ordinary iron salt to the sewage does not give the same or anything approaching the same results. Two reasons for this suggest themselves, the first being the fact that the iron oxide in the electrical treatment is used just as it is being made, and the second is that the arrangement of the plates and cells ensures the most intimate and thorough mixing of the precipitating agent with the sewage.

The two questions to be examined are now the efficiency of the treatment and its cost. As regards the result, we have the sludge and the effluent to consider. It seems to me that the chief point of importance in connection with sludge is its quantity; at any rate in a non-agricultural district such as that in which Bradford is situated, the quantity is the chief consideration. The electrical treatment possesses this distinct advantage, that, unlike lime, it adds very little to the sewage, and therefore limits the quantity of sludge to the lowest amount consistent with the removal of the solids from the sewage.

It has been found, also, that the grease, etc., present in the sludge tend to make it more easily burnt. The resulting ash contains a slight percentage of iron, and Mr. Webster suggests that this might make an excellent filtering medium, not unlike the polarite in the Acton process. The effluent, as you see from the specimen before you, is bright-looking, with a slight yellowish-green tinge, due, no doubt, to the small quantity of iron it contains.

It has not been found possible in the small laboratory attached to my department to make elaborate analyses of the effluent, even if such were necessary. The analyses which Dr. Arnold Evans—whom I have to thank for the great interest he has taken in this subject, and for the assistance he has given me—and myself have made clearly show that the electrical treatment does produce an effluent which is fit to go into a stream, such as the Bradford Beck. A great many samples have been taken and analyses made, of which the following is a fair example:

	Sewage before the Electrical Treatment.	Effluent after the Electrical Treatment.
Total solids...	127 grs. per gallon	66 grs. per gallon.
After ignition ...	69 " " "	47 " " "
Loss on ignition ...	58 " " "	19 " " "
Chlorine ...	10 " " "	9 " " "
Free NH ₃ ...	32 parts per million	21 parts per million.
Albuminoid ...	15 " " "	5 " " "

From the above analysis, it is evident that in Bradford we have to deal with a sewage containing an excessively large amount of solids. The effluent after the electrical treatment shows a reduction of nearly 50 per cent. It must be carefully noted, however, that the loss on ignition was 58 grains per gallon out of 127 grains total solids, or nearly 46 per cent.; while in the case of the effluent the loss on ignition was only 19 grains per gallon out of 66 total solids, or a little under 29 per cent. Thus it may be taken for granted that something like 70 per cent. of the putrescible and noxious portion of the sewage was removed.

This conclusion is borne out by the results of Wanklyn's process. Thus while the free ammonia was reduced from 32 to 21 parts per million, the albuminoid ammonia was reduced from 15 to 5 parts per million, giving a reduction of 66 per cent. of the objectionable constituents of the raw sewage, a result which the lime treatment falls far short of accomplishing. Microscopic examination of the sewage before treatment revealed an abundance of infusoria, bacteria, and other low forms of organic life, while in the effluent no living organism could be detected. From investigations conducted in Paris, Mr. Webster states that the organisms were reduced in number from 5,000,000 per cubic centimetre of raw sewage to 600 in the effluent.

A very important consideration is the amount of secondary putrefaction that takes place on keeping. If the electrical effluent be kept in a stoppered bottle for some days it becomes very dark in colour, a change which does not take place if it be kept in an open vessel, and in such a vessel it may be kept a long time without offensive smell being given off. Under the ordinary conditions of a running stream the effluent becomes materially improved from the aeration that takes place.

Another test, which to some may appear the most valuable of all, is that small fish, tadpoles, etc., have been kept alive for weeks in a glass vessel containing only the effluent to which some moss had been added.

To sum up, there is every reason for believing that in electricity as used in Mr. Webster's patent we have an agent capable of purifying even the worst sewage to such a degree as to render it fit to enter an ordinary stream. As to the question of cost, I am

sorry that I have no definite information to lay before you. There can be no doubt, however, that a large initial expenditure is necessary on account of the immense quantity of iron employed, and the large amount of tank room necessary. From the quantity of iron present in the sludge and the effluent, it is quite clear to me that a considerable amount of iron must be daily consumed, but as to the length of time that elapses before the plates must be replaced, I am unable to inform you. The experiments have been so interrupted that a sufficient time has not yet been given in which to form an estimate. I believe that if any difficulty arises in the employment of electricity for the treatment of sewage, it will be not the want of efficiency but the great expenditure which it entails.

II.—ALFRED HILL, M.D.,

Medical Officer of Health and Analyst Borough of Birmingham.

THE President said he did not think the effluent from the electrical treatment was sufficiently pure to go into a stream to be used lower down for drinking purposes. The effluent, on the other hand, from the Birmingham sewage farm was purer than the river water into which it flowed. The milk from the cows on the farm was most excellent; 13 per cent. of total solids was the average quality. Bradford ought to seek for a solution of its difficulties in this direction.

III.—A. BOSTOCK HILL, M.D., D.P.H.CAMB.,

Professor of Toxicology, Queen's College, Birmingham.

DR. BOSTOCK HILL said that he had examined all the plans of precipitation hitherto proposed, and had visited Bradford and observed their old lime precipitation process in 1885. While it was difficult to appreciate all the figures in a paper without having them before one, still, as far as he remembered them, it seemed to him that the results as given by Dr. MacLintock were not very favourable. He would like to ask Dr. MacLintock whether any analysis had been made of the sewage filtered from the suspended matter, as that was the only way the effect of any process on the dissolved organic matter could be ascertained. He would also like to ask whether Dr. MacLintock had any information as to the cost of the new process, whether or not there was an increase in the cost as the process went on. Up to now it seemed to him that the process did not compare very favourably with other existing methods, especially that of treatment by land.

IV.—ALFRED CARPENTER, M.D.LOND., J.P.,

Examiner in Public Health, University of Cambridge.

DR. CARPENTER advocated sewage farming as the only useful method of utilising sewage. He referred to the Birmingham Sewage Farm as a satisfactory solution of the difficulty as regards Birmingham. The electrical treatment could not remove much of the dissolved organic matter of sewage.

THE ABATEMENT OF THE SMOKE NUISANCE.

Read in the Section of Public Medicine at the Annual Meeting of the British Medical Association, held in Birmingham, July, 1890.

By SIDNEY BARWISE, M.B.LOND., D.P.H.CAMB.,

Medical Officer of Health Blackburn.

THE time is come when I think we can with great advantage review the progress that has been made in the means of abating the nuisance caused by smoke, and consider the reasons for the complete failure (except as regards the metropolis) of the legislation on this subject.

The agitation against smoke started in the year 1306, when, in response to a petition from Parliament, Edward I, by proclamation, "prohibited the burning of sea-coal in London and its suburbs, to avoid the sulphurous smoke," and commanded all persons to make their fires of wood. That the anti-smoke movement, after nearly six hundred years, has not yet attained its object is evident to sight, taste, smell, and touch in any manufacturing town on working days. Manifestly either means of abating the nuisance have not been discovered, or our legal procedure is at fault.

A glance at any manufacturing town on a Sunday, and again on a working day, proves at once that the smoke cloud does not

come from the dwelling houses; and in this paper I am dealing only with manufacturing smoke, especially that from the large horizontal boilers.

Smoke arises from a furnace both when the supply of air admitted is inadequate for the complete combustion of the fuel, and when a sufficiently high temperature to effect combustion is not maintained, this being frequently the result of endeavours to prevent smoke by admitting an excess of cold air.

I have tabulated the various methods of dealing with the problem, and the latter is the reason for the failure of many of them, especially of varieties of split bridge.

Contrivances for admitting air, either heated or cold, by steam injectors, fans, by special tubes through the flue, through the fire, through hollow bars, and so on, to various parts of the boiler, have been invented and patented a thousand times. This is a matter worth insisting upon, because someone is always making himself a nuisance by claiming to have solved the smoke problem, and inflicting upon an already surfeited public, methods that have been known for many years.

With regard to split bridges, one which works admirably is that of Roscow, of Bolton, and it well illustrates the necessity for a split bridge being provided with a movable door. In this apparatus the door is supposed to be kept closed; the result is that the bridge gets white hot; after firing, a cloud of dense smoke appears, but if the door be opened the air rushes through the white hot bridge and ignites the smoke, the chimney top getting clear in a few seconds. Smoke can be turned on again at pleasure by closing the door, and again stopped by opening it; if, however, the door remain open constantly until the next firing time, it will have lost its power, the fact being that it has cooled down. The draught through the fire at the same time is lessened by the amount of air passing through the hollow bridge, and smoke is emitted pretty much the same as if it were not there.

With this apparatus the heat would be maintained better by having a series of fire-brick reverberatory arches beyond the bridge. The most modern arrangement on this plan is Ashworth and Kneen's; in this system the air is heated in the side flues and forced by a special pipe along the flue to the back of the bridge, and there mixes with the smoke, passes over a series of zig-zag plates of special construction, and the smoke is burnt.

Most of these methods depend upon the attention of the stoker and the quality of the fuel for their success. Six hundredweight per hour is fair duty for a 7 ft. by 28 ft. double flued Lancashire boiler fired by hand, and whether there is a split bridge or no split bridge, where the work required of the boiler is much more, it cannot be done without creating smoke, except by means of a mechanical stoker; for this reason and the fact that they can burn an inferior slack and require less labour, mechanical stokers, at any rate for large boilers, are becoming more used every day, and in Blackburn between 60 and 70 per cent. of the large boilers are fired by these appliances.

Mechanical stokers can be divided into two classes: Those that constantly throw small quantities of fuel on the fire at different distances from the front of the grate; and those that coke the fuel, the gases given off in the process of coking being burnt in passing over the clinker.

With regard to the spray-scattering stokers they certainly diminish dense black smoke, but they substitute for it an almost continual outpouring of smoke of moderate density. In my own district I find that in a large number of cases mechanical stokers of the spray-scattering class have been tried and discarded, for although they may work well at first, in a few months they throw the fuel unevenly, and unless the furnace has travelling bars the rake has to be applied frequently to level the fire, cold air is admitted, heat wasted, and smoke made. Smoke observations made in Blackburn on these furnaces show that dense black smoke is emitted for 2.3 minutes per hour per double flued Lancashire boiler, while boilers without any appliances send forth smoke for 2.7 minutes. It is becoming common to make these machines with movable bars, and they certainly then cause much less smoke.

We now come to mechanical stokers of the coking class. Of this form Cass's, of Bolton, is the simplest, and is not a patent, but Vicar's and Sinclair's is equally good. Knap's, McDougal's, the Helix and Hodgkinson's coking furnaces are also, I believe, very effective in practice. In the Cass furnace the fuel gravitates from a large hopper on to the dead plate, where it is coked by the heat radiated from a fire-brick arch. The fire bars come out one at a time for

four inches, and then all go back together, carrying the fuel with them off the dead plate, and the half molten clinker flows over the ends of the bars into the ashpit.

Mr. Herbert Fletcher, of Bolton, a gentleman to whom all lovers of pure air have cause to be grateful and whose experience on this question would be most useful in our legislative assembly, has for thirteen years been using Cass's mechanical stoker at his colliery, and for thirteen years his chimneys have emitted practically no smoke. Vicar's machine is also one of the successful stokers, as the tall chimney by Blackfriars Bridge belonging to the London Hydraulic Power Company bears witness. The principle of it is practically the same as Cass's; it has a distinct fire-brick arch, short bars, and a series of pushers to feed the furnace. Messrs. Musgrave and Sons, of Bolton, write that they have tried a variety of methods during the last seventeen years, including six different kinds of mechanical stokers, and they were never satisfied till they put on this coking stoker. Sinclair's stoker is very similar to Vicar's; it appears to be capable of heavier duty, and at Messrs. Peter Crooks, of Bolton, 93 tons of cheap slack are burnt each week of fifty-six hours smokelessly in three 30 feet by 8 feet Lancashire boilers—rather less than was previously burnt by hand firing; there is, however, danger of the firebars burning unless the fireman does his duty.

The Health Committees of Oldham and Blackburn made independent inquiries into the best means of abating the smoke nuisance, and both approved of coking mechanical stokers only. Several coking mechanical stokers have already been applied at Oldham with most satisfactory results. At the West End Old Mill fifteen observations of an hour's duration before Cass's furnace was applied gave an average of 14 minutes 32 seconds dense black smoke; eight observations since of an hour's duration gave an average of 24 seconds. At the West End New Mill the same furnace has been applied, and reduced the smoke emitted from an average of 7 minutes 32 seconds to 6 seconds per hour. At the Wrigley Street Mill eight observations before Sinclair's furnace was put on showed that dense black smoke was emitted on an average for 8 minutes 41 seconds per hour, while eight observations of an hour's duration since it has been applied show that absolutely no dense smoke at all has been emitted.

It is not, therefore, for want of means of abating the nuisance that the anti-smoke movement has been so unsuccessful: the fault lies at the door of the sanitary authorities, who in the past have shirked their bounden duty under the Public Health Act in not specifying the means of abating this nuisance when dealing with it under that Act. The first part of the seventh clause of the 91st section of the Public Health Act defines as a nuisance "any fire-place or furnace which does not as far as practicable consume the smoke arising from the combustible used therein, and which is used.....in any manufacturing process whatsoever." The same section provides in its last paragraph that the Court shall dismiss the complaint if it is satisfied that such furnace is constructed in such a manner as to consume as far as practicable its smoke; if these words have any meaning when applied to horizontal boilers, they mean if they are fired by coking mechanical stokers, and not unless. That the authority must specify the means of abatement is quite plain, since Mr. Justice Mathew and Mr. Justice Smith delivered themselves so strongly on this point in the case of *Regina v. Wheatley*. Mr. Justice Smith's words are: "This point has frequently been involved incidentally in former cases, though not yet precisely decided, so that we are not bound by any authority. I agree with my brother Mathew that the necessary effect of the section is that the order must specify the works to be done, the notice served under Section 94 must state a time for abating the nuisance, and the things to be done. If any of the requisitions are not complied with, by Section 95 the party may be summoned before the justices. That section would not have been expressed as it is if the particulars were not to be specified in the notice of the nuisance. I also think that the forms given in the schedule show that these particulars must be part of the order, as was said in *Regina v. Llewellyn*."

At Bolton, owing to a case having to be withdrawn, the authorities there now specify the use of a mechanical stoker as the means of abatement, but I doubt whether this notice is good. How much better, then, to take the bull by the horns, and specify known and accepted means of abatement, instead of taking shelter behind vague phrases. In cases of special difficulty it might be necessary to consult a specialist; perhaps the new society for testing smoke appliances would advise, but in all ordinary horizontal boilers the specification of coking mechanical stokers, with

which the use of the rake is not required, would soon put an end to a nuisance which is a disgrace to our vaunted sanitary progress and civilization.

II.—THEODORE THOMSON, M.B.LOND.,

Lecturer on Physiology Sheffield School of Medicine; Medical Officer Sheffield.

DR. THOMSON entirely agreed with Dr. Barwise's exposition of the legal view to be taken as to the administration of the Public Health Act clauses. On the question of apparatus to be employed, Dr. Thomson pointed out that the question had too usually been considered entirely as a question of boiler furnaces, and these, too, in trades in which a tolerably uniform pressure was maintained. In Sheffield, in the heavy trades, the pressure in boiler furnaces had often to be very suddenly raised, and to a very high degree, which increased the difficulty of dealing with the smoke. Further, converting, heating, and other furnaces were, from their structure, beyond the reach of mechanical stokers and many other so-called smoke abatement apparatuses. He considered that in these cases, where local authorities are not prepared to advise what apparatus should be employed, and to prove their position, it should be their duty to ascertain by experiment what apparatus to recommend.

RESOLUTION.

The following resolution, proposed by the PRESIDENT, and seconded by Dr. UNDERHILL, was adopted:—"That the Section, acknowledging the difficulties of advising as to the best means of dealing with the smoke nuisance, points out to the Association the value of the work done by the Society formed for testing the various methods of smoke preventing appliances, and suggests that the British Medical Association recommend the various sanitary authorities to subscribe to it."

CLINICAL INSTRUCTION AT FEVER HOSPITALS IN CONNECTION WITH THE OPERATION OF THE COMPULSORY NOTIFICATION ACT.

Read in the Section of Public Medicine at the Annual Meeting of the British Medical Association, held in Birmingham, July and August, 1890.

By EDWARD SEATON, M.D., F.R.C.P.,

Lecturer on Sanitary Science and Public Hygiene St. Thomas's Hospital; Medical Officer of Health Chelsea.

WE shall probably all agree that one of the chief uses of the Compulsory Notification of Infectious Diseases Act is to secure the isolation of persons suffering from the diseases specified in Act, and which spread by contagion. We should also agree that in a very large proportion of such cases isolation cannot be obtained in the dwellings of sick persons, and that, unless a suitable hospital is provided for their reception, the sanitary authority will not be in a position to take effectual measures to prevent a spread of the disease. An authority which fails to provide an infectious hospital is severely in default. It is therefore assumed in this paper that the adoption of the Notification Act, as in the metropolis, has been preceded by the provision of hospital accommodation of a suitable kind. Under these circumstances, compulsory notification in many cases must virtually amount to compulsory removal to hospital, and, consequently, correctness in diagnosis becomes more important now than ever. It may be said that it is assuming too much to suppose that "compulsory" as distinct from "voluntary" notification may in some instances be injurious to individuals through possible mistakes in diagnosis, inasmuch as no one is compelled to notify until he is sure about the nature of the disease. To this it may be replied interrogatively, Is the practitioner always sure of the nature of the disease when he feels compelled to notify? Probably not; and so we may partly account for cases in which the diagnosis before removal to hospital has afterwards proved to be incorrect. Now in these cases serious and, as things are now, practically unavoidable accidents have happened. For the occurrence of such accidents the authority, or authorities concerned in the operation of the Compulsory Notification of Infectious Diseases Act, are, in a measure, responsible. This is the light in which our eminent and experienced colleague, Dr. Russell, evidently regards the situation, as is clearly shown by the prominence which he has given to the question of "Errors in

Diagnosis of Infectious Diseases," and by the stress he lays on the importance of making sanitary hospitals available for teaching purposes. The same view has been taken by the authorities at New York, whose system of compulsory notification is supplemented in various ways so as to provide against its operating injuriously to individuals. The occasional inspection of cases before removal by "expert diagnosticians," appointed by the municipal authority, prevents to a considerable extent harm resulting from what are styled "unpardonable errors in diagnosis;" while in other cases, pardonable or unpardonable, the interests of the patient are further safeguarded by the provision of ample accommodation for doubtful cases, which accommodation at New York is distinct from special hospitals. The hospitals of the Metropolitan Board, though well equipped in most respects, are deficient in this kind of accommodation. The recently published statistical report of the Board may be here referred to. It contains a quantity of very interesting information on this subject which deserves careful study. The cases of mistaken diagnosis at the metropolitan hospitals amount to less than 4 per cent. of the admissions, and are therefore rather less in proportion than those which are reported at Glasgow. But it may be observed that the proportion varied at the several hospitals of the Board. Thus, at the Eastern and South-Eastern hospitals the proportions were respectively 4.5 and 4.0, while at the North-Western and Western they were respectively 2.7 and 2.6. A difference between 4.5 and 2.6 per cent. is very remarkable, and some explanation should be given of this in the Board's report. The cases in which errors were least frequent were (as at Glasgow) in scarlet fever. They were more frequent in diphtheria, typhus and enteric; and they were most frequent of all in small-pox, only 5 out of 26 (or about 19 per cent.) cases of this disease being diagnosed correctly. This seems an astonishingly large proportion of error; but in estimating its significance there are special considerations to be taken into account. The policy of the Board during the last few years has been to move all doubtful or suspicious cases of small-pox by its ambulances to one of its hospitals. There further medical examination takes place without taking the patient into a ward occupied by other sick persons. By these special arrangements the spread of small-pox is prevented with practically no harm to individuals whose cases do not turn out to be small-pox. I am afraid the same cannot be said absolutely of all the cases sent in as scarlet fever, diphtheria, typhus, and enteric fever. In a few cases of convalescent scarlet fever, amounting to about 1 per cent. of the admissions, and in some cases sent as diphtheria and diphtheritic croup, the diagnosis of the certifying practitioner must be relied on entirely, as there are no symptoms at the time of admission which allow of an independent diagnosis being made. The last-named disease is likely to be a source of difficulty to sanitary authorities in more ways than one. Dr. Donkin, in a very important letter to the *Lancet* of July 5th, has indicated one difficulty, arising from the fact that cases certified as membranous croup may be, and are, sent to hospital. Dr. Sweeting, in his last report for the Western Hospital, writes passages of great significance regarding the policy of the Board in segregating cases of diphtheria. It is impossible to read this report without feeling that patients admitted into these wards and not protected against diphtheria may incur considerable risk.

It is unnecessary to dwell on this part of our subject any longer. Enough has probably been said to indicate the kind of risks that we have to be on our guard against. It is plain that the principle of compulsory notification itself would be in danger if all possible safeguards against injury through its operation be not provided. The precaution instituted by the American system is hardly possible in this country, although some modification of it might well be adopted. It would be much better for the public and the patient if the advantages of consultation with experts in the diagnosis of fevers were more frequently sought by general practitioners, and it would be a great advantage if, in the case of the poor, provision could be made by boards of guardians for the payment of the consultation fees. Such an arrangement would probably save the ratepayers money in the long run. The establishment of separate wards for doubtful cases is very expensive, as it greatly increases the difficulties of infectious hospital administration; but it is not improbable that the Metropolitan Board will have to make some provision of the kind. It is to be regretted that in some recently constructed provincial hospitals no accommodation for doubtful cases exists at all. But the employment of "expert diagnosticians" (to use the American phrase), or the establishment of wards or a separate hospital for doubtful cases, are only provisional