flagellate forms—often Leishmania-like—were more numerous. The authors recall the fact that a flagellate stage of *Leishmania donovani*—the causal organism of kala azar in man—has recently been found by Dr. Wenyon in a dog subinoculated with a strain derived from a human case, and that flagellate stages of *L. tropica*—the organism of oriental sore—have been found in man. In view of the similarity of the morphological cycles of Leishmania and Herpetomonas, the authors suggest that the species of Leishmania are probably insect herpetomonads introduced long ago into man, and usually perpetuating the non-flagellate and relatively non-resistant forms, though capable of assuming the flagellate form.

THE NEW ZEALAND INSTITUTE.

THE forty-seventh volume of the Transactions and Proceedings of the New Zealand Institute constitutes a record of much valuable and painstaking research, dealing chiefly with the fauna and flora of the Dominion. It is gratifying to find that the war has interfered so little with the activities of New Zealand naturalists, and that so many ardent workers are now engaged in adding to our already very extensive knowledge of this important region. Most of the papers in this volume are of a systematic character, and probably work of this kind is the most important that can be undertaken at the present time in New Zealand. Such papers, however, naturally appeal to a very limited number of readers, especially when they are written in the ultra-technical language which so many systematists seem to prefer. This appears very markedly in Mr. Meyrick's revision of New Zealand Tineina, in which the diagnosis of the very first genus contains the following cryptic sentence—if sentence it can be called:—"Hindwings under 1, termen abruptly emarginate beneath acutely produced apex; 3 and 4 rather approximated, 5 nearly parallel, 6 and 7 rather approximated towards base."

We cannot help thinking that, apart altogether from the question of style, a somewhat more generous expenditure of type would be appreciated by those who might like to take up the study of this group of Lepidoptera in New Zealand, and are not already experts in the subject. Mr. Meyrick is of opinion that there still remain a large number of additional species of Tineina to be discovered in New Zealand, and it seems a pity, therefore, that the generic and family characters given only hold good for the New Zealand species, for apparently they may be upset at any time by further discoveries, and may prove quite inadequate for the determination of new forms.

One of the most interesting discoveries recorded in the volume is that of a new genus of gymnoblastic hydroids, Ascidioclava, found living as a parasite in the peripharyngeal groove of an Ascidian, and described by Prof. H. B. Kirk.

We are glad to see that local botanists are paying attention to the life-history of the Lycopodiaceæ, which form such an important element in the New Zealand flora. Mr. J. E. Holloway contributes a note on the protocorm of *Lycopodium laterale*, and Miss K. V. Edgerley describes the prothallia of three species. Prof. Charles Chilton gives an interesting account of the recently established Mountain Biological Station belonging to the Canterbury College, the existence of which may be expected to do much to promote biological research.

It is impossible in a short notice to do justice to such a mass of valuable material as this volume contains. We can only express our satisfaction at the great activity displayed, and congratulate all concerned on the results of their labours. A. D.

THERAPEUTIC ACTION OF ULTRA-VIOLET RAYS.

ATTENTION has recently been directed again to the therapeutic action of ultra-violet rays by the publication of a paper in the *Lancet* of January 8, in which a source of light invented by Mr. Simpson was referred to. There is nothing novel, of course, in the fact that certain forms of disease may be cured by exposure to light of wave-length ranging from 300 $\mu\mu$ to 90 $\mu\mu$, but the discovery of a new ultra-violet lamp raises many questions of wide interest. Dr. Sidney Russ has now shown, however, that an arc simply produced between two tungsten rods exactly simulates the so-called "Simpson light," and it is evident that the powerful source of ultra-violet rays thus obtained will prove of service in the treatment of all those superficial lesions which Finsen and others have proved to be favourably affected by this type of radiation. Dr. Russ has further pointed out that even one-tenth of a millimetre of human skin readily absorbs a large part of the ultra-violet rays from this arc, and that less than one per cent. passes to a depth of one millimetre.

When its spectrum is compared with that of the mercury arc, the carbon arc, or one between copper and silver, it is seen to consist of numerous lines grading off towards the shortest wave-length, and affording an exceptionally rich source of ultra-violet light over the region, which is of great therapeutic use. In medical work, however, the cleanliness and convenience of the method by which any particular radiation can be produced are naturally of great importance, and in this respect it is evident that the electric discharge between a broken column of mercury enclosed in an exhausted quartz tube has much to recommend it. On the other hand, the new tungsten arc lamp made by Messrs. Edison and Swan (see NATURE of December 23, 1915, p. 467), enclosed in a silica bulb instead of in glass, would no doubt be an ideal means of producing ultra-violet light, and one which could be readily adapted for medical as well as other purposes.

Dr. Russ has contributed a short illustrated article to the *British Medical Journal* for January 22, in which some interesting points are considered respecting the seventeen octaves of radiations which are now available: from visible light to the gamma rays of radium. He deals very clearly with the X-ray spectrum, the dangers of prolonged or frequent exposure to that radiation, ultra-violet light, and some of the chief physical facts with which medical students should become acquainted.

THE UTILISATION OF PEAT.[1]

PEAT AS A SOURCE OF POWER.

THE problem of the utilisation of peat for industrial purposes is one of perpetually recurring interest, and scientific men in many countries have turned their attention to search out a solution. This is not surprising in view of the fact that the amount of combustible matter in the world's peat deposits exceeds that of all the known coal-fields. For Ireland the question is one of vital interest. Her coal deposits are small and relatively unimportant, while nearly one-seventh of the area of the country, *i.e.* more than two and three-quarter million acres, is covered with peat, much of which is of excellent quality. This represents a vast amount of potential energy awaiting only a practical means of utilising it.

[1] Abridged from articles entitled "Peat as a Source of Power," by Mr. George Fletcher, and "Some Chemical Aspects of the Peat Problem," by Prof. G. T. Morgan, F.R.S., published in the Journal of the Department of Agriculture and Technical Instruction for Ireland (vol. xvi., No. 1).

The defects of peat as a fuel are (1) that it contains and retains a large amount of water; (2) it has, compared with other fuels, a low calorific value; and (3) it is extremely bulky, involving a high cost of carriage. Thus it is that most of the schemes for peat utilisation have been concerned with artificially drying and compressing the material. This can be done readily enough, but the energy consumed in the operation, and the low calorific value of peat, render the commercial success of any such scheme extremely problematical. Other schemes have sought to combine the preparation of a fuel from peat with the extraction of by-products. When one recalls the fact that the by-products of the manufacture of coal gas, once regarded as useless, have come to rival the gas itself in value, this aspect of the peat problem appears full of possibilities; further reference will be made to his.

A new vista of potentialities for peat has opened up in recent years. Just as the nineteenth century will always be associated with the development of the steam engine, culminating in the steam turbine, so will the twentieth century be able to claim the triumph of the internal-combustion engine. The success of the gas engine has led to investigations which resulted in the many forms of producer gas plant, and there are now many thousands of installations of this method of producing power for mechanical purposes.

It is a noteworthy and encouraging fact that an installation at Portadown for utilising peat in gas-producer plant has been found to be entirely satisfactory, and to effect a considerable saving over anthracite. This is the more remarkable, as the by-products are not at present utilised. But these by-products are of considerable value, and it will be of interest to refer to two instances where peat has been used in plant designed to recover the by-products.

The first of these is the power plant of the Societa per L'Utilisazzione du Combustibili Italiani, at Orentano in Italy. This plant, erected by the Power Gas Corporation, Ltd., Stockton-on-Tees, is situated on the edge of a bog a few miles distant from Orentano. The area of the bog is about 1482 acres, of which the company operating the recovery power plant owns about 500 acres. This portion of the bog has an average depth of about 5 ft. of good peat fuel. The bog has to be drained by pumping. The peat, excavated by manual labour, is fed into Dolberg peat machines, and these are provided with belt conveyers to transport the peat to the macerators. Part of it is air-dried, and part mechanically treated and artificially dried. The peat delivered to the producers with an average moisture content of 33½ per cent., has an average nitrogen content of 1·04 per cent. The nitrogen is recovered as ammonium sulphate, and the gas is used to drive two gas engines of 350 metric horse-power each, which drive alternate-current generators—there being a transmission line to Pontedera, ten miles distant.

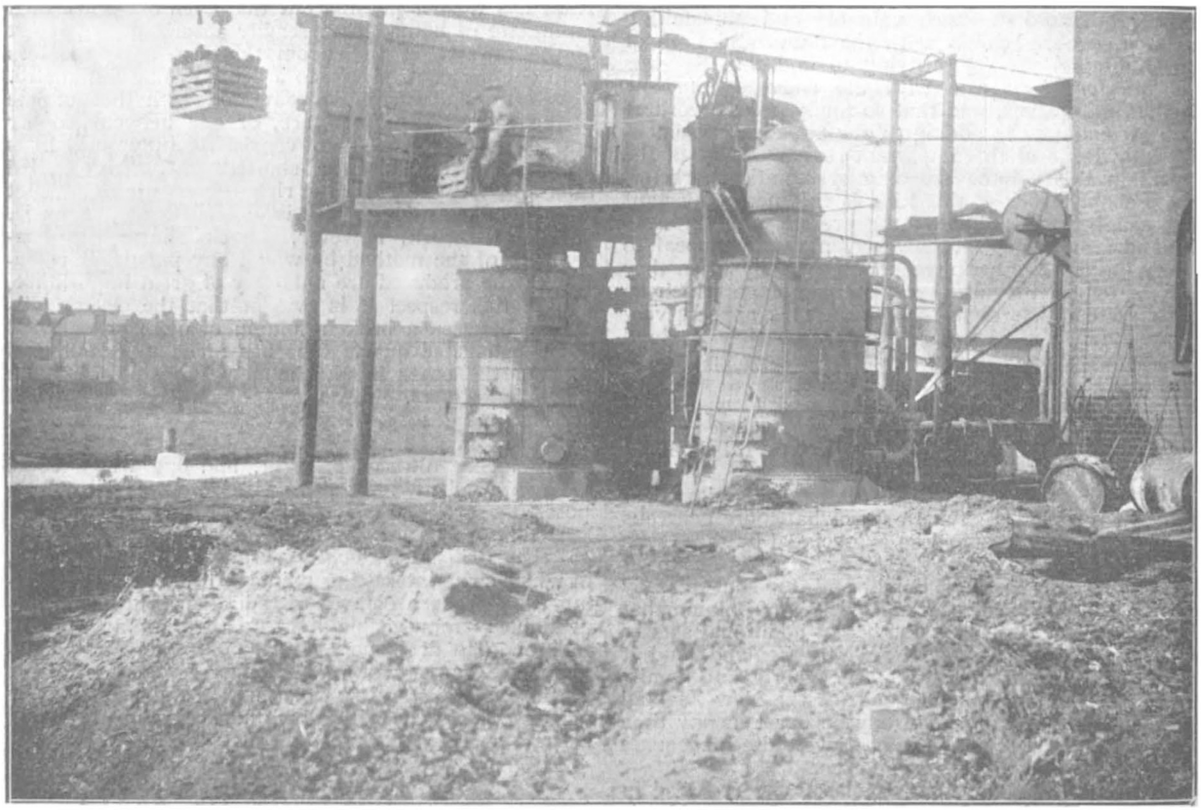


FIG. 1.—Producer gas plant, utilising peat, at Messrs. Hamilton Robb's factory at Portadown.

The second installation referred to is the ammonia recovery power plant of the German Mond Gas Company, situated on the Schweger Moor, about twenty-five miles from the city of Osnabruck. It is constructed according to the system of Frank and Caro, and was designed to utilise peat containing upwards of 60 per cent. moisture—an important point as lengthening the season during which peat manufacturing operations could be carried on. The gas plant is capable of gasifying and recovering the by-products from 210 tons per day of twenty-four hours of air-dried peat. The total power capacity is more than 3000 h.p., and the gas engines are coupled to alternators running in parallel. The current, transmitted at a tension of 30,000 volts, is distributed over an area of about twenty-five miles' radius.

If more rapid progress has not been made in solving the problem in the United Kingdom, it must be remembered that in the manufacturing parts of England coal is comparatively cheap, and owing to its greater heating power is more suitable for producer gas than is peat. In many parts of Ireland, however, coal is very dear, but (and to some extent because of this fact) in these districts we have not at present in existence industries demanding power. The possibility of securing cheap power would be a stimulus to industrial development.

Happily, a noteworthy step has been taken in the way of solving the problem by the action of Messrs. Hamilton Robb, of Portadown. This firm have in Portadown a weaving industry, and a little more than four years ago decided to try the experiment of establishing a (peat) producer gas plant. They accordingly installed a suction gas plant constructed by Messrs. Crossley Brothers, Ltd. of Manchester, of a capacity of 400 brake-horse-power. The fuel used is peat, and this is cut from a bog some miles distant and dried in the open air by the usual method of stacking. The plant supplies gas to two engines, each of 120 b.h.p., and one of 150 b.h.p. There are two producers, each having a capacity of 200 b.h.p. By means of the conveyer the peat blocks are elevated and carried to the feed hoppers on the top of the producers, from which they pass into the generators, where gasification takes place. It is stated that under working conditions, with peat at 5*s.* a ton, power can be obtained at the rate of one-sixteenth of a penny per horse-power hour.

The gas, before passing to the engine, must be purified, but the substances removed are valuable, although the by-products of a small plant would not justify treatment. There is nitrogen, which can be recovered as ammonium sulphate, and also peat ash and peat tar, containing valuable constituents. It is not unreasonable to assume that with an extension of this method of utilising peat, it would be possible to deal in a profitable manner with the by-products which would thus be produced in a sufficient quantity to allow of their being dealt with in chemical works. We should in this way not only establish an additional industry, but this method of obtaining power from peat would be rendered still more profitable.

It may be said that the conditions at Portadown are favourable, in view of the neighbourhood of the peat bog to the weaving factory, and it is undoubtedly a very great advantage to be able to avail of water carriage from the bog to the factory. There are, nevertheless, without doubt, many other places in Ireland where corresponding advantages could be found. But even in their absence it seems certain that peat could be profitably utilised on the lines indicated, with one modification, though that is an important one. Where a sufficient demand for power exists, it appears certain that instead of carrying the bulky peat either by road or by water, it would be advisable to instal producer plant on the bog itself and to convert the mechanical power into electricity, and transmit the energy at high pressure to the point where it is required. The efficiency of such conversion and transmission is now very high, and the financial results of such a mode of transmission can be ascertained with a considerable degree of accuracy in any case where the conditions can be stated.

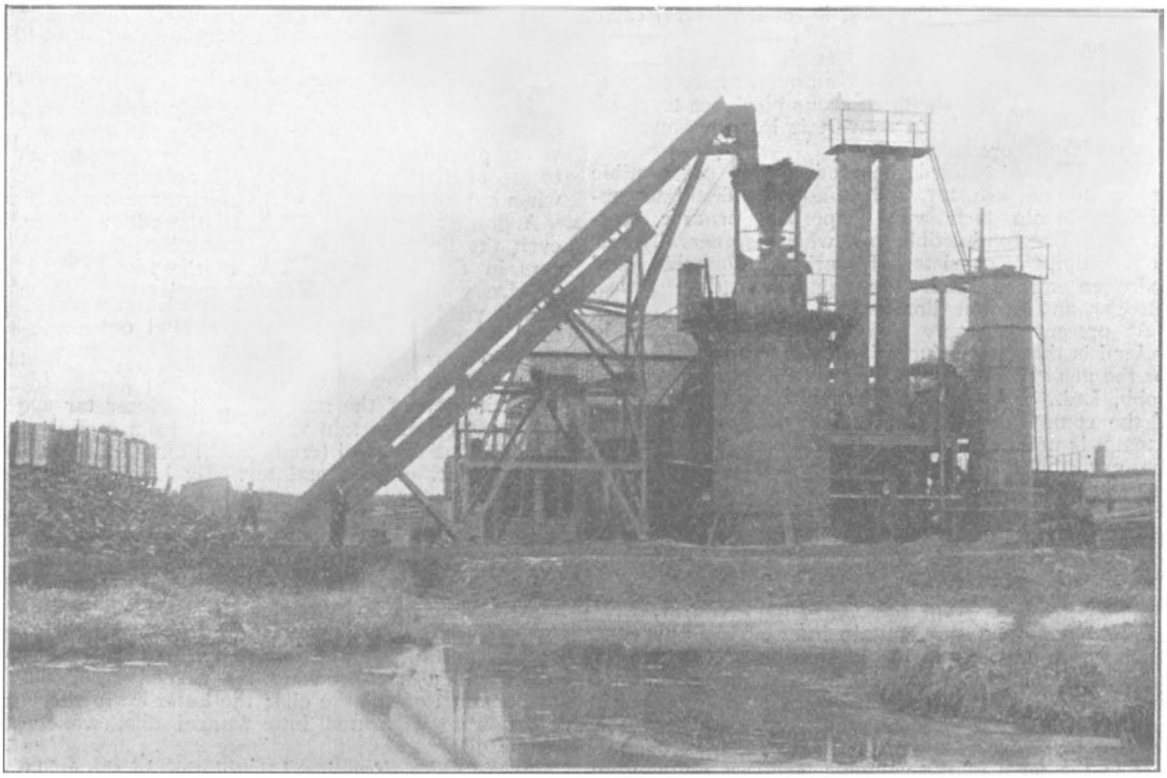


FIG. 2.—The first producer plant in the world making regularly producer gas and ammonium sulphate from wet peat, containing up to 75 per cent. of water.

CHEMICAL ASPECTS OF THE PEAT PROBLEM.

Extensive deposits of peat exist in Great Britain, France, Russia, Italy, Scandinavia, Germany, and Austria. One-seventh of the total area of Ireland is covered by peat, and enormous tracts of this deposit are found in Canada.

Only two years before the outbreak of war a practical solution of the peat problem was claimed for Germany by Dr. Carl Duisberg, of Elberfeld, who at the Congress of Applied Chemistry held in 1912 at New York, stated his case in the following words:—

"The latest and most rational method of utilising the peat or turf beds which are so plentiful in Germany and many other countries is practised in Schweger Moor near Osnabrück, according to a process discovered by Frank and Caro. There peat gas is produced and utilised, and ammonia obtained as a by-product, the required power being generated in a 3000-h.p. central electric power station. The moorland, after removal of the peat, is rendered serviceable for agricultural purposes."

The foregoing development appears to be a practical realisation of the view held by many workers on peat in this country, that the most economical use to make of this combustible is to convert it into gaseous fuel in suitable gas producers.

When peat is gasified the products are combustible gas, ammonia, ash, tar, and an aqueous distillate containing certain technically important organic compounds. The combustible gas, which is generally free from sulphur, consists of carbon monoxide and hydrogen mixed with the non-combustible gases, nitrogen and carbon dioxide.

At present the only plant of this description in Ireland is the gas-producer furnishing the gaseous fuel for the gas engines of the factory of Messrs. Hamilton Robb, Ltd., of Portadown, and although, on account of the comparatively small capacity of the plant, no attempt is made to recover and utilise any by-products, yet, nevertheless, this installation has proved to be a financial success. There can be little doubt that in a scientifically controlled plant, large enough to render practicable the recovery of ammonia and other by-products, the economy effected would be considerably greater.

By-Products from the Peat-Gas Producer.

Ammonia.—Peat may contain from 0·5 to 2·5 per cent. of nitrogen, and by passing steam over peat heated to 350–550° almost the whole of the nitrogen is obtained as ammonia. This improvement has been embodied in the modern types of Mond plant, so that now it is possible to recover the greater part of the nitrogen of peat in the form of the valuable fertiliser, ammonium sulphate. The importance of increasing the output of ammonium sulphate from peat lies in the circumstance that this salt can displace sodium nitrate as a nitrogenous manure, thus rendering the nitrate available for the manufacture of explosives and other chemical products.

The Power-Gas Corporation, Limited, of Stockton-on-Tees, who in 1905 first turned their attention to this method of utilising peat, have obtained the following extremely favourable results:—

Fuel used	German peat per cent.	Italian peat per cent.	English peat per cent.
Moisture content of fuel... ...	40 to 60	15	57·5
Nitrogen content of fuel	1·0	1·58	2·3
	cubic ft.	cubic ft.	cubic ft.
Quantity of gas produced per ton of theoretically dry peat.	85,000	60,000	90,000
	B.T.U. per c.f.	B.T.U. per c.f.	B.T.U. per c.f.
Heat value of gas produced ...	150	166	134
Sulphate of ammonia produced per ton of theoretically dry peat	70 lb.	115 lb	215 lb.

The Simon-Carves Bye-product Coke-Oven Construction and Working Company, Limited, have made large-scale experiments on the gasification of peat in Moore gas-producers. Peat, containing 63 per cent. of moisture and with a nitrogen content of 2·235 per cent., yielded per ton 94,850 cubic ft. of gas (100 B.T.U. per cubic ft.) and 168 lb. of ammonium sulphate.

Peat Ash.—Peat differs from wood in yielding on combustion a comparatively large proportion of mineral ash (5 to 15 per cent.). The ash of peat contains the oxides of aluminium, iron, and calcium existing to a considerable extent in the form of carbonate, sulphate, silicate, and phosphate, a very appreciable amount of alkalis, with a preponderance of potash. By using the peat ash as a dressing for the recovered land the potash locked up in peat would be rendered available for agriculture at a time when the shortage of this alkali is felt very acutely.

Peat-producer Tar.—The incomplete combustion of peat in the producer leads to the formation of a certain proportion of tar which is collected in the hydraulic scrubbers of the plant.

The amount of tar produced yearly in the Portadown plant is about one hundred tons. Samples of this waste product were examined in the chemical laboratories of the Royal College of Science for Ireland, when substances of industrial importance were isolated.

A greatly increased output of the peat tar is, however, the first essential step towards commercial success in this direction. Ten installations comparable in size with that of Messrs. Hamilton Robb, Ltd., would yield approximately an annual output of 1000 tons of peat-producer tar, a quantity which would furnish a practical basis for the industrial exploitation of the derivatives of this tar.

Distillation of the moist crude producer tar effected a separation of certain volatile oils from a non-volatile bituminous material (crude pitch) amounting to about 17 per cent. of the total tar. By heating the crude pitch to 122° C. and pouring off the liquid portion, about 6 per cent. of a refined soft pitch could be separated from a solid friable carbonaceous residue.

This pitch, either alone or mixed with the carbonaceous matter, could be used as asphalt, as a caulking material, or as an insulator in electrical work. The carbonaceous matter could be utilised separately as a self-briquetting combustible of high calorific value.

The moist peat-producer tar yielded on distillation 50 per cent. of volatile oils; the latter by further treatment were separated into neutral oils, waxes, and acidic oils.

Acidic Oils.—Fractional distillation of the acidic oils showed that these substances consisted principally of complex phenolic compounds. Attention was specially directed to these substances as they seemed likely to afford material for the manufacture of useful disinfectants comparable in efficacy with lysol, creolin, cyllin, and other coal-tar disinfectants.

The well-known Rideal-Walker test for disinfectants and the modified procedure devised by Martin and Chick afford methods for controlling quantitatively the separation of the germicidally active acidic oils from peat tar, and for ascertaining the bactericidal value of these acidic oils. Phenol and the cresols are segregated in the fraction boiling below 200° C., which is about seven times as toxic as phenol itself towards *Bacillus typhosus*. The fraction of acidic peat oil boiling at 200–250° is seventeen times as active as phenol (carbolic acid) on the same pathogenic organism.

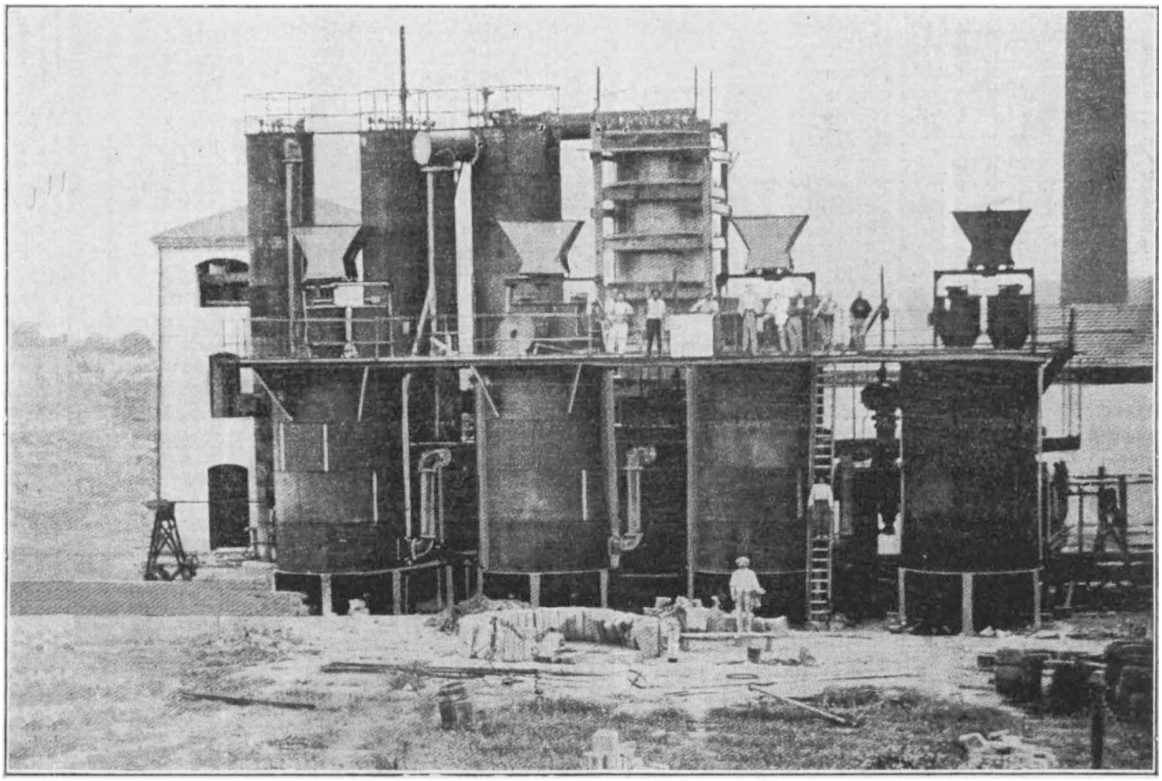
The most intense germicidal activity is possessed by the fraction of acidic peat oil boiling at 253–360°, for this product has a phenol (carbolic acid) coefficient of 31.

These results show that by distillation and simple chemical treatment of the oils obtainable from peat-producer tar one can, under appropriate bacteriological control, isolate oils of intense bactericidal activity suitable for the manufacture of antiseptics, disinfectants, and germicides. When it is remembered that phenol (carbolic acid), the standard disinfectant of this type, is greatly required in the manufacture of explosives (lyddite), drugs (salicylic acid, aspirin, etc.), as well as for many other synthetic products, it will be readily realised that these peat disinfectants would be welcomed as efficacious substitutes for carbolic acid, if they were forthcoming in sufficient amount, especially at the present time, when antiseptics are so urgently needed.

The neutral oils left after extracting the germicidal acidic oils with alkali could be used as lubricants, as liquid fuel, for example, in Diesel engines, and when mixed with the pitch from peat tar would furnish a refined tar.

The higher fractions of the neutral oils boiling above 250° C. deposit on cooling considerable quantities of almost colourless wax, which would serve as a promising starting point for the manufacture of candles.

The aqueous distillate from the producer contains, in addition to ammonia, certain organic substances soluble in water, among which have been recognised methyl alcohol, acetone, acetic acid and its immediate homologues, and pyridine bases. Methyl alcohol is an important solvent and the starting point for formaldehyde. Acetic acid and its homologues are required for the manufacture of acetone and other ketones. Acetone is an important solvent used in considerable quantities in the manufacture of the explosive, cordite. The pyridine bases are pungent liquids useful both as solvents and as disinfectants. The recovery of these compounds could be rendered practicable by suitably modifying the peat-producer plant.



The Power Gas Corporation, Ltd., Stockton-on-Tees.

FIG. 3.—Mond peat power gas plant, with ammonia recovery, designed to gasify about 100 tons peat per day. In operation at a Central Electric Station, Pontedera, Italy.

SUMMARY.

1. The industrialisation of peat could be most efficiently brought about by gasifying it in gas producers, as this procedure would render feasible the recovery of several valuable by-products.

2. The combined nitrogen of the peat can be economically recovered in the form of ammonium sulphate. This valuable fertiliser, together with the peat ash containing potash and phosphoric acid, could be restored to the land from which the peat has been taken.

3. Peat tar, another by-product, can be fractionated into the following useful materials:—Refined pitch and tar, candle wax, lubricating and burning oils, and very powerful disinfectants, greatly exceeding carbolic acid in germicidal strength.

4. The aqueous distillate from the producer contains methyl alcohol, acetone, pyridine bases, and crude acetic acid, all of which are capable of recovery and utilisation.

The economical utilisation of peat in the generation of gaseous fuel, even without recovery of by-products, is to-day an accomplished fact. It can scarcely be doubted that, with efficient chemical control, a larger plant of sufficient capacity to deal rationally with the ammonia, tar, and other products of the destructive distillation of peat would lead to still greater economies.