30 ton "Anrep" Peat Machine: general view when in actual operation.

CANADA

DEPARTMENT OF MINES

MINES BRANCH

HON. W. TEMPLEMAN, MINISTER; A. P. LOW, LL.D., DEPUTY MINISTER;
EUGENE HAANEL, PH.D., DIRECTOR.

BULLETIN No. 4

(SECOND EDITION)

INVESTIGATION

OF THE

PEAT BOGS, AND PEAT INDUSTRY OF CANADA

DURING THE SEASON 1909-10

BY

ALEPH ANREP, Jr.
Peat Expert

To which is appended Mr. Alf. Larson's Paper on Dr. M. Ekenberg's Wet-Carbonizing Process: from Teknisk Tidskrift, No. 12, December 26, 1908 —Translated by Mr. A. Anrep, Jr.; also a Translation of Lieut. Ekelund's Pamphlet entitled "A Solution of the Peat Problem," 1909: describing the Ekelund Process for the manufacture of Peat Powder, by Harold A. Leverin, Ch. E.

OTTAWA
GOVERNMENT PRINTING BUREAU
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No. 71

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LETTER OF TRANSMITTAL.

To Dr. EUGENE HAANEL,
Director of Mines.

SIR,—In accordance with your instructions, I continued, during the season of 1909, a thorough investigation of the peat bogs of Ontario, in order to ascertain the extent, depth, and quality of the peat contained therein.

The bogs first examined were those for which the Mines Branch had been importuned by petition; followed by those favourably located as regards transportation and market.

Several of these bogs are heavily wooded, while others are covered over with burnt logs and half burnt trees. An investigation of these bogs takes a considerable time, since it requires the cutting out of necessary lines and the drilling of a great number of holes.

Part of the summer months: July and August—September and part of October, were occupied in the development of the Government peat bog at Alfred, Ontario, and in the installation of the Anrep peat machine, with conveyer and platform—which were removed from Victoria Road to Alfred—together with other machinery recently imported from Sweden and Germany.

In October, last year's stock of manufactured peat fuel was shipped from Victoria Road, to Ottawa; for utilization in the Körting peat gas producer at the Government Fuel Testing station.

The Ontario peat bogs examined, delimited, described, and illustrated by maps showing their respective areas, depth of peat, and average degree of humification in each drill hole, are as follows:—

(1) Brunner peat bog, Ellice township, Perth county.

(2) Komoka peat bog, Caradoc and Lobo townships, Middlesex county.

(3) Brockville peat bog, Elizabeth township, Leeds county.

(4) Rondeau peat bog, Harwich township, Kent county.

(5) Alfred peat bog, Alfred township, Prescott county.

The Government peat bog at Alfred, Ontario, is generally described in the text; but many details are omitted, since they are clearly shown on the illustrative photographs and accompanying map.

I have the honour to be, sir,

Your obedient servant,

(Signed) ALEPH ANREP.

OTTAWA, May 29, 1910.

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CANADA.

DEPARTMENT OF MINES

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HON. W. TEMPLEMAN, MINISTER; A. P. LOW, LL.D., DEPUTY MINISTER;
EUGENE HAANEL, PH.D., DIRECTOR.

REPORTS, AND MAGNETIC SURVEY MAPS OF ECONOMIC INTEREST.

PUBLISHED BY THE

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2. Great Landslide at Frank, Alta. Report on—by R. G. McConnell and R. W. Brock, M.A., 1903.
3. Investigation of the different electro-thermic processes for the smelting of iron ores, and the making of steel, in operation in Europe. Report of Special Commission—by Eugene Haanel, Ph.D., 1904. (Out of print.)
4. Rapport de la Commission nommée pour étudier les divers procédés électro-thermiques pour la réduction des minerais de fer et la fabrication de l'acier employés en Europe. (French Edition), 1905. (Out of print.)
5. On the location and examination of magnetic ore deposits by magnetometric measurements. Eugene Haanel, Ph.D., 1904.
7. Limestones, and the Lime Industry of Manitoba. Preliminary Report on—by J. W. Wells, 1905.
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9. Hydraulic Cements (Raw Materials) in Manitoba: Manufacture and Uses of. Preliminary Report on—by J. W. Wells, 1905.
10. Mica: its Occurrence, Exploitation, and Uses—by Fritz Cirkel, M.E., 1905. (Out of print.)
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12. Zinc Resources of British Columbia and the Conditions Affecting their Exploitation. Report of the Commission appointed to investigate—by W. R. Ingalls, 1905.
16. Experiments made at Sault Ste. Marie, under Government auspices, in the smelting of Canadian iron ores by the electro-thermic process. Final Report on—by Eugene Haanel, Ph.D., 1907.
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18. Graphite: Its Properties, Occurrence, Refining, and Uses—by Fritz Cirkel, M.E., 1907.
19. Peat and Lignite: Their Manufacture and Uses in Europe—by Erik Nyström, M.E., 1908.
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21. Summary Report of Mines Branch, 1907-8.
22. Iron Ore Deposits of Thunder Bay and Rainy River districts. Report on—by F. Hille, M.E.
23. Iron Ore Deposits along the Ottawa (Quebec side) and Gatineau rivers. Report on—by Fritz Cirkel, M.E.
24. General Report on the Mining and Metallurgical Industries of Canada, 1907-8.
25. The Tungsten Ores of Canada. Report on—by Dr. T. L. Walker.
26. The Mineral Production of Canada, 1906. Annual Report on—by John McLeish, B.A.
27. The Mineral Production of Canada, 1908. Preliminary Report on—by John McLeish, B.A.
28. Summary Report of Mines Branch, 1908.
29. Chrome Iron Ore Deposits of the Eastern Townships. Monograph on—by Fritz Cirkel, M.E. (Supplementary Section: Experiments with Chromite at McGill University—by Dr. J. B. Porter.)
30. Investigation of the Peat Bogs and Peat Fuel Industry of Canada, 1908. Bulletin No. 1—by Erik Nyström, M.E., and A. Anrep, Peat Expert.
31. Production of Cement in Canada, 1908. Bulletin on—by John McLeish, B.A.
32. Investigation of Electric Shaft Furnace, Sweden. Report on—by Eugene Haanel, Ph.D.
42. Production of Iron and Steel in Canada during the calendar years 1907 and 1908. Bulletin on—by John McLeish, B.A.
43. Production of Chromite in Canada during the calendar years 1907 and 1908. Bulletin on—by John McLeish, B.A.
44. Production of Asbestos in Canada during the calendar years 1907 and 1908. Bulletin on—by John McLeish, B.A.
45. Production of Coal, Coke, and Peat in Canada during the calendar years 1907 and 1908. Bulletin on—by John McLeish, B.A.
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47. Iron Ore Deposits of Vancouver and Texada Islands. Report on—by Einar Lindeman, M.E.
55. Report on the Bituminous, or Oil-shales of New Brunswick and Nova Scotia; also on the Oil-shale Industry of Scotland—by Dr. R. W. Ells.
58. The Mineral Production of Canada, 1907 and 1908. Annual Report on—by John McLeish, B.A.
59. Chemical Analyses of Special Economic Importance made in the Laboratories of the Department of Mines, 1906-7-8. Report on—by F. G. Wait, M.A., F.C.S. (With Appendix on the Commercial Methods and Apparatus for the Analysis of Oil-shales—by H. A. Leverin, Ch.E.)

34. Magnetometric Survey, Vertical Intensity: Lots 2 and 3, Concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, M.Sc., 1909.

35. Magnetometric Survey, Vertical Intensity: Lots 10, 11, and 12, Concession IX, and Lots 11 and 12, Concession VIII, Mayo township, Hastings county, Ontario—by Howells Fréchette, M.Sc., 1909.

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68. Recent Progress in Electro-Metallurgy. Bulletin No. 3—Dr. Eugene Haanel.

69. Chrysotile-Asbestos: Its Occurrence, Exploitation, Milling, and Uses. Report on—by Fritz Cirkel, M.E. (Second Edition, enlarged.)

71. Investigation of the Peat Bogs, and Peat Industry of Canada, 1909-10: to which is appended Mr. Alf. Larson's Paper on Dr. M. Ekenberg's Wet-Carbonizing Process: from Teknisk Tidskrift, No. 12, December 26, 1908—translation by Mr. A. Anrep, Jr.; also a translation of Lieut. Ekelund's Pamphlet entitled 'A Solution of the Peat Problem,' 1909, describing the Ekelund Process for the Manufacture of Peat Powder, by Harold A. Leverin, Ch.E. Bulletin No. 4—A. Anrep, Peat Expert. (Second Edition, enlarged.)

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82. Magnetic Concentration Experiments. Bulletin No. 5—by Geo. C, Mackenzie.

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83. An Investigation of the Coals of Canada with reference to their Economic Qualities: as Conducted at McGill University under the auspices of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., and R. J. Durley, Ma.E.

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13. Magnetometric Survey of the Belmont Iron Mines, Belmont township, Peterborough county, Ontario—by B. F. Haanel, B.Sc., 1905.

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15. Magnetometric Survey of Iron Ore Deposits at Austin brook, Bathurst township, Gloucester county, N.B. Vertical Intensity—by E. Lindeman, M.E., 1906.

33. Magnetometric Survey, Vertical Intensity: Lot 1, Concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, M.Sc., 1909.

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Magnetometric Survey of Huron Mountain mine, Timagami Forest Reserve, Ontario—by B. F. Haanel, B.Sc.

Magnetometric Survey of Lot 7 A, Range V, Leeds township, Quebec—by B. F. Haanel, B.Sc.

NOTE.—All applications for Reports, or Maps issued by the Mines Branch of the Department of Mines, should be addressed to

EUGENE HAANEL, Ph.D.,
Director of Mines,
Ottawa.

INVESTIGATION

OF THE

PEAT BOGS AND PEAT INDUSTRY OF CANADA

BY

A. Anrep, Jr.

METHOD OF INVESTIGATION.

The methods of investigation are already described in Bulletin No. 1, page 7; but in order to prevent misunderstanding, it may be advisable to repeat part of the classification indicated on the above-mentioned page.

'The different degrees of humification are symbolized in letters, in accordance with the following scale:—

C C+ BC− BC BC+ B−	Indicating a peat more or less suitable for moss litter.	B B+ AB− AB AB+ A− A	Indicating a peat more or less suitable for peat fuel.

'The peat classified in accordance with this scale from C to B—is only suitable for the manufacture of moss litter or similar products, and that from B to A for peat fuel. B, for instance, indicates that the peat fuel produced from such peat is light, and consequently bulky, and AB, a heavier peat, well suited for the manufacture of fuel. In the same manner C indicates a peat, or rather moss, well suited for moss-litter; and B—a less suitable material. The signs + and—after the letter, respectfully increase or decrease the degree indicated.'

When the bog is under investigation, and is found to indicate a peat more or less suitable for moss litter, the peat taken out of the drill holes from the different layers, at a depth, for instance, of 3 feet or lower, shall represent from each depth a special sample; but if the bog is found to indicate a peat more or less suitable for peat fuel, the peat from the drill holes and different layers shall be mixed to form a general sample.

It is quite sufficient if the lines on the bog surface run 1,000 feet, or even farther apart; but where the manufacture of peat products is intended, drilling ought to be made closer: as for instance, at the Government peat bog at Alfred, Ontario, which will be ready for the manufacture of peat fuel in the summer of 1910. The lines run at 200 ft. intervals, and drilling was done in each of the lines, 200 feet apart.

At each interval a picket was put in and numbered. After the drilling and squaring in were performed, levels were taken at each interval.

Samples of the peat collected from 315 drill-holes, and from different depths, were made into one general sample.

DESCRIPTION OF INDIVIDUAL PEAT BOGS.

Brunner Peat Bog.

This bog is situated about eight miles west from Stratford, Ontario, in Ellice township, Perth county (see accompanying map), and covers more or less of:—

Lots 9–15,	Concession	IX,	Ellice township.
" 9–14,	"	X,	"
" 6–14,	"	XI,	"
" 6–14,	"	XII,	"
" 7–14,	"	XIII,	"
" 8–13,	"	XIV,	"

The total area covered by this bog is, approximately, 2,288 acres. Of this area—

468 acres have a depth of less than 2′–6″; average depth, 1′–6″.
792 acres have a depth of 2 feet to 5 feet; average depth, 3′–8″.
870 acres have a depth of 5 feet to 7′–6″; average depth, 6′–1″.
158 acres have a depth more than 7′–6″; average depth, 8′–1″.

The volume of the peat contained is:—

In an area with a depth of less than:—

2′–6″	1,132,560	cubic yards.
2′–6″ to 5 feet	4,684,971	"
5 feet to 7′–6″	8,421,600	"
More than 7′–6″	1,448,414	"

The peat is well humified and uniform in quality; and with proper treatment the middle part of the bog can be used for the manufacture of peat fuel. In considerable areas around the margin of the bog, the peat is very shallow, and heavily grown over with young poplar; and some parts are intermixed with spruce, tamarack, and cedar.

The peat, after the bog is thoroughly drained, will probably settle down about 2 feet. Deducting, therefrom, the 468 acres which have an average depth of about 1′–6″, and the 792 acres which have an average depth of about 3′–8″ (the last-mentioned is not likely to be profitably worked by machinery), and allowing for the decrease in depth through draining, we have left: 870 acres with an average depth of approximately 5 feet; 158 acres with an average depth of approximately 7 feet, with a total volume of 8,790,979 cubic yards of peat. Supposing that one cubic yard of such drained bog will furnish 200 pounds of dry peat substance, the total tonnage of dry peat substance available is 879,098 tons, of 2,000 pounds, or, 1,098,872 tons peat fuel, with 25 per cent moisture.

This bog is principally formed by hypnum plants, and in some parts eriophorum can be found; except around the margins, where the peat is mixed with carex and other aquatic plants. In some parts of the bog the peat itself is mixed with small roots. Occasionally, stumps and trunks can be found.

ANALYSES OF PEAT (ABSOLUTELY DRY).

Volatile matter	64·09
Fixed carbon	25·16
Ash	10·75
Nitrogen	1·73
Sulphur	0·303
Phosphorus	0·035
Calorific value, B.T.U. per pound	8·850

The surface of the bog has been burned over several times, which accounts for the fact that, the content of ash is comparatively high—but not excessive; while the calorific value is satisfactory. For the manufacture of peat on a large scale the bog ought to be systematically and thoroughly drained.

This will involve a large expenditure, but it might be undertaken profitably—considering the value of the land that would be recovered—which at present is practically valueless—together with the improvement which would result to the surrounding farming lands, due to the drainage of the enclosed bog.

The middle part of the bog could then be utilized for the manufacture of peat fuel, and the rest for agricultural purposes.

The bog is very advantageously situated as regards shipping facilities and market, being only eight miles from Stratford; and is traversed on the south side by the Grand Trunk railway.

In 1902, a peat plant was erected at this bog, where the manufacture of peat briquettes was started (see map) by means of the Dickson method. (For description of this method, see Bulletin No. 5, published by the Ontario Bureau of Mines, Toronto; also the Report on Peat and Lignite, by E. Nyström, published by the Mines Branch, Department of Mines, Ottawa.)

Some hundreds of tons of briquettes were made; but after a few years the work was discontinued. Part of the machinery was removed, and the rest left on the ground.

Komoka Peat Bog.

This bog is situated about two miles from London, Ontario, and about two miles from Komoka station, in Caradoc and Lobo townships, Middlesex county (see accompanying map), and covers more or less of:—

Lots	20–21,	Concession	V,	Caradoc township.
"	20–24,	"	IV,	"
"	23–24,	"	III,	"
"	1–2,	"	III,	Lobo township.
"	1–2,	"	II.	"

The total area covered by this bog is, approximately, 900 acres. Of this area:—

328 acres have a depth of less than 2′–6″; average depth, 1′–6″.

277 acres have a depth of 2′–6″; average depth, 3′–6″.

295 acres have a depth more than 5 feet; average depth, 5′–6″.

The volume of the peat contained is:—

In an area with a depth of less than:—

2′–6″	793,759	cubic yards.
2′–6″ to 5 feet	1,375,275	"
More than 5 feet	2,617,633	"

In the eastern part of the bog in Caradoc and Lobo townships the peat is fairly well humified, and is mainly formed by remains of sphagnum moss, intermixed with carex, and aquatic plants. The western part of the bog is mainly formed by hypnum, together with a large amount of carex and other plants. This part of the bog is very shallow, and has the appearance of having been burned over many times. The peat is covered by a 12″ layer of ash, which makes this part of the bog unsuitable for the manufacture of peat fuel. The area shown above is shallow, and by deducting the 605 acres with a depth of less than 5 feet, and allowing for the decrease in depth through drainage, it will be found that, the rest of the bog is of inconsiderable depth, and will hardly serve the purpose of manufacturing machine peat on any scale. If, however, the wood is removed, the above-mentioned part can be utilized for domestic purposes, by cutting the peat by hand; then we have left: 295 acres with an average depth of approximately 4 feet, and a total volume of 1,903,733 cubic yards of peat. Assuming that one cubic yard of such drained bog will furnish 200 pounds of dry peat substance to the tonnage of dry peat, then the substance available is 190,373 tons of 2,000 pounds, or, 237,966 tons peat fuel with 25 per cent moisture.

Large amounts of roots, stumps, burnt logs, and trees are intermingled with the peat. A great part of the bog is heavily wooded with spruce, tamarack, and cedar, and towards the margin, with poplar, pine, and other hardwood trees.

The east side of the bottom of the bog consists mostly of sand; the west part of reddish clay.

ANALYSES OF PEAT (ABSOLUTELY DRY).

Volatile matter	60·90
Fixed carbon	18·52
Ash	20·58
Nitrogen	1·63
Sulphur	1·34
Phosphorus	0·087
Calorific value, B.T.U. per pound	7·490

The content of ash is very high, and the calorific value about satisfactory.

If the bog were thoroughly and systematically drained, the land could be recovered, and could be utilized for agricultural purposes; at present it is practically valueless.

The Canadian Pacific railway (London-Windsor line) passes through the middle of the bog, and the Grand Trunk railway (London-Windsor) crosses the Canadian Pacific railway on the north side.

Brockville Peat Bog.

This bog is situated about three miles from Brockville, Ontario, in Elizabeth township, Leeds county (see accompanying map), and covers more or less of:—

Lots 4–5, Concession III, Elizabeth township.
" 3–10 " IV, "

The total area covered by this bog is, approximately, 1,400 acres. Of this area:—

356 acres have a depth of less than 5 feet; average depth, 2′–6″.
475 acres have a depth of from 5 feet to 10 feet; average depth, 7′–3″.
490 acres have a depth of from 10 to 15 feet; average depth, 12′–8″.
79 acres have a depth of more than 15 feet; average depth, 16 feet.

The volume of the peat contained is:—

In an area with a depth of less than—

5 feet	1,177,410	cubic yards.
5 to 10 feet	5,383,508	"
10 to 15 feet	10,001,293	"
More than 15 feet	2,039,253	"

The west part of the bog occupies a basin which was, some years ago, covered by a lake; but during 1903 a certain amount of draining was done by the Brantford Company, so that this part of the bog is practically a quagmire. The peat is, comparatively, poorly humified, hence can be expected to produce only a very light fuel.

In the northwest and centre of the bog, the peat seems to be more decomposed. With proper treatment, this part of the bog can be utilized for the manufacture of peat fuel.

In the eastern part of the bog, the peat is fairly well humified, and of a considerable depth; but it is heavily wooded with spruce and tamarack, and nearer to the margin intermixed with cedar and hardwood.

Deducting the 356 acres with a depth of less than 5 feet, and allowing for the decrease in depth through drainage, we have left:—

475 acres with an average depth of approximately 5 feet;
490 acres with an average depth of approximately 11 feet;
79 acres with an average depth of approximately 14 feet;

or a total volume of 12,705,969 cubic yards of peat. Calculating that one cubic yard of such drained bog will furnish 200 pounds of dry peat, the substance available is 1,220,599 tons of 2,000 pounds, or, 1,525,749 tons peat fuel, with 25 per cent moisture.

The formation of the eastern part of the bog consists, mainly, of carex plants, which to a certain extent—in some places—are intermixed with eriophorum. Around the margin the carex is compounded with aquatic plants.

In this part of the bog, which was formerly a lake, the bottom formation is, on account of the stagnant water, 1′-6″, and in some places up to 3 feet deep, formed of mire or mud, which is intermixed with diatomaceous, siliceous shells, insects, mollusk excrements, fish shells, mussels, and remains from the shores, and from the bottom flora.

The middle and the eastern part is principally formed of sphagnum, and is slightly mixed with eriophorum and other aquatic plants.

ANALYSES OF PEAT (ABSOLUTELY DRY).

Volatile matter	66·70
Fixed carbon	21·75
Ash	11·75
Nitrogen	2·41
Sulphur	0·90
Phosphorus	0·038
Calorific value, B.T.U. per pound	8·173

The content of ash is somewhat high, but calorific value about satisfactory.

Some years ago at this bog a peat briquetting plant was erected (see map) by a local company, in accordance with the Dickson system. In 1903, this property was transferred to the Peat Industries, Limited, Brantford, and the Sahlstrom system substituted. (For description of these briquetting systems, see Report on Peat and Lignite, by E. Nyström; also Bulletin No. 5, issued by the Ontario Bureau of Mines.) A few years later, the plant was closed down.

The middle part of the bog is traversed by the Canadian Pacific railway (Brockville-Ottawa line).

The bog is well situated in regard to transportation facilities and probable market: being only 2½ or 3 miles from Brockville.

Rondeau Peat Bog.

This bog is situated on the shores of Lake Erie, about six miles from Blenheim, Ontario, in Harwich township, Kent county (see accompanying map), and contains more or less of:—

Lots	1–2–E–F–G,	Concession	IV,	Harwich township.
"	D–C,	"	III,	"
"	B–A,	"	II,	"
Lot	C,	"	I,	"
Lots	14–15,	"	II,	"
"	16–20,	"	I,	"

The total area covered by this bog is, approximately, 1,571 acres. Of this area:—

959 acres have a depth of less than 5 feet; average depth, 2′–4″.

316 acres have a depth of from 5 to 10 feet; average depth, 7′–2″.

207 acres have a depth of from 10 to 15 feet; average depth, 11′–5″.

66 acres have a depth of 15 to 20 feet; average depth, 17′–5″.

23 acres have a depth of more than 20 feet; average depth, 21′–4″.

The volume of the peat contained is:—

In an area with a depth of less than—

5 feet..	3,873,350	cubic yards
5 to 10 feet..	3,653,661	"
10 to 15 feet..	3,812,339	"
15 to 20 feet..	1,854,519	"
More than 20 feet..	791,608	"

West of Pere Marquette railway the peat is principally formed of carex, and the remains of grasses and aquatic plants, and is of considerable depth.

The peat in the east part of the bog is composed of various plants, slightly mixed with sphagnum. This part of the bog is very shallow, with the exception of a few holes. At present, it is used for hunting grounds.

The peat located in the west part of Harwich township is fairly well humified. By a thorough and careful drainage, which will involve a large expenditure on account of low situation, and the fact that it is flooded most of the year—it would furnish a fairly good, but expensive fuel; compared with the price of soft coal, sold at the Rondeau harbour by the Pere Marquette Railway Company, about two miles from the bog. The price of soft coal is as follows:—

Run of mine coal..	$3 75 per ton.
Lump coal..	5 00 per ton.

The surface of the bog is absolutely free from trees, and the peat is practically free from logs, roots, and stumps.

Deducting the 959 acres with a depth of less than 5 feet, and allowing for the decrease in depth through the drainage, we have left:—

316 acres, with an average depth of approximately 5 feet.

207 acres, with an average depth of approximately 9 feet.

66 acres, with an average depth of approximately 15 feet.

23 acres, with an average depth of approximately 19 feet.

With a total volume of 7,856,581 cubic yards of peat.

Allowing that one cubic yard of such drained bog will furnish 200 pounds of dry peat substance, the total tonnage of dry substance available is 785,658 tons of 2,000 pounds, or, 982,072 tons of peat fuel, with 25 per cent moisture.

ANALYSES OF PEAT (ABSOLUTELY DRY).

Volatile matter	61·00
Fixed carbon	22·90
Ash	16·10
Nitrogen	2·77
Sulphur	0·73
Phosphorus	0·049
Calorific value, B.T.U. per pound	7914

The content of ash is high, the calorific value about satisfactory.

A peat plant was erected at this bog (see map) by the Western Peat Fuel Company, Limited, of Chatham. The process of manufacturing peat fuel was the same as that used at Welland. The results obtained must have been unsatisfactory, since the plant has been closed for several years. (For descriptions of the machinery and methods used, see Bulletin No. 5, published by the Ontario Bureau of Mines; and the Report on Peat and Lignite, by E. Nyström.)

Government Peat Bog at Alfred, Ontario.

(*a*) DELIMITATION.

This part of the bog is situated two miles from Alfred station, and about one mile from Alfred village, in Alfred township, Prescott county (see accompanying map), and covers more or less of lots 8-9, concession VII.

The total area which is owned by the Dominion Government is, approximately, 300 acres. Of this area:—

2 acres have a depth of less than 5 feet, with an average depth of 2′–8″.
135 acres have a depth of 5 to 10 feet; average depth, 9 feet.
160 acres have a depth of more than 10 feet; average depth, 10′–8″.

The volume of the peat contained in the area is, with a depth of less than—

5 feet	7,407	cubic yards.
5 to 10 feet	1,950,667	"
More than 10 feet	2,674,395	"

The peat is principally formed by sphagnum, and slightly mixed with eriophorum and hypnum. The bottom layer is mostly compounded of carex, grasses, and aquatic plants.

The peat is well humified, and uniform in quality, and with proper arrangement will produce a comparatively good and heavy peat fuel.

This part of the bog is intermixed with small roots, and occasionally logs and stumps occur, which to a certain extent render the digging of the peat more difficult.

Part of the surface is covered with young spruce and tamarack, which can be removed easily, and the surface leveled.

Deducting the 2 acres with a depth of less than 5 feet, and allowing for the decrease in depth through drainage, we have left: 135 acres, with an average depth of approximately 7 feet; 160 acres, with an average depth of approximately 9 feet, with a total volume of 3,774,496 cubic yards of peat fuel. Supposing that one cubic yard of such drained bog will furnish 200 pounds of dry peat substance, the total tonnage of dry peat substance available is 327,450 tons of 2,000 pounds, or, 409,312 tons of peat fuel, with 25 per cent moisture.

ANALYSES OF PEAT (ABSOLUTELY DRY).

Volatile matter	68·23
Fixed carbon	26·00
Ash	5·77
Nitrogen	1·76
Sulphur	0·218
Phosphorus	0·033
Calorific value, B.T.U	9005

The content of ash is low, and the calorific value satisfactory.

This property is traversed by the Canadian Pacific railway (Ottawa-Montreal line).

(*b*) DEVELOPMENT.

As soon as the investigation of the bog was finished, digging of the ditches was commenced.

Drainage of the Bog.

	Cubic yards.
(1) Main ditch, 3,125 feet long, by 6 feet wide at top, and 2 feet at bottom, by 9 feet deep	4,166
(2) Ditch, parallel to the main, 2,800 feet long, by 4 feet wide at top, and 2 feet at bottom, by 4 feet deep	1,615
(3) Covered in ditches, 6,000 feet long, by 2 feet wide at top, and 1′–5″ at bottom, by 3 feet deep	1,111
(4) Open ditches, 3,000 feet long, by 2 feet wide at top, and 1′–4″ at bottom, by 3 feet deep	555
(5) Water course ditches, 4,000 feet long, by 3 feet wide at top, and 1′–6″ at bottom, by 4 feet deep	1,333
(6) Enlarging ditches, 5,000 feet long, by 2 feet wide at top, and 1 foot at bottom, by 2 feet deep	555
Total amount of excavation for drainage done by 10 men from July 16, to September 7	9,335

The main ditch is situated on the east side of the bog (see map No. 76), and runs in a northerly direction from the road to the railway. This ditch receives the water from the drained part of the field. The profile of main ditch can be seen on map No. 77.

The ditch known as the 'Parallel ditch' is situated at a distance of 1,000 feet from the main, and runs parallel with the same. On the north side of the bog, and at right angles to the above-mentioned drains, another ditch has been dug; which receives the water from the drained part of the field, and empties it into one of the concession ditches.

Between the main ditch and the parallel, ditches are dug at an interval of 160 feet. Some of these are covered in, the others are open.

While the ditches were being dug, the following peat plant buildings were constructed and erected, by Daoust and Belanger, of Alfred, Ontario, in accordance with my plans and specifications:—

Buildings.

(1) Peat shed, for storage of dried peat (see Fig. 3)—160 feet long, by 22 feet wide, by 18 feet high. This building is erected alongside the ditch known as the Parallel ditch. A track runs through the building up to the railway, parallel with the ditch. This track is connected by a curve with a portable track in the fields. Both these tracks are intended for the transportation of the dried peat from the drying field to the peat shed.

(2) Tool and blacksmith shops—22 feet long, by 13 feet wide, by 7 feet high. This building is situated about 100 feet from the peat shed, alongside the Parallel ditch.

(3) Office—16 feet, by 16 feet, by 8 feet high.

(4) Movable housing for peat machine—22 feet long, by 8 feet wide, by 10 feet high.

Leveling.

One-third of the field—about 25 acres—has been leveled and cleared from trees, roots, and stumps. The remaining part of this field work will be done next summer.

Machinery Equipment.

The peat machine, with conveyer and platform, which was imported from Sweden in 1908, and was used for manufacturing peat fuel at Victoria Road (see Bulletin No. 1), was moved during the summer to Alfred, where it was installed along with other machinery imported recently from Sweden and Germany, making a complete modern plant for the manufacturing of air-dried peat.

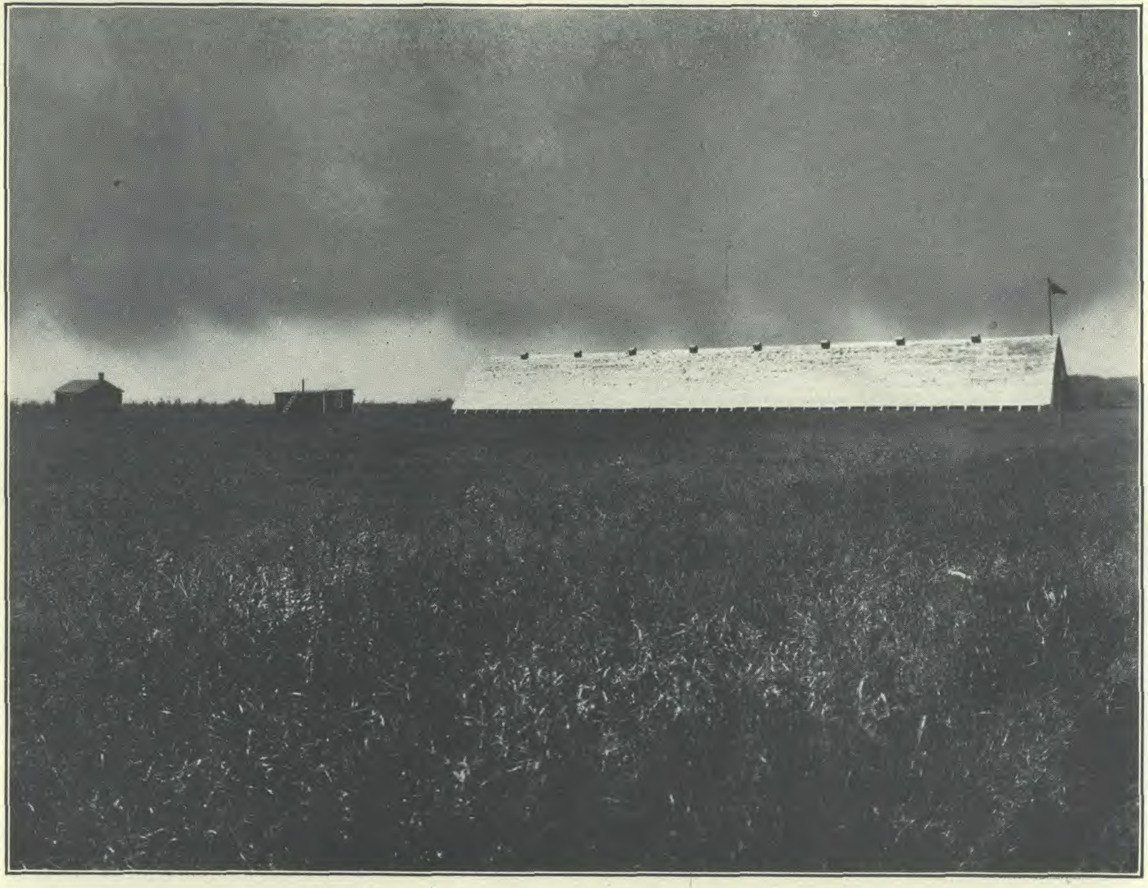
This peat machine, with cable transportation, round track, and Jakobson's field press, is installed on the north side of the bog (see Fig. 2), and will, during the summer of 1910, be in operation along the main ditch. (See Plate I.) The 35 horse-power engine is provided with a specially constructed grate and ash pan.

The productive capacity of the machine varies from 25 to 30 tons per day, employing a working staff of thirteen men and two boys. By using machinery of a large capacity the cost of manufacturing peat can, undoubtedly, be reduced.

The peat machine and steam engine are placed on the same platform; which is movable on rails.

The end elevator is dragged after the peat machine, and is fastened by bolts to the hopper frame.

7326—p. 16.

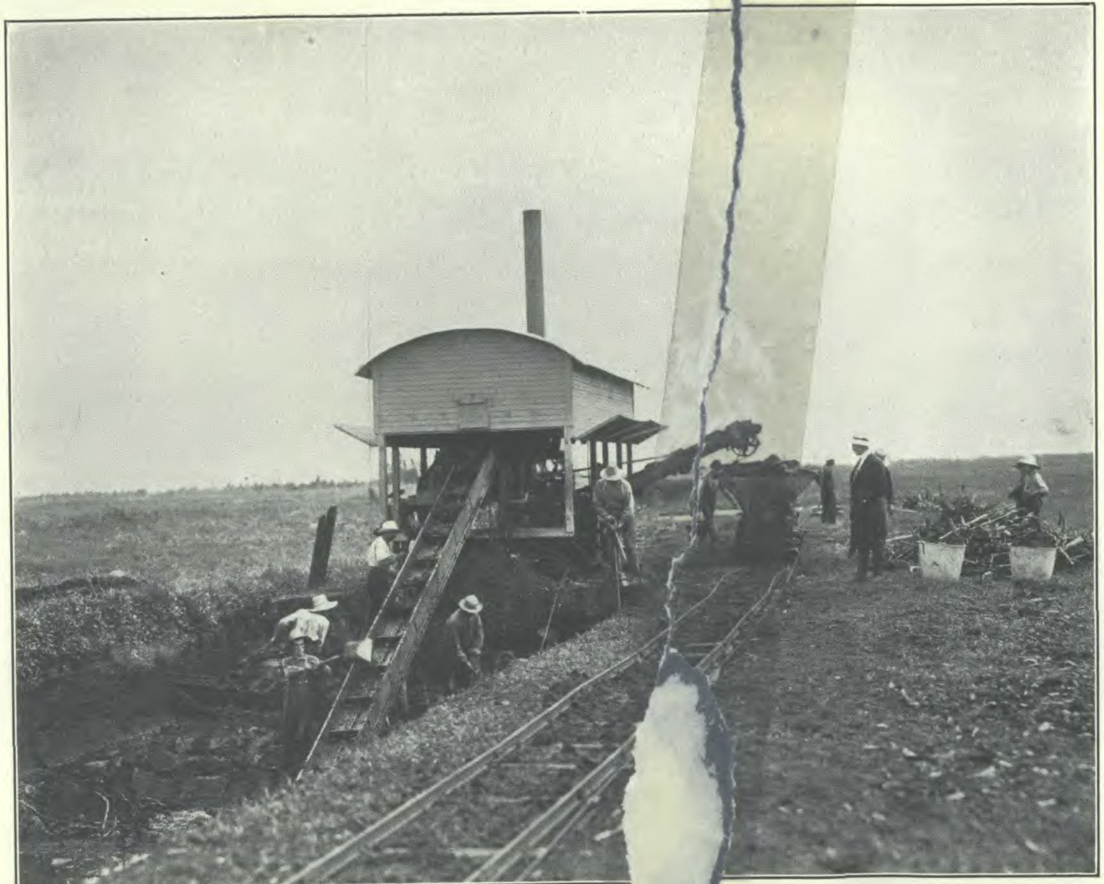


General view of Peat Storage Shed, Workshop, and Office.

p. 16

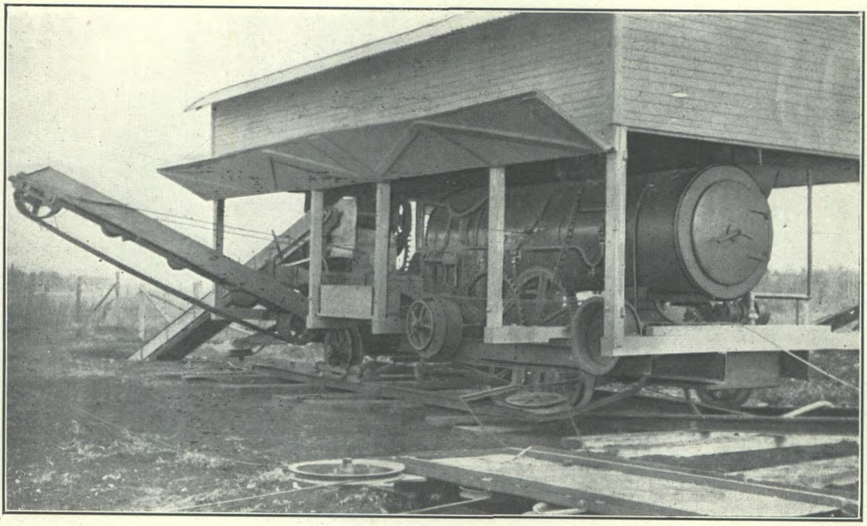
Peat Machine : side elevation showing Belt Conveyer and Dumping Car.

p. 16



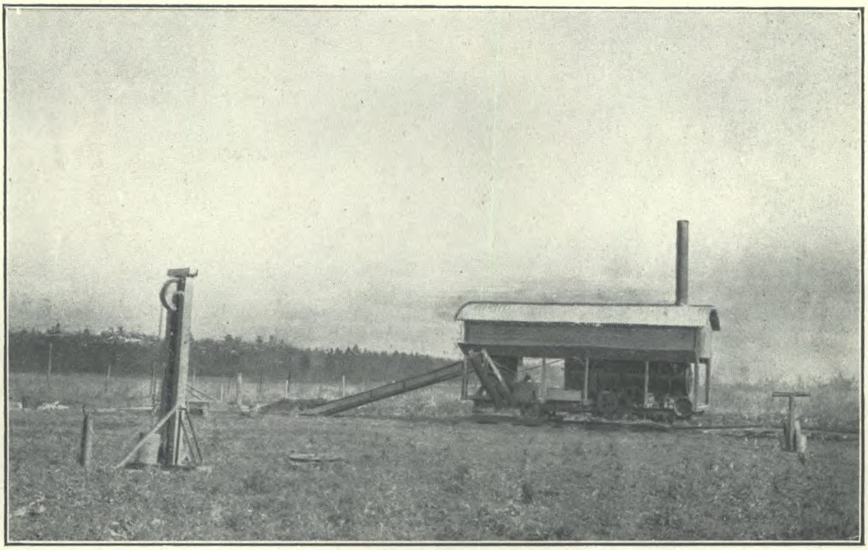
30 ton "Anrep" Peat Machine: end elevation, showing El[illegible] Trenching Operations, and Track.

PLATE V.



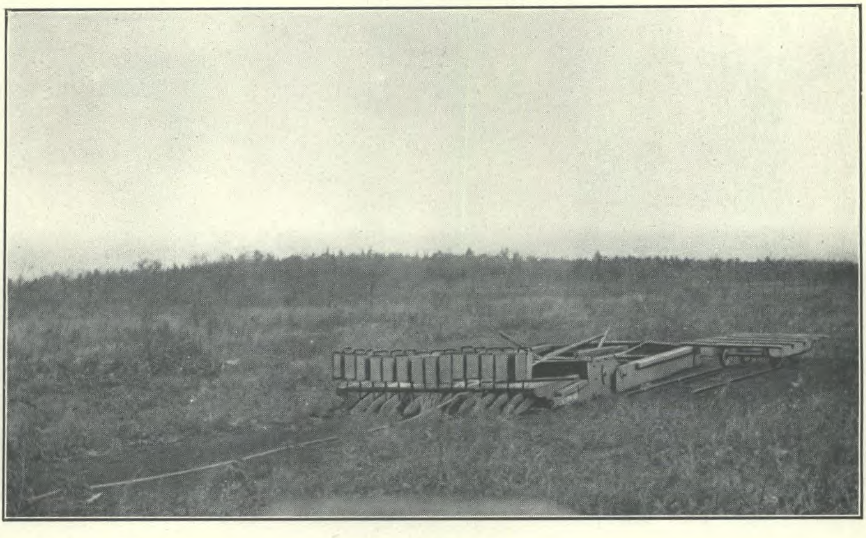
Mechanical Transportation Device : Station Car.

PLATE VI.



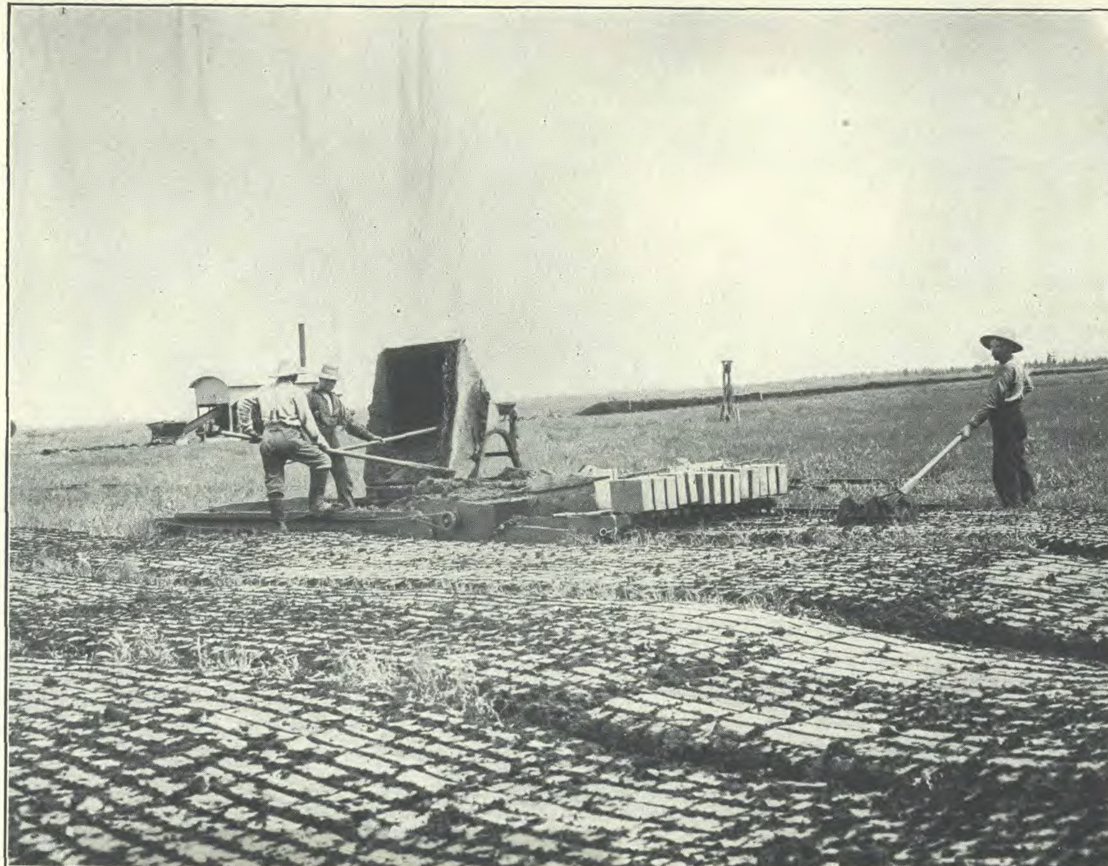
Mechanical Transportation Device : Guide Frame.

PLATE VII.



7326—p. 16b. Jakobson's Field Press.

7326—p. 18.



Perspective view of Drying Field: showing method of air-drying the Peat Briquettes.

For a larger plant, where a number of peat machines are in operation, it is cheaper to use electric power; since in this case, the employment of skilled engineers is unnecessary.

The platform is moved forward by engine power. (For further description of peat machine, see Report on Peat and Lignite, by E. Nyström.)

Anrep's Round Track, with Mechanical Transportation.

The dumping cars for transportation of the peat to the drying field, are transported by means of an endless cable, driven by the same engine as the peat machine.

The platform of the peat machine and engine is provided with two rope pulleys, one of which is driven by a chain and cogwheel, and connected or disconnected by means of a friction coupling.

The cable—0·36 inch in diameter—runs over two rope drive pulleys, and over two guide pulleys located on the truck, to the peat machine. From thence (see Plates VI and VII) it runs to a so-called station car, provided with one smaller and three larger guide pulleys. One part of the cable runs from the station car to a horizontal block, which is kept in place by a chain running over two vertical pulleys fixed in a frame, and kept tight by a weight. (See Plate VI.) The frame is kept in place by means of a square, pointed pole. The cable runs from the block, back to the station car, over a large pulley, and around the track: which is provided at each curve with four rollers.

The dumping cars are provided with a coupling apparatus constructed of wood, and operated with a lever.

Double tracks are used on the side where the peat is unloaded; so that when the whole width of the drying field is covered, only the curves need to be moved, and general operations can continue with a minimum of interruption. The stretching apparatus must also be moved simultaneously in order to keep the cable tight.

When the lengths of two sides of the track in the direction in which the peat machine is moved become too short, the whole track has to be moved forward.

Anrep's Mechanical Transportation System, Combined with Jakobson's Field Press.

The peat machine is provided with a belt conveyer, which conveys the peat from the machine to the dumping cars.

One man couples the cars—when loaded—to the cable; while on the drying field another man uncouples the cars, and dumps the peat into the field press.

The field press (see Plate VIII) consists of three parts; (1) front part, which receives the peat mass; (2) middle part, for leveling the mass to a layer of uniform thickness; and (3) rear part, for cutting this peat layer into parallel rows. When the press is hauled forward the peat layer is cut through by means of wooden knives, placed behind, and pressed down by weights; the mass is then divided into fifteen continuous rows. The peat rows laid out by the press are cut in suitable lengths by a special tool. The press is moved only in one direction, namely, towards the working trench.

The cable used for hauling the press is fastened in a ring connected with the front side of the press by two chains of equal lengths. From there it runs over a pulley held in place by two anchors, and also over two pulleys placed to the frame of the platform and fastened to a winch at the engine. When the end of the line is reached, the press is loaded on a low truck and brought back to the beginning of the next line. (See Report on Peat and Lignite, by E. Nyström, pages 92-96.)

Five cars are built for transportation of dried peat from the drying field to the shed.

Dorchester Peat Plant.

This briquetting plant near Dorchester, Ontario, is owned by Messrs. Milne and McWilliam. Last summer (1909) some reconstructive changes to this plant were made, and it is expected that peat briquettes will be manufactured during the ensuing season.

Farnham Peat Plant.

Several years ago a peat plant was erected near Farnham, Quebec, by the United States Peat Fuel Company. In 1909, this plant was transferred to the Canada Fertilizer Company, Limited, with head office in Chicago. This Company purposes manufacturing peat fuel during the summer of 1910.

APPENDIX I.

Manufacture of Peat Powder in Sweden.

An extensive peat plant has been erected at the Bäck peat bog, near Ljungley, Sweden, for the manufacture of peat powder, for heating purposes,[1] in accordance with the process of Mr. H. Ekelund. One drying oven designed in accordance with Mr. Ekelund's patent—having a capacity of 30 tons of peat powder per day—is at present in operation, and another of like capacity is being erected.

The inventor states that the cost of manufacture, including all expenditure, will not exceed $2.10 per ton; and that the cost of a complete plant with a yearly capacity of 20,000 tons of peat powder will be, approximately, $100,000 (not including bog, and transportation of the ready made peat to the station).

APPENDIX II.

Mr. A. Anrep, Sr., of Helsingborg, Sweden, has received a bounty of 16,000 kronor from the Swedish Government, for installing his new Peat Machine: which is combined with a mechanical excavator, field press, and stump pulling apparatus. The machine is expected to have a capacity of 80 to 100 tons per day. This plant will be tested by a commission appointed by the Swedish Government.

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[1] One pound of peat powder, with 17 per cent of moisture, evaporated 5·27 pounds of water in the same boiler where one pound of Newcastle coal evaporated 5·67 pounds.

With peat powder, 3·5 pounds of steam per square foot of heating surface were obtained; whereas with coal—under like conditions—only 2·41 pounds. (Report by Larson and Wallgren, Stockholm, p. 338).

APPENDIX III.

On the Dr. M. Ekenberg Wet-Carbonizing Process, by Mr. Alf. Larson, in Teknisk Tidskrift, No. 12, December 26, 1908.

Translated by A. Anrep, Jr.

During the last few years, peat, and its manufacture, has been the subject of much discussion. In view of its economic importance, it is very desirable that efforts be made to invent a more satisfactory method than air-drying for the preparation of peat for the market.

On account of climatic conditions, it is necessary, in order to ensure a constant supply of peat, that manufacturers keep a reserve stock for a year ahead.

Air-drying does not always furnish a uniform product, as during the early part of summer—which is usually fair—air-dried peat contains from 12 per cent to 20 per cent of moisture, while later in the summer from 25 per cent to 40 per cent, and that which is manufactured towards the end of the season is occasionally not quite dry the same year.

For the same calorific value, the air-dried peat is more bulky than coal. For example: 3 to 5 hectolitres (10·5 to 17·5 cubic feet) of peat correspond to 1 hectolitre (3·5 cubic feet) of anthracite in calorific value.

Many attempts have been made to devise a process to replace air-drying, but the results, so far, have not proved economical. The simplest artificial drying process, which at the same time produces a suitable product, utilizes heat and a strong draft of air: thus imitating the process of nature in air-drying; but this method is too expensive. For example, let it be supposed that a dryer could be constructed to utilize 80 per cent of the calorific value of the fuel consumed by it, and that its product was absolutely dry peat having a calorific value of 5,400 calories. The best drained and highest humified peat, on an average, contains 85 per cent of moisture, usually somewhat more. In order to evaporate the 85 kilograms of water from 100 kilograms of peat pulp, it would require the consumption of $\frac{85 \times 640}{0 \cdot 8 \times 5{,}400} = 12 \cdot 4$ kilograms of dry peat. It would produce only 15 kilograms of dry peat. Taking from this the 12·4 kilograms consumed by the operation, only 2·6 kilograms remain. Such a process would, of course, be impracticable. By similar calculation, peat pulp containing 87·5 per cent of moisture, from a fairly well humified and properly drained bog, would require the consumption of about 13 kilograms to produce 12·5 kilograms of dry peat. Consequently, this is still more impossible than the former case. Even taking into consideration, that during certain seasons of the year the heat from the air, which is blown through the dryer, aids in the evaporation of the water, this cannot be considered as a solution of the problem.

Two plants based on this method were erected in Germany, but after a short time they had to be closed down.

With the best vacuum apparatus which we now have we should be able to vaporize about 25 kilograms of water for every kilogram of dry peat, having a calorific value of 5,400 calories, consumed by it. If such an apparatus could be constructed, which is not inconceivable, for the drying of peat, then from the 12·5 kilograms of peat substance, contained in the peat pulp in question, we obtain $12{\cdot}5 - \frac{87{\cdot}5}{25} = 9$ kilograms of dry peat, that is 72 per cent, which is satisfactory. So far, no such apparatus has been invented, and I fear that the construction of such a machine would be too expensive, compared with its working capacity.

It has been attempted to remove mechanically, by means of filters, presses and centrifugal pumps, the water from the peat pulp to such an extent that, the residual water could be economically driven off by artificial heat. It has occasionally been found that the water in certain peat pulp could be reduced to 65 per cent, or possibly less; but in the majority of cases the water in the peat pulp could hardly be decreased down to 70 per cent, and this could only be done with great difficulty.

The machinery necessary for this would be too expensive as compared with its working capacity. Even with an efficient press, producing peat containing 70 per cent of moisture, the fuel consumption for artificial drying would be too large; for instance, 100 kilograms peat with 70 per cent moisture require, as in previous calculations, $\frac{70 \times 640}{0{\cdot}8 \times 5{,}400} = 11$ kilograms of dry peat for heating the drier. This does not make allowance for the working expenses or depreciation, nor for the fuel consumption for the mechanical power.

Of the 30 kilograms of peat substance contained in the peat pulp, at least half would be consumed in the operation. The centrifugal method, for ordinary peat, is less effective than pressing.

If peat containing 70 per cent of moisture could be dried in a vacuum apparatus, we should have a net output of $30 - \frac{87{\cdot}5}{25} = 26{\cdot}5$ kilograms, or 88 per cent of the fuel contents of the original peat. This would be a satisfactory result; but, on the other hand, it is very difficult to bring the water content down to 70 per cent, and, as before mentioned, no such vacuum apparatus has yet been invented.

The reason why it is so difficult to remove the water from peat pulp is on account of its gelatinous consistency. In this way it is similar to gelatinous silica and alumina. When pulped peat is treated in a filter press, a thin layer of gelatinous peat gathers on the surface of the canvas, preventing the water from passing through. It is a common explanation, that the difficulty of pressing water from peat depends on a property of the peat cells, and it is thought that the cells must be broken down before the water can be pressed from the peat. The case is, however, that the peat pulp does not consist of cells, for these are destroyed by humification, but of substance in a gelatinous condition.

Various treatments to facilitate the pressing of the peat pulp have been tried. One of these treatments is known as the osmotic method. Experience has shown that, if the peat pulp be submitted to mechanical pressure, and simultaneously an electric current is passed through it parallel to the direction of the pressure, the water tends to go to the cathode. Two large plants, based on this method, can be found in eastern Prussia, one at Schwenzelmoor, near Prökuls, and the other at Tilsit, both belonging to 'Ostpreussische Pentanwerke.' The methods are described by me in the Swedish Peat Society Journal (*Svenska Mosskulturforeningens Tidskrift*), 1903, No. 2, page 157, and 1905, No. 1, page 44. By more or less pressure and by means of the electric current, the water is reduced in the peat pulp to 80 per cent and 65 per cent at these two plants.

In the first case the peat, after being briquetted, is dried in Möller and Pfeiffer's drying ovens to 70 per cent moisture, and after that, air-dried. The manufacture of peat fuel even by this method is dependent on air-drying.

In the second case, the pressed peat pulp is dried in an oven direct to air-dryness.

Both methods are expensive. It is true, peat fuel is produced with about 30 per cent greater specific gravity than usual machine-formed peat, but with the same calorific value per kilogram as the air-dried. Hardly anything can be gained by these expensive methods.

If the peat pulp be treated, under pressure, to a temperature of 150° centigrade, or preferably higher, then the peat undergoes a two-fold change:—

(1) The peat loses its gelatinous property and becomes amorphous; thus the same physical difference exists in the peat pulp before and after the heating under pressure as between gelatinous and amorphous silica or alumina. Following such treatment, the water in the peat can be more easily pressed from it, and to a greater extent.

(2) A coking, which I call 'wet-carbonizing,' takes place during this process, the completeness of which depends, as in dry coking (dry distillation), on the temperature used.

Oxygen and hydrogen are separated during this process from the peat, in the form of water, and as a result the carbon content of the coke is increased, and at the same time, of course, a decrease of the peat substance takes place. During this process, no gases are evolved, as in the case of dry coking, when large amounts of gases (containing carbon in some form) are developed, decreasing the output of coke. The product obtained can be easily pressed into solid briquettes, without the addition of any binding material. These briquettes do not absorb moisture, and are very similar in appearance and weight to coal, provided that the coking and briquetting are performed at a sufficiently high temperature.

The peat substance obtained from wet-carbonized peat pulp at about 200° centigrade, briquetted at the same temperature, gives a product which in appearance, calorific value, weight, structure, and other qualities is similar to a coal rich in gases. It is a question, therefore, whether coal and lignite are not formed in the same manner. It is probable that the aquatic plants, from which coal and lignite are formed, have been exposed to a high natural pressure, and at the same time to a temperature of a few hundred degrees.

The wet-carbonizing can be performed, not only with decomposed peat, but also with other materials, such as peat litter, wood substance, straw, etc., or with any cellulose compounds. This process should be more scientifically studied than I have had the opportunity of doing.

The coking can be performed without any development of gases, which can be seen from the following analyses (table I) made at the Tekniska Högskolans (Technical High School) laboratory.

The analyses and calorific values were determined both before and after wet-carbonizing at 170° centigrade, with a pressure of eight atmospheres.

TABLE 1.

Composition of peat substance in:	Raw peat. A.	Wet-carbonized peat. A.	Raw peat. B.	Wet-carbonized peat. B.
Carbon	56·00	60·20	55·50	58·50
Hydrogen	5·90	6·00	5·70	5·90
Nitrogen	1·33	1·38	1·19	1·20
Sulphur	0·59	0·40	0·31	0·43
Oxygen	32·68	28·32	34·10	30·27
Ash	3·50	3·70	3·20	3·70
Calorific value of dried sample: calories per kg	5640	6240	5610	5990

The analyses show that a better coking has taken place in A than in B, for the reason that the former was more humified than the latter.

The experiments clearly show that at the same temperature and pressure the coking is more perfectly performed, the more the peat is humified, and that the pressing out of the water is more easily and more completely performed. The yield of peat substance, from the coking, is about 80 per cent.

Table 2 gives the calorific values and the yield of different peats after treatment at various temperatures and pressures.

TABLE 2.

Peat.	Pressure in atmospheres.	Temperature, degrees centigrade.	Ash after wet-carbonizing. %	Calories per kg. after wet-carbonizing.	Yield. %
Wet humified peat from Majenjänka	8	170	3·92	6230	76·5
" " Stafsjö	8	170	3·10	5880	72·0
" " "	25	225	4·72	6480	70·5
" " "	50	320	4·41	6800	68·3
" " "	75	375	6·03	6870	54·9
Sphagnum moss	8	170	4·30	4710	68·5

This table shows that with a higher temperature, and corresponding pressure, more water is removed from the peat, and the fuel value increases. To a certain extent, it is similar to what takes place in dry distillation. Practically no gases are formed during the wet-carbonizing, even at the pressure of 75 atmospheres.

The experiments have shown that from the same peat, treated at ascending temperatures and with corresponding pressures, a lower yield is obtained as the temperature increases, but with higher calorific value and higher ash.

The following table shows the percentage of the water removed from the raw material for varying degrees of dryness, supposing, for the sake of simplicity, that the raw peat contains 90 per cent moisture, which frequently occurs in drained peat bogs:—

TABLE 3.

Peat. %	Moisture. %	Amount of moisture removed from the peat. %
10	90	0
15	85	37
20	80	56
25	75	67
30	70	74
35	65	79
40	60	83
45	55	87
50	50	89
60	40	93
70	30	96
75	25	97
80	20	98

In a laboratory screw press, well humified peat, wet-carbonized at 180°, has been pressed so that the pressed cake contained only 30 per cent moisture.

If the raw peat contained 87·5 per cent moisture, and the yield obtained is 80 per cent, which is generally the rule in such cases, then the wet-carbonized peat contains 10 per cent of dry substance.

When a pressed cake contains 30 per cent moisture, that is 10 kg. dry substance and 4·3 kg. of water, then 85·7 kg. of water have been removed, or 98 per cent; but if, after pressing the wet-carbonized peat, the pressed cake contains 50 per cent of moisture, then 80 kg. of water have been removed, or about 92 per cent of the original water.

Several experiments have been performed by pressing the wet-carbonized peat, in order to find out the relation between pressure and the residue of moisture in the pressed cake.

These experiments show different results for each peat sample. On account of this variation in the quality of peat, no general table can be made, except for each individual class of peat.

In the meantime, a result has been obtained showing that a pressure exceeding 150 kg. per cm.^{2} gives little additional benefit compared with the difficulties of producing such a pressure. With a fairly well humified peat, wet-carbonized at 155°, and subjected to pressure of about 150 kg. per cm.^{2}, the pressed cake had a water content below 50 per cent. On the other hand, by means of a higher temperature during wet-carbonizing, a more easily pressed produce can be obtained, as the following experiments show.

The peat used for this purpose was of the same quality as A in table 1. The carbonizing was performed at 185° centigrade.

TABLE 4.

Pressure in kg. per cm².	Pressure in pounds per in². (approx.)	Content of water in the pressed cake. %
18	256	71
19	270	70
25	355	63
40	568	57
60	853	53
86	1223	46

In further experiments, using a more humified peat, wet-carbonized at a temperature of 185°, a pressure of 10 kg. per cm³. gave a cake containing only 62 per cent of moisture; while with a pressure of 50 kg. per cm.², the moisture was reduced to 43 per cent in the pressed cake.

When the critical temperature is reached, wet-carbonizing takes place immediately. During the different experiments, the peat pulp was subjected to the highest temperature for not more than 10 minutes, often less, and with experiments on a large scale the highest temperature was not maintained for more than 8 minutes.

In a filter press, where it is difficult to obtain a pressure of more than 10 atmospheres, the minimum content of water in the pressed peat was found to be 62 per cent. In continuous operations, on a large scale, and using the filter press, the percentage would be about 70; that is, of the original water content of the peat pulp—taking it at 87·5 per cent—65 per cent would be removed, and after the pressing we have to deal with only 42 per cent of the original weight of material.

It may be possible, as experiments tend to show, that on a large scale, with some other apparatus than a filter press, the content of moisture in the pressed peat could be reduced to 50 per cent. Dr. M. Ekenberg, and Mr. N. Alexandersson, claim that this problem is solved.

As already mentioned, the wet-carbonized peat substance can easily be pressed into very good briquettes. It is not necessary to add any binding material, because such is to be found in the peat. By the use of some solvent, such as benzine or carbon tetrachloride, from 3 per cent to 4 per cent of waxy substance has been extracted from raw peat. On analysis, this appeared to contain about 30 per cent of resin and 70 per cent of paraffin. This is the binding material for the briquetting. The water extracted from the wet-carbonized peat was found to contain about 1 per cent of this substance.

As the importance of peat for fuel purposes has not been generally realized, very little interest has been manifested from a scientific standpoint, except in its botanical and geological aspects. The scientists evidently did not find it important enough to study these large natural resources. It should, however, be scientifically examined, both chemically and physically. If this had already been performed, many mistakes could have been avoided and much money saved. I am sufficiently sanguine to believe that the peat problem would, by this time, be solved; but nowhere in the world have such investigations been made. Would it not be a good motive for scientists to devote themselves to this study, and also to study the dry coking of peat?

If this were done, many misunderstandings and prejudices against peat as fuel (when coked or not) would disappear. Hitherto, the peat question has been, for the most part, treated in a dilettante way, and has very seldom been an object of study for scientific experts, except in elementary analyses, or the determination of the calories.

After many experiments, it was proved that it was possible to extract the water from the wet-carbonized peat. Endeavours were made to utilize this knowledge for manufacturing peat on a large scale. Large amounts of money and much labour have already been expended on this process.

The character of the peat as it occurs in the drained bog varies greatly. Different parts of the bog have different grades of peat, and generally a vertical section of the bog shows several different layers with different humification and different percentages of ash and calorific value. These layers are also intermixed more or less with fibres, roots, stumps, and trunks of trees.

Bogs which are absolutely free from roots and stumps occur very seldom. In most cases, the peat is not of a homogeneous character, and in order to obtain an even product the structure of the raw material must be rendered uniform or homogeneous throughout, i.e., the different peat layers have to be intermixed, and the remains of wood and small roots, which cannot be separated during the work, must also be finely divided and homogeneously intermixed in the mass.

In the ordinary manufacturing the peat is dug out of the bog so that all the layers are taken up at the same time and pulped by peat machines.

Such a treatment was not sufficient for the wet-carbonizing process, and in order to obtain a more homogeneous mass special pulping machinery was constructed, and was erected on Stafsjö peat bog, where it was tried on a large scale. This is an Anrep machine, with a lengthened and enlarged mouth-piece having a steel plate placed at the end. The steel plate is provided with a number of holes from 8 to 19 millimetres in diameter. In front of the plate two rotating knives are placed, which keep the holes clean and cut any fibrous material not previously pulped.

This machine easily delivered 350 cubic metres (457·5 cubic yards) of homogeneous peat pulp per eight hours. The required power was furnished by a 60 horse-power electric motor.

The pulped peat was transported to the plant in dump cars and delivered to an elevator which conveyed it to a large tank, of sufficient capacity to supply the plant for six days, in order to be independent of any repairs or a few days' rain.

To work economically on a large scale, the next problem in the process was to convey the peat continuously in and out of the apparatus in which it is heated under pressure. For delivering the peat pulp continuously to the wet-carbonizing apparatus, a special pulp pump was used. This pumps the peat under high pressure. The pump is constructed by H. Eberhardt, in Wolfenbuttel, Germany, and was set up at Stafsjö. It proved to be very satisfactory. At a pressure of

30 atmospheres a capacity of 350 cubic metres (457·6 cubic yards) per 24 hours was obtained. After a few minor alterations, this pump worked to satisfaction, even with peat pulp containing 12 to 15 per cent peat substance, and it was found that the valves worked even better with thick peat than with thin. The peat pulp was brought to the pump from the tank by means of a specially constructed elevator.

The wet-carbonizing apparatus is constructed in the form of an oven, with many pipes, and is similar to a tubular boiler. It consists of double pipes; the inner one, which is spiraled with a worm, is free to rotate within the outer one. This revolving forces the peat forward in the pipe at the same time as the pump supplies it.

Fig. 6 illustrates the principle of this apparatus.

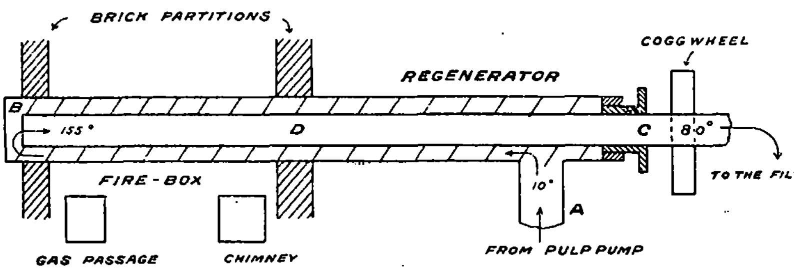

FIG. 6.—Theoretical working of a Wet-Carbonizing Oven.

The peat pulp is forced in at pipe A and, by means of the worm on pipe D and the pressure from the pump, is moved forward towards B, where it turns and passes through the inner pipe D towards the outlet C, which is controlled by a regulator, so that an even pressure is always maintained.

The peat is forced in at the outer pipes, which are 52 in number, moves forward through the firebox to a joint chamber connected to all the pipes, thence through the inner pipes to a common outlet. The peat, in making this cycle, is gradually heated, first, by the heat from the outgoing mass, and later from the fire in the firebox, where it attains its highest temperature; then, in passing out through the inner tube, it gives off a great part of its heat to the incoming pulp. The peat, let us suppose, during its passage has a maximum temperature of 185° centigrade; in passing through the inner pipe D towards the outlet C, it is cooled down by the incoming peat to a temperature less than 100° centigrade.

A temperature of 185° centigrade corresponds to a pressure of about 11 atmospheres, but in order to ensure that no steam be formed, a pressure of 15 atmospheres is kept up by the pump. When no steam is formed, the mass forced in has the same heat capacity as the mass passing out, and theoretically should be able to absorb all the heat contained in the outgoing mass. The incoming and outgoing masses would have the same temperature, if it were practical to make the pipes sufficiently long. The pipes used in Stafsjö are 11 metres[1] long, and a maximum temperature of 155° centigrade was maintained.

When the ingoing peat mass was 10° centigrade, passing through an 11

[1] One metre=3,281.

metre oven and heated to a temperature of 155° centigrade, the outgoing peat mass had a temperature of 70° to 80° centigrade.

For good wet-carbonizing, the temperature in the oven has to be from 180° to 185° centigrade. To obtain an outgoing temperature of 50°, the oven has to be about 15 metres long.

The experiments at Stafsjö have shown that the temperature of the outgoing peat falls 12° to 13° centigrade per metre, as it passes through the regenerator of the oven. At this plant it was found that 50 to 70 calories per kilogram of peat were lost through the heat of the outgoing mass. As the peat pulp contained 600 calories per kilogram, this represents a loss of peat substance of about 10 per cent.

The heat balance sheet in the wet-carbonizing oven with 52 pipes, at Stafsjö, was as follows:—

Loss by radiation, etc.	7	per cent.
Loss by waste gases	23	"
Power of fuel utilized	70	"

In a longer oven the calorific value of the fuel is more fully utilized.

It is a question whether the worm on the inner pipe could be dispensed with, thereby allowing the pulp pump alone to drive the peat mass through the pipes. We find this can only be accomplished up to a temperature of 150° centigrade, at which temperature the wet-carbonizing process begins. As soon as this takes place, the mass is easily pressed. The friction of the pipe retards the peat, the water separates to the middle of the pipe, leaving a hard layer of peat on the walls of the pipe, which in a few hours blocks all flow of peat. It was attempted to check this trouble by means of a worm having a pitch of about 2·5 metres, but the result was found to be the same, despite the fact that the mass was kept in motion by means of the worm. Experience has shown that the pitch of the screw should not exceed 150 or 200 millimetres. Even with a low pitch it did not prove satisfactory, and occasionally the peat mass was plugged at the turn round the corner B, and at the outlet C. To prevent this, special arrangements were made, which worked satisfactorily. Half a year was given to these special details, with an expenditure of 10,000 kronor[1] Other data have been obtained during the experiments; but it would be too involved to give a detailed account of all these. They are in regard to diameter of the pipes, the mechanical arrangements for rotating the inner pipe, and the arrangement of the outfit, etc.

In pressing the wet-carbonized peat mass in a filter press on a small scale, the content of water in the cake was 62 per cent. In continuous operations, on a large scale, with a filter press, I dare not count on a content of moisture below 70 per cent. This is too high to allow the pulp to be dried in the same way as lignite is in the plants manufacturing lignite briquettes; though more fuel can be afforded in the case of wet-carbonized peat than for lignite, since weight for weight of dry substance, the ratio of the respective fuel values is 62·58. The

[1] One krona=100 öre=27 cents.

highest content of moisture in lignite is 62 per cent, and it is dried to only 15 per cent moisture. In many districts the lignites contain only 45 per cent, or 50 per cent of moisture.

Means must be devised to lower the water content of the wet-carbonized peat to 50 per cent by pressure. Experiments have been made on a large scale, and at great expense; but no satisfactory results have been obtained. This should not be a difficult problem. It is only a matter of capital at one's disposal.

When starting a new process, experiments are commenced in a laboratory and carried out as far as possible. Then we must work with a small sized plant, in order to obtain the necessary information for the design of a full scale plant. Then we must carry out the final experiments in a moderate sized factory, capable of continuous operation, and turning out peat in tons instead of kilograms. These experiments are, of course, at first indefinite, while feeling one's way, and require so much time and money that a few hundred thousand kronor disappear very quickly. It is the working out of the details which requires the most time and labour. It is on the details that successful manufacturing depends. The general idea is, that great undertakings can be achieved with small capital outlay; which is a mistake.

Not only have small experiments been performed, but much has been done on a large scale, and many carloads of wet-carbonized peat have been sent from Sweden to German briquetting factories to be briquetted. Samples of these briquettes can be seen in Sweden. On examination, they appear to be of good quality, and, practically, do not absorb moisture. These briquettes were tested in many different stoves and fireplaces, and have also been tried on locomotives in England, where a high standard of fuel is required. Mr. Allen, who conducted the experiments, states that a test was made on March 18, 1907, on the Ashford and Rye Harbour railway. The test extended over more than two hours, and included the stops, etc. About 200 kg. (440 pounds) of briquettes were used to raise steam at 150 pounds pressure to the square inch. This corresponds closely with the quantity of coal required to do the same.

The train was run at full speed for about an hour. During this time, 1 kg. of briquettes generated 6·2 kg. of steam, which is only half a kilogram less than with ordinary English coal.

According to a locomotive test on the Government railway in Sweden, during the year 1902, 1 kg. of English coal generated 6·66 kg. of steam. The content of ash in the peat was 4·5 per cent. The briquettes burned with a long and lively flame. Neither smoke nor cinders could be observed from the smokestack. The ash was a fine and very light powder. The quantity of clinkers was remarkably small. The cost of peat bog, digging, transportation, the labour and the fuel consumption of the wet-carbonizing process amounted, at Stafsjö, in the summer of 1905, to 2·77 kronor per ton for wet-carbonized peat substance. The cost of the briquetting at a German plant, using three presses, was 1·44 kronor per ton, making a total of 4·21 kronor. This is based on the assumption that the water content of the carbonized peat can economically be brought down, by pressure, to about 50 per cent moisture.

Let us assume that the lowering of the moisture from 70 per cent to 50 per cent could not be done mechanically, but must be performed by additional drying by heat. For every 100 kilograms of peat substance, 133⅓ kilograms of water would have to be evaporated. According to the same method of calculation as on page 20, we find that $\frac{133\frac{1}{3} \times 640}{0{\cdot}8 \times 6{,}200} = 17{\cdot}2$ kilograms of fuel, having a calorific value of 6,200 calories, would be consumed in the drying operation, leaving 82·8 kilograms of peat substance. When the cost of wet-carbonized peat substance is 2·77 kronor per 1,000 kilograms, the price of the fuel for drying the peat from 70 per cent to 50 per cent will be 57 öre[1] per ton, net. This brings the cost, irrespective of interest on capital, administration, depreciation, maintenance, etc., up to 4·7 kronor. The total cost per metric ton of briquettes, having a calorific value of 6,200 calories, would be about 9 kronor, which could compete with the price of coal.

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[1] One krona=100 öre=27 cents.

NOTE.—According to Mr. Alf. Larson's statement, this process is still in the experimental stage.

As the wet-carbonized peat has not, on a large scale, yet been pressed below 70 per cent of moisture, it cannot be claimed that the process, so far, is economical; but if these difficulties can be overcome (as Dr. M. Ekenberg states they have), the process will be of great commercial importance.

APPENDIX IV.

THE EKELUND PROCESS FOR THE MANUFACTURE OF PEAT POWDER.

Translated by Harold A. Leverin, Ch.E.

Among the majority of the people who venture an opinion regarding the solution of the peat problem, there exists an invincible ignorance of the nature of the difficulties ahead, and of the means of overcoming these. Therefore, we often hear processes praised which do not even touch the central problem; and criticism made of others which really meet the case, but which are declared to be impossible, on account of mere details which do not please the critics.

The main question is, to produce a fuel which from technical and economical point's of view can compete with soft coal. This is attempted with peat—a raw material containing 90 per cent of water.

In the first place, this large amount of water must be removed; but then we obtain a fuel which is so voluminous, and of such low calorific value that, the consumer prefers soft coal—even though the peat may be cheaper. It must be remembered that 1 ton of soft coal equals in fuel value nearly 2 tons of peat containing from 25 to 30 per cent of water; and that the volume of coal is about one-fifth that of peat. A still more difficult factor is, that one never knows if it is possible to obtain a large amount of air-dried peat with the water reduced to 25 to 30 per cent; and in some years there is the risk of a poor peat crop, or of having it partly destroyed. In our country we can only count on three months for the main work on the bog, if air-drying is required. The frost is in the ground for about six months, which makes digging impossible. It is plain, therefore, that for production on a large scale, it is as useless to count on air-drying alone, as on a method which excludes air-drying entirely. Let us presume 20,000 tons are to be manufactured yearly without air-drying. During the six winter months the raw material cannot be dug out, consequently this would have to be done beforehand; that is, in six months 200,000 tons of raw peat would have to be excavated. This is possible, but 100,000 tons of the peat thus won must be carefully stored so that the frost does not render it incapable of being worked. This is doubtlessly impossible—especially in our climate. Moreover, there is no method known at present to replace air-drying; while in pressing out the water, technical difficulties are confronted, which will, probably, never be overcome. No mechanical obstacle exists against taking out peat during three months, or of air-drying the raw material for further refining; but there is no certainty of drying the peat to more than 40 to 50 per cent water. Ununiform bogs and stumps present additional difficulties. Not only has it to be taken into account that layers of peat are more decomposed at the bottom of the bog than at the top; but also that various kinds of peat are found in different parts of the same bog. Those who attempt to solve the peat question in the laboratory will be sadly disappointed when they put their theoretical experience into practice on the bogs, and have to handle material which is quite different from that which has been the subject of their experimentation. Stumps, white moss, and roots of grass will be factors that will interfere with their calculations. These, however, are only minor difficulties.

There are certain negative conditions which have become almost axiomatic: among these are the following:—

(1) Independent of the weather conditions, any quantity of peat can be air-dried to 40 to 50 per cent of water; but there is no certainty that the drying can be continued further.

(2) Artificial drying is economically impossible.

(3) Peat in blocks (including briquettes) has practically no higher fuel value than that 1·8 tons of peat equal 1 ton of good coal. To this may be added the experience which has been dearly bought, namely, that by charring the peat a fuel of higher heating value can be obtained; but from an economical point of view the result is poor. It is useless to pursue experimentation in this direction in the solution of the peat question.

Twenty years' work on peat, and a thorough study of the experience of others have proved that all who did not comply with the conditions indicated have totally failed; but that the problem can be solved if these conditions are practically observed.

The following are the means I have adopted: to take advantage of air-drying, which can always be applied, and is, after all, the cheapest of all methods. The air-dried peat, containing a maximum of 50 per cent water—but often as low as 35 to 40 per cent, and in favourable years as low as 25 to 30 per cent, is further dried artificially. It is hopeless to attempt to drive off the water in peat, when it is in blocks or larger pieces; since it is an extremely poor conductor of heat. A wet piece of peat put into the fire and partly burnt will still contain at the centre of the piece about as much moisture as at the beginning. Artificial drying can only be successfully performed after the peat has been broken up. I have broken it up as much as possible, hence get it evenly dried. It would be of little use to press the broken pieces into briquettes, as these have not much higher fuel value than air-dried peat; while as an industrial fuel the briquettes are inferior to machine peat, since they easily crumble to pieces and break in the grate, hence will not carry a load. Only for domestic purposes can briquettes be utilized. If, instead, the roughly treated peat is further ground up into a fine powder and dried successfully at a high temperature, and otherwise refined, a fuel is obtained which approaches that of an ideal fuel. Powdered fuel gives the most economical firing. Perfect combustion is obtained with sufficient amount of air required. All fuels are not suitable for firing in the form of powder: soft coal for instance. But peat powder has all the properties favourable to this method of firing. Thus, it is possible, by using suitable methods of firing, to obtain greater heating results from peat powder than from peat in any other form. In firing a boiler, one ton of peat powder is equivalent to almost one ton of good coal. The result thus obtained, is the only one on a large scale where the peat and coal compete on equal terms.

In manufacturing peat blocks there is considerable loss from crumbling; but in the peat powder process this is an advantage.

It is evident, therefore, that notwithstanding all difficulties there is a method by which the problem can be solved. In this way a peat fuel is manu-

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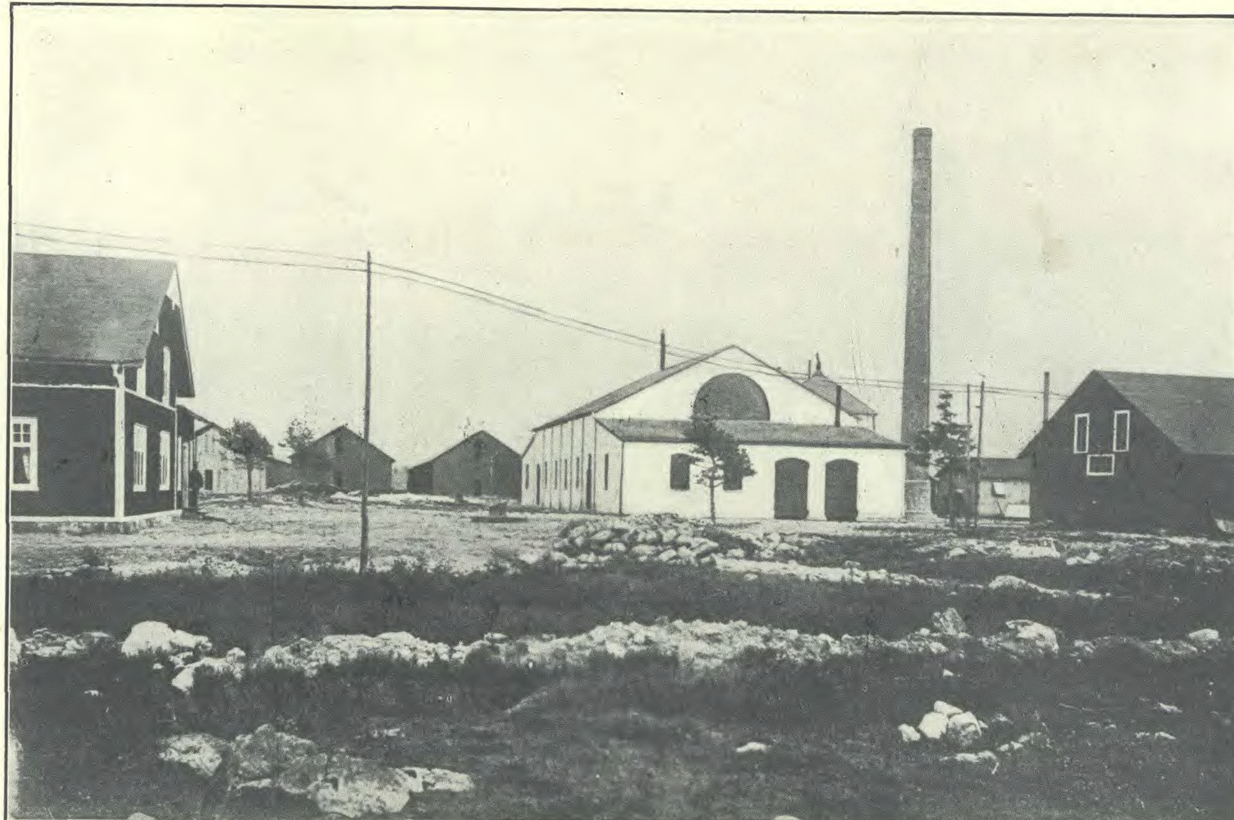

Peat Powder factory at Bäck.

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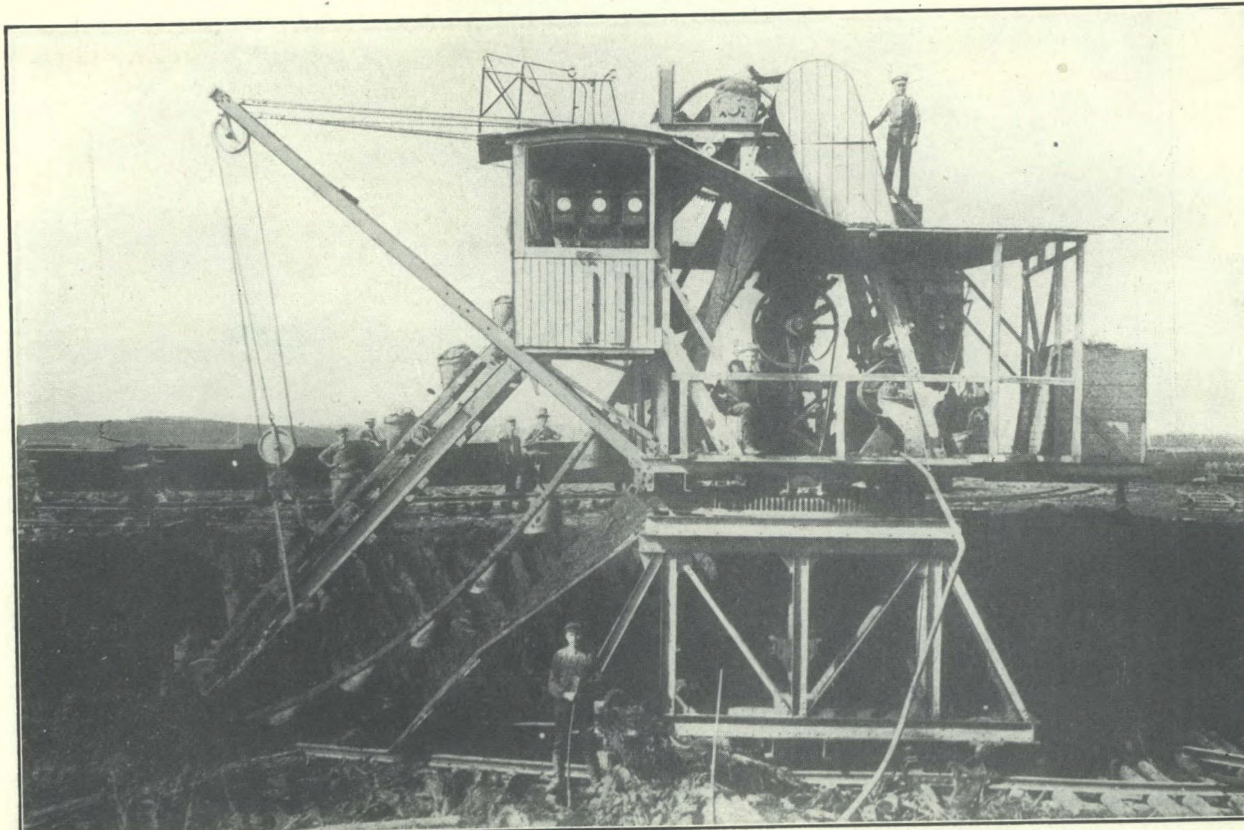
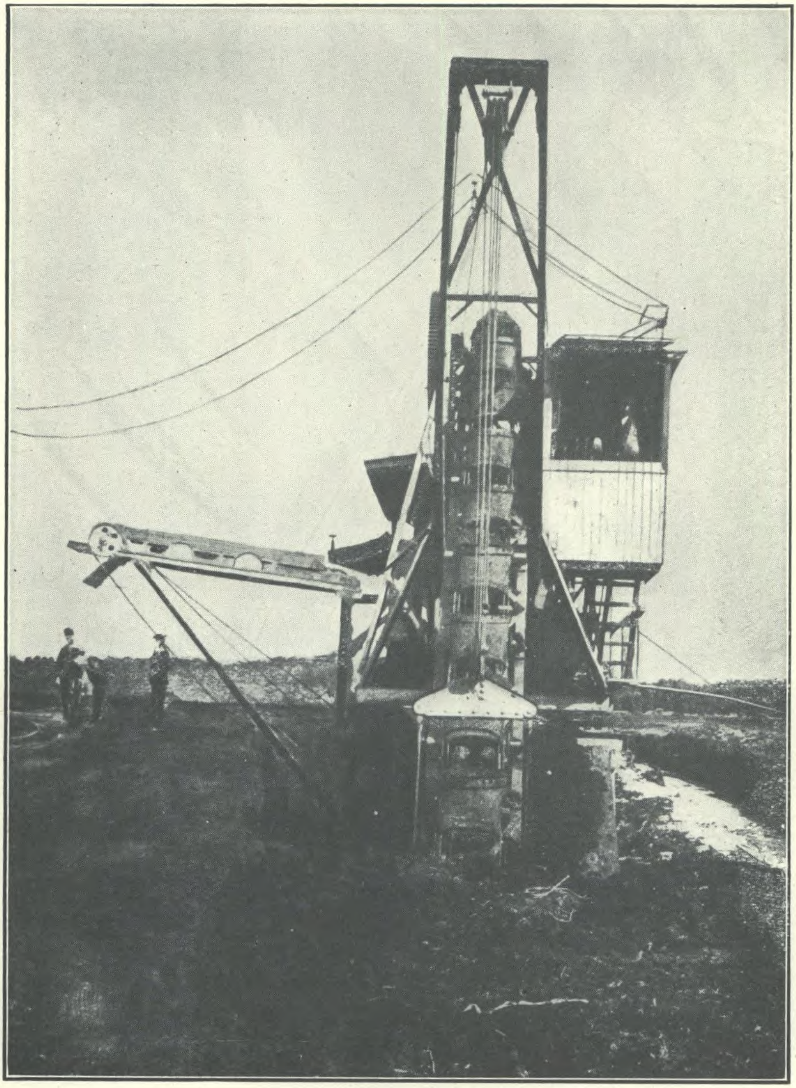


Large Ekelund Digging Machine, placed at bottom of peat bog at Bäck.



Front elevation of Ekelund Digging Machine.

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factured with minimum labour and cost, which gives the most effective heat value obtainable therefrom. The modus operandi may seem easy enough; but it has taken twenty laborious years to perfect this substitute for coal: which is not only a new invention; but the scientific manner of preparing it for domestic and industrial use is entirely new also; and to crown all, a process has been discovered which enables the manufacturer to triumph over weather conditions which had previously seemed insurmountable: thus rendering the manufacture of peat fuel an economic success

Digging the Peat.

Commencing with the raw material, new methods had to be discovered of digging this out and spreading it for drying; cheaper means of transportation had also to be devised on the bog. Up to the present time a force of at least 20 men—during the whole season—(90-100 days) has been necessary to take out and spread for drying 3,000 tons of peat containing 30 per cent of water. Should a production of 30,000 tons be desired, 200 men would be required during the time of the year when labour is scarce. Generally speaking, it would be impossible to get so many men, and house and feed them; not to mention the unfairness of bringing together such a large number of hands and leaving them idle during the winter. That the peat industry has been at a standstill for such a long period, has been due to the fact that this weakness and difficulty has not been considered. As soon as this defective system became apparent to me, I endeavoured to overcome it, and have succeeded.

On our plant at Bäck, Smaland, we have two digging machines. One is placed on the top, and the other at the bottom of the bog. They represent two different systems. Our experience teaches us that a digging machine able to give a uniform output on a large scale—especially where the bog is deep and where stumps are plentiful—must be placed at the bottom of the bog. Only on shallow bogs, without stumps, may machines—placed on the surface of the bog—be used. An effective digging machine equipped with necessary motors and elevators, and loaded with several tons of peat and exposed to the continuous jarring, is, when running, too much for the buoyancy of a bog, consequently, uneven sinking, and breaking of the peat bed takes place. These breaks often occur as far as 8 to 10 metres from the trench. The stumps are a cause of even greater trouble. A digging machine on the surface of the bog has only a limited and uniform working method; hence as stumps are generally found in rows they cause continuous obstacles to work of this kind.

The Ekelund digging machine, which is placed at the bottom of the bog, is not obstructed by the stumps, since it can be instantly moved, at will, from one place to another. It can dig straight forward with a width of 8 metres, and sideways 12 metres: and dig at any point in these 20 metres at the top or at the bottom; to the right or left. In case a stump is exposed, it is dug around, and the digging continued at another place, while the stump is being removed—if it is not desired to let the machine do this work—which it performs with remarkable ease. The digging arm, for this purpose, is similar to a great hand, able to take hold of anything and move with ease and speed. The machine is equipped with four electric motors, and is operated by a single man. By the pull of a lever the machine moves backward or forward; digs forward, or on the side; either at the top or bottom of the bog.

When the machine requires more track, the large digging arm is turned around and picks up the track behind the machine, and places it at the front, where it is fastened while digging is going on at the side. The track is placed on a platform of heavy boards 4 metres long. The machine is entirely independent of the character of the bog—depth and stumps.

It might appear that a soft bottom would cause difficulties, but as the machine works a great width, it moves very slowly forward, and gives plenty of time to level for the track. This rests on a movable platform, which makes a safe foundation even on poor ground; and, of course, the bottom of the bog will always be safer than the top. Two men have plenty of time to look after the track, and level the ground in front of the machine; which can move on fairly uneven ground. It is secured to the track with a cog rail. which is able to hold the machine at rather acute inclines.

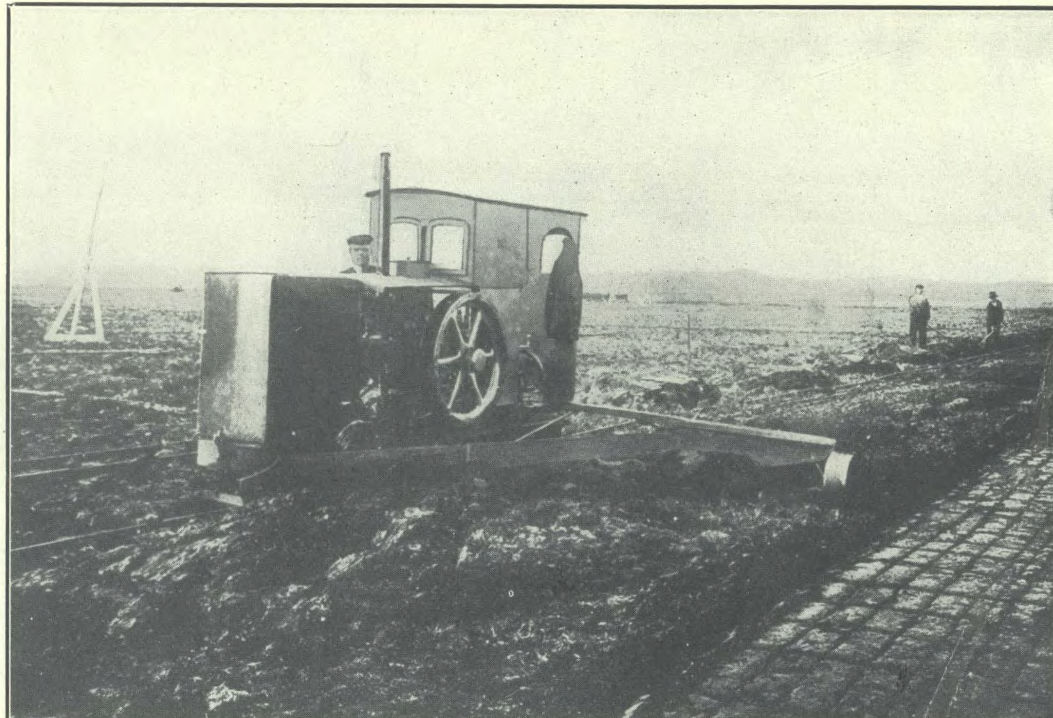
Next comes a machine for spreading the peat. When 100 cubic metres of peat per hour have to be taken up, it means quick spreading of the same. We have appliances for doing this cheaply and quickly. The moving of the peat on the ground does not depend on the spreading machines, as is the case with other machines. The peat is dumped from cars at the side of the round track, and is straightway attacked by the apparatus which does the spreading and cutting—which is pulled by a small locomotive—and in this way, in a short time, hundreds of cubic metres of peat are spread and cut; while the digging and running of the peat cars goes on without interruption.

Already, during the first months, we have obtained by piece work—by means of the machines and appliances described above—peat with only 30 per cent of water, at 75 öre[1] per ton; whereas by piece work at the same bog, with an ordinary large peat plant, the cost amounted to 3·22 kr. per ton. With the new machines, twice as much can be accomplished with eight men, as by the ordinary machines with twenty men.

The turning of the peat costs 12 öre, and stacking 25 öre per ton. By electrical equipment and small light petrol locomotives the transport to the sheds costs 45 öre per ton. Thus, the digging, drying and transportation to the sheds per ton of peat (calculated 30 per cent of water) costs 1·57 kronor; whereas by using older methods the same work costs 4·04 kronor.

Since the mechanical improvements made render it unnecessary to stop manufacturing operations when moving the tracks, the price of work for digging and spreading amounts to 52 öre; and the price of the peat in the sheds to 1·34 kr. per ton. Even this sum is likely to decrease when we obtain more practice in running our plant. and succeed in our efforts to invent new labour saving machines for turning, and piling the peat. But even the price of 1·34 kr. per ton may be considered as a revolution in the peat industry, making it possible to econ-

[1] 1 krona=100 öre=27 cents.



Part of Apparatus for Spreading and Cutting Peat on field.

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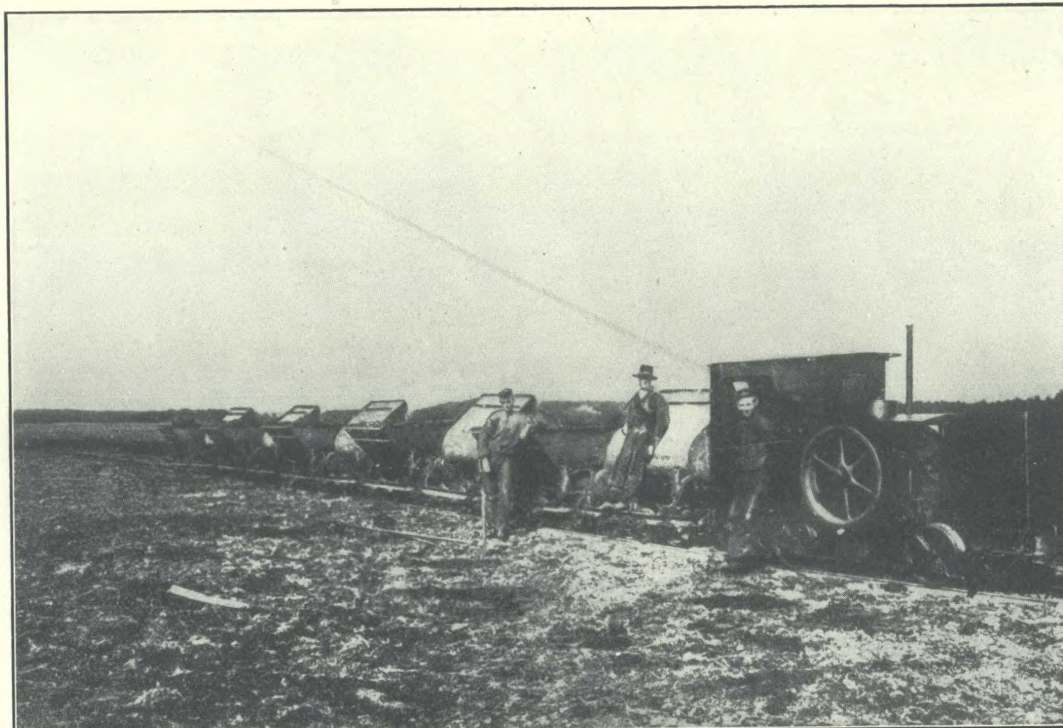

Spreading and Dumping Peat on field.

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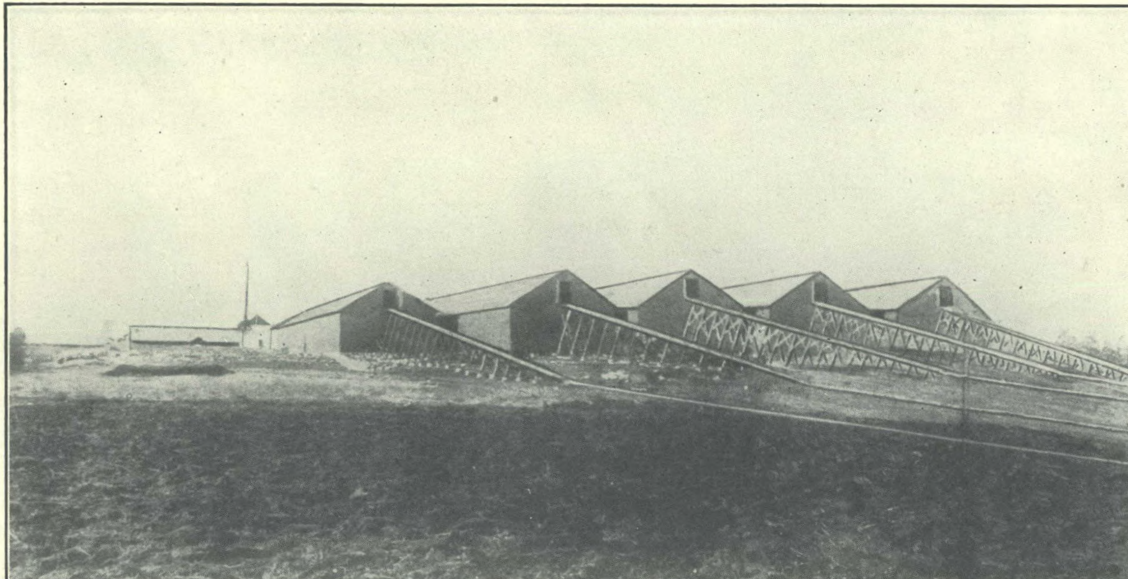
PTATE XIV.



Sheds at Peat Powder Factory at Bäck : each shed 100 metres long.

omically refine it into peat powder. The difficult problem of labour is also solved by this method; because one digging machine with full equipment, taking up and spreading 90 to 100 tons of peat per day, can be run with 8 men. Two machines running day and night (which can easily be done during the summer months) could manufacture 30,000 tons of peat with a force of 32 men; whereas 200 men would be necessary, if using the old method.

Many mechanical devices have been suggested for pressing out the water from the peat: and experiments have demonstrated that it is generally possible to reduce the water content by mechanical pressure from 90 to 80 per cent and sometimes to 70 per cent of water; but this process is costly, and presents difficulties, which, with some kinds of peat, will never be overcome.

The cold weather, which prevents continuous working by this method, is also an obstacle. It has been suggested to heat the peat, after which the water can be pressed out to 60 per cent; but this has never been demonstrated on a large scale, not even with the uniform peat found in our bogs. Laboratory tests on selected samples of peat cannot be depended upon. But suppose it possible to press out the water to 60 per cent, it would be useless work, when it has been possible to dig and spread the peat mechanically. It has been proved that 1 ton of air-dried peat in the shed, with 30 per cent of water, costs 1·34 kronor. Peat with 60 per cent of water may be estimated at 1 krona per ton. Even if the raw peat is pressed, it would require just the same amount of digging and transportation. This cannot be done for less than 50 öre per ton of peat containing 60 per cent of water; but for this 50 öre, 4 tons of raw peat will have to be heated to several hundred degrees, and 3 tons of water mechanically removed. Those who think it possible to do this at a cost of 50 öre, have little experience of the peat problem. But even if this could be done for half the price indicated it would not be economical when the peat—even during most unfavourable weather—can be air-dried to 50 per cent of water: and during normal weather conditions to 40 per cent; and a large part of it from 35 to 30 per cent of water—at a price of 1·34 kronor per ton. Thus, it would be of little value to obtain peat at 60 per cent water for a few öre less. The pressing method is more dependent on weather conditions than air-drying to 50 or 40 per cent water. Moreover, the new method does not require the large force of men, which was claimed as an advantage of the pressing method. It is said that by the heating and pressing method a higher quality of peat is obtained. This refining, however, which has been spoken of, has not been proved by production on a large scale; but it is a fact that by well regulated air-drying—as practised on our peat powder plant, we actually obtain that refined product which has been spoken of as possible with other methods.

Freezing, and sliming of the peat, in order to make it possible to press out more water, has also been tried. Both methods complicate the problem, and make more expense; since any gain is only apparent, and is only shown in certain kinds of peat. The condition of our bogs—which have more or less thick layers of white moss, on a layer of peat very unevenly decomposed—is not suitable for the pressing method. I have tried the pressing method more than anybody else, and have experienced how easy it is to be elated by good results obtained on a small scale; but to be miserably disappointed when it came to the actual manufacture of peat as found in the bog. I now consider the whole pressing scheme valueless, since equal or better results can be obtained without it.

Notwithstanding the difficulties and cost of pressing—which must be accompanied by heating or other means—it only touches a small part of the problem, since its final result is only peat with 70 to 60 per cent of water; and then there is a long distance between this half-made product and a good fuel able to compete with other fuels. Briquetting under all conditions is uneconomical. If the pressing method is ever successful, it will be to the advantage of the peat powder manufacture, and contribute to a simplification in the production of the raw material; because why should briquettes be made of the raw material when a peat powder, 60 per cent more effective, can be made at a lower cost?

But returning to the main question. By mechanical means we have been able to become fully independent of the labour question and have reduced the cost to a minimum, this being 1·34 kr. per ton, 30 per cent water in the sheds. To this 1·34 kr. per ton of peat must be added—with a yearly production of 30,000 tons—

Interest and amortization of the bog........	0·25	kronor.
" " " machinery for digging and transportation..................	0·50	"
Interest and amortization of the sheds......	0·25	"
Management, taxes, fuel, etc............	0·70	"
	1·70	"

which means that peat with 30 per cent of water costs 3 kr. per ton. The greater part of the peat is kept in sheds; but a large part is brought directly to the factory from the bog.

This price is given for the manufacture of 30,000 tons of peat using two large digging machines like ours at Bäck, with similar arrangements for spreading and transportation. But in such case the machines will have to work 20 hours per day in two shifts; operated by electric energy from a central power plant. Two shifts are, in my opinion, necessary; especially when so few men are required. The capacity being doubled, and with the same machinery, the cost of the plant, interest, amortization, management, etc., will be reduced; but, of course, the fact that the works have to be closed down during the rainy season has to be taken into account.

Using double shifts there will be sufficient time for one digging machine to take up 15,000 tons of peat per year, the price of the peat per ton being 3·40 kr. —in the shed; and if we could calculate upon final peat fuel with moisture of 30 per cent of water, the main question of the peat problem might be considered solved; because peat at that moisture and cheapness should provide a fuel suitable for many purposes.

But it must be remembered that only a part of the peat can be dried to 25 or 35 per cent which could be sold at a good profit; but of the total yearly output of peat, the greater part is only half dry. Experience, however, has proved that even during bad drying seasons the peat can be dried to 50 per cent, or, with certainty, an average of 45 per cent water. In the event of some part of the peat, during an unfavourable drying season, running higher than 50 per cent of moisture, it is left on the bog during the winter, and with the advent of spring the water will be reduced to from 30 to 40 per cent. The peat will crumble somewhat; but this is not detrimental in peat powder manufacture, as demonstrated at our plant.

We have found that peat having 60 per cent of water can be made into powder with good results, and have been using peat at even 62 per cent for a longer time; but this material causes severe strain on the furnace, and the powder becomes somewhat more expensive, and, therefore, peat with 40 to 50 per cent water is preferred.

Manufacture of Peat Powder.

We have found that the manufacture of peat with 40 to 50 per cent of water can be done on a large scale, independent of weather conditions, at a very low price, and with a small force of men. The price of peat containing 50 per cent water in the shed, in piles on the bog, and partly hauled to the factory for immediate use, does not exceed 2·20 kr., if two digging machines take up enough raw material for 20,000 tons of powder per year; and 2·50 kr. for one machine, providing raw peat for 10,000 tons.

From this raw material is produced the cheapest fuel that can be asked for. and according to our most prominent authorities on this subject 'the most excellent fuel we possess.'

The peat powder, however, does not become effective, unless it is produced at a very high temperature; the moisture reduced to from 10 to 15 per cent; made very fine and uniform, and the fibre removed; for the latter is obstructive in the refining process, as well as when used as fuel. All this, together with the necessity of getting a product cheaper than coal has rendered the task very difficult; since the necessity of attaining a high heat causes much work, because it is far from an easy matter to dry to such a low content of water, by direct firing (which from an economical point of view is absolutely necessary) a substance which is so finely divided, inflammable, and even explosive.

We had grinding machines which worked very well, but required to multiply the output. An order was placed with a foreign firm, and large quantities of peat were sent to them to be tested by their machines. They guaranteed their machines, which were delivered. But these proved far from satisfactory. With frozen peat they did not work at all, and with normal peat their capacity was only one-fourth of what had been guaranteed, and they required three times as much power. To these defects may be added ignitions, explosions, and a dust which was terrible. These machines were returned, and a series of new machines working together were installed, and now the production is sure, cheap, and comfortable. We are now able to work with peat of all kinds: containing 20 per cent, and 60 per cent of water (the former somewhat more difficult to handle than the latter); frozen or not frozen, undecomposed, white moss, or first-class raw peat.

At Bäck our method is now being applied on a manufacturing basis, and on a large scale. The factory is an iron and stone structure. The whole refining process is entirely automatic from the time the peat is put on the cars at the sheds until the finished product is taken out packed in bags. We are now manufacturing with one furnace 30 tons of peat powder per 24 hours, and when our second furnace is ready we shall have an output of 60 tons; but the plant is designed for two additional furnaces, which will then give a production of 120 tons per 24 hours.

After having thoroughly tested our method of manufacturing on a large scale for one year, with all kinds of peat, and during all seasons of the year, and having learnt all that has a bearing on the practical use of the method, we are now able to announce that our process has realized all our expectations, and offers neither technical nor economical difficulties. During this time, the operations have been conducted with great thoroughness down to the smallest detail: regardless of the fact that our cautious procedure has, in many cases, been considered as failure to obtain good results.

We now purpose setting forth the manufacturing costs per ton of operating two furnaces—the labour, management, etc., being the same for two, as for one furnace.

Peat in the shed, with 50 per cent of water—for the manufacture of 20,000 tons of peat powder—costs 2·20 kr. per ton: including interest, amortization, and management. Experience has proven that, as a rule, less than 50 per cent of water can be counted on; but we propose showing what the price will be for the refining of that raw material. From two tons of peat containing 50 per cent of water, we obtain somewhat more than one ton of powder, after having taken into account the amount of fuel consumed by the furnace. Two tons of such peat cost 4·40 kr.; but as a profit of 25 öre is made from the fibre obtained from the peat, the raw material costs 4·15 kronor.

The manufacturing cost of one ton of peat powder is as follows:—

Raw material, and fuel for the furnaces.	4·15	kronor.
Power.	0·24	"
Wages.	1·40	"
Interest and amortization.	0·50	"
Management, taxes, and insurance.	0·65	"
Wear of bags.	0·40	"
Miscellaneous.	0·16	"
	7·50	kronor.

It must be remembered that the price of the raw material includes interest, amortization, taxes, management, etc. In this, as in the other calculations, these items are given very liberally: thus the price 7·50 kr. is stated high. But as a lower content of water can be counted on, a further reduction in the cost seems reasonable. Working with one digging machine in the manufacturing of only 10,000 tons of peat powder per year; peat containing 50 per cent of water costs 2·50 kr. per ton, and the peat powder 8·50 kr. per ton.

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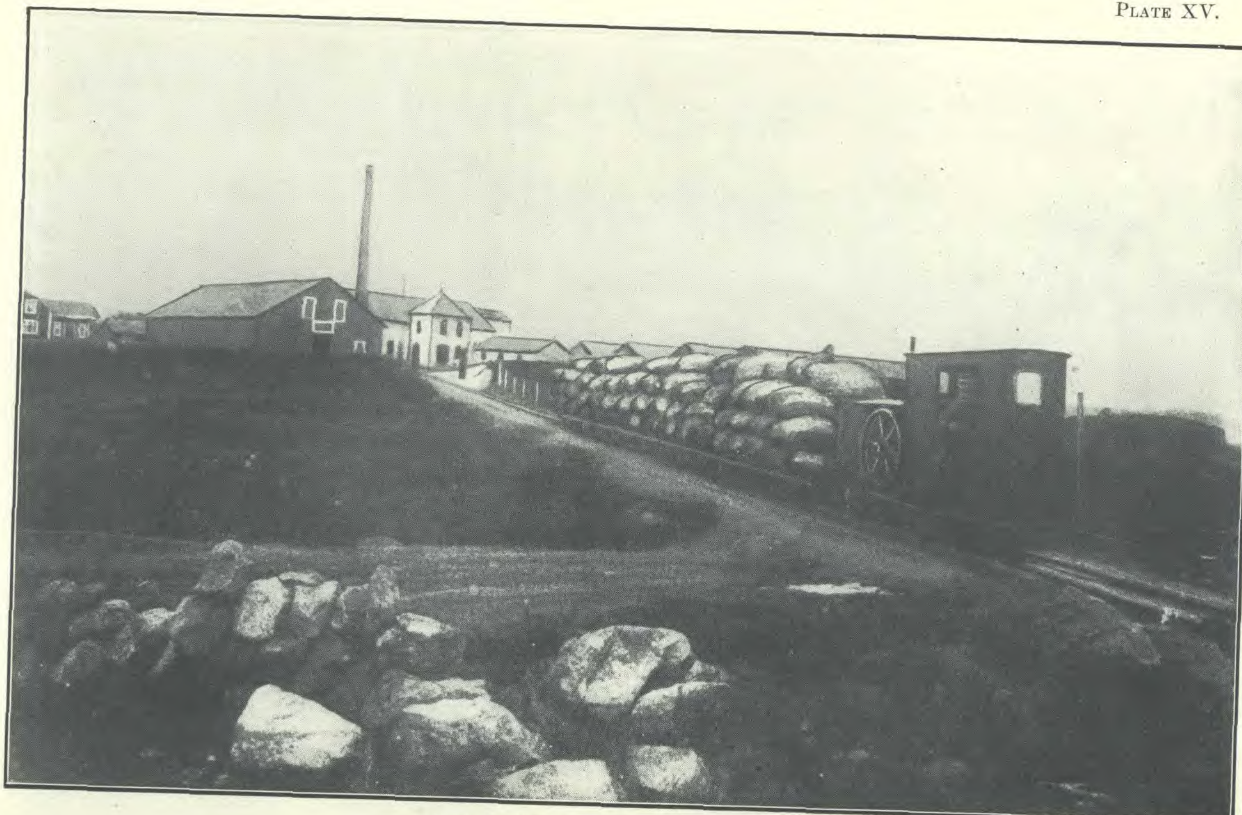

Peat Powder being transported to depôt.

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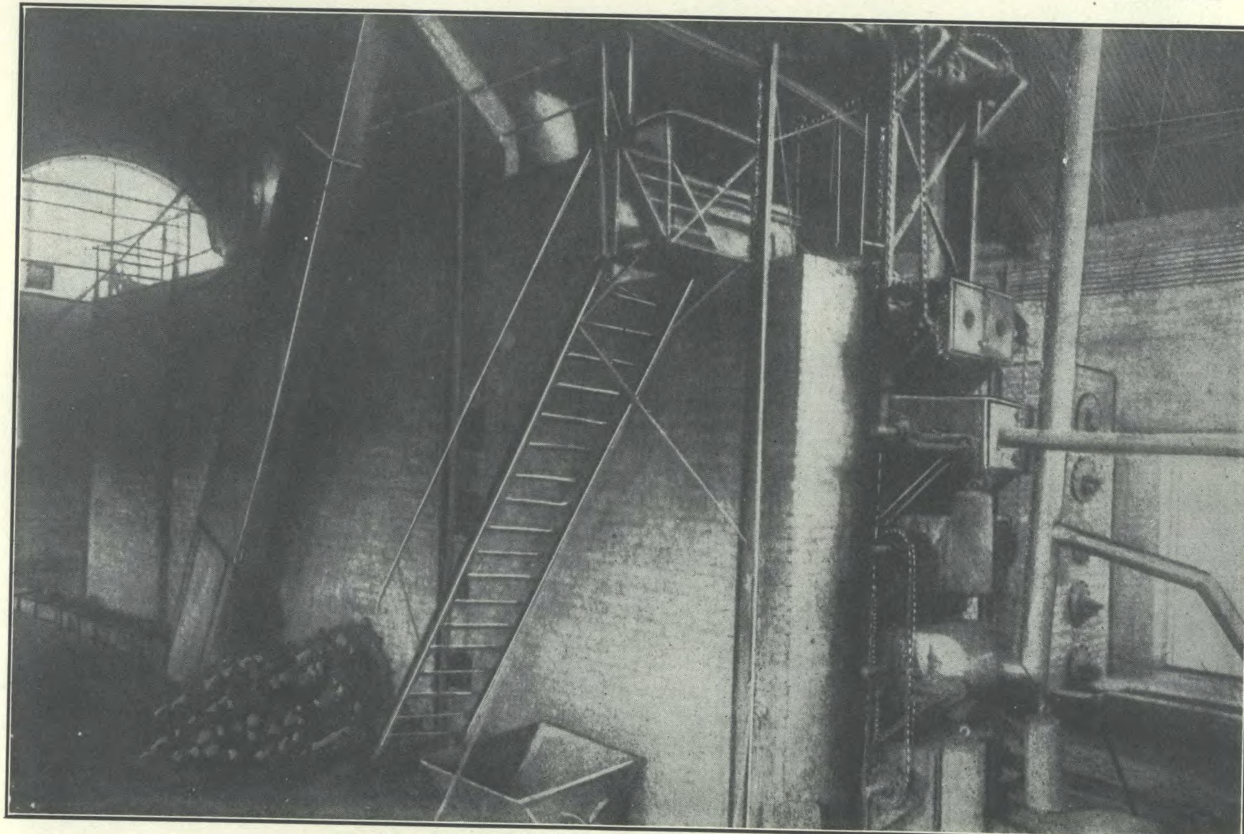


Interior of Peat Powder Factory at Bäck.

The general opinion seems to be, that owing to the fuel necessary to remove the water, the manufacture of peat powder should be a very expensive process; but since we have succeeded in constructing a furnace in which 1 kg. peat powder can remove 8 to 10 kg. water from finely ground peat which in suitable manner is brought through the furnace; the fuel consumption becomes a smaller factor—only 6 to 9 per cent of the produced peat powder.

This is a conclusive solution of the peat problem: that we are able to produce an unlimited amount of peat containing 40 to 50 per cent of water at a price of 2·20 kr. per ton; that the water can be reduced to from 10 to 15 per cent, with extremely low fuel consumption, and that the fuel obtained is not only as good as soft coal, but is more convenient to handle.

Uses of Peat Powder.

From the beginning of my enterprise, the objective has been to produce from peat a first-class fuel for boilers: and the peat powder produced has proved most successful for that purpose. Anyone seeing it fired in the way it is now being done daily, must realize that we have not only an ideal fuel, but an equally ideal appliance for firing. The powder gasifies instantly, and burns with a clear white flame, without soot or smoke. The combustion is perfect, leaving only a fine yellowish ash.

In soft coal firing a thick black smoke is emitted from the chimney, soot forming a cover on the tubes or other surfaces for the fire, isolating the same; and then there is the trouble and fuel waste of removing clinkers several times a day; which causes a severe strain on the boiler shell, due to the sudden cooling. The ash contains in most cases a very considerable amount of coal and coke.

In firing with peat powder there is no smoke; no carrying away of unburned coal; no soot deposit, and no unburned residue in the ash. No removal of clinker, or taking away of ashes is needed while running. For boilers using peat powder altogether, the ashes need only to be taken away twice a month, and 30 to 40 tons of powder can be fired before it is necessary to remove the ash, and not a minute's time is lost by interruption of change in firing. Firing with soft coal requires about four times more air than is theoretically necessary to effect combustion; but with peat powder only a few percentages more are required. The consequence is, that the flue-gases generally contain 5 to 6 per cent of CO_2, when using soft coal; but 14 to 16 per cent when using peat powder. The large amount of excessive air causes a loss of about 30 per cent of the fuel, which shows the great advantage of peat powder for firing.

Still better results are obtained by using hot air. By placing some tubes in the spark chamber, and leading the blast through them, it will be heated up to a temperature of 90° C. Firing with soft coal requires more than 35 cubic metres of air for each kilogram of coal; and this amount of air, especially during the winter time, of low temperature. Peat powder requires about 12 cubic metres of air of 90° C, and this temperature can be increased without danger.

The result obtained by test firing is now, that one kilogram of peat powder, manufactured by our method, fully corresponds in heat effect to one kilogram of the highest grade English soft coal.

The mechanical appliances for firing with peat powder are remarkably simple, dependable, and firm, and work in a perfectly automatic manner. The powder is emptied into a bin near the boiler, and conveyed to the fire place; the amount of air and powder being easily regulated by a screw. Both powder and air can be shut off at will. The fire can be started at any time with ease, and as easily put out. No change of the boiler is required, even the grates may be allowed to remain without being damaged.

As mentioned, the ash need not be removed oftener than twice a month, which is done conveniently with a suction fan. Using a flexible tube, the whole amount of ash can be taken out and delivered into a sewerage pipe, in which it is easily carried away by the water, thus saving the work of cartage.

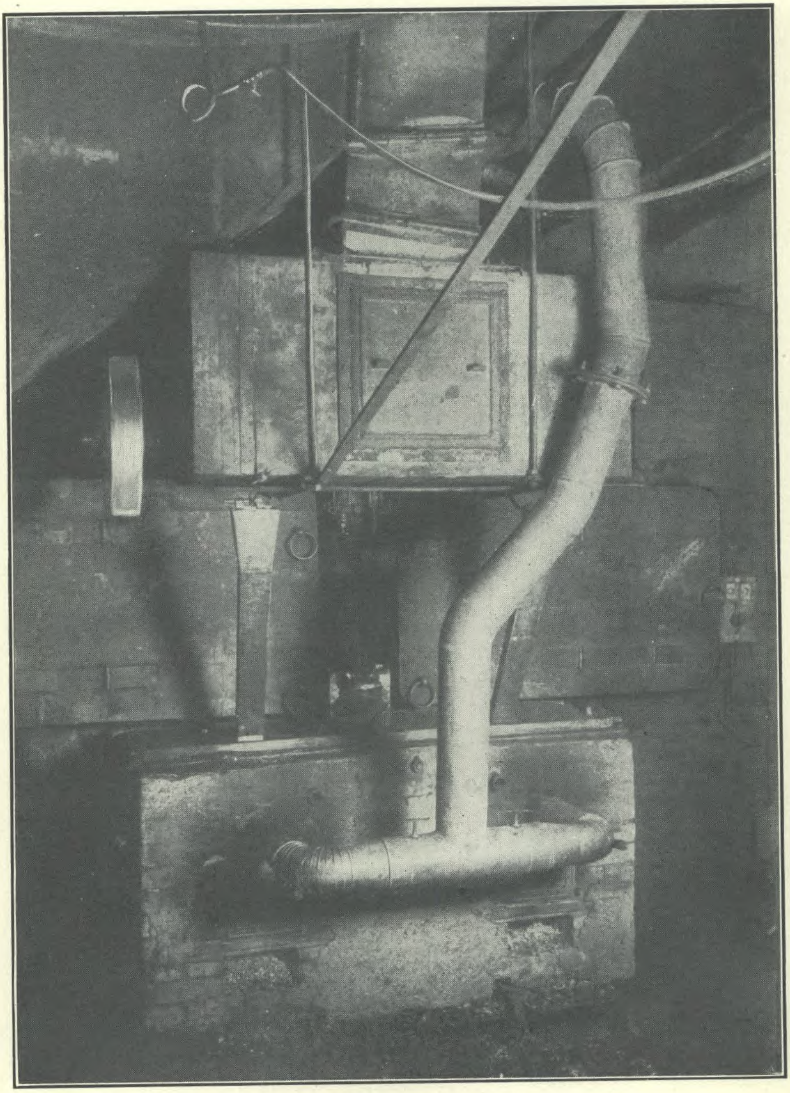
Any boiler can use the peat powder, and no doubt it can be as effectively used on a locomotive, as coal. My object is to prove this, hence I have obtained drawings of an engine from the Royal Railway Commission of Sweden, in order to work out a scheme for that purpose. It is evident from the drawings that the appliances for firing must be placed on the tender; but as there will not be sufficient room on the tenders now in use, I intend proposing to Aktiebolaget Torf, that a suitable tender be constructed for the test. We know by years of experience that locomotives can be fired very economically with peat powder, and it is only a question of room, and the convenient placing of the machines that we have to work out.

It is evident that peat powder can be used to great advantage on ships—especially on war vessels, since it is a smokeless fuel. Volumes of smoke from soft coal naturally betrays the whereabouts and number of ships; but the smokeless fuel will render the ship invisible in our archipelagoes, which must be considered a great advantage. Powder for this purpose must be of the highest quality, and packed hard. It will then require about the same space as soft coal.

Regarding peat powder for factory use, I wish to call attention to experiments now going on, to find out whether it will be possible to use it directly as motor fuel. At suction gas works peat is used, but this should not contain more than 30 per cent moisture. As is well known, these plants are only economical for continuous run, and full load; this being the weakness of the generator. The ease, however, with which peat powder can be gasified, and the feeding regulated, makes it possible to assume that all the difficulties which are now associated with peat fuel in lumps will be overcome. We may, therefore, expect gas engines—as regards running and regulation—much superior to those now in existence. But this is not the final possibility. Experiments are now being conducted with a view to constructing a gas engine which can be run with peat powder without using special gas generators.

Inasmuch as we are now able to produce 1 ton of peat powder at 7·50 kr., which, for boiler firing, corresponds to 1 ton of soft coal, and which, as a rule, does not cost less than 15 kr. in Swedish harbours, and averages 18 kr. in the country; hence, we feel entitled to claim, that with peat powder we are practically independent of coal for domestic purposes. But we must go still further, and from peat produce a fuel which can be satisfactorily utilized in our iron industry, and thus displace expensive soft coal and charcoal.

During the last three years, a number of experiments have been made to



Firing Peat Powder under Boiler.

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determine whether peat powder can be used for metallurgical purposes, and the good results obtained are chiefly due to Professor E. G. von Odelstierna[1], who has given much time and work to this question, and announced his opinion that in peat powder our iron industry has got a valuable metallurgical fuel. Several furnaces have been specially designed and built, and hundreds of tons of peat powder have been used already.

Report on Lieutenant Ekelund's Peat Powder.

BY

Professor E. G. von Odelstierna.

'After having made thorough and comprehensive tests with a crucible furnace, built by Lieutenant Ekelund, and using peat powder, the undersigned can without hesitation certify the following, regarding Lieutenant Ekelund's peat powder:—

(1) The fuel is easily inflammable in fire-box; but there is no danger of spontaneous combustion, which often occurs with somewhat more moist and powdered fuels.

(2) The fuel can be easily regulated, so that a residue always free from carbon is obtainable; but at the same time so that its carbon and hydro-carbons completely burn to carbonic acid and water, giving highest heat, and if desired, more or less oxidizing flame—(the former with excess, the latter with sufficient air for combustion); or, it may first burn to generator gas, low in carbonic acid and aqueous vapour at red heat temperature, and this hot gas can be burnt completely to water and carbonic acid in the proper furnace giving this highest heat. The generator gas can be used in soaking pits as reducing gas: thus protecting ingots, etc., from oxidization, and after this can be used in other furnaces for high temperature.

(3) Reversing from an oxidizing to a reducing flame—and *vice versa,* can be accomplished with perfect ease and certainty in a moment.

(4) For complete combustion, as in the making of generator gas, the amount of powder or air can be perfectly controlled according to requirement, and at uniform run, after the valves have been once correctly adjusted—the man running the furnace need not change them. This is an invaluable advantage.

(5) The fuel gives—with less consumption than all our solid fuels—the highest temperature the structural material in our furnaces can stand, and may be used advantageously for the welding of hard and soft steel, and the melting of pig iron and other materials; glass, and non-metallic minerals. A welding or melting furnace can be heated up more quickly by using peat powder, than by older methods of firing.

(6) Furnaces using peat powder are much cheaper to construct than those which have hitherto been fired with peat, wood, soft coal, or generator gas.

Based upon the facts cited, I claim, that peat powder is the best fuel we possess, and hope, from partiotic reasons, that it will soon come into general use.'

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[1] Professor in Metallurgy in the Royal Technical High School, Stockholm.

Part of a later report 'On the significance of Peat Powder for the Iron Industry of Sweden,' by Professor Odelstierna.

'Using peat powder, iron of the best quality can be produced from iron ore in electric and other smelting furnaces. We have successfully made it in electric furnaces of three different systems called 'burning furnaces;' and have produced iron of all degrees of hardness: highest carbon pig iron and cast iron, hard and soft tool steel, hard, and extremely soft wrought iron—the last named directly from the ore without the expensive re-melting. The powder has proved to be of equal use for the welding furnaces, soaking pits, and other steel furnaces, and there is no doubt about its adaptability for reverberatory furnaces, etc.

Charcoal is scarcer, and more expensive every year, and must soon be replaced with another fuel. Our iron industry cannot depend on foreign coke; but we have immense quantities of peat, hence it is my conviction that the Ekelund peat powder will render our iron industry independent of foreign fuel.'

Peat powder has been tried in the glass and clay industries. It was found that the furnaces, when using peat powder, could be made cheaper. Glass melting was done very easily, conveniently, and more cheaply when peat powder was used.

For brick making the powder is excellent, since it makes a uniform burning.

Preliminary tests have been made using peat powder for cement works, and as soon as we are able to produce more powder than is now in demand we shall commence shipping it to cement works.

COST.

Cost of erection of plant producing 20,000 tons of Peat Powder per annum.

Production of raw material:—

	Kronor.	
[1]The bog, drained and leveled	60,000	
Two large digging machines, electric motors, elevators, etc.	50,000	
Common motor, arrangements for transmittal of electric power	25,000	
Tracks, 4 petrol engines, spreading machines, cars, etc.	46,000	
Sheds, capacity 35,000 Kbm. peat	52,000	
Miscellaneous	2,000	
		235,000

Production of powder:—

Building	25,000	
Furnaces, crushers, screens, conveyers, transmission lines, etc.	55,000	
Motor, with supplies, lights	25,000	
Inventory of repair shop (in the factory building)	3,000	

[1] This figure naturally varies.

	Kronor.	
Bags	15,000	
Miscellaneous	2,000	
		125,000
Office	10,000	
Store house	5,000	
		15,000
Total cost		375,000

To this should be added, cost of transportation from the factory to the railway depot to other places where the powder is to be delivered; but this depends on local conditions, hence a general sum cannot be given.

As previously shown, the peat powder can be produced at 7·50 kr. per ton. This includes the amortization and interest of the whole plant, and wear of the bags. Notwithstanding the low price of soft coal at the present time, the peat powder is readily bought at 14·00 kr. at the railway station, and the price of loading and transportation from the factory to the station being not more than 50 öre, per ton, would give a profit of 6 kr. per ton, and 120,000 kr. on the whole yearly production. If the factory is situated near a city on the coast, still greater gain can be expected, on account of lower freight charges by water. Generally the price of soft coal is 2 kr. higher than now, which would increase the yearly profit 40,000 kr. On the other hand it is evident that the price of the powder can be lowered to 8·00 kr. f.o.b., and still have the interest and amortization on the capital expended. A plant of 10,000 tons, yearly capacity will come proportionately somewhat higher, the whole expenditure being * 215,000 kr. The peat powder will, therefore, be somewhat higher; the cost at the factory —including interest, amortization—being say, 8·50 kr. per ton, and loaded on cars 9 kr. Such a plant should give a profit, excluding interest on the capital, of at least 50,000 kr. per annum.

It may also be mentioned that a large amount of peat—not included in the 10,000 to 20,000 tons of peat powder manufactured—is obtained which is air-dried to from 25 to 35 per cent of water. This peat costs 3 to 3·50 kr., and can be sold with good profit for domestic purposes. This should increase the yearly profit considerably.

The peat powder—which is shipped in bags—does not absorb moisture. This is due to the high temperature used in manufacturing it, and also to the hard packing in bags. The bags are made of waterproof material, to prevent them being damaged by water. Using well decomposed peat, and suitable arrangements for shaking, when the bags are filled, the peat powder does not use more space than coal. One hectolitre weighs about 80 kg., or about the same as soft coal. Peat powder of less decomposed peat is somewhat lighter; but the difference is considerably less than it was thought.

* The price of the bog at 40,000 kr.

We have given every machine a thorough test. For instance, the most important apparatus, the furnace in which the peat is dried and refined, is so constructed that any part which is exposed to severe strain can be easily and quickly removed if damaged, and replaced with new. The movable parts of the furnace are made very strong. They move slowly, and will not wear out quickly.

We were running our furnace for half a year with quadrupled speed, and giving it a most severe test, running it only during the days, allowing it to cool at night, and resuming the running next day. It stood the test admirably.

This furnace is my fifth, and its design and construction are the result of fifteen years experience and work.

For the success of my process, I am greatly indebted to Prof. Odelstierna; Captain Ernst Wallgren, Government Peat Engineer; and Captains B. Munck, Edw. Hageus, and R. Gallander.

Our object is not only to manufacture peat powder on a large scale, but to allow any one to use our process on a royalty basis. Aktiebolaget Torf offers to construct plants at the price previously stated, and guarantees the output and cost of production set forth in the estimate given. The figures were obtained at our own plant, manufacturing on a large scale. The Company will not allow anyone to use the Ekelund peat powder process unless the plant is constructed by themselves, as it is of importance that all is done in accordance with what they have found by long experience, to be the best plan; for a change in some part: other dimensions; speed; change in temperature, etc., might have a serious effect on the durability and efficiency of the plant.

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