PEAT FUEL:

ITS MANUFACTURE AND USE.

BULLETIN No. 5

OF THE

BUREAU OF MINES, ONTARIO.

PREPARED UNDER THE DIRECTION OF

THOS. W. GIBSON, DIRECTOR,

BY

W. E. H. CARTER, B.A.Sc.

PUBLISHED BY ORDER OF
THE LEGISLATIVE ASSEMBLY OF ONTARIO.

DIEU ET MON DROIT

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INTRODUCTORY LETTER.

To the Honorable E. J. DAVIS,

Commissioner of Crown Lands:

SIR,—The possibility of producing a good and economical fuel from the peat bogs of Ontario is one that engaged the attention of the Bureau of Mines almost immediately after its establishment in 1891, and in the Report for that year will be found a pretty full review of the progress made by the industry up to that time both in Europe and America, including Canada. In subsequent Reports, particularly those for 1892, 1893, 1894, 1896 and 1897, the [illegible] was reverted to, and additional information furnished. In view of the recent and still remaining scarcity of fuel consequent on the strike of the anthracite miners in Pennsylvania, the present seems an opportune time to submit a summary of the existing condition of the peat fuel manufacture in Ontario, and the prospect which it holds out of affording relief from a well-nigh intolerable situation.

The data contained in the report are drawn from many sources, but in the main have been collected by Mr. W. E. H. Carter, Secretary of the Bureau of Mines, who for this purpose has visited almost all the peat factories of the Province, and investigated the efficiency and cost of the methods and machinery made use of; and the report is largely Mr. Carter's work.

Determinations and analyses of peat and peat gas were made by Mr. J. Walter Wells, who also reports on practical experience with peat fuel burned at the Provincial Assay Office, Belleville. Thanks are due to Mr. J. G. Thaulow, engineer to the Norwegian Government, for permission to make use of his valuable report on peat fuel in Europe and Canada, to Peat Industries, Limited, the Peat Machinery Supply Company, Limited, and to others connected with the industry, for assistance rendered.

Discussion is restricted solely to the value and use of peat for fuel and the processes employed for manufacturing it for that purpose, this being the aspect of the subject which confers upon it pressing, if not vital, importance. There are many other economic uses for peat, but they are not dealt with in this report.

I have the honor to be, sir,

Your obedient servant,

THOS. W. GIBSON,

Director.

BUREAU OF MINES,

Department of Crown Lands,

25th February, 1903.

PEAT FUEL:

ITS MANUFACTURE AND USE.

Life in a northern climate implies the free use of fuel. Abundance of fuel means comfort and the smooth working of the social and industrial machine; scarcity means inconvenience, distress and the dislocation of industries; absolute want of it would render the temperate regions of the earth uninhabitable. The prime necessity of ample supplies of so obviously important an article requires no proof; but if any were needed it has been thrust upon the people of Canada by the recent strike of the anthracite coal miners of Pennsylvania, and in a way calculated to open the eyes of the most unthinking. A generation ago such a strike would have excited little interest here, because the splendid hardwood forests of southern Ontario had not then disappeared, and good "body" beech and maple warmed the houses and generated steam in the mills and factories of the time. To-day the situation is changed. The dwindling forests have retreated to such a distance from "older" Ontario as to make wood expensive and scarce. All things considered, anthracite for domestic use and bituminous coal for steam raising are preferable to wood; and so partly for this reason, and partly because of the diminishing supplies of the native fuel and the increased facilities for procuring the foreign article, it has come about that the urban and town dwellers of Ontario almost wholly, and to a lesser, but still appreciable extent, farmers and villagers also now rely entirely upon coal for fuel. The number of coal-users is constantly increasing, and the area in which wood is the chief article of fuel is yearly retreating farther to the north.

One effect of the change has been to place the people of Ontario in a position of absolute and abject dependence on the coal barons—or coal miners, it matters little which—of a foreign state for the right to live. As to the merits of the dispute between the coal companies and the mine workers, the people of Ontario may have their opinion, but they have no voice whatever in its settlement, and can have no share in framing laws which might make a recurrence of it impossible. Their only privilege is to accept with gratitude whatever coal their dealers can induce the companies in Pennsylvania, whether mining or railway, to send across the border, and to pay such prices therefor as may be dictated by business slightly tempered with philanthropy.

It is not an easy matter to arrive at the total amount annually paid out for fuel by the people of Ontario. The quantity and cost of the coal consumed can be ascertained with much exactness, since it is practically all imported from a foreign country and the figures are therefore to be found in the trade and navigation tables, but the production and consumption of wood, which constitutes the source of heat for one-half the population or more, is not so easy to estimate. An attempt, however, may be made. According to the census of 1901 the population of Ontario was 2,182,947 persons, of whom 935,978 dwelt in the cities, towns and incorporated villages of the Province. The bulk of the people, 1,246,969 in number, are classed as "rural," and are made up of the farming community and those living in hamlets and places too small to be incorporated as separate municipalities. In view of the originally wooded condition of the country, it is probably within the mark to assume that wood is still the fuel mainly used by the rural population. True, much wood is used in the cities, towns and villages, and much coal in the country; but roughly speaking, urban dwellers are users of coal and country-dwellers of wood. Now, taking into account all the purposes for which wood is employed as fuel, including the raising of steam as well as domestic uses, and having regard also to the fact that the original abundance of wood created the habit of using it with little regard to economy,—a habit which, despite the changed conditions, still survives—it does not seem excessive to place the quantity of wood annually consumed for all purposes at 2½ cords per head of the rural population. At this rate the consumption of an ordinary family comprising five persons would be about 12 cords a year. To supply the community at this rate would require say 2,900,000 cords of wood per annum, the cost of which, taking one quality with another, may be placed at $1.50 per cord. Good, dry hardwood cannot be purchased anywhere now for such a price, but much of the wood burned for fuel consists of the inferior varieties, such as ash, elm, tamarack, or the branches and limbs of the more valuable kinds, and is sold at a smaller price. At $1.50 per cord, the value of the wood burned every year would be $4,350,000.

The imports of anthracite into Ontario during the twelve months ending 30th June 1900, (the last fiscal year in which imports were classified according to Provinces) were 1,075,441 tons, valued at $4,406,231, and of bituminous coal for home consumption, 2,362,115 tons, worth with the duty added $5,357,373. The quantity of coal brought from Nova Scotia in a normal year is so small as to be hardly worth taking into account, consequently the imports of anthracite and bituminous coal may be regarded as covering the total consumption. Adding then the several items together, and leaving out of consideration petroleum and natural gas, which have a restricted use for fuel, we reach the following as representing the fuel bill of the people of Ontario for a year :—

	Value.
Anthracite, 1 075,441 tons	$4,406,231
Bituminous coal, 2,362,115 tons	5,357,373
Wood, say 2,900,000 cords	4,350,000
Total	$14,113,604

The expenditure annually of so large a sum of money stamps the fuel question at once as one of the first importance, and in any circumstances it would be a proper subject of inquiry whether the sources and supply of so necessary and largely used an article could not be augmented ; but there is a double motive for such inquiry when it has been brought home to us that one of the principal items on our list of fuels is but a broken reed.

The old adage of the advantage of having several strings to one's bow is applicable to this question of fuel. Those who, finding it impossible to procure coal during the present winter have had recourse to wood, have found themselves not in such bad caseafter all, considering the fact that their stoves, furnaces, etc., were constructed to consume coal only. If still another fuel could be added to the list, comparable in efficiency to coal or wood, the situation would be decidedly improved. If, too, the preparation of this article would create an entirely new industry of the first magnitude, employing labor and capital on a very large scale, utilizing resources now almost entirely dormant, and substituting a native product for one of foreign origin, there would seem to be every reason, both from the private and the public point of view, for welcoming the introduction of the new fuel. The peat bogs of Ontario are, it is believed, quite capable of furnishing such a fuel and sustaining such an industry.

Peat Fuel No Novelty.

Peat fuel, though new here, is no novelty in older lands. In Scotland and Ireland in the ordinary or air-dried form it has been burned for many centuries, and still in places survives the competition of coal from the English and Scottish mines. In the countries of continental Europe, especially Germany, Holland, Russia, Denmark and Sweden, there is annually a large and apparently increasing consumption of peat. In central Sweden it is said that as much as one million tons of peat are prepared and used yearly, and two million tons in the whole country. Not only is peat in demand as domestic fuel for cooking and producing warmth, but in metallurgical processes, in steel and glass furnaces, for firing locomotive boilers, for generating electric power and for many other purposes it is used in solid or gaseous form. Germany is believed to have more fuel in peat than in coal, and much ingenuity has been displayed in that country and elsewhere in devising processes and machinery for preparing it. In short, so far from peat being an obsolete fuel, it is coming more and more into use as its manufacture is being perfected and a better article produced.

The Comparison Must Be with Coal.

Coal is the standard by which any competing fuel must be measured, though there are substances which for special purposes are equal or superior. Some petroleums, for instance, give better results in locomotive or steamship boilers, costing less and occupying smaller space for the quantity required to produce a given amount of power. Charcoal from wood makes a better product in the iron blast furnace than mineral coke, because of its greater freedom from sulphur, which deteriorates the quality of the pig. In certain other respects, such as cleanliness of handling and completeness of combustion, coal compares unfavorably with wood and peat ; but in the main, and for general use coal (including both anthracite and bituminous) is the fuel which at present holds first place in public esteem, and no doubt rightly so.

The comparison of peat with coal must be at two points (1) efficiency, (2) price. Unless there is a fair equality in the result of these factors, peat must be ruled out. If on the one hand it is so far below the level of coal in calorific value that no matter at what price produced it would not be used where coal could be had ; or if on the other, it cannot be produced and sold for a price at least as low as that for which the equivalent in heating value of coal could be bought, all efforts to introduce peat will be unavailing except at times when nothing else can be had.

The fact that peat continues to be used in many countries concurrently with coal where there is no difficulty in procuring the latter, is proof that for some purposes at least it is equally well adapted and not more expensive. The Holland housewives, proverbial for their neatness, will have no other fuel, and in the Dutch brick-yards peat only is used.

Peat is in reality incipient coal. The coal beds, which are the basis of modern arts and industries, were laid down ages ago in some such way as peat bogs are now being formed, except perhaps that in most cases trees were the source of the carbon of the coal instead of the mosses or aquatic plants of which peat bogs are composed. A regular gradation can be traced beginning with peat or wood and passing through lignite, bituminous coal, anthracite and even graphite, the various stages of the process depending upon the degree of pressure or heat which has been exerted ; and doubtless the peat bogs of to-day, if not sooner consumed, may in subsequent ages be metamorphosed into seams of coal for the benefit of the coming man. Being incipient coal, peat contains less carbon and is inferior in specific gravity to coal, though, as has already been pointed out, its properties in this respect must be considered in relation to the price at which it can be produced and sold.

The Place of Peat among Fuels.

The following figures taken from Percy's Metallurgy will serve to show the place of peat among the fuels, so far as its chemical composition and physical properties are concerned :

Substance	Carbon C.	Hydrogen H.	Oxygen O.	Nitrogen N.	Sulphur S.	Ash.	Specific gravity.
Peat	54 02	5.21	28 18	2.30	.56	9.73	.850
Lignite	68.31	5.63	22.86	57	2.36	2.27	1.129
Bituminous coal	78.69	6.00	10 07	2.37	1.51	1.36	1.259
Anthracite	90.39	3.28	2.98	.83	.91	1.61	1 392

The above analyses are exclusive of water, which in the peat amounted to 25.56 and in the lignite to 34.66 per cent.

Comparing the calorific value or heating effect of the various kinds of fuel, Thurston, in his Elements of Engineering, gives the following figures :

Fuel.	Calorific power.		Water vaporized at boiling point. Parts by one part.
	Relative.	Absolute, B T.U.	
Coal, anthracite	1.020	14,833	14.98
" bituminous	1.017	14,796	14.95
" lignite, dry	0.700	10,150	10.35
Peat, kiln dried	0.700	10,150	10.25
" air dried	0.526	7,650	7.73
Wood, kiln dried	0.551	8,029	8.10
" air dried	0.439	6,385	6.45

The absolute calorific power is expressed in British thermal units (B. T. U.), one such unit being the quantity of heat required to raise a pound of water from the temperature 39.1° to 40.1° Fahrenheit. The heating value of peat briquettes is placed at about two-thirds that of coal, but it is not possible to give more than approximate ratios, for the reason that neither coal nor peat is a definite chemical compound, and both vary in composition very considerably within certain limits.

As between peat in its several classes and bituminous coal, the comparison is as shown by the following figures :

Material.	Weight per cubic foot as piled pounds.	Relative weight for same heating value.	Relative bulk for same heating value.	Specific gravity.
Cut peat	13	2.99	14.36	.50
Machine peat	21	2.45	2.56	.95
Peat briquettes	56	2.04	2.14	1.12
Bituminous coal	60	1.36	1.43	1.30
Anthracite	63	1.	1.	1.45

The comparison is with anthracite rather than with bituminous coal, for the reason that the sphere of usefulness for peat is in the home, rather than the factory or the mill. For steam-raising purposes, run-of-mine bituminous coal or screenings will probably be found more economical in use. One advantage peat possesses over any form of coal is the much smaller percentage of sulphur which it contains, hence its use is less injurious to grate-bars, boiler tubes and the like.

Anthracite and Peat Compared.

The principal uses of anthracite are in cooking and heating, being burned for the former purpose in stoves and ranges, and for the latter in stoves and furnaces of varying design. The large percentage of carbon and high specific gravity of anthracite constitute it a dense and lasting fuel, requiring little attention after being once ignited, and, as householders know, there is little difficulty in maintaining a fire in stove or furnace over night ready for fresh fuel in the morning.

Peat when first placed on the fire burns with a short blue flame, continuing to do so until the grate spaces become covered with embers, when it emits an intense yellow glow and short flame of the same color. It is now giving out an intense heat, which may be easily and accurately controlled by adjusting the draught. A peat fire may be made to last over night by banking it properly and closely stopping all the draughts. Once well lighted a peat fire will not go out until every atom of fuel has been consumed. This is due to the fact that it requires very little oxygen to sustain its combustion.

The ordinary methods of burning fuel, whether coal or wood, are very wasteful, only a comparatively small proportion of the theoretical heating value being utilized. This is partly due to the large amount of air which finds access to the fuel, carrying off the heated products of combustion into the chimney or smoke-stack before they have performed their work. With coal the clinkers and live embers which drop through the grate bars are an additional source of loss. There are similar losses in the case of peat when burned in apparatus not well suited for its combustion, such as ordinary stoves or furnaces intended for coal or wood. Hence much attention has been given in Europe to specially constructed stoves for burning peat, in the invention of which the Danes appear to take the lead. Further mention of these is made below.

AN ACTUAL TEST OF PEAT FUEL.

At the Provincial Assay Office, Belleville, Ontario, peat briquettes alone were used as fuel for a portion of the winter of 1901-2, and the results are given in the report of Mr. J. Walter Wells, then Provincial Assayer. The office building contained upper and lower flats with a total air space of 23,000 cubic feet, for heating which two coal stoves were ordinarily employed. The same stoves—one an Imperial Oxford Air-tight Heater, and the other a Fire King—were used for burning the peat. The stoves were filled whenever necessary, and no special attempt was made to economize fuel. From careful observations covering a period of twenty days the following figures were obtained: Average temperature of outside air, 21° Fahr.; ditto inside air, 56°; ditto upper flat, 61°; ditto lower flat front room, 61°; back room, 53°. The peat was consumed at the rate of 186 lbs. per day, at a cost of 37 cents, the price of the fuel being [illegible].00 per ton, delivered. Starting or replenishing the fire caused smoke, and it was found advisable to prepare for adding fuel by creating a strong draught to carry off this smoke, after which the draught could again be cut off. The stoves required feeding about six times a day, or once every two or three hours. Fire was maintained during the night by covering the peat with ashes and closing all the draughts. When the latter were opened in the morning the fire would spring into life again. No visible amount of soot was deposited in the flues.

In these stoves, as well as in several types of cooking ranges in which peat briquettes were experimentally burned last winter, the gratings were found too coarse, and it was not practicable to prevent an excess of draught, or to wholly check loss of fragments falling into the ashes below. This difficulty was partially overcome by covering the bars with clinkers or wire netting. These observations agree with the experience of the people of Beaverton, where peat briquettes made by the Dobson process are in common use as fuel.

For many purposes, such as culinary uses, it is more important to have an intense heat for a short time than a lower heat for a longer time, and the rapidity with which peat reaches a high temperature renders it very useful in such cases. Often a burning briquette becomes white hot over its entire surface while the interior, if broken into, is seen to be quite cool.

Peat makes no clinker, but leaves considerable ash, depending in this respect upon the composition of the bog from which it is made. The ashes are light and powdery, and in weight are usually greater proportionally than those of wood, though not greater than those of coal as ordinarily burned. When peat burns without any particles falling through the grate bars, there is absolutely no unconsumed fuel, whereas with coal the percentage of half-burned fragments which escape with the ashes is usually considerable. Peat ashes consist partly of the inorganic substances taken up by the growing mosses or plants during their lifetime, but chiefly of the clay, sand and silt drained or blown into the bog from the surrounding soil. They occasionally run high in alkaline earths, carrying carbonates, phospate of lime, potash, etc., and when rich in phosphoric acid and potash they are suitable for fertilizing purposes.

Peat has some disadvantages, one of which is the considerable proportion of water which it contains even in the briquetted form, thus lowering its calorific value. Another, as noted above, is the tendency in ordinary grates of unconsumed particles to escape into the ash-box.

THE QUESTION OF PRICE.

Then, as to price, which in some respects is a consideration paramount even to quality. The cost of producing "machine" peat in Europe is from 85 cents to $1.35 per ton; of peat briquettes $2.15 per ton. As the detailed data set out in the following pages show, peat briquettes can be made in Ontario at about $1.00 per ton of 2,000 lbs. Allowing a suitable margin for profit, interest on investment, etc., it is evident that compressed peat fuel can be sold at the place of production for $3.00 per ton, and at a correspondingly greater figure if railway freights have to be paid. As a matter of fact, it has already been sold by one maker for two successive seasons at $3.00 per ton, and beyond doubt in this price was included a fair profit. Putting the theoretical value of peat briquettes at two-thirds that of coal, at $3.00 per ton their cost would be equivalent to anthracite at $4.50 per ton, and at $4.00 per ton to anthracite at $6.00 per ton. Such figures at once bring peat fuel into the economic arena, as it may be doubted whether with the effective control now exercised by the trusts over the production and sale of anthracite, we are likely to see it again drop to a lower retail level than $6.00 per ton. In the light of the facts brought out in this report, it will be surprising if the citizens of Ontario are not soon given their choice between compressed peat fuel and coal, instead of as at present being confined entirely to the latter.

EUROPEAN METHODS OF MANUFACTURE.

The peat fuel industry being of comparatively recent origin in Ontario, and little having been accomplished in the United States, where the abundance of coal relegates the question to a position of minor importance, it is to the countries of Europe, where the peat industry is of venerable standing, that we must turn for fuller information as to cost and methods of manufacture. The government of Norway, where the fuel question is in almost the same position as it is in Ontario, both countries being without coal, and both being situated in a northern climate and containing within their borders many peat bogs, commissioned Mr. J. G. Thaulow, a mechanical engineer of that country, to investigate the peat industries of Europe and Canada, and his report dated June, 1902, contains much interesting and valuable information concerning costs and manufacturing methods in the countries which he visited. Mr. Thaulow's report is freely drawn upon in the present paper, and other available sources of information have been made use of. Comparisons with European countries in the matter of costs should be made with care, because of the lower price commanded by labor there; but so far as climatic conditions are concerned, which play a very important part in the manufacture of peat fuel, there is no great difference between Ontario and the countries of central Europe, where peat is largely made and used. There is probably a longer summer season, more sunshine and less rain in Ontario than Denmark and Sweden, so that processes depending upon the weather such as outside drying, which are practicable there, ought to be even more successful here.

In European countries three kinds of peat fuel are known; (1) cut or "stick" peat, namely, the crude peat cut in blocks out of the bog and dried in the air, after which it is burned without further treatment; (2) "machine" peat, which is the name given to peat ground or macerated to a pulp while wet, sometimes with the addition of water, and then cut or moulded into blocks and dried with or without artificial heat; (3) peat briquettes made by artificially drying and compressing powdered peat.

Coke or charcoal is also made from peat and is used in the smelting of ores and other metallurgical processes. In converting the raw peat into charcoal practically the same range of by products is obtained and made use of as in the coking of coal; but charcoal fuel is little used in this country, and it has not been thought necessary to make any extended allusion to this aspect of the subject in the present paper.

CUT PEAT.

The first mentioned variety, or cut peat, is the sort used by the poorer classes, who employ their own labor in the spring and summer in making it. Though constituting a fuel by no means to be despised, especially when taken from the decomposed layers of a good bog, cut peat is suited only for local use, because of its retaining, even when apparently quite dry, a considerable proportion of moisture, and because of its bulkiness and friability and consequent unfitness for transportation to long distances. This variety of peat can only be made from a dry or drainable bog. After digging, for which purpose a specially shaped spade is used, with a wing at one side, in order to cut out rectangular blocks, the latter are laid on the surface of the bog, where in a few days they lose sufficient water to be turned over and afterwards piled up. During the summer months the blocks of peat will dry down to a water content of about 30 per. cent., by which time they have shrunk to about one-quarter of their original size. Probably the larger proportion of the peat fuel used in Europe is of the cut or "stick" variety, its great recommendation being its cheapness. An able-bodied laborer can dig up the equivalent of 1¼ tons dried peat per day, and in most cases the digging and subsequent handling is done by himself and members of his family. The use of cut peat as fuel for general consumption is out of the question in Ontario.

MACHINE PEAT.

"Machine" peat is a compacter and better article. It is sold in large quantities in Holland, Germany, Austria, Denmark, Sweden and Russia, and is used not only for domestic purposes, but also in manufacturing, metallurgical and other industrial operations. A great many steam boilers, including railway locomotives, are fired with this variety of peat, while in breweries, distilleries and under salt pans in Germany, it is preferred to other fuel. In Austrian glass-works and brick yards it is also freely employed. Most of the peat consumed in Europe, except by the peasantry, is machine peat, and it forms in fact the only fuel for large bodies of the population. The methods of preparing it are very numerous, and much ingenuity has been displayed in inventing machinery and devising processes to suit varying conditions.

Two principal systems are distinguished in making machine peat, depending upon the treatment of the raw material immediately upon raising it from the bog. One plan is to digest the peat with the addition of water into a liquid mud, which is then poured into moulds in the open air, and after losing some of its water, divided into blocks and allowed to dry. The product is sometimes called "knead" peat. The other and more commonly employed process consists of grinding or mincing the peat as it comes from the bog, into a soft plastic mass, which is then cut into bricks and dried.

A DANISH PEAT PLANT.

A well known and successful establishment for the manufacture of "knead" peat, is in operation at Sparkjer, Denmark, on a large scale. The works are either stationary or portable, in the latter case floating in the bog, where there is sufficient water. The peat, dug by hand or machines, is conveyed mechanically to the works, where water is added and it is passed through the mixing machines,—plain wooden boxes, containing rotating screw-shaped knives—whence it is elevated to a large tank, and afterwards taken in cars to the drying fields. These consist of fields of sandy soil covered with grass. Elevated flats or gentle slopes are preferred well exposed to prevailing winds. The peat mixture is then poured into bottomless cast iro moulds, after standing a few hours in which sufficient water is absorbed by the sandy soil t consolidate the peat and allow the moulds to be removed. In three or four days the pea lumps or bricks are turned and subsequently piled in heaps. The whole drying process re quires from three to six weeks, according to the weather, the finished product containing abou 22 per cent. water.

At other works the dense peat liquid is poured in thick layers over the drying ground and when in semi-dry state is rammed and cut into small bricks. By this method the drying capacity of each acre of ground is increased, and the labor cost reduced.

The cost of peat plants, such as those at Sparkjer, is about $80 per ton of daily productio when of the portable variety, and about $135 per ton when stationary. In 1901 the tota production of the Sparkjer establishment, which comprises a large number of individual works, was 25,000 tons of dry peat, which had a selling value of $54,000, or $2.16 per ton (2,240 lb.) The cost of production varied in the separate plants from 85 cents to $1.10 per ton f.o.b. railway cars. The laborers work by contract and earn on an average $1.35 per day. The power required is small, the product of one nominal horse-power being placed at 5 to 8 tons per day.

In the manufacture of ordinary machine peat more powerful machinery is used. After reducing by drainage the water content of the bog to 80 or 85 per cent, the peat is dug and and thrown at once into an elevator which carries it to the peat-mill. This may be either portable and capable of being moved on tracks laid on the surface of the bog, or stationary and placed at some central point. The mixing machine (see illustrations of Anrep's peat-milling machine) consists of a hollow iron cylinder or cone in which rotate one or two rollers set with screw ridges, which break up the peat and any accompanying small roots, thoroughly working the whole into a soft, plastic mass and forcing it out in long rectangular shape to be cut into bricks. These are then transported to the drying ground, either *terra firma* or bog. The drying process occupies from 6 to 8 weeks, and when finished the peat bricks contain about 22 per cent. water, below which point it is scarcely possible by air-drying to reduce the moisture in machine peat.

MILLS FOR MAKING MACHINE PEAT.

The mills or machines used in making machine peat are of various construction, but all incorporate very much the same principles. Their operations have proven so satisfactory that the demand for them has increased very greatly within the past year or two. The plant usually stands complete in itself on the bog, either all on the one portable platform, or with the locomobile, or power plant of engine and boiler, a short distance away and connected by belting.

The Akerman machine, manufactured by Akerman's Foundry and Mechanical Works, Eslof, Sweden, requires an 18-h. p. engine and boiler, and can turn out from 20 to 25 tons machine peat per ten-hour day with the help of 15 men. With locomobile, rails, wagons and other requisites, the plant complete costs $1900.

The Anrep (or Anrys) peat machine, probably the most modern and approved, is the invention of Aleph Anrep (or Anrys) a Swedish engineer now resident in Russia, where over one thousand of them have been built and are in use. It is also now being constructed by the Munktell's Mechanical Works Company at Eskilstuna, Sweden. On some of the larger Russian bogs, often up to 20,000 acres in extent, 50 or 70 of these machines may be seen at work. In principle they are much the same as Akerman's machine, the main difference being that with the latter the locomobile and mill are separable, while with Anrep's they stand on the

the same carriage. It is accounted superior to all other existing machines of the kind because of its greater capacity per man per day and consequently lower cost of production.

The Anrep machine is built in two sizes, the larger producing from 40 to 60 tons finished fuel per 10 hours with 28 workmen, and requiring 38 horse power. It costs $1,900 exclusive of power plant. The smaller type is built in light and heavy styles, the former turning out 20 tons peat fuel per 10 hours with 13 men, and consuming 19 horse power. It is sold for $830, exclusive of power plant. The stronger machine produces from 25 to 30 tons of finished fuel per 10 hours, employing 15 men and using 25 horse power, its price being $1,200, exclusive of power plant.

Another machine has recently been put on the market by the Abjorn Andersson's Mechanical Works Company of Svedela, Sweden, and a number are now in use. Several sizes are made, ranging in capacity from 20 to 40 tons finished peat per day. The machines proper cost from $215 to $675.

In Germany most of the peat-milling machines are made by R. Dolberg of Rostock and A. Heinen of Oldenburg. They are similar in construction, and resemble the Swedish machines already described. Much hand labor is required in their operation, but they are able to produce 1½ to 2 tons peat fuel per man per day.

With wages ranging from 95 cents to $1.20, or averaging say $1.00 per day, at some of the large Swedish peat works machine peat is made at a total cost of $1.35 per ton, though this figure may vary appreciably one way or the other depending on the condition of the bog which affects the cost of labor alone to the extent of from 56 to 80 cents per ton.

Machine peat contracts very much in drying, the volume of the dried peat often being not more than one-sixth that of the original block. Thus the bricks acquire a very compact consistency, bearing a close resemblance to lignite both in appearance and density. In specific gravity it often surpasses water, but commonly weighs from 30 to 40 lb. per cubic foot. It will stand ordinary handling in being moved from place to place, is less hygroscopic than cut peat, and may easily be stored without absorbing moisture. In some places in Germany and Denmark the practice is to thatch the peat stacks to keep out the rain.

"Cut" and "machine" peat in their various methods of preparation almost exhaust the forms in which peat fuel is used in Europe, comparatively little pressed or briquetted peat being manufactured as yet. Of recent years, however, the briquetting of fuels has assumed large proportions, especially in Germany, where in 1901 the output of briquetted fuel was 1,643,416 tons. Of this quantity about half was used by the railways and one-third in factories and industrial works, the remainder being about equally divided in use between dwelling-houses and steamships. The principal substances used in making these briquettes are coal screenings or waste, and lignite, but peat is now also employed. In the case of peat an attempt is made to carbonize it by heat and compression during the process of manufacture in order to give it greater fuel value. Briquetted fuels sold in 1901 at an average price of 13½ marks ($3.13) per ton wholesale.

In face of the general acceptability of machine peat, and the firmly established position of its manufacture in Europe, there is not the same inducement there to apply briquetting processes to peat as to other crude fuels which cannot be solidified or reduced in bulk in any other way. The peat briquettes are produced in presses of the open-tube type, similar to those hereinafter described, the pressure required being about 11 tons per square inch, a very solid block with smooth, polished surface being the result. Cut peat air-dried down to 30 or 40 per cent. water is first pulverized, then artificially dried in a pan-drying apparatus heated with live or exhaust steam, until not more than 12 per cent. moisture remains. The briquettes are oval in cross-section, instead of circular like those made in Ontario. Four plants on'y are known to be making peat briquettes in Europe at the present time, namely, two in Germany, one in Russia, and one in Holland at Helenaveen. At the last named place the cost of production is from $2.00 to $2.15 a ton.

Peat Fuel Making in Ontario.

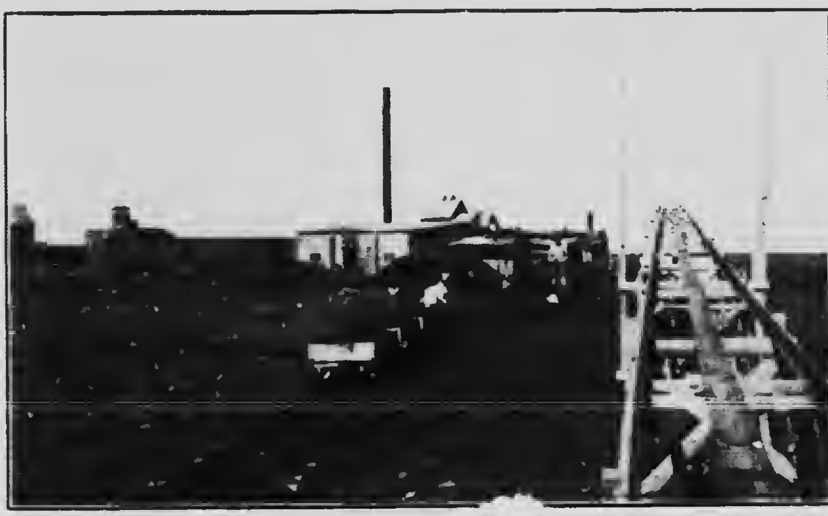
For several years the peat fuel industry of Ontario has been gradually developing, and the point has now been reached at which the makers can turn out their product at a profit. The burden of experiment and investigation, always an onerous one in establishing a new industry, has been borne by a few, and no doubt much money has been spent on methods and machinery which in the end gave only negative results. But there were those who did not despair of ultimate success, and with dogged resolution determined to persevere until the goal was reached. Among the most persistent of the inventors and experimenters have been Mr. A. A. Dickson, formerly of Montreal, but now of Toronto, who has spent a lifetime in intelligent efforts to solve the problem of peat manufacture; Mr. Alexander Dobson, of Beaverton, whose mechanical skill and ingenuity have been of signal assistance; Mr. J. M. Shuttleworth of Brantford, and Mr. E. J. Checkley, of Toronto, all of whom are deserving of praise for their sustained and well-directed attempts to put the industry on a practical and paying basis. The Canadian Peat Fuel Company, the Peat Development Syndicate,—now Peat Industries, Limited—and the Peat Machinery Supply Company are the organizations through which the above-named gentlemen and others associated with them have carried on their labors. It would perhaps be too much to assert that all the difficulties have been surmounted, and that the success of the industry is an assured and established fact; but at any rate, the preliminary stage appears to have been passed, and there can be little doubt that what yet remains to be done will soon yield to the address and skill of those who have already done so much. There have been many problems of manufacture which defied for years the wit and inventiveness of man, but few indeed in the long run have failed to yield to bold experiment and patient investigation. We may be certain that the difficulties surrounding the production of a cheap and efficient fuel from peat will in like manner disappear; indeed, some of them have already vanished, and the question seems to be rather how to produce the best possible fuel at the least possible cost, than how to produce a good fuel at a fairly low cost.

The peat fuel question presents itself in somewhat different shape to the people of Ontario than to inhabitants of European countries. Here we have for long been able to obtain hard coal, or anthracite—the best domestic fuel in the world—at comparatively low cost, and this has made us fastidious in the matter of fuel. Anthracite is unknown in Europe, and the consequence is, that forms of peat or other fuel perfectly acceptable to Europeans, would not be regarded with favor here. The assumption however that we can continue to rely upon anthracite has been suddenly and rudely dispelled, and the possibility of obtaining an efficient substitute has at once become a matter of vital importance. What has happened once may happen again; and—to put an extreme supposition—if trade with the United States were to be interrupted by war, or if for any reason the government of that country should in times of strike or scarcity of coal forbid the export of anthracite, the need for some other kind of fuel would be instantly and most severely felt. Coal there is in Nova Scotia and British Columbia, but freights are prohibitive from either place, and to raise the price of fuel [illegible]inately is only another way of cutting off the supply to very many. The fact however [illegible]ns, that peat must compete with anthracite under ordinary conditions; and this has been kept steadily in mind throughout the present report.

Visits have been paid to most if not all the peat fuel plants so far erected in this Province, and mention is made of them below, together with the bogs on which they are situated; but detailed account is given only of methods and processes themselves, and in the main [illegible]ly those plants and distinctive features have been selected for description which have actually proved

Welland bog—harrowing the peat

Welland bog, scraping the peat



Welland peat

Brockville peat bog

Sounding a peat bog

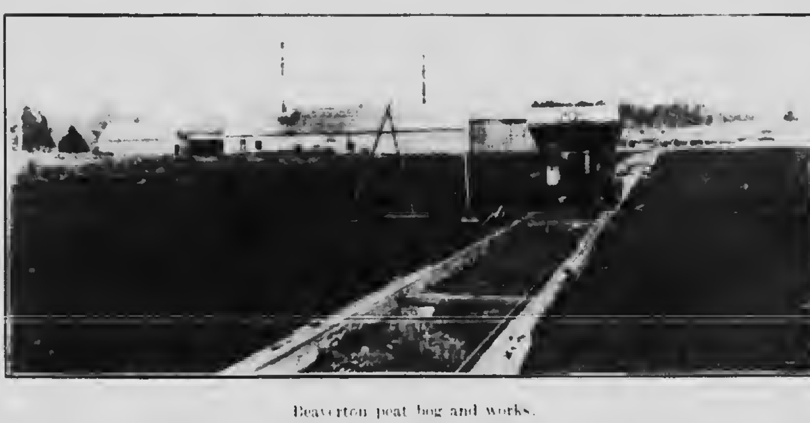
A Norwegian peat bog

Brockville peat bog and works

Dobson's peat excavator, side view

Dobson's peat excavator, front view.

Beaverton bog; scraping and raking pe



Beaverton peat bog and works.

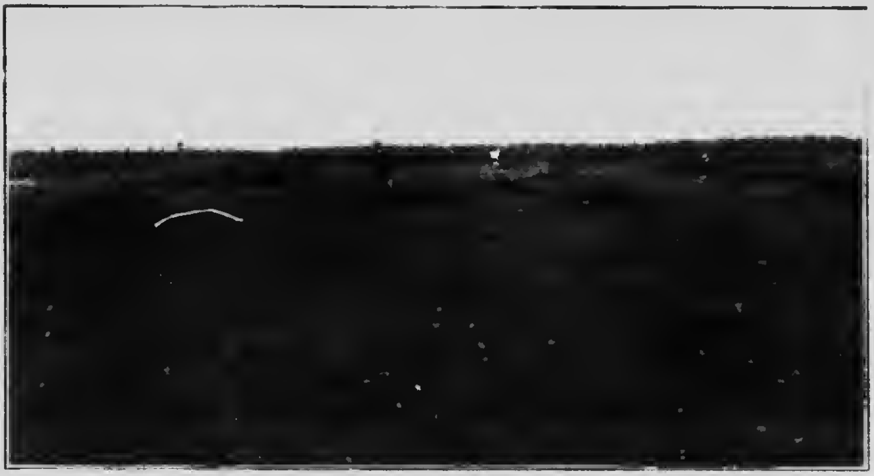
Perth peat bog

Perth peat works

Rondeau peat bog

Rondeau peat bog and works

Newington peat bog, near margin



Newington peat bog, central area

Newington peat works, under construction

Brunner peat bog and works

A load of Dobson peat briquettes

or give good promise of proving successful. Complete data as to costs and efficiency could not in all cases be obtained, because of the intermittent working of many of the new plants, but where details of working costs are given they have been deduced from tests or observations actually made, and are believed to be correct within narrow limits.

PROGRESS OF THE INDUSTRY.

Little attempt was made in this country until comparatively recent years to utilize peat for fuel purposes. Emigrants from Scotland, Ireland or Germany occasionally cut and saved peat from neighboring bogs, as they or their fathers were accustomed to do in the land of their birth, and small quantities of peat fuel were even manufactured, as by Hodges by the machine process (described by Sterry Hunt in the Geology of Canada, 1866), and Aikman, who in one operation compressed and carbonized his fuel, about 25 years ago. Fuel made by the Hodges and Aikman processes was tested in railway locomotives and under steam boilers, with results more or less satisfactory. Though there was little immediate result of these efforts, inventors and experimenters continued to work at the problem. Briquetting presses of various designs were constructed until what appeared to be a satisfactory machine was evolved, when a number were built and sold to intending peat fuel makers. The process of preparing the peat was simply to dig up the blocks from the bog, let them dry in the air, and after comminuting the material in suitable machines compress it into briquettes. The result of the first season's operations was to show : (1) that peat could not be successfully and constantly dried down in the field to below 30 per cent. moisture ; and (2) that in this condition it cannot be compressed into dense, solid briquettes. The consequence was that the peat factories ceased their operations.

The old belief that the application of artificial heat to the drying of peat was too expensive to be profitably employed had now to be proven unfounded if progress were to be made. Probably the cost of artificially expelling all the water contained in the saturated peat would be prohibitive, but some combination of air-drying in the field and artificial heat might be successfully used. Drying machines of varying principle and design were invented or adapted, but all proved unsatisfactory until the type now in use consisting essentially of one or more encased and revolving cylinders, was employed. These have done the work more or less satisfactorily from the beginning ; and it may here be conclusively stated, that with the many improvements which have been made on the original, this type of drying machine has, in conjunction with a preliminary use of wind and sunshine, solved the problem of getting rid of the water at a reasonable cost.

The real problem of peat fuel manufacture lies in removing the water : this solved, the other processes do not present insuperable difficulties. The peculiar power which peat possesses of absorbing and retaining moisture arises out of the unique character of the peat itself. In the growing bog raw peat contains from 85 to 90 per cent. of water, so intimately associated with the plant fibres that drainage will not reduce the water contents to less than about 85 per cent., while with 60 per cent. the peat feels and looks merely damp, and at 30 per cent. it is to all appearances dry. The application of heat is necessary to transform the water into vapor, and the process of evaporation is furthered by a preliminary breaking down and disintegration of the tough cell walls of the peat fibres. How the problem of ridding peat of the water has been attacked and solved is narrated below.

PEAT BOGS AND PLANTS IN ONTARIO.

What Ontario lacks in coal beds is made up by her wealth of peat bogs, which in extent and wideness of distribution are probably not exceeded by those of any other country of equal area. Peat bogs of greater or lesser size are conveniently situated at almost any point, both in older and newer Ontario, and are so common as not to require any attempt to enumerate them. In the southern part of the Province, bogs, while numerous, are not usually of commanding area, though many are of sufficient size to be the basis of a large fuel factory; but north of height of land say 50 miles south of James Bay, peat muskeg covers the face of the earth hundreds, perhaps t[illegible], of square miles and stretches northwards along the weste shores of Hudson' [illegible] [illegible] northern reserves of carbon will no doubt some day play important par[illegible] of the Province; but for a long time all the fuel which be required may [illegible] [illegible]ed from the bogs which, so to speak, lie at our doors.

The reason for the existence of so great an extent of bog land is found in the clima which includes warm rainy seasons of several weeks' duration twice a year favorable for growth of peat bogs, and a winter season of five or six months, during which the surface of bog is frozen over and so preserved in *statu quo*. On the other hand there are no long-co tinued periods of drouth and heat to bring about the drying up and consequent termination the bog.

Considerable variety exists in the composition of bogs, depending to some extent up the nature of the rocks and soil of the surrounding country, but chiefly upon their method origin. The greater number are composed of sphagnum moss in its many varieties, some compact growths of other species of moss, and others of a mixture of aquatic plants, with without moss, or of the common marsh grasses. On all these kinds of bog, except the l mentioned, evergreen trees, such as spruce, cedar and pine, and occasionally hardwoods, gr but do not flourish, except on the edges and on the least submerged portions of the bogs.

Analyses of Ontario Peats.

It is not every bog that will make good fuel. The choice of a good bog, high in carb and low in ash, is the first essential of a successful peat factory, even more necessary th good shipping facilities and a well-adapted process of manufacture. The two latter may provided if wanting, or improved if faulty, but the bog is a product of nature and must accepted as it is. The following table shows the quality of several of the bogs on which pe fuel plants have been erected in Ontario:

Bog.	Water in original sample, per cent.	Calculated on 15 per cent. water content.		
		Volatile combustibles, per cent.	Fixed carbon, per cent.	Ash, per cen
1. Welland:				
From top to 20 in. depth	82.20	59 27	21 66	4 07
From 20 in. to clay bottom at 42 in	87.48	56.78	21 05	7.17
2. Beaverton:				
From top to 7 in. depth	62 98	57.13	11.67	16 20
" 7 in. to 15 in. depth	83.31	67 58	10 39	7.03
" 15 in. to 26 in. depth	84 86	73.60	4.72	6.68
" 26 in. to 40 in. (bottom)	82.98	56 93	.40	27.67
3. Perth:				
Top 5 feet		54.72	19.85	10.43
" 4 "		57 81	18 92	8.27
4. Brunner:				
Top 3 feet		60.10	15.70	9 20
5. Brockville:				
Upper stratum, 3 feet		55 08	20.62	9.30
Part lower stratum, from 3 down to 5 feet		57.15	13.73	14.12
6. Rondeau:				
Lower stratum, beneath surface growth		58 56	23.29	3.15
" " " "		64 60	22 44	7.96
From stock pile		67.99	11.06	5.95
7. Newington:				
Sample No. 1	87.94	56.74	27.21	1.05
" " 2	86.66	54 42	28.61	1.97
" " 3	87.62	58.70	24.73	1.57
" " 4	90.12	58.15	25.30	1.55

THE WELLAND BOG.

The Welland bog is situated in the townships of Humberstone and Wainfleet, six miles north of the town of Welland and between the Welland canal and its feeder, and is owned by Peat Industries, Limited, of Brantford. It covers an estimated area of 4,000 acres, or between 6 and 7 square miles, and varies in depth from 3 to 7 feet, averaging probably 5 feet. It will furnish over 4,000,000 tons of finished fuel, estimating 1,070 tons to the acre. Composed of sphagnum moss, it typifies the great majority of such areas in this country. The upper portion of the bog consists of fresh or growing moss. This in the course of propagation dies out at the roots with the appearance of new growths above, the result being a gradual accumulation of moss and plant remains. Proceeding downward, the brown light moss changes in color and density until at the bottom there is an almost black, very compact muck, super-saturated with the peaty waters. These lower layers are not decayed, but by chemical alteration and elimination of some of the volatile constituents the percentage of carbon has been increased, and the first step taken towards the formation of a future coal bed. Numerous large and small roots are found embedded in the peat from top to bottom, the only remains of a once flourishing forest of cedar, spruce, and other hard and soft woods. Now nothing but scattered shrubs and grasses are capable of subsisting on the surface of the bog. Very compact, clean, greenish clay forms the bottom, the usual underlying bed of shell marl being in this case absent. The lowest six inches of the bog contains too much clay and other incombustible material to be of value for fuel, a fine silt having impregnated it, doubtless through the unrestrained movement of the waters in the early days of the bog. The remainder of the bog overlying this stratum is low in ash, and is quite suitable for fuel. If the 6 inches at the bottom had been eliminated from the sample, there would have been an appreciable decrease in the amount of the ash shown in the lower portion of the bog (see analysis in foregoing table).

Many years ago when the Welland canal and its feeder were under construction this bog formed an immense undrained swamp, so full of malaria that nobody lived within miles of it. The unfortunate laborers died in scores. Now all this is changed. By means of the artificial waterway and the county and township ditches, both swamp and surrounding country have been reclaimed for habitation, and the locality is as healthful as any.

The Welland bog, described above, and the Beaverton bog, a description of which is given in the following paragraph, together with the factories respectively belonging to them, are classic scenes in Ontario peat fuel manufacturing. Scores of experiments in drying and briquetting processes, the two most troublesome of the inside operations, have been conducted at these places, tests of machinery and presses having been carried on at Welland for nearly twelve years, and at Beaverton for about half that time.

THE BEAVERTON BOG.

This bog covers an area of about 100 acres in the township of Thorah, Ontario county, adjoining the village of Beaverton, and is owned by Mr. Alexander Dobson of that place. It is composed of the dead and blackened remains of rushes, grasses, weeds and other aquatic growths, with practically no moss except a stratum of a few inches in width at the bottom. In depth it measures about 40 inches, but of this only the upper 26 inches is fit for manufacture into briquettes, the lower 14 inches resting on the sand and marl bottom containing, as the analysis shows, too high a percentage of incombustible material to be of value for saleable fuel. It is consequently left for subsequent removal to be consumed in the works. The analysis figures of this bog show that in peat beds the percentage of fixed carbon does not always increase with the depth. The advisability is also shown, in order that a product of uniform quality may be obtained, of excavating the peat from top to bottom at one time: or if this is not possible, of mixing that from various levels. In this way a thin bed containin too much ash may be utilized, provided the other strata are of good quality. This is illustrate in Mr. Dobson's practice on the Beaverton bog. The uppermost layer of peat 7 inches thic contains over 16 per cent. of ash, which is certainly high; yet after being mixed with 8 inche containing 7.03 per cent. and 11 inches containing 6.68 per cent. respectively, a good fuel produced, showing less than 10 per cent. of ash. This bog, though not of large extent, admit of easy drainage, and is remarkably free from buried stumps, roots or timber of any kind. I has therefore formed an admirable arena for the evolution and testing of mechanical method of performing the necessary field operations, in the devising and application of which no les than in the invention of apparatus for the drying and briquetting of peat, Mr. Dobson ha shown much ingenuity.

THE PERTH BOG.

The Perth bog, or No. 3 in the foregoing table, lies in the township of Drummond, abou a mile and a half north of the town of Perth and half a mile from the Canadian Pacific railway It is known locally as the "blueberry marsh," and is roughly estimated to cover an area c 2,000 acres, of which the Lanark County Peat Fuel Company of Perth owns a small portion comprising some 35 acres. This was formerly ploughed and cultivated for grass, so that fro the surface down all is now rich, black, crumbly peat. It bears a dense growth of willo bushes, while on the next lot and in the middle of the bog, a small forest of stately hardwoo trees flourishes. This seemed so remarkable that a number of soundings were made of th ground on which the trees stood, the result being to prove that they were actually growing o peat of considerable thickness. The average depth of the bog is between 8 and 10 feet. Th peat is composed of the remains of grasses, both fine and coarse, large-stemmed weeds an aquatic plants, well preserved, but with an almost entire absence of moss. Fallen logs an roots are plentiful, but do not interfere with excavating operations, except when near th surface, as when deeply buried they are so completely waterlogged that the spade cuts throug them nearly as easily as through the peat itself. But exposed to the air, the timber in a shor time turns tough and very hard.

The company has partly ditched the bog, and installed a plant for making peat fuel including a dryer and a briquetting press of the Dickson or open-tube type, but for variou reasons little practical success has attended its operations.

THE BRUNNER BOG.

The Brunner bog lies in the township of Ellice in the county of Perth, and is traverse by the line of the Grand Trunk railway. It covers an area of about 2,000 acres of whic 1,300 acres are held under lease by the Stratford Peat Company, Limited, the peat plan erected in the middle of the bog beside the G. T. R. tracks being about 2 miles south of Brunne station, or 9 miles north of Stratford. The bog is of the true moss variety, but differs fro most bogs of the kind in that the moss is of the genus hypnum. Marked variations in qualit characterize the bed, the upper foot or so yielding a brown to black, fairly compact muck highe in carbon than the beds below. Next comes an 8-inch stratum of bluish-black dense peat devoi of vegetable fibre, but containing charred fragments of surface shrubs—evidences of fire i by-gone times. From here to a depth of 3 feet from the surface more brown peat occurs, whic is then succeeded by a dark bronze-colored mass with fibre almost as distinct and fresh, excep for the hue, as when living, and not much more compact. This material is said to extend t the bottom of the bog, the total depth of which is 6 to 10 feet. Probably only the upper 3 fee will prove of value for fuel purposes. Many stumps are embedded in the bog, while over th surface a forest of upturned pine stumps is scattered, the labor of clearing the ground c which will be in part compensated by their value as fuel. Willows have densely over-grown several extensive areas of the bog, and over all of the remaining surface tall weeds flourish.

The company put in a plant for making peat fuel, the drying machine being a modification of the Simpson apparatus, and the press a Dickson one, which appeared to work satisfactorily, making briquettes 2 inches or 2½ inches in diameter as desired. Owing to the large number of stumps and roots on the ground, harrowing is the method employed for harvesting the peat. A quantity of fuel was produced, but a fire in the works about the end of 1902 interrupted the operations. These have since been resumed, and some alterations made in the apparatus, including the substitution of a Dobson press for the open-tube one formerly employed. Shipping facilities are unusually good, a switch from the Grand Trunk railway running into the plant, and cars can be loaded by conveyors leading directly from the press.

An interesting fact was noted in connection with the operations here. Air-dried peat cut and stacked on the bog several years ago was drawn in last summer (1902) in as dry a state, except for the outside of the piles, as when first gathered. The unusually heavy and prolonged rains of 1902, which hampered peat-making everywhere in Ontario, had penetrated the heaps only for about 30 inches, and where the covering was of fine or broken peat, only the outside 6 inches was wetted. It will be an important economy if it is found that the supply of air-dried peat for winter manufacture can be stored without having to provide sheds or other covering for it.

THE BROCKVILLE BOG.

Bog No. 5 in the list lies two miles north of Brockville, in the township of Elizabethtown, Leeds county, and is reached by a branch of the Grand Trunk railway, which skirts its north-easterly edge. It covers some 1400 acres in rectangular area, and occupies a basin with clay and gravel bottom. Soundings taken from the edge toward the centre increase in depth to 40 feet and probably upwards. The upper 3 feet is composed of the remains of grasses, grass roots and slender aquatic plants, and but little moss could be detected. Scattered patches of moss of the genus sp[illegible]num occur, however, apparently increasing toward the central portion of the bog [illegible] still submerged. The upper stratum of 3 feet is of uniform quality throughout, an[illegible] fuel value. At this depth a sharp change takes place both in the character and q[illegible]ity of the peat. A dark brown plastic bed or stratum comes in here which is said to extend to the bottom of the bog. It is dense and finely stratified, and except for occasional minute fragments of plant roots, vegetable fibre is entirely absent, the whole presenting a uniform, smooth surface when torn or cut. On thin edges it is translucent. When dried the color changes from brown to black, but at a distance has a grayish cast, from the minute particles of incombustible material desseminated throughout the mass, some of which are quartz grains. The texture of a specimen while being dried passes into a rubber-like consistency, and finally becomes quite hard and brittle, splitting along the lines of lamination and curling up at the e[illegible] As the analysis in the foregoing table shows, this lower bed is much inferior to the upper one for fuel purposes, being higher in ash and lower in carbon. The surface of the bog is heavily covered with grass and shrubs, and stumps of evergreen trees, such as spruce, tamarack and cedar, the remains of a dense forest some time ago cut down.

Considerable ditching was done by a local company and peat works erected, the plant consisting of two 60-h. p. boilers, a horizontal engine, two Dickson briquetting presses, and a Dickson dryer. This dryer followed original designs, but unfortunately proved unsuccessful. It differed entirely both in principle and construction from the dryers now in use. Since these short first trials the works have remained idle, and the property has been transferred to the Peat Industries, Limited, Brantford.

THE RONDEAU BOG.

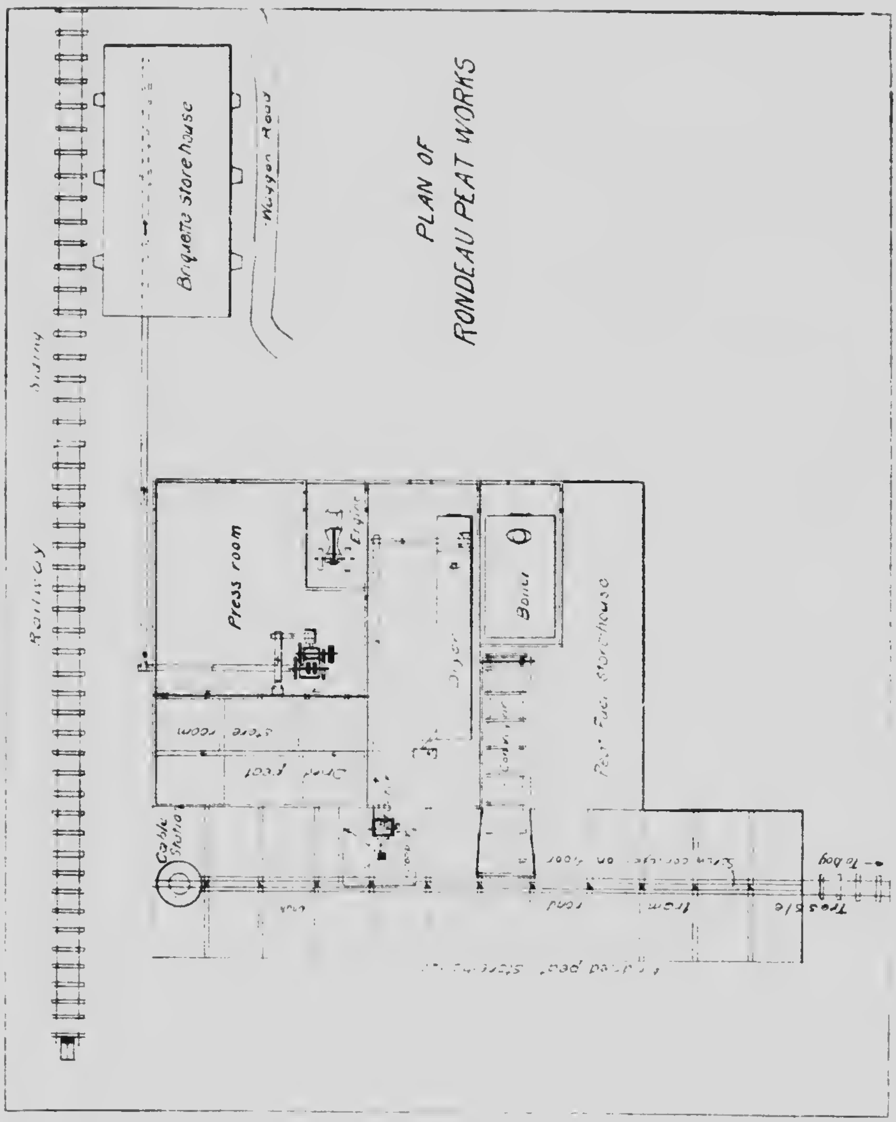
The Rondeau bog, or No. 6 in the list, borders on Rondeau harbor, a lake like bay on the shore of lake Erie, in the county of Kent. It extends along the water front a distance of several miles and has a width of one-quarter to one-half a mile. Wide but low sand bars separate the bog from the waters of the harbor. It occupies an area of about 1500 acres in the township of Harwich. The Western Peat Fuel Company, Limited, of Chatham, own 328 acres of the bog on which they have erected a peat factory and installed the necessary machinery. The depth of the peat is markedly variable, ranging from 1 foot to 30 feet within short distances, leading to the belief that a series of sandbars underlies the bog similar to that which now divides it from the lake, in the quiet waters behind which grew and accumulated the plants whose decay resulted in the present bog. The upper stratum consists of a light brown, intricately interlacing mass of minute plant roots, quite different in texture from the peat of a moss bog. Lower down the color deepens, and a coarser flora appears : no doubt the remains of a growth entirely aquatic and submerged. The upper portion is not sufficiently dense for compression into good briquettes, but farther down the peat is fairly dense and good. The first two analyses in the above table were furnished by the secretary of the company.

A railway filling guards one side of the bog, a farmer's dike another and the company's dikes the remainder, but all proved ineffectual to exclude the waters of lake Erie when their level rose in 1902. Just when the company had everything ready to begin operations the bog was flooded and work had to be suspended. A pumping station was built on the bog earlier in the operations to keep down the water, and this will be used to unwater the bog again as soon as the outside lake lowers to normal level. A ditch 2000 feet long, 3 feet deep, and 30 feet wide has been dug, which will, by forming a drainage channel, assist in keeping the bog dry. There is a complete absence of roots or trees of any kind, and consequently mechanical methods of removing the peat may be conveniently employed.

RONDEAU PEAT WORKS.

The works erected by the company on a rise of clay, which comes nearly to the surface towards the interior of the bog, show much judgment in design and arrangement, as will be seen from the illustration, and may be here briefly described. One main brick building 60 by 60 feet in plan with steel trussed roof of sheet iron and cement floors has been divided by brick walls into dryer room, press room, engine room, and storage bins for the dried peat, and is entirely fire proof. The boiler room, also of brick, is annexed and is contained in the shed where the peat for fuel purposes is stored. At the side of these is built a storehouse for air dried peat, 120 feet long, 28 feet wide, and 20 feet high to the eaves or tram track. A short distance away is another building in which 200 tons of peat briquettes can be stored, and from which fuel can be loaded in the farmers' wagons on one side and into railway cars on the other.

The process of manufacture includes methods and machines of both Welland and Beaverton designs. An endless cable hauls the air-dried peat into the storing sheds in cars carrying V-shaped balanced side-dumping boxes ; from the shed it is elevated into a large hopper over the breaker, which is of somewhat different construction from the other machines for the same purpose described in this report. The fingers on the periphery of the revolving cylinder work between corresponding fingers projecting from the interior circumference of the casing, the two systems interlocking as closely as possible. The drum makes 800 revolutions per minute, and the effect is to disintegrate the peat into a light pulpy mass most suitable for drying, and yet with fibres sufficiently intact to compress into a very coherent briquette. The machine appears to be well adapted to tear apart the mass of interwoven, tough and yet minute fibres of this class of peat without shattering the plant cells, which in this case are of fairly compact


PLAN OF
RONDEAU PEAT WORKS
Briquette Store house
Waggon Road
Railway
Siding
Press room
Engine
Boiler
Dryer
Store room
Dried peat
Peat Fuel Storehouse
Cable Station
Trestle
To bog

structure and not merely water receptacles, and the consumption of power is moderate. The dryer is an improved Simpson, and the briquetting press is of the Dobson type, manufactured by the Peat Machinery Supply Company of Beaverton.

All elevators and conveyors are tightly boxed, and each part of the works is partitioned off from the rest so that dust-raising is not only minimized, but confined to its source. The fire-doors of boiler and dryer being side by side with but a brick wall between, one man is able to keep the fires going in both, and one engineer will attend to both engine and press. Another man will distribute and dump the in-coming cars of air-dried peat, and this man, the fireman, the engineer and the foreman constitute the entire inside working force. The output is expected to be 15 tons fuel per ten hours, or 30 tons working day and night shifts.

The cost of erecting these works, together with other charges for bringing the whole to completion, have been furnished by Mr. J. L. Scott, manager and secretary-treasurer of the company.

Buildings	$ 6,872.17
Plant, except briquetting press	8,820.59
Briquetting press	2,000.00
Tramway	943.19
Expense account	2,864.17
Bog	3 671.60
Railway spur	533 74
Charter for company	400 00
Total	$27,986.15

THE NEWINGTON BOG.

The Newington bog, No. 7 in the above table, is a large muskeg 20 miles northeast of Cornwall, or 2 miles south of the village of Newington on the New York and Ottawa railway. It covers an area of about 1,200 acres in the township of Osnabruck in the county of Stormont. Dominion Peat Products, Limited, of Brantford, have purchased 1,000 acres of this bog and are erecting a peat fuel plant, a description of which is given below.

Several varieties of sphagnum moss combine to form the body of the deposit, the uppermost 2 feet of which is alive showing various shades of light yellow, green and red. This stratum is valueless for fuel, but would make excellent moss litter. A sturdy forest of spruce flourishes on the edges of the bog, but quickly dwarfs and thins out towards the interior. The central areas are composed of small lakes and ponds deep, soft masses of impenetrable ooze. The average depth of a section a mile wide was found by soundings to be about 25 feet, ranging from 20 feet at the sides to 27 feet in the centre. The analyses given in the above table were furnished by the company, and show the peat to be of unusually fine quality, being rich in carbon and poor in ash. It should make the best of fuel.

THE PROCESS OF MAKING PEAT FUEL.

The three divisions in which may be grouped the various operations comprised in making peat fuel by what we may call the Canadian process, are (1) Excavating, (2) Drying, (3) Compressing. Various methods are adopted of carrying on all these operations, according to the nature of the bog and other controlling circumstances; but it cannot be too strongly stated that the crux of the manufacture lies in drying the raw material. The difficulty consists, not merely in getting rid of the water, but in getting rid of it at reasonable cost. It is at this point that numberless promising processes have broken down, and it is this essential feature of manufacture that requires unceasing vigilance on the part of the peat-maker if his product is to be satisfactory. In describing the manufacture of peat fuel, it has been thought that a more intelligible account would be given if the several steps were taken up in order and the various methods of accomplishing them dealt with, than if a detailed description were attempted of a number of peat factories, in which different means of doing the same work are employed. In this way the disadvantage of unnecessary repetition will be avoided, and emphasis laid on the process rather than on the plant. Wherever practicable, the cost of the several operations is given.

WET AND DRY BOGS.

Peat bogs are of two classes, wet and dry. In a permanently wet bog, the peat is submerged in water which does not admit of being drained away. The method of recovering peat from such a bog may be seen by the plan adopted near Kirkfield in Eldon township, Victoria county, three miles west of Victoria Road station, which was worked in 1900 and 1901 by the Trent Valley Peat Fuel Company, Limited, of Peterborough. The bog is situated on the route of the Trent Valley canal and covers about 10 square miles in one immense muskeg on both sides of the canal. The water lies flush with the surface of the mass, and the depth of the peat is from 4 to 50 feet. A dredge floating on the bog excavated the peat in trenches and then followed into the paths thus cut for itself with scows attending, each carrying a number of boxes of about 2 cubic yards capacity into which to load the peat. The scows were towed to the terminal of an aerial tramway, over which the boxes were conveyed to the works about 500 yards away, where the saturated peat was dumped into the hopper of a root extractor and disintegrating machine, from which it issued as a fragmentary muck with the fibres pretty well broken or fractured in preparation for the drying process which followed.

Another method of extracting peat from a wet bog, is the one proposed to be put in practice by Dominion Peat Products, Limited, of Brantford, on the bog near Newington, in the County of Stormont, above described, where a peat fuel plant is now in course of construction. A German machine, known as the Brosowski or Jasenitzer Peat Digger, will cut and lift out cubical blocks of peat 3 feet long by 1 foot wide and 1 foot deep, by means of a rectangular knife, which is driven or forced down into the peat. The same knives raise the mass and dump it into a conveyor, which transports it to the works. The digging continues in the same place to a depth of 25 feet, the limit of the machine, when it is moved sideways and begins on the next section of the bog. Hand power alone is used. This digger is said to be in successful operation in European countries.

DITCHING A DRY BOG.

For "dry" bogs, different methods are required. The word "dry," as applied to a peat bog, does not mean the absence of water, but rather that the bog is not submerged and is capable of being drained. The first thing to be done is to get rid of the surplus water, for which purpose drains or ditches must be dug. At the Welland bog, already spoken of, the following system has been adopted: Two or more parallel drainage ditches are run through the length of the bog, 660 feet apart and 10 feet wide. They are sunk through the peat, which is about 4½ feet deep, and to a depth of 2 feet or more into the clay underlying the bog, and conduct the water to the county ditch with which they connect. A series of cross ditches is now run at right angles to the first, intersecting them at intervals of 50 feet, until a plot or working area 660 feet square or 10 acres in extent has been ditched and drained. Cross ditches 100 feet apart would probably be as effective, and would certainly leave the surface of the bog less cut up and in better condition for subsequent operations. Two main ditches 660 feet long, 10 feet wide and 6 feet deep, and 13 cross ditches 3 feet wide by 5½ feet deep being dug for every 10-acre plot, it follows that 8,170 cubic yards of material is removed per 10 acres. The equivalent per acre is 817 cubic yards which at the contract price of 6 cents per yard, costs

$49 per acre for ditching. As one foot of the top of this bog is moss, valueless for fuel, and 6 inches at the bottom contains too much ash, but 3 feet remains for good fuel, with which thickness the bog it is estimated will yield 645 tons finished fuel per acre. The cost of ditching the Welland bog is therefore equal to $0.0759 per ton.

Physical conditions, to a large extent, govern the expense of ditching, and at the Beaverton bog the expense is considerably less. A few main drains 400 to 600 yards apart, and cross ditches 100 feet apart, are all that is necessary, involving 420 feet of ditching per acre. It was ascertained that a man at a wage of $1.40 per day can shovel 26 cubic yards of peat per day, so that, these ditches being 3 feet wide and 3 feet deep, 140 cubic yards per acre are removed at a cost of $7.53. An acre of this bog 2½ feet deep will yield 535 tons finished fuel, and the cost of ditching the bog per ton of fuel is therefore $0.0141.

At nearly all of the other bogs in the Province where peat fuel manufacture has been attempted, drainage has been necessary, the expense per acre varying with the depth and size of the drains.

CLEARING THE SURFACE.

After draining, the light, growing or undecomposed moss is removed, together with protruding stumps and roots of trees, and a level surface is prepared for the digging or excavating [illegible] which comes next in order.

In some European countries the moss is manufactured into litter for bedding cattle and horses, for which its high powers of absorbing moisture render it peculiarly suitable. An attempt was made at the Welland bog some years ago to establish a moss litter industry, but though there was no difficulty in preparing a first-class article, the business languished and did not succeed, presumably through lack of demand.

On a 10-acre plot at Welland $25 was paid for extracting stumps and roots, and $50 for removing the covering of moss. For one acre, the cost therefore was $7.50, or $0.0116 per ton of finished fuel. The moss and roots are allowed to dry in the air and are subsequently used for fuel at the peat works. At Beaverton, the cost of clearing the bog is estimated at $0.0052 per ton of briquettes.

LAYING DOWN TRAMWAYS.

The bog being drained, levelled, and sufficiently consolidated to be worked, the laying of light tramways on which to haul the peat into the factory is the next preliminary. The tracks are sometimes laid along the ditches, as on the Welland bog, in order to bring the trucks on a level with the surface and so facilitate loading; but this is a temporary advantage only, for as the peat is removed the height of the bog decreases. It is more satisfactory to lay them on the surface, where they may be quickly shifted to any place or in any direction desired. The bottom of the ditch is too wet and soft for the tram horse, which is obliged to walk along the top, playing havoc with the crumbling sides of the trench.

At Welland a track runs down each of the 13 cross ditches in a 10-acre plot, involving the laying of 860 feet of track per acre. The track being constructed in short sections is easily and quickly handled, two men at $1.20 laying 300 feet per day. The cost of track-laying therefore amounts to $6.86 per acre or $0.0106 per ton of finished fuel.

At Beaverton a single tram line is constructed down the centre of each 100-foot section, leaving a 50-foot strip of bog on either side. About 400 feet of track per acre is required, the cost of laying which is $3.75, or $0.0070 per ton of finished fuel. The ordinary method of hauling the peat is by horse, but at Beaverton the motive power is electricity.

HARVESTING THE PEAT AT WELLAND.

Usually the first step in the actual harvesting or gathering of the peat is to run an ordinary farm harrow over the surface and expose a thin covering of peat to the action of the wind and sun. This is the plan perforce employed where stumps and roots are numerous, as on the Welland bog. In the main it answers very well, but one disadvantage it possesses is that successive strata in the bog being often of varying composition, differing in proportion of ash and in other ways, the peat product will not be of uniform quality. Provision may, however, easily be made for mixing these different strata by stacking them in large heaps, from which the supplies for manufacture will be drawn. By harrowing the ground twice on each occasion, a layer of peat from 1½ to 2 inches deep is exposed, the work being done by the tram horse and driver during spare intervals, and occupying about one-quarter of their time. Man and horse are paid at the rate of $1.75 per day. When dried down to a water content of about 45 per cent. the peat is scraped by hand over to the tram roads and loaded into the cars by 3 men, each of whom is paid $1.20 per day. At the factory or stock pile another man helps the driver unload the cars, which are not self-dumping. These men will in one day with fair drying weather harrow and scrape over an area of 48,700 square feet, or 1.118 acres. The average depth of air-dried peat removed at each scraping is about three-quarters of an inch, which gives an output of 3,044 cubic feet for the above area, or 2,722 cubic feet per acre. A cubic foot of peat in the air-dried condition, containing 45 per cent. water weighs on the average about 24 lb. Therefore 2,722 cubic feet weigh about 32 tons, equal to 21 tons finished fuel containing 15 per cent. water. The items of cost in connection with this part of the field operations when summed up are as follows :—

For one day.	
1 horse and driver	$1.75
3 scrapers and loaders, at $1.20	3.60
1 unloader	1.20
Total	$6.55

This sum representing the cost per day of harvesting 1.118 acres, the cost per day per acre is $5.858, or $0.279 per ton of finished fuel.

The cost of field operations at the Welland plant may now be tabulated as follows, per ton of finished fuel :

Ditching	$0.0759
Clearing	0.0116
Track-laying	0.0106
Harrowing, scraping and tramming in	0.2790
Total	$0.3771

THE DOBSON MECHANICAL EXCAVATOR.

The Beaverton method of excavation is entirely different. After the bog is drained and levelled, a mechanical and electrically driven digger is set at work, which travels slowly up and down one or both sides of the area under removal, the excavating device working in the side or wall of the ditch. A good idea of the excavator may be had from the accompanying illustrations. It consists of a platform 7 feet wide by 10 feet long, mounted on four wood-faced wheels, the front pair being the drivers and measuring 33 inches in diameter and 18 inches face, and the rear wheels being 22 inches in diameter and 18 inches face. The large superficial area of these wheels is necessitated by the softness of the bog surface. A 10-h.p. electric motor operates by belting and gear wheels all the machinery and at the same time propels the carriage forward at the desired speed. Overhanging the ditch on the right hand side is the combined excavating and elevating mechanism which is free to swing in a vertical plane about the upper sprocket wheel shaft, and may be raised or lowered according to the depth of cut to be made, the maximum depth being 4 feet. It consists of an endless chain which travels down the outside and up the inside of the elevator box, and which is set alternately with a row of cutting teeth and a sharp-edged plate. It serves the double purpose of scraping off a thin slice of peat and elevating it to a conveyor running across the front of the carriage. At the opposite side the distributor, a partially hooded paddle wheel revolving at a high velocity, catches the stream of fragments and showers them over the surface of the bog to a distance of 30 to 50 feet, or as far as the tramway running down the centre of the section in which the excavator is working. Each such shower of peat forms a deposite about half an inch thick, consisting of finely divided fragments, which are in excellent condition to be dried by wind and sun. The machine travels at the rate of 3 to 3.5 feet per minute. The workable depth of the Beaverton bog being 2.2 to 2.5 feet, the quantity of peat handled by the excavator is 7.5 cubic feet per minute, or 4,500 cubic feet per day of 10 hours. A cubic foot of peat in the bog weighs 56 lb., consequently the machine raises 126 tons of wet peat per day, equivalent to 22 tons of finished peat containing 15 per cent. water. Heavily insulated transmission wires trail over the bog behind the carriage from a central point in the field and convey the electric current to the motor. One man at $1.40 per day attends the machine, which requires 8 horse power to operate it. As will be shown further on the energy consumed by the entire plant at Beaverton, when it is all working, is 40 horse power, the generation of which costs $4.28 per day. The excavator's share of the cost is one-fifth of this sum, or $0.856 per day. The entire expense of operating the machine per day is therefore:

Attendance	$1.400
Power	0.856
Total	$2.256

On the quantity of peat handled by the excavator per day, which is equivalent to 22 tons of finished fuel, the cost per ton of briquettes is $0.1025.

It is not necessary that the first layer of peat should be dry before another is scattered upon it by the excavator, as experience has shown that successive layers up to six inches in depth may be deposited without hindering the drying process. Consequently, the work of excavating the peat may go on irrespective of the weather until, at any rate, six inches of peat cover the ground.

Scraping and raking the peat, in the Beaverton process, begin immediately upon the uppermost layer becoming sufficiently dry. Two men, each with a wooden scraper about four feet wide in the blade draw the layer of dried peat—from half an inch to an inch in depth—to the side of the tramway, and a third man following close behind drags after him a wide, long-toothed rake, thus loosening the next layer and putting it in condition to be dried. In favorable weather the whole process is a continuous one, consequently the cost of scraping and raking is the wages of three men at $1.40 per day, or $4.20 in all, equal to $0.1909 per ton of finished fuel, the basis being the output of the excavator per day.

AIR-DRYING THE PEAT.

The time required for drying the excavated peat depends of course upon the weather. The wind is a more efficient agent than the sun, a good breeze carrying off the moisture and so promoting evaporation. Under the best conditions, bright sun, high temperature and strong wind, a layer of distributed peat from 1 to 1½ inches deep will dry down from 85 per cent. to 45 per cent. moisture in about 2½ hours. This is approximately the period required by the men scraping and raking the peat to complete the tour of one of the areas 300 feet long by 100 feet wide into which the bog is divided. Hence, in a day of 10 hours they can, under the most favorable conditions, harvest an area 1,200 feet long by 100 feet wide, or 2¾ acres.

Experiments show that while a layer of excavated peat lying on the surface of a bog is being evaporated down to the economic working point, or 45 per cent., a similar layer spread on a raised dry surface, say of wood, will evaporate down to 35 per cent., thus apparently proving that while the upper portion of the layer lying on the bog is losing moisture, the lower portion is drawing moisture by capillary action from the damp bog below. If it were feasible, it would apparently be an advantage to dry the peat on an elevated platform.

Loading the air-dried peat and tramming it into the factory complete the field operations as practised at Beaverton. An electric tram-car, holding the equivalent of one ton of finished peat, and fitted with bottom dump-gates, is worked by a 4-h. p. electric motor, taking power from the generator through a pair of trolleys running on wires beneath the car and beside the rails. One man loads and operates the car, the track leading to an elevated trestle at the works, where the load may be deposited on the stock pile in the bins, or in the disintegrator hopper, as may be required. Including loading, the round trip can be made in 20 to 25 minutes, so that the equivalent in air-dried peat of 27 tons briquettes can be gathered in daily. In practice, however, the quantity is limited by the capacity of the excavator, so that the tram-car man has employment for 8 hours only. The actual running period of the car during which it is drawing upon the electric current, is about 4 hours per day. This is equal to using four tenths of 4-h.p. ; or 1.6-h.p. for the entire day. The power used in drawing in the peat costs therefore $\frac{1.6}{40}$ of \$4.28, or \$0.1712 per day, or $\frac{0.1712}{22}$ = \$0.0078 per ton of finished fuel. The attendant who loads and operates the car is paid \$1.40 per day which is equal to \$0.0636 per ton finished fuel ; therefore the cost at Beaverton of loading and bringing in the air-dried peat per ton of finished fuel is ;

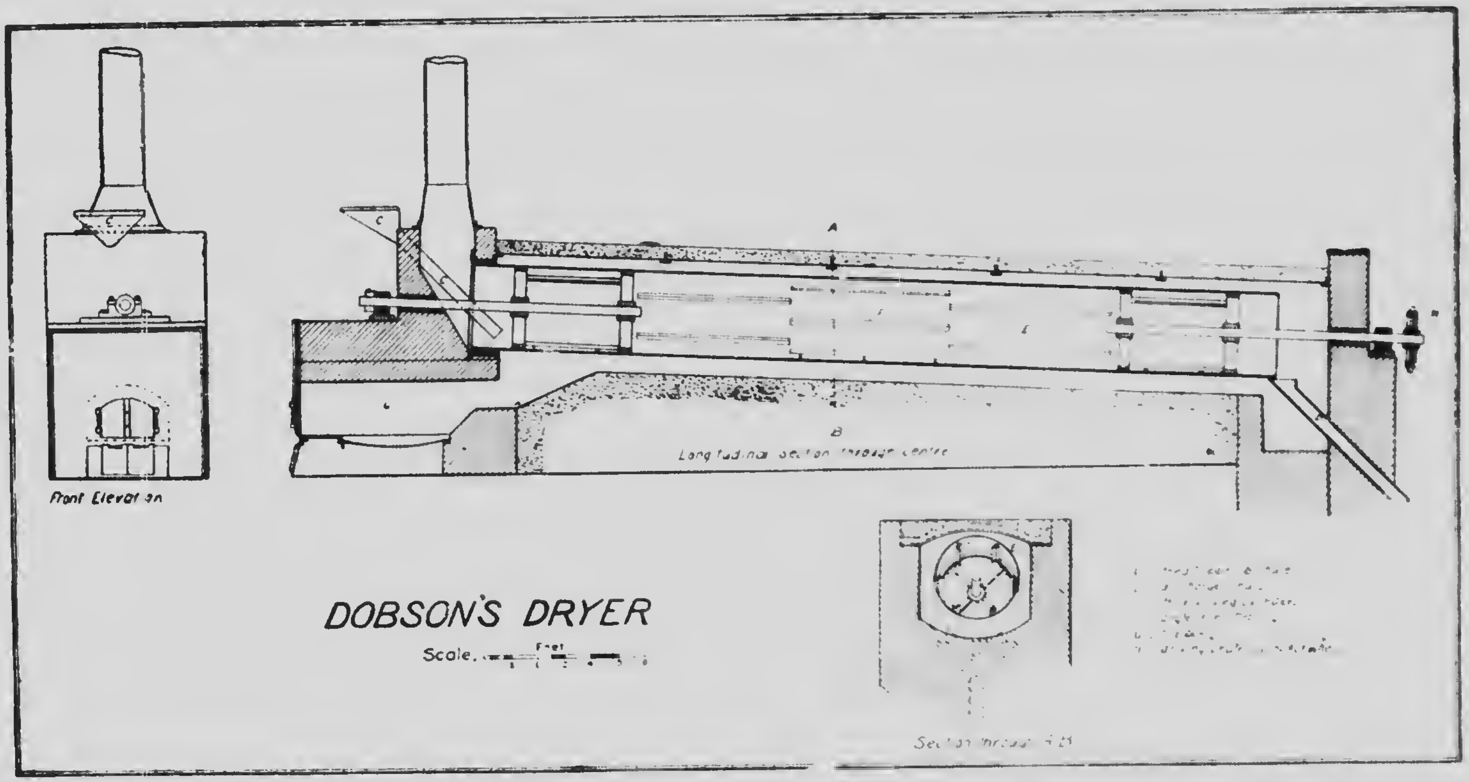
Power	\$0.0078
Labor	0.0636
Total	\$0.0714

Summarizing the field operation costs at Beaverton we have the following, per ton of finished fuel :

Ditching	\$0.0141
Clearing	0.0052
Track laying	0.0070
Excavating and spreading	0.1025
Scraping and raking	0.1909
Loading and tramming in	0.0714
Total	\$0.3911

DISINTEGRATING AND DRYING.

Following the progress of the peat at the Beaverton works we come to the processes of disintegration and drying. Conveyed from bin or stock pile, or deposited directly from the tram-car, the air-dried peat passes into the hopper of the "breaker" or disintegrating machine, where it is subjected to a fierce hail of blows in order to reduce the size of the fragments and destroy the minute plant cells of the peat fibres, thus permitting the remaining moisture to be more readily liberated in the dryer. The machine consists of a circular sheet iron box, encasing a horizontal shaft from which project radial cast iron arms about a foot in length. Through the ends of these and parallel to the shaft run iron rods each suspending a row of knob-like cast steel fingers 4 inches long and free to swing about the rods. The shaft makes 400 revolutions


A
B
Longitudinal section through centre
Front Elevation
DOBSON'S DRYER
Scale.
Feet
Section through A B

per minute, and the steel fingers flying out radially dash the peat fragments against a semi-circular grizzly set close beneath. Through the 1 16-inch spaces of this grating the peat drops as a mixture of fine particles and dust, damp to the touch.

The breaker itself requires no special attendance, being looked after by the dryer attendant ; but for the greater part of the time a man must be employed to shovel the air-dried peat into the conveyor leading from the storage bins or stock piles to the disintegrator, since, for a portion of the year only, can the peat be dumped directly into the hopper of the machine from the tram-car bringing it in from the hog. Estimating the time this man will be required at seven months in the year, that is 180 working days, his wages at $1.40 per day, or $252.00, must be distributed over the product for the year, say 3,800 tons. The power required for conveying the peat is small, and its cost is included in that given below for this section of the works as a whole. The approximate cost of conveying the peat to the disintegrator is therefore $252 ÷ 3800 = $0.0663 per ton of finished fuel.

THE DOBSON PEAT DRYER.

From the bottom of the breaker a conveyor carries the disintegrated peat to the hopper over the dryer, into the cylinder of which a regular feed is maintained. The Dobson dryer, along with the Dobson excavator and Dobson press, is a distinguishing feature of the Beaverton works. The principles it embodies are : Applying the greatest heat to the exterior of the upper end of the cylinder where the damp peat enters ; causing the flames and hot gases to pass along and about the outside of the revolving cylinder, to the lower or rear end before entering, and then to pass back through the interior of the cylinder, traversing the showering peat ; arranging an internal system of lifters so that this showering of the peat will be continuous and uniform from side to side of the interior of the cylinder ; slightly pitching the cylinder so that as it revolves the peat will travel slowly towards the discharge end ; and so adjusting the firing in accordance with the proportion of water present in the peat that a product uniform in moisture content will be the result.

The Dobson dryer is simple in construction and operation, and does good work at a moderate cost. A reference to the cut will show its plan of construction. Inside the rectangular brick casing is a cylinder 30 feet long by 3 feet diameter made of ⅜-inch sheet iron plates, and set with a pitch of 14 inches in its length. Shafting resting on bearings outside the brickwork extends 12 feet into each end of the cylinder, supporting the latter by cast iron arms. Sets of six 3 by 3-inch angle irons five feet long are equally spaced around the interior of the cylinder, each angle raised by pins 3 inches from the surface, and each set advancing on the preceding one through a small angle of revolution to break the ends. The fire-box is built at the front end as a separate structure. The spacing between the cylinder and brickwork allows of unobstructed circulation of flames and gases about the exterior from front to rear. The cylinder revolves by chain gear at the fixed speed of 1½ revolutions per minute, at which rate a charge of peat will pass through it in 20 minutes.

The dryer was under observation for test purposes during part of a working day, samples of the peat before and after drying being taken for analysis, and the quantity of product and fuel consumed being also noted.

This test gave for a day of 10 hours : Weight of air-dried peat charged into dryer, 29,300 lb., containing 34.21 per cent. water ; weight of peat discharged from dryer, 23.000 lb., containing 16.61 per cent water. The weight of water evaporated was 6,300 lb. Blocks of crude air-dried peat containing 34 per cent. water were used as fuel at the rate of 3,145 lb. per day. As is noted above under the head of ditching, one man at $1.40 per day will dig 26 cubic yards of bog, the equivalent of which in peat containing 34 per cent. water is 8,935 lb. ; hence the labor cost of the 3,145 lb. peat used as fuel is $0.4431 per day, or $0.0385 per ton of finished fuel.

One man at $1.40 per day is employed in bringing in air-dried peat or other fuel to boiler and dryer; one-half of this sum is chargeable to the latter, amounting to $0.0608 per ton of output.

The quantity of power used by the disintegrator and dryer, with accompanying conveyors and elevators, together with an exhaust dust fan, was found to approximate closely to 15 horse power. The cost of this is $\frac{15}{40}$ of $4.28, or $1.605 per day, equivalent on the output of 11.5 tons to $0.1395 per ton of briquettes.

One man at $1.40 per day attends dryer and disintegrator, and this sum amounts to $0.1217 per ton of output.

The cost, therefore, of operating the dryer on the occasion of the test with an output of 11.5 tons per day was as follows, per ton of finished fuel:

Fuel, digging	$0.0385
" bringing in	0.0608
Power	0.1395
Attendance	0.1217
Total	$0 3605

These figures differ somewhat from those of the actual working cost, since at the time the test was made only one of the two punches in the press was in operation. The output of the press was therefore diminished by one-half, and the peat was allowed to remain longer in the field and dry down to 34 per cent. moisture, 10 per cent. less than the ordinary of air-dried peat.

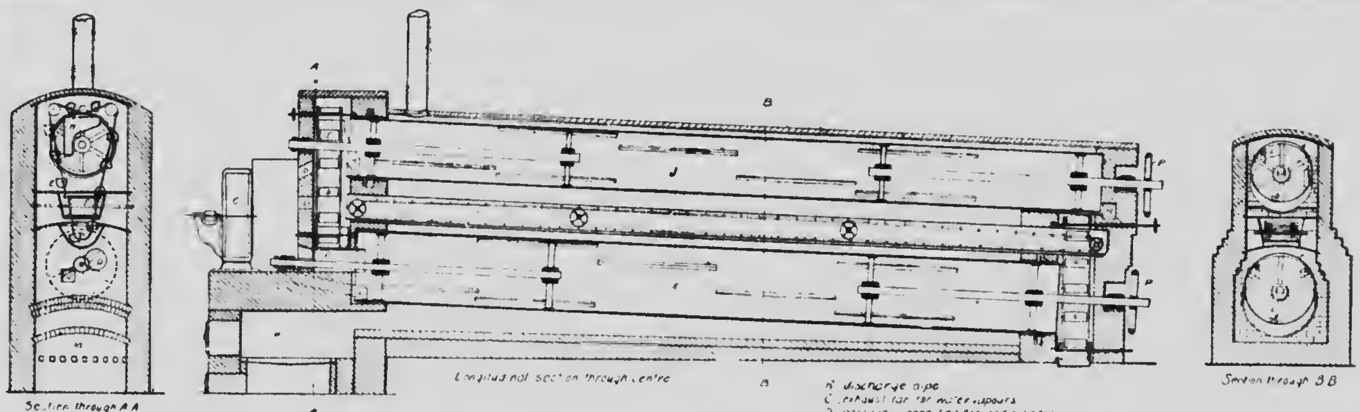
The dryer is said in actual operation to deliver 12.5 tons peat to the briquetting press from air-dried material containing 45 per cent. water. This means the evaporation of 13,600 lb. water per day, double the quantity given off during the test. The expulsion of this additional volume of water involves the use of more fuel, i.e., increases the charge for digging the crude peat for this purpose, but not that for bringing it in, as one man easily gathers a supply for the dryer in half a day. Doubling, then, the cost of this item and distributing it and the other charges over an output of 12.5 tons finished fuel per day, the following table of costs for operating the dryer is obtained, per ton of peat briquettes:

Fuel, digging	$0.0709
" bringing in	0.0506
Power	0.1284
Attendance	0.1120
Total	$0.3673

The crude peat fuel used under dryer and boiler is dug at the beginning of the season in sufficient quantity for a year's supply, and allowed to lie on the field for a season to dry. Necessary ditching operations may be taken advantage of to procure the fuel, so reducing the cost. Analysis of the crude fuel taken from top to bottom of the bog gave:

	per cent.
Moisture	34.19
Volatile combustibles	45.28
Fixed carbon	13 42
Ash	7.11
Total	100.00

In the Welland peat works the air-dried peat is first screened, then put through the mechanical dryer, and then disintegrated or reduced. The main tram line from the bog approaches the works through long stock piles where the field product has accumulated. The present hand methods of unloading and moving the peat will no doubt be replaced by labor-saving appliances, such as elevated trestles, side-dumping cars, conveyors, etc., when the works are in continuous operation.



THE SIMPSON DRYER

Scale. Feet

B discharge pipe
C exhaust fan for moister vapours
D passages connecting fan and cylinders
E elevator from conveyor to top cylinder
F conveyor compartment
G feed pipe
H feed chute to top cylinder from elevator
J upper cylinder
K lower cylinder
L angle iron lifters
M fire box
N elevator from lower cylinder to conveyor
P driving chain sprocket wheels

The air-dried peat is emptied into the hopper of a slowly revolving screen or trommel, 4 feet long by 30 inches diameter, and set with a gentle pitch. The sticks and moss separated from the peat drop in front of the dryer fire-box in which, along with better material they are used as fuel. The peat particles are elevated at once to the feed hopper of the dryer.

THE SIMPSON PEAT DRYER.

The drying apparatus at Welland is known as the Simpson dryer, having been worked out and constructed by Mr. T. F. Simpson, late superintendent of the works, in conjunction with Mr. J. M. Shuttleworth, president of the company. It consists essentially of two parallel revolving cylinders, 30 feet long, one above the other, made of ⅜-inch sheet iron. Inside the cylinders are iron cleats or lifters for more effectually stirring the peat as the cylinders revolve. The space between the upper and lower cylinder is occupied by a conveyor pan, forming a third compartment. The peat first passes through the lower cylinder, then through the intervening compartment, and finally through the upper cylinder, from which it is discharged into a chute leading to the breaker or disintegrator. The gases of combustion from the fire-box in front of the dryer never come into actual contact with the peat, passing first around and along the lower cylinder and second compartment, and thence into the chamber containing the upper cylinder, the peat being heated entirely by radiation. This, it is claimed, prevents the loss of volatile constituents through direct contact with the flames. On top of the fire-box is an exhaust fan which draws away the water vapors given off by the drying peat. The upper cylinder makes three revolutions per minute, and the lower nine, a charge of peat occupying 20 minutes in passing through the dryer from one end to the other. The mechanism is operated by sprocket wheels and chains.

Three tests were made of the efficiency of the Simpson dryer, one in the autumn of 1901 and the other two in May, 1902. In the first, 3,006 lb. of peat, containing 42.64 per cent. water, was reduced to 2,280 lb., containing 24.38 per cent. water, with a consumption of 128 lbs. wood (black ash [illegible] fuel. Time, 2 hours 37 minutes; average temperature of dryer 300° Fahr. In the se[illegible] lb. of peat, holding 46.38 per cent. water, was reduced to 1,451 lb., containing 17.90 per[illegible]. water, in 3 hours 32 minutes; and in the third, 2,752 lb. peat, with a water content of 54.59 per cent., was dried down to 1,925 lb., containing 25.96 per cent. water, in 2 hours 20 minutes. A rather damp mixture of air-dried roots from the peat bog and screenings of sticks and moss from the air-dried peat was used as fuel in the second test, and in the third the roots alone.

These experiments failed to prove the Simpson dryer, in its then form, to be the efficient machine necessary to cope with the difficulties attendant upon this crucial process in peat manufacture. Better fuel may have given better results, and improvements in the construction of the apparatus may give it greater effectiveness, but it is evident from the figures given above that neither in rapidity of working, nor in reduction of moisture to the maximum permissible in peat briquettes, say 15 per cent., can the machine be said to meet the requirements of the situation. It may be added that an improved form of the Simpson Dryer has been made, which it is claimed will take peat carrying 50 per cent. water, and deliver it cold to the briquetting presses, with 10 to 15 per cent. moisture, and that the fuel consumed per ton of product will not exceed 200 lb. air-dried or stack peat.

There are two elements of cost in operating the dryer apart from power: (1) fuel, (2) labor. The fuel consists mainly of roots from the bog, whose cost has already been included under the head of clearing operations; the labor is that of one man at $1.20 per day. The proportionate quantities of power for the various operations were not determined, and this item is consequently charged to the product as a whole. Taking the results of the second test, the only one in which the moisture was reduced to a point approximating the normal moisture content of peat briquettes, as a basis, the output of dried peat per 10 hours would be 14,510 lb., or 7.25 tons, the labor cost of which would be $0.165 per ton of briquettes.

After drying, the peat at the Welland works is passed through a disintegrator, the object being to promote further evaporation and cool the peat. At other works the peat is disintegrated before being put through the dryer, which would seem to be the natural and more effective method. The machine much resembles the one used at Beaverton already described, the chief difference being that the fingers attached to the cylinder are rigid instead of being loosely suspended. From the disintegrator the peat goes into storage bins, and another man at $1.20 per day is employed to shovel the peat out of the bins when the presses are in use. This labor represents $0.0686 per ton on a daily output of 17.5 tons briquettes.

DRYING BY PRESSURE NOT SUCCESSFUL.

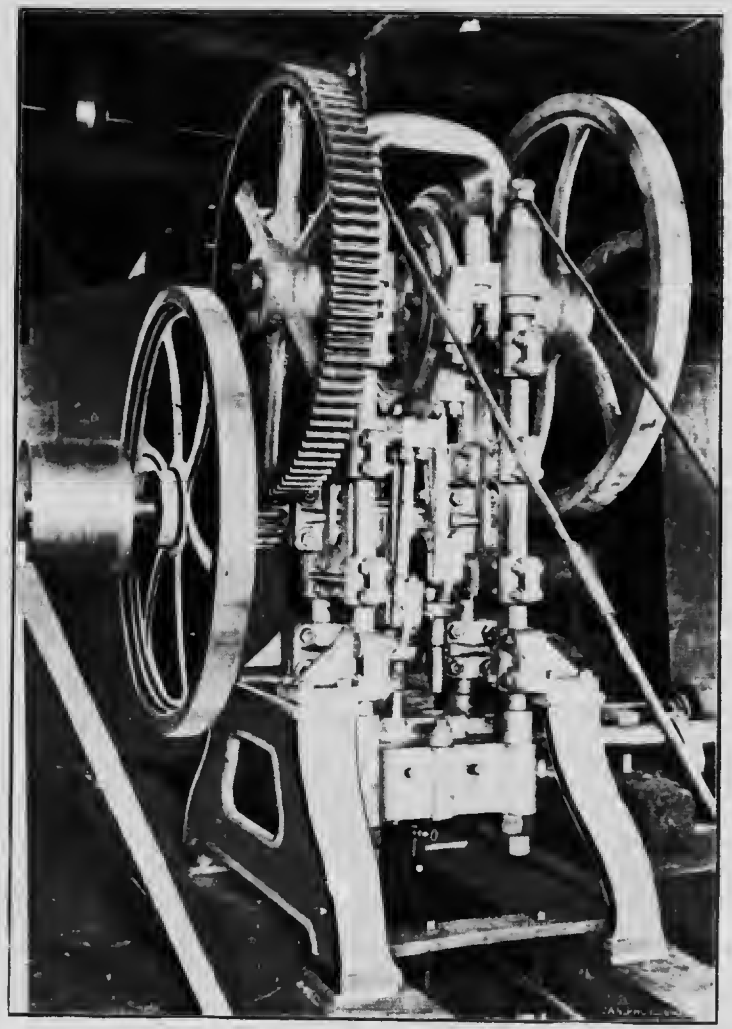
Countless attempts have been made to mechanically expel the water from crude peat by pressure, filtration or centrifugal force, all applied in a multitude of ways, but so far these attempts have invariably ended in failure. At the Trent Valley peat works hydraulic presses built for the purpose by Boomer and Boschert, of Syracuse, N.Y., capable, it is stated, of exerting a pressure of 300 tons, or 2 tons per square inch, were employed, the peat after passing through the macerating machine being loaded on trucks in layers between perforated trays overlaid with filter cloths, and in this manner subjected to pressure. Nineteen pressings were made in 10 hours, the output being 14.42 tons of partially dried peat per press. The following table summarizes the results so far as removing the water is concerned :

Sample Number.	Water content of peat.		Water displaced, per cent.
	Entering press, per cent.	Leaving press, per cent.	
1	78.19	58.89	19.30
2	79.35	63.16	16.19
3	77.24	64.49	12 75
4	76 92	64.29	12.63
5....	75.48	61.52	13.96
6.........	78 17	65 56	12 61
7	78.28	65.27	13.01
8....	79 40	63.24	16.16
9...............	79.41	66 58	12.83
10...............	77.99	64.63	13.36
11...............	74.42	60.70	13.72
Average ...	77.71	63.48	14.23

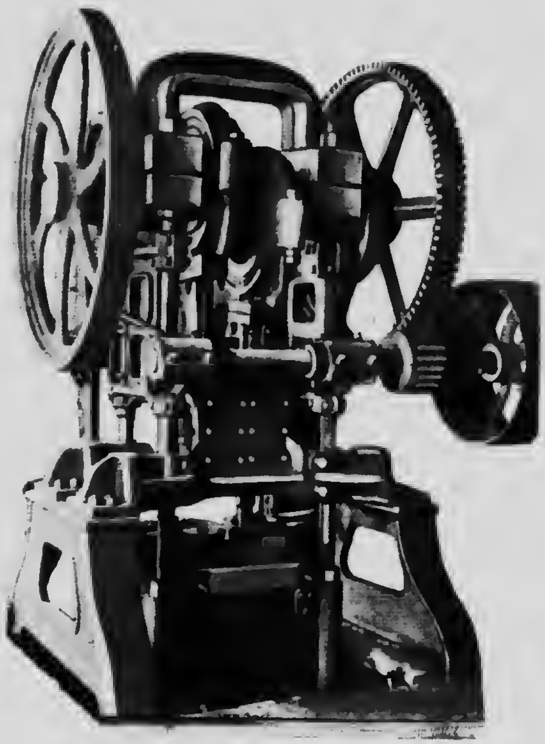
It will be seen therefore that an average of 63.48 per cent. water remained in the peat after pressing. This is almost too high for subsequent drying by artificial heat ; but criticizing the results from the other point of view. namely that of expense. 4 men and an engineer being required to tend the machine, it must be conceded that the cost was out of proportion to the comparatively small quantity of peat handled and the low extraction of water.

The last momentous experiments in this line were carried on for a period of several years at Dusseldorf, Germany, with a patent hydraulic filter press. Unlimited capital was available, and the expenditure amounted to about $100,000, every idea which appeared feasible receiving a thorough trial, so that if at all possible the aim of the process might be accomplished. But all in vain, for the attempt has recently been abandoned as impracticable. Mr. Thaulow thus reports on this point :

" It was contended that this press would bring the peat down to contain about 50 per cent. water, but it proved difficult to reduce the water even to 66 per cent ; and this required so long



Dickson's peat briquetting press



Dobson's peat briquetting press

Dobson peat briquettes

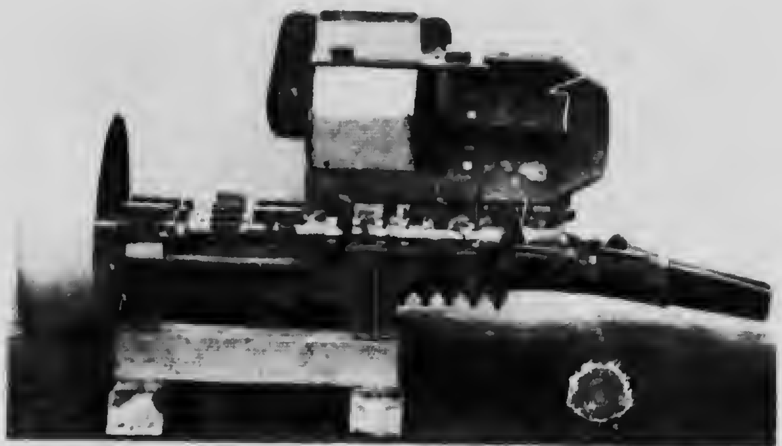
Fresh from press

After transportation by railway.

Peat briquettes made by Dickson process

Lange, Jenson & Co.'s peat stove.

Fire-box for burning peat under steam boilers



Anrep's peat-milling machine opened to show construction.

Anrep's peat milling machine at work.

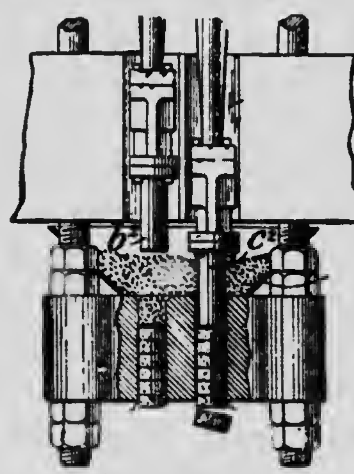
a time that for a greater production it would be necessary to employ several presses, which means a large expenditure of capital. The different parts of the machinery, intended to work partly automatically, get out of order easily. . . ."

At the Trent Valley works the slabs of peat after leaving the press were put through a disintegrator and then through a drying machine built by F. D. Cummer & Son, of Cleveland, Ohio This is a well-known machine, containing a long rotary cylinder, many of which are in use for drying materials other than peat. Its evaporative power proved to be 6,000 lbs. of water per hour, and the output of dried peat 3 tons per hour, but the water content of the product was still too high for successful briquette-making. Eleven samples averaging 63.48 per cent. water before entering the dryer contained an average of 23.41 per cent. on leaving it. The temperature of the furnace was from 965° to 980° Fahr.

Making the Briquettes.

The final step in the Canadian method of peat fuel manufacture is compressing the dried and powdered peat into blocks or briquettes. The shape and size of these briquettes are not unimportant details, but should be such as to allow of free admission and circulation of the air required for combustion between the individual briquettes when thrown on the fire, and at the same time to allow each briquette to contain a sufficient reserve of fuel to afford fresh food for the fire as it eats its way into the block. It has been found that a cylindrical briquette say 2 inches long and about the same in diameter answers these requirements, and is also of convenient form for manufacturing.

THE DICKSON PRESS.



Die-block of Dickson peat press.

The original briquetting apparatus employed in Ontario was of the open-tube type, patented by Mr. A. A. Dickson, and known by his name. It was first set up at Welland about 12 years ago, and since then the many modifications and improvements made by the inventor from time to time have been tested there, including both the upright and horizontal forms of the press, water-jacketting, steam attachments to the tubes, etc. The principle of this press lies in the fact that if a tube of indefinite length be fed with any material, the resistance due to friction between the material and tube walls will gradually rise until no more can be forced in. Peat is of such a nature that when once caused to pack in the tube continued pressure on the material generates a rapid and great increase in the frictional resistance. For a die or tube 2½ inches in diameter, a length of about one foot will give a frictional resistance equal to a pressure of 8 tons per square inch on the punch. One difficulty in operating this style of press satisfactorily has proven to be the excessive consumption of power in simply moving the column of briquettes in the dies; in other words, in expelling the briquette from the die. The tube cannot well be of shorter length than sufficient to ensure a sound briquette being made from the poorest quality of peat; but with dense or gritty peats the resistance rises far beyond the required point. This in turn heats the die, causes an appreciable wear on the inner surface, and consumes unnecessary power. The end of this severe duty is usually a broken die or a ripped or cracked gear wheel. A water jacketting device has been introduced to keep the tubes cool, but apparently not with complete success.

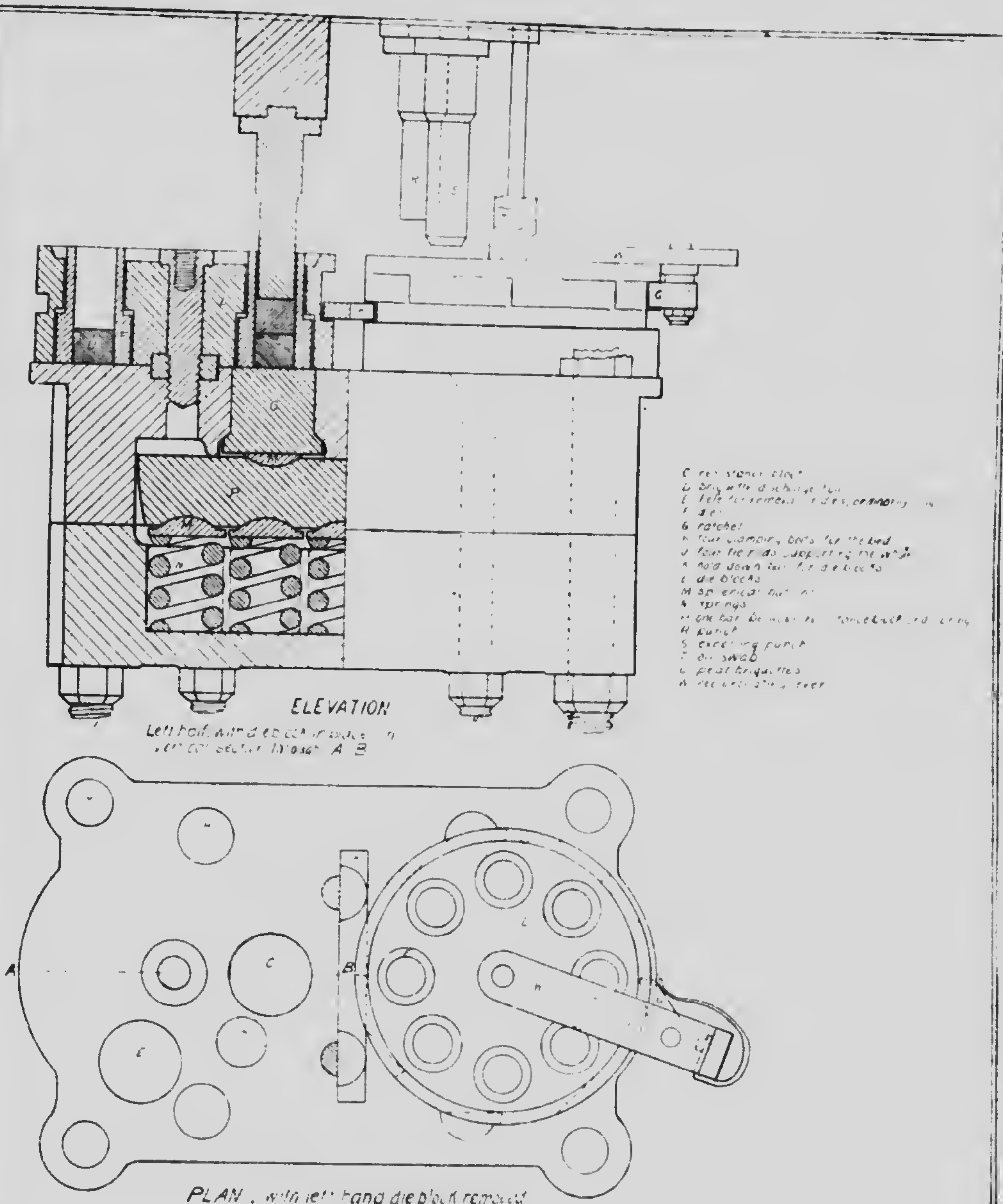
The continued use of the open-tube type of press for briquetting peat in Russia, Germany and Holland makes the difficulties developed here in its operation somewhat surprising, and it is possible that if the machine were improved at certain points, particularly if the dies were greatly strengthened, it might be found capable of good work here. The advantages claimed for its product are important. The heat developed in the tube draws out the tarry constituents of the peat and appears to induce a chemical change which decreases the hygroscopic power of the briquettes and improves their heating value. A ready demonstration of the former of these results is obtained by placing a briquette made in an open-tube and one made in a resistance-block press in water, allowing them to remain for five minutes, and then setting them aside to dry. In a short time the resistance-block briquette falls apart, partially or wholly, while the open tube briquette remains practically unchanged. The bearing of this fact on the effect of rain on peat fuel is apparent. The solidifation or cementation produced by the heat in the open-tube briquette, by means of the tarry substances it develops, also makes the fuel more dense and less liable to crumble and fall to pieces while in the fire.

Observations were made on the working of two Dickson presses on several occasions. Each punch made from 54 to 60 strokes per minute, and the combined output of the two presses ranged from 17 to 18 tons per day of 10 hours, an average of 17 5 tons per day; the capacity of each press therefore being 8.75 tons briquettes per day The labour required was that of two men, one at $1.40 and the other at $1.20 per day, the latter being free also to render assistance in other ways. The wages of the feeder at the conveyer are also included, or $3.80 a day in all, equal to $0.2171 per ton of finished fuel.

THE DOBSON PRESS.

At the Beaverton works the discharge pipe from the dryer empties into the shoe of an elevator, which carries the dried peat into a large galvanized iron hopper or bin interposed between the dryer and the briquetting press. This reservoir serves several important purposes, and is practically indispensable. It permits of a reserve supply in case of accident to the dryer; allows the dried peat to cool; and enables the press attendant, by drawing from various parts of the bin containing material differing in degree of dryness, to send to the press a supply of peat practically uniform in water content.

The resistance-block press in use at Beaverton is the result of four years' experiments carried on by Mr. Dobson. A Dickson or open-tube press was originally installed, but after long-continued trial was changed for a press embodying Mr. Dobson's own idea, that of a closed die resting on a solid base. One of these presses worked successfully during the summer of 1901, and, with some important improvements, during the summer of 1902, making about 600 tons of briquettes each season. In the Dobson press friction is almost entirely eliminated, each die previous to being re-charged being oiled to prevent friction of the peat against the die wall in the subsequent expulsion of the briquette. It is estimated by Mr. Dobson that the total pressure exerted by each punch is about 50 tons which, the diameter of the briquette being 2¼ inches, amounts to 12½ tons per square inch. The large number of dies employed for each punch keeps the temperature low. The briquette is allowed to remain in the die in which it is formed for one cycle of the system (about 6 seconds) and is then subjected to another compression by a second briquette being formed on top of it. Immediately after this it is expelled and the second block takes its place. It is found that after the first compression a certain amount of expansion—about one-eighth of an inch in the length of the briquette—takes place, due to the escaping of the imprisoned air forced into the briquette by the descending punch, and this expansion the second compression counteracts, leaving the briquette more solid and compact.



DIE BLOCK AND BED
DOBSON PRESS

Scale, inches

There are two punches in each machine, and to each punch a die block containing eight snugly fitting dies. The dies are heavier in the lower end where the compression takes place. The base block against which the briquettes are formed, remains rigid, unless for any reason the strain exceeds the working pressure, when a set of spiral steel springs, on which the block rests, takes up the excess pressure and prevents any breakage.

The down-thrust of the punches is imparted by two heavy eccentrics faced with roller bearings, and with each stroke of the punch the die block is turned through one-eighth of a revolution. Working in the next die to the compressing punch is the releasing punch which expels the finished briquette, while the third receives an oil swab which coats the inside of the die with a film of crude petroleum, to lessen the friction and facilitate expulsion of the briquette. The two punch-systems of the press act reciprocally, a stroke being delivered at every half revolution of the eccentric shaft. With each down stroke the compressing punch forms a briquette on top of the one previously made in the same die, the discharging punch expels from the next die the bottom or completed briquette, and the third die receives its coating of oil from the oil swab. The cut illustrating the die block and bed of the Dobson press may serve to make clear the construction and working of this part of the machine. Power is transmitted through belting to a pulley on the pinion shaft, and thence by a 5-foot gear wheel operating the eccentric shaft. The machine is steadied by a heavy fly-wheel on each of these two shafts, and runs quietly and with little vibration, notwithstanding the immense and sudden pressure exerted twice every revolution. It makes 50 or 51 revolutions per minute, producing 100 or 102 briquettes per minute. Twenty-five briquettes weigh about 10 lb., consequently the output of the press in 10 hours is about 12½ tons finished fuel.

To operate the press with the accessory shafting, conveyors, etc, 13-h.p. is required, costing $1.391 per day, or $0.1112 per ton of briquettes. The press operator is foreman of the plant, receiving $1.75 per day as wages, making the labor cost of briquetting $0.1400 per ton. The cost of this operation may be summed up as follows per ton of finished fuel:

Power	$ 0 1112
Attendance	0.1400
Total	$ 0.2512

A modification of the open-tube press has lately been tried at Whitewater, Wisconsin, apparently with successful results. The die-block instead of being water-jacketted to keep down the temperature, is heated by steam, and the stroke of the pressing punch is shortened to about 2 inches, working at the same time at a correspondingly higher rate of speed. The effect of the improvements is said to be the production of a denser fuel, the heat developing the tarry constituents of the peat and uniting them with the fibrous material into a more coherent mass. Instead of issuing from the press as separate briquettes the peat comes out lengths or sticks which may be broken to suitable sizes. The improved press is being experimented with at Welland.

THE NEWINGTON PLANT.

One or other of the two different presses above described has been used in every peat factory hitherto established in Ontario, except that at Newington, where Dominion Peat Products, Limited, are installing a European process of manufacture which does not include briquetting, and the product of which will in fact be "machine" peat, either in the form of blocks or charcoal. At these works after the raw peat is dug from the bog it is to be put through a German kneading or macerating machine called the Lucht mill, in which it is thoroughly mixed or pulped, being afterwards cut into blocks weighing about 2 lb. each. These are placed in drying kilns, and relieved of moisture by the application of heated and inert gases which, while carrying off the moisture, will not attack the carbon of the peat. If it is desired to produce peat coke the drying process is carried farther in the same chamber by raising the temperature of the gases to the necessary degree of heat for carbonizing the peat, the liquors and tarry substances in the peat being duly recovered and the coke removed into and cooled in other chambers. The plant has been partly completed, and is expected to be in operation this summer.

Power Generation and Distribution.

The power plant at Welland includes two steam boilers of 120-h. p. each, one of which has sufficient capacity for the present plant; a horizontal engine of 175-h. p.; the necessary pumps for supplying the boiler and press water-jacket; and a small auxiliary portable boiler with super-mounted engine for operating the dryer plant when the remainder of the machinery is not in use. The fuel used is air-dried peat, of which 4 tons per day were consumed when the tests were made, the cost to dig and deliver being $1.359 per day. One engineer was required whose wages were $2.00 per day. Lubricating oil for the entire plant was used at the rate of two gallons per day, costing $0.34. The total cost therefore of generating power for the entire plant was $3.70 per day, or $0.2113 per ton of finished fuel.

The grate bars of the boiler which were designed for burning peat were fitted with ½-inch space and 5-16 inch bars, thus lessening draught and preventing the fine particles of peat dropping into the ash-pit below. The distance between the grate bars and bottom of the boiler had been reduced to 18 inches, and between boiler and fire wall at the back of the grate to 6 inches, the reason for the latter changes being that peat, both in the air-dried form and briquettes, burns with a short flame. When firing with compressed peat fuel a depth of not more than 4 inches is maintained over the entire surface of the grate. The bottom layer of an inch in depth will be fine ash gradually dropping through the grate spaces as the peat is consumed. The heat is easily and quickly regulated by means of the chimney draught. It is necessary when using briquettes to replenish the fire every 5 minutes.

The fuel employed at Beaverton was dried cedar cordwood, one cord weighing 1700 lb., and costing $1.50. One cord was required for a day's run. Air-dried peat would have been cheaper, but the grate of the boiler was not adapted for burning it. Delivering fuel to the boiler occupied half of one man's time at $1.40 per day, and the engineer in charge was paid at the same rate. Four gallons of oil are consumed in the whole plant per day, costing $0.68. The power cost for the entire process, including field operations, is made up as follows:

	per day
Fuel	$1.50
Delivery of fuel	.70
Attendance	1.40
Oil	.68
Total	$4.28

Mr. J. J. Milne, mechanical engineer, Toronto, also examined and reported on the Beaverton plant and found the power required for operating it to be 40-h. p., distributed among the various plant units as follows:

Briquetting press and elevator	13	horse power.
Tram car	4	" "
Excavator	8	" "
Dryer, breaker, conveyors and exhaust fan	14	" "
Total	40	" "

From these figures the proportionate costs for power for the several parts of the process have been deduced in this report.

Cost of Manufacture.

We are now in a position to sum up the cost of manufacturing the briquettes both at Welland and Beaverton. The totals resulting are not directly comparable because of different conditions existing at the two places. At Welland the workable depth of the bog is 5 feet, as against but $2\frac{1}{2}$ feet at Beaverton, which at once gives an advantage to the former in price per ton in distributing the costs of parts of the field operations; also at Welland the capacity of the two briquetting presses is considerably greater than that of the one at Beaverton, while at each the expenditure for labor is about the same.

At Welland, $17\frac{1}{2}$ tons briquettes per day:

	per ton
Field operations	$0.3771
Attendance on dryer	0.1650
Attendance on presses	0.2171
Power	0.2113
Total	$0.9705

Wages have gone up since the Welland tests were made, and laborers now get at least $1.40 per day. This advance will add proportionately to the cost of manufacture.

At Beaverton, $12\frac{1}{2}$ tons briquettes per day:

	per ton.
Field operations	$ 0.3911
Drying	0.3673
Briquetting	0.2512
Total	$ 1.0096

In neither case do the above figures cover more than actual operating costs, nothing being allowed for interest on capital investment, wear and tear of machinery, royalty charges or profits.

The Peat Machinery Supply Company, Limited, of Beaverton, of which Mr. Alex. Dobson is president, quotes the following prices (subject to revision at any time) for the machinery and apparatus required for a complete peat plant according to the Beaverton plan, with a capacity of 3,000 tons of briquettes per year, working 10 hours per day, or 6,000 to 7,000 tons when run continuously 24 hours per day:

Briquette press	$ 2,500
Dryer	1,350
Breaker	400
Excavator, including motor	600
Generator, tram car, motor and tracks	1,200
Engine and boiler, 50-h.p.	2,000
Shafting, belts and conveyors	700
Buildings (brick)	1,500
Sundries	200
Total	$10,450

The same company also manufactures the Dickson briquetting press for $1,500, and the Simpson dryer for $1,500 or, including cost of brick work and setting up, for $1,750.

The price of bog lands owned by private individuals will in most cases be less than that of arable land, probably not exceeding $10 or $20; while those belonging to the Crown, situated mostly in more remote districts, may be purchased for much less. In a bog costing say $18 per acre and yielding 1,000 tons fuel per acre, the outlay for land regardless of interest, equals $0.018 per ton of briquettes. Depreciation of plant is difficult of estimation, but let it be taken at 10 per cent. per annum. This on the above cost of $10,450 would require a sum of

$1,045 a year, or $0.3483 per ton on an output of 3,000 tons. Interest on capital at 5 per cent. will amount to say $522.50, or $0.1741 per ton of output. The Dickson patents cover product as well as machinery, and have been assigned to Peat Industries, Limited. A royalty of 25 cents per ton is demanded under these patents on all pressed peat briquettes made in Canada. It must be said that this toll, if legally leviable, will be a decided obstacle to the progress of the peat industry. The Dobson machines are all covered by patents issued or pending, in this and other important manufacturing countries.

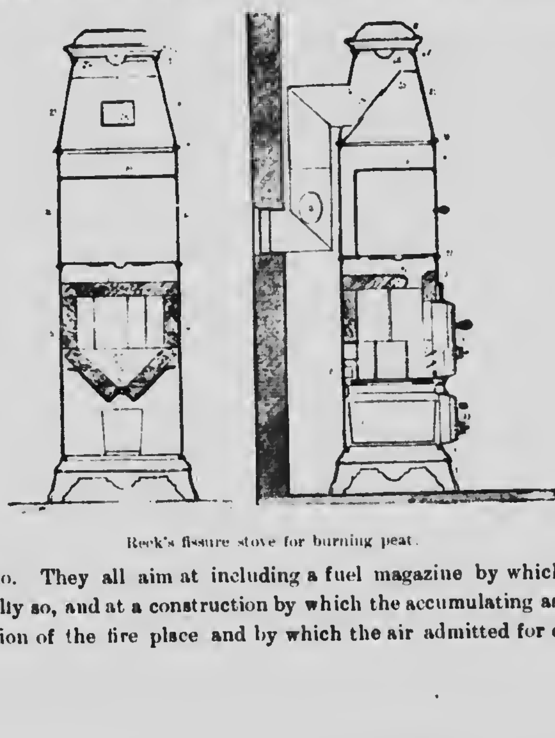
In the following figures an attempt is made to include all items of cost such as those for depreciation, interest, etc., which can only be approximate :

	per ton.
Manufacturing	$ 1.0096
Cost of bog	0.0180
Depreciation of plant	0.3483
Interest on capital	0 1741
Royalty	0.2500
Total	$ 1.8000

The price at which the Beaverton product sold at the factory in 1901 and part of 1902 was $3.00 per ton. In the autumn of the latter year owing to the advance in price of all kinds of fuel, it was increased to $3.75. There was good local demand for all that could be made. At $3.00 per ton peat briquettes of good quality would sell readily in competition with coal at $5.00 per ton and upwards. From conveniently situated plants they could be delivered with reasonable railway freights and sold in cities and towns at $4.00 or $4.50 per ton, at which price they would be about on an equality with anthracite at $6.00 per ton.

Special Apparatus for Burning Peat.

The special stoves and fire places of foreign design are all intended to burn machine peat, and hence are perhaps not entirely suitable for briquettes, which is the form so far taken by

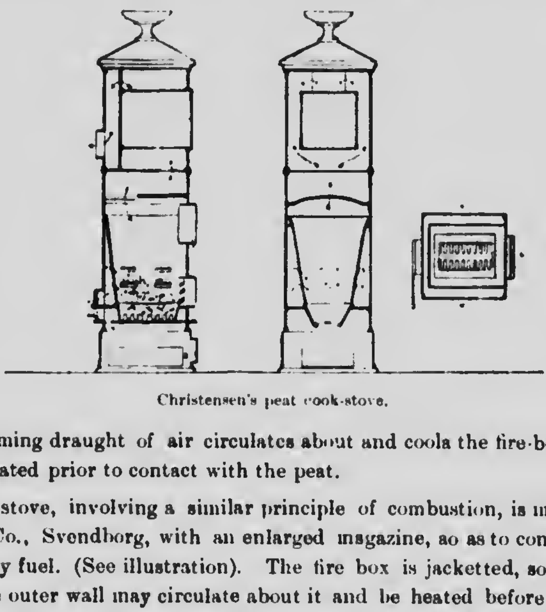


Reck's fissure stove for burning peat.

peat fuel in Ontario. They all aim at including a fuel magazine by which the feed will be automatic or partially so, and at a construction by which the accumulating ashes will not interfere with the function of the fire place and by which the air admitted for combustion will be fully utilized.

The best known peat burner is Reck's fissure stove, a Danish invention, which was originally designed to burn wood, but has proven well adapted for peat (see illustration). These stoves are also used in Germany and Norway, and have been found to have a heating efficiency of 90 per cent., the waste gases leaving the chimney at a temperature of 30° to 50° C. higher than that of the outside air. The peat is stored in a magazine above the fire box, into which it is dropped at intervals by means of a trap door at the bottom. The fire box is V-shaped, and the proper supply of air enters through holes in the side, thus striking the surface of the burning peat. Grate bars are done away with. The draught is therefore never choked, and there is no loss of unconsumed peat. The ashes accumulate in the "V" or trough of the fire box, by opening or shaking which they are dropped into the pan below. Practical tests made in mid-winter with this stove proved that a continuous fire could be kept up for 96 hours on 46 lb. of machine peat by firing seven times at intervals of 12 to 15 hours, an even and suitable temperature being maintained in the rooms during that time.

Christensen's cooking stove for peat is also illustrated. It is built entirely of iron and is somewhat similar to Reck's stove except that the fissure, besides being larger, is provided with



Christensen's peat cook-stove.

a grate. The incoming draught of air circulates about and cools the fire-box becoming at the same time itself heated prior to contact with the peat.

Another peat stove, involving a similar principle of combustion, is made by the firm of Lange, Jenson & Co., Svendborg, with an enlarged magazine, so as to contain a more ample supply of the bulky fuel. (See illustration). The fire box is jacketted, so that the air which enters through the outer wall may circulate about it and be heated before coming in contact with the fuel. The combustion takes place from the top downwards, and the gases travel from the bottom of the storage place outside of the same to the chimney. This heater also attains an efficiency of 90 per cent.

Doubtless these and similar stoves designed for machine peat are more or less suitable for peat briquettes, and later we may expect to see burners of equal efficiency constructed for briquettes, though the need is not so great, since the latter class of fuel so closely resembles anthracite, for which most of our stoves are designed.

For industrial operations, as for instance in generating steam in ordinary boilers, burning apparatus containing similar features have been devised and put into practical use. An example is shown in the accompanying cut. Mr. Thaulow thus describes its working in his report: "The peat (machine peat) is charged into the top of a shaft every half hour by removing a close-fitting lid. The air supply, which is controllable, enters partly through the slanting grate at the bottom, and partly through pipes over the fire box. Fire-proof stone (fire brick) lines the front part of the boiler, as well as the fire box itself, to withstand the great heat—about 2,500° C.—at which peat burns when the air supply is properly regulated; the best kind of fire-proof material should be used for this purpose. The influx of cold air which takes place through the fire-box door in the ordinary boiler, is avoided in this case, and as the amount of smoke is less than with any other kind of boiler, the loss of heat through smoke is also less."

There does not appear to be any reason why the ordinary soft-coal boiler equipment, with automatic stoker and automatic dampers, could not be made to work satisfactorily with peat briquettes at small cost. The grate would require to be raised nearer the boiler, and also the fire-wall at the back of the grate; the spaces between the grate bars should also be reduced one-half. A description of such a grate is given in connection with the Welland peat plant.

In an open grate peat makes a cheerful, strong and steady fire, radiating heat into the room rather than sending it up the chimney, by reason of the small draught required.

Peat Gas.

The use of peat gas for fuel purposes is of long standing in the iron and steel industry of Sweden, in which it is preferred to coal gas on account of its much greater freedom from sulphur and phosphorus. At the rolling mills peat gas is used in the plate furnaces with the result of reducing the formation of scales, particularly in the rolling of thin steel plates. The use of peat gas has contributed largely to improving the quality of Swedish steel, the excellence of which is well known. Peat gas has also come into use as fuel in steam boilers.

THE MERRIFIELD GAS GENERATOR.

In 1901 the perfected Merrifield peat-gas generator was designed and constructed by Mr. L. L. Merrifield, engineer to the Economical Gas Apparatus Construction Company, Limited, of Toronto. The new plant was erected for demonstration purposes at Toronto Junction, and during the autumn of 1901 a number of experiments were made, several of them under the supervision of the Bureau of Mines. Considering the intermittent nature of the tests and the imperfect installation of the plant, a satisfactory showing was obtained. A gas rich in heating value was produced at a fairly steady rate, and at small cost for maintenance and attendance. Without going into detail, it may be stated that the experiments warranted the following conclusions, namely: That, with connections of suitable size, the generator could produce a much larger quantity of gas per hour or minute than was actually obtained; that the production of gas will depend almost wholly on the quantity of fuel consumed; and that this in turn depends on the volume of the air blast.

The cost of maintenance or attendance may be reduced to a minimum by handling the bulky peat and removing the ashes by mechanical means, and this would also effect a saving in time.

The Merrifield gas generator resembles the extensively employed Loomis-Pettibone plants, and particularly that one at Nacozari, Mexico, where the usual Loomis system is somewhat modified with a view of making a uniform and fixed gas out of the mixture of water- and producer-gases, which will be higher in calorific power than producer-gas and lower than water-gas, the fuel employed being wood instead of coal. This result is effected by introducing very little steam with the air blast. The ordinary Loomis generator produces alternately producer-gas and water-gas for short periods of five minutes or so each way, each gas being conducted to its own holder. The Merrifield furnaces are also set up in connected pairs, with charging doors at the top. The grates are near the bottom, and below them is a tapering bottomless ash chamber, terminating several inches below the surface of the water in the ash-pit. The water seals the bottom of the generators, preventing the ingress of air, and yet does not interfere with the discharge of the ashes.

Crude air-dried peat in lumps forms the fuel. By the time it reaches the generators from one-third to one-half will have crumbled into fragments and dust, making a compact and suitable charge for uniform consumption in the furnace.

The air blast is generated by a small blower operated by gas engine, taking gas from the holder. It passes first through the pipes of the condenser, where in condensing the moisture out of the hot gases from the generators it is itself heated up previous to entering the furnaces by way of the chamber below the grate in the bottom. The pipes for injection of steam also enter here. However, on account of the high percentage of moisture contained in the peat fuel, an internal supply of steam for the mixture of water- and producer-gas is usually assured.

After making a good fire, say of wood, in the grate, the peat is charred into the furnaces by the port holes at the top until they are full, when the caps are again clamped down. By forcing the blast for a while and heating the peat into a glowing mass the process becomes properly started, after which the volume of air is adjusted to the production of the maximum capacity of the generators. From now on the operation is continuous except during the loading or re-charging periods, covering a quarter of an hour or so once or twice a day.

Although set up in pairs the generators, like the Nacozari machines, will most of the time work as one, producing the uniform mixed gas ; but should a partial production of water-gas alone be desired, the air blast is shut off and steam injected into one generator, up through the glowing mass of peat, across into and down through the hot coals in the other machine and out thence to the condenser and scrubber. This continues for a few minutes, until the fire has cooled off, so that the air blast is again required to bring it up to the proper temperature, when the same course is again followed, except that this time the direction of the steam in the generator is reversed, entering the bottom of the second and leaving by the first.

Peat, like wood, particularly green wood, is naturally suited on account of its large percentage of moisture, to steady production of the mixed gas, rather than to the alternate generation of first water-gas and then producer-gas, as with dry fuels such as coal.

QUALITY OF MERRIFIELD PEAT-GAS.

In these experimental runs of the Merrifield gas generator the calorific determinations and analyses of the gas were made by Dr. W. Hodgson Ellis, professor of applied chemistry at the School of Practical Science, Toronto. The gas produced on 28th October 1901 gave the following calorific values at the different stages of the operations :

Time.	B. T. U. per cubic foot.
3.00 p.m.	96.4
3.10 ,,	118.
3.20 ,,	149.
3.25 ,,	154.6
3.55 ,,	159.
4 15 ,,	125.
Average	133.7

The quantity of gas made and peat consumed was not ascertained.

The plant had been kept warm during the previous part of the day without generating much gas until this test began, and soon after gas of good quality began to appear a mishap caused a sudden termination of the test. This accounts for the gradual rise and subsequent abrupt fall in the quality of the gas.

Shortly afterwards another test run gave the following quality of gas :

Time.	B. T. U. per cubic foot.
2.10 p.m.	156
2.40 ,,	156
3.10 ,,	157
3.40 ,,	156
4.15 ,,	153
4.30 ,,	155
Average	156

For some hours previous the generators had run steadily and continued so to the end.

In November another run was made giving gas of the following quality :

Time.	Calories per litre.	B.T.U. per cubic foot.
10.45 a.m.	889.6	100.5
10.55 "	906.8	102.5
11.15 "	951.	107.5
11.25 "	889.6	100.5
11.35 "	966.4	109.2
11.45 "	944.1	106.7
11.55 "	1019.	115.2
12.05 "	1041.	117.6
3.20 p.m.	1059.	119.7
3.30 "	1074.	121.4
3.45 "	1092.	123.4
4.00 "	1113.	125.7
4.15 "	1097.	124.0
4.30 "	1147.	129.6
Average	1013.	114.

From these determinations it will be seen that the fuel value of the gas on the day of the test rose from 100 to 130 B.T.U. per cubic foot. The analysis of a sample of the gas taken from the pipe at the conclusion of the calorimeter test, which also marked the end of the whole experiment, gave as follows :

	per cent.
Carbon dioxide, CO_2	20.5
Carbon monoxide, CO	10 2
Methane, CH_4	1.9
Hydrogen, H	22.8
Nitrogen, N	44.6
	100.0

The quantity of carbon dioxide in this sample is larger than was obtained in samples taken in previous tests. In one there was but 12·4 per cent. CO_2, and in another but 7·4 per cent. An increase of CO_2, accompanied by a decrease of CO, such as the above analysis shows, would be caused by the lowering of the temperature of the retort at the end of the operation when the sample was taken.

The analysis of the peat used in the experiment is as follows :

	per cent.
Moisture	25.94
Volatile organic matter	48.41
Fixed carbon	18.69
Ash	6.96

Another run of the generator was made, and the gas this time tested by Mr. J. Walter Wells. The analytical work was conducted at the gas works, but for the calorimeter determinations samples of the gas were taken in a large aspirator can from the gas-holder and tested at the School of Practical Science laboratory in the same Junker's calorimeter as was used at the works by Dr. Ellis in the experiments previously described.

In forcing the gas out of the can by in-running water some of the tarry vapors were lost by condensation, as was apparent on examination of the water from the aspirator. In all other respects, however, the method and apparatus worked admirably.

In the accompanying table of analyses on page 40, samples Nos. 1 to 11 are of the water gas type, made by injecting a large excess of steam with a moderate air blast over the hot peat in the generator. Samples Nos. 12 to 16 are of producer gas made in reheating the furnace charges, which were cooled by the flow of steam for the water-gas, by reversing the direction of the air blast through the generators and shutting off all steam. On leaving the holders this gas smelt very strongly of tar and contained considerable vapors.

Another similar Merrifield peat-gas generator was installed at the Trent Valley Peat Fuel Company's works, Kirkfield, to produce fuel gas for the dryer, but no tests were made with it, which is to be regretted, since it is said to have worked satisfactorily.

The original Merrifield generator, first set up at Toronto Junction, on which the above experiments were conducted, has since been removed and reinstalled at the Welland peat works, where, if desired, test runs may be made with it. Later the intention is to incorporate it as part of the peat works, to furnish fuel gas for boilers and dryers

COST OF GAS PLANT.

From the prospectus of Peat Industries, Limited, concerning this method and all necessary apparatus for the production by it of peat gas the following is quoted :

"From one ton of compressed peat, analysing approximately : moisture 15 per cent., ash 7 per cent., fixed carbon 21 per cent., volatiles 57 per cent., valued at \$1.50 per ton delivered at gas retort, figuring wages at 20 cents per hour, and yearly depreciation at 6 per cent. upon value of machinery, and in a plant capable of producing 40,000 cubic feet of gas hourly, a yield will be had of not less than 100,000 cubic feet of fixed gas, carrying not less than 150 B.T.U. per cubic foot, at a cost not exceeding 2½ cents per 1000 cubic feet. We will supply all apparatus and material for a plant producing not less than 20,000 cubic feet of gas per hour for \$5,000, exclusive of freights, cartage to site and erection; larger plants proportionately. Peat carrying up to 30 per cent. moisture may be used, but the yield of gas will be reduced about 1,000 cubic feet for every additional 1 per cent. moisture."

This estimate was made for gas plants situated at a distance from the bogs, to which the peat would have to be shipped, and which therefore must first be manufactured into compressed fuel. If the use of cut-peat be made possible by locating the gas works at the bog, or only at such distance that the peat could be economically transported thereto as cut peat, the cost of the fuel should not exceed 50 to 75 cents per ton.

The above experimental runs with the Merrifield generator were made on cut peat, and the analytical tests show that it gives high results. With compressed peat briquettes the advantages over cut peat would be smaller bulk and therefore less frequent handling, lower moisture content and consequently a higher calorific value.

There are many advantages to be gained in the use of peat by converting it into gaseous fuel, many of them appertaining equally to other gaseous fuels. While the consumption of the solid fuel involves a loss of heat of 25 to 30 per cent. or more, this loss, if the fuel be

Gas made from Cut Peat in Merrifield Gas Generator at Toronto Junction.

	Water-gas, per cent.											Producer-gas, per cent.					Mixture of water and producer gas, per cent.				
Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Benzine and benzoles	.4	.6	7	3	.3	.3	.5	.4	.8	.4	.8	1.8	1.2	1.6	1 0	1.2	.5	.5	6	.7	.8
Illuminant	.2	2	.2	.3	.2	.2	4	.3	.2	.2	.2	.2	.2	.4	.4	.6	.2	.2	.8	6	.4
Carbon monoxide, CO	17.8	17 8	17.4	17.3	17 2	17.4	17 2	17.2	16 8	16 8	16 5	13.6	13 6	7 8	7 8	11 6	15 0	15.4	15 25	16 6	16.2
Hydrogen, H	14 9	12 1	13 02	12 87	12 98	12.50	13 6	12.5	12 43	12 34	12 58	8.56	8 99	4 19	4 87	3.13	12.5	12 6	11 8	12 2	12.3
Methane, CH_4	4.15	4 26	5 48	6 11	5.19	5 86	5 2	5.86	6.17	6.17	6 29	7.14	7.49	[illegible] 24	5.24	4 68	3 9	4 0	4 2	4 1	4 6
Oxygen, O	0	.0	.0	0	.2	.0	.0	.2	.0	.2	.2	.6	.6	.4	.4	.2	.6	.5	.85	.0	.4
Carbon dioxide, CO_2	11 0	10.8	10.3	10 7	10.7	10 7	9.5	10.5	10.8	11 6	9.7	12.4	12 0	11.2	11.8	15.2	13 3	13.2	12.3	12 1	12.2
Nitrogen, N	51.55	54.24	53.9	52 42	53.23	53 01	52 60	53 04	52.8	52 69	53.73	55.7	53.92	69.17	68 48	63 39	54 0	53 6	54 2	53.7	53.4
Calorific determinations, (B. T. U. per cubic foot)						137 72 146 89 146.89 137.92 157.0								109.2 109.8 109.8 109 8					136 8 135.65 136.8 136 7		
Average						145.3								109 6					136 4		

converted into gas, will be reduced to from 15 to 20 per cent. When the fire-box is sufficiently large the combustion is complete, and without smoke or soot, leaving always a clean boiler surface. A properly regulated draught insures complete and even combustion. Its comparative freedom from sulphur makes possible a long life for the boiler. A better insulation may be had against loss of heat by radiation, and the hot gases from the generator may be utilized for drying the peat which is to be converted into gas.

The most important reason, however, why peat gas can be more profitably and extensively employed than peat in large industrial works lies in the fact that by locating a large central power station at a suitable bog the cheapest kind of peat, namely cut peat, satisfies all requirements; and the gas may then be piped for distribution, or, if the place of consumption be at too great a distance, it may be converted at the bog into electrical energy.

Sulphur in Ontario Peat.

At the Provincial Assay Office 36 samples of peat from different bogs in Ontario were analysed for their sulphur contents. The results serve to show the general character of our peat in this respect.

Each sample was analysed in duplicate by three different methods. The sulphur content was found to range from 0.112 to 1.00 per cent, with an average of about 0.5 per cent. Pennsylvania anthracite contains over .6 per cent, and bituminous coal over 1.4 per cent. sulphur.

Bogs are however to be had, as the analyses show, which carry little more than traces of sulphur, should freedom from this ingredient be particularly desired.