners Association and Chairman of The Ebbw Vale Steel, Iron & Coal Company Limited presented Certificates and Awards to successful Candidates.

Sir JOHN W. BEYNON.—It gives me very great pleasure to be here tonight to distribute the Awards of your Association to those who have been fortunate in gaining them. I believe your Association goes back some twenty years and I should like to impress on the members the desirability of inducing all young electricians who are members of the Association to take up their certificates. Electric science is becoming more and more evident every day in colliery work and we, who are looking so much to the electrician for the working of the collieries, naturally desire to have some certificate as to the ability of the men whom we engage as electrical engineers.

The certificate of this Association stamps a man as having passed through a certain training and naturally gives a feeling of confidence to those who are employing him, and it is therefore most desirable that every effort should be made to encourage all those young electricians to take these certificates and thereby get a certain hallmark of reliability which they can present to the colliery officials who employ them.

Coal mining generally has advanced very considerably during the past few years in matters pertaining to electricity. From day to day we see greater requirements from the electrical engineer and from electrical science ; the coalfield presents to the electrical engineer a very great opportunity and the reward of those who can supply both electrical knowledge and electrical appliances will be to reap a rich harvest in the future, because evidently there will be an increasingly large demand both for the services of electrical engineers and for electrical appliances generally. I hope your Association will go forward with renewed strength from year to year and that we, as colliery proprietors in South Wales, might look forward to an ever growing number of men who not only take up the electrical science but who will pass through your Association and bring to the coalfield the benefit of their advice and also the benefit of being a member of the Association of Mining Electrical Engineers.

Sir John W. Beynon then presented the Awards as follows—

Association's Third Prize to Mr. J. Vaughan-Harries, Pontypridd, for his paper entitled "Earthing of Electrical Apparatus."

Branch Prizes, added together and divided equally between, Mr. W. A. Hutchings, Oakdale, and Mr. J. Vaughan-Harries, Pontypridd, for their papers "Safety and Efficiency in Mines" and "Earthing of Electrical Apparatus" respectively.

Examination Certificates were also presented as follows :—Second Class, Mr. H. G. Cooke, Six Bells ; Service Certificates, Mr. F. E. Pring, Varteg ; Mr. D. Thomas, Glyn Neath ; Mr. F. A. Brock, Pontypridd ; Mr. D. Jones, Aberaman ; Mr. R. Russell, Pencoed ; and Mr. R. B. Phillips, Glyncorrwg.

After the presentation of the awards the incoming Branch President, Major Wm. Roberts, took the Chair and after suitably acknowledging the honour conferred on him, read his Presidential Address, "Transportation of Coal versus Transmission of Electricity."*

Mr. SIDNEY B. HASLAM moved the vote of thanks to the President for his address. They had expected much from Major Roberts and they had received a most valuable and interesting address which would rank worthily with all the other addresses given by previous Presidents of the South Wales Branch. There were many controversial points raised in the address which, perhaps, they would have an opportunity of discussing at a later date.

THE BRANCH PRESIDENT moved a hearty vote of thanks to Sir John W. Beynon for his attendance.

* See *The Mining Electrical Engineer*, Nov. 1931, p. 161.

LONDON BRANCH.

Presidential Address.

Energy Dissipation in Metallic and Fluid Resistances, Insulations, etc.

H. BROOKE.

(*Meeting held* 3rd *November,* 1931).

On occasions such as the present, it is frequently customary to take a broad survey of recent developments but as these have been so fully dealt with in the technical press, the author proposes to make a departure. which he trusts will not be unacceptable. This address concerns a subject which may be considered as one of the branches of fundamental principles: electrical power dissipation in reference to resistances, liquids, coils, Insulation, etc.

Every electrical man is familiar with the cause of the generation of heat by the passage of an electric current and the I^2R law. It is usually more convenient when dealing with heat units obtained electrically, to make the calculations in terms of watt-seconds, horse-power-minutes, kilowatt-hours, etc., as these units are simply a constant multiplied by the standard heat unit such as the British Thermal Unit. It will also be found more convenient, particularly when dealing with intermittent ratings, to use the terms, infrequently, per hour, or, per 15 minutes. An example would be " horse-power-minutes per 15 minutes." This method enables one to decide ratings for resistances of all kinds.

With regard to the methods of dissipating this heat in, say, resistances which may be used for infrequent starting, frequent starting, or continuously in circuit, the requirements for these services necessitate various considerations. For infrequent starting with a cooling period of say four hours, this should be such as to make use of the heat absorption capacity of the material. The heavy cast iron resistances grids shewn in Fig. 1, are very suitable as their mass is large compared with their surface.

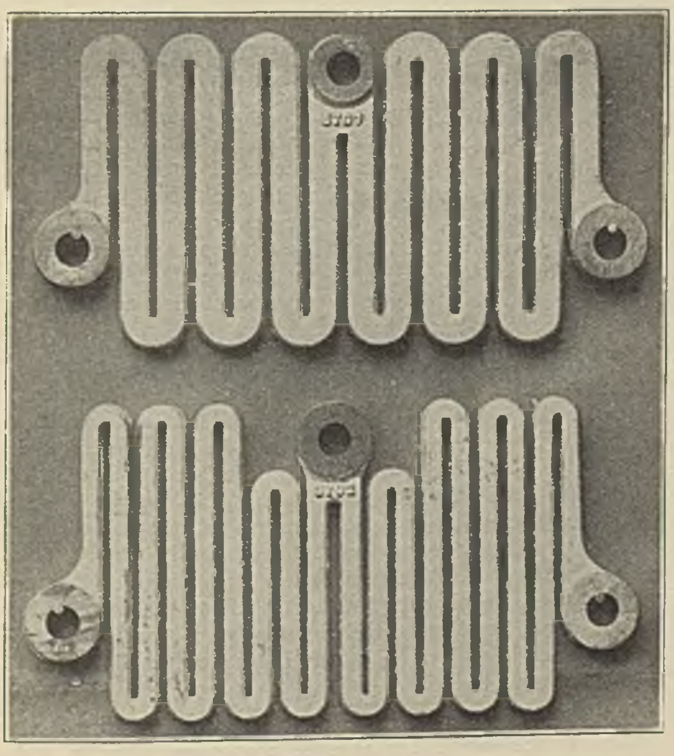


Fig. 1

Fig. 2

For continuous regulation, the essential is a large surface of material such as is shewn in Fig. 2, where the surface is large compared with the weight.

The amount of radiation also depends upon the nature of the surface and the spacing of the grids.

The factors which determine the heat absorbing capacity are:—

(1) The maximum permissible temperature.

(2) The specific heat of the material.

(3) The weight of the material.

Thus cast iron with a specific heat of 0.125, a temperature rise of 280 deg. C. with a specific gravity of 7.2 as a comparison with water at 50 deg. C. specific heat 1.0 and specific gravity 1.0, gives a comparison in volume of as 1 is to 5.

Owing, however, to the spacing required in a metallic resistance, to obtain the ohmic values and another factor in a liquid resistance mentioned later, the overall dimensions are more usually nearly equal.

Assuming that a resistance has been designed for a given maximum temperature rise, the resistance with the larger surface will reach that temperature more quickly than the heavier one.

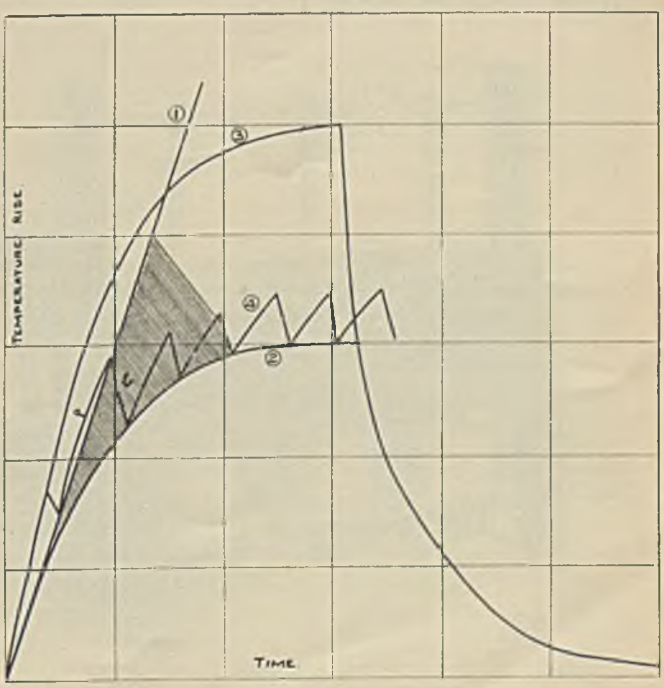


Fig. 3

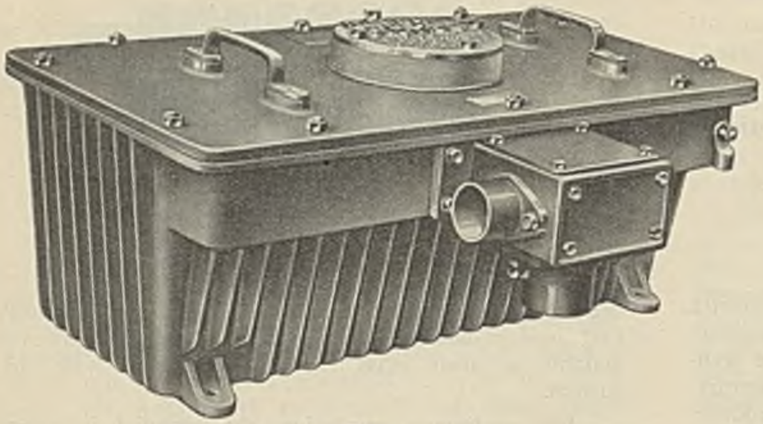


Fig. 4

The curve in Fig. 3, is a typical heating and cooling curve. The time may be short, say 10 minutes to reach the maximum temperature, or long say 3 or 4 hours, the cooling also being proportional. The temperature rise may be 50 degs. C. for liquid or 280 degs. C. B.E.S.A. standard for resistance units.

(1) Shews the increase in temperature due to absorption and assuming no radiation.

(2) Shews the effect of radiation or convection where the curve departs from the straight line, also the flattened part indicated where the rate of generation equals the rate of dissipation.

(3) and (4) are shewn to indicate what may be termed frequent intermittent rating. If an intermittent rated resistance were left in circuit continuously, it would reach a much higher temperature than normal and (3) indicates this temperature.

On intermittent service, the rise in temperature follows Curve 3 at point "a" when in circuit and the cooling at say point "b" also follows Curve 3.

If, therefore, the time "on" and "off" cycle is as shewn, the rise and fall of temperature follows that indicated by Curve (4) and it will be noted that the curve follows that of the continuous rating.

Therefore, if an allowance is made for peaks, a time factor of, for instance, 1 to 2, requires a resistance of approximately half the size of that for continuous rating for the same temperature rise. That is assuming that the "time on and plus time off" cycle is comparatively short.

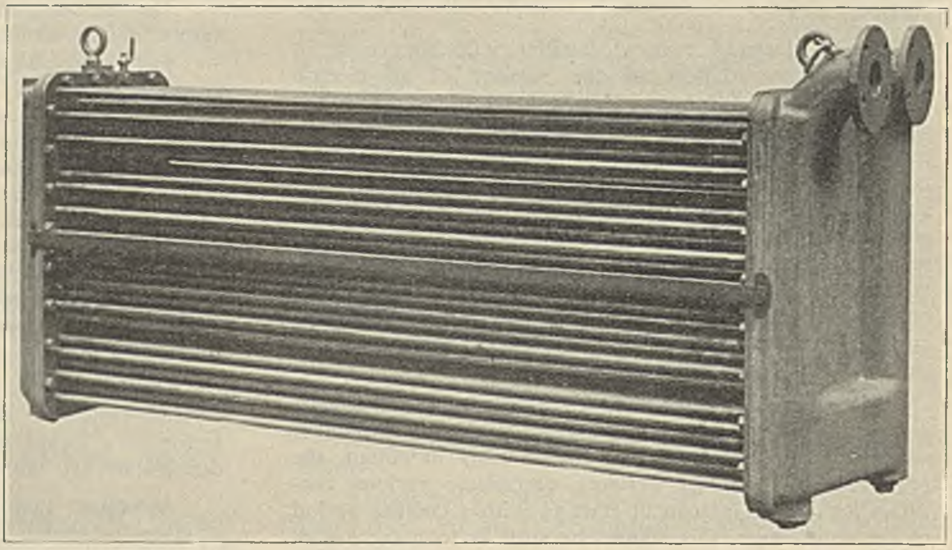


Fig. 6

In proportion to the absorption capacity, the values for time will be modified and for a resistance of large mass and one of small mass, the rates of heating and cooling on the peaks are different, the peaks for the heavy one are flattened out requiring longer to heat to peak temperature. One having a heavy mass, therefore, is more suitable for emergency overloads such as may be necessary for a haulage.

Where a resistance has to be flame-proof and rated for frequent intermittent or continuous service, there is generally difficulty in confining it to a reasonable size, as the surface of the enclosure has to dissipate all the heat. To obtain the minimum size, the resistance can be made in a number of boxes giving a large total outside area. A typical box is shewn in Fig. 4. The cooling fins which increase the effective cooling area are to be noted. Incidentally, for flame-proof resistances the smaller boxes would set up a smaller total pressure in the event of ignition of gas inside.

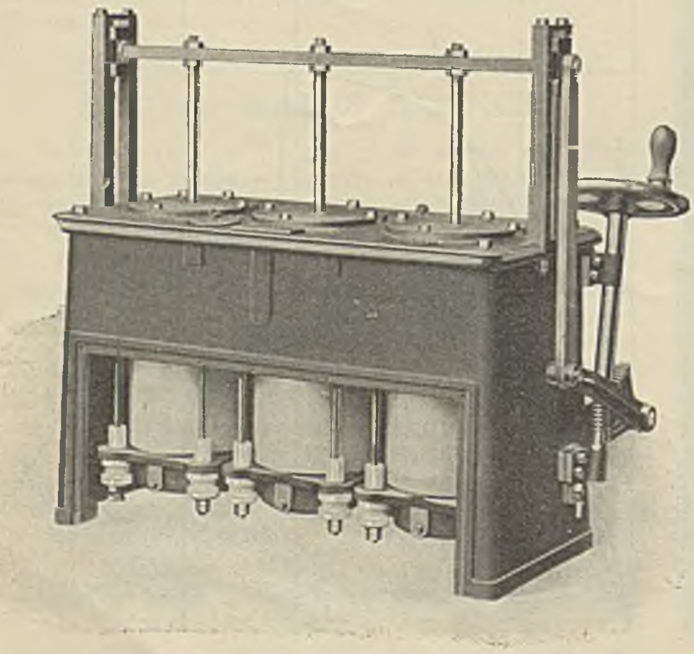


Fig. 5

The illustration, Fig. 5, shews a liquid starter switch which has a large absorption capacity and is comparatively small as it forms the complete rotor starter. It should be pointed out that the total volume of the liquid is effective for heat absorption during the starting period owing to its circulation. This starter can be fitted with cooling pipes to give continuous speed regulation.

A liquid controller on frequent intermittent or continuous service generally requires a cooling pipe system as shewn in Fig 6. It will be noted that the total area of cooling surface on these pipes is large and it is this large area in contact with the heated liquid forming the resistance which again considerably increases the continuous or frequent intermittent rating. To illustrate how effective this cooling is, the controller shewn in Fig. 7 will, without cooling pipes, only dissipate 15 h.p. on continuous rating, but it will dissipate 900 h.p. when the cooling pipes previously shewn (Fig. 6) are used. A motor having starting peaks of 4000 h.p. may therefore be controlled by this equipment. The illustration, Fig. 8, shews how the liquid is caused to flow past the cooling pipes, thus making the cooling more effective.

The heating of the coils is another problem, the laws of absorption again apply for infrequent use, but more often it is necessary to have a continuous rating and, as the coil is practically solid, much of the heat has to be conducted through insulation. Usually a coil is hottest nearer the core, and it is difficult to measure that internal heat. Owing to the temperature coefficient of copper, the part of the winding away from the outside dissipating surface tends still further to increase its temperature. Measurement by thermometer or thermocouple on the outside of the coil, does not therefore give the maximum temperature. Measurement by increase of resistance will give the average temperature and with these two temperatures some indication of maximum temperature can be obtained.

It may also be mentioned that users of electrical apparatus should remember that when running on overloads the windings in the motor coils and resistances

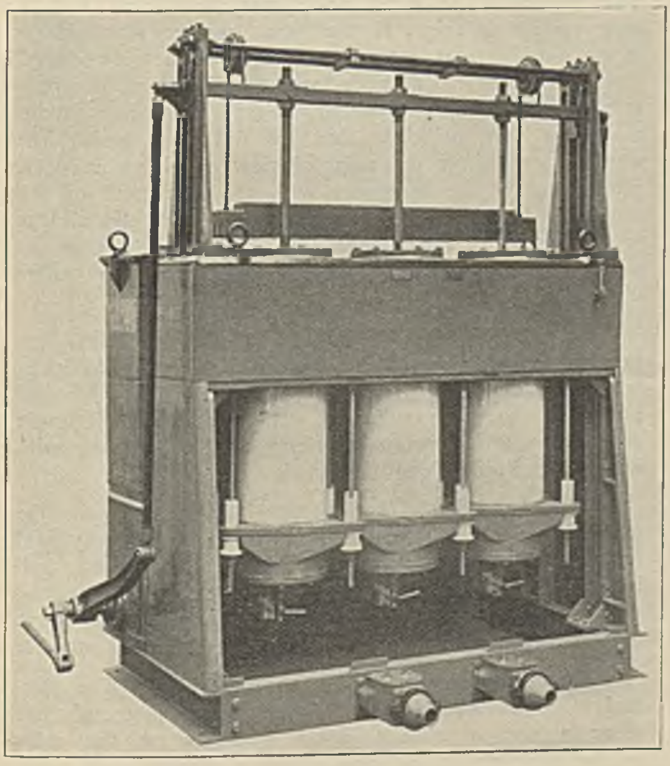


Fig. 7

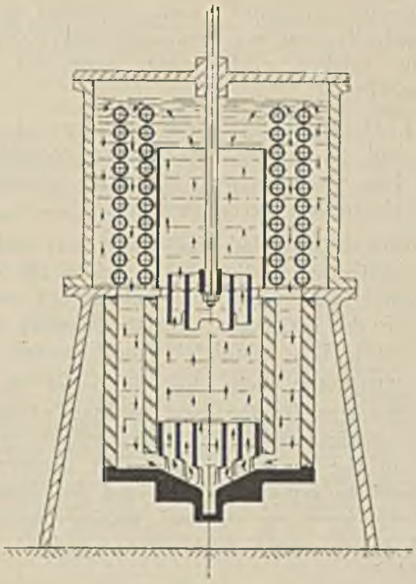


Fig. 8

in circuit are, during the period of overload, absorbing heat in the proportion of the square of the current. Thus: 10% overload will give 21% increased heating, 20% overload 44%, and 40% overload approximately 100% increase in heating. If heavy overloads are to be anticipated therefore, information in this respect should be considered in the design.

In considering commercial types of resistances, the above basic facts should be kept clearly in mind. Mechanical constructions may differ and some may be better than others but there is no witchcraft of design that permits a given nature of surface, or size of surface or mass of material, to dissipate or absorb more electrical energy than these basic facts permit.

One is frequently confronted with a new design for which it is claimed that it will, with less than the usual bulk, deal with a larger power dissipation, but actual comparative tests if carried out with proper regard for the unalterable principles referred to herein will demonstrate the error.

The author has chosen this comparatively small subject for an address on this occasion because once the truth of it is grasped, many problems can be better understood, dangers of overloading can be avoided, and the correct design applied for any known set of circumstances.

Discussion.

Mr. H. M. MORGANS (Past Branch President), referring to the cross-section of a cooler for a controller, shewn in Fig. 8, asked whether the centre stem was a contact.

Mr. BROOKE pointed to the centre electrode and the fixed electrode and said there were three of them.

Mr. MORGANS said he gathered that the cooling pipes were all built into the controller and that there were not separate banks of cooling pipes.

Mr. BROOKE agreed, and added that they could be taken out.

Mr. MORGANS asked if the cast iron grids were liable to break.

Mr. BROOKE replied that they were liable to break if they were thin, but his firm did not make thin grids. The thicker ones which they made were exported in considerable quantities, some of them to Canada and to Australia, but no breakages had occurred. Of course, the thicker grids were large for a heavy starting capacity.

Mr. G. M. HARVEY (Past President of the Association) asked if, in the case of the controller illustrated in Fig. 8, there was electrical metallic contact when the electrodes were together.

Mr. BROOKE replied that there was not on that particular controller, but the slip, when the electrodes were engaged, was very small—about 0.5 or 1.0 per cent., due to the resistance. On the starters they were made to touch, i.e., completely short circuit.

Mr. HUEBNER, who had in mind the use of such an apparatus by the type of man often engaged in haulage underground and who might overload it and heat up the resistance, said that apparently, if it were allowed to remain on overload for long periods, and if there were no external cooling water supply, the liquid in it would boil. He asked if a cut-out was provided.

Mr. BROOKE replied that there was no cut-out. The balance of design was such as to give about 50 degs. C. rise with a certain number of gallons of cooling water. The 50 degs. C. was permitted by B.E.S.A. The ambient temperature at 20 degs. C., was increased to 70 degs. C. There was a large volume of liquid in the apparatus and the temperature would have to be increased a further 30 degs. C. before it boiled: that margin was usually units sufficient in a large controller of the type. In any case, if it did boil it would do no damage, and the man in charge of it would realise the position at once.

Mr. HUEBNER suggested that such a man would not realise the danger until the apparatus had given out.

Mr. BROOKE pointed out that a great advantage of these controllers was that there was no arcing. There was always a large head of liquid over the electrodes; and therefore, in his opinion, it was safer below ground than most flame-proof apparatus. The liquid did not give off gas, but it gave off steam if overloaded for a long time.

Mr. J. W. MACDONALD, having in mind that the boiling of the liquid would result in the generation of steam, asked if provision was made for the release of excess pressure.

Mr. BROOKE replied that the top was not in direct contact with the body of the apparatus all round, but was in contact only in places, so that there were slots at the top, through which any vapour arising from the liquid could escape.

Mr. J. W. WILKINSON said he gathered that the circulation was so arranged that an increased temperature would result in an increased rate of circulation, so that the rate of heating would be slowed down thereby.

Mr. BROOKE agreed and added that the heat was generated at the bottom of the controller, which was the right place if circulation were to be ensured.

Mr. WILKINSON asked if any variation in the rate of circulation affected the stability of the resistance.

Mr. BROOKE replied in the negative. He added that liquid, of course, had a negative temperature coefficient: the hotter it became, the lower was the electrical resistance. It would compensate for itself in that way to some extent, as the resistance went down, and therefore, the motor speed went up, and there was less h.p. minutes loss in the controller.

Mr. J. W. MACDONALD asked whether the plates in such an apparatus became coated with slime or anything of that nature.

Mr. BROOKE replied that they did not but, he added, they should be examined about once every six months; sometimes a kind of scale was formed, and it was necessary to pickle the plates in order to get it off. Recently, however, his Company had used a special metal for the electrodes, and the difficulty had by that means been overcome. The slip with this special metal was very low—from 0.5 to 1.0 per cent.— and it remained at that figure. In some cases electrodes had not been replaced over a period of years, and the users had made no complaint.

Mr. C. L. BUSBY asked if the insulated parts of the liquid resistances as described stood up to their work for lengthy periods, because, with the old-fashioned liquid resistance, the question of the actual resistance to earth or to the frame was very debatable. One day it might be 3 or 4 megohms, whereas the next day it might be zero. Referring to the liquid controller shewn in Fig. 6 he said that the jar, which was of porcelain or earthenware construction, appeared to be liable to mechanical damage; for example, due to carelessness in operation, and he asked whether any protective device was provided.

Mr. BROOKE again exhibited the slide (Fig. 6) and indicated how rubber washers were used in the construction of the controller. The porcelain had a very long creeping surface and would stand up to 3000 volts or more. Discussing the possibilities of breakages of the controller, he said that the porcelain was the best that it was possible to obtain and, as the temperature was fairly uniform throughout the mass of the porcelain, no trouble, or very little trouble, was experienced in that respect. The great point was that there was a long surface in air. If that long surface was placed in the liquid it was not so good, because that introduced a shorter short circuit path from the liquid on the outside of the electric chamber. Some controllers were made on that principle, but he did not think they were so good from the point of view of giving an even cutting out of the resistance with the movement of the controller handle. The resistance was practically always proportional to the amount of handle movement as adjustments were made on the particular controller illustrated.

Mr. A. C. SPARKS (Past Branch President) expressed appreciation of the Branch President's Address, but regretted that it was so short, as he had left untouched so many other related subjects which were covered by the ingenious products of the Company with which Mr. Brooke was connected.

With regard to the several questions about the maintenance of the controllers shewn, Mr. Sparks said he did not wish to appear to add to the replies; but, having had experience during about ten years' service with a number of the largest type of controllers shewn, the following points might be considered as of interest:

The maintenance cost was practically nil. The electrolyte was emptied about every eighteen months to clear a form of sludge which collected on the sides of the tank above the pots. The electrodes had never been changed. There had been no pot troubles under the heaviest normal duties; but, on one occasion, when there was an abnormal difficulty during rope changing, one main pot, and on another, two small connecting pipes cracked.

Mr. J. W. GIBSON, (Past President of the Association) who seconded the vote of thanks, congratulated the Branch President upon his enterprise in combining a Presidential Address with a technical paper, and also expressed agreement with Mr. Sparks that, having regard to the great interest of the Address, it would have been of advantage to have had it extended. Mr. Gibson also urged all members of the Branch to support the Branch President by greater attendances at Branch meetings, and wished him a successful year of office.

The vote of thanks was accorded with acclamation, and the Branch President briefly responded.

MIDLAND BRANCH.

Social Evening.

The new session of the Midland Branch was inaugurated at a smoking concert held in Nottingham on Saturday, October 31st last.

Mr. C. D. WILKINSON presided, and in his opening remarks said the good attendance that evening led him to look forward to a busy session, with well attended meetings and keen discussion. He had hoped to have had the pleasure of introducing to them the President of the Association, Major Ivor David, but he had just received a letter stating that owing to pressure of work that gentleman was unfortunately prevented from coming.

Mr. Wilkinson then referred to the activities of the Branch. Last session they had a unique feature in the series of lectures given by Dr. Cotton, to whom they owed a debt of gratitude. This year they were to have a number of papers arranged; there were still a few vacant dates and he would ask all members seriously to consider giving a paper.

Referring to the Association Examinations, Mr. Wilkinson said they had had a number of candidates, and the successful ones were that evening to receive their certificates and also the prizes offered by Dr. Cotton. The work done in preparation for these examinations was probably quite as useful as the fact of passing the test, as it certainly made the candidates better men. This thought brought up the question of the mining electrical classes which had been provided in the district; these had been organised at all the Technical Institutes in the two Counties, and he was sorry that the number of students enrolled hardly justified the continuance of the courses. This might lead the authorities to think that they were not required, which would be a wrong impression. He would urge members to attend the classes which had been established primarily for their benefit. It did not mean that a candidate would be definitely tied to pit work if he wanted to get away from it. Colliery work constituted the finest training in electrical engineering. There was, moreover, no doubt that ultimately compulsory certification would come, and when it did the men who were prepared now would be the men who would stand the best chance.

MAJOR FOINETTE proposed the health of Mr. C. D. Wilkinson, the Branch President, whom they honoured and respected. They were very glad to have him at their head, and he personally felt privileged to call him friend.

Mr. WILKINSON, in response, said this honour was quite unexpected to him, and he thanked all present for the kind way in which they had received the toast. He would like to take this opportunity of thanking them for electing him for a second year of office.

Dr. H. COTTON said that as this was essentially a social gathering he did not intend to take up much of their time. He was usually expected to say something about educational facilities; first of all he would like to say how glad he was to see rather more candidates at the last examinations than in previous years. This he thought was a very good sign, although unfortunately only two of our members were successful. He would extend to the unfortunate candidates his congratulations at having made the attempt. He was the local examiner for the Association and his duty was to examine the candidates orally. It was no use trying to obtain examination successes without proper training, and he would like to lay stress on the necessity for the candidate really preparing himself for it. It was a rule of this world that nothing really worth having was obtained without effort. If a certificate such as that issued by the Association was to be of any real value it must be worked hard for. The examinations were on the difficult side, especially for those who had not proper facilities. The difficulty in obtaining the certificate ensured that when gained it was well worth having. Compulsory certification had not yet come along, but those who ought to know thought that it would be coming in the not far distant future, and when it came it would mean that the holder of a certificate would be in a strong and safe position. There was another point apart from the possibility of getting a valuable certificate; the fact that one had been educated to the necessary standard was a very good thing. A man might be physically strong, but he was only half alive if his brain was not trained. In these days it was the brain and mind which were of vital importance; a man who had a good education involving English literature, history and economics ought to get the best out of life.

The speaker also referred to the facilities existing in the County for training for these examinations, and said the response to the special courses which had been prepared by all the Colleges had been disappointing. He would like to draw the attention of all members to the fact that these facilities were available and peculiarly adapted to their needs.

With regard to the more advanced candidates who had already taken certificates, perhaps he might be excused for mentioning that they had facilities at the Nottingham College for obtaining honours certificates, by daytime studies. He did not know whether similar classes were held elsewhere in the County.

In conclusion he strongly recommended the younger members of the Association to come forward with papers for discussion. After reading several papers which had obtained prizes he was of opinion that members frequently obtained the prizes because the discussion following the paper has been exceptionally good; when younger members gave papers, if only for that reason, would appeal to the older ones to ensure that good discussions took place.

Dr. Cotton then distributed First Class Certificates to Mr. T. M. Muirhead and Mr. H. W. Randall, to each of whom were handed prizes of Books presented by Dr. Cotton as promised at the beginning of the last session.

Mr. R. WILSON proposed "The Visitors," and said he would like to bring to their notice the Journal of the Association (*The Mining Electrical Engineer*) which he considered had no rival in its class. During the summer he had had the privilege of showing round the collieries with which he was connected, a representative of the Soviet Government of Russia, who held a position somewhat similar to our own Electrical Inspector of Mines, and in conversation this gentleman stated that although they had periodicals from all over the world he considered that *The Mining Electrical Engineer* was one of the finest they received. Mr. Wilson said he thought this was a great tribute and should enable members to realise the value of their journal.

Mr. M. A. CROSBIE, O.B.E., President of the Nottingham Society of Engineers responded to the toast.

The musical programme, which was thoroughly enjoyed, was provided by the "Derby Cables Concert Party."

WEST OF SCOTLAND BRANCH.

The opening meeting of the session of the West of Scotland Branch was held in the Royal Technical College, Glasgow, on 14th October, at which there was a good attendance. After the minutes of the previous meeting had been read and adopted, the following applications for membership, which had been approved by the Council, were unanimously passed: George Jeffrey Neilson, 77 Merchiston Street, Glasgow; William Gray, 31 Loanfoot Gardens, Plean, Bannackburn; John Bentley, Edenbank, Garngaber Avenue, Lenzie; William Hanley, Effieville, 20 Kirk Road, Shotts; William Milne, 13 Dunn Street, Paisley.

Thereafter Mr. Arthur Dixon, Branch President, gave his Presidential Address entitled "The Modern Trend of Industry".

At the conclusion of the Address Mr. Beckett proposed a vote of thanks, which was endorsed by Messrs. Frank Anslow and W. G. Gibb.

Presidential Address.

The Modern Trend of Industry.

ARTHUR DIXON, B.Sc.

Many presidential addresses begin by emphasising the difficulty inherent in their preparation, and particularly in the choice of subject, but it was not until I myself was faced with the task that I realised how much truth there is in the statement. Some presidents base their remarks on subjects in which they are specially qualified; others give their views regarding various aspects and progress of our Association. This Address does not fall under either of those heads. One reason for this is that the subject uppermost in all our thoughts in these days is the state of the Country and trade. We are all prompted to think nationally and internationally, rather than locally. It will be generally agreed that a Presidential Address provides an opportunity for the speaker to develop and communicate some of his own ideas. Naturally such ideas and opinions only carry weight in proportion to the experience, special qualifications, and the amount of thought and consideration put into them by their exponent, and in considering this Address these points should be kept in mind. The Modern Trend of Industry is a subject to which I have given a great deal of thought. It is one of the most difficult matters to understand clearly, and it involves many questions on which there are widely conflicting points of view. I would nevertheless make bold to present the situation as I see it.

It is admittedly difficult when living in an age of rapid progress, development, or historical importance, to obtain a proper perspective of the broad issues, free of confusing detail. There is no doubt that 100 years hence, the period which commenced in 1914 and is still going on, will be recognised as one of the periods of greatest change, on the grandest scale, that has ever taken place. For this period, the title "The Second Industrial Revolution" would not be inappropriate.

There is hardly any common ground on which to compare industry of the present day with industry of, say, 50 years ago. What are the reasons for this change? One main reason is given by the single word "communications". Before the introduction of electricity in the forms of telegraphy, telephony, and wireless, and before the development of the internal combustion engine, places separated geographically by any appreciable distance were greatly restricted in communication. The result was to limit the amount of co-ordination which could take place between various persons and organisations in different parts of the country. Another restriction was that, until the universal adoption of the typewriter, letter-writing was an extremely cumbersome and time absorbing operation.

Let us try to visualise trade in the old days. In the case of the coal trade, the size of a pit would necessarily be small according to modern standards, as it would be limited by the capacity of the machinery then available to haul or wind the coal, and pump the water. In many cases there was no machinery at all. Owing to the restrictions of transport, as much of the output as possible would be disposed of locally, at such prices as could be obtained. There was considerably more flexibility in the question of price, as, without heavy on-costs, there was some margin available for "come and go". If a collier thought he could do better elsewhere, he would—and did—migrate to some other district; if a pit ceased to be remunerative, it was closed, and little capital would be lost and not much harm would be done. With settled conditions, periods extending over a number of years at a time, the universal law of supply and demand had full opportunity to operate, and was the automatic regulator of prices and costs.

Take an example from another industry, agriculture. A large proportion of the population grew a certain amount of produce, mainly for their own consumption. Any excess could only be disposed of locally, as there was no means of quick transport, or even quick communication, between buyer and seller, and no means of delaying the "perishability" of the goods. Thus the tendency of trade and industry was towards a large number of small producing units situated close to their respective markets.

Compared with the present, life in those days was slow, simple, and undoubtedly more healthy and satisfying, excepting perhaps for those unfortunates at, or near, the "starvation line". Such a line is unfortunately a fundamental accompaniment of the natural operation of the law of supply and demand, and it means that the wage for the lowest class of labour is that at which it is just possible to exist, and no more. If wages fall below this limit, then in time the labour supply diminishes and higher wages have to be offered to obtain labour; if, on the other hand, wages are above this level, the supply of labour tends to increase until it is in excess, in which case some are forced to accept work at lower wages in order to exist, and thus bring about a return to the stable condition.

All this has now been altered. The standard of life, and what might be termed the "rate of living" have been artificially raised. Things which were once looked upon as luxuries are now considered necessities. Business, trade, and labour, if they have become less strenuous physically, are certainly more exacting from the mental and nervous points of view. Surely progress of civilisation should bring with it greater general happiness : but can anyone say that progress in real happiness has been made of recent years ? The tranquil temperament and the simple life are things of the past, and now recreation, interests, and amusements, instead of being sedative, as they should be, are mostly of a further stimulating nature. The human race is wonderfully adaptive, and is able to change its characteristics and habits very considerably, but it is at least doubtful whether the rate of change of late has not been greater than the adaptive capacity. It is perhaps too early yet to see the definite results of these tendencies, but there can be no question as to the increase in nervous complaints, and the lack of time, energy, and disposition, for leisure and intellectual pursuits. Under the old conditions, a man could retire at an age sufficiently early to gain some enjoyment from his later years with such hobbies or interests as he had time and energy to keep going during the most active part of his life. Now-a-days such a condition is a rarity, alike from the financial, physical, and mental points of view. Does the drive of progress bring us better things worth while ? This is rather in the way of a digression but it is necessary to enable a true comparison to be made with present-day conditions, and to form an opinion as to the possible trend in the future.

When the use of steam had become general, it was found that, by the installation of machinery, a manufacturer could turn out so many more articles, that he was able to sell in competition with hand labour, after paying the additional cost resulting from the installation of machinery, and the better class of labour required for supervision. Naturally, the effect was to reduce the price of the article in the market until those with out-of-date methods had either to bring themselves up to date or go out of existence. Consequently a gradual adoption of machinery took place, which in time left the man who had originally put in machinery in the same position as he was before, that is, no better off than his competitors. Usually, by the installation of further machinery or the adoption of new ideas, all costing money, the journey on the road to prosperity was resumed. It has very much resembled a rolling snowball, which, starting from the smallest proportions, gradually increases in size. The analogy of a snowball naturally suggests itself, but we know what happens when a snowball becomes too big. Will modern industry have the same fate ?

This building-up process has now reached such gigantic proportions that, unless a large and steady output can be obtained from a unit which has been put down at heavy capital cost, it is not long before the concern is losing money heavily. The balance sheets of many of our colliery, iron and steel, and shipbuilding companies afford ample evidence of this.

One reason for the financial difficulties in which many large concerns find themselves when trade becomes poor, is the costliness of amalgamation. This arises mainly from two causes, the first being the cost of preliminary expenses and stamp duties, and the second (and by far the more important) is the price paid to the previous owners for their businesses. There is no doubt that often the prices paid have proved to be more than the concerns were worth. A person who is giving up control of a business at another's request requires compensation, and this will be based on past results and future prospects. Unfortunately, the effect of this compensation on the agreed purchase price, in many cases, has been to saddle the new undertaking with a load which at times of poor trade it is unable to carry. The money required for amalgamation is generally found by the investing public, and there is not always the strict economy that there might be in taking over the constituent businesses.

Again, is not the capital structure of present-day companies open to serious criticism, as compared with older methods ? Take, for example, a company floated for a million pounds. Until a few years ago this might have been divided into 200,000 preference shares and 800,000 ordinary shares, all of one pound value, that is, a ratio of one to four. The preference shares were preference shares in the real sense of the word, that is, in return for a restricted and reasonable share of the profits, the holders of preference shares had a real sense of security of both income and capital. The value and dividend fluctuations of the ordinary shares would be small and gradual in a reasonably stable business. A permanent investor or a speculator could select securities to suit his requirements, as the types were easily distinguishable.

Now-a-days the structure would be different. It might be 600,000 preference shares or even more, and the balance in ordinary shares of a small denomination, which has the effect of making the number of ordinary shares equal to or greater than the number of preference shares though the actual capital which they represent is less. Can the preference shares in such a structure be looked upon as really "preference"? In spite of the fact that the preference shareholders have supplied most of the capital, they do not usually hold the controlling voting power, this being vested in the ordinary shares, which so often pass into the hands of the vendors of the original businesses. This means, in effect, that the owners sell their businesses to the public but continue in control. These ordinary shareholders have everything to gain and little to lose as they have not paid cash—only prospects—and the shares fluctuate considerably in value with the prospects and profits of the concern. Should evil days arrive, it is not long before there is insufficient profit to pay the preference dividend. While trade is good, the preference shareholders are not receiving the benefit, and as soon as trade becomes poor, both their interest and their capital are in jeopardy. This type of capital structure encourages speculation, and it so often happens that, not only do the vendors receive a high price for their undertakings, but where they receive part payment in ordinary shares, they can make further and substantial profits, at the expense of the investing public, out of the wild fluctuations which take place in the value of the shares. It may be an old-fashioned view, but I cannot feel satisfied that the principle of the Preference Shares representing more capital than the Ordinary Shares is sound or equitable. In recent years, investors who have avoided this class of investment may have lost opportunities of making money, but they have undoubtedly been saved many losses. I have dealt with this matter at some length, as I am satisfied that the present troubles have been greatly increased by this method of modern finance.

For the last few years the word "Rationalisation" has been on everyone's lips, and for the most part it has been hailed as a "cure-all" for the ills of modern industry. Latterly, however, doubts have been expressed by a number of people—some of them eminent industrialists—as to whether rationalisation can be universally applied, and whether in fact it is not being over-done. The author would suggest that it is. The large unit can operate successfully when conditions are stable, and when it is known what can be produced and disposed of at remunerative prices ; but, with fluctuating world conditions and the instability of every factor which affects trade, there is obviously a limit in size beyond which the risks become too great. We all know how unstable conditions are in the following vital matters affecting trade : international and national politics ; international finance, involved with debt and war-time obligations ; labour ; immobility of labour ; the introduction of new devices, methods and goods ; and the constant attempts of new producers to enter markets. If stability in these factors could be achieved, even for a year or two, matters would probably automatically adjust themselves, but in this age of progress at an ever-increasing rate stability is impossible.

One might ask, can rationalisation and large combinations really be over-done ? Consider the engineering industry. The vital question seems to be on-cost. As soon as a concern grows beyond a certain limited size, all kinds of activities and assistance are added, which, though admittedly necessary to a certain extent, have nothing to do with the actual production of goods. This is demonstrated by the tremendously increased participation in industry of financiers, chartered accountants, secretarial staffs, sales organisations, advertising, and lawyers. None of these are actual producers, few of them are engineers. All must make a living, and their cost to the undertaking has little relation to the quantity of goods produced. Incidentally, the growth of heavy on-costs has been greatly accelerated recently by the necessity of the control of large concerns being centred in London and other large cities, where running expenses are relatively greater. London is not too well situated geographically for keeping in touch with many parts of the country, and this particularly affects this (Scottish) district, where much time and energy is lost, and expenditure incurred, in keeping in touch with headquarters.

An argument put forward in favour of large scale combinations is the saving which can be effected by buying in large quantities, the combination of research, and advertising on a large scale ; but in so many cases these advantages are only obtained by the addition of so much to on-cost on the lines already indicated, that the expected benefits are not realised. For instance, the author understands that in some large firms it costs £10 to book an order. If the value of the order is in itself only £10, the position is absurd. It is a fact that the author was once given a small replace part by one of the large concerns, without charge, because the firm would lose less that way than by passing the transaction through store records, bookkeepers, cashier, and accountants.

In considering the difference between former and present days, it must be remembered that an enormous dead-weight has been added, represented by differences in the standard of living. The luxuries of one age become the necessities of the next, and, as these are usually non-productive, the wasted effort and its cost have to be provided for out of productive effort, and add further to on-costs on a national scale. The same thing applies to national commitments, such as social services and the expense of running the country.

Most of the members are no doubt familiar with Kelvin's Law for Electrical Transmission. In the case of a transmission line of fixed length carrying a definite load, when capital charges are added to resistance losses, and plotted against the size of conductor, the resultant curve is U shaped (Figure 1). Starting with a small cable, the capital charges are low, but the cost of resistance losses is high. As the size of cable is increased, the cost of resistance losses decreases at a greater rate than the capital costs increase—up to a certain point—after which the capital costs increase at a greater rate than the resistance losses decrease. Kelvin's Law shews that there is one size of cable where the total cost is a minimum.

This same law has its general application apart from electrical transmission. For instance, it can be applied to the boiler-house of a power station and to generating plant generally ; and there is no doubt that some of the larger stations recently installed are getting very near the minimum point of the curve, if some of them have not already passed it. They are getting to the stage where the expenditure necessary to obtain that extra 1% in efficiency is out of all proportion.

The principle can be applied to industry by plotting the sum of production costs and on-costs against output (Figure 2). When industry is considered, however, it is much more difficult to determine a curve with anything like accuracy because the question is so complicated, but there can be no doubt that in many cases the minimum point of the curve has been reached, and in some cases passed. Undertakings which have passed the minimum point of the curve include those which are generally looked upon as over-capitalised. These opinions receive support from the report of the Government Commission of Inquiry into the German Iron and Steel Industry, published some time ago, where a case is quoted of a rolling mill equipment of the very latest design installed to replace an older equipment. It was shewn that, when working at three times the capacity of the old plant, an advantage of 4% in working cost was obtained. With diminution of trade, however, it was found impossible to continue operations at this high output, with the result that working costs actually came out 4% higher than the older equipment. After making many investigations of this type, the Commission is definitely of opinion that there is a distinct danger in increasing the efficiency and complication of plants beyond a certain stage, excepting where continuous maximum outputs can be guaranteed. If this output cannot be maintained, not only does the result prove a loss in working, but the tendency is to cut losses as much as possible by continuing to produce at an uneconomic rate, resulting in a further general reduction in prices and consequent increased loss.

So far, the illustrations given have been confined to tangible matters such as finance and production, but there are other intangible, but nevertheless important, aspects that are worth consideration. Let us consider a few of these points.

(1) When a business is small, personality counts for a good deal. A worker or a junior is in close touch with his principal and differences can be discussed easily and settled. A good principal will attract good men, and a bad one will not be able to keep his best employees.

(2) If a man is not "pulling his weight" in a small concern, it is soon known, whereas in a large concern the effect is not necessarily so noticeable. For this reason, the average overall efficiency in the staffs of of large concerns can never be so high as that in good small businesses. The word "good" is used advisedly, because it is certain that some small businesses are not efficient ; but the author contends that a large combine can carry more inefficiency and survive than can any small business.

(3) Consider the question of responsibility and initiative. In a small business the man who must make

the ultimate decision can always be found, because there is no one higher to whom it can be referred. In the larger concerns, probably ninety-nine out of a hundred problems occurring in everyday business life will be settled, not by a principal, but by a subordinate, from whose decision there is always an appeal to a higher stage, and which decision may ultimately be reversed or modified. Under such conditions it is not surprising that subordinates do not voluntarily incur responsibility. The only officials who can give the final rulings and take full responsibility are so far removed from everyday matters of detail that, from the producing side and the carrying out of contracts, they virtually cease to exist; for the larger the concern the less is it possible for the principals to be in close touch with the everyday business carried on. The most they can do is to know and direct general trends from summarised information set before them in the form of statistics.

(4) Mention has been made of the difficulty of head men keeping in touch with the details of their businesses, but there is another side which must not be overlooked, and that is the tendency of men in subordinate positions to work in "water-tight compartments", their interest and knowledge being confined to their own particular sphere. Every man's stake is smaller; his outlook tends to become less broad, and the feeling of working for a machine becomes more pronounced as the size of the undertaking grows. Loyalty is apt to suffer.

(5) Another effect arising out of the previous point is that few men can either deal with or co-ordinate anything in the nature of a complete or composite contract because, owing to the scale on which things are done, work is more and more specialised. This specialising tendency also makes it very difficult to have any flexibility in manufacture. Alterations to processes or methods become so costly and complicated that they are only undertaken when absolutely necessary. In these days of progress, when technique is developing almost continuously under conditions of severe competition, a tremendous strain is imposed on large concerns in the effort to take advantage of any development before it, in its turn, is superseded and a new organisation or programme has to be built up.

(6) It is amazing how difficult it is to have anything done out of the ordinary under modern conditions, and how delays become magnified. A new proposition may easily be held up for years before it can mature, owing to the lack of the one man who can, or will, say: "We will try it out"; to the large number of interests that must be considered; and to the elaborate structure that must be provided to put the decision into effect. Britain used to be referred to as "a nation of shopkeepers". It is equally true to say that it was a nation of individuals, and that there was somebody somewhere who could make or sell you anything. There will always be a considerable amount of goods and services required which cannot lend themselves to mass production methods, and such goods and services cannot be dealt with economically by large combinations.

(7) The larger the business, the bigger the man, and the broader the mind necessary to run it successfully. The available number of suitable men is limited, and it remains to be seen whether the supply is, or will be, sufficient to meet the demand at the present rate of progress. The powers for good or evil in the hands of present-day leaders of industry are great, and when a concern collapses in these days, as a result of men running it who are not big enough, or whose business moral standards are not of a sufficiently high order, the results are disastrous indeed. At a time like the

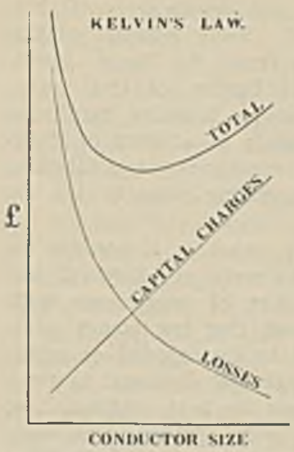


Fig. 1.

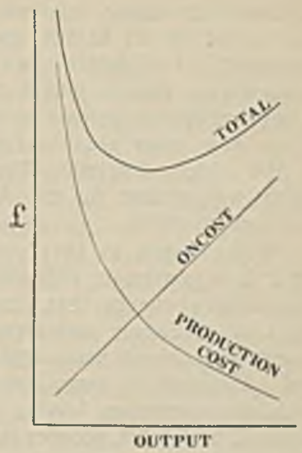


Fig. 2

present it is natural that many of those who have shewn an aptitude for running a small or medium-sized business should find themselves directing the fortunes of the large concerns brought into being through amalgamation. How successful they will be in their new sphere can only be conjectured, and great credit is due to those who have "made good" under the new conditions. In the old days, if a man's business did not prosper, he might fail and his business would stop. In that case few people would be affected, and little capital would be lost thereby; but one of the great difficulties of modern conditions is that where a concern is on the usual large scale, it is almost impossible for it to cease operations should trade become bad, without involving ruin to a large number of people, and without causing great local —if not general—dislocation. Of this we have had ample evidence in recent years. For this reason, we now see many large concerns still carrying on which might well be done without, yet they have so much momentum that they cannot be braked quickly without undue heat, or collapse.

A reference was made earlier to the introduction into industry of parties who were not directly concerned with either engineering matters or manufacture. As the size of a concern increases, the number and relative importance of these "outsiders" increases, until the position is reached where a business which is primarily concerned with, say, the manufacture of highly technical electrical goods, is controlled by people who are not engineers at all. It may be said that this is inevitable, but surely it cannot be to the best interests of the concern. These "outsiders" may help, and do help, to finance the business; to make its wares known; to supervise its accounts; and to check its costs; but they do not of themselves produce a single article. In the best interests of an industry, its control should not pass from the hands of those directly concerned with production.

An interesting example of large-scale working is afforded by the National Electricity Grid. There is a good deal of difference of opinion as to how far the savings to be expected from concentration of the demand into the more economic stations may not be counterbalanced by the increased capital charges and losses on transmission, together with the additional control organisation. The author holds the opinion that the scheme is fundamentally sound, and that, while difficulties and expense are inevitable in the transitional stages, it will in time prove to be of great benefit to the country as a whole. If it can assist in spreading industry into new areas, by providing a cheap supply of electricity where this was not previously available, that would be all to the good. Some evidence of the movement of industry away from the large towns is apparent, mainly where the burden of local rates in the towns has become excessive. Working conditions in the new areas are tremendously in advance of those in the older districts. The conditions at Lydbrook, which was visited by the Association recently, are an excellent example.

With regard to the future, what is it possible to say? It is extremely difficult to make any forecast, but the author believes that, in spite of interference with the Law of Supply and Demand, that law stands paramount and cannot permanently be disregarded or modified. Many of the large concerns will disappear as their usefulness decreases, leaving only the best qualified, best situated, and most economical units. At the same time, there will be a continual re-appearance of small firms and businesses, organised on efficient and up-to-date lines, and specially adapted to meet the demands which cannot be satisfied economically by the larger concerns, and particularly dealing with local requirements. This point was recently stressed by the late Minister of Mines, when he advised the country not to be too hasty in adopting wholesale amalgamation of collieries, with the resulting elimination of many of the smaller units which by themselves are able to satisfy a restricted but local want, but which as items in a large concern would be quite uneconomical.

Many people still contend that the salvation of the coal trade lies in the universal mechanisation of the mines. It is well to emphasise, therefore, that there is a definite limit beyond which this can never provide a cure, a fact well recognised in this part of the country (Scotland) where mechanisation has been adopted to a greater extent than anywhere else.

We have all been taught that "Britons never shall be slaves". This phrase was intended to refer to domination by some other country, but are we not in fact becoming slaves of the modern task-master "big business"? Moreover, we are restricted to an alarming extent by laws, regulations, and excessive official interference, which affect our activities in every phase of life.

While this address was in its early stages, the Macmillan Report was issued. The author must confess that to him it was a most disturbing document. It is so highly technical that to understand it properly is a matter of great difficulty, but it is ominous in that it contains recommendations which would further interfere with the Law of Supply and Demand and which would add further regulations and restrictions having almost universal application. The recommendations referred to are :—

a.—To influence the relation of gold to commodities ;
b.—To stabilise prices artificially, in a wholesale manner;
c.—To manage the monetary system of the country ;
d.—To control the banks' gold reserve by Law.

These recommendations are certainly at variance with the economic law and, while such expedients may perhaps be used at times temporarily to ease a difficult situation, all such interferences have eventually to be paid for, and the author is convinced that in the long run no good ever accrues from such practices. It is a relief therefore, to find the approval of this report has been far from unanimous.

This address can, unfortunately, only be inconclusive, as it deals with problems which are being given earnest consideration by the best brains of the world, and it is doubtful how far anyone can really envisage the whole position, with its tendencies and consequences. The author has attempted to give you his own views, in the full realisation of the controversial nature of the subject, and with deference to the opinions of older and more experienced men.

In conclusion, the present tendency is towards an ever-increasing size of producing units, which require ever-increasing consumption for their economical operation and continued existence. There is surely a limit beyond which consumption cannot be stimulated, and at present the supply of most products exceeds the demand. Is this not an indication that the limit has been reached?

AYRSHIRE SUB-BRANCH.

Presidential Address.

General Notes on Progress.

JAMES GARVEN.

(*Meeting held* 17*th October*, 1931).

This Association was formed over twenty-one years ago. Machine mining had by then made some progress and we can understand that the promoters considered that such an association would be mutually beneficial. We have seen that it has attained its object and has been very successful, although there are still a large number who would be benefitted by joining us. Electricity in mining is progressive and it is only by following a lead given here and there that we can keep up with the progress made. Some of the members present have seen the application of electricity to mining almost from its infancy and can remember when all operations had to be carried on without it.

Coalcutting in seams between two feet and three feet in thickness made rapid progress after its successful application to the easy conditions first chosen. It was not long in spreading to more difficult places that at first were considered impossible of machine mining and some agreeable surprises were experienced. It was found that the rapid advance of machine mining made bad roofs easier to control. Coalcutters worked on rails in these days and I remember there was a good deal of labour in passing the rails over the machine to reset in front. The distance cut in a shift then was quite favourable but the shift was longer and perhaps we were not so particular about cutting the corners. Coalcutting is now applied to seams as low as fourteen inches and up to the thickest seams, although in thick seams, its advantage cannot be very great, we can understand that a fourteen-inch seam requires a coalcutter.

Before the advent of electricity haulage was limited to a rope from the surface, to the advantage of gravity and to horses, which compelled the management to be very careful in the direction of the roads and limited the distance from the pit shaft. This was all changed in a few years and, if we take a mental view of the operations carried on by the aid of electricity, it should appear a bright picture.

The coal face is undercut by electric power. Shot holes may be electrically drilled. The fallen coal only requires filling into tubs or, better, into a conveyor ; or, still better, it may only require to be pushed into the path of a scraper ; at the end of the run it automatically drops into, or is elevated into, tubs which are moved to the pit bottom by electric power.

The mine management does not view the electrical development quite so brightly. Previous to the electric period the advancement of the face was slow. The faceman had almost complete responsibility for his working place. He could take a day off if his funds permitted and little or no harm was done so long as his place was advanced in relation to the other places. Machine mining changed all this. It now falls to the management to see that the run has just the right number of men to strip it completely ready for the coalcutting shift. It must also be timbered not merely according to the idea of faceman for his safety, but so that the coalcutter can get through safely and without loss of time.

The great necessity for clearing off the fast advancing face is a good supply of tubs.. Haulage facilities must be adequate or operations must be curtailed. The management, however, has a choice to suit all conditions. If the section warrants they may install an endless rope which has almost unlimited capacity, but which is awkward to advance and requires straight roads.

If to the rise or dip a main rope may suffice if its capacity is sufficient, or if the road is level or undulating a main and tail rope may be used. When the section is undulating or faulted a considerable number of small haulages or putters may be required but for whatever is necessary electricity is easily brought forward to the point of application.

The first generating plants were almost necessarily a simple steam engine driving a dynamo by a belt and, by the time it had reached the limit of its capacity the high speed reciprocating set would be well forward and was the natural development of extension of the plant, but it required a higher steam pressure than was usual at the collieries to take advantage of steam expansion in more than one stage.

The turbine soon ousted the reciprocating set and the mixed pressure turbine was regarded as the acme of economy ; and it undoubtedly fitted in admirably at one period, as the increased power required was obtained without increase in boiler plant or fuel bill. The gradual reduction of steam driving on the surface proved that the all electric drive is more economical than mixed pressure and we have now arrived at a point where we need consider no other than electric drive.

In Scotland direct current at five hundred volts would be almost universal at an early stage of colliery electrification, and small collieries still find it very suitable. We can remember when a.c. was considered quite unfit for colliery work, but the reverse has been amply proved. Lack of starting torque was the great drawback of a.c. motors when compared with d.c. motors. We hear nothing of that now. That objection has been completely overcome or heavy starting currents do not matter in the large plant. We now find coalcutters with a.c. motors rated much higher than d.c coalcutters and the coalcutters of very low height are not so easily produced for d.c. working.

With a.c. we can get any voltage we require readily. The shaft pump may employ a high voltage, and inbye there is a medium voltage for power ; there is a low voltage for light and a still lower voltage for signalling, each a separate circuit ,supplied from the same source, but which in the event of faults have little repercussion on each other.

Considering the ease of attainment we believe that voltages inbye should be kept low and that all apparatus, including trailing cables, should have an earthed shield. If voltages are high the object of an earth shield may not be attained unless the resistance of the earthing system is low, as in event of a fault to earth inbye the voltage between earthed shield and earth at the point of fault is only reduced by the conductivity of the earthing system.

The value of the earth plate depends considerably on its proximity ; but if we connect the rails, pipes and earthing system together and to earth, the difference of potential between faulted apparatus and earth must be small and the danger correspondingly reduced. In a dry section this is not easily attained, but where pumps are required it is readily established.

The author remembers when he was first called on to instal earth plates. There was an overhead line connecting two shafts about half a mile apart. A pipe was put in the ground at each end of the overhead line and connected to the outer of the concentric system. To test their efficiency they were connected in short circuit with the full voltage through the overhead lines and back through the earth plates : it was found that only twenty-five amperes passed, which shewed that the earth resistance was no less than twenty ohms. That was not considered as very satisfactory but it was not remedied at the time. Perhaps the value of an earth plate near the generator was not realised ; but the value of being well earthed near the furthest away point is now fully understood, as the voltage between the cable armour and earth is a measure of the voltage drop on the negative side if it is not connected to earth. An a.c. system with a fault to earth is on a parallel with that but the voltage between the point of fault and earth is proportionate to the resistance of the earth connection only. Unless that voltage is low earth trips should be used to insure that the pressure will be immediately cut out.

Electrical plant has so developed that steam may be entirely dispensed with in the working of a colliery. The grid is spread over the country and it can be tapped to supply power for every purpose.

A colliery just starting away will be very much tempted to link up. The capital expenditure will be small and if in these dull days if we can imagine a new colliery, we can imagine it connected to the grid. We can also picture it at a considerable disadvantage in this respect to the older collieries that already have a plant of their own, laid down in better time maybe.

Perhaps not the last word in the economical production of electricity but unfailing in its service and using coal for which the outlet is nil or very limited.

Attached to the grid we may find that our power is costing us something between sixpence and one shilling per ton of output, or more if the water is very heavy, and we will find that it is not there just to be used as we like. We may find that we cannot switch on that large motor while this other one is running or the cost for power will have jumped up through increase in maximum demand.

In this connection *The Mining Electrical Engineer* has recently published several interesting articles shewing savings effected by arranging the running of the different items of plant. One of those installations, in Scotland, shews a saving of £500 per year in this way, and another in England shews a saving of £2000 per year. Even in the limited Scottish case the difference meant a saving of twopence per ton of output, and there are not many opportunities of saving twopence per ton about a colliery to-day.

Another paper shewed how a large saving was effected in a private plant at a gold mine by obtaining a better load factor for their more economical generating sets and by improvement of the power factor.

There are many difficulties in the way of attaining the arrangement of working that gives the best load factor. No two cases are alike. Pump motors and pumps may be too large and take too much power, or they may be too small and require to run when other plant is running. Pumps may not always run at the same efficiency and may be required to run longer than their set time. Water lodgment area may be limited and the mine manager is always anxious that he retains ample margin against flooding. Another difficulty is to get the men to understand that there is such a very important reason why the power should not be used at any time, as it is always there and only requires switching on.

The knowledge that the nearest power station will be an outlet for small coal may influence a colliery in deciding to take power from the grid, but through the rationalisation of electric supply that particular power station may be closed down and the colliery power then be drawn from a water power station or from a more remote station, and that just at the time when the great necessity of the district is to burn local coal. We in Ayrshire, said Mr. Garven, are nearly in that position. Kilmarnock power station was closed down. Water power partly supplies the grid and plans have been brought forward for a water power station comparatively near at hand.

It was shewn in the several hydro-electric schemes promoted that their costs were lower but their efficiency as shewn is partly at the expense of the steam stations. Hydro-electric stations are to be kept running at full capacity while the steam stations' load fluctuates with the demand. The increased efficiency is not nearly sufficient to justify great capital expenditure while other efficient plant is shut down and made obsolete.

The aim today is to place industry in the position that nothing can be employed that is not the most efficient ; but we condone the greatest inefficiency of all, idle plant and men while goods are dumped in from abroad. It is impossible to understand how this can continue. Do our investments abroad sustain us so that we do not require to earn our own living? Does the fiscal policy of other countries give them an advantage we have not got? Our connection with the gold standard may be the trouble for we know that the sovereign through generations became less and less valuable until 1920, since when it has considerably increased in value. If our trouble is due to either or all of these things we should be on the border of a new era of prosperity.

Electricity supply has been rationalised and is now a national affair. Coal is to be reorganised in a similar basis but, if the result throws men and plant out of employment, the object will be defeated. Its success can only be through better selling. There is no necessity for attempts to speed up progress by legislative effort. It is sufficiently rapid through the efforts of those whose business it is to promote efficiency and economy in the course of their vocational duties.

The economic position requires the greatest consideration at present. As our currency is not now linked with gold, we may be able to restart our industries on a different basis even if that basis means a lower standard of living for those not connected with industry, or even for those connected with industry. Industry has suffered long enough and, almost at any cost, steps should be taken to make it bloom again even if using what we have got is not the most efficient plant. The effect of employing less efficient plant than the best, could only be a lower standard of living : and we certainly cannot continue along present lines. Inefficiency does not apply to coal mining operations in Scotland ; when we consider that in Lanarkshire 14 inch seams are being cut with 12 inch machines cutting in the coal, and the coal drawn into hutches by a scraper, and at a reasonable cost, surely the limit of efficiency has been reached.

Discussion.

Mr. WALTER UPTON, in response to a request, said that during the summer months the Kilmarnock Electricity Station was completely shut down. They had no steam plant running whatever. On October 1st they partly started up again, running from early morning till tea-time, when the plant was shut down, and during the evening and night they, took their supply from the Grid. That was still the position at the moment. He understood that the Rannock Scheme, in so far as it had plant running, was working to the full. While the Kilmarnock Station was shut down in summer the Glasgow Stations were running very light, and they must have been running very uneconomically.

Mr. ALEX. McPHAIL said he would like to ask Mr. Garven a question with regard to a.c. plant underground. Mr. Garven had mentioned working with high tension so far and lowering it as required, and that each system was a system of itself. That was correct enough, but if there was a fall in one system it would affect the whole system right through, and not merely the system it was on: it would find its way to the other side of the transformer. The Coal Mines Act laid it down that every system should be earthed with an earthing plate at the surface of the mine. If the system were a mile or two in and it was necessary to bring back an earthing cable for two miles, it would be a very expensive matter. In putting in earthplates in mines, unless the conditions were very good, the earth was poor. If the earthing system was in any way faulty and there was a leak on the 3000 volts system it would be felt on the 415 volts system. There was danger if the earth-plates were faulty, and there was no way to escape it except by putting a bore hole down and running the cables down it.

Mr. GARVEN said that in a d.c. system there might be a fault on one side which was spread over a large area, and when a fault occurred on the other side of the system these two faults affected everything on that system: for it was all one system and not divided up as in a.c. If you had a fault that threw an overload on any part of an a.c. system it went right back to the generator: but even a fault in an a.c. system did not act as in d.c. unless it was a dead short, and even then it choked itself much readier than a d.c. did. The fault to earth on any part of an a.c. system did not affect any other part of the system that was supplied by the generator: it was limited to the part that was fed by the secondary of the transformer that supplied it. With regard to earthing he decided that underground earthing was easily established if there was water and pumps in that section, but that earth-plates inbye would be useless if the section were very dry.

Mr. McPHAIL said that in a colliery not long ago the motor shorted on one of its phases, with the result that the voltage between the neutral and the earth was 154 on the 415 volts system. It was a dangerous position but luckily, being wet, the fuses were tripped. In another system where it was dry the same thing happened but in that case the voltage rose to about 280 volts between the neutral and the earth.

Mr. UPTON asked what was the position if, on the low tension side, or 415 volts side, they adopted a mesh connection instead of a star connection, which did away with neutral point earthing. They had no neutral, and consequently it could not get above earth potential. He took it that in that case the only remedy was efficient leakage current protection.

Mr. McPHAIL said that some time ago it was almost compulsory to earth the neutral point in connection with transformers. That was why they ran stars instead of mesh. But it could not rise in mesh.

Mr. GARVEN said he would object to a transformer running in mesh in a colliery. He held that in a colliery the neutral point should be earthed.

Mr. UPTON said they always made a point of definitely and permanently earthing the neutral. On occasion the earth had failed, and the fault even on a consumer's small circuit, on any one phase—brought that phase to earth potential, and so neutral immediately came up. If that was in some consumer's section, on a very low section cable, a man seeking for the source of the trouble and who happened to encounter the neutral point got rather a nasty surprise. The whole thing seemed to hinge on efficient earthing: that meant continuous inspection and tests, for it was really difficult to obtain and keep an efficient earth.

Mr. McPHAIL said one of the worst things in connection with mines was that there were so many jointing boxes and unless at these points a proper earth bonding joint was made there was trouble. If the earths were properly made and tested, and the conductivity across the back was more than at the cable, it was all right, but through time the protection between the armouring and the glands became inefficient. The best way he had found was to cross the armouring right over and make a soldered joint between the two armourings.

Mr. UPTON said he plumbed the joints, and considered that was the far more satisfactory way.

Mr. McPHAIL objected that in a gassy mine blowlamps could not be used.

Mr. REID said that where there were two systems down a pit, 3000 volts and 415 volts, Mr. McPhail had remarked that a fault on the 3000 volts cable would have a bad effect on the 415 volts system, through all the armouring being blended through and taken to the same earth-plate. Assuming the 415 volts installation to be all right, what would be the effect on the whole system; apart from the disturbing of the electrical balance on the 3000 volts distribution.

Mr. McPHAIL said the electrical balance would not be disturbed unless the fault was large. If the earth-plates were faulty and a fault took place from any plates to the armouring, the potential would be raised: it would rise on the 415 volts side also, and might rise to a dangerous voltage. The earth-plates were not able to carry current sufficient to keep the earthing system down to almost earth potential, with the result that the potential rose on the armouring and the cases of motors which were connected to the armouring. That was the danger on the 3000 volts system.

Mr. GARVEN said if there was no fault to earth, any shock that would be got would be from the neutral point to the armouring. When you stood on the ground you were on the neutral point and the fault you got was in the armouring unless there was a leakage on the other side of the system. If there was a leakage the other side and it was not earthed you might get full voltage between the phases. That was the reason for the neutral point being earthed, so that you could only get the voltage between phases and neutral at the most. If the neutral point was not earthed you might get the full between-phases voltages.

Mr. McPHAIL said the system he had spoken of was one completely insulated, with no neutral point earthed. The whole system was revolving round the earth potential. A cable was in phase if it was 3000 volts, it could run over 2000 volts, or 170 volts or so above earth potential, while the other would be below earth potential, whatever cable was touching the armouring. If it was a completely insulated system a phase could touch the armouring and yet not cut out the fuses. That had happened. If the neutral point was earthed there was no chance of that happening, because it would immediately cut itself out and be a short circuit.

Mr. REID.—That brings it all back to the necessity of the earth-plates being 100% efficient.

Mr. GARVEN said that in a colliery the earth-plate was actually connected to the armouring. In the csae of an overhead line it was perhaps different: there would be an earth-plate at one end and an earth-plate at the other, and the earth circuit was depended upon as of 100% conductivity. But in a colliery the armouring was connected to the earth-plate and the neutral point was connected to the same earth-plate, so that when a phase came into connection with the armouring it came into connection with the neutral point. He did not depend on the earth-plate in that case but on the conductivity of the earthing system for the tripping of the switch.

Mr. UPTON said the system Mr. McPhail spoke of was the equivalent of a mesh-connected system.

Mr. MURRAY said that since the earthing was so important to the safety of all, was not the proper place for earthing at the nearest point to the operator? What were the difficulties that presented themselves in preventing them from having a proper earthing system near the operator? As he saw it, that would eliminate a lot of the difficulties and dangers that might arise in having proper continuity in all their bonding and earthing devices more especially as they were progressing in-bye from the surface longer distances than were expected when earth-plates were talked of as being required at the surface.

The President had mentioned the application of electricity to high seams. He, personally, was of opinion that much more could be got out of the big seams by the application of electricity than had hitherto been credited, and that with economy. There were far too many people in the industry to say: "Oh, the old-fashioned methods are good enough." He could see no reason why they should not use the most suitable electrical appliances for the working of the high seams.

Mr. GARVEN said he appreciated Mr. Murray's remarks. He believed Mr. Murray was sound about having the earth-plates near the operator. In the case of a haulage he thought the whole framework and the point the operator stood on should be connected to the earthing system. There could then be no appreciable difference of potential between what he was standing on and the switchgear he was operating, or between the point he was standing on and the casing of the switchgear, so that he was not in much danger of a shock.

But when he stepped off on to earth he was in a different position altogether, unless the haulage gear itself was connected to earth near that point. As he had stated, the value of the earth-plate depended on its proximity. If it was not close at hand you were dependent on the conductivity of the earthing cable. Mr. Murray had asked why the point nearest the operator could not be earthed. In a dry section it was not possible to get a good enough earth. In a wet section the whole framework of the haulage was automatically earthed.

Mr. McPHAIL said the Coal Mines Act laid it down that where the neutral point was earthed there was to be only one earth-plate, and that at the surface of the mine. If you were to put another earth-plate beside the operator you would create a dangerous position because of the currents set up between the armouring and the earths. It would be all right in a completely insulated system. If you had a good earthing system there would be a good earth at the earth-plate and there would be less for the cable to carry. They would find that earth-plates were just like lamps in parallel. The more they put on, the less would the resistance be. They might have to put in as many as twenty before they brought the resistances down sufficiently to comply with the Mines Act, which was to pass two amperes through at 4 volts.

Mr. MURRAY said the Mines Act was passed a number of years ago, and electricity had advanced very rapidly. Was it not possible that the Mines Act now stood in need of revision?

Mr. McPHAIL said it was an electrical law, which they could not get past by any legislation they might make, that an earth-plate at each end of an alternating current, where the neutral point was earthed, was a very dangerous thing. The Mines Act was right in saying that only one earth-plate could be used, because they would find they were setting up local currents which might be almost as large as what the cable was carrying. The best plan was to have the earth-plates at the surface of the mine in good condition and then to look well after the joints and cables. They would be all right then.

LOTHIANS BRANCH.

The Earthed Neutral.

W. WEBSTER.

(*Paper read* 31*st October*, 1931).

It is the purpose of this paper to draw attention to some practical points in connection with three-phase systems and the earthing of the neutrals on colliery installations. Many electrical engineers have advocated that to earth the neutral points of three-phase systems direct, is good practice, and that may be so under certain circumstances. Simply to earth the neutral direct, without giving thought to the extent of the system, the general arrangement and the types of apparatus, as well as to the nature of work done by apparatus, is liable to cause trouble and may be a source of danger. It is true, of course, that, given a certain main voltage of say 440 v., the pressure to earth on a free neutral system with resulting surface leakage would be nearly twice as much as on an earthed direct neutral system of the same mains voltage; and pressure, amongst other things, has a good deal to do with severity of shock.

In the report on Electrical Accidents for the year 1925, it was stated that there were still some engineers who would argue that there was less danger of a fatal shock from a free neutral system; the report also stated that in the preceding three years out of 28 fatal accidents on three-phase systems the neutral point was insulated in 19 cases. That statement in itself was rather misleading, as it did not take into consideration the respective totals of free neutral systems and earthed neutral systems. On the other hand, it was found that from 1925 to 1929 inclusive, out of 36 fatal accidents by electrical shock, 19 were on earthed neutral systems as against only eight on free neutral systems, seven on high tension systems and one not stated.

Those figures were, of course, just as misleading as the previous ones, and for the same reason, but they gave strong cause for thought on the subject. Did the number of accidents on earthed neutral systems increase by reason of there being a majority of earthed neutral systems, and had electrical engineers changed over the old systems and installed new ones with direct earth neutral because of a stated opinion that direct earthed systems were safest? Figures on this would certainly be interesting.

Under certain circumstances, earthed neutral systems may be safest, but there are certain cases in which it would be unwise to earth the neutral direct without giving due regard to all the circumstances. Consider the case of a large medium pressure system where supply is from a common source, the generators or transformers in parallel, supplying a large system of shaft and roadway cables to motors of all types, e.g., squirrel cage for coalcutters and pumps and slipring for haulages, etc. Faults on such a system are quite numerous, and more or less affect the whole system. In some installations circuit breakers, oil or air break, may be installed at the surface only, and in other cases they may also be installed at pit bottom distributing centres. The inbye distributing centres may have only air-break switches and fuses.

Take as a specific example a 300 amp., d.w.a., shaft feeder cable 200 yards to the pit bottom, protected by circuit breakers on the surface; from the pit bottom a main road cable of 200 amp., s.w.a., 1000 yards, protected by circuit breakers at the pit bottom, a subcircuit inbye of 1000 yards of 0.04 s.w.a. cable protected by switches and fuses, and 100 yards of C.T.S. trailing cable protected by switch and fuses. Other sub-circuits will, of course, be fed from this inbye switch and fuse board. This is quite an ordinary circumstance to be found in many colliery installations.

This detailed circuit may be feeding a coalcutter or conveyor, or both, and there are two faults which may occur; a fault between phases or a fault to earth on any one phase. It is faults of these kinds with which protective gear will have to deal. The inbye circuit way and gate-end will require to be fused for 100 amps. for a 440 v., 30 h.p., squirrel cage coalcutter motor and probably for a higher current if the motor is started by switching direct on to the mains instead of by a star-delta switch, since the fusing point of a fuse is twice to three times its working load, depending on the design of the fuse holder, etc.

The pit bottom and surface circuit breakers will be set for much higher values than 100 amps., and may have values of 250 and 400 amps. respectively. On a short between phases at or near the coalcutter the total resistance to current would be approximately two ohms, and at 440 volts the current value would be approximately 220 amps. That current would probably cause fuses in gate-end switch or sub-circuit, or in both, to blow. It is to be noted, of course, that these values would be the same on either free neutral or earthed neutral.

The other kind of fault—one phase to earth on a direct earthed neutral—would mean a value of approximately 80 amps. and that current would not blow the fuses instantaneously and so the fault might be maintained long enough to cause considerable damage to apparatus or danger to persons.

The potential rise between the earth plate on the surface and the fault might quite well be 160 to 200 volts, or even higher, as it is quite common to find colliery cables working overloaded, and this pressure would be felt on machines and apparatus in the vicinity Should the fuse eventually blow, the machines may be left working on two phases which may result in the windings being overheated. On a free neutral system the value of the fault current of this nature would be negligible; and on an earthed neutral system with limiting resistance, the value of the fault current would depend on the amount of limiting resistance. Assuming 20 ohms, the value would be 10 amps. approximately. There would thus be no appreciable rise of potential and practically no danger of the fuse blowing and leaving motors working on two phases.

In discussing the advantages from the point of view of this paper, it can be stated that the advantages of earthed direct neutral are, given low resistance of earth system and circuit breakers throughout set at correct values, the particular faulty circuit will be selected and protected automatically on both kinds of faults. The advantage of the free neutral would be, protection against short circuit, and practically no fault current on a fault to earth of one phase.

The advantage on an earthed neutral through resistance would be protection on shorts, and on one phase to earth fault, the current value would be much less dangerous. The faults in the instances given, the plant being far away from the source of supply, would be limited to comparatively small values due to resistance of cable cores and armour; but consider the very high values of fault current if they occur nearer to pit bottom. The value could quite easily reach 1000 amps. or more, depending on the power capacity of the source of supply.

All the apparatus from the fault to the source of supply would be subjected to dangerous shocks; this, of course, would apply equally to all of these systems if faults were all short circuits, but on the earthed direct neutral, a fault in a similar position would also mean large values of fault current but in the other two cases would not be felt at all.

So far only medium pressure systems have been mentioned, but one has to consider the respective values of k.v.a., on H.T. systems.

Switches are often repeatedly closed on faults, the operator not realising that a fault is there, and it is not difficult to visualise quite well what may happen where this is done. Heavy surges with resultant potential fronts may cause considerable damage to other parts of the system. The earthed direct neutral encourages those heavy surges, but on free neutral and neutral with limiting resistance they are controlled to a certain extent, that is to say on the one phase to earth fault which is by far the most numerous on colliery installations.

So far, mention has only been made of protection in the ordinary or most common way, that is by circuit breakers and fuses, this being the simplest, although probably not the most effective way.

It is possible to deal with practically all kinds of faults in such a way that the values of current would be limited to less dangerous values, i.e., by using reactances, leakage trips, etc. The inclusion of these devices will call, of course, for skilled attention and, except for reactances, they cannot be applied in the case of air-break switches and fuses. To apply a leakage trip device to the circuit already detailed, would mean that the nearest point where it could be applied would be the circuit breaker at the pit bottom. This would mean the complete isolation of subcircuits from this point until the fault had been located and isolated.

The loss of continuity of supply to such a section would be serious, and if auxiliary pumps and fans are stopped, there may be danger to persons, and the stoppage of haulage would mean large output losses. Continuity of supply is looked upon by most colliery officials as the most important point in electrical installations and they hold the electrician responsible for this; so it would appear that any installation which is laid out strictly on lines of safety only, would not be likely to meet with the officials' approval. Some thought therefore, must be given to these points before deciding to earth a neutral point direct. Where installations have double wire armoured cables, circuit breakers throughout, and metallic protected trailing cables, earthing the neutral direct might be considered as the simplest means of protection, provided the circuit breakers are maintained at the proper current release values. When single wire armoured cables, ordinary unarmoured CTS trailing cables and air-break switches and fuses are used, the free neutral is to be preferred. If leakage trip devices are to be considered it should be in conjunction with the neutral earthed through a limiting resistance and that of such a value as would allow sensitive trips to operate at small values of fault current; that would be the most satisfactory arrangement.

The economies of the question cannot be ignored; d.w.a. cables and metallic sheathed trailing cables protected by circuit breakers, and leakage trips are much more costly than s.w.a. cables and ordinary CTS trailing cables with switch and fuse units. The simplicity of attention and repair to the last mentioned types of apparatus must also be considered.

In the daily working of colliery plant, cables and switchgear have to be shifted and altered at quite short notice, and circuit breakers of heavy calibre may have to be used in circuits of a lower range than their particular setting; those conditions would mean keeping in hand, and fitting when necessary, other trip coils if proper protection is to be ensured. Fuses, of course, would only require the alteration of the sizes of fuse wires.

Colliery officials in these days are faced with high costs in getting and low prices in selling, and as long as these types of apparatus are allowed in mines, small blame is attached to them if they take advantage of the simplest and the cheapest material consistent with maintenance of service.

Electricians may be confined in their supplies to such types of apparatus and they should, therefore, give consideration to all the different circumstances before deciding what is to be done in each particular case. There is not much to be gained by earthing neutral points direct if, when an emergency arises and when a fault to earth is difficult to locate and the supply must be maintained, the neutral point is deliberately disconnected to allow things to carry on until the fault can be located at some more convenient time; that practice would only put such a system on the same basis as the others.

Before concluding, a word might be said on the methods of providing an effective earthing centre. In many papers read before the Association, great stress has been laid on surface earthplates. Interpretation of "Earthed," according to Special Rules, means so connected to the general mass of earth in such a manner as will ensure at all times an immediate discharge of electrical energy without danger.

Some engineers take this definition of requirements as meaning the very lowest resistance that can be attained, and much time and money has been expended on elaborate earthplates at surface and means of testing same. Efforts in that direction are quite futile and do but add to the dangers instead of lessening them, unless the same due regard is paid to earthing and bonding below ground. If it is important to have large earth-plates making good contact with ground at surface, then it is much more important to have good earth plates below ground where the accidents are more likely to happen. There are only two cases can arise in which earthplates at the surface will require to carry current to any appreciable extent: one is a fault to earth of a trailing cable of the ordinary C.T.S. type, the other, a disconnection of the earthing system wth a fault beyond the break, and in both cases it would be better without earth plates if they were only to be placed at the surface and without sensitive leakage trips on all circuits.

Where installations are transmitting at high tension to inbye transformers, the earthplates at the surface would not be called on to deal with faults on the low tension distribution and the H.T. cable armours, if used as part of the earth system for L.T. circuits, would be of too high resistance to deal with L.T. faults without undue rise in potential.

Earth plates at the surface have little if any effect in reducing the potential values which might arise through fault currents carried by cable armours unless good parallel paths can be obtained by connection to earth or other means below ground.

The whole subject should be regarded rather from the point of view of controlling fault currents at low values than from that of preparing for or encouraging the highest values.

KENT SUB-BRANCH.

Social Evening.

A very enjoyable time was spent by members and friends of the Kent Sub-Branch when a whist-drive was held at Cave's Café, Dover, on Saturday, 21st November, 1931. Two such functions were held with success during the last session; again, on this occasion it was unanimously agreed that the evening had been one of real enjoyment and hopes were expressed that a similar event might be arranged before the end of the session.

Many good prizes had been kindly given by members and friends of the branch, and these were graciously presented to the lucky ones by Mrs. F. Hall. Among those present were Mr. Cooper (President of the Branch) and Mrs. Cooper, Mr. W. T. Cox (Vice-President), Mr. and Mrs. W. R. Howard, Capt. and Mrs. C. H. Smith, and Mr. S. Ford, to all of whom in particular the thanks of the Branch are due for the very material help given towards the success of the evening.

British Standards Institution.

Every engineer is familiar with the work of the British Engineering Standards' Association. He will now need to become as accustomed to the new name under which that work will be carried on in future. Under the ægis of the British Engineering Standards Association numerous Specifications and Standards not only for use in the engineering field, but also for a growing range of materials in the building, chemical and textile industries, have been established. The need for regularising the extension of the original functions of the Association has been under consideration from time to time, and it became imperative when the chemical industry, as a result of a fully representative Conference convened by the Association of British Chemical Manufacturers, invited the Association to widen its scope to include Chemical Standardisation generally.

The Building Industry also desired a substantial extension of the work of standardisation within that industry, and urged that the title of the Association should be brought into conformity with the wideness of its scope.

At the Imperial Conference held in October 1930, the desire was expressed that there should be a single centralised National Standardisation Body in each of the countries forming the British Empire.

It was therefore decided to re-organise the work of the Association into four main Divisions of equal standing, responsible for the preparation of British Standard Specifications in the Engineering, Chemical, Building and Textile Industries, each of the Divisions being under the control of a representative Divisional Council.

The Council, therefore, after securing the approval of the members of the Association, applied for, and have been granted a Supplemental Royal Charter, authorising these changes.

In future the name of the Association will be the "British Standards Institution," and its activities will be under the control of a General Council which will have under it the four Divisional Councils. The work of the Engineering Division, will as before, be delegated to Industry Committees dealing with the main branches of the Engineering Industry, such as civil engineering, mechanical engineering, electrical engineering, etc. and, of course, it will for a time, represent the larger portion of the activities of the Institution.

The great development in the standardising movement which has taken place since the first Committee was set up by the Institution of Civil Engineers in 1901 as the Engineering Standards Committee, is a clear indication that industry as a whole has increasingly recognised the economic value of the work. There are now 600 Committees and over 400 published British Standard Specifications. The term "British Standard" has been registered by the Institution as its standardisation mark. The Institution is not a profit making concern and apart from the grants received from the Government and the amount derived from the sale of its publications, it has to look to the associated industries for the funds necessary to carry on the work. Every British firm in these industries is eligible to become a member of the Institution at a nominal fee.

Standard Air Receivers.

British Standards Institution has issued three new specifications as follows: No. 428, Forge Welded Steel Air Receivers; No. 429, Riveted Steel Air Receivers; No. 430, Solid Drawn Steel Air Receivers. Each specification provides for the quality of material used, the method of construction, formulæ for the determination of plate and end thicknesses and requirements for workmanship and testing. The specification for forge welded air receivers lays down details as to the methods of making forge welded joints for attaching the ends and also for inlet and outlet connections. The riveted air receiver specification lays down requirements for efficiencies of joints, thickness of butt straps, methods of riveting and the staying of end plates. Adequate provision is also made for suitable access, for examination of the interior surface, drainage, and the necessary strengthening of the plates where holes have been cut.

Manufacturers' Specialities.

Ferflex Braid Repairs on Trailing Cables.

The colliery engineer is frequently put to considerable delay and inconvenience in the matter of repairs to copper screens on trailers when these take the form of a braided "ferflex" envelope surrounding the collective cores—whether the metallic screen be composed of copper or of copper interwoven with cord.

This braided screen may have been damaged as the result of direct mechanical injury to the cable, or it may have had to be cut to give access to the insulated conductors.

The usual method of repair hitherto adopted, namely the threading over the cable length of a repair piece in the form of a sleeve, has three distinct drawbacks, namely:—

(1) The repair piece must of necessity be of larger diameter than the actual "ferflex" braiding of the cable.

(2) The threading over process, in the conditions obtaining in a colliery yard or workshop, is always a matter of difficulty and it is usually attended by contamination of the repair piece with dirt or grease.

(3) The pommel has to be detached from the cable end.

Glover's Repair Cage (Patent Application No. 30201/31) has been devised to overcome these difficulties and it constitutes a much simpler means of repair. The cage consists of two flat strip metal end rings, split obliquely, and connected together by tinned copper strands in the form of a hollow spiral. The strands are soldered to the metal end rings and they are so arranged that a continuous opening is formed throughout the length of the cage when the rings are bent open. The diameter of the end rings is such that, after being opened out (for clipping on) and closed into position, they completely envelop the sheathed cores and bridge the severed "ferflex" braid.

The angle, or lay, of the copper strands of the cage, is approximately the same as that of the wires comprising the braided screen of the cable. The sectional area of the wire comprising the strand is such that the electrical conductivity and the tensile strength of the wire cage, after completion of the repair, is substantially the same, and not less than that of the original ferflex screen of the cable.

With regard to its application; after any necessary repair to the cable proper has been completed, the copper members of the original braid forming the "ferflex" screen, are untwisted and bent back in either direction away from the repair as shewn in Fig. 1.

Fig. 1.

The cage, Fig. 2, is then opened out in a spiral direction by bending open the end rings, Fig. 3, so that they will pass over the inner layer of the tough rubber sheath.

When the cage is in the correct position, it is fitted by re-closing the end rings round the inside portion of the sheath referred to, the ends of the cage being twisted in opposite directions and, at the same time, extended longitudinally to cause the strands of the cage to wrap closely over the rubber throughout their length. Binding wires are then applied to close the end rings tightly on to the cable. These binding wires should be applied over the stranded wires where they are already soldered on to the rings, to prevent them from coming unsweated. The strands of the original "ferflex" screen on the cable are then bent back again on to the outer halves of the rings, bound down with fine tinned binding wire, cut off to suitable length and soldered into position, as shewn diagrammatically in Fig. 4.

Fig. 2.

Fig. 3.

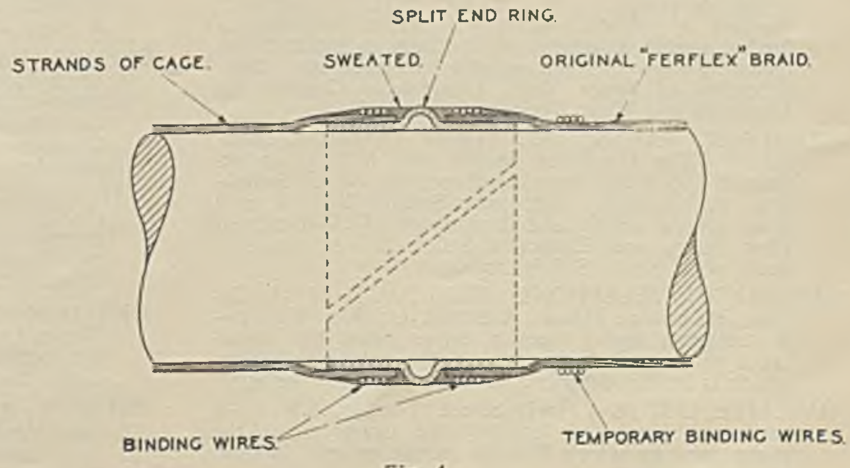


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 5 shews the joint sweated in position.

The final operation in making the repair is to wind strips of rubber compound over that part of the cable which has been operated on until the thickness of the layers is equal to that of the original rubber layers and then to vulcanise in position.

Fig. 6, from which it will be seen that the original diameter of the cable is only very slightly increased, shews the joint completed.

NEW CATALOGUES.

BRITISH INSULATED CABLES Ltd., Prescot, Lancs.—"B. I. Philosophy" is the title of a new style of trade publication which will attract many appreciative readers. The first part appeared last month and the December issue is also to hand. Edited by William Feather, the contents are very true to title presenting solid wisdom in the brief short witty phrase which is so entertaining.

A number of colour printed leaflets and cards have been prepared for the B.I. trade counter publicity.

A handsome and profusely illustrated broad sheet shews the part played by B.I. Cables in British Industry generally. Particular emphasis is given to a remarkable series of Overseas Empire Contracts.

Catalogue No. H 126 is a new edition of the complete catalogue and price-list of B.I. "Helsby" Rubber Cables and Wires.

GENERAL ELECTRIC Co. Ltd., Magnet House, Kingsway, London, W.C. 2.—A new edition of the X. and Y. Section of the G.E.C. catalogue deals with the Company's range of Ironclad Switchgear.

The catalogue section W (1) is devoted to particulars and prices of the G.E.C. Pirelli-General Wires and Cables.

Leaflet O.F. 5086 is a reprint of the profusely illustrated article describing the Mass Production of Incandescent Electric Lamps by G. Chelioti which appeared in the "G.E.C. Journals" of February and May last.

The November issue of the "G.E.C. Journal" contains a valuable series of articles including a further expert descrption of Precision in Incandescent Lamp Making. Other notable contents are, Electrification of Paper Mills, Load Ratio Control for Transformers, Heat Treatment of Steel, etc.

FERGUSON, PAILIN, Ltd., Higher Openshaw, Manchester.—The Catalogue Section No. 6 II is an attractive and useful technical description of the Switchgear at Kirkstall. Catalogue Section No. 74 S 2 gives general details and illustrations of Oil-immersed Plug Fuses, and Catalogue Setion 207 AI similarly deals with Kiosk Sub-Stations.

AUTOMATIC TELEPHONE MANUFACTURING Co. Ltd., Melbourne House, Aldwych, London, W.C. 2.—A humorous leaflet forcibly drives home the advantages of the "Strowgerphone," the automatic system which is boldly described as "the phone of the age."

BAKELITE Ltd., 68 Victoria Street, London, S.W. 1.—A series of illustrated leaflets give examples of the many uses to which Bakelite moulding can be successfully applied.

BRITISH THOMSON-HOUSTON Co. Ltd., Rugby.—Many new editions of the standard B.T.H. catalogues have been published recently. These cover Liquid Controllers for Slip-ring Motors, Traction type Motors, A.C. Motor Control Panels, Unbreakable Grid Resistances, Single-phase Starters, Pipe Ventilated Induction Motors, Air-break Flame-proof Controllers, etc.

The September/October issue of the journal "B.T.H. Activities," publishes an appreciation of Michael Faraday. Other interesting articles deal with the equipment of two P. and O. Liners; Machines Controlled by Light; New type of Frequency Changer, Electric Shunting Locomotive, and several other notes of recent B.T.H. developments.

ELECTRICAL APPARATUS Co. Ltd., South Lambeth Road, London, S.W. 8.—A circular letter indicates that this Company not only supplies motor control gear for all classes of services, but is prepared to supervise the general maintenance of such gear, mentioning particularly their expert experience in regard to collieries, steel works and general industrial applications. A leaflet illustrates the E.A.C. On-load Tap Changer for attachment to Transformers; the particular example shewn is a 1500 k.v.a. unit.

INDIA RUBBER GUTTA PERCHA & TELEGRAPH WORKS Co. Ltd., Aldwych, London, W.C. 2.—The "Silvertown Company" indicate in their list No. L.B. 2 the remarkably extensive range of industries for which they manufacture electrical and other trade specialities; such specialities for example include rubber sheet, hose pipes, belting, gloves, tank and pump linings, ebonite specialities, vulcanite fibre, etc.

ENGLISH ELECTRIC Co. Ltd., Stafford.—Mining Electrical Engineers will be particularly interested in reading the detailed description of a new type of Flame-proof Switchgear known as the class "OLA" for Mining Service. Details of the construction of the English Electric Steel Tank Rectifier are exhibited on a colour printed leaflet.

Four other new catalogues of the English Electric Company relate respectively to Trolley Buses, Bus Bodies, "Closvent" Motors, and Textile Motors; in each case the subject is dealt with by detailed story and several illustrations.

HEYES & Co. Ltd., Wigan.—The November issue of the "Wigan Review," topically refers to some of the Company's installations connected with War Memorials. Mention is made of the comparatively modest War Memorial of Wigan and, at the other extreme, the imposing Masonic Peace Memorial, London, in the electrical equipment of which "Wigan" fittings serve their good purposes.

GENT & Co. Ltd., Faraday Works, Leicester.—The new edition of the catalogue Book 7, Section 8a lists the well-known "Tangent" specialities in the way of Bells, Signals, Relays, Telephones, etc. for use in Fiery Mines.

OXFORD UNIVERSITY PRESS (Humphrey Milford) Amen House, London, E.C. 4.—Those looking for the latest authoritative books concerning Science and the Classics should enquire for the Select Compendious Catalogue of which the new edition has just been published by this house.

J. H. HOLMES & Co. Ltd., Hebburn-on-Tyne.—Pamphlet No. 827 gives illustrations, technical particulars and general details of construction together with rating and dimensions of the "Castle" Class "C" Variable Speed A.C. Commutator type Motors.

CROYDON CABLE WORKS, Ltd., Greenwich Cable Works Ltd., Croydon.—A number of new publications set forth the particular advantages of the "Pernax" Cable Sheathing.

EVERETT, EDGCUMBE & Co. Ltd., 117 Victoria Street, Westminster, London, S.W. 1.—The sheet No. 450/3007 is a useful technical description of the Company's "Luxometer" Portable Photometer.