

Discussion.

Mr. Giles.

MR. ALFRED GILES, President, said he was sure members would accord to the Author their cordial thanks for the useful information he had given. Speaking from his own experience, he did not think that householders in general were very regardful of the waste of water. The water-companies had not endeared themselves to water-consumers, who generally considered the rates rather high, and therefore were somewhat reckless in the expenditure of water. He hoped this Paper might lead to a better result.

Mr. Collins.

MR. COLLINS observed that his Paper had been compiled eighteen months ago, his object being to place on record certain facts which had come to his knowledge during a rather long experience in the introduction of a system for the prevention of waste. He had felt some doubt as to the possibility of introducing sufficient novelty into the treatment of the subject to justify the reading and discussion of the Paper. The matter, moreover, had been dealt with some years ago before the Institution, and his Paper had therefore been compiled mainly with a view to publication in the Minutes of Proceedings. In regard to his statement concerning the objectionable and unreliable nature of the automatic flushing-tank, he did not mean to imply that it must in every case be condemned, but that, as it was a wasteful apparatus, it was objectionable when it was in direct communication with the supply-works of the company. He was quite prepared to admit that under certain circumstances the apparatus might, when properly applied, be of the greatest importance from the sanitary point of view. He had known cases in which the flushing apparatus had been placed in such a position that it acted as a receptacle for all water which had already served a useful purpose, such as water which had passed through the household for baths, as also for other harmless liquids, until a sufficient quantity had been collected. The contents were then discharged with a sudden and rapid flush through the drains, thereby keeping them clear between the house and the sewer. The question of cleansing the drains between the house and the sewer was one that was now coming into great prominence.

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Bramwell.

SIR FREDERICK BRAMWELL, Past President, said the Paper dealt with a very important subject, the waste of water. He was not in the habit of applying the word "waste" to the excessive use of water within the house, but rather to such dealing with it as to cause it to disappear from the works of the water-company and

never to appear in the house of the consumer. In this country it was believed to be best on sanitary grounds to charge for the water used in private houses by a rate, and not by the quantity taken. It was probably an illogical system; but so was the plan of charging for the use of the sewers, since a man who lived in a high-rented house did not burden the sewer more than a man who lived in a low-rented house. Again, households were content to pay by a rate for street-lamps and for paving, and they ought therefore to be content to pay for water in the same way, although the payment that different individuals were compelled to make per 1,000 gallons was very unequal. He believed that the average return per 1,000 gallons for the whole supply of London was somewhere between 6*d.* and 8*d.*; but he found that he was paying between 3*s.* and 5*s.*, and he did that in order that some man, say in Limehouse, might get his 1,000 gallons for 1*d.* or 2*d.* It might be, as he said, illogical; but there were many things that were illogical and yet worked. He had commenced his remarks on the Paper by the consideration of the mode of charge, because no doubt that mode conduced to waste. It required a man with some notion of fair dealing, even in regard to companies, to feel that he ought not to waste water. He was sorry to say that that condition of mind did not always prevail, and many a man dealt in a very different way with the water for which he paid by rate, from the way in which he dealt with gas for which he paid by meter. Until, therefore, people adopted a meter-supply (and he well remembered the admirable Paper on the sale of water by meter in Berlin¹) it was their duty to do all they could to prevent that which he called real waste, and also, although very rarely, to prevent the use of water in a way which was scandalous, as, for example, when a woman, in order to save some soap and labour, put the clothes to be washed into a pail and set the tap running upon them all through the night. That, in a certain sense, was a use of water, but it was a scandalous use. He did not think there was much scandalous use, although there was one water-company that was considerably afflicted by it. He was, however, rather dealing with the pure waste, the waste which took place without even the knowledge of the consumer. He had prepared a diagram to illustrate what he meant.

The parallelogram, *Fig. 12*, represented by the open hatched lines from right to left showed the amount of water going away

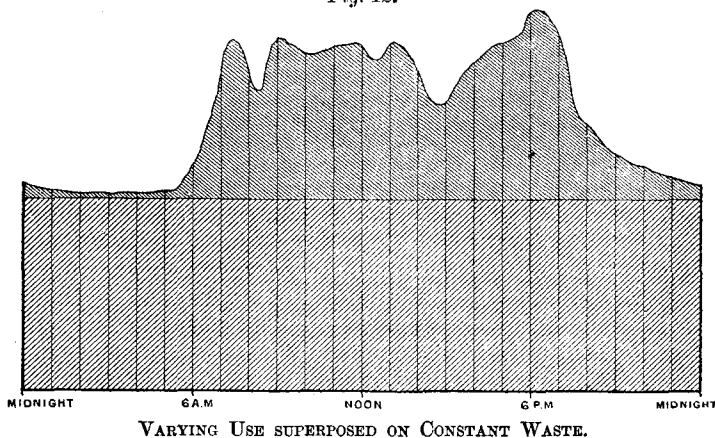
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¹ Minutes of Proceedings Inst. C.E. vol. cvii. pp. 203 *et seq.*

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during the whole twenty-four hours, without getting to the consumer at all, or without his knowing anything about it. That which the householder knew about and used was represented by the irregular shape, distinguished by closer hatched lines from left to right above the parallelogram, showing a use beginning at about six in the morning and varying during the day. The use might be somewhat negligently lavish, but Sir Frederick Bramwell did not complain of that; that of which he did complain was the expenditure of water indicated by the parallelogram beneath, and anything that would get rid of this waste ought to be received with interest and they should do their best to forward its adoption. Simple as was this separation of use known to the householder from the pure waste which was unknown

Fig. 12.



to him, Sir Frederick Bramwell had found it difficult to make it clear to men of even more than ordinary intelligence. After trying to explain the matter to a person in a high position in connection with an inquiry, he was asked by him, "Don't you think that if you endeavour to cut off that portion the consumer will complain?" The whole gist of his argument was that the parallelogram represented a part of which the consumer knew nothing, as was proved by the fact that the loss went on while he was asleep. It was that loss which the waste-water-meter and other contrivances were intended to get rid of. To show what might happen when the water-supply was in the hands of a town council afraid of their electors and not daring to make regulations, he might refer to the case of Philadelphia, a city which many of the

members had visited. He had brought with him several reports of the water-supply, and in reference to these he desired to give a word of warning to any of his hearers who might look at American water statistics, namely, that it should be borne in mind that the American gallon was only five-sixths of the English gallon. From these reports he had compiled a Table for the period from 1881 to 1890.

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PHILADELPHIA WATER-SUPPLY.

Year.	Gallons per head per day.	
	American.	English.
1881	71	59
1882	76	63
1883	75	63
1884	74	62
1885	72	60
1886	80	67
1887	89	74
1888	100	83
1889	110	92
1890	132	110

From this Table it would be seen that in 1881 they were supplying in Philadelphia 59 English gallons per head per day, and that by 1890 the amount had grown to 110 gallons, showing that the increase of useless water had been extended by 51 gallons per head per day, or many times more than was sufficient for the town supply. He held in his hand the report of the Water Bureau for 1890. "The most notable feature" (the report stated) "of the report is the startling increase in the quantity of water pumped. Considered from either the standpoint of the total pumpage, or the quantity per capita, this subject should have immediate consideration by Councils." After giving a comparison with the figures of ten years ago, the report continued :—"Wasted water. No one would pretend to believe that this represents water actually consumed, for either household or manufacturing purposes, and that in 1890 there should have been required 131 gallons per day, or 63 gallons per day more than in 1880, for every man, woman and child in Philadelphia. On the contrary, everybody must be satisfied that these figures represent a flagrant waste of water." The compiler of the Report then tried to ascertain how this waste was caused, and they stated that they were too much interfered with by the Council, and suggested that if some one man were appointed to look after

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the whole water supply it would be done properly. Waste of water was no doubt attended by many evils. There was a large addition to both the initial expenditure and to the annual expenditure, especially when pumping was needed, and further water was diverted from its proper uses to be sent needlessly down the drains. That was evil number one. Evil number two was, that all the water that went down the drains added to the volume of the sewage, and to the difficulty of getting rid of it by any means that might be employed, unless it pleased Providence to provide a river flowing in a given direction, taking it away from the town and not annoying any other neighbourhood. These cases, however, were most rare. Another point was the diminution of the pressure in the pipes. It was impossible to obtain an extra amount of water through a given sized main, except by having a greater differential pressure between the entering end and the delivery end of the main. The entering end of the main was fixed by a reservoir or a stand-pipe level, or whatever it might be, and the consequence was that the increase in the differential pressure must be obtained by diminishing the pressure at the delivery end. What was the result? Any hope of using the water for hydrant purposes for extinguishing fires, was gone; there was no pressure for that. Moreover there was not pressure enough for household purposes. In New York, for example, matters had come to this pitch, that in the ironmongers' shop-windows hydraulic engines were exposed for sale to be put in the cellars of the houses, to be worked by the feeble pressure water that still remained, so that some portion of it might be pumped into the upper storey. The last time he was in Philadelphia, in 1884, in the midst of some terribly hot weather, the thermometer being over ninety, he stayed in one of the best streets of the town, and had for his host a member of the Institution of Civil Engineers; but in this first-class house, and notwithstanding the engineering skill of its owner, it was impossible to obtain water in the bath on the first floor, because there was not pressure enough, and the water had to be carried up in cans. These were the results of waste. With regard to the waste-preventer fittings, he had had a large share in their introduction twenty years ago, having Sir Robert Rawlinson as one of his judges, and Lord Methuen and Captain Tyler for the others. They thought they were doing wisely to prescribe apparatus to prevent the excessive use of water in water-closets. There were certain well-disposed men (as for instance a Baron of the Exchequer whom he knew) who thought they were doing the right thing by lifting up the handle and propping it up with wood, so as to "flush the drains." Circumstances, however, had so much altered since the date of these

regulations that he now doubted whether they were not actually adding to the waste. It was well known that modern water-closets were made with lifting seats for the convenience of male urination. A waste-preventer, known as the "pull-and-let-go," was put in, and with such an apparatus the whole quantity of water came out, whether they liked it or not; so that, for the mere purpose of washing down the liquid urine, two gallons of water were delivered into the drain (and now some said it ought to be three gallons). That was a waste greatly to be deplored, and he thought it would be well worth the attention of the directors and engineers of water companies to consider whether, having regard to those facts, it would not be advisable to leave the old fittings as they were, so that a man could not discharge more water than was required unless he stood and held the handle. Such flushings were most undesirable, and enormously increased the amount of sewage. With regard to waste-water-meters, he knew more about the Deacon meter than about others, because it so happened that Mr. Deacon was engineer to the Corporation of Liverpool when Sir Frederick Bramwell was called in to advise them as to its adoption. He spent a considerable time looking into the matter, and advised the Corporation that they ought to use the meters, and they did so with great success. The meters gave much economy in supervision, because they showed what houses or what streets the inspectors had to supervise, and they also prevented them from going and troubling the wrong man. There was nothing that made an innocent man more angry than to have someone calling and saying, "I want to see whether you are doing right." It at once made the man an enemy. If, however, they only went to the man who had been doing wrong, he had not much to say. Not only was the number of visits thus diminished, but the population was kept in good temper, which of itself was an extremely important matter. Waste-water-meters gave them the means of discovering concealed leakages in the mains and pipes. When the water was shut off from every house, if it were found that the night quantity was still abnormal, the suppliers of the water might be sure that their own mains were broken or defective. The introduction of waste-water-meters dated from sixteen years ago or more. They had been gradually taken up—rather too gradually—but they had been approved by very many of the best engineers. He remembered a Paper read some years ago before the Society of Arts, when he himself was in the chair, and also a very valuable report by Mr. Binnie, who was engineer of the Bradford Corpo-

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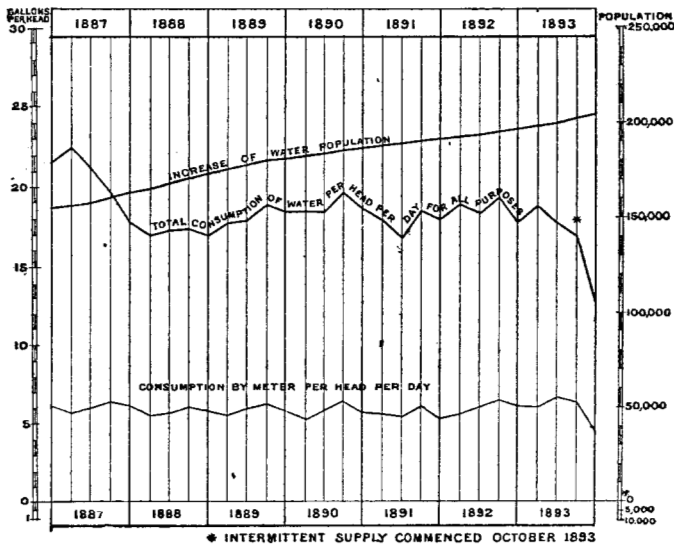
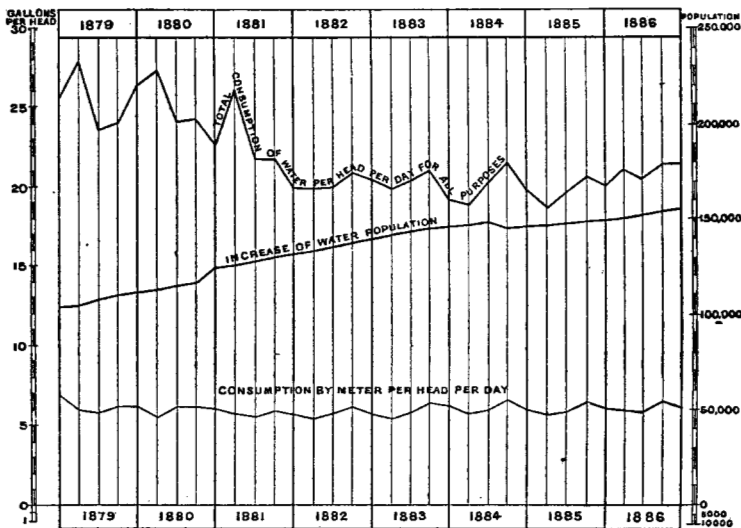
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ration, as to the way in which he had adopted these meters, and the beneficial results arising from their use. Reverting to the meter-diagrams placed on the wall by the Author of the Paper, one of these showed a midnight consumption of 2,500 gallons before the attempt was made to discover and localise the places of waste, and showed also that after the waste had been localised (the localisation probably not amounting to one-tenth of the whole property served) the amount was reduced to 900 gallons; in other words, the open hatched portion of his (Sir Frederick Bramwell's) diagram, *Fig. 12*, was greatly diminished, while the close hatched part was not affected. There was no interference with the water which the consumer used, the only interference was with the water of which he knew nothing, and which was pure waste. It was certainly worth while for the Institution to do its best to enable water engineers to stop all such useless expenditure.

Mr. Griffith.

Mr. F. GRIFFITH said that the Author was to be congratulated in being associated with a water undertaking which could afford to be satisfied with such a large amount of permanent waste as 8 gallons per head per day. In many of the Midland towns the question of reducing waste of water to a minimum had forced itself on the engineers having the control of such towns. This had been especially so in the case of Leicester, in consequence of the rapid increase of water-consumers, and also the diminished rainfall in recent years. The consumption for all purposes, including waste, for a constant supply had been reduced to 17·56 gallons per head per day; and for the last quarter of 1893, owing to a limited supply, to 12·31 gallons per head per day. The results of the reduction of waste from 1879 to 1893 were illustrated by *Fig. 13*, which showed the yearly increase in the water-population, and the consumption per head per day measured by meter for trade and municipal purposes. These results had been obtained without invoking the aid of a waste-water-meter. The following simple means had been successfully adopted in tracing waste of water in the case of defective services and fittings above ground and below ground:—The area within the limits of supply was divided into 331 districts, each district being controlled by a stop-valve, which during night inspection was closed and opened slowly. During this operation the flow of water was heard by the aid of the stethoscope. The amount of waste on the district under inspection was gauged according to the number of revolutions by which the valve was opened when the sound of water was heard to be flowing through. If there was no sound there was no waste. Where water was found to be flowing through valves at more

Fig. 13.



LEICESTER CORPORATION, WATER-WORKS.

DIAGRAM SHOWING THE CONSUMPTION OF WATER PER HEAD PER DAY AND THE INCREASE OF POPULATION.

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Mr. Griffith. than a quarter of a revolution the result was booked and the matter was referred to the day inspector, who followed up the report of the night inspector, and traced the waste to its source, by sounding and inspecting the various fittings and services in the district. The sound increased as the point where waste existed was approached and the leakage was thus eventually found and repaired. Samples of defective lead services found underground by these means were exhibited; and as many as three fractured service-mains had been found in one night's inspection. The water-population was 203,035. There were 40,607 houses, and 26,704 water-closets. The use of siphon-cisterns, as well as of double-valve cisterns to give a 2-gallon flush, was permitted, if equal to the specification and sample exhibited in the testing-room. A test by meter on water-closets where siphon-cisterns were used, as against double-valve cisterns, showed a result in favour of the siphon-cistern; and a similar test by meter between the self-closing tap and the screw-down tap showed a result in favour of the self-closing tap. Meters were changed, tested and repaired every three years, the results being entered in a book stating the cost of the meter, date of purchase and the cost of repairs. The whole of the fittings within the limit of supply were periodically surveyed and the result entered in the fittings register. The staff of waste inspectors consisted of one chief inspector and six sub-inspectors, who devoted their whole time to detecting waste and re-washing taps. The number of reports attended to in 1893 was 17,744, consisting of burst service-pipes, closet-fittings, and tap-repairs. Waste-water-meters were in use in many water-works undertakings. Without the aid of a staff of waste inspectors such meters could not be worked successfully, but the case illustrated in Leicester proved that with efficient and intelligent inspection such meters were unnecessary for detecting waste. The system by which the water-supply in Leicester was controlled had from time to time been referred to by the late Mr. T. Hawksley, the last occasion being in his evidence before the Royal Commission on the Water-Supply of the Metropolis.

Mr. Morris. Mr. W. MORRIS said that the Author in one of the appendixes appeared to abandon one of the great features of Mr. Deacon's system of waste-detection, namely, the use of the outside stop-cocks, which he seemed to think impracticable in the metropolis. The Author had done a great work in establishing a system of stamping fittings. The other London Water Companies had not taken any action in that direction, but several of them had

fixed outside stop-cocks to the houses and had not found much difficulty in doing so. When the Kent Waterworks Company, with which he was connected, put the district under a constant supply, they did the work themselves, fixing the stop-cocks at moderate prices. People knew that the work was done more cheaply by the Company, and they therefore asked them to undertake it. The stop-cocks were fixed outside as close to the boundary as possible, and there had been no such litigation as the Author appeared to apprehend. With regard to repairs, it was not absolutely necessary that every time a stop-cock was out of order the paving should be taken up to get at it. By means of a key they could take off the top of the stop-cock, put on a fresh valve, and make it tight. It ought not to be supposed that the water-works engineers of the metropolis had given up the idea that outside stop-cocks were a valuable part of the Deacon system. On the contrary, they regarded them as most desirable, and perhaps as even more important than the meter itself.

Sir ROBERT RAWLINSON, Vice-President, desired to make a few suggestions for the benefit of those who had to deal with small populations and a comparatively small area, and who could not afford to use the Deacon or any other expensive apparatus for testing the waste of water. In a village with which he had been connected forty years ago, there was a waste of water in the mains, and the solicitor of the place, who was a very ingenious man, hit upon a method, by isolating one area after another. He brought a bit of hose to one of the fire-hydrants and a bucket. He then put the hose in, filled the bucket and shut off the in-flowing water in the main. If there was a leakage it very rapidly emptied the bucket by the hydrant, and by the rate at which it emptied the bucket they had a gauge of the waste going on in that particular district. The plan really answered admirably and it was a cheap method of waste-detection. By shutting off area after area they ascertained within which area the waste was taking place.

Mr. G. F. DEACON thought it unnecessary, even in London, the stronghold—if any stronghold still remained—of the system of intermittent supply, to answer an apologist for that system, whatever the circumstances might be which induced its continuance. He would therefore confine his remarks to the only rational system of supply, namely that of constant service under high pressure.

There was still much misapprehension as to the proportions

Mr. Deacon. between water misused, water wasted, and water used. Water misused was an exceedingly small factor of the whole supply. He had been in the habit of including it with the water used and not with the water wasted, and the water used and misused taken together, formed in most supplies but a small portion of the whole; the remaining and larger part being water unnecessarily and harmfully wasted by leakage. The extent of this unnecessary and harmful waste was still but little understood by the majority, even of water authorities. It had no connection with the misuse or misapplication of water, which as he had said might safely be disregarded, and he would go further, and say that this unnecessary leakage did not depend chiefly upon the class of fittings used, but rather upon the condition of those fittings and of the pipes and ferrules. That was a bold statement to make, but it had been proved over and over again. It must not be thought, however, that he deprecated the use of the best fittings. He had always, where possible, adopted them, and intended to do so in future. It was undoubtedly the fact that a water-supply with very old and common fittings could, by the application of proper methods for the detection and suppression of waste, be brought into and maintained in a very efficient state, without any wholesale change such as had been made in the fittings of those places where the more exact methods of waste-detection had not been employed. He would give a few illustrations. In Liverpool, until five years ago, the statutory powers of the Corporation with reference to the consumer's fittings and pipes were very little wider than those given by the Waterworks Clauses Act. Twenty-one years ago the Corporation had tried, at his recommendation, to obtain powers such as those possessed by Norwich, Leicester, Nottingham, Manchester and some other places, to interdict the use of existing fittings and to prescribe the nature of the fittings to be employed. But the ratepayers were apathetic concerning the matter, and, at a poll under the Borough Funds Act, less than a third voted, with the result that the Corporation was defeated and the promotion of the Bill had to be abandoned. The state of the supply was, however, so serious that it was absolutely necessary to discover a remedy for the evil. That remedy was found in the waste-water-meter system. Simultaneously with the introduction of that system twenty-one years ago, they adopted—as the Author had done more recently in the New River District—a testing and stamping department. That was the first testing and stamping office which had ever been established without statutory

powers to compel the plumbers to use only the tested fittings. Mr. Deacon. Very little difficulty was experienced. Naturally the plumbers at first rebelled, but in a short time they were glad to have their names put on the backs of the waste-water notices. That system had gone on successfully, and notwithstanding the absence of statutory powers, notwithstanding the fact that Liverpool was an exclusively water-closeted town, that the majority of the closet-cisterns were not regulating-cisterns and that the draw-off taps were for the most part plug-cocks, the result had been that, whereas in 1873 the supply for domestic, sanitary and public purposes, for hotels, public houses, warehouses, offices, shops and trade purposes not metered, and including all waste, was $33\frac{1}{2}$ gallons per head per day under a constant service, and under a corresponding intermittent service $24\frac{1}{2}$ gallons; in 1876, the year after the constant service had been universally applied, it was less than 18 gallons, and it had ever since been less than 18 gallons with a considerable increase of pressure generally. The only supplies omitted were those sold by meter for trade purposes, which were of course unaffected by the suppression of waste. That was one example of a great city in which the fittings were for the most part old, and had not been constructed as regulation fittings. It was therefore in a very different position from London, where, after a constant supply had been decided upon in any district, the Company possessed statutory powers to interdict the use of fittings liable to lead to waste. He would next take the case of a seaside district, including several towns and villages with which he was dealing at the present time. The houses were for the most part near the sea-level and were supplied direct from a reservoir situated 370 feet above the sea. Three years ago, when that supply was not in the hands of the Municipality, he was requested to examine the district, and he had found that, notwithstanding the great static head, the water would not in many cases rise above the level of the scullery taps, while in some cases during part of the day it would not rise two feet above the pavement. The main from the reservoir to the town, though sufficient for the legitimate supply of the people, was quite insufficient to maintain that supply in addition to the waste from leakage, and the pressure therefore fell. Subsequently the works were purchased from the company by the local authority. Within one month of that purchase the waste-water-meter system was applied. Very few fittings were changed, but so great was the volume of hidden waste detected and suppressed within and without the houses, that

Mr. Deacon. at midsummer, within three months of the purchase, the water had risen in nearly every case to above the level of the upper floors, and the unrestricted consumption was only 20 gallons per head per day for all purposes. It was now further reduced to about 15 gallons per head per day for all purposes. In the consumption of 15 gallons there was still included considerable waste, but throughout the district there were few, if any, regulation fittings, no restrictions whatever had been in force, and the authorities were only now, under his advice, applying to the Local Government Board to approve certain bye-laws, the application of which would further reduce the leakage and improve the supply, though he was satisfied that it would rarely be necessary to replace existing fittings. Other cases were known to him where the waste-water-meter system, without statutory powers over the fittings, had so far suppressed the waste that, including the domestic consumption, the supply only amounted to 10 or 12 gallons per head per day. It was found in such places that the people would not take more water than was represented by these figures, with the residual waste deducted; for residual waste there must always be. In contrast with these instances of the attainment of low waste and unrestricted supply, without resorting to radical changes or inquisitorial inspections, he would refer to only two other cases. Concerning the first, a town in England, he had been lately consulted. He found the total rate of supply to be 130 gallons per head per day. Here, he need hardly say, the mains were unusually large, or so great a waste would have been impossible; indeed he found that a system of distribution left to itself would leak more and more, until the increased friction in the mains so far reduced the pressure that the increase of velocity was arrested. In America the mains were generally much larger than in England, and the last instance he would refer to was one in that country. His authority was a report, published in an English engineering journal, stating that the average supply of Pittsburg last year was 230 (American) gallons per head per day; yet the director of the department stated that there was great need for increased reservoir and pumping capacity and that during the past summer the city was on the verge of a water famine.

It had been stated repeatedly that the waste-water-meter system was unnecessary for the suppression of waste; he could only say that he had not yet met with a case of works, once allowed to get into a bad condition, which had been brought into a satisfactory state by any other system without immoderate

cost to the water authority, and without great expense and Mr. Deacon. annoyance to the consumers. The fittings and pipes could of course, under statutory powers, be renewed, but that course—to anything like the extent it had been adopted elsewhere—he had found quite unnecessary. On the other hand, in districts of London and elsewhere, not provided with the ever-watchful differentiating meter, he had seen gross and widespread waste arising from the continuous leakage of so-called regulation fittings only a few months or years old, simply for want of trifling repairs. In the waste-water-meter districts this rarely happened, for the detection of waste from outside by the meter system was so simple and easy that, if that system were worked at all, the leakage could not escape attention.

Mr. W. B. BRYAN said it was twenty years since he had visited Mr. Bryan. Liverpool, in order to see some of Mr. Deacon's experiments with the waste-water-meter. Two or three years afterwards he had adopted the system in Blackburn. The results were striking, and he believed that even Mr. Deacon had not obtained better in any of the districts in Liverpool. He agreed with Mr. Deacon's statement that the waste in many places was only limited by the size of the mains. That was the case in some of the worst districts served by the East London Water-works Company with which he was associated. He also agreed with the remarks of the Author with reference to the automatic flushing-tanks. Although they were good from a sanitary point of view, he thought they were best controlled by a meter, in which case people could let them run as long as they pleased. There was another source of waste in connection with hot-water apparatus, which was now being extended even to the smaller class of houses, caused by allowing the cold water to run until the hot water came. The new lift-seat closets would also entail a very serious source of waste, because they were not used once or twice but many times a day, and for a very small amount of urine there was relatively an enormous flush. Some complaint had been made as to the amount of flush. He had himself found two gallons to be sufficient, provided the outlet at the bottom was of a proper size. The water ought not to be allowed to dribble through, but to sweep all before it. He agreed with the Author as to the difficulty of carrying out the Metropolitan water-regulations and of persuading magistrates that those regulations were not absolutely in favour of the companies. In his company's district nearly all the houses were built by

Mr. Bryan. speculators, who ran up fifty or sixty at a time and put in the cheapest class of fittings. If a cistern which cost 4s. 6d. did not waste water at the time it was fixed, they could not compel the builders to put in fittings like the splendid ones exhibited by the Author. Where the waterworks belonged to the municipal authorities, and disputes arose as to fittings, the magistrates invariably decided in favour of the authorities. The class of fittings mentioned by the Author in the Appendixes to the Paper were as good as any they could wish to have. In Manchester and other municipal boroughs, they had statutory powers to compel the use of a prescribed class of fittings and to require all of them to be tested and stamped. The East London Company had tried to get similar powers and had scheduled an exact copy of the regulations of the Manchester Corporation, but the Bill was thrown out on the second reading. The only difficulty he saw with regard to stamping and testing in London was that without statutory powers many builders refused to have their fittings tested and stamped. The East London Company had for many years tested fittings free of cost. Many builders absolutely refused to send their fittings to be examined; they said—"We will not be bothered to send our fittings to you. We will do as we please. You can take us before a magistrate and he will decide in our favour." He might mention with regard to sounders, that two or three years before the Tylor sounder was invented another sounder had been brought out by Mr. Deacon which was successful. The waste due to frost was enormous. In the case of the same company supplying 40,000,000 gallons a day before the late frost, the volume taken four days later went up to 57,000,000 gallons in consequence of people leaving their taps running. The Paper contained an assertion that "the statement made by many engineers, that although they are able to reduce the waste for a time, the districts, after a short period, return to their former wasteful condition, is an admission either of want of organisation, an insufficient staff for the work of the district to be controlled, or else of an absence of proper supervision of the quality of the water-fittings used." He could not agree with the Author. In the East London Company's district an immense amount of waste arose from gross carelessness, which waste was detected by Deacon meters and by inspection. Thereupon the waste was at once reduced, but in a week or so afterwards the waste-line on the diagrams would be as high as before, and another inspection would prove this to be due to carelessness.

In consequence of that, day examinations had frequently to be made.

Mr. WALTER HUNTER said he had attended the meeting principally in the character of a director of one of the London Water Companies, and looking at the question from that point of view, he thought that the Paper and the discussion it had elicited were of the greatest importance. The population of England was constantly increasing, while the water-supply was necessarily the same. It therefore became every year of more importance to see that no waste took place. In the course of a discussion two years ago on Mr. Gill's Paper on "the Sale of Water by Meter in Berlin," Mr. Binnie¹ gave the cost of the saving effected by the use of the Deacon meter at $1\frac{3}{4}d.$ per 1,000 gallons. Mr. Collins stated that in the district of Shoreditch the quantity saved per day was 1,947,000 gallons, and that it cost to do this £926 a year. The cost of pumping in the case of the New River Company was $0.558d.$ per 1,000 gallons, and that showed a saving upon 720 million gallons of £1,674 a year, so that, deducting £926, there was a net saving of £724 a year. The figures did not seem quite to agree (possibly because the New River operation was upon a larger scale) with the result achieved by Mr. Binnie at a cost of $1\frac{3}{4}d.$ It would be interesting to have the matter thrashed out, in order that they might see exactly where the difference arose. The question was no doubt one of great importance to the Metropolis, because the quantity saved per day in the Shoreditch district was 1,970,000 gallons, which quantity at 30 gallons per head per day would supply an additional population of 65,000, and, taking the capital cost of works necessary for 65,000 people at 30s. per head, it would come out to a capital sum of £100,000, which he presumed would be the saving effected by the system of inspection established by Mr. Deacon. The matter was receiving attention from waterworks authorities. They were all endeavouring to do what they could to make a saving in that direction. It had been stated by the Author that he had not found it necessary to use stop-cocks. Mr. Hunter thought it had been shown by experience that the use of stop-cocks outside houses was of the greatest possible importance in tracing waste while putting the householder to the least possible inconvenience. With reference to the water companies of London he thought that anyone reading the Report of

¹ Minutes of Proceedings Inst. C.E., vol. cvii. pp. 244, 245.

Mr. Hunter. the Royal Commission, would come to the conclusion that they had done their duty to the public in regard both to the quantity and quality of the water supplied, and that they should be looked upon as benefactors to the metropolis.

Mr. Eaton. Mr. E. M. EATON wished to make a few remarks from the point of view of saving waste water presented by Mr. Griffith. He represented the town of Sheffield, supplying over 370,000 people. Before 1869 the water was furnished on the intermittent system. In that year a constant supply was introduced under the provisions of an Act of Parliament. Prior to the introduction of the constant supply, the amount consumed was 21 gallons per head per day. On the introduction of that system, the amount rose to 41 gallons per head per day. The Company then obtained, under the powers of their local Act, authority to make regulations which had to be confirmed by two justices, and a very remarkable investigation ensued, referred to by Dr. Pole in some reports which he subsequently made to the Home Office, as an episode in waterworks legislation not likely to be repeated. These regulations came into operation at the beginning of 1870. The immediate result was to reduce the waste of water, so that within two years the consumption had dropped to 22 gallons per head per day, practically the same figure as when the water was supplied only for twelve hours a day. In another year it was further reduced, and for twenty years past the amount had varied between 13 and 14 gallons per head per day for all purposes other than trade supplies. The process adopted in Sheffield differed in a remarkable manner from that described by the Author. The Paper appeared to deal first with the consumer's fittings and subsequently with the town pipes. He proceeded in the opposite way. He started with the town pipes, which he thought the simplest method. He sent out the turncocks at night and stethoscoped the main pipes in the manner indicated by Mr. Griffith. The result was that they could detect at the service-cocks the existence of a single leaky tap in the district. Having ascertained that the pipes were tight, they set to work to investigate the district where the leakage was indicated, by, in their case, anything more than one-sixteenth of a turn on the district cock. Whenever the water began to spit through the faces of the cock, the lever was turned over, and if the sound ceased at one-sixteenth of a turn on an ordinary 4-inch district cock, he considered that there was nothing of any vital importance, and the men were despatched to more pressing work until they could see to this in their regular

course. If the leakage exceeded one-sixteenth of a turn, the waste- Mr. Eaton.
water inspectors were sent during the day to visit the house. A remarkable result had followed these proceedings. So far from the inspectors being regarded as nuisances, as Sir Frederick Bramwell had styled them, they were everywhere welcomed. Washers were put on by them, if required. He felt quite sure that the result could not be otherwise than successful. Last year, during the excessive drought, which many towns had felt so severely, the supply in Sheffield had not been intermitted for a single day, the amount consumed day and night being $14\frac{1}{2}$ gallons per head per day for other than trade purposes, which latter amounted to another $7\frac{1}{2}$ gallons, a total of 22 gallons per diem. The Author had stated that in connection with the district at Shoreditch, containing about 87,000 people, the cost of waste detection was £926 per annum. In Mr. Eaton's case they did the work regularly year by year for a population of over 350,000 people for £1,005 per annum.

Mr. PEREGRINE BIRCH said that the Author's stamping establish- Mr. Birch.
ment was one of great importance; and it would be interesting to have some figures as to the magnitude of the business, showing how many waste-preventers and other fittings had been stamped since the establishment was started, how the business had increased, and whether the trade sympathised with him or thwarted his efforts. He had understood that the trade had sought to help him; and if so, the fact ought to be generally known. It appeared from the figures in Shoreditch, where the consumption was reduced from 36 to 14·1 gallons, that practically half the water which was pumped in London was pumped to waste—pumped away, and as Sir Frederick Bramwell had said, never seen by the consumer at all. It also appeared from those figures—and they concerned sanitary authorities and medical officers as well as water companies and water-supply officers—that a considerable percentage of the houses in Shoreditch were pouring into their foundations and into the ground upon which they stood something like 3 tons of water per day. He hoped that the medical officers of local boards who were concerned in the health of the district and might be reckless about the water wasted, would take that fact to heart and see what could be done to stop such a state of things in London and elsewhere.

Sir ROBERT RAWLINSON, Vice-President, remarked that he had Sir R. Rawlin-
observed that there had been a paper controversy in London as ^{son.}
to whether service-boxes should hold $1\frac{1}{2}$ or 2 gallons. It had

Sir R. Rawlin- been his province to examine the applications for bye-laws when
son. they were brought into the Local Government Board, and in many
instances the service-box was restricted to 1 or $1\frac{1}{2}$ gallon. In all
cases he required that the service-box should hold not less than
2 gallons; 1 or $1\frac{1}{2}$ gallon was not sufficient.

Mr. Hawksley Mr. CHARLES HAWKSLEY said that, owing to the fact that his
father had sixty years ago introduced that system, he had been
brought up as it were in an atmosphere of constant supply.
He did not quite agree with Sir Frederick Bramwell that the
amount of waste indicated by the parallelogram in the lower
part of his diagram was altogether unknown to the consumers;
he thought the consumer often knew a great deal about it.
He might mention that, in respect to his own house, he had
known about it for some time. He thought that the limiting-
service cistern was a piece of apparatus it would be very disas-
trous for companies or public authorities to abolish. He quite
agreed with Sir Frederick Bramwell that it was not desirable
it should be of the type known as the siphon flushing cistern,
which emptied itself every time even half-a-pint of water was
needed for the purpose alluded to. He regretted that the Author
had qualified the horror he had expressed of flushing-tanks, be-
cause he thought that it was the duty of the water-supplier to
provide in that way for cleansing drains, which were imperfectly
cleansed in the ordinary way. He had one of those tanks in his
own house, and he was almost ashamed of the waste every time he
thought of it; but he hoped before long to do away with this
apparatus. There was no real necessity for it. He thought
that for such purposes the supply should be by meter, so that
if people liked to have such appliances in their houses, the
cost would not fall on other consumers who did not indulge
in those somewhat unnecessary contrivances. There was a good
deal of difficulty thrown in the way of the proper regula-
tion of fittings by Parliament itself, and by the authorities to
whom Parliament relegated that portion of its duties concerned
with the regulation of water-supply. He did not think that the
authorities sufficiently understood the nature of the subject to
enable them in all cases to comprehend the difficulties under which
water-suppliers had to carry on their business. The authorities
often failed to see that the regulations, when properly understood,
were really for the benefit both of the water-supplier and the con-
sumer. He hoped that in course of time other views would
prevail. With regard to what had been said in reference to in-

spection, in order to show that without any system of inspection Mr. Hawksley. waste could be kept down, he could instance a number of houses in which the consumption of unmetered water ranged from 11 to 13 or 14 gallons per head per day, and there was no restriction placed on the use of the water. The waste was looked after by a much smaller number of inspectors than that mentioned by the Author. The secret was perhaps to be found in that part of the Paper which spoke of "the ordinary superficial house-to-house inspection." House-to-house inspection should not be superficial, but must be thorough and complete. He thought that it was thus possible to explain why, in London at least, house-to-house inspection had not brought the waste down to the point to which it had been reduced under the system explained by the Author.

Mr. ERNEST COLLINS, in reply, said he had anticipated that a Mr. Collins. question would be asked as to the quantity of fittings which had passed through the testing-shops of the New River Company and he was accordingly prepared with a few figures on the subject. They commenced work about ten years ago. Going back for eight years and taking the average quantity of the fittings, he found that during that period they had passed through the testing-shops approximately 120,000 articles, consisting of taps, stop-taps, waste-preventers, &c., in each year; this quantity would be sufficient to provide all fittings annually for a town of about 150,000 inhabitants. From the manufacturers, he had received nothing but kindness and good-will. He had always tried to meet them in every way and to be as lenient with them as he could, consistently with good work. At first it was thought that it would be sufficient if each manufacturer sent a sample of his own productions, so that from the testing of that sample he would be able to provide other articles; but they soon found out that that would not do. They found that some manufacturer bought another manufacturer's goods and ascertained that there would be some little advantage gained by making the pattern lighter, or by making some little difference in it, and then fresh samples needed passing. That was the reason why they established a definite form, printed in the Appendixes to the Paper, regulating the weights and gauges of each article. When they began each manufacturer had his own screw; every tap had a different thread to it. They now had a specific weight for each part and a total weight for the whole; and they had gauges, some of which were on the table—the actual gauges used in the testing-shops—from

Mr. Collins. which it could be seen that they were enabled to obtain the correct diameter and pitch of the various screws, and the proper relative weights and sizes of all the different parts of the fittings, at the time they were undergoing examination.

Correspondence.

Mr. Griffith. Mr. PERCY GRIFFITH was much surprised to find such an important subject dealt with in so short a Paper and one having so limited a scope. The bare record of two instances in which a particular system had produced certain results, with no attempt to discuss the merits or otherwise of other systems, appeared to him very inadequate treatment for a subject of such vital importance. Referring only to the water-supply of London in the hands of the eight companies, a saving of one gallon per head per day implied an economy of over 2,000 million gallons per annum, and the value of this amount of water, taking the cost to the companies of simple pumping and filtration as shown by Lass' Analysis, was £5,500. In considering questions of waste, however, it must be remembered that wasted water had to be dealt with a second time in the form of sewage. The total cost of this one gallon per head per day might therefore be safely reckoned as £10,000 per annum. In order to estimate the actual quantity at present wasted in London, the consumption per head per day in other towns might be taken as a guide. The following were a few examples:—

	Gallons.		Gallons.
London	26·56	Liverpool	15·00
Sheffield	14·00	Leicester	14·00
Nottingham	13·50	Manchester	13·00
Derby	13·00	Norwich	10·50

In all cases the figures related to domestic supply, as apart from meter-supplies for special purposes. In the two cases referred to in the Paper, savings respectively of 9 and 22·7 gallons per head per day were effected. It was, therefore, well within the mark to put down ten gallons per head per day as the average amount of waste all over London. The total value of this amount of water, based upon the preceding estimate, was £100,000 per annum. There was, however, another element in the question as regarded the London water-supply, viz., the immediate necessity of expending enormous capital sums in extensions of the storage and