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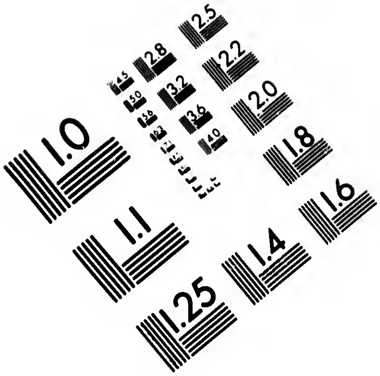

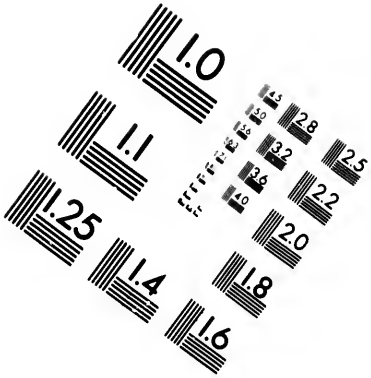

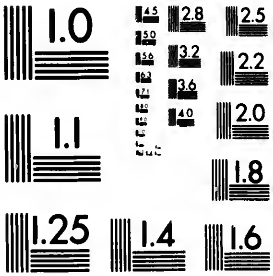

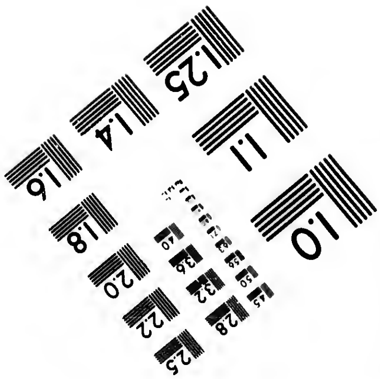

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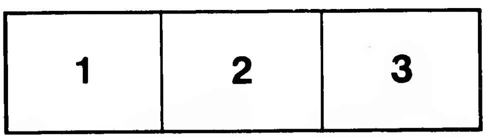

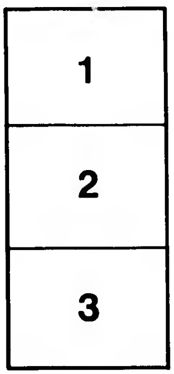

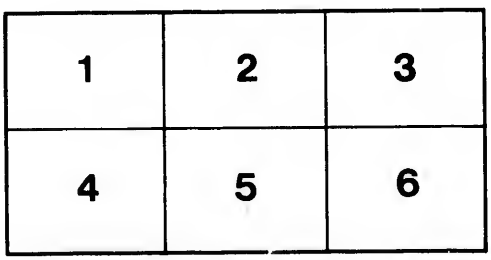

COAL MINING

IN

NOVA SCOTIA,

BY

E. GILPIN,

M.CAN.SOC.C.E.

BY THE PERMISSION OF THE COUNCIL.

EXCERPT MINUTES OF THE TRANSACTIONS OF THE SOCIETY.

VOL. II. PART. II. SESSION 1888.

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The Society will not hold itself responsible for any statements or opinions which may be advanced in the following pages.

Thursday, 22nd November.

E. P. HANNAFORD, Vice-President, in the Chair.

Paper No. 23.

COAL MINING IN NOVA SCOTIA.

By E. GILPIN, JR., A.M., F.G.S., F.R.S.C., ETC.

Deputy Commissioner and Inspector of Mines.

The earliest discoverers do not mention coal in their accounts of Cape Breton, although its outcrops in the sea cliffs are visible for miles. The first printed account is found in Denny's work, published in 1672. In 1711 considerable amounts of coal were taken away by the French and English, being broken out by crowbars, and loaded into boats. The building of the great fortress of Louisberg in 1720 led to the first regular coal mining in the Island of Cape Breton. The great numbers of artificers, soldiers, etc., engaged in its construction were supplied with fuel from the ten feet seam on the north side of Cow Bay, now known as the Block House seam. These old workings were carried on above water level, and can still be entered.

During the English occupation of Cape Breton from 1745 to 1749, the beds of coal at Burnt Head and Little Bras D'Or were drawn upon for fuel, and block houses were built to protect the workmen against the Indians and Pirates. In 1752 the pit at Burnt Head took fire, and the fort and other buildings were burned. The traces of the fire are still visible for nearly a mile along the outcrop of the seam. From this date until 1784, when Cape Breton was erected into a province, little was done in the way of coal mining. No satisfactory leases were issued, and the records show little beyond the supplies of fuel dug by the soldiers for the garrison at Halifax, and the steps taken to prevent theft of the coal by Americans, etc.

In 1820, when the island became part of the Province of Nova Scotia, more decided steps were taken, and considerable amounts of coal were mined from the Sydney main seam. Finally, in 1827, all the mines of the Province passed into the hands of the General Mining Association of London. It may be remarked here that in the Pictou and Cumberland districts the coal seams attracted less attention, as they were not so accessible as in Cape Breton; but previous to 1827 numerous attempts were made to open mines in Pictou County. The causes of the ill success of all these ventures hitherto made were the excessive royalties charged, the shortness of the leases, two to five years, and the want of a regular market.

From 1785 to 1827 the annual coal sales in Cape Breton varied between 2,000 and 11,000 tons. The selling price per ton being about $2.50. The royalties charged were from 60 to 90 cents per ton.

The transfer of the crown mineral franchises of the Province was a curious one, and marks almost the last of the excessive prerogatives exercised by the English crown in colonial matters. The Duke of York having become greatly embarrassed financially, his brother King George the Fourth, by an act of the Royal prerogative, granted him for 60 years all the mines and minerals of the Province, subject to certain rents and royalties, for the purposes of the provincial civil list. This princely gift, recalling the generosity of eastern potentates, was transferred by the Duke of York to the great firm of London jewellers, Messrs. Rundell & Bridge, who had organized the General Mining Association of London, for the purpose of acquiring and working mines in various parts of the world.

This company expected at first that the copper ores of Nova Scotia would prove a source of revenue to them, but after a careful minera. survey they decided to turn their attention to the coal deposits. They vigorously opened mines at Sydney, Bridgeport and Lingan in Cape Breton, in Pictou County at a point now known as Stellarton and at the Joggins in Cumberland County, and worked them with varying success up to the year 1858, which saw the opening of a new page in this history.

The monopoly was at first viewed with great approval in the Province, and the immense expenditures necessarily involved in starting these mines, and their equipment of foundries, machine shops, tramways, etc , were favorably received by a scattered population, entirely engaged in farming, fishing, and lumbering. In a few years, however, as population and enterprise increased, the restrictions of so great a monopoly began to cause irritation, which found expression in many an angry speech in the Provincial Legislature. Finally in 1858 the General Mining Association agreed with the Province that they would retain for a term of 18 years certain large tracts of coal lands, with powers of extension under lease, and surrender for ever all other coal seams and other minerals. The consideration for this was the reduction of the royalty on large coal to $4\frac{8}{10}$ d, and the abolition of the fixed rent of £3,000 per annum. The General Mining Association under this agreement retained possession of 46 square miles of coal lands. These areas were selected by Mr. R. Brown, then their general manager, with excellent judgment. His work on the coal fields of Cape Breton gives the Coal mining history in full detail.

By the judicious and well timed compromises made by the four parties interested,—the crown, the representatives of the Duke of York, the Province of Nova Scotia, and the Association, a happy settlement of this great monopoly was arrived at. The incubus of a single corporation, owning by an unassailable title the varied minerals of a Province, in great measure settled by those who left the rebel colonies to live under the English flag, was happily removed in time to prevent the development of feelings inimical to the powers that thoughtlessly perverted the guerdon of nature to those who had, by the greatest possible test, demonstrated their loyalty.

The energy and wealth of this Company was of great benefit to the Province, and its conduct and that of its chief officers has ever been honorable, and calculated to set an example of honesty and reliability. The Association has now disposed of all the coal lands owned by it in Nova Scotia proper, and retains its selections in Cape Breton, operating chiefly in the historical Sydney main seam, which has been drawn upon by the miner for over one hundred years.

The natural result of the unlocking of so vast an amount of possibilities of mineral wealth beyond the dreams of avarice followed this settlement. The development of the gold, gypsum and other minerals immediately followed the period during which the simple farmer doubted if clay were a mineral or not. The Government upon the completion of the agreement threw open the coal districts, and leases were readily obtained. A large number of collieries were opened and much speculation indulged in. The 24 per cent. ad valorem duty on coal going into the United States having been removed in 1853, it was anticipated that an unbounded market was assured. The total sales in 1858 were 226,725 tons, of which 186,743 were sent to the States. From this date up to 1867, when a duty of $1.25 was imposed, the exports to the United States had increased to 404,252 tons out of a total sale of 471,185 tons.

In 1872 the duty was lowered to 75 cts., when the United States took 154,092 tons out of 785,914 tons sold. Last year the State took 73,892 tons (of which about 50,000 tons were smalls) out of a total of 1,519,684 tons sold. These figures show the steady growth of the home markets, and the fact that there is at present little room for Nova Scotia coal in the New England markets. The mutual removal of the duties on soft coal would, in the opinion of many of the provincial coal mine managers, result in the almost total loss of the Upper St. Lawrence trade, without any prospect of replacing it by a trade with the Eastern seaboard of the United States, which would have to start with a basis of at least 750,000 tons.*

The following Tables show the coal sales to the United States for number of years, and the annual sales to all quarters by decades:—

* The ton of coal in this paper is 2,240 lbs.

COAL.

NOVA SCOTIA EXPORTED TO THE UNITED STATES.

Years.	Tons.	Duty.	Years.	Tons.	Duty.
1850	118,173	24% ad.	1869	257,485	$1 25
1851	116,274	"	1870	168,180	"
1852	87,542	"	1871	165,431	"
1853	120,764	'	1872	154,092	75
1854	139,125	Free	1873	264,760	"
1855	103,222	"	1874	138,335	"
1856	126,152	"	1875	89,746	"
1857	123,335	"	1876	71,634	"
1858	186,743	"	1877	118,216	"
1859	122,720	"	1878	88,495	"
1860	149,289	"	1879	51,641	"
1861	204,457	"	1880	123,423	"
1862	192,612	"	1881	113,728	"
1863	282,775	"	1882	99,302	"
1864	347,594	"	1883	102,755	"
1865	465,194	"	1884	64,515	"
1866	404,252	"	1885	34,483	"
1867	338,492	$1 25	1886	66,003	"
1868	228,132	"	1887	73,892	"

Nova Scotia coal sales from 1785 to 1887.

Year.	Sales.	Year.	Sales.
1785 to 1790	14,349	1841 to 1850	1,533,798
1791 to 1800	51,048	1851 to 1860	2,399,829
1801 to 1810	70,452	1861 to 1870	4,927,339
1811 to 1820	91,527	1871 to 1880	7,377,428
1821 to 1830	140,820	1881 to 1887	8,992,226
1831 to 1840	839,981		

The following figures will show the markets in which Nova Scotia coal is being sold at present:—

COAL.—SALES.—1887.

Markets.	Year 1887.
Nova Scotia :	
Land Sales	266,005
Sea borne	203,459
N. S.—Total	469,464
N. Brunswick	186,511
Newfoundland	82,053
P. E. Island	50,615
Quebec	650,858
West Indies	6,140
United States	73,892
Other countries	151
Total	1,519,684

The limits of this paper would be too extended were the geological and chemical particulars of the Nova Scotia coal beds to be given here, and the author trusts that at some future time the Society may see fit to allow a description of them to find a place in the Transactions.

The coal of Nova Scotia is bituminous and frequently coking, the differences in quality between the various districts being referable perhaps to local conditions of pressure, etc. Stratigraphically the Cape Breton seams hitherto worked are flat lying, those of Pictou and Cumberland are pitching, the average of the former being, say, 1 in 10, of the latter 1 in 3. The thickness of the seams worked in Cape Breton varies between 4 ft. 9. in. and 9 feet, of the Pictou seams 4 to 15 feet, and of the Cumberland seams 3 ft. 6 in. to 11 feet. The conditions of floor and roof vary in each mine but do not present any striking peculiarities. In the thicker seams when the roof is bad, it is sometimes practicable to leave on a few inches of coal to assist in supporting it. In some cases this coal is recovered when the pillars are drawn.

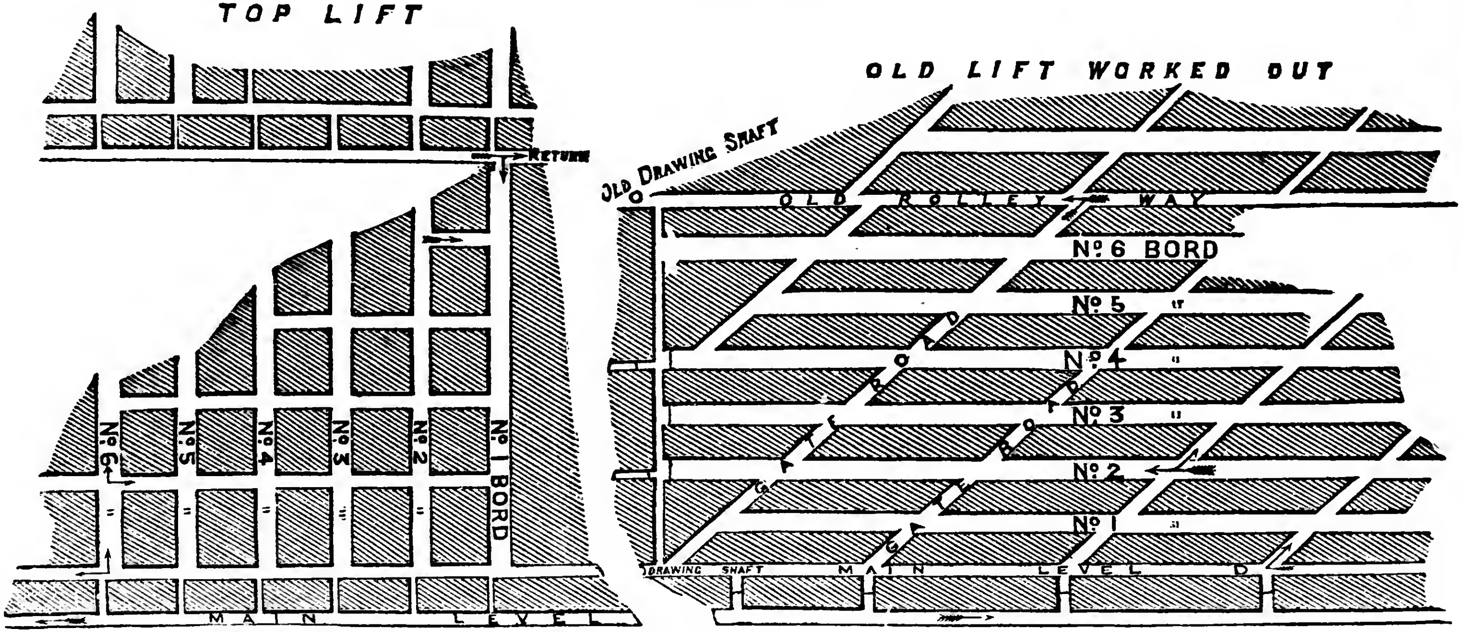
The earliest operations in the pitching seams of the Pictou district were conducted by sinking pits to gain successive lifts. The Pictou main seam, having a thickness of 38 feet, has so far been mined on two systems, of which the following account, taken from a paper read by the author a number of years ago before the North of England Mining Institute will serve as a description. The first system has now been abandoned, but it is interesting, as by it the coal was taken to the full height.

Levels were turned right and left from the pit, and when the shaft pillar was won, incline or gate roads were driven uphill, one half on the angle of the seam, every 50 yards. Six "bords" or working places, 18 feet wide, were turned away as the gate road went up, parallel to the levels, and at distances far enough apart to secure pillars 8 to 10 yards thick. Eighteen inches of coal were left on as a roof. These "bords" were driven 12 to 15 feet high, and continued until intersected by the next "gate" road. Rails were laid up the gate roads, and into the bords, and over them the tubs, holding 12 bushels, were drawn by horses, into the working faces, filled, and taken down to the level. The force of the loaded tub descending the inclined gate road was lessened by fastening to the rear of the tub a loose chain passing round a stout post, fixed at the head of the gate road, and dragging on the ground.

When it was determined to work the lower division of the seam, the same gate roads were driven level until the bottom of the coal bed was reached, and then continued as before. The second lift of 15 to 20 feet in height was taken out in bunches of regular open cast work in the former bords already worked in the top of the seam. Beams of 6 inch timber placed horizontally at the level of the pavement of the former bords secured the sides of the pillars, and if the roof proved bad, props were set on them. This plan of working was attended with much danger to the miner. His eye could not reach the roof of these murky chambers, and his candle's gleam was reflected only by the white fungus which covered the timber. The shape of the pillars at right angles to the dip, narrow, and having long jibs, was not calculated for strength. The dip of the seam rendered the course of the bords imperative, and the ribs were weakened by the cleat of the coal running obliquely across them. These pillars were never robbed, and have now nearly all crushed. As considerable amounts of gas were given off, ventilation was attended with difficulty, and serious fires happened, some of which were put out only by filling the workings with water.

The accompanying sketch plan No. 1 will show how these workings were laid out.

MAIN SEAM WORKINGS
PICTOU CO.



PLAN No. 3. SCALE 30 Yds=⅜ of an Inch. PLAN No. 1.

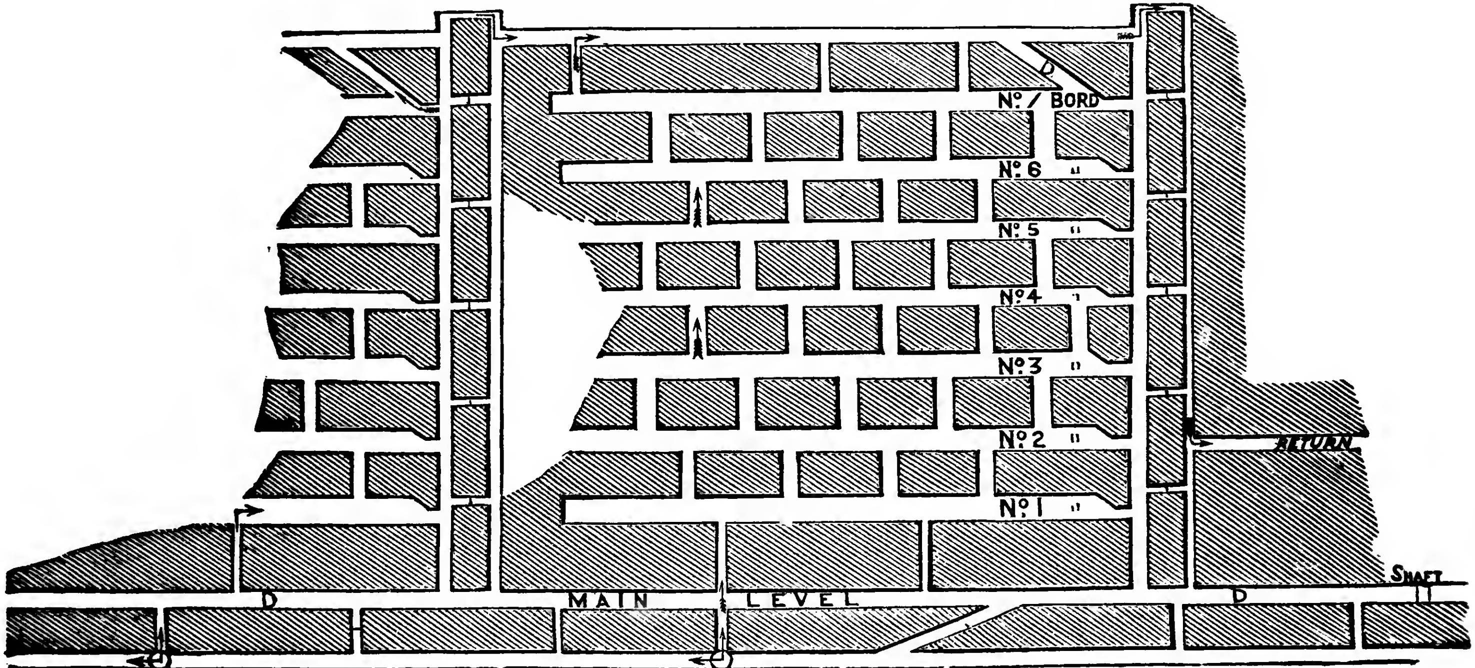
The plan now most in favor is to drive a "balance" 10 feet wide and 10 feet high from the level straight to the rise of the seam for a distance of about 450 feet. One or more parallel airways are driven at the same time, and of smaller dimensions, in order that the necessary air may be carried uphill and down again as the work progresses. Two tracks of about 2 feet gauge are laid in the balance to within 20 feet of its face. Upon one of these tracks is placed an empty tub to be filled with ballast, on the other a truck having its floor made level through one pair of wheels being greater in diameter than the other. A section of rail corresponding in gauge to that used in the pit is laid on the platform.

At the head of the balance is placed a drum, having a powerful brake, and two ropes leading to the ballast tub and platform. The former being at the top of the balance, and the platform standing in a gap in the level railway or in a siding from it, a continuous track is obtained by the rails referred to on the platform. An empty tub being pushed on the platform it is evident that the road becomes self-acting, for the tub, at the top of the balance, on being loaded with ballast, will by its weight draw up the empty tub and platform. The platform can be arrested by means of the brake opposite the mouth of any of the bords which are driven similarly to those already referred to. There being a section of track in the bord, the empty tub is landed and replaced by one filled with coal. This additional weight causes the platform to descend and draw up the ballast box which is ready for another tub. The accompanying sketch shows how this system of work can be laid out.

The pillar above the level is left 50 feet thick, and the bords start from the balance and run level for about 150 yards to the next balance. They are 15 to 18 feet wide, and 12 to 15 feet high, with pillars 35 feet thick, and cross cuts for air every 60 feet. The top bord is frequently driven through into the next balance, and the rest squared up, leaving a thin barrier of coal; but to gain time the next balance can be driven through the pillars of the bords of the first balance. The boxes are handled by the miners, and two boys can transfer the coal from a dozen bords to the level, without any assistance from horses, etc.

When the seam pitches at an angle heavier than 25° there are two modifications of this system that can be adopted. By one of them the track in the balance is done away with, and the coal tubs of each bord are emptied into the balance itself. In this case the coal will run either in the pavement or in a shoot made of iron sheets. At the point where the balance meets the level, the shoot is

METHOD OF WORKING PITCHING SEAMS.—NOVA SCOTIA.



SCALE 30 Yds.=⅔ of an Inch.

PLAN No. 2.

carried at a lessened angle, so that it will project into the level at a height sufficient to allow the pit tubs to pass under its mouth. They are filled by lifting a door at the mouth of the shoot opened by the driver with the assistance of a lever. In the other modification the bords are driven direct to the rise from the level and a shoot laid in each one. The coal is loaded from the shoots on the level in the manner just described. This system has not been generally approved of from the difficulty of airing so many uphill places, and the cost of getting timber to the faces, etc. On the other hand, the cost of material is less, there being no rails or tubs required in the bords, and the pillars are formed parallel to the dip of the seam.

In the Pictou and Cumberland districts, of late years, the seams, whenever local conditions permitted, have been opened by slopes. The slopes are usually driven in pairs with one or more back slopes for ventilation. A crop pillar of two or three hundred feet being left, the first levels are turned away at a distance of six or seven hundred feet from the crop, and operations carried on as from a shaft. The slopes are driven wide enough to admit of a double track of the gauge of the pit tubs, usually from 1 ft. 6 ins. to 2 ft. 6 ins., and provided with the usual switches. The signalling is done by wire signal cord striking a gong or giving a blow by means of a hammer on an iron plate. This method answers with a well stretched wire neatly hung and smartly handled, but electric signals would prove more satisfactory. The writer understands that the experience of H. S. Poole, Esq., agent, with electric signalling at the Acadia Colliery, is so far satisfactory. Telephonic communication, between the pit workings and the bank head has been tried, but at present is in operation only at the Vale Colliery. There is an arrangement made at some mines, whereby the ascending train of loaded tubs by striking a lever a few yards before the bankhead is reached rings a bell in the engine room, and cautions the engine tender. To prevent the empty tubs from running down the slope should they escape the banksman's hands, a weighted lever is placed at the head of the slope, between the rails of the track for the empty tubs. When at rest, the unweighted end rises above the rails so as to engage with any descending tubs, while it offers no obstacle to the passage of ascending tubs, which are heavier than the weighted end.

In the flatter lying seams of Cape Breton, the methods of winning and working the coal do not differ materially from those common in England. Usually the levels are driven in pairs from the shaft bottom.

Gate or horse roads are turned away from them, and the bords opened out of the horse roads at such angles as may best suit the requirement of the mine. As the bords advance the gate road is frequently turned up the first bord until it reaches a point near the working faces, when it resumes its normal course, so as to shorten haulage.

At the Gowrie Colliery bords are driven eleven yards wide and the pillars left seven yards thick. When the bord is first started a road is laid on each side, and the dirt, etc., stowed in the centre. Afterwards a cut is made through the stowage, and the double road maintained only at the face. By this system under a moderate cover, the maximum of coal is got at the first operation, and the drawing of the pillars when the rooms have gone their distance, should give a good pillar coal with little danger of creep.

Pillarage.—The shape and size of pillars varies with the depth of the seam, and the nature of the roof. The earliest workings along the crops of the seams left small square pillars, which have frequently crushed and caused trouble by the admission of surface waters.

At Springhill between the 1,300 and 1,900 feet levels, the main "level pillar" is 100 feet thick, then succeed 12 feet bords, with 35 feet pillars, with the middle pillar of the balance 50 feet thick. There are seven bords on each balance, and the block of coal between the 1,300 and the 1,900 feet level is 550 feet wide. The loss of coal in working the bords and heads is about 18 per cent., and when taking out the pillars the loss is 15 to 20 per cent. in the high coal ([illegible] 14 feet), and in the low coal (4 feet thick) about 5 per cent. At the Albion Colliery, when working nine to fifteen feet of the upper part of the main seam at a depth of 900 feet, the bord pillars were left 35 feet wide and from 75 to 100 feet long, the level pillars being a little thicker.

In Cape Breton, at the Sydney (main seam) workings, in the earlier mining, the bords were 6 or 7 yards wide, and the pillars 10 by 14.5 yards. In the Queen Pit workings, 360 feet deep, the bords were 5½ yards wide. In the present workings, 600 to 800 feet deep, the size of the bords has not been altered, but the pillars have been made a little larger.

These examples will serve to show the practice generally adopted. In a few collieries the extraction of pillars is systematically carried on, and usually closely follows the completion of a panel of bord and pillar workings. No regular rule has been laid down for the initiation and conduct of the operation. In some mines, as soon as the workings of any lift are finished, the pillars are drawn back; in others the pillars of each balance or shoot are drawn to suit the trade. The experience so far gained is in favor of the former practice. Frequently, the extraction is so arranged, that the upper pillars are worked in advance of the lower ones, under a belief that by this means the roof is most readily let down and settled. In other cases the line of the full dip is taken as the range of the working faces.

The top and bottom pillars, forming the high and low sides of the levels of the various lifts, are allowed to remain untouched, in order to provide for drainage, etc., or the bottom pillar, immediately above the main level, is left to be taken out in the extraction of pillars in the next lift, whenever there is other provision made for air, etc. The pillars are either attacked from the lower end next the goaf, and carried back the full width, or a head is driven into the pillar and widened out sideways, first toward the goaf and then backward. The aim is to allow the roof to fall as quickly and completely as possible, to prevent weight from being thrown down-hill on the levels or any lower workings, and the timbering is proportioned so as to afford protection only for the removal of the succeeding pillar. But it will be understood that in steep seams, with questionable roof, having a thickness of 10 to 15 feet, no hard and fast rule can be carried out.

In the flat lying seams of Cape Breton, little pillar work has been done except at the Caledonia colliery, where the pillars lying under a pressure of 100 to 200 feet, and of good dimensions, have been successfully drawn.

In many cases, however, the pillarage has been viewed rather from the standpoint of a support to the roof than as a future supply of coal. The great question is that of water, and no doubt in many of the Cape Breton collieries worked at shallow depths, the increased pump costs would, at the present price of coal, outweigh any gain from the cheapness with which it can be mined in comparison with bord coal. At present the most advanced mining practice in the province, is in favor of moderate sized pillars, to be drawn at the earliest possible moment. Even adopting this principle, except in the case of a few mines, the conditions of trade are unfavorable to extended and systematic pillar workings at considerable depths, for the shipments are interrupted during the depth of winter. When pillars are not taken out, the percentage of coal removed may vary between 25 and 35 per cent., when they are drawn, as high as 90 per cent. of the seam has been gained.

In Cape Breton the coal lying, as already mentioned, at easy angles is attacked through shafts, except at the Victoria and Reserve collieries. At the Victoria mine, at Low Point, the seam lies at a heavy angle.

Here two slopes spread out on the half pitch of the seam, and have, intermediate between them, one driven on the full pitch of the seam. This is used for ventilation and pumping, and will ultimately serve for the tail ropes of a system of haulage, which will pick up the tubs in the level and haul them direct to bank. The empty tubs running down the slopes by their own weight, will be taken along the levels by the tail ropes. This arrangement will do away with the level horses. The balance system has been adopted here.

At the Reserve mine, the seam was opened by a slope, but the mining wisdom of this procedure is doubtful, the seam lying at so low an angle that the empty tubs are landed with difficulty at the bottom of the slope. In order to provide more pit room, at a point in the slope, about ten chains from its mouth, a steeper slope, having an inclination of one in three and a half, has been driven to intersect the Emery seam lying 95 feet below the one at present worked.

The following Table shows the depth of the main shafts of the principal collieries :—

Sydney,	681 feet.	Round diameter 13 ft.
International,	87 "	14·5 by 16·5 ft.
Glace Bay,	224 "	10·5 by 11 ft.
Caledonia,	205 "	11 by 11 ft.
Gowrie,	260 "	11·5 feet diameter.

At the Sydney mines of the General Mining Association is found the largest shaft plant working in the Province. The main pump and back shafts were sunk under unusual difficulties from heavy feeders of water. The shafts are situated at the Northern point of Sydney Harbor, a few yards from the sea shore, and were intended to command the coal in an area of four square miles extending under the sea. At a depth of 200 feet heavy feeders of salt water reaching 1800 gallons per minute were met, and after severe exertions they were stopped by cast iron tubbing.

The following memorandum of tubbing used in the new shafts will be of interest :—

	Depth tubbed,	Segments,	Weight lbs.
Winding shaft,	275 ft. 6 in.	1269·	658,724
Pumping "	284 ft. "	1168·	569,639
Staple "	283 ft. 3 in.	736	323,975
			1,552,338

Underground, two large engines stand near the shaft bottom, and draw the coal along a rise engine plane with dip slants. The rope on he main level is an endless one. The train of full tubs starting from the landing near the face of the plane run by gravity to the pit bottom, and he train of empties, is drawn out by the tail rope. By means of spare ropes lying in the dip slants, this system can be extended in any direction, and has been found to work satisfactorily for a number of years. Under this arrangement, horses are used only to collect and distribute the tubs from the landings and working falls, and their employment for the long level haulage, which is over a mile on one side of the pit, is avoided.

At the International mine the coal to the rise of the shaft (80 feet deep) having become exhausted, a slope was driven from a point a few yards to one side of the shaft, on the full dip of the seam, for a distance of about 2,500 feet, and at an inclination of $5\frac{1}{2}^\circ$. The engine stands at bank and is signalled from the foot of the slope. The track is of the ordinary character, and a double rope being used, the employment of an automatic switch allows the train of empty tubs to pass the full ones, irrespective of the landing they are being drawn from.

At the Caledonia mine a portable engine and boiler have been placed underground at the head of the slope driven to the full dip. The smoke is led into the return. The system of raising steam underground is open to objections. Precautions are taken to remove the soot, and to lessen its liability to combustion, but any fire underground is a standing menace to a mine. The writer is pleased to learn that preparations are being made to generate the steam for the underground haulage at the surface as such an arrangement must add to the safety of the pit.

At the Gowrie mine the haulage from the dip slant is conducted on a system resembling that referred to as adopted at the International.

The tables of machinery will give full particulars as to size of engines above and below ground, their loads, steam supply, etc.

VENTILATION.

The furnace was employed for ventilating the Nova Scotia mines, until a change was made in 1871 by the introduction of a Guibal Fan at the Albion mines. This fan was ten feet wide, and thirty feet in diameter, and yielded 75,000 cubic feet per minute at 47 revolutions, being driven by a direct acting engine having a 24 in. stroke and 24 in. cylinder. The length of air ways was about 15,000 feet. Afterwards fans were introduced at the Sydney, Intercolonial, Low Point, and

Springhill collieries. At the latter the seams being inclined and close together, it was found practicable to use "blow-down" fans placed directly over the downcast and driven by a belt, so as to air the mine in sections having comparatively short airways. The volumes of air in cubic feet passed per minute by these fans vary from 15,000 to 89,000. The highest record being that of the Intercolonial colliery, which during the year 1887 maintained an average monthly circulation of about 85,000 cubic feet.

In Cape Breton at the Reserve, International, Caledonia, and Gowrie mines, furnaces are still used, but the rapid extension of the workings of these collieries during the past few years renders a more efficient ventilating power imperative. At one mine only, the Gowrie, is there any opportunity given for the furnace to do proper duty. Here it is placed near the bottom of the drawing shaft, being connected with it by an ascending drift, which enters the shaft above the door heads.

Its dimensions are, length of bars 7 feet, height of bars above floor 2 ft. 6 ins., width of bars 7 ft. 8 ins., length of heated column, 307 feet, height of crown of arch above bars, 5 feet.

The total length of air course is about 170,000 feet, least sectional area, 56 ft., average sectional area, 64 feet. There are two air courses, 8,000 and 9,000 feet long. This furnace passes on an average 44,000 cubic feet of air per minute, with a consumption of about 1½ tons of coal during the twenty-four hours. The capacity of the furnace could be increased to about 50,000 feet if required.

At the other mines, wooden chimnies fifty to eighty feet high have been placed on the shallow crop pits, which were first used for ventilating, but as the efficiency of the furnace increases in a ratio much smaller than the increase in length of the upcast, these additions give little assistance. The furnaces are of the usual pattern, being of brick, with arched roof, and having the grate about 2 feet from the floor, about 6 feet wide, and 9 feet long. The volumes of air passed vary from 20,000 to 43,000 per minute, the consumption of coal varying from one to two and a quarter tons a day.

The furnace under favoring conditions of large grate area, roomy air ways, and a long heated column, forms an efficient ventilator, but the last named condition in our mines is but partially presented at the Gowrie Colliery. At present, they are operated under conditions which should lead to the prompt replacement of the furnace system by mechanical ventilators. The cost of the latter, if one of the smaller and semi-portable patterns be adopted, is but littte larger, and it yields a much greater efficiency on the basis of coal consumption. Its work can be constantly supervised, its maximum capacity readily reached, and in case of accident, if it be properly placed, it is readily available for renewing the ventilation of the patterns adopted here. The Guibal has most satisfactorily stood the test of steady and long continued work, and its strength and durability recommend it for mines having extended and irregular airways. The Capel fan, which is highly spoken of, has not yet been introduced here.

The seams of the Cumberland and Cape Breton districts are very free from gas, it having been met in appreciable amounts only in the Springhill, Sydney, and Caledonia collieries. Still, reasonable care in systematically carrying the air through the workings is needed to prevent dangerous accumulations. Paradoxical as it may seem, mines giving off a small but steady amount of fire damp require constant watchfulness on the manager's part, as the employees do not bear in mind that their enemy, although easily routed, seldom omits to avail himself of any forgetfulness. Open lights and powder are used in all these mines.

In the Pictou district the seams are decidedly fiery, and much care is given to ventilation. They are as far as possible divided into separate districts for ventilating purposes, and in all safety lamps are more or less used, and the use of gunpowder either guarded by appointing men to fire the shots, or in special cases prohibited.

TABLE SHOWING PRINCIPAL MECHANICAL VENTILATORS.

ENGINE AND FAN.

Colliery.	Name of Fan.	No. of cylinders.	Drain of cylinders, inches.	Length of stroke, inches.	Width of Fan, feet.	Diam. of Fan, ft.	Av. cubic feet per m.	Revol. per minute engine.	Pr. of Steam, lbs.
Pictou Co.									
Intercolonial.....	Guibal	1	16	20	7	20	85,000	52	70
Acadia............	Guibal	1	20	24	8	24	54,000		105
Vale	Guibal	1	24	24	10	30	42,000	55	90
Do	Blowdown	1	12	24	6	16	20,000	......	85 Belt, 2 to 1
Albion	Guibal	1	24	24	10	30	80,000	39	45
Nova Scotia......	Sturtevant	1	8	12	5.5	2.75	15,000	......	70
Cumberland Co.									
Springhill........	Blowdown	1	12	36	7.5	18	41,000	35	55 Belt, 2 to 1
Do	Do	1	12	36	6	14	42,000	35	60 "
Do	Do	1	14	30	8	20	41,000	35	70 "
Cape Breton.									
Sydney............	Guibal	1	24	24	10	30	67,000	40	35
Victoria	Champion.	1	8	17	4 turn fans	59	40,000	65	35 geared $3\frac{1}{2}$ to 1

PUMPING.

The seams of the various districts may be considered as not carrying large amounts of water. In the Springhill district three seams, lying close together, are worked with a steady extraction of pillars, under a roof carrying several beds of porous sandstone, and a heavy surface cover, and these conditions cause a heavy pump charge.

In the Pictou district the overlying measures are shaley and compact and pass little water, and at a depth exceeding 700 feet the workings are dry and dusty. In Cape Breton nearly all the mines are above the dry zone, but they are not very wet. In the Sydney mine workings there is little water, the submarine workings being remarkably dry. At this colliery a large amount of water from the old workings has to be handled. The pump is a direct acting Cornish one, the dimensions being given in the table of Cape Breton pumps, working through two lifts, the low set 335 feet, the staple set 350 feet, total lift of water to delivery drift from pump being 668 feet. The same was noticed in the "Lingan" submarine workings. Under the Mines Regulation Act submarine seams having a cover of less than 500 feet must be worked in panels, and approaches cannot be driven under a cover less than 100 feet thick.

At several of the Cape Breton mines the pit waters are decidedly acid, and necessitate phosphor bronze and other patent linings, etc., for the working parts of the pumps.

At the Gowrie mines, Mr. Chas. Archibald has had much trouble in contending against corrosive effects of the pit water. The pumping shaft is 200 feet deep, and is divided into two bucket lifts. It was found necessary to use babbit metal lining for the working barrels, and iron and brass and gun metal shells, falls, etc. As the water grew more acid from running over the small coal and stone in the bords, as the workings extended, it was found that pump rods, pumps, nuts, etc., were very quickly eroded. Finally wood pumps were used, and the straps, clamps, flanges, etc., protected by layers of tarred flannel. Similar precautions were taken with the rods, and finally the bucket doors and clack pieces were made of wood instead of iron. Mr. Archibald gave an interesting account of this matter in the Transactions of the North of England Mining Institute. The writer published some years ago a paper on the Nova Scotia pit waters, from which he gives the following analysis as serving to show the composition of some of these acid waters.

Block House mine; Cow Bay Analyst, Geo. Suv. Canada, 1872-73.

Suspended matter.	
Sulphate of iron	·1510
Insolution.	
Iron (as per salt)	·2426
Iron (as proto salt)	·1168
Manganese	·0078
Aluminum	·0420
Calcium	·1498
Magnesium	·0618
Potassium	·0134
Sodium	·1884
Silica	.0116
Sulphuric Acid	1·4808
Chloric Acid	·4100
Phosphoric Acid	traces
Organic matter	·2844
Total in 1,000 parts	3·0094

Water, yellowish brown color, acid reaction, and styptic taste.

*Gardener Colly, Bridgeport.

Iron Sulphate	2·750
Potassium sulphate	·185
Calcium Carbonate	·736
Magnesium Carbonate	·025
Sodium Chloride	·096
Alumina	trace
Silica	·225
Total in 1,000 parts	4·881

Water, clear with blueish shade, after standing, deposited reddish sediment, acid reaction and highly styptic taste.

The appended table will show that direct acting pumps are at present the most fashionable, especially those of the Cameron and Knowles pattern.

* Analyst, E. Gilpin, Jr.

DETAILS OF PUMPING APPLIANCES.

CAPE BRETON.

COLLIERIES.	Number of Pumps.	Name and Style of Pump.	Steam Cylinder diam. inch.	Water Plunger diam. inch.	Length of Stroke.	Strokes per Minute.	Length of water-pipe.	Length of steam pipe.	Steam pressure at Bank.	Steam pressure at pump.	Vertical Lift.	Gallons water per day.	Tons of Coal raised during 1886.
Sydney Mines (Queen)....	1	Made to order.	30	8	48 in.	17	360 ft.	430 ft.	27 lbs.	....	360 ft.	172,620	
do (Princess Pit)....	2	do	62	20	84 "	4½	720 "	....	40 "	....	720 "	139,863	139,646
Victoria......................	1	Elliot.	18	7	44 "	14	590 "	890 "	40 "	37 lbs.	305 "	142,380	50,156
International	1	Knowles.	24	8	24 "	30	2100 "	2250 "	45 "	33 "	195 "	....	
do	......	do	12	5	12 "	60	3547 "	1592 "	45 "	20 "	185 "	64,000	118,129
Reserve......................	2	do	12	7	24 "	60	....	2080 "	50 "	35 "	....	115,984	81,783
do	......	do	14	9	18 "	50	3037 "	1486 "	50 "	35 "	283 "	12,450	
Caledonia (two setts)	2	Lifting.	......	8	48 "	12	128 "	....	30 "	....	123 "		
do do	.....	do	......	8	48 "	12	60 "	....	30 "	....	60 "	86,400	72,810
Little Glace Bay	3	Cameron.	8	8	30 "	40	310 "	340 "	....	....	260 "		
do	......	Lifting.	6	6	48 "	10	255 "	....	....	....	255 "	205,834	33,382
do	......	do	6	6	48 "	10	255 "	....	....	....	255 "		
Gowrie	3	Knowles special.	20	10	48 "	20	254 "	244 "	43 "	35 "	215 "		
do Lifting	......	Built to order.	......	10	36 "	36	110 "	....	....	....	110 "	328,265	95,307
do do	......	do	......	10	36 "	36	110 "	....	....	....	110 "		

1886. DETAILS OF PUMPING APPLIANCES, PICTOU AND CUMBERLAND.

Company.	Appliances.	Length of Stroke.	Diameter Steam Cylinder.	Diameter Water Cylinder.	Number strokes per minute.	Steam pressure at Boiler.	Distance of pump from boiler in ft.	Steam pressure at pump.	Vertical height of Discharge.	Pressure of head per sq. in. lbs.	Length Steam pipe.	Length Water Pipe.	Diameter Water Pipes.	Diameter Steam Pipes.	Average gal on discharge per day approximately		Tons of water raised, year 1886. (Estimated)	Tons of coal raised during year 1886.	Remarks.
Intercolonial Coal Company. Westville. Connected. Bot. Mid. Top.	Cameron Pump. No. 8.	36 in.	18 in.	8 in.	20 to 40	lbs. 80 (Nos. 8, 3.5, 3.4)	480	lbs. 79½	350	lbs. 208	800	....	....	5 in.	60,000 (Nos. 8, 3.5, 3.4)		104,500	108,498	Pipes cover'd with composition made by Mechanical Engineer.
	No. 3.5.	12 "	10 "	4 "	40 60		1380	77½	300	130	900	900	3×2½	2×2½			......	....	
	No. 3.4.	12 "	7 "	3½ "	40 to 60		1780	75	113	49	400	400	2 in.	2 in.			......	....	
Acadia Coal Co. Westville.	Duplex Compound Pump.	24 "	H. P. 12 " L. P. 22 "	5½ "	45	105lbs	2600	95	996	433	2600	2400	6 in.	4 in.	108,000 per day of 24 hrs.		167,000	93,891	Pipes cover'd composition clay & straw.
Joggins.	Burling and Johnston's Pump.	40 "	20 "	8½ "	15	60 "	1500	38	205	89	1500	600	8 in.	4 in.	84,000		153,300	22,243	Pipes not covered.
Vale Colliery. 6 ft. Steam.	Cameron Pump.	24 "	15 "	5 "	50	80 "	1240	70	365	159	1240	1040	....	....	144,000		262,800	128,539 (Vale Colliery)	Pipes cover'd to pit head. Balance of pipes in mine exposed. (Vale Colliery)
	Blake Pump.	12 "	8 "	5 "	60	......	510	....	130	57	510	310	....	....	8,640		......		
McBean Seam. Connected. Mid. Bot.	Knowles.	30 "	30 "	8 "	25	70 "	1400	60	650	282	1400	1200	....	6 in.	234,000	Disch'rgs to mid. pump.	......		
	Cameron	30 "	20 "	6 "	50	......	500	....	238	103	500	500	....	4 in.	252,000	Disch'rgs at surface.	459,500		

DETAILS OF PUMPING APPLIANCES, PICTOU AND CUMBERLAND.

SPRING HILL MINES.	West Slope. Connected.	Top Allison Pump.	6 ft.	30 in.	14½ in.	15	75 "	750	68	340	148	750	750	12 in.	9 "	1080,000	Disch'rgs at surface.	1976,000	416,739	750 feet of pipes covered.
		Bottom. Allison Pump.	.....	.....	....	.....	.....	1430	55	310	134	680	680	12 "	6 "	1080,000	Disch'rgs to top pump.	....		
		Special Blake.	3 ft.	28 "	11½ in.	32	60 "	512	40	430	187	890	850	8 "	4 "	742,080	....	1354,296		Covered from boil'r to pit mouth with infusorial earth.
		Blake, not used.	......	......	... ..	......	......	......	....	....	....	....	....	....	....	....	....	....		
	Cameron Pump.	Special, No. 7.	30 in.	22 "	9 in.	40	60 "	......	40	....	....	....	....	....	....	460,200	....	840,960		
	Connected.	No. 5.	24 "	15 "	7 "	50	85 "	1500	60	278	121	1500	1400	4 "	3 "	216,000	....	394,200		
		No. 3.	18 "	10 "	4 "	65	85 "	1800	50	32	14	300	300	2 "	2 "	86,400	Disch'rgs top to pump.	....		
ALBION COLLIERY		Foord Pit.	Two	Iron	T'nks	8 ft.	6 in. x	6 ft.	x3ft	40ta	nks	per	ho'r	22 h	per	dy. 873,840	....	1599,758	....	....

From these Tables it appears that in the year 1885, 1,352,205 tons of coal were raised, and that during the same period 3,646,889 tons of water were pumped—or nearly three to one. This estimate of the relative amounts of coal and water extracted has seldom been made over so large a district, and is interesting for reference beside the enormous tonnage of water to ore in many metal mines. It should however be remembered in considering these results that much of the water is from old workings, and forms a permanent duty. At the Sydney mines the present workings make little water, and the pumps have to handle the seepage of the acreage resulting from a century of mining and pillar working. At the Albion Colliery the pump duty represents in a similar manner the water of the underlying seam, as well as of the old workings in the thick coal which broke the roof for many feet. Here the main shaft of the workings furthest from the dip has been selected for pumping. The work is performed by substituting for the two cages, two tanks each 8 ft. 6 ins. by 3 ft. 3 ins. by 5 ft., which automatically open on entering the water, and by engaging with a lever at the top of the shaft discharge without any attention. The tanks are raised and lowered by the winding engine at an average rate of 600 trips per day of 20 hours, which is equivalent to about 520,000 gals.

The pump at the Acadia Colliery is one of the best in use in our coal mines. The lift is one of the heaviest single lifts in America, and the following note will be of interest.

The mine is opened by a slope 2400 feet long, vertical depth 1000 feet. The pump is a Knowles of the duplex compound condensing type, with high and low pressure steam cylinders, 12 and 22 inches in diameter, 24 inch stroke with four 5½ inch plungers working against a head of 435 lbs. per square inch. The column is six inches in diameter, of wrought iron, the air chamber is 30 by 15 inches, the steam pipe, 2600 feet long and four inches in diameter, takes the steam from Babcock boilers on the surface, at a pressure of 105 pounds. The pipe is protected with an infusorial earth jacket, the material being taken from a local deposit. After four years' service this pump has given no trouble, and no joints have leaked. There is no suction on the pump, the lower valves being below the level of the water. The pump usually makes 10 double strokes a minute, but could run 25 strokes, equal to 100 feet piston speed a minute. A small hydraulic ram will raise the water from the lower level to the pump.

PARTICULARS OF WINDING ENGINES NOVA SCOTIA COAL MINES.

COLLIERY.	Nos. of cylinders.	Dia. of cylinders, inches.	Length of stroke, in.	No. of Drum brls.	Dia. of Drum barrels, feet.	Weight of load, cwt.	Diam. of rope, inches.	Length of haul. in ft.	Pressure of steam, lbs.	
Pictou Co.										
Intercolonial { Slope	2	16	36	2	8	126	1	1,800	70	Geared, 2 to 1; dip 15°
Colliery, { Underground	2	16	{ 28 24	2	{ 8 8.66	126	1	1,200	70	do 3 to 1; do
Acadia Colliery (Slope)	2	16	42	1	9	*100	1 1/8	3,100	85	Geared, 3½ to 1; dip 27°
Vale Colliery, { McBean Slope	2	32	60	1	14	120	1 7/8	2.400	55	Direct, dip 35°
Vale Colliery, { Six-feet do	2	16	36	2	10	†80	1	1,800	60	Geared, 3 to 1; dip 23°
Albion Colliery (McGregor Pit)	1	24	72	2	—	‡80	4 ×	1,800	45	Flat ropes, direct acting
Cumberland Co.										
Springhill Colliery, { West Slope	2	20	36	1	9	100	1¼	1,300	55	Geared, 3 to 1; dip 25°
{ North Slope	2	15	30	1	9	120	1¼	800	60	Do
{ East Slope	2	16	36	1	9	60	1 1/8	800	70	Do
Joggins Colliery (Slope)	2	18	36	1	9	60	1	1,350	75	
Cape Breton Co.										
Sydney Colliery (Pit)	2	36	60	1	18	132	1 3/8	660	40	Direct acting.
" " (Underground)	2	16	36	2	4	792	7/8	5,400	40	Gross lead, geared 2¾ to 1
do	2	16	24	2	4	252	7/8	5,800	40	Gross load, geared 1¾ to 1
Victoria (Slope)	2	22	54	2	6	152	1	1,959	50	Direct, dip 15°.
International Col'y { Pit	2	16	40	1	7	39	1 1/8	100	40	Geared, 2 to 1.
{ Underground	1	12	20	2	3 × 3½	224	¾	2,100	40	{ Stands at Bank, dip. Geared, 3 to 1.
Caledonia (Pit)	2	11	24	2	6	49	3½ × 5/8	205	50	Geared, 4 to 1.
Glace Bay (Pit)	2	12	36	1	6½	58	1¼	245	47	Geared, 2½ to 1.
Gowrie, { (Pit)	2	20	42	1	8	49	1 3-16	235	60	Direct.
{ (Underground)	2	10	12	1	4¾	192	7/8	1,000	45	Geared, 5 to 1; dip 8°.
Reserve, { French	2	20	54	2	4	256	7/8	2,754	50	Do 2 to 1; dip 5° 20′.
{ Slope						256				Twin engine at Main slope.

* Wt. of coal, tubs, ropes, etc. 200 cwt; add. 5 p.c. for friction; total, 210 cwt. † Coal only. ‡ Gross weight, § Nett Load.

Expansion in the steam pipes is guarded against by U pieces. The pump stands in a house lined with brick, and having a cement floor.

The appended Table shows the winding engines at the principal collieries, above and below ground. They are generally direct acting for shaft work and geared three to one for drawing through slopes. As fuel forms a small item in the expenses of raising coal, low pressures and simple engines are in use. The economy is more apparent than real, and compound engines with the lessened wear and tear of boilers would prove more satisfactory. The speed in the shafts is low owing to their comparative shallowness. In the slopes the speed is practically limited by the rate at which the empty tubs can run safely down the incline.

At many of the deeper slopes, the men are raised in long tubs, holding from one to two dozen, with extra couplings, and a trip bar, or " durkey " at the end of the last tub.

At the Intercolonial colliery, the coals are drawn up the slopes, dipping at an angle of 15°, 1,800 feet long, the gross weight being 11,400 lbs. in the space of 1 minute and 50 seconds, and the empty tubs are lowered by brake in one minute.

The tubs hold from one half to one and a quarter tons of coal. The wheels are made with fast or loose axles, and vary in diameter from 10 to 12 inches. The gauge of the tracks is from 2 ft. to 2 ft. 8-in.

The following table will show the tubs used at the principal mines:

A TABLE

OF THE DIMENSIONS OF PIT TUBS IN USE AT THE PRINCIPAL COLLIERIES.

NAME.	Track Gauge.	Dia. of Wheels.	Wheel base.	Height above track.	Width.	Length.	Height.	Capacity.
	in.	in.	in.	in.	in.	in.	in.	C.ft.
Joggins	30	12	20	37	37	48	23	23 6
Acadia	28	11	22	31	42	60	24	35.
Albion Mines	26	12	18	42	33	44	28	23.5
Intercolonial	32½	14	20	42½	26	50	28	21.
Caledonia	24	11	22	38	33	94	24	35.5
Glace Bay	30	10	16	36	33	60	24	27.5
Gowrie	24	12	18	38	34	80	24	19.6
International	32	14	18	45	30	49	29	24.6
Reserve	26	11	20	43	32	44	30	24.4
Sydney	24	11	16	40	34	37	27	19.6
Vale 8 ft seam	29	10		45	33	54	26	26.8
" 6 ft. seam	29	12		42	33	54	25	25.7

Boilers.—In Cape Breton the boilers used for supplying steam to the pumps and winding engines are generally plain egg ended and cylindrical. Their dimensions vary in length from 20 to 37 feet, in diameter from 3 to 5½ feet. The working pressure varies from 30 to 50 lbs.

In Pictou and Cumberland there is a greater variety seen. At the Acadia Colliery four Babcock boilers, running at a pressure of 105 pounds, supply the fan and underground engine and pump.

At the Vale Colliery, Lancashire and tubular boilers are used. At the West Slope, Springhill Collieries, two Galloway boilers, 7 by 30 feet, form part of the battery. At several mines the plain egg ended boilers are used with pressures varying from 30 to 55 lbs. The consumption of coal, part round and part slack, used for stationary and locomotive engines, during the year 1887, was about 139,777 tons.

Transportation.—The various collieries are provided with railways varying in length from one half to thirty-seven miles for shipment of coal. The longest line in operation is that of the Cumberland Railway and Coal Company, who carry coal four miles to the Intercolonial Railway and thirty-three to Parrsboro on the Bay of Fundy. The latter line is operated at present principally for general passenger and freight business, but it is expected that when their shipping facilities are completed, much of their coal will find an outlet to St. John, New Brunswick, and the United States, via Parrsboro. The same company are now building toward the Gulf of St. Lawrence to obtain an outlet at Pugwash, so that they can secure water transportation to Quebec and Montreal during the summer months. A branch line ten miles long from Macan, on the Intercolonial Railway to the Joggins shore, runs along part of the outcrop of the northern edge of the Cumberland coal field. It has been opened this year, and promises to develop several valuable coal seams.

The Pictou Collieries are connected with shipping piers in Pictou Harbor, and with the Intercolonial Railway by short branches which they operate with their own engines and cars, using the Government rolling stock when shipping over the Intercolonial road. In Cape Breton the Sydney mines ship at North Sydney while the Victoria, International, Reserve and Bridgeport Collieries ship at piers on the south side of the Harbor. At Glace Bay, a brook, emptying into the Atlantic, has been dredged into a spacious dock, capable of holding half a dozen large steamers and twice as many square rigged vessels. This dock was originally made through the enterprise of the Glace Bay

Coal Company, but the Caledonia Coal Company have recently utilized it for shipping coal. At Cow Bay the Gowrie mine coal is shipped at a pier protected by the Government breakwater. The railway now being built through the Island of Cape Breton will, it is expected, be extended, so as to connect all the principal mines with Sydney Harbor, and ultimately to reach Louisburg Harbor, so that during the summer, the busiest season, two outlets will be available, while the lessened winter trade can be accommodated at Louisburg. At present the cost of maintaining roads from one to eleven miles in length, with the rolling stock equal to a shipment of 2,000 tons a day, for summer shipments, only forms a heavy charge.

The various colliery roads and their equipments call for no special notice. The locomotives are of English and American types, the cars carry from four to six tons, and empty below. At the Sydney Mines effective service is rendered by a locomotive built in the Company's shops, the frame, axles and tyres only being imported.

The locomotives vary in power and weight up to a Baldwin 50 ton freight engine. The roads are largely laid with steel rails, and are kept in very fair order. The only road calling for any special notice is that of the Sydney and Louisburg Coal Company. This road runs from Sydney to the Reserve mine, a distance of 8 miles, and 10 miles further to the colliery at Schooner Pond, formerly operated by the company, and extends to Louisburg Harbor, making in all 32 miles. At present the line is working only from Sydney to the Reserve Colliery, the rest having been closed during the late depression in the coal trade. It is expected, should the trade continue to improve as it has for the past few years, that operations will be resumed on the Schooner Pond branch, and the shipping piers at Louisburg be again utilized.

The road is well built and ballasted. Its gauge is 3 feet, with maximum grades of 1 in 100 against, and 1 in 75 with, the traffic. The nature of the country has permitted a nearly straight line with a minimum of curvature. In addition to two ordinary tank locomotives, it is equipped with three Fairlie double truck locomotives, 25 tons loaded weight, with 11 inch cylinders, 19 inch stroke, and 3 feet 3 inch wheels, about forty trucks, holding 4 tons each, make a train.

These locomotives have done very good work, but it is a question if this pattern of engine on a narrow gauge road, will prove as effective in winter as one of American pattern on the standard gauge, as they are not so handy in snow, and have very little clearance.

The wharves for coal shipments are all of wood, usually constructed with blocks and lines of piling. The cheapest form is that of a long pier with shoots on each side. In some cases a fall is given to a central track for the loaded cars to run towards the end of the pier, and a reverse grade for them to pass back to the shoots and return empty. In other wharves the loaded and empty cars are moved by horses. Where a level pier top is adopted, a system of ropes with hydraulic capstans would be found quicker and cheaper than horse-power.

The pier of the Sydney and Louisburg Railway, as described in the report of the Geological Survey, may be taken as a type of the most approved wharf. This structure, at the terminus of the railway in the town of Sydney, is a handsome and substantial structure, 620 feet in length, and 40 feet wide, with 36 feet of water at the end at high tide (the rise and fall being about 4 feet.). The top of the pier standing 24 feet above high tide level is furnished with 4 tracks, and seven loading shoots, and four traversing tables. The wharf is built upon very long and stout piles of Baltic timber, creosoted, and suitably braced by caps, ties, and trusses. The superstructure is of native timber of good quality, and strongly framed. The cost of the wharf is given at about $20,000.00.

The creosoting has proved an effectual preservation against the ravages of the teredo, and the piles, except a few imperfectly impregnated, are in good condition at the end of fifteen years. The author is not aware of other applications of chemically prepared timber for this purpose in Nova Scotian wharves. Reference has been made to the very acid water pumped from the Gowrie colliery. This water runs into the sea alongside their shipping pier, and, it is said, exercises a decided effect in preventing damage from the naval borers, etc.

The systems of cutting the coal vary slightly. In the Pictou and Cumberland districts, the bords, except in the very steep seams, are necessarily driven level, regardless of the cleat of the coal. In the flat Cape Breton seams the bords can be frequently turned so as to reap any benefit from the aid afforded by the vertical natural divisions of the seams. In the thicker seams the work embraces taking down the "fall" or division of the seam next the roof, in a layer 3 to 4 feet thick, and then lifting the rest of the coal in two benches of 2 to 4 feet in thickness. The precise thickness of each division is regulated by any partings or "dirt bands."

The coal is "holed or undercut" below the fall to a depth of 3 to 4 feet, and the low side wall continued about the same distance into the solid coal, so that a shot in the upper fast corner will bring all the coal down. The benches are kept a few feet behind, so as to allow a footing for work at the fall, and are blown up in one or more lifts as the face advances. In Cape Breton the holing is in the coal on the floor, the coal being nicked on one side or in the middle. In the Gowrie seam, the coal in the bords, thirty feet wide, after being holed, and allowed to stand, is brought down without powder.

Each working place has two miners, who sometimes employ a loader. The coal in some of the Cape Breton pits is riddled underground through meshes of ½ to 1 inch, and screened at Bank over bars ½ to ¾ inch apart. At the International mine the slack coal is raised by an elevator, the Culm, separated by screening, and the nut added to the round coal. At this colliery, Riggs' patent screen and tipper are found to prevent much breakage of coal.

The prices paid for cutting coal vary slightly in each district. In Pictou the prices paid in pillar working are from 37 to 40 cts. Bords 40 to 50 cts., narrow work 55 to 70 cts. per yard. The width of the bords varying from 9 to 15 feet. Shiftmen are paid $1.30 to $1.50 a day.

Loaders $1.20 to $1.30 a day. Boys employed on balances 80 cts. to $1.00. Driver and trapper boys 50 cts. to $1.00 a day.

In Cape Breton the price per ton in bords varies from 35 to 47 cents, the highest being at the Victoria mine. Pillar coal varies from 35 to 40 cents. The cross cuts are paid at the rate of 35 to 59 cents. Levels and winning places 50 to 69 cents, the wages paid to deputy overmen vary from $1.25 to $1.60. Shiftmen are paid 80 cts. to $1.25. Laborers wages are from 85c. to $1.00. Drivers underground 60 to 85 cts. Trappers and couplers receive 32 to 40 cts. The miners in all the districts generally live in houses provided by the companies, which are rented at from $1.10 to $4.00 a month.

In the Springhill district the prices are nearly those of the Pictou mines, so that the figures given fairly represent those of the Province.

The coal seams of the Province, as may be inferred from the historical sketch, belong to the Government. The principle upon which they are leased may be briefly discribed as follows : A license to search for twelve months is granted over an area not exceeding five square miles in extent. During this period the holder of the license can select a block of one square mile out of the five square mile area. This is called a License to work, and can be held for three years. If during this period effective mining operations are begun, the Licensee is entitled to a lease for eighty years in four equal periods. A few of the leases pay a royalty of 9.7-cents on every ton of 2,240 lbs. of round coal only, *i. e.*, coal that has passed over a screen, the bars of which are not more than $\frac{3}{4}$ inch apart while others pay 7.5 cents in every ton of coal round, slack, or run of mine. In both cases coal used for workmen and engines is free. There are at present 190 square miles under lease for coal mining, of which not more than a quarter is actually being worked.

All leases, transfers, etc., are registered in the Mines Department, which facilitates enquiry into title of mining properties held all over the Province. There is also a Mines Regulation Act, based on the English act, and the companies comply readily with its provisions.

The accompanying Tables, pages 379-381, will show the production and sales of each colliery during the year 1887. The amounts used for engine purposes include pumps, winding and other engines, locomotives, etc., and are not in every case directly representative of the power required for raising coal and pumping water.

The writer desires to express his indebtedness to the Deputy Inspectors, Mr. P. Neville, of Bridgeport, C.B., to Mr. Wm. Madden, Jr., of Westville, Pictou county, and to the managers of several collieries, for tabular and other information. Among the sources of information on the coal deposits of the Province may be mentioned Dawson's "Acadian Geology," "Coal Mining in Cape Breton" by Mr. R. Brown ; "Mines and Mineral Lands of Nova Scotia" by E. Gilpin ; Reports of the Department of Mines 1862–1887 ; Papers by the writer and others in the Transactions of the North of England Mining Institute and of the Nova Scotia Natural History Society ; and the Royal Society of Canada, etc.

In conclusion, the writer trusts that the sketch given by him of Coal Mining in Nova Scotia may serve in a general way to show the systems followed, and to indicate the capabilities of the different mines to meet any expansion of trade. The tabular information has been carefully revised, and it is trusted that the sins of omission have not been important. Within the scope of a brief paper it has been found best, as far as possible, to speak in general terms, as any detailed reference to each colliery would have necessitated much repetition, and occupied much space.

Statement of the Classes and Number of Men employed, etc., at each Colliery during the year ended December 31st, 1887.

COLLIERIES.	Underground.				Above Ground.				Construction.				Total.		Average number of tons per Cutter.	Average tons per day per Cutter.	Average quantity raised per day.	Horses.		Pits Worked.
	Skilled Labor.	Laborers.	Boys.	Days' Labor.	Skilled Labor.	Laborers.	Boys.	Days' Labor.	Skilled Labor.	Laborers.	Boys.	Days' Labor.	Persons.	Days' Labor.				Above.	Below.	Days.
Cumberland Co.																				
Chignecto	20	9	5	8224	2	9	3	4289	....	....	....	....	48	12513	824	2.9	58	1	1	283
Joggins	32	7	8	8643	4	21	6	7103	4	....	....	283	82	16029	520	2.5	81	4	2	204
Springhill	506	237	142	248033	80	130	19	62651	9	10	...	5227	1133	315911	881	3.2	1622	17	60	275
Pictou Co.																				
Acadia	263	210	81	120382	66	133	20	62250	3	....	....	132	776	182764	876	5.2	1389	16	16	166
East River	5	1	....	1395	1	....	....	330	1	....	....	250	8	1975	229	1.1	5.8	....	....	201
Intercolonial	129	62	69	74496	32	56	9	30733	1	1	....	258	359	105487	1186	4.2	543	7	18	281
Barton	2	1	....	187	....	....	..	....	....	....	....	....	3	187	162	1.3	2.7	1	....	117
Cape Breton Co.																				
Block House	9	3	....	1646	8	....	....	1613	....	....	....	....	20	3259	852	5.2	47	2	8	163
Bridgeport	19	....	2	6090	2	3	1	1671	....	....	....	....	27	7761	1013	5.6	107	2	3	179
Caledonia	115	10	32	30137	17	31	12	14579	4	....	....	1157	221	45873	590	3.2	940	7	20	183
Francklyn	7	....	2	2315	....	....	1	274	....	....	....	....	10	2589	774	3.2	22	....	1	241
Glace Bay	101	9	15	21910	23	24	4	12737	....	....	....	....	176	34647	787	4.2	425	4	16	187
Gowrie	131	14	46	38674	21	52	19	22782	....	....	....	....	283	61456	980	5.6	738	9	40	174
International	109	29	33	13951	32	33	12	5931	....	....	....	....	248	19882	1003	(?) 9.4	1032(?)	6	25	106
Ontario	20	2	3	3827	3	2	1	1558	....	....	....	....	31	5385	388	2.6	52	4	2	147
Reserve	97	15	30	27395	17	18	5	9653	2	....	2	1361	186	38409	915	4 7	425	6	17	209
Sydny	230	40	108	91624	57	85	35	50533	7	....	1	2382	563	144589	712	3.0	708	11	42	241
Victeria	87	31	10	34880	7	38	7	16083	....	....	....	....	180	50963	701	2.3	240	4	5	296
Inverness Co.																				
Mabou	3	....	....	15	....	...	...	....	....	....	....	....	3	15	....	....	....	....	....	....
Total	1885	680	586	733824	372	635	154	304820	31	11	3	11050	4367	1049694	....	....	....	101	271	3653

The statement of men employed and labor performed may be taken as correct except in the averages. The averages of coal per man per day are not reliable, as the softness of the coal varies, and pillar work yields coal more readily than the bords, and in many cases coal is cut and loosened on idle days, and hoisted on days that the pit is working.

COAL PRODUCE OF NOVA SCOTIA DURING THE YEAR ENDED DECEMBER 31ST, 1887.

COLLIERIES.	Produce.	Sales.				Colliery Consumption.	
		Round.	Slack.	Run of Mine.	Total.	Engines.	Workmen.
Cumberland Co.:							
Chignecto	16,480	7,237	3,131	2,160	12,528	3,708	215
Joggins	16,649	10,415	2,971	......	13,386	3,122	1,013
Lawson	120	90	10	......	100	......	......
Patrick	......	......	......	......	......	......	......
Spring Hill	466,223	38,307	75,766	325,061	439,134	21,363	5,718
Pictou Co.:							
Acadia	230,611	129,663	64,532	......	194,195	34,558	4,154
Barton	325	150	11	......	161	......	......
East River	1,145	1,200	515	......	1,715	206	174
Intercolonial	152,825	109,052	33,911	......	142,963	5,565	2,877
Cape Breton Co.:							
Blockhouse	7,676	7,522	......	......	7,522	......	154
Bridgeport	19,265	16,688	1,326	......	18,014	115	110
Caledonia	108,144	72,293	29,797	......	102,090	1,494	1,259
Francklyn	5,422	4,219	1,203	......	5,422	......	......
Glace Bay	79,516	66,778	8,864	......	75,642	3,109	4,094
Gowrie	128,477	96,413	23,341	......	119,754	2,968	1,601
International	169,404	58,712	18,403	25,370	102,485	2,009	2,994
Ontario	7,768	7,426	21	......	7,447	276	125
Reserve	88,849	66,142	10,063	......	76,205	5,957	3,573
Sydney	170,782	129,950	15,260	......	145,210	15,618	7,772
Victoria	61,057	48,555	5,800	1,296	55,651	2,773	2,103
Inverness Co.:							
Mabou	100	60	......	......	60	......	......
Total	1,670,838	870,872	294,925	353,887	1,519,684	102,841	37,936

COLLIERY CONSTRUCTION ACCOUNT, 1887.

Collieries.	Shafts.	Slopes.	Adits.	Machinery.	Colliery Build'gs	Dwell'gs	Surface Works.	Railw'ys	Wharv's	Pros-pecting.	Totals.
Cumberland Co.											
Chignecto			$ 200 00		$750 00						$ 950 00
Joggins											
Springhill		$981 00		$7600 00	2900 00	$5259 00	$2360 00	$716 00			19815 00
Pictou Co.											
Acadia		338 00		721 00	187 00		285 00				1531 00
Intercolonial				8367 00	584 00					$329 00	9280 00
Barton											
East River	$40 00	300 00		200 00	150 00		240 00				930 00
Cape Breton Co.											
Bridgeport											
Blockhouse											
Caledonia			1830 00								1830 00
Francklyn											
Glace Bay											
Gowrie			1156 00		300 00						1456 00
International			85 00				80 00		$33 00		198 00
Ontario		753 00	829 00		137 00	70 00					1789 00
Reserve				2062 00		338 00					2400 00
Sydney											
Victoria		1035 00	7478 00								8513 00
Inverness Co.											
Mabou							34 00				34 00
	$40 00	$3407 00	$11578 00	$18950 00	$5008 00	$5658 00	$3007 00	$716 00	$33 00	$329 00	$48726 00

DISCUSSION.

Sir Wm. Dawson in the course of his remarks referred to the good works which had been done by Mr. Gilpin in connection with coal mining in Nova Scotia, and said that he was indebted to him for much information and assistance in connection with the Geology of the Province of Nova Scotia. Sir W. Dawson.

Mr. Gilpin's history of the coal mining of the Province was very interesting and in the main correct. The name Pictou is said to have originated with the old Micmacs, because of the gaseous emanations which were continually taking place on the outcrops of the coal seams, and the mines of that county had been opened by private enterprise, a long time before they were acquired by the General Mining Association. He referred in this connection to some of the early pioneers of coal mining in Pictou.

The coal wealth of Nova Scotia was undoubtedly great, and it would be long before anything like exhaustion took place. On the contrary the mining was only beginning to be developed, and he had no doubt that the time would come when Nova Scotia and Cape Breton, would become the England of the Dominion and great centres of population. Mining and minerals, unless a great change took place, would undoubtedly form the basis of the wealth of the Dominion; and determine the position of the great cities of the future.

He was not prepared to speak of the professional aspects of the question, but he thought they could gather from Mr. Gilpin's paper a good deal of information in regard to the work that had been done, and the fact that a good deal of mining skill had been brought to bear upon the mines. The difficulties that had occurred in mining some of the pits, especially in regard to the inflammable gases, had caused considerable troubl and many serious accidents, notwithstanding the precautions that had been taken and the means provided for the ventilation of the mines. It was a matter of regret that so much good coal had been lost by these accidents, and it was to be hoped that the mining companies would guard against them so that the loss of life and of money might be reduced.

Mr. J. H. Bartlett considered this paper a very valuable one, not only because it gave a history of the development of the mines and so many Mr. Bartlett.

details of the various collieries, but because it brought so clearly before the Society the value to the Dominion of the Coal Fields of Nova Scotia.

There were one or two points he desired to call attention to. The first was the marked increase in the annual consumption of coal since Confederation, which had risen from $\frac{3}{4}$ of a million tons in 1867 to $3\frac{1}{2}$ million tons in 1886, the production of coal in Canada having risen from 623 thousand tons to 2,100,000 tons in the same period. The substitution of coal for wood on most of the railways no doubt accounted in a measure for this large increase—but the increase in railway mileage from 2,218 miles in 1867 to over 13,000 miles in 1886, the addition of $1\frac{1}{2}$ million people to the population, and our constantly increasing manufacturing interests must not be forgotten.

Having given some special attention to this subject of the coal trade, and published some statistics, he presented tables showing the details of the trade since Confederation as well as other particulars of the collieries.

He desired to make a few remarks about the waste of coal in the pits, the loss of time at the collieries, and on the subjects of handling and freighting.

It will be noticed that the markets for Nova Scotia coal have, owing to alterations in the United States Customs Tariff, been repeatedly changed and, that since the duty was fixed at 75 cents per ton, very little coal has been sent there, the local home market and the inter-provincial trade having to be relied upon instead. This trade is growing, but even with the duty of 60 cents per ton against imported coal, there is a very small margin in the Montreal market between the prices of American Bituminous Coal and that from Nova Scotia.

The methods of conducting the business have been entirely changed within the last few years. The old plan was to give a price per ton at the shipping wharf in Nova Scotia; competition now necessitates a price being given delivered, so that a coal mining company has now not only to mine and ship coal but has to charter vessels, or engage freight and look after all the details of delivery and be responsible for the condition of the coal when delivered here.

The customary methods of selling coal by what is known as "run of mine," which, as the name implies, is the coal of all sizes as it comes from the pit, or the opposite method of screening and separating "the round" from "the slack," need only be mentioned except to say that as it costs as much per ton to carry any size to market, and as a much better price is obtained for "round" coal, it is obviously an important matter to prevent breakage as much as possible.

In many of the Cape Breton mines the coal used to be and may still be riddled in the pit and only the screened coal hoisted, the slack coal being left as not being of sufficient value to pay for the labor and government royalty.

The season of navigation limiting the time of water shipment from Pictou and Cape Breton, it naturally follows that in order to get a good output, the mines have to be equipped to do what should be a year's business in six months' time, and during the winter there is nothing to do for a considerable period, except to keep the pits pumped and in good order. If by any means this waste of coal and time could be obviated it would be of great benefit to the trade and the solution would appear to be found in the manufacture of coke and of iron.

It has been found in the United States that coke can, to a large extent, take the place of anthracite coal, and a large and important business is done in crushing coke into sizes to correspond with the size of anthracite coal so that it can be used in the same stoves, grates or furnaces. It is used domestically for cooking in base burning stoves and in open grates. Large quantities are used in hotels for broiling purposes, as it makes a very clear and hot fire, and manufacturers of all kinds use it in preference to anthracite.

The questions of handling and freighting are naturally considered together, and owing to the short season of navigation, and the long distance, about 800 miles by water to Sidney or Pictou, dispatch and facilities for both loading and unloading are of the utmost importance, a few hours extra delay per trip often losing a round trip in the season. The number of round trips varies, of course, with the speed of the steam collier, but about 12 to 13 round trips is an ordinary season's work, depending upon the dates of the opening and closing of navigation. Most of the vessels are hired by time charter for the season, and cost from 100 to 150 dollars per day, exclusive of the fuel they burn and the pay of the crew. The vessels carry from 1,600 to 2,000 tons of coal to Montreal and return to Nova Scotia with water ballast, there being no return cargo.

The usual time of unloading is from 25 to 30 hours, and means that a vessel is usually in port 1 day and 2 nights, or 2 days and 1 night loading and trimming taking about from 1 to 3 days.

Modern appliances, except bottom dumping coal waggons, are not used at any of the colliery shipping points. The waggons or cars are run out on to the pier the bottom dropped, and the coal falls into the vessel.

As many of the collieries are isolated, they could not afford any improved appliances, but in many instances there can seem to be no good reason why every individual coal mine should own a separate and distinct railway to the loading ground and a separate and distinct shipping pier. The situation at Pictou is shown on the map on the wall. Had the same amount of money been spent instead in rolling stock and improved appliances for loading, much money would have been saved. The Port of Montreal with a fine water power running to waste in the very harbour, seems to be equally innocent of modern progress in the way of facilities to expedite unloading and to save breakage. The colliers use their own steam winches, and when the coal is raised in buckets from the hold it is dumped over the side of the vessel into carts. The lighter the vessel the higher the drop, or when dumped on to a stock pile in the dock it is even more roughly handled in the height of the drop.

An interesting account of modern coal shipping machinery is to be found in a paper read by Mr. McConnochie before the Institution of Mechanical Engineers, England, (Vol III, 1884).

Ninety hydraulic cranes are employed in the coal trade at the Royal Albert Docks, London, seventeen at the Bute Docks, and one hundred and twenty-two at the Tilbury Docks, of which fifteen are portable.

A method, and one much in use in the United States, which handles coal very quickly and cheaply is Hunt's Automatic Machinery. Several examples of this plant, owned by private individuals, are to be seen in Montreal on the Canal.

Mr. Brown. Mr. T. B. Brown remarked that Mr. Bartlett had seen most of the ground within his range. He would say, however, that he was much interested in the accounts given of the several appliances. But the trouble was that while they would like to have anything that would facilitate the handling of coal, reduce the breakage and enable the collieries to place it in the market at a lower price, the difficulties of season, navigation, wharves and barges stood very much in the way and made it impossible for them to advance as they would like, however much they might desire to do so. Those who were interested in the business would welcome anything that would improve matters, but no one knew better than they did the danger of going too fast. Some time ago a company was started that brought into use, or tried to bring into use, what they considered the most suitable appliances for the purpose, but owing to various difficulties that could not be overcome, connected with the season trade, the flooding of the wharves, etc., the appliances fell into disuse, much to the regret of those who would have liked to continue their use.

While in years to come they might have a better process of handling coal, he thought that the facilities in the St. Lawrence, and particularly at Montreal, had improved very much, when the difficulties of the situation were borne in mind. The speed with which the coal was discharged had greatly increased, although the somewhat simple method of discharging by means of the ships own winches was still resorted to.

A good many propositions of new methods were made, but he found that they generally emanated from those who knew the least about the practical working of the coal.

The coal that came from Cape Breton was very friable, and those who saw it leave the collieries in large round handsome pieces, averaging the size of one's head, would be surprised to see it arrive here as small as it might be seen at any time on the wharves. The Pictou and other coals were much harder and arrived here in better condition, although of course all the advantages were not supposed to be with that coal.

It might not be appropriate at an engineer's meeting to say so, but he would remark that there had not been that superabundance of profit in the business to encourage or enable those engaged in it to launch out into the improvements that such a trade demanded.

He would be delighted if any means could be introduced whereby the conditions of this valuable trade could be improved. It was of great commercial interest to the community at large, but, as he had said, they had many difficulties to contend with, and he did not know any business whatever to which the adage of making haste slowly, could be better applied.

Mr. Kennedy asked if Mr. Brown could give any items of cost of transportation, etc., to work upon, so that they might see what margin of improvement could be made. **Mr. Kennedy.**

Mr. T. B. Brown said that his commercial memory was very faulty, and though he might at some future time be glad to volunteer Mr. Kennedy the information asked for, he did not think that it would be exactly the thing for him to go into a general anatomy of the trade just then. **Mr. Brown.**

Mr. Bartlett said it seemed to him that if they could attain a saving of a bag and a half on each cargo it would make considerable difference in the cost of transportation. The methods that he had given a description of were being used in Duluth, and the speed at which vessels were unloaded was remarkable. A two thousand ton vessel could be unloaded in 12 hours. The features of the trade there were very much the same as in this country, the work being all done by seasons, but here they understood and appreciated the value of the saving of time. **Mr. Bartlett.**

Sir W. Dawson. Sir W. Dawson suggested that it would be more advantageous to discuss the introduction of manufactories and the possibility of smelting ores at the places where the coal occurs rather than the manner of handling the coal and reducing the breakage.

Mr. St. George. Mr. St. George remarked that there were some rich men in Nova Scotia, but there seemed to be little enterprise. Mr. Brown had spoken of Cape Breton coal being friable and broken up on its arrival here. He thought this was due in some measure to the way in which it was handled. He had seen coal dumped from a height of 40 or 50 feet into the hold of a vessel.

Mr. Kennedy. Mr. Kennedy could corroborate what Mr. Brown had said in regard to the friability of the coal. It was not altogether a question of handling. The coal would arrive here in large lumps, but about a week or two after landing on the wharf, the lumps would fall to pieces of their own accord. This he presumed was occasioned by the action of the weather. It seemed to him that it would scarcely pay to handle this coal carefully because it would fall to pieces anyway.

Mr. St. George. Mr. St. George thought that if the coal had not been cracked or broken before it arrived the weather would not effect it so easily. At the mines he had seen trolleys running along with three or four blocks on a trolley, but after it had been let down into the hold, the coal could be counted in a hundred pieces. It might keep better if it were placed in sheds.

Mr. Hannaford. Mr. E. Hannaford, chairman, asked Sir Wm. Dawson if he could suggest the cause of the disintegration of the coal.

Sir W. Dawson. Sir Wm. Dawson replied that the coal was traversed by joints running transversely (sometimes filled with thin films of pyrite or sulphide of iron) which admitted air and water causing the coal to decompose and fall to pieces. This was particularly the case with the Cape Breton coal. If exposed to the weather for any length of time it was apt to become very friable, the least disturbance causing it to fall to pieces. The Pictou coal was not so bad in this respect.

He referred to the fact that a good deal of coke was now being made at Londonderry, and was of opinion that a large amount of slack coal, now being shipped would make good coke. It was the purest of coal yet of no marketable value except as fuel for blacksmiths' fires, but would make excellent coke.

Mr. Blackwell. Mr. K. Blackwell said that he had occasion to look into the system of undercutting the coal in the mines by the use of a pneumatic coal cutting engine. He went down to Ohio and investigated the matter thoroughly and found that this machine had been the means of saving all through the State from 25 to 30 cents a ton. He had purchased a plant for the Galt mines at Lethbridge in the N. W., which was now working and giving every satisfaction with a saving of about 25 cents a ton.

The Spring Hill were the only mines in Nova Scotia having a decent output and where perhaps it would pay them to get the best modern machinery, but if all the mines at Pictou were under one management the output might be sufficient to demand modern appliances also.

Mr. Bartlett.

Mr. Bartlett said, that the total output of the Pictou district was under half a million tons and not so much as that of the Spring Hill collieries.

Mr. M

Mr. Gilpin has so happily summarised the salient facts of a very extended subject that only one or two remarks need be added with special reference to the practice in the Cape Breton coal field.

In discussing his description of plant, it must be remembered that Cape Breton collieries have a daily output of from 50 to 100 per cent. greater than that for which the shaft, hauling and hoisting apparatus was originally designed.

This increase has been made rather by extension or forcing of existing appliances than by modifications which every expert would suggest. Consequently we have many appliances obviously uneconomic, but with an ultimate justification in a state of trade for several years so depressed, that no surplus has been available for reconstruction on the most approved methods. Therefore, for example, the different capacities of pit tubs does not indicate different views of the most economical size, all the tubs are the maximum the shaft in each case will admit. Again we do not consider hauling and pumping from long distances to the dip or furnace ventilation from shallow upcasts good practice, but the alternative is usually a new winning, which an engineer would recommend, to be met by the *non possumus* of his directors.

Again the isolation of Cape Breton has developed a system of home production really foreign to the business of mining, and a good deal of mechanical work is made which at collieries nearer trade centres is bought. At the Sydney mines of the General Mining Association, the shops are extensive, and this year they built or finished building a locomotive. Probably when we have rail connection with the continent this will gradually disappear.

The readers of Mr. Gilpin's paper will scarcely realize the destructiveness of the water in some of the pits from his or any description of its effects. The illustration usually given to visitors is that a steel shovel placed underneath a drip from the roof over night, will be eaten through by the morning. At the International mine the corrosive bronzes of pumpmakers were tested by hanging them in the discharge, and were all eaten although this test is less severe than service as a working part.

Mr. Charles Carmichael, mechanical engineer of the Gowrie mines, after many experiments compounded a Babbitt metal, on which pit water has no effect. The principal pump at Gowrie mines, is a Knowles plunger pump, with four large valves instead of nests of sm 'l ones, and with the plunger covered with their own composition. So strong was the opposition oft he mechanical staff at the Knowles works that a special mandate from the president was necessary to have the pump built as ordered. It has worked perfectly, and when through the kindness of Mr. Archibald, manager of Gowrie, the International ordered a pump on the same lines, the Knowles people began to feel that their anticipations of failure were not to be realized. They have, the writer thinks, now adopted Mr. Carmichael's formula. It is as follows:

Tin,	25 parts
Lead,	65½ "
Copper,	5 "
Antimony,	4½ "
	100

It is, of course, soft, but even with a certain amount of grit in the water, a covering of tar and tallow keeps a smooth surface on it. Hard brass valves, with rubber facing give a fair service.

Some of the new aluminum bronzes might stand well, but the writer does not know of their having been tried. Wooden suction and discharg pipes are much more satisfactory and cheaper than iron. Those made by the Wykoff process are capable of withstanding as heavy pressures as our service requires.

The fact that these corrosive waters are found chiefly in the roof and underlying strata, in immediate contact with the coal rather than in it, saves us from being thrown out of the market. As a matter of fact prepared coal from Cape Breton is remarkably low in ash and comparatively free from sulphur. It has the reputation of being hard on bars, owing mainly to a fact so hard of comprehension by ordinary stokers, that a coal high in volatile carbon compounds must be treated differently from coal the carbon in which is mostly fixed. Proper firing is every day giving us perfectly satisfactory results. So too with spontaneous ignition. Even in the summer of 1887, when coal from the old country, the United States and Nova Scotia, was on fire at different places on the St. Lawrence, the writer knows of only one coal from Cape Breton which, *piled by itself*, ignited. That was from a mine where the coal was not screened at bank, a practice which is to be abandoned next season.

The above remarks apply only to large coal. They may not be apposite, but the matter is important and one on which but little apparently is known. Was there any atmospheric condition in 1887, which made the ignition of coal heaps so common? Why should coals from different mines ignite more easily than if piled alone? These are questions in which both the consumer and burner are interested.

The screening of coal has much to do with its economic value. Several Nova Scotian collieries have apparatus working different from the ordinary fixed bear screens, but the subject may perhaps be worth treating in a special paper.

On reading Mr. Gilpin's paper on Coal Mining in Nova Scotia one can only admire the completeness of the paper and the conciseness with which he has treated the prominent features of the industry. **Mr. Leonard.**

While the subject is under discussion the following description of a balance for lowering the coal down to the railroad level, which, although hardly beyond the experimental stage, is doing very good work here, may be of interest and may be found very serviceable under similar circumstances elsewhere. The Spring Hill coal is of a tender nature and crushes easily. In the deep workings it is costly to keep a place wide enough for a double track timbered up to prevent crushing. In these lower workings several balances have been driven just wide enough for the cage.

About midway up the balance, the track is laid on longitudinal sills instead of on cross ties. Between these cage tracks, is laid the narrow gauge back balance track.

The back balance is made of two long cast iron square bars with channels on the under sides fitting over the square axles.

This forms the balance weight, and it runs under the cage at the "meetings" where the cage tracks are laid on the longitudinal sills. The drum at the head of the balance is fitted with a separate rope for the balance and for the cage as usual, one winding on as the other winds off.

This method secures the advantage of the separate ropes with the short single drum necessary in this case to prevent the fouling of the ropes.

Mr. Archibald. The important point to be decided, as to the method of how coal is to be worked in a seam, is the percentage that can be removed with safety and economy.

For some years the Gowrie seam, four feet six inches to five feet in thickness, was worked by pillar and stall, the stalls being six yards, and pillars seven yards. Above the natural water level the pillars were removed. In 1872 the rooms were widened to eleven yards, resulting most favorably to the owners and miners. The bords or stalls are started from the main level, at a width of six yards, and widened gradually to eleven yards: a turn is then put in and a road is extended upon each side, close to the pillar. In order to economize rails, as the room advances, only one road is left permanent, and the crossing is moved from time to time. Two great advantages were gained by widening the rooms; a much larger percentage of coal was obtained by the first working, and the cost reduced, less rails bring required, but the greatest reduction of expense was found in removing pillars. By the old system a road was laid in the middle of the bord, and all the roof coal and dirt were stowed on each side, which cost a large sum to remove, when the pillars were required. By the new system, the roof coal and dirt, are stowed in the centre, thus leaving the pillars free from all debris. If the roof were bad, and the cover heavy, wide rooms could not be worked with safety and economy, but here this method is feasible, and the pillars can be removed. In the writer's opinion it is more satisfactory, and less expensive than longwall.

Underground haulage is one of the most important features that can engage the attention of a manager. Where a large quantity of coal has to be raised in ten hours from one shaft, the supply to the bottom, must be well arranged to keep the hoisting engine constantly employed. Good and well kept roads, and perfect running tubs assist the transportation of coal immensely. Hadfield's fixed steel wheel seems to be a great improvement upon the cast iron wheel formerly used. At the Gowrie Mines they are used entirely. The tubs carry from twenty-five hundred to three thousand pounds of coal, and the wheels only weigh thirty pounds each: the wheels are turned on the axle, and run perfectly. In point of wear, it may be stated that we have wheels running that have been in constant use for five years, and have never had one break, whereas the old cast iron wheel, weighing sixty pounds, rarely lasted three years, while accidents from broken wheels were frequent. In connection with the Hadfield wheel, there is a patent keep which does not cover the bearing, but allows the axle to be satisfactorily greased. This patent keep enables an automatic tub grease to be used, which is a great saving of grease and labor, and has the advantage of being more reliable than boys. The automatic tub grease was patented in the United States and Canada, and has been in use at the Gowrie Mines for the past three years, giving every satisfaction. Excepting at Sidney Mines, the coal is hauled on the levels by horses. Self-acting inclines are used in several of the mines, where practicable, and this is one of the cheapest methods of reducing the number of horses required to haul the empty tubs up to the faces of the bords.

In this paper Mr. Gilpin touches on the history, trade statistics, and methods of working the Nova Scotia coals, each of which divisions might be independently and variously treated in more or less detail according to the bent of the individual writer. **Mr. Poole.**

Geologically the different fields have been reported on in the most comprehensive form by the officers of the Survey, who of course utilized the material supplied by the several observers who had preceded them in each locality. The official reports relating thereto begin with that of 1866-9.

The early history found in Mr. R. Brown an exponent in his "History of the Island of Cape Breton," and in his "Coal Fields and Coal Trade of Cape Breton"—works which necessitated much research and are now freely quoted. One historical note may be added: prior to the granting of the general lease to the Duke of York, coal was freely stolen from the unleased outcrops exposed on the Cape Breton cliffs, and preventive officers were appointed; of one, it was related to the writer by an old revenue officer, that zealous in his duty he effectually prevented further depredations by setting fire to the exposed coal.

The lease to the Duke of York that Mr. Gilpin speaks of being "a princely gift" did not prove so to his assigns, for many a year; as it seems that the first dividend paid by the General Mining Association was not until 1845. They had, however, in addition to the royalties, to pay certain sums to the Duke's creditors for the transfer of the lease.

The royalties reserved by the Duke's lease would not in the present day be considered merely nominal. A concession certainly was named for the first five years, but afterwards the rates were 5%. on gold, silver, &c. (the present rate is 2%); 4 pence per ton on iron ore (the present rate is 5 cents per ton), and for every ton of coal one shilling (the present rate is 9.7 cents); and as there were reserved leases and grants of land without reservation of mineral, the monopoly was not a close one, and it was not felt except in coal—the reserved leases having subsequently been bought up by the General Mining Association until the modification of the lease in 1857.

Mr. Gilpin speaks of the development of the gold, gypsum and other minerals immediately following the period during which the simple farmer doubted if clay were a mineral or not.

The practical discovery of gold was not made until 1860, three years later; gypsum had been quarried and exported in large quantities for many years, regardless of any rights the monopoly legally may have had for 80 or 90 years' says Professor How, in his most valuable "Mineralogy of Nova Scotia," 1868; and he gives a table of the shipments of gypsum running back to 1833, in which year no less than 52,460 tons were quarried. He also speaks of the bricks made and the limestone quarried prior to 1857, and describes at length the operations at the Londonderry Iron Mines, then as now independent of the great Monopoly.

Mr. Brown in his book, page 76, speaks of the General Mining Association *purchasing* the leases held by parties at Pictou, but that Mr. G. Smith, who on payment of £1100 cash held a lease for 20 years from Nov. 3rd, 1819, did not so regard his share of the transaction in question, is evident from his petition to the Government for redress in 1831. He wrote as follows:

"The strongest ground I think I have for compensation to rest my claim on is that it was not the intention of Government, at the time I obtained my lease, to license any other person in the district of Pictou, while I continued to comply with the terms of my lease, and the attempt of his Royal Highness' sub-lessees to interfere with me would not be justified on any principle. I had the opinion of the late Attorney General on this subject, who stated to me that under my lease I might follow the seam to the Bay of Fundy, provided I could satisfy the proprietors of the soil for surface damage; but to hold as against the Government and enter into a competition with the lessees of the Duke, whose lease was for 60 years, while, during the first five years they were only to pay 20% per annum, and I having to meet their capital and gratuitous lease, with annual rent of £370 and 3d. per chaldron of 36 bushels over 1400 chaldrons, you will at once see that whatever might be my legal right I could not persist with safety to myself and therefore I sold my material and utensils for some £400.0.0 to the agents of the General Mining Association."

He elsewhere in explanation of this writes: "In consequence of the construction which by the Colonial Government was given to my lease, I was compelled to pay £110 annual rent for a mine on the East side of the East River, which, owing to the quality of the coal, I never was able to work."

Mr. Gilpin speaks of careful revision of the accompanying tabular statements, which previously had been published in his and the Inspector's Reports to the commissioner of mines. The writer is inclined to hold that too great care cannot be taken in the preparation of tables from which any deductions are to be drawn, and therefore the writer would venture, in spite of a possible charge of being captiously critical, to point out errors that have crept in or have not been corrected since the figures first appeared in the Departmental Reports.

First, he would correct one of his own making when the Table of Sales was compiled. It was due to want of data, since partially obtained.

The sales of coal should be increased from the figures given for the decades

1811—20 to not less than 104,650 tons.
1821—30 " " 169,282 tons.

The Table of Pit Tubs has not been revised since 1872, except in the additional cases, the Vale, where the 'contents' figure up to 26% not to 14 cubic feet as given in the table, while changes have been made in at least three of the cases cited. The wide mine gauge of 4 feet has been done away with, and one of 26 inches substituted, for one reason, because at greater depths the increased pressure necessitated narrower places than the wide gauge required; and as it is now, at greater depths bords driven in 9 feet wide become so reduced in size by the pressure when the pillars are being drawn, that there is nothing to spare between the tubs on the narrower tracks and the timbers of the bord.

In the table of Winding engines, the gross load, coal, cages and ropes, and in the case of inclines the additional friction of rollers and pulleys, does not seem to be uniformly given, nor is the vertical height of the lifts stated, so that the work done by the several engines does not clearly appear, nor why ropes of such various sizes should be used. In some cases it would seem the table is in error, and in three at least the sizes of the ropes are too large.

Under the head of Pumping the estimates of the total output of water can be at the best but approximate only, and would be better in round numbers; in some cases due allowances do not seem to have been made for idle days, and the figures would appear rather over than under the actual make of water.

Explanatory notes seem necessary in connection with some of the tables:—By that of Exports to the United States it might be inferred that all the late shipments of coal to that country paid a duty of 75 cents per ton, when in fact about half of those of late years, being entered as "Culm", paid but 40 cents duty.

Mr. Gilpin rightly questions the reliability of the averages, for without full explanations or knowledge of the varied conditions, no deductions as to average earnings of men, or labor cost of production, could be made from the Returns given quarterly to the Government. For example, one concern may shew the cost of transportation in labor chiefly on the colliery railway, while another has no such charge, cash being paid to an independent organization for carriage of coal to the port of shipment. Again if we take the number of hands employed, and the total days' labor they perform during the year, it would appear that at some mines the men and boys below ground average but 175 or 190 days, and that consequently their gross earnings must be small indeed, while at another mine, with an average of 270 days, the circumstances of the workmen must be vastly superior, and yet the former may not be so badly off, as a large proportion may be transient, employed during summer only, and retiring to their farms during the dull season.

The construction account given is from data supplied in consequence of requirements in the Leases, and is supposed to include charges to capital account only. If rightly given, a comparison of several years would show periods of expansion and depression.

The sketch Mr. Gilpin has given of the older method of working by gate-roads driven at half pitch recalls a still older system, when skips were used before the introduction of tubs, *i.e.*, mine cars, say, prior to 1852. Then, on the railway bord at the foot of each gate-road, where Mr. Gilpin shews a head down to the parallel mine bord below, there was a "horse hole", a place where the horse could turn when he dragged the skip on to the platform at that point. The skip was a sled with runners, and a strong iron bale over which broad iron rings were thrown as the coal was skilfully built up within them; hoisted to the surface it was run on a trolley to the screen or brow of the coal heap, and toppled over, the rings of course rolling down to be subsequently collected and carried back to the pit mouth.

Mr. Gilpin brings before us so many subjects of colliery interest, and the practice is so varied, that one is at a loss what to select and what to avoid. Success in mining the soft coals, especially in inclined seams, largely depends on the judicious use of mechanical appliances, and the cost of production has a wider range under what might appear very similar conditions than would be supposed.

The difference in the life of ropes for the amount of work done at the several mines is almost incredible, and consequently the cost of many thousands of feet of rope is of no small moment. The variation is at least four to one. Various sizes, makes and qualities may be seen; the "lock coil" looking like a continuous bar of iron, and presenting a continuous surface, with consequently less abrasion for itself and the pulleys and rollers that bear it; Lang's patent with the lay of the strands and the wires in the same direction, and ropes of the ordinary lay of fine and course wires of all qualities from plough steel down to iron. Ropes of one half the weight, but of improved quality, have in some cases been substituted with advantage. Then again the treatment ropes receive is various, some drag on the ground or are exposed to the corrosive action of mine waters, others are lubricated with an oil that searches in between the wires; more ropes are destroyed by internal corrosion than by external abrasion, some are well rollered, and others pass over pulleys lined with wood.

The gauge of mine tracks and sizes of tubs or cars calls for a division of opinion; one contends he has effected economy by enlarging, another by reducing the size.

The efficiency of the blow down fans of local design is open to question. Mr. Gilpin refers to and contends that the measure of success they enjoy is due rather to an absence of friction in the air-ways than to their construction.

Signalling is not alone confined to the method spoken of, there is an improved means by two taut reciprocating wires conveying uniform motion to pointers on dials thousands of feet away; and electric signalling is in use in at least one mine, and so arranged within reach of men riding on the incline that contact can be made at any point; but in that position it is exposed to damage or rather annihilation, when a run-away of the rake of mine cars clears the slope of wires, timbers and rollers. Speaking of run-aways brings up the "durkey" question and appliances for catching the tubs when rope or coupling breaks. The ordinary durkey, a pointed bar trailing behind the rake, is useless on slopes of 20 degrees or more that are too high for the bar to thrust the hind tub to the roof. In ordinary course of working the durkey is seldom used, more reliance being placed on careful inspection of ropes and couplings, but a frequent thorough examination of all draw bars and links is not possible, and a more efficient safeguard than the ordinary durkey is desirable. The writer devised, and has in use on some riding tubs, a contrivance which relies on the reversed motion pressing knife edges into the sills to which the inclined rails are spiked, and so bringing the car with its load of men to rest without the sudden jerk that the use of the rigid durkey entails.

These are small matters which have been referred to, Mr. Gilpin having introduced the broad outlines of the practice at the Coal Mines, comments on modification or details alone are left. Yet details are not to be despised if improvements—elsewhere designed—are to be successfully adopted, and certainly the practice of the colliery engineer gives many opportunities to effect economies by attention to little things. He also can with advantage bear in mind the lesson taught the cotton spinner when told to "chalk your bobbins".

Mr. Gisborne. Mr. Gisborne desired to express his regret that he was unable to be present at the reading of Dr. Gilpin's interesting, historical and practical paper upon the Coal Fields of Nova Scotia.

He had been the engineer and manager of four collieries in Cape Breton, during the years 1869 to 1875, and had opened the "Reserve," "Lorway," "Emery," and Schooner Pond mines from the surface, besides being the contractor for the construction of the Sydney and Louisburg Railroad and piers, and the shipper of all the coal raised by the Company to Canadian, United States and other foreign markets.

His experience with narrow gauge railways and Fairlie engines (originally adopted by the English Company which he represented, as a matter of (false) economy and contrary to his advice) was conclusively in favor of the standard 4 feet 8½ inches gauge and ordinary engine, for as a matter of fact, two out of his three Fairlie engines were almost invariably "in hospital."

Then again narrow gauge coal trucks cannot be efficiently and economically unloaded from their bottoms; but had to be discharged from their sides, which was a slow process until he invented a balanced tip-shoot-platform, by which the entire truck was tilted sideways, and then returned to its horizontal position automatically. An inspection of this invention, which enabled one man to discharge 60 to 80 tons of coal per hour into a vessel's hold, would be interesting to narrow gauge railway proprietors.

There was a considerable difference also in the economic value of the bituminous coals of Nova Scotia as would be noted in the following analysis, some being better adapted for household fuel, other seams for steam raising purposes and others for gas.

Thus Old Sydney gave:	Pictou coal gave:	And Spring Hill, Cumberland:
Volatile matter, 28	Volatile matter, 27	Volatile matter, 22
Carbon, 67	Carbon, 60	Carbon, 66
Ash, 5	Ash, 13	Ash, 12
100	100	100
Yielding 6,500 feet of gas to the ton.	Yielding 7,000 feet of gas to the ton.	Yielding 6,000 feet of gas to the ton.

Whereas the Reserve Cape Breton gave the following analysis of cargoes sent to the Manhattan Gas Company of New York and a later sample to the Royal School of Mines in London:

	Bank crop coal at New York:	Deeper mined coal at London:		And Schooner Pond:
Volatile matter,	34·5	37·26	Volatile matter,	38·10
Carbon,	59·5	58·39	Fixed Carbon,	58·45
Ash,	6·0	4·35	Ash,	3·45
	100·	100·		100·
Yielding 9,500 minim. to 9,950 max. feet of gas to the ton.			Yielding about 9,500 feet of gas.	

All of the foregoing gases averaged 13 candle power.

Another matter of vital interest was the cost of freighting Canadian coal, by steam or sailing vessels and the loss from demurrage when unloading, either from lack of facilities at the receiving ports, or the suicidal labor combinations to which colliery proprietors were helplessly subjected.

He had employed two English steamers, the "Dodd," carrying 1,300 tons and the "Dione" 850 tons at the chartered rate £1 stg. per *registered* ton per month, and notwithstanding that these vessels were invariably loaded within 48 hours the result of the season's work showed a heavy loss, solely and entirely from the two causes above referred to.

He might add that frequent strikes among the coal cutters greatly augmented the risk of loss to colliery proprietors, but that from his own experience he was decidedly in favor of a friendly interest in the well-being of the men and conciliatory though firm dealing with incipient discontent.

Colonial coal fields, at the time to which the writer refers, were eagerly fought for and unstintedly provided with powerful machinery and transport facilities. Within a brief period, however, the British coal fields were proved to have two or three centuries of mineral supply in reserve, and the bright outlook for Nova Scotia mines was relegated to the future—Cape Breton coal became a drug on the market, even at less than $1.40 per ton at the mines, and his company collapsed after an expenditure of over $2,000,000, having made no profit out of which they could pay interest upon their bonded debt. The property passed out of the hands of the shareholders, and thus he had abandoned mining ventures and returned to his "first love" Electrical Science.

Mr. Gilpin. In closing the discussion begged to express his thanks for the kind references to his paper. He regretted that the space and time at his disposal did not permit of his giving more details on some of the interesting points connected with the practice of coal mining in Nova Scotia. The tabular statements had received numerous corrections since they had been submitted to the Society, and he hoped that when published they would be fairly accurate.

He, like Mr. Poole, approves of the exhaust fans as conducing to more permanent efficiency, and as capable of bearing greater burdens than the ordinary pattern of forcing fans. The friability of the Cape Breton coal has been employed as an argument against its use for all ordinary purposes. The fact, however, remains that under intelligent handling more heat can b egot from small than from large coal, which is in the line of the experiments that show that the ultimate greatest efficiency of a pound of coal is to be sought from its component parts on the eve of their greatest dissociation.

If it were possible to ship the coal as run of mine, screen it at point of delivery, and make coke and briquettes out of the slack coal, there would be a larger percentage of round coal for the conservative householder.

The percentage of ash in the Cape Breton coals is lower than in the Nova Scotia coals, but although the total theoretical evaporative power may be highest in a low ash coal, there are, as a rule, certain practical objections to this. There seems to be an advantage in a considerable percentage of ash in coals burned under a very strong draft, and the explanation may be that the slightly retarded combustion is the most perfect.

In this connection, Johnstone, in his little work on the Coals of British America, gives the result of an official test by the American Government of Sydney and Albion coal as follows:

Sydney coal-ash, 6 p.c.; lbs.of steam from 212°, 7·90.

Pictou coal-ash, 13·38 p.c.; lbs.of steam from 212°, 8·41.

In a paper read some years ago, before the North of England

Mining Institute, on Canadian coals, the author gave a fairly complete set of analyses of the ashes of Cape Breton coals. These analyses show that, broadly speaking, the composition of the Capo Breton coal ashes, as distinguished from those of the mainland is of a ferruginous character, while that of the latter is silicious. It would seem that the fusible clinker of the former with too thick a fire, is the principal reason why complaints are heard of the destructive action of Cape Breton coal on fire bars. This can readily be avoided by proper firing.

There is no question that the interests of the coal owner demanded the introduction of mechanical cutters and haulers. The first cost was very heavy for air compressors and pipes. and the use of electricity seemed to afford the happy medium of cost versus portability. The ingenuity and skill displayed by the management of the Gowrie mine in dealing with acid pit water was deserving of the greatest praise, and he would suggest that Mr. Archibald and his staff should devise some plan of revenge upon the acid water by utilising it in some commercial process, which in return would call for their coal for steam and power raising.