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CANADIAN MINING & MECHANICAL REVIEW

CONDUCTED BY . . . . B. T. A. BELL.

THE OFFICIAL ORGAN

—OF—

HE GOLD MINER'S ASSOCIATION OF NOVA SCOTIA,

THE UNITED MINING SOCIETY OF NOVA SCOTIA,

THE ASBESTOS CLUB, QUEBEC,

THE GENERL MINING SSOCIATION OF QUEBEC.

OFFICES:

Victoria Chambers, 140 Wellington Street,

OTTAWA.

Vol. XIII. JULY, 1894. No. 7

The School of Mining at Kingston.

This School begins its second session next October, with increased staff and equipment It has already done good service in giving to men interested in our mineral wealth opportunities for acquiring precise and practical knowledge of this subject. This it has done not only by its regular classes conducted throughout the session, but by special short courses at the School and at Marmora. This latter feature of the work of the Mining School commends itself to us as of great importance and value. The men who attended the class at Marmora speak in the highest terms of the character of the work conducted by Mr. Hamilton Merritt. We note that in the calendar for 1894-95, just published, provision is made for extension of these classes to other mining centres. No doubt practical men will be ready to take advantage of this opportunity. We note also that "the School is provided with chemical laboratories, an assay, a blowpipe, and a petrographical laboratory. There will be built during the summer a mining laboratory and experimental reduction works, which will be furnished with a stamp mill, concentrators, separators, amalgamators and other machines with which ores are treated at the mines. The machines will be of sufficient size to operate upon large quantities of ore, and those opening up mines are invited to send in large samples of ore (a ton is a good sample), to be put through a milling process in order to test the suitability of the process for their ores. In this way, costly mistakes may be avoided. The School is prepared to undertake a limited number of such tests and will charge only for running expenses."

These laboratories must give every opportunity for practical study in assaying and milling. Certificates are given by the School for a special course in Analytical Chemistry and Assaying. The course as laid down in the calendar is very complete and practical.

In our opinion the proper functions of a Mining School in Canada are (1) to provide education more particularly in those subjects which bear upon the discovery, winning and dressing of ores, rather than upon smelting and metal working, (2) to give opportunity for working out problems in Canadian mining, ore dressing, &c., and (3) to lead the way in improving methods at present in vogue, and in suggesting new methods, to keep a step in advance of the requirements of the country; to be the pioneer in mining ideas.

The School at Kingston bids fair to discharge most, if not all, of these functions.

Mr. Hugh Fletcher, B.A.

On the eve of the visit of Canadian mining men to the Sydney coal field, the subject of our portrait this month is, appropriately, Mr. Hugh Fletcher, B.A., whose geological investigations in this field are so widely known and have been of so much value to the development of the coal mining industry of Cape Breton.

The official reports of the Geological Survey since 1874, speak for themselves of the zeal and industry of Mr. Fletcher in the work of unravelling the structure of Cape Breton, and recording its resources, and mapping the surface configuration as well as its geological features. Of Mr. Fletcher it may be said no other living man is possessed of his familiarity with crag and fell, with wave washed cliff and wood encumbered dell throughout the Island of Cape Breton. From Cape North to Cape Porcupine, from Cape Mabou to Scaterie, he knows it all.

Mr. Fletcher was born in London, England, of Scotch descent, in 1848, and emigrated to Canada in 1857, when his father leased the Bruce copper mines. He is a graduate of Toronto, with honors in languages and science. His vacations were spent with his father at the various operations with which he was engaged, and he thereby acquired a valuable insight into copper, silver and gold mining and the associate rock formations. A term spent in an engineer's office fitted him for the preparation of the neat and careful mapping for which his geological work has since been distinguished. In 1872 he joined the Geological Survey of Canada, under Mr. Robb, in Cape Breton. On Mr. Robb's resignation he succeeded him in the charge of that important work, and ever since has devoted himself to the survey of Eastern Nova Scotia. It was in 1875 that he made the important discovery of copper ores in the Coxheath felsites that has led to the operation of the Eastern Development Company. In the same year he found fossils of Lower Cambrian age at Long Island on the Bras d'Or and at Mira, the first to be noted in Nova Scotia. His systematic surveys naturally took him over the portions of country that had been given previous attention by Dr. Dawson and Dr. Honeyman, and with a wider range for generalization, his conclusions were not always quite in accord with what they had written. That the close observations of the Survey would lead to conclusions in some cases different from theirs was to be expected, the only surprise is that Sir W. Dawson with his comparatively limited opportunities should have been so generally correct over so wide a field.* Differences seemed to turn on names rather than facts in the correlation of some horizons, as in the age of the rocks below the primordial, and as to whether the slates and quartzites of Loch Lomond are Horton or Devonian.† That the latter are unconformable below the Carboniferous Limestone is certain.

On crossing the Strait of Canseau the differences of opinion became more marked, Fletcher declining to recognize Medina at Arisaig or to regard the rocks at Riversdale otherwise than as Devonian. This remark is merely by the way, *our present purpose being to confine ourselves* to Cape Breton only.

Having separated the Laurentian rocks of Cape Breton into an upper crystalline and gneissic series, and into a lower syenitic and feldspathic series, he traced, in 1876, the Cambrian rocks to East Bay, and found in them Lingula nodules.

Among the coal measures the Survey was anticipated by Brown, Lesley and Lyman. The former especially, did a great deal of valuable work and recognized the conformability of the millstone grit with the coal measures in Nova Scotia, a point of much importance. Mr. Fletcher, in going over the work that had been done in the carboniferous, was able to correlate the several portions of the coal field and show the relation of the coal beds throughout it. The voluminous reports and the maps which accompany them, speak for themselves; they are mines of facts for subsequent writers to work in and although they have not been the finger posts to wealth that some have hoped for, they should *be as "danger boards" to those otherwise* tempted to seek their fortunes in unkindly ground.

Of Mr. Fletcher's subsequent work on the main land we make no reference on this occasion, nor of his services as the representative of the Geological corps before the special committee of the House of Commons, their value is so well known.

EN PASSANT.

In view of the Cape Breton meeting of Canadian mining societies, at which the REVIEW will be represented, the present number is issued earlier than usual. Our next impression will contain a very full report of the proceedings of this meeting and many portraits of the principal operators, engravings of the collieries and works to be visited, a new map of the Sydney coal field, drawn specially for the REVIEW, and other features which will insure our readers an unusually interesting and attractive number. Look out for it!

Mr. A. L. Russell, Dominion and Provincial Land Surveyor, Port Arthur, has, with character-

*Acadia Geology, 1878, pp. 86-90.

†Acadian Geology, 1891, p. 20, line 3.

istic enterprise, just publisl. 'l a very useful and handy map of the Rainy Lake and Seine River Gold District, Ont., which is attracting so much attention as a new gold field among capitalists. The map is printed on the scale of 2 miles to the inch, and is published at $1.

Mining prospects in East Kootenay, B.C., are, as a matter of course, dull on account of the low price in silver, but discoveries are being made that indicate the district will rival West Kootenay in mineral wealth. Besides the great North Star mine, near the St. Mary's river, very promising leads of argentiferous galena have been discovered on the Moyea, near Cranbrook, and from the assays and the immense bodies of ore in sight there is no question that these mines will be exceedingly valuable when silver is reinstated in currency. The reports of the gold quartz leads at Wild Horse, near Fort Steele, are very encouraging and are attracting considerable attention.

The immensity of the operations carried on at the Witwatersand mines can be gauged from the fact that 4,046 whites and 29,500 natives are regularly employed on the mines. The average wage paid to the natives amounts to 58s. 10½d. per month on the Rand, but at Barberton and Lydenbury the average pay is much lower, only amounting to 33s. 3d. and 32s. 6d. per month respectively. A return of the stores consumed on the Witwatersrand mines during the past year places the total value at £1,428,477. By far the largest item was coal $314,127, machinery coming next with $298,255, and timber (including deals) being responsible for £109,400, chemicals $70,027, mealies (for feeding natives), £73,010.

A huge 8,000 ton forging press is now in use at the River Don works of Messrs. Vickers, Sons & Company, Sheffield, England. The shareholders, at the close of a recent meeting, were invited to inspect the working of this machine, and, it is stated, an ingot weighing 66 tons was taken from the furnace and conveyed to the press, under which it was swiftly and silently squeezed to the required proportions. When finished it will be 18in. thick and is ultimately, we understand, to form one of the plates of the Russian warship Three Saints.

The Schlesische Nickelwerke is now preparing to erect works for the extraction of nickel from the ores. It is expected that the construction and arrangement of the plant will take about 18 months. This company owns several mines near Frankenstein, and in 1891 began working the Benno and Martha shafts, from which 1,160 metric tons of nickel ore had been taken up to the end of 1893, carrying from 1·5 per cent. to 4 per cent. of nickel. The Benno shaft is now 170·5 feet deep, and so far the nickel contents of the ore have increased gradually with depth. The work of exploration is to be continued on an extended scale.

Diamonds are still down despite all the efforts of that powerful combination, the De Beers Consolidated Company, to manipulate the market to their own advantage, and the explanation of the depression is said to be a decreased demand for the precious stones in America. The Americans are credited with absorbing, in normal times, one-third of the total output of diamonds, but the effect of commercial depression has been felt in the States as elsewhere, and has restricted the demand for such luxuries. It was expected that the unfavorable state of the market for diamonds would seriously affect the De Beers returns, but Mr. Cecil Rhodes, at the last annual meeting of the company, at Capetown, on July 17, was able to tell shareholders that the usual dividend would be paid. The company had, he said, reduced their obligations by £700,000, and had increased the value of the reserves of blue earth on the floors to £4,000,000, besides maintaining a reserve of £700,000 in Consols. The company spend £100,000 per month in South Africa, and are now using local coal.

A new form of prospector's stamp battery specially designed for use in rough country is described in the last issue of the Australian *Mining Standard*. The patentees are Melbourne mining engineers. The improved stamp mill weighs complete 230 lbs., the heaviest piece being 40 lbs.; the whole when in working order being only 3 feet 10 inches high by 16 inches wide and 12 inches deep. It can be readily taken to pieces and carried by men or packhorse. The machine is of the best mechanical design, very simple, and specially constructed to stand rough usage, the principal parts being of wrought iron, such as the bedplate, standard, mortar box, etc., the cams and tappets of steel. The stamp crushes with ease the very hardest quartz gangue obtainable in Victoria, and reduces it to go through a screen of 144 to 196 holes to the square inch, the matter being discharged continuously as it is crushed through the screen, and is discharged or delivered all round the circumference of the stamper box. The small, or No 1 mill, as now made, is a *one man machine*, but the principle can be applied to the largest type of stamp battery, and it is claimed by the inventors to solve the difficulty of crushing ore dry by stampers, whilst getting a rapid and continuous delivery of the material as it is crushed. It is acknowledged by all practical men that no machine has yet been introduced to transplant the stamp battery, which has been in existence since the 12th century in Germany, and the machine under notice aims at providing prospectors with a long felt want, viz., a crusher capable of reducing large samples of reef outcrops to a fine powder, either crushed dry, with water, as may be desired. A trial took place recently, and some of the hardest quartz obtainable in Ballarat was put through the machine, which needs only one man to work it, and which delivered the stuff in the form of a fine powder continuously. The powder can then be treated either by washing in a dish in the ordinary way or by Clark's patent dry process gold concentrating machine. The stamper should prove handy for prospectors desiring to test large samples of reef outcrops.

In the course of an address delivered at Nottingham College, Feb. 24th, Mr. C. M. Percy made the following observations on fan construction: Simplicity should never be lost sight of, and strength should always constitute a first consideration. These two virtues ensure what is so desirable in colliery appliances—continuity of work, and non-liability to get out of order. I have always had an objection, which has increased as time went on, to "mammoth" slow-running fans. They are cumbersome in themselves. They absorb power by the movement of themselves. They are costly to make. They occupy much space, and necessitate extensive and expensive foundations and houses. I believe that the entry of the air to the fan should be easy, which means large inlets having a clear course, not baffled by projecting arms or cones, or even blades "veed" towards the centre. The inlet should be on each side of the fan, with a central diaphragm to prevent the two currents conflicting. The passage of the air through the fan should be easy, which means that there should be sufficient and not excessive fan capacity. In open running fans the blades should be so formed that the air may pass through as nearly in a straight line as possible, and leave the circumference with as little circumferential velocity as may be, because all velocity of discharge in open running fans represents a loss of energy. This means that in open running fans the blades should have considerable backward curvature, and the number of blades should not be too great, producing by their surface excessive friction and drag upon the air. I have come to the conclusion that the inlets and the outlets, and the circumference of the inlets, multiplied by the width, and the total blade surface, should represent equal quantities, and that the circumference of the fan at any point, measured by its width at that point, should be an equal quantity. In a closed running fan the circumstances are somewhat different, because the energy of discharging air can be utilized after leaving the fan, in diminishing the pressure outside the fan, and thus expediting the delivery from the fan. The curvature backward of the blades need not, in consequence, be so great as for an open running fan. The air should be free to leave the fan at any point of the circumference, and the spiral casing all around should be continued into the chimney. But the quantity in proportion of the inlets to the fan, the passage into the body of the fan, the passage through the fan, and the discharge from the fan, should be equal, as in the open running. I believe that the sides of the revolving parts should be enclosed, preventing leakage, and only allowing discharge at the circumference. The journals and bearings of the fan should be so perfectly constructed that

Mr. Hugh Fletcher, B.A.

Geological Survey of Canada.

they fit exactly, and can revolve without heating, at practically any speed. The engine which drives the fan should be designed on lines by which the highest economy in the use of steam can be obtained. The engine should work with a high pressure of steam, because it is only with high pressure steam that we can get the maximum economy. The engine should be compound, to admit of the highest range of expansion, and discharge the exhaust into the condenser at the lowest possible pressure. Excessive speed in the engine is undesirable, and to enable a moderate speed of the engine and a high speed of the fan, the power should be transmitted by rope gearing. An approximately perfect ventilating arrangement would be two fans, each with its own engine, but, in any case, there should be duplicate engines. On such lines as I have sketched, I believe we have at our command the highest type of ventilating fan. For further improvements in the production of great volumes of air, with a comparatively small expenditure of coal and power, we shall have to look, not so much to improvements upon our present fans, as improvements in the arrangements of the mine itself.

The value of the mining machinery imported free of duty into Canada since the special provisions were enacted in the Custom's Tariff has been:

1890 (to 30th June)	$ 9,950
1891	78,432
1892	61,848
1893	87,208

The American liner "Paris" has had constructed for her a spare length of shafting of nickel steel. This is believed to be about the first application of this alloy in a merchant steamer, notwithstanding that it is five years since Mr. Riley, of the Steel Company of Scotland, first demonstrated in this country its greater elasticity and tensile strength. The "Paris's" new shaft has tensile strength of about 90,000 lbs., probably 25,000 lbs. more than any British or German steel shaft. It has been established by tests that nickel steel has a higher elasticity than ordinary steel to the extent of 31 per cent., and that the tensile strength is 20 per cent. greater. Moreover, ductility is not adversely affected. Although, therefore, the size and weight of the "Paris's" shaft might have been reduced with maintenance of strength, it has been kept the same as those first fitted at Clydebank.

In a recent discussion of a paper on the result of an experimental research into choke-damp poisoning, before the Mining Institute of Scotland, the writer, Dr. Thomson, as the result of special investigation arrived at the following conclusions. 1. That in some explosions men could have been rescued had an apparatus been at hand to enable some of the rescue party to penetrate the after-damp, and that in some cases the distance to be traversed was short. 2. That the Fleuss apparatus was too much after the fashion of a diving dress, closing up the ears and covering the whole face, to commend itself to the practical miner. It was also somewhat costly. 3. That there was a want of a simple apparatus for use by those of the rescue party to enable them to penetrate the after-damp, and perhaps of a means of supplying air to the victims whilst removing them. 4. That it would be a great advantage for the mason putting in a stopping in the face of a fire, to have a simple apparatus which would enable him to work and breathe in a bad atmosphere without considerable restraint of his movements and without interfering with his speech and hearing. He had accordingly designed an apparatus on the principle that carbonic acid gas in fairly large amount may surround the head and face provided a stream of respirable gas be kept upon the mouth and nose. His apparatus, which was exhibited, is intended to serve two purposes. 1. Where pure air was obtainable at no great distance, such as was the case in building off a fire. 2. Where pure air was not obtainable, as when penetrating after-damp. Speaking generally, the apparatus consisted of an arrangement by which, in whatever position the workman places his head, there is constantly coming to his mouth and nose from a face-piece (the distance of which can be regulated), a supply of fresh air in a diverging stream, the intention being not necessarily to supply the whole 30 cubic inches of air which is taken in at each inspiration, but to dilute to a greater or less extent the heavy atmosphere existing about the head, and to add also to the percentage of oxygen present. The conclusions he had come to were as follows. 1. His apparatus would, he believed, be useful and effectual for breathing in a poisonous atmosphere in those cases of building off where good air is accessible at no great distance. In such cases the air would be supplied by a hand pump or bellows. 2. When the distance to be traversed was not very great through a region of after-damp, or when, carbonic oxide being absent, the percentage of carbonic acid gas was not great, the apparatus might be used in connection with a cylinder of air strapped to the back, which would last the longer, the smaller the amount of carbonic acid gas present. Oxygen should be compared with air too see if it has any advantages, for the reason above adduced, namely, that a smaller bulk of it than of air will bring the percentage of oxygen up to the normal. A working model of the apparatus, with bellows, could be made for about £2 10s., or perhaps even less. A 20 cubic feet cylinder with regulator costs about £3 5s. od., but for experimental purposes these might be hired. It was only by trial that the question could be settled, and the best way to try it would be to use it when putting in a stopping. He thought the question of resuscitation of victims must wait till it had been determined whether they could get to them.

Mr. John S. Kennedy, of Chambersburg, Pa., has invented and patented an apparatus for breaking pig iron, which may be briefly described as follows: The method consists in lifting the beds of iron, when cold, by means of an overhead crane and traversing same to a breaking table, which may be located at the end of the cast house for a single blast furnace or centrally located for a plant of two or more. The beds of pig iron are lowered on a breaking table, where, by a series of vertical hammers, striking a cushioned blow, the sow is broken from the pigs, broken to length and the pigs are broken at their centres. In case of strong iron, the sows are first broken and then the pigs, but when the iron is weak the sow and pig hammers strike the bed simultaneously breaking it at one operation. No movement of the bed is necessary after it is placed on the breaking table. The sow is cast thin and wide, giving an easily broken section as well as a minimum of sow-iron, and the necks of the pigs at the junction with the sow are cut down to a small section, which allows their being readily detached. It is claimed that this method of carrying out and breaking iron, will be found much cheaper and quicker than the present practice. It will reduce the labor cost per ton of iron, lighten the work of the furnacemen, effect a saving in scrap and "sandage," as well as giving a cleaner fracture to the iron.

According to the report of Mr. A. H. Stokes, inspector of mines for the Midland district, Great Britain, there appears to be a growing demand for a safe, effective, and economical explosive, but at the present we are far from having reached the maximum of either safety, efficiency, or economy, or restricted their use to the minimum required for the working of the mine. Great strides have been made within the last few years in the attempts to produce a safe explosive, but at the present moment he is not aware that we have an absolutely flameless explosive, or one by which infallible security may be attained during blasting in a mine. The chief element of danger in connection with blasting operations is the production of a flame of high temperature, which may ignite inflammable gases in the vicinity of a shot, or by the concussion of the shot in dusty places raise sufficient dust to convert an atmosphere only slightly charged with gas into an inflammable mixture. Recent experience leads him to think that gunpowder should be prohibited from use in all fiery and dusty mines, and although we have high explosives which, with care and under stringent regulations might be used, yet all such shots should be fired by an official of the mine who has been taught the nature and power of such explosives, for miners are liable to use a high explosive for a given amount of work in the same proportion as they would use gunpowder, and with the frequent result that explosives are wasted and the element of danger from a blown-out shot, or exposure of flame of intense heat, which would result from an overcharge shot is intensified. Miners accustomed to gunpowder all their lives scarcely understand the power of a high explosive, and do not consider the importance of using the minimum quantity of such explosive substance to perform the work required, neither do many men appreciate the importance that stemming or ramming should consist of a damp non-inflammable material, and that the first part of the tamping should be introduced in small proportions, to prevent the compression of air at the bottom of the shot-hole. In mines worked with safety lamps, Mr. Stokes considers that all shots should be fired by electricity and low tension fuses, for the employment of ordinary gunpowder fuse is liable to emit sparks at the moment of ignition, which will ignite gas, and the incongruity of prohibiting a man from using a naked flame to light the end of a fuse, which, when lighted by a red hot wire, is equal to a naked flame, cannot be justified, especially when we have at command electric exploding appliances which are both safe and efficient, and present many advantages as regards safety over any kind of fuse which emits sparks that will ignite gas, or which cannot be ignited except by the application of flame to its extremity The simplicity and certainty of firing by the low tension system of electrical blasting commends itself to all who have adopted its use. The electric fuse can be safely tested by a galvanometer before being taken into the mine, and little fear need be entertained that the operatives will be troubled with mis-shots, and the weight of the firing apparatus need not prevent its general use.

The Canada Coal and Railway Co., Joggins Mines, N.S., are putting in a 300 horse power Lancashire boiler fitted with Galloway conical tubes. It was built by the Robb Engineering Co. who have another of the same size under construction for them.

THE ASBESTOS CLUB.

Proceedings of the Annual General Meeting—Election of Officers, Etc.

The Annual General Meeting of "The Asbestos Club,"—adjourned from 27th April—was held in the Club Rooms, at Black Lake, Quebec, on the evening of 25th day of May.

A larger number than usual of the officers and members of the Club were present, thus manifesting an increasing interest in its welfare and success.

The usual routine business having been accomplished, the election of officers for the ensuing year was proceeded with. The ballot papers, which had been received by the Secretary during the previous month from members at a distance, were opened and read.

The following officers were then elected by acclamation :—

President:

Mr. John J. Penhale, Black Lake.

Vice-Presidents:

H. J. Williams, Thetford, and R. T. Hopper, Montreal.

Secretary-Treasurer.

R. Stather, Black Lake; B. J Bennett, Assistant.

Council:

Capt. Mathew Penhale, Black Lake,
Wm. King, Quebec, D. A. Brown, Boston,
Capt. Prideau, Black Lake, T. H. Crabtree, Black Lake,
Dr. J. A. Marcotte, Black Lake.

FINANCIAL STATEMENT.

May 1st, 1893—	
Bal. E. T. Bank	$ 59 80
Subscriptions, 1893-4, 28 Members	140 00
Note at Interest	92 17
May 25th, 1894	$291 97
Sept., 1893—	
Insurance	$ 9 15
Rent Club Room to 1st May, 1894	40 00
Postage Account	9 25
Express "	2 62
	$ 61 02
Bal. in Bank	$174 80
" due on Note	52 17
Cash on hand	3 98
	$230 95
	$291 97

The Report was adopted. On resolution of Mr. Klein it was decided: "That in view of the flourishing financial condition of the Club—having a surplus fund of $230—the annual dues for 1894-5 be remitted, or abandoned, but that all members who are in arrears to the Club to 1st May, 1894, shall pay up the said arrears previous to 1st August, 1894, or be no longer considered members, thereby forfeiting all claims to any and all privileges of said Club."

The meeting then adjourned. The regular monthly meeting of the Club will be held in the Club Room on the evening of Thursday 28th, when business of importance is up for consideration.

The Profits of Coal Mining.

In a recent issue of the *Nineteenth Century*, Mr. G. P. Bidder, Q.C., has the following article on the Profits of Coal Pits:

Nothing became more apparent in the course of the late coal strike and of the conferences between coalowners and men, and discussions in the Press and elsewhere arising out of it, than the extreme ignorance on the part of the public, and even of the representatives of the miners themselves, of the elementary conditions of the coal trade and of the principles upon which the question at issue depended. The public may well be excused for not having mastered the details of a subject of no little complexity; but it might have been expected that those who undertook to be the guides of some 200,000 men in a matter of such importance to their well-being would have shown a better acquaintance with the subject. Yet it was abundantly evident that they had for the most part regarded the question only from the point of view of the men, and their very natural desire to maintain, if possible, the rate of wages at the level of recent years, and that their ideas of the financial condition of the coal industry and the factors on which the capacity to pay wages depends, were of the most limited and erroneous description.

In view of the possible recurrence of disputes such as that of last year, it does seem very desirable that the governing elements of the problem should be better understood. It may therefore not be amiss, now that the struggle is over and there is a truce between employers and employed, to illustrate the financial economy of the coal trade in such a way as to show what are the conditions on which the profitable working and wage paying power of a colliery depend. Before proceeding, however, it is to be observed that there is, of course, considerable variation in different colliery districts and in different collieries in the same district, both as regards the cost of production, the selling price, the demand, and the markets available. Thinness of seams, greater depth, heavier pumping charges, bad roof, or other causes may raise the cost of working. The distance from the best markets will vary, so also will the nature and extent of the fluctuations in the demand for the coal, which depend on its character and the purposes for which it is in request. Clearly, therefore, no figures can be presented that will exactly represent the position in every or any district; but the general conditions are practically the same, and a statement based on any fairly normal collieries will reliably illustrate the principles applicable to all. In the following remarks I have drawn mainly on experience derived from collieries in the district with which I am best acquainted.

The capital employed in a colliery, including the original and subsequent development, sidings, plant of all kinds and working capital, though, of course, subject to variation, may be taken at about 10s. for every ton of annual output, so that a colliery which produces for sale 500,000 tons in a year presents a total capital of some £250,000. What, taking one year with another, is a fair and reasonable return to look for from this capital? The business is one of a very fluctuating character. There are occasionally periods of inflation, when the profits are excessive; they are invariably followed by periods of depression, usually of much longer duration, in which little or no profit is realisable. Moreover, in any individual colliery profits are liable to disappear entirely, apart from rise and fall of markets, in consequence of accidents, failure of the seams, faulty ground, or other contingencies impossible to be foreseen. I know a case of a colliery which, after having returned substantial profits, made a loss every year for fifteen years in succession. It is also to be noticed that some time must always necessarily elapse before a colliery can be developed sufficiently to earn profits, and during this period the capital is necessarily unproductive. Now, there are many opportunities for investing money far less risky and fluctuating than the coal trade, by which a return of 5 per cent. per annum or upwards can be obtained. It seems, therefore, not unreasonable to expect a return somewhat higher than 5 per cent. on colliery capital. Further it must be remembered that the life of a colliery is limited by the extent of workable coal that can profitably be won from it, and therefore, in addition to interest an annual sum must be provided for the redemption of the capital sunk. Taking all these circumstances into consideration, an annual return of 10 per cent. on the capital, to include both interest and depreciation or redemption of capital, is surely a very reasonable remuneration. To put the same things in other words, no man would embark his money in colliery property *unless he had a fair prospect* of obtaining at least this return for it. Taking, then, such a colliery as we have supposed, with a capital of £250,000 and an output of 500,000 tons in the year, there must be an annual profit of at least £25,000, or 1s. per ton of output.

Next, as regards working cost. This, of course, varies considerably; *but, assuming the colliery to be working* full time—that is, six days a week—and wages to be at their present rate, it will probably be between 5s. 6d. and 6s. 6d., let us say 6s. per ton. It is important to note how the cost is made up, especially as wild statements have been made on the subject, one assertion being that only 1s. 6d. per ton is paid in wages to the men. The *following is very closely the distribution of the cost* throughout the year, based on actual experience:—

Wages	69·26
Materials	15·26
Royalties on coal raised	7·70
Surface rents	1·52
Rates and taxes	3·15
Salaries, general expenses, etc	3·11
	100·00

It will be seen that nearly 70 per cent. of the whole cost is paid in wages. It is interesting also to notice, with reference to the cry for the abolition of royalties in the interest of labour, that the sum paid for royalties is only one-ninth part of the amount of the wages bill. Further, in order to properly understand the economy of a colliery, there is another matter of the utmost importance to be considered, and that is the proportion of the working cost that consists of fixed charges. This is one of the most powerful factors affecting the profitable working of a colliery. Without a due appreciation of it, it is impossible to understand the relations of price and tonnage, on which the profit and wage-paying capacity of a colliery depends. Fixed charges—that is, expenses which are constant and independent of the amount of business done, and which must be incurred week by week whether the concern is working full time or standing altogether idle—are incidental to every business. Rent, rates and taxes, salaries, repairs, etc., must be paid whether business is brisk or slack. There is, however, this difference between a colliery and a manufactory: If a mill or workshop be idle for a considerable time, a good many establishment charges can be temporarily put down. The owner can stop his machinery, discharge many hands, put the key in his pocket, and wait for better times. But in a colliery there can be no stopping. The pit must be kept clear of water, the roads and roof require constant attention and expenditure, the horses must be fed and attended to, and, consequently, the pumping and winding engines must be kept constantly in steam. All these items, together with the other general expenses I have mentioned, involve a heavy expenditure, and it follows that the fixed charges of a colliery represent a considerable item in the working cost.

In such a colliery as I have taken for illustration they will probably amount to about £700 a week, and this sum must be spent, although not a ton of coal is raised. Suppose now our colliery to be in full work, it will produce about 13,000 tons of saleable coal in the week. The £700 divided over this tonnage is equal to 1s. 1d. per ton nearly. Therefore, as we have taken the whole cost per ton at 6s., the portion of the cost, exclusive of fixed charges, is 4s. 11d. per ton. In other words, the total weekly cost of the colliery is £700 plus 4s. 11d. for each ton raised. If, now, trade falls so that the colliery is only able to work three days in the week, the tonnage produced being only one-half of what it was, the fixed charges rise to 2s. 2d. per ton, and the entire cost of production per ton becomes 2s. 2d. plus 4s. 11d., or 7s. 1d. per ton. When the colliery was working full time at a cost of 6s. per ton, a selling price of 7s. was sufficient to yield the 1s. profit required. It will be seen that the result of working half time is not only to have the tonnage, but, assuming the price to remain the same, to sweep away the entire profit and convert it into a loss.

The consideration of these facts will throw much light on several fallacies which have been put forward by representatives of the miners and others. One is, that owners might profitably restrict their output in order to maintain the selling price. The figures given show that if the coalowner reduces his working days from six to three, his profit is reduced to 1s. 1d. per ton; and as he sells only half as much coal, he requires 2s. per ton profit instead of 1s. to yield the same weekly profit. So, unless he is able to raise the price 1s. 1d. plus 1s. (or 2s. 1d. per ton), he is a loser by the transaction. But this is utterly hopeless to expect—in fact, unless the conditions of general trade are materially altered, any artificial rise in price operates adversely to the coalowner, both by restricting demand and inviting competition of coal from other districts, or even from abroad. The men have also asserted that coalowners act against their own and the men's interests by reducing the price of coal, in order to get orders and so make a reduction of wages necessary.

This is the same fallacy in another form. The cost per ton when working six days a week being 6s., and when working three days being 7s. 1d., it is obvious that it pays the owner better to work six days at a selling price of 6s. 6d. than to work three days at a selling price of 7s. In the one case he gets a profit of 6d. on 13,000 tons, or £325 in the week, in the other a loss of 1d. on 6,500 tons, or £27 in the week. In fact, in order to get the same weekly profit in the latter case he requires a profit per ton of 1s. on the lesser tonnage, and in order to realize this, must have a reduction of 1s. 1d. per ton in wages, which is equal to 26 per cent. of the present rate of wages. It must not, moreover, be forgotten that the reduced price, by stimulating consumption in iron making and other coal consuming industries, tends to improve the demand, whilst prices unduly raised have, of course, an opposite tendency. The all important principle to be recognised, and which cannot be too strongly emphasised, is that so long as a colliery is not working at or near full time, tonnage and not price is and must be the primary factor in determining the profit, and therefore the amount of wages the coal owners can afford to pay.

It is impossible to leave the subject without a few words on the present cry for "a living wage." Every one, and employers especially, must wish that working men should be able to earn wages that will enable them to live in comfort as well as make provision for old age or illness in the future. But to put up the cost of production for this purpose to a point which the state of trade will not bear, and which either kills the demand by enhanced prices or renders it impossible to work except at a loss, must be a suicidal policy. In order, however, to rightly appreciate the unreasonableness of the demands made, it is necessary to examine them in detail. The daily wage of a collier may be taken as varying from 6s. to 10s., according to his skill and the conditions of the stall in which he works. No one suggests, not even the miners themselves, so far as I am aware, that this wage is inadequate, but their contention is that, owing to slackness of trade, a miner often only gets three days' work or even as little as two and a-half days a week, and they argue that 15s. or 18s. is not a sufficient weekly wage, and therefore the standard daily wage should be increased, so as to make the wage adequate. Can anything be more unreasonable or impracticable? If the miners, and therefore the pit, is only working three days in the week—and this is the very time when trade is slack, prices low, and, as I have shown, owing to small output, the colliery owner's burdens are heaviest, and when he most probably is losing money—that, according to the reasoning of the men, is the time when wages should be raised so as to enable them to earn in three days the wages they formerly earned in five or six. In other words, the weekly earnings of the miner are to be practically guaranteed whether there is or is not sufficient trade to keep him employed, and consequently in case of extreme depression the wages may rise to a point at which it is impossible to work the pit at all. In what other trade is such a demand made? Has not the bricklayer, the carpenter, or the dock labourer, and every other artisan to take his chance of employment, and when his employer suffers through slackness of trade, to suffer with him? So long as the claim of the workmen is directed to attaining a fair wage for a fair day's work it is legitimate, but when it takes the form of requiring a fair week's wage when only a fraction of a week is worked it becomes impossible and absurd. Are there, then, no ways in which it is possible to adjust the relations of coal owners and miners in the varying condition of trade without resort either to the barbarity of strikes or the tedious and invariably unwieldy process of arbitration.

One plan, that of the sliding-scale, in which the day's wage rises and falls with the price of coal, has been tried with, at times, considerable success; but, although undoubtedly a step in the right direction, it is open to the objection that, as has been shown above, price alone does not always correctly represent the wage-paying capacity of the coal owner. There is another plan which has been more than once suggested, and which, if the miners could be persuaded to have confidence in it, would, I believe, work far more justly and satisfactorily. I allude to profit sharing. On this plan the coal owners would be entitled to a minimum interest on their capital and the miners to a minimum daily wage, *i.e.*, such a daily wage as could be paid under the most depressed condition of trade; the whole of the profits remaining after these payments being divided equally each year between owners and men, and the men's share being divided among themselves in proportion to their individual earnings during the year. The men would of course be entitled to appoint auditors or accountants of their own to examine the accounts, but it is essential to the successful management of the colliery that it should be left entirely and exclusively in the hands of the masters. Such a system, if cordially accepted by men and masters, would, I believe, soon be recognised as enormously to the advantage of both. There would be established and felt a unity of interest that would practically abolish the trade disputes and strikes that at present interfere so much with the prosperity of trade. But who shall persuade the men to lay aside their attitude of suspicion and their inveterate distrust of results obtained from the books of their employers? Could this be accomplished, and could they be induced to see that with proper safe-guards and checks they would be safe in so throwing in their lot with the owners, and in trusting to their self-interest for an intelligent management of the business in which both are interested, the results that would be realised in general prosperity, contentment, and absence of friction are not easily to be estimated.

Nickel—Its History, Uses and Distribution.*

By Mr. A. G. Charleton.

(Concluded from page 110.)

To explain the genesis of this class of ore deposits one must glance for a moment at the sources from whence nickel is derived. Native nickel is found alloyed with iron in meteorites, and also in some ultra basic lavas, while the spectroscope reveals its presence in the solar atmosphere. It is showered on the surface of our planet in the form of meteorites, those fiery messengers telling of the wreck of other worlds, and testifying to the common origin of the material universe, in the form of (1) holosiderites composed entirely of nickel iron; (2) syssiderites the nickel iron of which contains silicates of magnesia and iron protoxide, identical with olivine, and at other times a mineral resembling augite; (3) sporadosiderites, the most common kind, usually crystalline in structure, and containing nickel iron, trollite, chrome iron, olivine, titanic and phosphoric acids; (4) asiderites, distinguished by the presence of hydrocarbons in which nickel is present as an oxide. Some of them have been shown to contain pyroxine and felspar (chiefly anorthite) and the absence of quartz and highly silicated felspars is to be noted. These four classes of meteorites show a gradation from almost pure metal containing over 98 per cent. of nickel iron to a stony mass closely resembling some basic lavas. Now, according to the latest determinations of M. Alphonse Berget,† the density of the earth is 5·41, whilst, so far as our limited observation extends, that of the crust is about 2·5. Various theories have been advanced to account for this, and some very first-rate authorities have suggested that the heavier metallic elements might possibly be found to predominate in the nucleus, basing their views on widely extended observation of past and present volcanic phenomena.

It has been found that once the acid stage is past lavas become more basic, and while each succeeding flow from any one vent might not be more basic than the preceding one, yet the tendency is in that direction, till, finally, ultra-basic lavas are excluded from the centres of intense and long-continued activity. This average order invariably, I believe, holds good everywhere over the earth's surface, provided the volcanic force is long enough active. The ultra-basic rocks have in composition many points of resemblance to some of the above-mentioned meteorites. Thus dunite is a crystalline granular aggregate of olivine and chrome iron, which passes by alteration into serpentine; we have also picrite, half of which is olivine, associated with hornblende, diallage, and magnetite. Lherzolite is another of these peridote rocks, consisting of olivine and enstatite, with other accessory minerals. Olivine is the dominant constituent of such rocks, and as a class they possess the highest specific gravity and least oxygen of any known.

Some of the basalts, notably those of Antrim in Ireland, contain metallic iron in microscopical particles, and Professor Nordenskiold discovered, in 1870, on the shores of Disco, on the coast of Greenland at Ovifak, fifteen blocks of nickel iron within an area of half an acre, the two largest being 20 and 8 tons weight respectively; while further observations in the same locality showed that a basalt dyke, at no great distance from the supposed meteorites, contained lenticular disc-shaped blocks of precisely similar iron, and crystals of labradorite and arigite associated with viridite, round which minute particles of iron were moulded. These facts led Professors Judd, Daubrée, and others to decide that the blocks of iron Nordenskiold discovered and took to be meteorites were of terrestrial origin, as the basalt was certainly not derived from the clouds. The Ovifak iron contains 0·5 to 6·5 of nickel, and a nickel-iron awaruite, lately discovered in New Zealand, presumed also to be of terrestrial origin, is said to contain 68 per cent. Ni, 31 per cent. Fe, and 0·7 per cent. cobalt.

In the Urals platinum is found alloyed with nickel iron in association with olivine. Taking the mean density of awaruite as approximately 7·1, and that of rhyolite as 2·6, the terrestrial basic and ultra-basic rocks, which include basalt, gabbro, Lherzolite, trachite, and dolerite, are found to closely correspond in density with the extra-terrestrial meteorites. Those of solid nickel iron have a specific gravity of 7·1, and graduate down to stony asiderites, which possess a density of 2·7.

Meteorites.

	Sp. Gr.
Nickel iron solid	7·1
" considerable	6·8
" medium proportion	3·5
" small quantity	3·1
Stony	2·7

Terrestrial Metals and Rocks.

	Sp. Gr.
Awaruite, (approx)	7·1
Nickel iron in Ovifak basalt, (approx)	6·8
Basalt, gabbro, Lherzolite	3·0 to 3·5
Trachyte and dolerite	2·7 to 2·9
Rhyolite petro-silex	2·6

The conclusion to be drawn appears to be that the genesis of nickel deposits may, in most instances, be traced to the ultra-basic rocks and their derivatives, serpentines and magnesian silicates. The great nickel deposits of the world are found in rocks in which olivine is the predominant mineral, while we have seen that olivine and the magnesian silicates are found not only in the ultra-basic rocks of the earth, but also in meteorites. While these facts alone do not prove that the nickel was derived from the olivine, it is well to note the conditions under which the olivine was formed, and to see how far it is nickeliferous. Assuming a semi-metallic nucleus for the earth, and that in this nucleus iron and nickel are the predominant metals, as they are in meteorites, and allowing that the ultra-basic rocks came from the greatest depths in the earth's interior, under such circumstances, it would not be remarkable for silicates, crystallising out of the magma, to contain such metals.

From the microscopic study of the igneous rocks, much light has been thrown on the order of crystallisation of their component minerals, which has pretty definitely been proved to be fairly uniform. Thus the first minerals to form appear to be magnetite and illmenite, sometimes chromite and picotite. Next come silicates, which occur in minute quantities, such as zircon and titanite; pyrite and pyrrhotine usually follow; and next the metallic oxides and sulphides, and the heavy dark-coloured basic silicates, olivine, augite and hornblende. Olivine is the first of the rock-forming silicates to crystalize out of the basic magna. According to Rutley, olivine sometimes contains traces of titanic, phosphoric and chromic acids, and the protoxides of nickel and cobalt. Sandberger's experiments with rock silicates almost invariably show traces of Ni, Co, and Cu, from olivine and augite. Whether the nickel occurs, as he supposes, in chemical combination, or, as Mr. A. W. Stelzner thinks, mechanically admixed, is practically immaterial to the question under discussion; it is sufficient to know that olivine contains the metal in quantity enough to form, when dissolved and re-precipitated, rich and extensive deposits. We have seen, indeed, that the olivine in the Oregon rock gave 0.25 per cent. Ni, while the serpentine from Dillenberg showed 0·66 per cent.; and much of the serpentine in New Caledonia runs over 1 per cent. A review of the foregoing facts certainly points to the conclusion that the nickel, at least of the serpentinous deposits, has been derived from the basic magnesian silicates of the original rock masses. As regards the nickeliferous pyrrhotite deposits, they may possibly have a different origin as suggested by Vogt.

It has been proved that workable deposits of titaniferous iron have been probably formed in certain basic eruptives in Norway and Sweden by a process of differentiation or segregation of the iron ore to the centre of the eruptive mass; and Vogt has suggested, and endeavored to apply, the same theory to account for the formation of the nickel sulphide deposits in the norites of Norway and Sweden and the Huronian deposits of Canada. As against this theory, it is remarked that the pyrrhotite deposits referred to occur along the contact planes of the gneiss and schists; and therefore, if they were formed by segregation from a molten magma, this process has taken place from the centre towards the outside, or in reverse order to that which characterizes the iron ore and the supposed structure of the interior of our globe.

Though there may be grounds for further investigation in this direction, these ore bodies would seem more probably to have been deposited from circulating mineral waters. Some geologists explain the presence of deposits of mineral by supposing them to have been formed by the agency of circulating solutions bringing them to the surface from unknown depths, disregarding the fact that fissures have never yet been proved to have indefinite extension, nor can water circulate below certain limits. Before, therefore, adopting an ascension theory for the formation of nickel deposits in basic eruptives, it is well to recollect that these rocks came from greater depths within the earth than circulating water is likely to have penetrated; much deeper in all probability than any vein fissure could have extended to. It is more rational, it seems to me, to suppose that the metals were brought within reach of surface agencies, and it is probably owing to the subsequent leaching of these basic eruptives that our principal deposits of nickel were placed at the disposal of the miner's pick. The practical lesson to be gathered from this is, I think, that the prospector looking for new deposits of this class will best turn his attention to a field where rocks of this character are met with.

The progress of science day by day makes the art of mining less speculative and more business-like, and it should be I think, the function of the engineer to apply science to this legitimate commercial end; to raise it, in fact, into the position of an industry, which has materially assisted in building up the prosperity of all new countries; which has done so for America already, and which will do so for our British colonies in the future, with marked advantage to us. Mining supports tens of thousands of our population, opens outlets for remunerative enterprise and emigration, and exercises a civilising influence which is world-wide, and, I think, the surest means to foster it is to point out its risks as well as its advantages; to encourage the employment of necessary capital in profitable fields; and, equally, to discourage wasting valuable money on enterprises which do not possess the elementary conditions for achieving success. There are, in fact, three classes of people, I believe, who engage in mining; those who get most metal out of the pockets of the public, those who are content to mine in pockets of ore, and those whose endeavour is to successfully develop valuable mineral deposits on what I would term a profitable commercial basis, with the aid of scientific knowledge applied practically.

The contracts for the metal in America closed early in 1892 were made at prices ranging from 55 to 60 cents

*Abstract of a paper read before the Society of Arts, May 2, 1894.

†*Comptes Rendus*, July 1893.

per lb., these quotations being for metal of 98 to 99 per cent. fine. Later on very good nickel of the same fineness has been offered at 52 to 54 cents, and at the close of 1892 could be bought for 50 cents. The dry process has greatly tended to cheapen the cost of producing nickel, but this, it must be recollected, is off-set when there is a demand for metal of extreme purity, which can only, as yet, be obtained by wet treatment. This feature of the nickel confers a great advantage on the New Caledonian ores: to illustrate it, it may be stated that the leading nickel refiners in the United States asked 70 cents per lb. for metal of first-class quality, while the price asked for the regular 98 per cent. grade was 56 cents prepared from the same ore.

The Walker Patent "Indestructible" Ventilating Fan and Engines, as Erected at the Park Collieries, Garswood; Their Construction, Arrangement and Efficiency

By Mr. Charles P. Higson.*

The Walker "Indestructible" ventilating fan and engines were introduced some seven years ago by Messrs. Walker Bros., of the Pagefield Ironworks, Wigan, and a ventilating plant of this description having been erected at Messrs. J. and R. Stone's collieries at Garswood, of which I have charge, it has been suggested to me that a description of its construction, arrangement and efficiency would be acceptable to the members of this Society.

In designing this machinery endeavour has been made to produce an arrangement which, while obtaining a high degree of economy and efficiency, should possess freedom from liability to break down, and also sufficient simplicity in its working parts to bring it within the comprehension of the every-day colliery engineman. With this view the engines have been made large enough to perform their duty at a moderate piston speed, and all complicated valve gearing has been avoided. Experience in the construction and working of engines driving ventilating machinery, and, indeed, in colliery engines generally, has shown the advantage of moderate speeds. These engines were designed for a speed of 50 revolutions per minute. This gives a piston speed of 400 feet per minute, which is very moderate when compared with the performances of many engines driving mills; but it is found that the destructive effect lies not so much in the speed at which the piston travels as in the frequency of its change of direction, and that a speed of 50 revolutions per minute is the most advantageous when dealing with engines of the class and size herein referred to.

In the case of mill engines it is usual to run them at much higher speeds; but the difference between these engines and those driving ventilating machinery is that the former work with the advantage of the intervals of meal-times and stoppages during the night and at week-ends. but with fan engines the stoppage is limited, as a rule, to a very brief interval on Sunday mornings, and in some cases even this is not permissible.

Taking the hours worked during a week, mill engines run only one-third the time of fan engines; or, in other words, each year the work done by ventilating engines represents three years' work as compared with mill engines.

The engines are of the twin or side by-side compound, condensing type—that is to say, there is a crank at each end of the crank shaft, one crank being actuated by the high-pressure piston and the other by the low-pressure piston, the driving pulley being placed midway between the two cranks.

The stroke of each cylinder is 4 feet. The diameter of the high-pressure cylinder is 22 inches, and of the low-pressure cylinder 38 inches.

The valves are ordinary slide valves, an adjustable cut-off valve being fitted to the high pressure cylinder. The cut-off valve can be regulated while the engines are running and it is intended that the stop-valve should remain at all times wide open, the speed being controlled by the cut-off valve.

A warming valve admits live steam to the low pressure cylinder to warm it before starting and to start the engines when the high pressure crank is on the dead centre.

In Messrs. Walker's more recent engines, adjustable cut-off valves are fitted to both cylinders. This enables the load to be equally divided between the high and low pressure cylinders at all speeds, to meet the varying duty required from ventilating machinery, as in the case of new mines opening out.

By means of a system of valves in the exhaust pipes, either engine may be disconnected and the remaining engine may be worked alone, either condensing or otherwise, and is sufficiently large to develop almost the full duty of the fan when so doing.

A separate steam stop valve is provided to admit live steam direct to the low pressure cylinder when working alone, and a combined reducing and safety valve, reduces the steam pressure in proportion to the increased diameter of the piston and prevents the accumulation of dangerous pressure in the pipes leading to the low pressure cylinder.

A three way valve on the main exhaust pipe and controlled from the engineroom enables the man in charge to turn the exhaust steam into the condenser or into the atmosphere as may be required whilst the engines are running.

The air pump is worked by a drag-crank from the low-pressure crank pin.

* Manchester Geological Society Trans.

Motion is transmitted to the fan by fifteen cotton ropes, each 1⅝ in. diameter. The grooved driving pulley is 16 feet diameter, and the driven pulley on the fan shaft is 7 feet 6 inches in diameter, giving a ratio of one to a little over two.

It is found that these cotton ropes run most satisfactorily at speeds of 3,000 feet per minute and over, and it is therefore now the practice to increase the diameter of the driving pulley to 20 feet for engines of this size.

The power which may be safely transmitted by a cotton rope 1⅝ in. diameter may be taken at about 10 horse power per 1,000 feet per minute up to 3,000.

In mill practice it is found that the average life of cotton driving ropes when properly treated is about twelve years. The comparatively recent application of these ropes to ventilating machinery renders it impossible to say what their durability is likely to be, but experts say that it will probably exceed that of mill ropes, in consequence of the steady load and freedom from sudden strains.

The method adopted for lubricating the crank pins is a noteworthy feature of the engines.

A cylindrical vessel filled with oil is suspended above the crank pin. A rectangular brass tube passes through the bottom of the vessel and projects above the surface of the oil inside. A number of woollen threads are led from the inside of the vessel through the tube, and are allowed to hang downwards from its end.

The wool becomes saturated with oil by capillary attraction, the flow of oil being regulated by a brass plate inside the tube, which may be caused to compress the wool.

To the end of the connecting rod is attached a brass tongue in such a manner as to come into contact with the saturated wool at each revolution, wiping off a certain quantity of the oil, and conducting it to the crank pin. The tongue is faced with flannel to prevent the oil being thrown off by centrifugal force.

The consumption of oil is 1½ pints per week for each crank pin.

When local circumstances will permit of its adoption the "twin" arrangement—that is, placing the high and low pressure cylinders side by side—is much superior to the tandem arrangement, in which the cylinders are placed one behind the other.

By the twin system the inconvenience of dead centres is avoided, as live steam can be admitted to the low-pressure cylinder to start the engines when the high-pressure crank is centered. The driving pulley receives a comparatively light impulse at each of four points in the revolution, instead of receiving a heavy impulse at each of two points in the revolution, and greater regularity and evenness in the running of the ropes is thereby secured. The working parts may be lighter and are more evenly balanced, and an accident, for instance, to a crank pin which could be met by disconnecting the disabled engine and by running the other alone, would, in the case of the tandem engines, lay the fan idle and stop the pits until the damage was repaired.

The Fan.

The chief points aimed at in designing the "Indestructible" Fan were (I learn from the makers) to produce a ventilating machine which should obtain a high percentage of useful effect without the great weight, unwieldy dimensions or expensive foundations of the large direct driven fans, and which should at the same time possess the strength, rigidity and durability of the smaller fans, whilst avoiding their high speed and consequent frequently heated bearings.

The construction of the fan, which is 24 ft. diameter and 8 ft. wide, and is built up exclusively of iron and steel, is as follows:—

There are two strong cast iron bosses. These bosses are carefully bored out and made a good fit upon the fan shaft, and are further secured to the shaft by means of steel keys. The bosses extend lengthwise on each side towards the journals, thereby distributing the weight of the fan over a considerable portion of the fan shaft.

Between the bosses are placed two discs of steel, of uniform thickness, bored in the centre to fit the fan shaft.

The bosses, where they come in contact with the discs are turned on the face.

Each disc is in halves, the joints being placed at right angles to each other. By this arrangement the two discs form one disc of considerable strength, much lighter but stronger, than if the disc were in one solid plate.

Between the two discs the iron arms of the fan are fixed "sandwich-like," and are gripped tightly by them. These arms extend from near the axis of the fan to its periphery, being supported half-way by the discs.

The two bosses are secured together by means of turned bolts passing into carefully rymered holes; the bolts being lock-nutted, and as these bolts pass through both the discs, the bosses and the fan-arms, the whole structure becomes specially strong.

In the small spaces between the discs which are not filled up by the fan arms, there are inserted annular plates. The whole portion outside the boss is then securely rivetted together.

Angle irons are rivetted to the fan arms where they extend beyond the discs, to these angle irons the vanes, eight in number, are firmly secured, the cross section of the arm and vane together being like the letter T, thus forming a beam of great strength and rigidity. The top of the T representing the vane and the surface pressing against the air. The vanes which spring tangentially from a small circle concentric with the fan shaft are curved longitudinally to the arc of a circle of a certain radius and are cut away from the edge of the inlet to the fan shaft to minimise central resistance.

The main bearings of the fan are placed in the two inlets of the fan chamber, the distance inside the bearings being only 8 ft. The outer bearing being placed just outside the rope pulley upon the fan shaft. The latter bearing is made with adjustable brasses so that the wear produced by the tension of the ropes may be taken up.

The pedestals are cased all round to prevent access of dust to the bearings.

It is very necessary to minimise the slipping of the air between the sides of the vanes and the walls of the fan chamber as far as practicable. The vanes being strong and of iron cannot be brought close to the walls, as in the event of any side movement of the fan on its bearings the vanes might "catch" and be injured. This clearance is, therefore, made up by attaching strips of pliable hoop iron to the sides of the vanes.

The method adopted for obtaining constant lubrication of the fan bearings is worthy of notice. An eccentric upon the crank shaft of the engines actuates a small pump which delivers oil from a tank beneath the floor of the engine-room into one fixed high up against the wall. From this latter tank the oil flows by gravity through pipes communicating with each of the fan bearings, and, after lubricating the journals, is collected by cups fixed to the sides of the pedestals and conducted to the lower tank. Here it is filtered by passing through a sheet of copper gause, and is again pumped into the upper tank. Constant lubrication is thereby secured, the bearings practically running in a bath of oil. The consumption of oil is 4 pints per week for the three bearings.

The fan is fitted with the Walker anti-vibration shutter. The history of the invention and introduction of this shutter (for which I am indebted to the makers), is very interesting.

About 1886 Messrs. Walker constructed and erected three Guibal fans for ventilating a portion of the Metropolitan and District Underground Railway.

Those who have had experience with Guibal fans will be aware that as each blade or vane passes the lower edge of the shutter a pulsatory action takes place. When the fans above mentioned were set to work the pulsation or vibration of the large volume of air discharged was so great that it caused a corresponding vibration of the window sashes, doors, &c., of the surrounding buildings, and this was so unpleasant that the professional men and others near obtained an injunction against the railway company compelling it to stop one of the fans. The work by this time was out of the makers' hands, and they only casually heard what had taken place, learning, also, that in addition to this injunction another was threatened in the case of the second fan, and that the railway company had thus far escaped the enforcement of this threat by agreeing to run the second fan at a few short stated intervals only during the day.

In considering the case it occurred to the makers to incline the lower edge of the shutter instead of making it parallel with the axis of the fan, by which means it was thought that the waves of air might be broken up or at least reduced. It was, however, ultimately decided to make the shutter like an inverted V, and this was found to be completely successful.

Having thus explained the history of this invention and its utility in removing vibration and consequent noise, we now come to a still more important advantage to be gained by its application. Experience in the working of Guibal fans proves that fan shafts, even though made unusually strong in proportion to the horse power transmitted through them, frequently break. In Belgium, the birthplace of the Guibal fan, the average life of the shafts is found to be from twelve to fifteen years. The breakage of fan shafts, and the loosening of bolts and rivets in fans generally, are to be attributed to the excessive vibration hitherto inseparable from their working. This vibration is caused by the too abrupt cessation of the delivery of the air from the fan vanes or blades as they pass the opening to the chimney, and for this the shape of the regulating shutter or slide is responsible. The upper part of this opening, formed by the shutter, as hitherto constructed, has a line parallel to the tips of the fan vanes, and as the fan revolves these lines become identical; the delivery of the air is as a consequence abruptly terminated.

Whilst discharging the air, the pressure is against the front of the vane, but immediately the vane enters the fan casing the load upon it is suddenly removed, and the pressure, owing to the vacuum within the casing, is instantaneously reversed, and a rebound upwards of the previously depressed blade takes place. The effect is communicated throughout the whole of the fan and to the shaft also, and as each blade represents a powerful lever, the momentum of the blow or jerk becomes serious on reaching the shaft and a dangerous tremor or vibration is set up.

As an illustration of the effect of this action let us take the case of a fan constructed strictly on Guibal principles and upon which experiments were made some time ago. In these experiments readings were taken from a water gauge which was attached to the fan casing at intervals from the centre to the periphery, above the shaft. At the centre the water gauge indicated 3 inches, but near the outer edge or periphery it was half an inch. The fan was 24 feet diameter and ran at 80 revolutions per minute. Taking the average water gauge over the surface of the blades at 1½ inches it would represent a pressure of 7·8 lb. per square foot or a total pressure on each blade of nearly 500 pounds. Assuming the centre of the blade to be the centre of the load, the distance from the centre of the load to the centre of the fan shaft would be approximately, 9 feet. Taking the work of one day of 24 hours, the fan running at 80 revolutions per minute:—eight blades, by 80 revolutions, by 60 minutes by 24 hours = 921,600. This product represents the number of times in a single day that a weight of, at least, 500 pounds is, as it were, instantaneously removed from the blades and the shock resulting from the removal is transmitted to the fan shaft. The shaft is thus in a constant state of tremor, and sooner or later reaches its elastic limit. The consequent injury to the general structure of the fan is obvious. The Walker anti-vibration shutter as attached to the fan at the Park collieries removes this evil by effecting a perfectly gradual change in the pressure referred to, and so governs the discharge of the air as to cause it to pass, without objectionable eddying in a continuous stream from the fan vanes into the chimney, instead of intermittently, and without the pulsatory action described.

The shutter is constructed in sections, any of which can be removed for the purpose of adapting the area of the opening to varying duties of the fan.

The fan is suspended eccentrically in a volute or spiral chamber.

In the experiments, the results of which are given in the annexed tables, elaborate precautions were taken to avoid error. Each airway was divided by wires into a number of similar and equal parallelogrames, and the calculations are based upon the average of several measurements in each parallelogram. The anemometer used had been sent to the makers for adjustment for the purposes of these experiments. A competent person remained in charge of the engines to ensure a constant speed being maintained. The end of the water-gauge tube was fixed at right angles to the current, about half-way between the fan inlet and the pit, and was enclosed in a box filled with cotton waste to avoid false readings through fluctuation of water in the tube. The water-gauge readings were also checked at several points in the fan drift, and found constant.

In the experiments made to ascertain the coal and steam consumption, indicator diagrams were taken from the engines once in each hour, other observations being taken every half-hour. The results given are the average results yielded by an experiment extending over six hours.

The feed water passed through a Green's economiser before reaching the boilers.

The steam was generated by two Lancashire boilers, each 30 feet long by 8 feet diameter.

The fuel used was slack from the Wigan Nine-Feet and Wigan Four-Feet mines.

In comparing the relative merits of the fan with the furnace as a ventilating appliance, the advantage is, without doubt, largely in favor of the fan. It is not uncommon for a furnace to consume 50 pounds of coal or even more per horse power per hour, in the air at the bottom of the upcast pit, whilst the tables annexed shew that by the employment of a fan the fuel consumption need not exceed 4·75 pounds per horse power per hour, in the air at the upcast pit bottom. In addition to this the fuel burnt at a ventilating furnace is usually of superior quality, and therefore of greater value than that burnt under steam boilers.

The ventilating power of a furnace is limited, and when that method of ventilation is employed, in addition to the danger of introducing fire into a mine which may give off large quantities of inflammable gas, and the risk of setting fire to adjacent coal or other strata, trouble constantly arises from the corrosive action of the products of combustion upon shaft fittings and tubbing, also from collapse of brick-work and leakage of tubbing owing to contraction and expansion due to the wide range of temperature in the shaft. This leakage has in some cases been so great as to reverse the air current by the cooling of the shaft, and the momentum of the falling water.

The smoke and fumes are a source of great inconvenience where the shaft is used for winding coal, and this is especially the case where the shaft has to be utilised for the descent and ascent of workmen.

MR. J. UNSWORTH proposed a hearty vote of thanks to Mr. Higson for his very valuable paper, in which he was very much interested. Perhaps it was only reasonable he should be, inasmuch as he had no practical knowledge of the working of fans and consequently he had listened to him with very great attention. He was quite sure he had made his points very clear, and had done his work well and was entitled to their thanks.

MR. J. DEAN, in seconding the vote of thanks said he had had to deal with a similar fan at the Broomfield pit and he could endorse everything Mr. Higson had said about the satisfactory working of it. It was a strong fan, economical, and certainly non-vibrating. He did not think they could hear it 30 yards from the place. He should like to ask Mr. Higson if he had had much experience with regard to the tightness of the rope gearing; they found that when the ropes were put on taut, according to the makers' wishes, they were very much troubled with them coming out of the grooves and getting broken. They had had two ropes broken. They had lengthened the ropes and given them from three to four feet of bag and they ran as steadily as possible.

THE CHAIRMAN, congratulated Mr. Higson on his paper, and said: He had been a member of the Society a good many years and he did not remember hearing a paper from a mining point of view which he considered to be a better one. He thought it was more especially useful now that so many people had it on their minds to change their system of ventilation from furnace to fan, and those members who were thinking of doing so must be very grateful to Mr. Higson for his paper.

The motion was passed with applause.

MR. HIGSON said he was very much obliged to them and as to Mr. Dean's question about the ropes, they had found exactly the same difficulty, when the ropes were very tight they did not work satisfactorily. It was only when they had been running some time and had become slack that the jumping out of the grooves ceased.

MR. DEAN asked what was the size of the shaft the ventilation came up.

MR. HIGSON: 14 feet 6 inches diameter.

MR. THOS. GRUNDY asked Mr. Higson as to his experience in the thickness and construction of the walls of the fan chamber. They were putting down a large fan; and had noticed that the footing of walls, as given by the makers, had not proved sufficient, owing to the damp weather, he fancied, the water had acted upon it and the wall had given a little bit. When he mentioned it to the makers they suggested chipping the bricks off; but that did not suit his idea, because they had put the very best bricks in they could, to form the casing of the fan. If he was informed rightly, he believed considerable chipping had had to be done in connection with other fans. He would like to known what kind of bricks were used inside the chamber, and what were the means of carrying the rain or storm water from above the top casing of the fan.

MR. C. M. PERCY said he had no doubt in his own mind that furnace ventilation was a thing of the past and ought to be, and that fan ventilation was much more efficient; but the difficulty was in getting to know which was the best fan. They heard of such startling results—sometimes the efficiency claimed was more than 100 per cent.—that really practical men were bothered what to do; and whilst he was exceedingly glad that that paper, which was a very valuable one, had been read, he thought the discussion would more likely be of a searching character, and effect more good if it took place at a meeting after the paper had been printed and distributed. He joined in the congratulations to Mr. Higson. He might say that, at times, papers were not prepared with sufficient care. Papers ought to be prepared, first, to maintain the reputation of the person reading them, and, second, the reputation of the Society before which they were read. Looked at from these two points, Mr. Higson had set an excellent example, and had increased his own reputation and not lessened the reputation of the Manchester Geological Society.

THE CHAIRMAN asked Mr. Higson to tell them what was the amount of coal in bulk used by the fan, and the amount of coal in bulk used by the furnace, when he made the comparison, assuming the two to be getting the same quantity of air. The Chairman went on to say that the question of fan and furnace was a very important one, both from a safety and also from an economical point of view. Where they had a fan they were able from the fact that they could manipulate it so easily to deal with dangers they could not overcome where they had a furnace. If they had a fire underground they could deal with the ventilation at once with a fan, but with a furnace they were perfectly helpless. With regard to the shaft, if they had a furnace it was difficult to examine it, and he imagined the ropes suffered very much, which must be a great drawback. If they had a fan they could examine the shaft and the ropes did not suffer in the same way. If Mr. Higson was correct in his statement as to the consumption of coal, there could be no question which system of ventilation was the most economical. During the last 10 or 15 years fans appeared to have made great headway more especially in the northern districts, and in Lancashire they had made some steps in the right direction. They had a great many good fans, and he thought most of their large collieries were now thinking of changing from furnace to fan, but there were always a great many people whom it was difficult to get to make any improvement. There were two or three classes of colliery managers, and also of colliery owners. He found there was a class of colliery owner who seemed to love to see a huge black cloud of smoke coming up the pit. He did not know why it was, but he (Mr. Hall) thought he fancied it showed there was somebody below who was very busy. He often went to the extent of loving to see about his pits broken boxes, iron, and machinery, and he seemed to think it was a sign of energy on the part of his manager. It was a sign of energy in a certain direction. He loved to see the men and women employed on the pit bank exposed to a hurricane of rain and wind, and seemed to think it hardened them, and that it was a proper thing for colliery people to submit themselves to. As to the managers he personally tried to make the meeting at Wigan a good one. Whenever he met a colliery manager he asked him to come to the meeting. Some of them came, others looked at him with a kind of supercilious smile and passed on. He thought they were the losers and not those who attended. He was sure if any colliery manager in Lancashire had been there that afternoon he would have been interested in the paper which had been read. He did not know what steps one ought to take to get rid of that feeling of opposition to improvements. There was that feeling of opposition to improvements on the part of colliery managers and also of owners, but he did not quite see how they were to get over it. If one could hope to get them to join this Society, possibly it would be the right course, and before he sat down he should like to say a word about the support accorded to it. In the North of England nearly all the colliery owners subscribed to or became members of the Mining Institute, not possibly with the intention of attending the meetings, but simply to give it their support from a monetary point of view; whereas in Lancashire they had very few of the owners subscribing. He thought it would do great good if the owners would help the Society in that way, and although some of them might look down upon it—some of them he was sorry to say looked down upon that mining school and anything that was technical—but as far as he could judge their managers by attending these meetings would gain some knowledge which would eventually save the owners' pockets.

The motion was then put to the meeting and was heartily adopted.

MR. HIGSON, in reply, said that with regard to the comparison of the results from the furnace and the fan, he might say they had not got a furnace at Messrs. Stone's collieries, but he had made enquiries and obtained the results he had quoted. Some were so startling that he was afraid to produce them. They had had no difficulty in the foundation of the fan race, and they used ordinary machine-cut brick.

MR. TONGE said it was well known that the work of furnaces in mines varied proportionately with their depths; those at great depths giving far better results than those near the surface. In comparing the work of the fan with that of certain furnaces, Mr. Higson had not stated any depths, and so they could not form an accurate or definite judgment. However, he was not speaking at all in favour of the furnace; and he trusted when the time arrived for the paper to be discussed there would be a full meeting, as no more important subject could be discussed in connection with mining.

The discussion was then adjourned.

A vote of thanks to the Chairman closed the meeting.

Coal Tar Pitch—Its Uses and Future Market.*

By MR. R. WATT.

Coal tar pitch twenty-five years ago was comparatively a new factor in the commercial world. It was almost unknown. Whenever pitch was mentioned, the mind of the merchant or manufacturer reverted to the pine tar product of North and South Carolina. Even the gas companies of the United States were ignorant of the commercial value of tar. Instead of turning it into a source of revenue their main object was to dispose of it in a way that should not pollute the rivers or streams near the works and cause a public nuisance. Consequently they wasted millions of gallons of tar which, if turned into pitch and the avenues of uses had been opened to it, would have largely augmented their revenues. As a result of this lack of foresight, consumers not being educated in its uses, they were limited to the use of pine tar pitch and resin for roofing and other purposes. When pitch was placed on the free list foreign pitch was reduced in price, and came into general use in this country, largely owing to its cheapness, but it was often of such poor quality that it was unavailable for many of the functions of pitch. The cause of this poorness was obvious. Foreign producers, who were also little instructed in the advantages of pitch in its various lines, did not regard their product of much importance, and thought that anything would suit so long as it was called pitch. They distilled the tar mainly for the resultant oils and chemicals, and pitch with them was only a by-product of many impurities. It was usually hard and brittle, and contained many foreign substances which were detrimental to its utility. Its importation, however, brought pitch into more general use by reducing the price of what pitch was manufactured in this country.

Now, while this result curtailed the revenues of the gas companies engaged in the production of coal tar, it also stimulated them into better appreciation of the commercial worth of the product. The tar distillers revised their methods of manufacture, and sought to meet the necessities of the growing market. Instead of treating pitch as a by-product as many of their European competitors still do, they now distilled the tar solely for the pitch, and looked upon the resultant oils and chemicals as the by-products of secondary interest from a commercial point of view. Owing to this change of front on the part of the distillers, the coal tar pitch of the United States takes first rank in the market. It is free from the impurities of the imported article, and therefore better adapted for the various purposes for which coal tar pitch is now used.

In this brief paper I need only call attention to a few of the leading uses of coal tar pitch. For roofing purposes it is unsurpassed, and in general vogue in all our large cities. Its superiority over tin and iron roofs is everywhere admitted. During the past fifteen years it has become the principal factor in nearly all the prepared roofing on the market. A combination of pitch and felt resists the action of water much lo ger, and is more durable than any other class of roofing material; and, what is of equal importance, the cost of such roofing is one-third less than roof of tin or iron. It moreover makes a much safer roof in the case of fire. While the metal aoofs disjoint and fall to pieces from the action of heat, rnd thereby add to the intensity of the fire, pitch roofs fall down bodily and tend to smother out the flames, and in this respect effect a much quicker result than thousands of gallons of water.

In street paving the advantages of pitch have frequently been demonstrated. In many cities specifications call for from 10 to 20 per cent. of refined Trinidad asphalt added

*Abstract of a paper read before the Ohio Gaslight Association, Columbus, Ohio, March 21, 1894, with discussion thereon.

to pitch or cement employed in paving; but this clause is rarely complied with. Practical men know that the addition of this asphalt is more of a detriment than a benefit to the pavement, and they condemn and reject it, even when set forth in the specifications. City authorities, as well as contractors, know that block stone pavements are not satisfactory or durable unless pitch has been used for filling the crevices or cementing the blocks together. Years of costly experiments were needed in many instances to substantiate this fact; but to-day pitch filling is regarded as of the utmost importance, since pavements so treated are more lasting and less subject to ravages of water than those which have been laid without pitch as cement and filler. Indeed, pitch pavements are practically impervious to water, and accordingly escape its corrosive or undermining effects.

But there are other and equally important avenues for the employment of coal tar pitch. It enters extensively into the manufacture of carbons for electric lighting. Various substitutes for pitch have been tried, but none have thus far proved successful. In Germany it is used in the manufacture of pipes for the conveyance of cold acids in chemical works, and also for lining acid holders. Underground pipes for gas or water are coated with pitch to prevent rust and corrosion. Boat bottoms are pitched to preserve the timber and give a smooth surface. The wooden pipes, manufactured in Michigan and New York, are made more useful and durable by their pitch coating.

Another important use for coal tar pitch has been found in the manufacture of patent fuel. This fuel is made of hard and soft coal dust mixed with 10 per cent. of pitch, and pressed into egg shaped pieces. Its popularity for family and manufacturing purposes is already so pronounced that factories for its production are contemplated in various sections. This industry will undoubtedly give great impetus to the pitch market. Even the dust and screenings of the mines can be converted into as valuable a fuel as hard coal; while many grades of western coal can be rendered bituminous by the use of pitch as a binder. All the indications are that the demand for the new fuel will go on increasing. In England its manufacture and sale has already reached large proportions.

Owing to the manufacture of gas from petroleum products, of late years the supply of coal tar has diminished. A quantity of pitch obtained from gas tar derived from petroleum products has been used for paving and roofing purposes; but the large percentage of water in the tar has rendered it very difficult to handle. While the pitch made from this tar is not so good as genuine coal tar pitch, yet the cheapness of the tar has forced it into the market as a substitute for many purposes, with fair success.

The expanding market, as well as the revenue from the production of pitch, ought to stimulate the production of coal tar, and tend to the diminution of gas making from petroleum. When the gas companies fully realize the conditions of the market, they will no doubt govern themselves to meet those conditions in the most profitable manner. Besides those already referred to, there are hundreds of avenues, some of them individually small, but large in the aggregate, for the consumption of pitch. Indeed, taken altogether, the outlook for this valuable product of coal tar is very promising. With the increasing demand for felt roofing, the growing popularity of brick for paving, where pitch will in time be universally used for filling, the employment of granite block for paving with pitch filling, the extension of electric light, causing a larger demand for carbons, and the expanding consumption of the new fuel, to say nothing of the many minor avenues of use, the producers of coal tar pitch certainly have every reason to expect a bright and profitable market.

Discussion.

Mr. Somerville, in the discussion which followed the reading of the paper, referred to the excellent result obtained at Peebles, in Scotland, where there is a plant getting 14,000 feet of 22-candle gas out of a ton of tar, and 13 cwt. of coke, averaging 0·96 carbon, which is eagerly bought up by brassfounders and others. He thought that was the proper thing to do with the tar. Were he constructing a new retort house, he would have some means for the tar, as it comes from the hydraulic main, to get into a still and have the oily matter distilled and go into the hydraulic, and the residue drawn off as pitch; and just put the oil and hydrocarbons into the gas, where they belong, and where they are worth more than anything else, and sell the pitch, as pitch, right from the works.

Mr. Miller, referring to the paragraph which says "a quantity of pitch obtained from gas tar, derived from petroleum products, has been used for paving and roofing purposes; but the larger percentage of water in the tar rendered it very difficult to handle," stated that, as the result of a number of experiments, he had found that if the separator was kept hot—at about 140 to 150°—no difficulty would be experienced in separating the water from the foam.

Mr. Somerville, rising again, said there was at present a large demand for water gas tar, which was used for making a perfectly pure asphaltum. No difficulty was experienced in eliminating the water from this tar. The asphaltum was used in the production of a deodorised paper. A sheet of paper dipped in it, he stated, became odorless, and therefore more valuable for some purposes.

Mr. Holmes—I would like to enquire whether there is very much by-product, in addition to the pitch, that is secured from the distilling of the tar? I infer from what has been said, that it will take about five barrels of tar to make a ton of pitch. That is, there is something like 35 per cent. deterioration in it, and it strikes me that this is overestimated, unless there is some by-product to realise upon it.

Mr. Watt—The by-products are the light and dead oils. The dead oil is not worth quite so much as the tar. The price of dead oil has been demoralised somewhat owing to the amount that has been imported of a poorer quality than could be produced from the tar in this country.

The President—The dead oil is worth less per gallon than tar?

Mr. Watt—Yes sir. The lamp black manufacturers use it largely for producing different kinds of blacking.

The President—Is it valuable for fuel?

Mr. Watt—Yes, it can be used for that. It produces a stronger heat if used as a fuel; it is better and stronger than Lima oil. One barrel of dead oil for fuel purposes will go as far as, at least, 15 per cent. more Lima oil.

Gold-Milling at the North Star Mine, Grass Valley, Nevada County, Cal.

By Emile Rector Abadie, Grass Valley, Cal.*

The picturesque little mining town of Grass Valley, nestled in the foothills of the Sierra Nevada mountains, at an altitude of 2,500 feet, has been for 43 years the scene of uninterrupted activity and prosperity, as the center of a mining district which was intimately associated with the pioneer days of California, and the discovery of gold by James W. Marshall, in El Dorado county, in January, 1848.

Although placer-mining was inaugurated in Nevada county as early as 1848, the first quartz ledge was not located until the summer of 1850. Discoveries made on Gold Hill and Massachusetts Hill increased the excitement in quartz mining, and hastened the erection (during the same year) of the first mill operated in the State.

At the close of 1864, the district had produced $23,000,000 in gold, and all the well-known properties of to-day had been discovered and worked. The Eureka-Idaho, the North Star, and the Empire mines were in active operation; and to-day we still find them equipped with large crushing plants, operating 80 per cent. of all the stamps in the immediate Grass Valley district. Of the mines just named, the North Star possesses the most recently constructed mill, a description of which, the writer believes, may prove of interest to members of the Institute engaged in the milling of gold ores.

During the year 1886, operations at the North Star mine (the property of the North Star Mining Company) had reached such a stage of development that the necessity of a crushing plant at the mine became imperative, and early in October the erection of a 30-stamp mill was in progress. The building designed to contain 40 stamps was speedily erected; and within sixty days the large structure was under cover.

Late in February, 1887, the mill was in readiness, and, upon the completion of the water power system, then being introduced at both mine and mill, the crushing of ore was commenced March 15, 1887.

The local topography presented most favorable conditions for a mill site. At a distance of only 142 feet from the landing floor of the main incline of the mine, it was found possible to discharge the ore at a vertical height of 67 feet above the projected concentrator floor. During the construction of the mill all mining operations continued uninterruptedly, the ore extracted being crushed in leased plants one mile distant.

From the numerous stopes, the ore is trammed to the main shaft, which has now reached a depth of 2,400 feet, with an average incline of 20°. The shaft is well equipped with a double track-way, over which 140 cars can be delivered to the surface in 9 hours, actual running time. One man on each shaft delivers the quartz to the mill and waste to the dump.

The ore, as raised from the mine, is delivered in mine cars, containing a little over 13 cubic feet each; three cars making 40 cubic feet, or two tons of ore. Sorting on the surface is not resorted to; underground, however, the custom of "stripping" the ledge *in situ* insures for the mill a clean product, generally free from diabase (the enclosing rock).

On passing into the mill the ore is discharged over grizzlies, placed at the top of long ore bins. There are 8 fine ore bins, one for each battery, of 5 stamps, each provided with a grizzly 4 by 12 feet in size, set at an angle of 40°. The 3 by ¾ inch bars are placed on edge, 2 inches apart. These grizzlies simply classify the mine ore into fine and coarse. The former drops through the grizzly directly into the fine ore bin, from which it passes through a gate, supplying the automatic feeder, which in turn supplies its own particular battery. Meanwhile, the coarse ore is delivered over the grizzly into the coarse ore bin, from which it passes through a gate into one of the three rock breakers. From the breakers it drops as "fine" into the fine ore bin, mixing with the mine fine, and passing on into the ore feeders as above described.

The ore thus passes, by gravity alone, from the dumping floor to the automatic feeders. One man on the day shift operates the rock breakers to crush the accumulated coarse ore delivered from the mine. The breakers (improved Blake, 9 by 15 inches), run intermittently, aggregating not over 7 hours' work during the 24.

From the automatic feeders the quartz is delivered into the batteries for stamping and amalgamation. The free milling character of the material demands only the simplest methods of amalgamation and concentration for the recovery of its gold contents. The pulp discharged through the battery screens flows over silver plated copper amalgamating plates to concentrating machines beyond, passing thence for further treatment in pans, or escaping from the mill direct as tailings.

The mill contains 40 stamps, weighing, when newly shod, 875 pounds each. The stamps drop 7 inches eighty-six times per minute. The shoes (steel exclusively used), weigh 159 pounds, and the remaining 716 pounds of the stamp are distributed as follows: stem, 358 pounds; stamp head, 228 pounds; tappets, 130 pounds.

The life of a steel shoe averages 130 days, and it crushes during that period 260 tons of ore. The weight of the shoe, when removed, will average about 38 pounds. The very smooth and uniform wear observed on these shoes is due in great measure to the use of cast iron dies.

The weight of the die when new is 100 pounds, and it loses during a life of 70 days one-half its original weight. The recent introduction of cast iron plates 2 inches thick has increased the life of the die to 80 days, the die, when removed, weighing from 40 to 45 pounds. These plates, two in number to each battery, fit snugly in the mortar, forming a false bottom, upon which the dies are bedded as usual. They serve a double purpose, prolonging the life of the dies and decreasing the height of the discharge, which ranges from an initial of 4 inches to a maximum of 6 inches.

Brass wire No. 30 screens and perforated No. 0 tin screens are used exclusively. The latter screen is an experiment, and thus far has given good results. The life of a tin screen is about 30 days; the cost, one-fourth that of wire screens. At the North Star mill, in crushing 113,955⅓ tons of ore, the cost for screens has been $0.008 per ton. Dies have cost $0.026 and shoes $0.056 per ton, exclusive of a rebate of 1½ cents per pound on removed shoes and dies.

The recovery of gold is first made in the mortar, where the amalgamation begins. Mercury is fed to the batteries at regular intervals, the amount varying with the grade of the ore crushed. At times, this amount has exceeded one pound per battery, or a flask of 76½ pounds in nine days. Of this amount, however, 35 per cent. is recovered at the fortnightly retorting of amalgam. There is, however, a considerable loss of quicksilver, which, in treating 113,955⅓ tons of ore, has amounted to $3,680.05 or $0.032 per ton.

In the interior of the mortar, immediately under the screen frame, are silver plated copper plates 4½ inches wide by 52 inches long. These plates, one for each mortar, are bolted to chuck blocks fitting tightly against the lip of the mortar. As the pulp is discharged from the mortar through screens, it falls upon an outside battery or splash plate 18 inches in width, covering the iron mortar apron, which is bolted to the mortar and forms part of it. The length of this plate is equal to that of the inside plate.

The apron plate, 48 by 58 inches, lies below the splash plate, tapering to 24 inches and connecting with the three sluice plates which cover the sluice 12 feet long and 24 inches wide. From the sluice, the pulp passes over shaking tables, which have a plated surface of 10 feet by 48 inches, made up of two plates 48 by 36 inches and two smaller ones, each 48 by 24 inches.

The grades of the above plates are as follows: battery and apron plates, 1½ inches to the foot; sluice plates, 1¼ inches to the foot; shaking tables, 1⅛ inches to the foot. The natural tendency of the narrow sluice plates to "scour" has always been objectionable, and in fitting the more recently erected batteries with a line of plates, the width of the sluice has been doubled. These plates, eight in number, are placed side by side, and overlap slightly, aggregating 15¾ feet by 4 feet wide, the total actual plate surface being equal to that of the narrow sluice plates and shaking table plates combined. The grade of these new plates is approximately uniform at 1½ inches to the foot.

Two-thirds of all the gold recovered by amalgamation is found in the batteries. The yield is, however, variable, frequently reaching 75 per cent. Of the amount recovered from the outside plates, the battery and apron plates will produce 70 per cent., the sluice plates 23 per cent., and the shaking tables 7 per cent. The average value of amalgam from all sources is about $7.25 per ounce, the fineness of the gold bars is 856.

The batteries are cleaned up fortnightly; the outside plates, every other day, frequently daily, and, on rare occasions, morning and evening.

In addition to the usual method of recovering the amalgam from the plates, the writer introduced, several years ago, the method of hot water "sweating," which can be recommended for its simplicity, safety and excellent results. The effect of simply pouring boiling water upon the plates or immersing them (on the apron), is a source of as much pleasure as surprise when the amount secured from a poor looking plate is weighed. Notwithstanding previous sweatings during the year, the December or annual sweating at the North Star mill produced 1703 ounces amalgam from which 600 ounces gold was obtained, valued at $10,524.82.

Leaving the battery floor, the pulp is conveyed through 3-inch pipes to the concentrators on the floor below. Each battery of 5 stamps being provided with two machines, the full complement consists of 12 Triumph and 4 Frue vanners. The latter machines are preferred, and were introduced when the 10 additional stamps were in

* Transactions American Institute of Mining Engineers.

stalled. The machines are conveniently arranged on one floor and readily overlooked by one man on each shift. The ore crushed at the North Star mill contains about 4 per cent. of "sulphurets." Their average value is $53.58 per ton; and they have yielded in seven years a total product of $236,756.63. The concentrates are sold to the local chlorination works.

From the concentrating machines the pulp escapes as tailings, containing more or less gold, notwithstanding a high percentage saved of the ore value (reaching 94 per cent. under favorable conditions). At the present writing there is in operation a simplex rotary amalgamator, treating 10 tons of tailings per 24 hours. Results obtained thus far have reduced the loss in the tailings 22 cents per ton.

The mill is operated entirely by water power, and notwithstanding a high rate per available horse power, the cost of power per ton of ore crushed has not exceeded $0.32. The water used has previously been utilized by the Original Empire Mill and Mining Company under a head of 450 feet. At the North Star, the effective head is 275 feet at the mill.

Electricity as a Motive Power in the Iron and Steel Industries.*

By D. Selby Bigge.

In accepting the invitation of the Council of this Institute to write a paper on Electric Power applications, the author can only hope that, however unworthy his paper may be in itself, it may yet be the means of bringing forward a comparatively new subject in which considerable interest is being evinced by engineers at the present time, and that, in this manner, the opinions of more experienced men will be brought forth, and additional light thrown on the subject.

During the past three years the author has been almost exclusively engaged in applying electricity in the form of power to different mining and industrial operations, and in the course of his work, has been struck with the vast field which lies open to the application of electric power, and the numerous branches of engineering to which the new, and, perhaps, it may be said, coming power, is applicable.

In taking for the subject of his paper Electricity as a Motive Power in the Iron and Steel Industries, the author will endeavour to trace out those branches of the iron and steel industries in which electricity in the near future may take a predominant part. It will be his endeavour in the following pages to treat the subject as far as possible from the standpoint of those engineers who are connected with the daily management of iron and steel works, etc., and not from that of a purely electrical engineer.

Electric power has been applied in this country hitherto chiefly for the purposes of traction, or for carrying out various operations in mining work, such as hauling, pumping, winding, ventilation, drilling, etc., and its chief advantages and characteristics in these branches are now very generally known. All these applications, up to the present, have come under the head of long distance transmission, and there has been a general tendency on the part of engineers to consider applying electric power only in those cases where the power has had to be transmitted a considerable distance. The author is particularly anxious to draw the attention of engineers to what he may term short distance transmission, or concentration of power. Seeing that it may be considered as coming within the scope of the iron and steel industries, ironstone mines, blast furnaces, iron and steel works, engineering shops, shipbuilding yards, the author will endeavour to point out the cases in which electric power is applicable to each of the above.

1—Long Distance Transmission.

Ironstone Mines—When transmitting electric power over long distances it is necessary, in order to keep down the cost of the conducting cables, to employ high tension currents, that is to say, the generating dynamos are wound to give off their power at a high voltage and small current. It has hitherto been the practice in mining work to convey the power at voltages of 300, 500 or 800 volts. Electric power in this way may be transmitted with a comparatively trifling loss to distances of several miles in length. It was not long therefore before electricity found an opening in its application to various mining operations, and especially to hauling and pumping. It was the author's privilege some two years ago to apply electricity in the Cleveland mines for drilling purposes, and since then these electric drills have proved themselves in every way a thorough success, and their use is being further extended into other mines in the district. The voltage in the case of the electric rock drills does not exceed 300, as the power involved is comparatively small, and the distances do not exceed one to two miles in length.

In the case of ironstone mines situated at any great distance from the main line, or in cases where a special line has to be built to the mines, an electric plant could be laid down, not only to operate the drilling in the mine, pumping the water, hauling out the ironstone, but could also be employed to generate current, at the same time for performing all the traction on the branch line. The whole of this work could be performed by current generated from a single engine and dynamo at the mine itself.

In the case where several ironstone mines are situated in close proximity one to the other, a central power station could be laid down, by means of which there would be no separate steam plants situated at the different mines, these all being replaced by electric motors, driven off one main generating dynamo situated at the central station. There is no difficulty whatsoever in carrying out the winding, hauling, pumping, drilling and ventilating arrangements at these mines electrically.

Blast Furnaces—There may be some at this meeting who may think that the author now proposes to work blast furnaces by electricity. He regrets, however, it is not yet in his power to revolutionise the world by doing this. He would, however, seek the aid of blast furnaces in generating his electricity, and considers that, after a water fall, a Cleveland furnace is the next best friend to those desirous of generating electric power economically. In many cases there are large amounts of waste gases available from the furnaces. These are generally used for firing the boilers necessary for driving the blowing engines, etc., but there is frequently a considerable amount of waste gas left over. It is with this waste gas he would propose firing the boilers in connection with the electric generating plant. The power thus generated could be transmitted at a high tension to engineering works situated at a considerable distance, and, if necessary, transformed again to a lower tension for use in the works.

At blast furnaces themselves there are not a great number of applications to which electricity could be adapted for driving purposes, excepting perhaps in pumping water from a neighboring river for condensing. The mineral hoists could be worked electrically.

From the few remarks above, engineers will easily be able to see for themselves the cases in which electric power is applicable at the mines and in connection with blast furnaces.

2—Short Distance Transmission and Concentration of Power.

Iron and Steel Works—By short distance transmission the author means the distribution of electrical energy for the purposes of driving engineering works. As already mentioned, there has hitherto been a tendency on the part of engineers to consider electricity as applicable only in those cases where the power has had to be transmitted over a long distance. It is now necessary to consider quite a different case, in which the power has only to be transmitted over distances not exceeding 300 or 400 yards in length, but in which area a multiplicity of uses may be found for the application of electric power to driving various classes of machinery.

First of all, let the case of iron and steel works be taken, and the classes of machines most frequently employed in these works be considered. These will be found in a great measure to consist of the following: Punching and shearing machines, straightening machines, cold and hot saws, drilling machines, planing machines, blowers, overhead travellers, locomotive cranes, rolls, winches, scrap breakers, etc.

In connection with iron and steel works there are frequently found girder shops, fitting shops, etc., in which the machinery is driven through shafting and belting off one or more engines situated in the shop. In laying down machinery of the above class it has almost invariably been the practice, not only when the machine tools are driven by separate engines, but also when they are driven by belting and shafting, to make allowances in these engines for very large losses, due to condensation or leakage in steam pipes, or to friction caused in the belting and shafting. It is a well known fact that the power actually expended in performing the work on these various machines is a mere fractional part of that transmitted from the generating source. In those cases where the machine tools have been driven by separate engines, it has been a regular practice to provide engines with cylinders sufficiently large to compensate for any possible losses which may occur through leakage, condensation, etc. It seems generally to have been the practice in engineering works to indicate the main driving engines, but during the author's visits to some thirty or forty of the principal engineering works in this country, he has never been able to obtain indicator diagrams showing the power absorbed by each steam driven machine tool in the works. Although attention has been paid to the economy of the main engines, the question of that in the small engines driving these machine tools, and the conveyance of steam has often been entirely overlooked, and an enormous waste has been going on in this manner for years past.

With the advent of the electric motor this condition of things was at once changed. Every electric motor may be said to be a self-indicating machine in itself, in that the power which it absorbs can be immediately detected through the readings on the ammeter and voltmeter provided in connection with the motor.

The following are results of experiments that have been recently carried out by the author, in conjunction with Mr. H. Panton, on the actual power absorbed by various machine tools in doing their work. The figures are extremely interesting, as showing the very small amount of power absorbed by the different tools when doing their work:—

Table of Electric Motor Tests taken at the Works of Messrs. Dorman, Long & Co., Middlesborough.

Description of Machine.	Driven by Engine capable of Indicating.	Replaced by Motor capable of Indicating.	Voltage at Generator.	Voltage at Motor.	Current taken by Motor.	E. H. P. absorbed in doing Work.
	H. P.	H. P.			Amperes.	%
Group of machines as under:— Three cold saws; Two ending machines; One saw sharpening machine	27	10½	120	115	70	10·7
Troughing straightening machine	14	3½	120	118	12	1·9
Double-ended punch, punching four holes one side one other	14	5	120	115	25	3·7
Straightening machine, all sections	14	3½	120	115	15	2·3
Straightening machine, biggest sections	16	3½	120	115	35	5·4
Cold saw, 26 inches diameter	9	3½	120	110	15·27	2·2 3·9

The saving in coal effected on above machine tools amounted to 30 tons per week, after the adoption of the electric system.

The author now wishes particularly to draw the attention of engineers to the concentration and distribution of power in works by means of electricity, and in order to fully demonstrate his ideas on this subject he has had two diagrams prepared, one showing the various cases of power transmission one meets with at an old works, and the other showing the way in which these works could be remodelled, and what savings could be effected by a judicious application of electric power. Of course the works represented above are purely imaginary, but it will be found that almost any works will contain some or other of the examples of power transmission depicted on this plan. The plan contains examples of power transmission met with in iron and steel works, engineering shops, shipbuilding yards, etc. In the case of the old works there are examples: 1. Of a large number of scattered steam engines; 2. long lines of shafting and belting in the various shops; 3. considerable lengths of steam pipes; 4. separate and scattered groups of boilers; 5. low pressure steam; 6. old or uneconomical engines, especially in the smaller sizes; 7. intermittent character of the work.

Turning back to these cases, it is very evident to all engineers the great economy which would be realised if all these scattered engines could be concentrated in one large and highly efficient engine. The amount of coal taken per unit of work done would necessarily be very much less, and in replacing these engines by electric motors the services of a large number of men could be dispensed with.

Taking the second case of shafting and belting, the author thinks that few engineers really realise what is actually lost in the transmission of power through long lines of main shafting, counter shafting, pulleys, belts, etc. The power lost has often been ascertained to vary between 30 and 69 per cent. of the total power transmitted.

In the case of long steam pipes, it is a difficult matter to entirely prevent condensation, and one is always liable to leaky valves and joints. With separate boilers, this of course entails extra men to attend to the firing. With low pressure steam, it is impossible to use the economical class of engine one could do with high pressures. In many large works the auxiliary engines are often found to be of an uneconomical nature. The work carried out is frequently of an intermittent nature, and machines which should be stopped when not in use are left running.

The author will now proceed to demonstrate a manner in which these old works could be entirely remodelled so as to effect an enormous saving both in coal consumption, wages, and upkeep.

The first thing to be done is to make a general survey of the whole works, and to have as many engines indicated as possible. Where this cannot be done it would be advisable to lay down a small temporary installation of an engine and dynamo, with a motor which could be transferred from one machine to the other, in order to ascertain accurately the exact power absorbed by the

*Iron and Steel Institute of Great Britain.

machine in question. In this way an accurate opinion could be formed of the amount of power actually required for operating the different machines throughout the works.

Having arrived at the total horse power absorbed by all the scattered and outlying machinery, it is advisable to divide this into, say, two units of power. If the total power involved is 1000 horse power, this would mean that it would be advisable to have two units of 500 horse power each.

The reason why so large a power is selected as unit is that in electric power installations the load diagram will be found to be of quite a different nature to that of an electric lighting station, which exhibits a more or less constant rise and fall according to the time of day, whilst the load line in an electric power station is of a very different and fluctuating nature, varying at times between a quarter and full load, half load and full load, and so on. It is necessary, therefore, both for simplicity in working and for economical reasons, to have a steam dynamo capable of giving out current for at least half the installation. It would be necessary in the case of the five small machines to keep them all running, even if the load was only 25 per cent. of the total, in case at any moment the load should suddenly rise. This practice has been adopted in nearly all large power installations on the Continent, and the author cannot help feeling that it is the right one.

In the case of works where waste furnace gases are available, the evident site for the generating plant would be in close proximity to these furnaces, in order that the boilers of the generating plant might be fired by the waste gases, the cost of the production of the electric current being thereby reduced to a minimum. Should there be no waste furnace gas available, the generating plant should then be placed close to the main battery of boilers in the works, and if these boilers are of a pressure below 80 pounds, it will be found economical to lay down entirely new boilers of say 150 to 180 pounds pressure.

Having settled on our site, the next question to be decided is the form which the generating plant should take. In the case of a unit as large as 500 horse power, one out of three alternatives may be resorted to: a compound condensing Corliss engine running at 80 revolutions per minute, with a multipolar dynamo, built up after the Continental fashion with the armature forming the fly-wheel of the engine, may be employed. Great confidence may be placed in a plant of this description, but the initial cost is comparatively a large one, owing to the large dimensions of the dynamo, and the slow speed at which it runs. If this speed were doubled, and an engine running at say 160 revolutions a minute taken, it would be possible to employ a triple expansion marine engine provided with condensing arrangements. A great reduction will be effected in the cost of the dynamo, and an engine of this type should work with great economy. It will be found necessary, however, to provide this marine engine with proper automatic expansion and regulating gear, owing to the variations in load and the necessity of absolute steadiness in running. The third alternative is still further to increase the speed of the dynamo, and to employ an engine of the high speed type, similar to those adopted in our electric lighting stations. These engines would run at about 300 revolutions per minute, thereby doubling the previous speed of the dynamo, and again reducing its cost. These high speed engines would be of the triple expansion type, and provided with condensing arrangements. Their consumption should not exceed 15 pounds of steam per indicated horse power per hour. In any case, the plant to be laid down should be of the steam dynamo type, that is to say, steam engine and dynamo combined on one and the same bedplate, and direct coupled.

Having taken a decision as regards the generating plant, it is necessary next to consider the actual application of the electric motors themselves to the various machines, and the distribution of the power generally. According to the character of the works, the main conductors would be carried either overhead or in a culvert underground, and, in order to keep down the cost, should be, if possible, bare copper, uninsulated. As works which have not a greater extension than 300 or 400 yards in length are now under consideration, the voltage which will be employed will be of a low tension.

In this manner can not only the whole of the power be run off the one single generating plant, but the entire lighting, both arc and incandescent, of the works themselves. The author considers that the voltage in such a case should be 120 volts. If the distances are too great to allow of this, owing to the expenditure in copper, the voltage could be increased to 500 volts. In iron and steel works, however, the low voltage is for many reasons preferable, as it is far easier to maintain a high insulation on a low voltage system than it is when a high voltage is employed. In all cases where new machinery is ordered for extensions or otherwise in the works, it would be preferable to embody the electric motor in the actual construction of the machine tool itself. In the case of old works, this is hardly feasible, and the next best thing to do is to drive direct by belt on to the fly-wheel of the machine in question. The motor itself, in the case of machines having to start up against any sudden or heavy load, should be of the shunt-wound type, with the shunt coils permanently excited off the line. Every motor should be provided with a starting and stopping resistance switch, by means of which the current could only be thrown gradually on to the machine, thus ensuring slowness and steadiness in starting up, and avoiding any sudden rises of voltage in the magnet coils, owing to instantaneous breaking of the circuit. Every motor should be enclosed with a suitable covering to protect it from damp or dust, and should, if possible, be kept under lock and key, only an authorised attendant having access to the motors. The author has found the use of carbon block brushes almost indispensable with motors, and especially with those that have to run in both directions. The oiling arrangements of every motor should be perfect.

Supposing that the whole of the outlying machinery is actuated by electric motors, and that motors have been substituted for the engines and boilers on the overhead and locomotive cranes, that the driving power in the fitting shops and other places where shafting is employed has been split up, and that separate motors have been applied to the various counter shafts, the following are the practical results which will have been obtained by remodelling the old works on the lines described and shown in diagram No. 2.

Coal Consumption.—The total efficiency of the new installation, provided that the distances involved do not exceed 500 yards, should attain 75 per cent. The loss of 25 per cent. would be made up as follows:—

Loss in main generating dynamo..	7 per cent.
Loss in the mains..............	3 "
Loss in the motors........	15 "

In many works where the engines are very much scattered, it will be found that the coal consumption per horse power of work turned out will amount from 8 to 15 pounds of coal and even more. Although a great reduction in the coal consumption will be effected through the use of the improved class of machinery employed and means for transmitting the power generated, there is another way in which the coal consumption can be further decreased, and that is by the instantaneous switching off of the motors when not in use. Many of the outlying engines in the old works will no doubt have been left running when not actually employed; and even when not running a considerable quantity of steam may have been escaping from them or from the steam pipes leading to them. Unlike steam, the moment a motor is switched off, electric current ceases to be generated, and the small loss in conveying the power through cables instead of steam pipes is a matter evident to every engineer. In the case of the remodelled works, the coal consumption at the end of a year's work will probably be found to be one-half, or even less, of what is was previously, before the adaptation of electricity.

It is advisable that in every case the electric lighting of the works should be combined with the power, current for the lighting being obtained from the same generating dynamo. In looking at a total coal consumption, it must be remembered that the considerable proportion of this goes towards the electric lighting. Previously the works may have been lit either by gas, oil, or lucigen lights. In the case of the remodelled works, the lighting would be carried out in the yards by means of arc lights, in the fitting and engineering shops by means of inverted arcs, and in offices and such places where arc lighting is not suitable, by means of incandescent lighting. The cost of coal consumed in producing electric light for the whole of the works, should compare very favorably with that of gas and oil lighting previously employed.

Wages.—The next point to be considered is that of wages. It is evident that by the entire suppression of the scattered boilers, the services of a considerable number of stokers can be entirely dispensed with. This is also the case with those steam engines which require an engineer to run them. It is also probable that more men will have been employed in looking after the gas and oil lighting, than will be required for the electric light. The motors can be kept practically under lock and key. Should anything go wrong with them, this will be at once indicated on the instruments in the engine room, and an attendant can go from there to see what is the matter. The motors, therefore, in no way involve the necessity of special attendants, and one man to see that they are properly oiled and the brushes set, is all that is required. For powers up to 500 horse power, one stoker, one engineer, and one electrical attendant, is all that should be required at the generating station per shift. It will therefore at once be seen, in comparing diagram No. 1 with diagram No. 2, that the wages of a large number of men could be entirely dispensed with, owing to the application of the electric system.

Upkeep.—We have now a further point to consider, and that is the question of upkeep of such an electrical installation. The upkeep on electric power installations which have already been running over three years, involving the use of a large number of motors, arc lamps, etc., has proved that this can be safely estimated at something under 5 per cent. on the total capital expenditure of the electric installation. No hard and fast rule, however, can be laid down for the exact cost of upkeep, as this must necessarily vary with the different classes of works to which electricity is applied. It is clear, however, that the maintenance of bare copper conductors must be very much less than that of a large system of steam pipes, lines of main shafting, ropes or belts, which have hitherto been employed as a means for transmitting the power, from the generating source to the spot at which the power is actually applied. The depreciation on the copper cables should therefore be very small. As to the upkeep of the electrical machinery itself, nearly everything depends on the cleanliness with which this is kept. If properly attended to, the only wearing parts requiring renewal wil consist of bearings, brushes, and commutator, all of which can be replaced for a very small outlay. These renewals compare very favourably with renewals in steam engines, shafting, gearing, etc. The cost of upkeep of a well considered electric power installation shoul therefore be very low; and, indeed, many proofs are forthcoming that this is actually the case.

Control.—The author thinks that one of the most important features in connection with electric power installations is the absolute check or control one has over the coal consumption and running expenses at the works. It is advisable, where possible, that circuits from all motors or groups of motors should be taken direct to the generating station, that on each of these circuits a separate ammeter should be placed, which will indicate the exact power taken by any of the machines at any time of the day. With a little practice, the man in charge at the engine room can tell from the various indications on the measuring instruments almost exactly what the various machines in the works are doing—whether standing idle, or whether working up to their full power or not. By means of an automatic registering ammeter placed in the main dynamo circuit, the total amount of power going off into the works will be recorded on a card; and the coal consumption for the day having been kept, the cost of production per unit of electrical energy can be ascertained. Owing to the self-indicating nature of electrical motors, in this and other ways, can a most perfect check be kept on the running expenses of the electric power plant, and the slightest loss due to leakage or undue resistence in any part of the electrical apparatus can be at once detected and remedied.

Rolling Mills.—It is quite within the bounds of possibility that electricity may find a new opening in its application to driving the lighter class of rolling mills. The result, as far as economy in steam consumption is concerned, would show a great saving on methods formerly employed. The saving would be arrived at in the following manner: Instead of the present form of engine used for actuating the rollers, which is necessarily of a somewhat uneconomical nature owing to the work it has to perform, and in which the cut-off is of a very imperfect character, an engine could be laid down on the most highly economical principles, working at a high pressure, with three expansions of steam, and taking not more than 1½ pounds of coal per 1 horse power per hour. This engine would be coupled direct to a dynamo of suitable power, and the steam dynamo generator would be kept running continuously. On each set of rollers would be directly coupled an electric motor. The switching apparatus would be worked by means of hand and foot levers, almost in identically the same manner in which the steam is shut on and off existing rolling mill engines.

An electric motor may be considered as an elastic coupling in itself, and provided that the power furnished to it is sufficient, it will revolve when the necessary torque has been obtained. The jar, however, would be furthermore reduced by mechanical methods of coupling, and the wr ter does not anticipate any difficulty in being able to obtain a motor which would resist such strains as would be put upon it. The switching apparatus, however, would require carefully planning out and constructing, in order to withstand the rushes of current which would take place through the apparatus, but here again there is nothing that cannot be overcome.

The main advantages, however, to be derived from the electric system, would be the following:—

1. The question of dead centres would be practically eliminated. An electric motor in itself, unlike a steam engine, having no dead centre. The main engine driving the generating dynamo being kept continuously running, the difficulty of dead centres would be overcome there also, the result being that the total size of the engines employed would be considerably reduced, as in the present case it is necessary that either cylinder of a rolling mill engine should be capable of starting the rolls from nothing to full load, in case one of the engines should be on its centre.

2. Owing to this new arrangement of driving, a totally different class of engine could be employed to what is now used, and instead of using 7 to 8 pounds of coal per indicated horse power owing to its imperfect cut-off, the coal consumption should be reduced to 1½ pounds per indicated horse power.

3. A considerable number of small mills could be actuated in totally different parts of the works by means of the one generating engine and dynamo, and would thus save wages and upkeep over several smaller engines scattered about.

4. The whole of the auxiliary engines required for working the live rollers, elevating, or transverse gear, overhead cranes, etc., could be replaced by electric motors all worked of the one generator.

5 Great economy in steam consumption owing to concentrating the production of the power in one spot, under highly efficient conditions.

In speaking of the above applications the author does not, of course, refer to the heavier class of rolling mills, which absorb several thousands of horse power, but firmly believes that as regards the lighter class of mills there is a future for the application of electric power, the great advantages to be derived being the large economy which could be effected in coal consumption and wages.

There is another point that should be taken into consideration when laying down an electric power installation, and that is, the small size of the motors themselves, which, owing to the rotary and not reciprocating motion, only require light and inexpensive foundations. The same thing applies also to the foundations required for the central generating plant.

Engineering Works and Shipbuilding Yards.—The same arguments apply to the application of electricity to engineering shops and shipbuilding yards as have already been cited. In shops where the work is of a very intermittent nature, it would be an economy to drive the larger machine tools by separate motors, and there is do doubt that in the near future manufacturers of machine tools will turn their attention to embodying the electric motor in the actual construction of their tools. Where the tools are of a lighter character, economy will result from doing away with the main shafting, and applying motors, at the intersection of this with the secondary lines of shafting, and in other ways subdividing the power and running the various machines, as far as possible, independently one of the other.

The following table, calculated by Mr. Felix Melotte, shows a very interesting comparison between the efficiencies, obtained on a varying load, of electrical and mechanical transmission of power:—

Electrical Transmission.

Load on the engine	1000	750	500	333	250	200
Constant frictional loss	50	50	50	50	50	50
Variable electrical loss	50	27	11	4.5	2.2	1.2
Total loss in dynamo	100	77	61	54.5	52.2	51.2
Available power of dynamo	900	673	439	278.5	197.8	148.8
Efficiency, per cent	90	89.7	87.8	83.5	79.1	74.4
Loss in conductors	18	10	4	1.7	0.8	0.5
Energy available at motor terminals	882	663	435	276.8	197	148.3
Of which, 6 per cent. frictional loss	53	53	53	53	53	53
4 per cent. variable loss	35	20	8.5	3.4	1.7	1
Total loss in motor	88	73	61.5	56.4	54.7	54
Power available	794	590	373.5	220.4	142.3	94.5
Final efficiency, per cent	79.4	78.7	74.7	66.2	57	47.2

Mechanical Transmission.

Load on engine	1000	750	500	333	250	200
Loss in shafting, etc.	206	206	206	206	206	206
Useful effect	794	544	294	127	44	0
Final efficiency, per cent	79.4	72.5	58.8	38.1	17.6	0

From this table it will be seen that the two systems of transmission, which at first appear to be equivalent, become very different as the load diminishes. Thus, when only one-fifth of the power is developed, electrical transmission still yields 47.2 per cent, whilst mechanical transmission has had all its power absorbed in the constant frictional loss of 206 horse power.

In shipbuilding yards there are few machines that cannot be run electrically. The whole of the machinery usually found in the machine sheds, such as punching, shearing, bending machines, etc., saws, wood-working machinery, can all very easily be run by electric motors. Owing to their light and portable nature, there is a considerable opening for electric machines on board ships during construction. Electric power can be utilised with advantage for the drilling of ships' plates, temporary winch and derrick crane work. The author understands that it has also been successfully applied for planing wooden decks.

Results Obtained—There are few works in this country, if any, that are solely actuated by electricity. The principal applications of electric power for driving works, up to the present, may be found in the workshops of electric manufacturers themselves, who have naturally had more opportunities for investigating the advantages to be derived from electric driving.

In order to give some idea of results actually obtained in the running of works for a considerable period, the author will take some figures from electric power installations carried out in Belgium, which have now been running some three years, cases in which the entire works have been actuated solely by electric power. This information may possibly be of interest to the members of the Iron and Steel Institute, who before long will be paying a visit to Belgium. One of the first, and perhaps most important, electric power installations that has been laid down in that country, is that of the National Arm Factory at Herstal, near Liége. It would be impossible in this paper to deal with a full account of this installation. The plant in the first instance consisted of a 500 horse power compound Corliss engine and multipolar dynamo combined, the armature acting as fly-wheel of the engine. The Arms Factory is solely and entirely driven by electricity derived from this one dynamo, which provides at the same time the whole means of illuminating the works. Until about nine months ago there was no other engine or dynamo on the place. Some 2000 hands are employed, and have been dependent for over two years on the running of this one dynamo. There has been no stoppage from the day of starting the installation up till the present time. About nine months ago another 300 horse power was put in. This, however, was not to act as reserve power, but to supply power for extensions which had been made to the factory. The steam consumption of the engine is 13 lbs. of steam per indicated horse power. The total efficiency, reckoning from the indicated horse power of the engine, has proved itself to be 71.3 per cent.

Following the example of the National Arm Factory, the Belgian Government decided to remove all the steam engines and boilers from the Royal Arm Factory at Liége, and to replace them by electric distribution. It was ascertained that for a certain portion of the work which, previous to the introduction of electric driving, had taken 3 tons of coal per day, this was found to have immediately come down to 900 kilogrammes, or less than 1 ton, for the same amount of work done.

About a year and a half ago a 100 horse power dynamo and six or seven motors were laid down at the glass works of the Val St. Lambert, Belgium, the total efficiency attained coming out to 75.5 per cent.

At the zinc works of the Veille Montagne Co. a large electric power installation has lately been laid down, by means of which these old works will be entirely remodelled, every engine and boiler on the place being done away with. The power at present installed consists of a 600 horse power dynamo and compound Corliss engine combined, running at a speed of 80 revolutions per minute, and wound for a voltage of 500 volts. The following are the number and sizes of the motors employed in this installation:—

5 motors of	1	horse power.
7	"	2	"
6	"	3½	"
6	"	5	"
4	"	7	"
2	"	10½	"
4	"	14	"
2	"	45	"
1	"	64	"

The following additions are now being made:—

1 motor of	80	horse power.
1	"	14	"
5	"	1	"
1	"	10	"

Another section of 600 horse power is provided for. The engines have been specially built by the Société Cockerill, and the dynamos by the Compagnie Internationale d'Electricite, under the direction of their chief engineer, Mr. Henri Pieper. Babcock & Wilcox boilers are used, and the steam engine takes from 13 to 14 lbs. of steam per indicated horse power. The efficiency of the engine is 90 per cent., that of the main generating dynamo 90 per cent. at full load, and the efficiency of the distributing cables, also at full load, is 98 per cent.; the average efficiency of the motors is 86 per cent., and the commercial efficiency of the whole installation is there ore 68.5 per cent., that is to say, the proportion of work done to the indicated horse power of the steam engine. A continuous current transformer is used to reduce the voltage from 500 to 100 volts for lighting purposes.

Several works in Germany and Switzerland are also operated solely and entirely by the electric system.

CONCLUSION.

Taking into consideration all that has been stated in the preceding pages, it will be seen that electric power is destined in the near future to become an important factor in the iron, steel, and engineering trades. Whether applied for the purpose of long distance transmission at the mines, or for short distance transmission and concentration of power at works, great economy will be realised in wages, fuel, and upkeep, over methods hitherto employed. Old works can be remodelled with advantage, as shown in the cases of the Royal Arm Factory and the Veille Montagne Zinc Works in Belgium, and the case of Messrs. Dorman, Long & Co's Steel Works at Middlesbrough, and what possibilities lie open to those contemplating laying down entirely new works! The author was fortunate a few months ago to come across a company who were about to lay down entirely new works, and finally succeeded in getting them to promise to look into the electric power question thoroughly before taking any definite decision as to what power they would adopt for their works. Some four months were spent in visiting power installations in this country and abroad, and the electric system was minutely compared with steam and gas, actual experiments were carried out, with the result that the Bedson Wire Company finally decided on adopting electricity as their sole power for manufacturing purposes.

These works in many respects are so entirely novel, the question of economy has been so minutely gone into, that the author belives that Mr. Bedson, in the course of a few months, will be able to publish a record in working efficiency and steam consumption which has seldom, if ever, been equalled. Messrs. Bell Brothers, of Middlesbrough, who have also been taking great interest in electric power question for some time past, are installing electric power at their Clarence Works.

There are, no doubt, many of the author's colleagues in electrical work who could add many interesting examples of electric power applications in this country.

The author trusts that in the foregoing paper he has shown that electric power has passed out of its experimental stage, and should he have been so fortunate as to have provided a subject worthy of interest, and subsequent discussion by the Iron and Steel Institute, his task will have been amply accomplished.

Pneumatic Electric Coal Cutting Machine.

At a recent meeting of the Manchester Geological Society, Mr. Joseph Crankshaw read a paper describing Hurd's pneumatic electric coal cutting machine. He said that the president of that society, in his address at the opening of the session, mentioned the fact that coal cutting machinery had not been adopted on a large scale in this country, and it was strange that, while mechanical was superseding manual labour in so many branches of industry, and while they were doing everthing they possibly could to improve their appliances for pickin., screening, winding and hauling the coal, and ventilating and lighting the mine, the actual tool for extracting the coal—viz., the collier's pick—was practically what is was a hundred years ago. He thought that not only for the sake of economy, but in the cause of humanity, it was a reflection upon the enterprise of Lancashire that there was not a single coal cutting machine at work in the Manchester district to-day, and he ventured to bring the subject before the society, not from any special knowledge he had upon it, but in the hope that his action might, if only to a feeble extent, stimulate thought upon the subject.

In considering the subject of motive power for coal cutting machines, he stated there are three methods of driving to choose from, viz., steam, compressed air, and electricity, but the heat from steam and the difficulty of dealing with the exhaust in the workings practically reduce the choice to compressed air and electricity. There is much to be said in favour of compressed air; it is safe and helps to cool and ventilate the workings, but the loss in transmission is very great. The machine, briefly stated, consists of a cutter bar drill and an electric motor, connected by suitable gearing. The combined forged or cast-steel cutters bar drill, with separate chilled steel or chilled iron cutter fixed on its end along its fluted or twisted periphery is actuated by the motor, and is caused to revolve and reciprocate in a twisted or rifled sleeve having a key cast in it, which fits the fluted or twisted cutter bar drill; the sleeve forms the wheel boss, by which it is driven through suitable gearing from the motor shaft. The driving wheel may be cast or keyed on the sleeve or wheel boss. A number of dovetailed recesses are formed at intervals along one edge of the twisted groove, and holes are drilled from such recesses transversely through the bar. The cutters are formed to fit the recesses, and are retained in position by a split locking shank, which may be separated from or attached to the cutter, and the head of which, when made in one piece with the cutter, springs into a countersink formed at the outer end of the transverse hole; the end cutter is of slightly modified auger form.

When the machine is brought up to the face of the coal or mineral to be operated upon the cutter bar drill is set in motion, and while revolving is fed into the face by an automatic or hand-feed motion, in which latter case a circular or screw rack is cast or cut on the cutter bar or otherwise combined therewith, a pinion being arranged to gear into the rack. When the cutter has entered to the depth required, it is locked by the reciprocating motion here and all strain taken off the feed gear. The reciprocating motion is obtained preferably by forming on the sleeve a worm thread, into which gears a worm wheel, carrying on its gudgeon two crank pins, which actuate two rocking levers. Fitting around the sleeve between two or more shoulders is a thrust block in halves, each half being coupled by a right and left hand screw. These divided thrust blocks are fitted to connecting rods operated by the rocking levers, which imparts the reciprocating motion of the latter to the cutter bar drill when the thrust block and drill are connected. The machine is traversed forward along the face of the mineral by means of a snatch block and a hauling drum, chain wheel or connecting cranks, and rods mounted on the axis of a switch, the casing of the latter being fixed to the front trunk of an electro-motor, and the hauling drum, or chain wheel and connecting cranks and rods, is or are driven from the motor shaft by means of worm gearing and friction cones. The cutter bar drill at the same time revolves, thus cutting away the coal in front of it, while its reciprocating motion assists in breaking up the coal and dislodging any lumps of pyrites that may be met with. In order that the coal or mineral may be nicked on end to expedite the breaking down of the mineral when undercut, the cutter bar drill, with its sleeve and feed gear, are carried by a separate casting carrying the bearing for the motor shaft, and which is arranged so as to make a whole or partial revolution around the motor shaft. By this arrangement the machine is also enabled to cut either right or left hand thus dispensing with the costly left-hand cutting arrangement required in other machines.

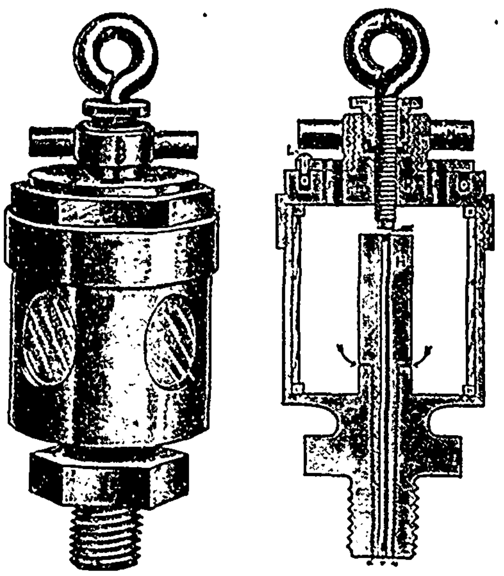
In ordinary machines the vibration when at work is very great, but this is greatly reduced by fixing or constructing the journal to carry the cutter bar drill at an angle of about 80 degs., with the rails in the direction in which the machine is moving, thus causing the machine to hold itself well up to its work. To take out the cuttings made by the cutter bar drill a clearing bar is used, preferably U shaped in section, set at an acute angle to and behind the cutter bar drill, and fixed to the machine by suitable means when at work. The cuttings are caused by the forward motion of the machine to slide along the face of the cleaning bar, and are deposited between or at the side of the rails as the machine proceeds. Irregularities are removed from the face of the mineral and from the floor by means of a fixed cutter attached to the journal casting of the cutter bar drill, and forming at the same time a cover for the thrust lock gear. This fixed cutter has a cutting edge to clear the bottom, and an inclined cutting edge to remove projections on the face of the mineral, sufficiently high to clear the cutter bar bearing. The fixed cutter is also formed with an inclined groove, so arranged as to carry the cuttings back over the cutter bar front journal to the rear of the machine. The machine is thus enabled to proceed with its work without stoppages. In using the machine for tunnelling or sinking a slight modification is necessary.

The danger of working an electric motor in an explosive atmosphere has been overcome in the novel manner which has given the machine the name of pneumatic electric. The motor and all the moving parts of the machine, except the drill, are enclosed in a neat insulated casing, both air and water tight. The wires conveying the electric current are enclosed in a flexible tube, which also carries a supply of compressed air, which enters the machine along with them. The motor is thus immersed in a bath of cool, dry, compressed air, which is kept constantly passing through every part, and is discharged into the atmosphere of the mine at the pressure of 15 pounds to the inch, which effectually prevents anything from the mine getting into the machine, and also helps to cool and purify the air. The coal cutting mechanism can be detached, and the motor used as a locomotive for hauling the coal along the main roads. At collieries where electric and air compressing plant are already at work the motor power can be taken from them; but Mr. Hurd has also patented a direct-activity engine for driving the dynamo, and an air pump for the compressed air is worked from the same shaft, so that the whole of the power for the machine can be derived from the same self-contained engine. Mr. Hurd has also designed special rails for the machine, made of malleable cast steel in one yard lengths, and with steel sleepers. The machine as a whole has a strong, neat, workmanlike appearance, and gives one the impression that it will stand the rough and tumble of the mine, from ironstone modules in the coal, to falls of roof on the face, without much damage. Among its advantages are the following: It not only undercuts the coal, but nicks on end, and will cut either right or left hand, while the drill can be instantaneously withdrawn to sharpen the cutters and another as quickly inserted; the self-acting scoop fills the holings into bags straight from the face; the exhaust air helps to ventilate the mine; electric lamps can be attached to it for lighting the working place; and it can be used as a locomotive.

Mr. C. Cookson said he should not like the impression which seemed to be conveyed by the opening portion of the paper read by Mr. Crankshaw, to the effect that colliery owners had not done all in their power to provide the best appliances for the safe working of their mines, to go forth without some remark. The reason why coal cutting machinery had not been more largely adopted in the collieries throughout Lancashire was not because of any prejudice against them, or unwillingness on the part of the coalowners to adopt them, but simply because inventive engineers had not produced machines that would work successfully with the bad roofs they had in most of the mines. He had worked with several of the machines, and had not found them suitable for working the mines in the district. The machine described, however, seemed to him to be an effective one, and, subject to the question of satisfactory arrangements, he should be disposed to try a machine of that description in one of their mines. It was not so much a question of diffidence on the part of the coalowners to the introduction of these machines as of obtaining a machine which would satisfactorily and efficiently do its work.

A New Crank Pin Oil Cup.

There has always been a demand among engineers and engine builders for a Crank Pin Oil Cup, which will give a steady flow of oil in just the right quantity to keep the crank pin from heating, while not allowing sufficient oil to pass to it so as to cause a waste. Many schemes have been devised for effecting this result, but up to the time the Penberthy Injector Co. placed their Safety Crank Pin Oiler on the market, about two years ago, there has been nothing devised that was entirely satisfactory. Cups have been made which would insure a steady flow of oil, but many of them were so constructed that when in use the oil would be thrown out of the top of the cup, and others were very easily clogged by dirt. The Safety Cup met with a very rapid sale, owing to its simplicity of construction, and its very satisfactory operation. The Penberthy Co., however, is noted for never being satisfied until the articles which it manufactures are as perfect as skill and ingenuity can make them. Recognizing the fact that their cup, as originally made, had one or two weak points about it, they set to work to remedy these defects, and have recently produced their improved Double-Feed Crank Pin Oiler, which we illustrate herewith. The



improvements have lessened the number of parts of which the cover is composed and have also simplified the construction of the cup, while at the same time allowing of a much finer regulation than any other cup made. A careful reading of the following description will show the points wherein the cup is superior to others.

H is the plunger, which rises and falls with the motion of the engine, forcing part of the desired amount of oil to the crank pin, while at the same time the oil is flashed on top of the plunger and passes down through its hollow center, thus giving two distinct and separate feeds, so that in using this cup there are two chances against its feed becoming clogged. K is the cover of the cup, containing two passageways P, P. One of these is to allow the oil to enter the cup, and the other is the vent hole by which the air in the cup passes out. On top of the cover is an escutcheon S, operated by means of a handle N passing through it. When the cup is in operation, this handle is turned hard to the right, bringing the holes in the escutcheon out of line with the holes in the cover of the cup, and the escutcheon being threaded and turning on a corresponding thread on the cup cover, allows of an absolutely tight seat being made between the escutcheon and the cover, so that it is impossible for the oil to spill out while the cup is working. To fill the cup, the handle N is turned to the left until the holes in the escutcheon and the cover are in line, when the oil can be quickly poured in from a spring bottom can, and as the air is allowed free vent through the vent hole, there is no spilling of oil possible with ordinary care. In this manner the cup is filled without changing the regulation in the least. The screw L, passing through the escutcheon allows it to turn to the left just a sufficient distance to bring the holes in line. The feed is regulated by the regulating screw R, which admits of a regulation as fine as $\frac{1}{1000}$ of an inch or less. This regulating screw passes through the stuffing nut M and through the packing I, in the same manner that the stem of a globe valve passes through its stuffing nut, and the tension on the regulating screw is altered by turning this stuffing nut M same as the packing is tightened or loosened on a globe valve.

As will be seen, the cup is simplicity itself, and it is impossible to get it out of order. The plunger H having a square shoulder against the bottom of the cup, the oil stops feeding as soon as the engine stops running, and there is therefore no waste. Owing to its fine regulation, it can be set to feed just the desired amount of oil, and with the proper size cup it can be so regulated as to run for a half day or a full day as desired, so that the engine need never be stopped to refill the cup, and the only attention required from the engineer is to fill it at the proper time, as it does its work automatically. This cup has been adopted by several of the largest manufacturers of threshing engines in the United States, and also by several large engine builders, and wherever introduced is meeting with a rapid sale.

The manufacturers, the Penberthy Injector Co., of Detroit, Mich., will be pleased to send descriptive circulars and quote prices on application.

Disputed Mica Ownership Settled: The Court of Review, Montreal, on 30th ulto, gave judgment in the cases of A. W. Stevenson vs. Wallingford, and Gilman and Hatch, et al, defendents en garantie, confirming, with costs, the decision of Judge Gill at Alymer by which Mr. Stevenson was declared the owner of the mining rights in dispute and was awarded the sum of $3,300 for the value in the ground of mineral extracted by the defendents without his permisssion. The cases were of especial interest, both to mining men and to the legal fraternity, as they involved several intricate questions in regard to the mining law of the Province of Quebec, as well as on account of the value of the property. The property was purchased, prior to the suit, from Mr. A. W. Stevenson, Montreal, by the Lake Girard Mica System, Ottawa. It is situated in the Templeton district and contains valuable deposits of large sheet mica.

The Copper Trade.

In their fortnightly "Statistics of Copper," Messrs. Henry R. Merton and Co., of London, Manchester, and Birmingham, gave the visible supply for England and France, including copper afloat from Chili and Australia, as 49,153 tons on June 15th. These figures show an increase of 1,573 tons in the available stock during the fortnight, and the quoted price of Chili bars and G.M.B's, £38 per ton, shows a further fall of 17s. 6d. per ton within the same period. The continual decline of the price of copper, regardless of the statistical position will, however, be best seen from the following table, showing the visible stocks and the prices at various dates:

	Visible Supply Tons.	Price. £ s. d.
May 31, 1891	58,258	55 5 0
May 31, 1892	53,965	46 7 6
May 31, 1893	49,951	43 2 6
May 15, 1894	46,259	39 10 0
May 31, 1894	47,580	38 17 6
June 15, 1894	49,153	38 0 0

It is true that the decline during the past four weeks has been coincident with some increase of stocks, but a glance at the figures for previous years shows that with falling stocks prices have also fallen. Thus with the stock now nearly 16 per cent. less than at the end of May, 1891, the price is about 31 per cent. less. The latest mail advices from the United States intimate that orders had meanwhile, that is since the beginning of this month, been placed for quite a large quantity of Lake Superior ingot copper for delivery several months ahead, the amount thus contracted for being estimated at about 10,000,000 pounds, and the price 9 cents per pound, or, say, about £41 5s. per ton. These transactions, it is stated, have served to unsettle the market. There have been exceptionally large exports of ingot copper from the United States to this country and the Continent during the past year, as will be seen from the following table showing the figures for the first 10 months, July to April inclusive, of the fiscal years 1893-4 and 1892-3 respectively:

	1893-4. lb.	1892-3. lb.
To United Kingdom	61,069,038	2,308,259
" Germany	21,164,702	2,863,142
" France	26,619,864	9,769,766
" Other Europe	59,427,139	9,261,520
" Other countries	617,311	209,252
Total	168,838,054	24,411,939

The American Nickel Market in 1893.

The nickel trade in 1893 differed considerably from preceding years, as consumers found no difficulty in getting what they needed, while before they had often been hard put to secure supplies, the question of price not considered. Then it was the custom to make contracts calling for deliveries a long time ahead, the terms of such contracts not being allowed to become generally known. This year it has not been so, as what was left over from the supplies contracted for 1892, together with what was readily obtainable, was amply sufficient to enable the manufacturers to fill all demands for German silver, while the nickel plating business, like many another, has been almost at a stand still.

In previous years almost all the nickel came from abroad, although there was one producer at home, in the interior, who now produces chiefly from Canadian ores, selling under the old time brand. The new factor in the market has been the Canadian Copper Company, whose product being placed upon the market, to compete with any and all others, caused the foreign makers to reduce their prices, which, at the opening of the year, were about 60 to 62 cents, while at the close they are but 52 to 53 cents, American refined nickel being quoted at 45 to 47 cents.

Most of the nickel produced in this country from Canadian ores has been exported to Europe in the form of oxide of nickel, for which a ready market, notably among the iron and steel industries, has been found. *The Mineral Industry*, 1893, vol. II.

Repairing a Broken Pipe in a Mine.

An interesting expedient was adopted in replacing a broken length of pipe at the Claycross Colliery, described as follows in a mining journal: The pipe in question was the discharge pipe from a set of pumps, and was carried vertically up the shaft, its length being about 420 feet and its diameter 6¾". The break took place in the lower portion of the pipe; and to make the repair it was necessary to raise the column slightly. To this end a couple of balks were put across the shaft at a height of 70 feet above the pumps. These timbers formed a support for a sleeve which could be clamped to the pipe. By turning steam in the pipe the latter was warmed and expanded, and it was then clamped by the sleeve. The bolts being loosed at the broken length; the pipe as it cooled contracted upward, leaving a 1" space at the broken joint, thus giving room for the insertion of a new section.

Compressed Air at High Pressure for Tramways.

It is not much more than thirty years since street tramways were brought into use in this country. During this period their development has gone on rapidly until there is now a large capital invested in these properties. Compressed air is used as the motive power in driving locomotive cars on a few tramways, and the same power is applied for locomotive traction in coal mines. The experience gained in working tramways may possibly be applied to the more advantageous working of locomotives underground, where long distances and other circumstances give some scope for this system of haulage. Both above and below ground the competing systems are horse traction and ropes worked by stationary engines. Besides these there are locomotives on tramways driven by electric power and steam.

For tramway service, the engineer will be guided in his choice of a system by questions of economy, safety, and convenience. Horse traction may be convenient, but it is not generally economical, while steam locomotives are generally inconvenient and not adapted to circumstances inseparable from the traffic of towns, large and small, though it is principally in the latter where they have gained a footing The getting rid of the exhaust and products of combustion is the chief difficulty in this form of traction.

For tramway locomotives driven by compressed air, several designs have been brought out in the past, of which the following are most noteworthy.

In Colonel Beaumont's locomotive the air was compressed to sixty eight atmospheres, equal to about 1,000 pounds per square inch. It was compressed in four stages, passing successfully from one air cylinder to another without difficulty, the heat being absorbed to a certain extent at each stage. The first compressing cylinder was 12 in., the fourth $2\frac{1}{2}$ in. diameter. The engine itself worked on the compound principle, the storage at the above pressure consisting of seventy steel cylinders, 6 feet long, 4 inches diameter, two of the cylinders being $1\frac{1}{2}$ in., two of 3 in. and two of 7 in. diameter. The engine worked over the ordinary 4 ft. $8\frac{1}{2}$ in. gauge. Trials were made with it on the Metropolitan Railway, but the necessary plant to work the line on this system would have been great, and made it prohibitory.

Another engine of the same type was constructed by Colonel Beaumont to work on tramways, the gauge being 4 feet $8\frac{1}{2}$ inches. The air was compressed in four stages, up to near 1,000 pounds per square inch. The locomotive had two cylinders, to work on the compound principle, the first or high pressure cylinder being $2\frac{3}{4}$ in., the low pressure cylinder 10 in. diameter. The consumption of air at 1,000 pounds pressure was 10 cubic feet per mile.

Mr. Scott-Moncrieff's compressed air locomotive consisted of a car for passengers, the compressed air reservoirs and engine being placed underneath. There were three reservoirs at each end of the car, placed horizontally, each 7 feet 9 inches long, 2 feet diameter. In the space of 8 feet between each set of three reservoirs the engine is placed Each reservoir was made of wrought iron, welded at the seam, the hemispherical ends were also welded to the cylindrical part; they were tested to 750 pounds pressure The working pressure of compressed air was twenty six atmospheres, equal to 382 pounds above the atmosphere; at this pressure there was storage for 140 cubic feet of air. As this force, at which the reservoirs were primarily charged, was continually decreasing so long as the engine continued to work, and the variation in gradients had to be dealt with, it became necessary to reduce the pressure by a throttle valve to about 100 pounds to an inch, but this meant loss of power. The plan adopted was by means of adjustable expansion valves, to be able to cut off at any part of the stroke, and thus assimilate the decrease of energy in the reservoirs to the work to be done. Expansion could be carried out to its full extent—that is, to ordinary atmospheric pressure under these circumstances, there would then be no trouble with the formation of ice, as does occur when the air escapes considerably above this pressure. In a locomotive car it is desirable to start with a maximum diameter of cylinder, affording energy to overcome the maximum resistance, as on uphill gradients, and yet to cut off early so as to have the exhaust terminate almost at atmospheric pressure. This car is stated to have performed a journey of three miles with one charge of compressed air.

M. Mekarski's pneumatic locomotive has worked well on tramways in Paris. The gauge is the ordinary one on railways in France, 4 feet $8\frac{1}{2}$ inches. The air reservoirs are thirteen in number and cylindrical. At the biginning of each journey they are charged at 25 atmospheres, equal to 367 pounds per square inch. The pressure is reduced by throttling to 5 atmospheres, equal $73\frac{1}{2}$ pounds. This is the constant initial pressure in the first cylinder of the motor, but reduced by variable expansion gear to atmospheric pressure at the exhaust of the second cylinder. Before passing the throttle valve the air is heated by steam, which increases its elasticity. This tramcar is stated to have carried forty-five persons over a distance of $4\frac{3}{8}$ miles with one charge of compressed air.

The Ryhope compressors are two 33 in. cylinders, 5 ft. stroke; the steam cylinders are 32 in. diameter. The receiver at surface is 30 ft. by 6 ft. The air is conveyed down the shaft, 518 yards in depth, through 9 in. wrought iron pipes, $\frac{3}{8}$ in. thick, to the second receiver; from thence underground to a third and fourth receiver and to the first hauling engine, which is placed 1,505 yards from the receiver at bank. This engine has two 14 in. cylinders by 22 in., geared 1 to 3. The drum is 4 ft. diameter, and a train of thirty-six tubs is brought up a steep gradient in ten minutes; each tub carries one ton of coal.

MINING NOTES.

The last clean up of the Kootenay Hydraulic Placer Mining Company, on Pend d'Oreille River, B. C., netted 22 cents. per cubic yard.

Burleigh Rock Drills are being put in at the LeRoi mine, Trail Creek, B.C.

Fifteen new claims were recorded at New Denver during the first half of the month of June.

Mr. H. E. P. Haultain, M.E., has been appointed assayer to the Alpha group of mines at New Denver, B.C. This section of the district is, and in all probability will continue to be, the busiest portion of the Slocan. The number of men employed at the Alpha group, i increased, work being carried on at the "Silverton," "Fisher Maiden," "Kazabazua" and "Wakefield," while work will shortly be resumed on the "Vancouver," "Mountain Boomer," "Read" and 'Robertson," in addition to numerous assessment work.

Alex. McKenzie, manager of the Grady group, reports nearly 4,000 tons of ore in sight on the Grady and is well satisfied with the property. As soon as the railway reaches Rosebery 1,000 tons of supplies will be shipped in and an equal amount of ore sent out. Mr. McKenzie will try the experiment of shipping ore in bulk and expects to effect a saving of $6 per ton in this way.