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

pumping capacities of the existing works. Upon this question, which the Report of the Royal Commission of last year had shown to be a pressing one, the saving of 20,000 million gallons per annum had surely a very important bearing, as it would, at any rate, postpone the necessity for these extensions, and thus give time for the formulation and development of some comprehensive scheme upon which all the companies might act in concert and prevent the concentration of the capital expenditure upon any one or two of them. In the light of these facts it was surely worth making some effort to save these ten gallons per head per day all over London before burdening the consumers with the dividends and interest on additional capital, and at the same time accepting as inevitable the great expense of dealing with this useless water as sewage. Besides this, the Author had distinctly shown that the saving of waste water could be effected upon a very remunerative basis. He stated that in Shoreditch some 720 million gallons per annum were saved at an annual charge of £926 for working expenses and interest on outlay. This amount of water, valued at the cost per million gallons of pumping and filtration as given in Lass' Analysis (viz., £2·39), was worth to the New River Company about £1,700 (in round figures), and the actual saving amounted therefore to about £800 a year. It would be evident, from every aspect of the question, that any system by which the absolutely useless and very costly waste of water now prevalent in London could be reduced, even to the amount of ten gallons per head per day, would prove an inestimable boon to the consumers as well as to the Water Companies. Mr. Griffith.

Turning to the Paper, Mr. Griffith was much surprised to hear of the Author's condemnation of the automatic flushing-cistern. Like every other mechanical contrivance, this (now universal) sanitary apparatus required some attention to keep it perfectly efficient and economical in working, but in face of its general adoption by sanitary engineers for flushing purposes it was very startling to see it condemned as "a very objectionable form of apparatus." With regard to faulty designs of closet-pans and the consequent necessity for an excessive flush of water to clear them of soil, the Author made no suggestions as to any method by which this might be prevented. As matters now stood, this question was entirely in the hands of the builder or owner, the Water Companies apparently having no control beyond the flushing-tank and flush-pipe, and cheap, inefficient closets were put in entirely at the discretion of those who had no concern whatever in their use. Could not the rules and regulations of

Mr. Griffith. Water Companies be extended so as to include the control of closet-pans as well as of the flushing apparatus? He considered the Author's description of the water used in low-pressure lifts, ornamental fountains and careless garden-watering as "undue consumption" and "wilful waste" to be a great mistake if made without qualification. In London such supplies were often charged at a lump sum per annum irrespective of the amount used, and in such cases the consumer's natural indifference to the quantity of water employed by him was the cause of useless consumption and waste; but the evident remedy for this was the application of the meter to such supplies; and if this were done, the more water used the better for the companies, as the rate of charge could always be made a profitable one. Without a meter-supply it appeared impossible to check the consumption under those heads, as there was no legal limit to the amount of water which might be used for such purposes so long as the sum demanded by the companies was duly paid.

It was, he thought, to be regretted that there was no reference in the Paper to systems other than that adopted by the Author. Very remarkable results in the reduction of waste had been obtained in many towns without those expensive self-recording meters and it would have been interesting to compare particulars as regards annual expenses and amounts saved in each case. From all the records which he had seen, it appeared to him that the adoption of a universal system of constant supply, coupled with an organised system of regular periodical inspection, had been perfectly successful in many cases, and the question therefore was: Did the saving in cost of inspection compensate for the outlay on these meters, including the cost of fixing and repairing? The Paper gave no data whatever upon which such a comparison could be made. The cases referred to appeared to have proved successful, entirely owing to the inspection which the excessive night-consumption involved, and he believed that the detection and localisation of night-consumption could be effected perfectly well by the use of the stethoscope, independently of the meters.

Mr. Francis. Mr. H. FRANCIS observed that the use of the waste-water-meter recommended by the Author appeared to be a very expensive mode of detecting waste, both from the point of view of first cost and also in the subsequent maintenance of the necessary staff for working. He believed that the company engaged in making the Deacon waste-water-meter now recommended that stop-cocks should be placed on all services and that the stethoscope should be

employed, this being found sufficient in most cases without the meter. Mr. Francis had in the course of 1877 changed an intermittent supply to a constant supply in a town of some 50,000 inhabitants, where the condition of the fittings was probably very similar to that in the district under the New River Company referred to by the Author. He then adopted the system of dividing this town into districts, each containing about 4,000 inhabitants, and he had continued to work on this plan with satisfactory results. In each district is fixed a by-pass with a 2-inch Siemens meter. At the time referred to he had been experimenting with a pipe-scraping apparatus made by the Glenfield Company, who had forwarded for use therewith a stethoscope. This stethoscope he employed for night inspection in the detection of waste, in connection with the Siemens meter and an ordinary pressure-gauge, with perfect success. An improved stethoscope was now always used. The plan adopted was for the night inspector, before passing the water through the by-pass meter, to ascertain the pressure at the fire-plug on the highest level in the district under test. He then shut off the valve controlling the main and passed the supply through the meter. He next proceeded to sound the valves and stop-cocks, returning at intervals to observe if the gauge continued to record the same pressure as it did at first. If he found that it failed to do so, he shut off the service-valves in succession and determined in which main the waste was taking place. It became possible by this means to prevent waste at one-fourth of the cost of the Deacon meter system. Mr. Francis.

Mr. E. B. MARTEN stated that he had accomplished much at Stourbridge in preventing waste, but strange to say, the loss of water, which upon the average was not very considerable, had not been felt by the company, but had been a source of serious complaint on the part of the sanitary authorities, on account of the quantity of clear water in the drains. This was due to the fact that the greater part of the district, containing the best houses, was drained on a system which involved pumping, and the testing was undertaken because of the excessive volume of the sewer-water. It was then found that the waste occurred in proportion to the number of water-closets on the service. Mr. Marten.

It so happened that a Deacon meter on one connecting main between the high- and the low-pressure districts permitted any street or district to be supplied through this meter without disturbing the rest, as nearly every street had a supply from each end, and there were so many street stop-valves that any one main could be isolated at pleasure. It was found that, in the area

Mr. Marten. supplied with water-closets, the daily amount of night-waste would vary from 8 to 50 gallons per head, whereas in those districts where there were few or no water-closets the total waste would be from 3 to 5 gallons per head per diem. With a pressure of 80 lbs., the ball-taps soon got out of order and permitted waste, and in spite of regulations and inspection, the owners allowed the waste pipes to discharge into closet-pans and drains, and took no notice of the waste of water.

Mr. Paterson. Mr. MALCOLM PATERSON wished to ask the Author if he condemned all automatic flushing-tanks as untrustworthy. This question affected not only the waste of water but the efficiency of sewers. In the present day no system of town-drainage was complete without such flushing and it was important to know which kind of apparatus could best be relied upon in respect of durability and general efficiency. He had fixed such tanks discharging 2,000 gallons in about three minutes, but time had not yet permitted a sufficient test of their durability. As to the capacity of closet-cisterns, he regretted that the Author pinned his faith to the obsolete 2-gallon flush. Experiments carried out by the Sanitary Institute had effectually disproved the efficacy of the volume in question; but even those tests did not embody the full conditions requisite for a proper conclusion. The conditions of experiment were:—(1) Fifty feet as the limit of length. (2) An invariable flush of 3 gallons. (3) No complication of horizontal bends and junctions. (4) Drains made watertight. With these conditions, the 3-gallon flush left an average of 3 per cent. of solid matter in the drain. The actual conditions were:—(1) No limit in length up to 150 feet. (2) Variable flushes acting one day and not the next, as frost, want of repair, neglect, &c., might order it; and sometimes, as in the case of self-acting flushes, rendered intermittent by reason of too rapid sequence in the use of the closet. (3) Bends and junctions of a complicated nature, each adding to the friction and retarding the solids; and (4) Drains good, bad and indifferent, but mostly leaking more or less. He was convinced, as the result of some hundreds of experiments, that any one of these conditions sufficed to vitiate conclusions based upon the above-mentioned tests; the tests upon which he relied were made in actual practice with existing drains. Loss of water in drains meant loss of carrying power. The current soon dwindled and crept, and the solids were stranded; therefore a surplus to meet the loss, as well as the distance travelled, was imperative. This was a matter on which, like all others, experience should be allowed to have due weight, and there was no experienced sanitary engineer

who would now accept the 2-gallon flush. What was really needed was a minimum of 3 gallons for distances not exceeding 40 feet, up to a maximum of 6 gallons, varying according to fall and distance; or, to simplify matters, according to distance alone. To prevent waste in mains, the best means would be to uniformly test them in the open trenches under a pressure of 50 per cent. in excess of the working pressure, and in no case of less than 50 lbs. per square inch. If every pipe and joint were then rung with a hammer and scrutinised, all defects would be discovered. This he had done in his own practice with most satisfactory results and the experience so gained was instructive. In one case a 10-inch pipe, 3 miles long, had Kennedy meters fixed at each end, which had proved entire absence of leakage throughout a period of sixteen years, although the maximum working pressure was 156 lbs. to the square inch. It would be interesting to learn if similar results under the same means of detecting leakage, could be adduced where the method of laying without testing had been adopted. Mr. Paterson.

Mr. H. W. PEARSON remarked that the continuous running of garden-hose at night was largely practised in the residential suburbs of Bristol, and that, in the absence of special by-laws framed upon a clause in an Act of Parliament, it was a difficult matter to obtain a conviction for this offence. He would be glad to learn what measures the Author recommended for meeting this difficulty. He inquired whether the waste-line of 14·9 gallons per head, shown in the diagram, and the subsequent reduction to from 5 to 8 gallons per head, included trade-meter consumption or not? He asked this question, because it was obvious that whatever was being drawn for trade purposes or otherwise through meters, should not be included, as the water was in that case honestly consumed and was being paid for at an agreed rate per thousand gallons. It was worthy of remark that in the Bristol district, when the waste-water-meters were first adopted, many quarters containing from 500 to 1,000 houses did not show a waste line of more than from 700 to 1,100 gallons per hour, equivalent to from 3 to 5 gallons per head; there were now many of these districts where the waste was, and still remained, only from 2·4 to 4 gallons per head. This result might no doubt be attributed to the fact that Bristol had always been a constant-supply town and that great care had been taken to insist upon good fittings. A steady improvement had taken place in late years in the quality of the fittings and the system of inspection had been extended, consequent upon the introduction of the waste- Mr. Pearson.

Mr. Pearson. water-meter system. There were in Bristol fifty-nine districts (now reduced for convenience to forty-five) under waste-water-meter detection, containing 45,357 houses, with a population of 283,654. From 600 to 1,400 houses were entered weekly, and last year the total number of houses entered and inspected was 46,000. It would be interesting to learn whether the Author experienced any considerable difficulty in enforcing the repairs of faulty fittings after due notice had been served, and, further, whether under these circumstances, his company prosecuted for waste and obtained conviction.

Mr. Rigg. Mr. JAMES RIGG pointed out that one cause of the waste of water mentioned by the Author was the practice of leaving taps open; this was rendered impossible by the use of the automatic tap, which closed automatically under sufficient pressure, by the action of the water itself on differential areas of the same piston. He wished also to observe that one of the regulations laid down by the New River Company was that taps should be non-concussive; this was a matter of impossibility with the ordinary T-headed plug-tap under pressures continually experienced with water supplied for domestic purposes. In the case of the automatic tap, the gradual discharge of the water-cushion, formed in the cataract-chamber, entirely obviated concussion, even under extreme pressures. Mr. Rigg stated that the application of this principle to a ball-valve involved the use of the float and lever only for the purpose of opening the tap, and being unconnected with the valve-spindle the tap was left free to close itself when the tank became filled. The advantage of this was chiefly apparent in its application to direct supplies from mains, no matter whether the pressures were high or low; the special applicability of these taps to high pressures being due to the section of the hydraulic packings employed on the piston and on the spindle which permitted of adjustment without undue friction.

Mr. Schönheyder. Mr. W. SCHÖNHEYDER stated that the Author had furnished a strong condemnation of the whole existing system of delivering and charging for water to private consumers. It appeared to him that any system of distribution must be faulty which involved the entrance into private houses of an inspector, and although by such inspection it might be possible to stop waste due to faulty fittings, it was impossible by these means to put an end to wilful waste. The only remedy was to sell all water, as gas was sold, by meter, and thus to deal with it in the same way as every other necessary commodity. Two objections to this system had been urged by the Author—(1) The probable injury to health by restricting

the free use of water; and (2) The initial cost of the meters and their maintenance. As to the first of these objections, it had never yet been proved that the public health suffered in towns where waste was prevented, and where the consumption of water had been reduced to one-half or one-third of that previously supplied. Nor was it possible to inculcate cleanliness by cheap and abundant water. With reference to the second objection, that of cost, he was convinced, that an efficient meter system would pay for itself many times over, by putting a stop to waste in private houses and by entailing compulsory payment for all water used. The meter required for this purpose must, however, if it was to stop all waste, be of a type which would register the smallest flows, even to a dribble, and it must require practically no repairs even after many years of use. Such a meter was not by any means an impossibility. Referring to the great inconvenience and loss due to the bursting of pipes in winter—a subject to which the Author had not alluded—he was of opinion that the rule mentioned in the Appendix, that all service-pipes should be placed at a depth of not less than 2 feet 6 inches below the surface, was a good one, but he knew that this matter was not properly attended to by builders and others. Mr. Schönheyder.

Mr. GEORGE WINSHIP observed that the waste of water ascribed by the Author to a population of 87,000 at Shoreditch was not an uncommon one, although the quantity amounted approximately to 21 gallons per head per day. A return had recently been issued (February, 1894) by the surveyor to the Rugby Local Board, from which it appeared that from a list of fifty-three towns in England the consumption of water in— Mr. Winship.

4 towns exceeded	40	gallons per head per day.					
7	„	„	30	gallons and upwards per head per day.			
22	„	„	20	„	„	„	„
18	„	„	10	„	„	„	„

At Sowerby Bridge and Abingdon, by the meter system, the quantity used was under $7\frac{1}{2}$ gallons per head per day. He wished to draw attention to the fact, that where the sewage of a town had to be raised on to the land for the purpose of disposal, any quantity of water passing away as waste from any of the causes mentioned by the Author, constituted an extra charge on the inhabitants of that town by reason of the expense in raising the sewage. There was also another point to be observed, namely, that by dribbling waste-water had no appreciable

Mr. Winship. flushing effect upon a sewer, and it had been proved that in towns recently drained, flushing had to be resorted to in order to remove deposit from the sewers, although the supply of water allowed exceeded 20 gallons per head per day. Abingdon under the meter system had a consumption for domestic purposes of less than 4 gallons per head per day. The sewers had to be flushed by automatic tanks and fifteen years' experience had shown no evil results. The cost for meters, repairs and all charges was less than 8*s.* per head, or say 6·4*d.* per head per annum. Taking the cost as set down in the Paper, and discarding the capital outlay, the cost by waste-water-meter system for a population of 87,000 had been £926, or 2*s.* 5*d.* per head per annum. In one case the whole of the wasted water had been paid for, in the other case 21 gallons per head per day had been supplied to the consumer free of charge but at considerable expense to the company, this quantity, probably, having to be again raised and distributed and disposed of at the expense of the sanitary authority. It must also be observed that to obtain the extra quantity of wasted water there must have been a great waste of capital expenditure.

Mr. Collins. Mr. COLLINS, in reply, thought that from Mr. Griffith's expression of surprise at the shortness of the Paper, and from the complaint that the record of only two instances of the use of a certain system had been given, it might have been supposed that he would have endeavoured to introduce into the correspondence some description of the other systems which, according to his view, had produced such remarkable results in the reduction of waste. This, however, he had failed to do, and it would appear that the only other plan advocated by him was the use of the stethoscope, in preference to the waste-meter system. Without doubt the stethoscope was a most valuable instrument, but its utility was increased enormously when it was employed in conjunction with the "waste-meter system." He was of the opinion that the comparison made by Mr. Griffith, between the rate of supply of different towns and that of London, was very misleading, because the following widely differing percentages had to be deducted for trade supplies:—

	Per cent.		Per cent.	Per cent.
London	13	*a* Liverpool . . .	33 [1]	43 [2]
a Sheffield	22·2 [1]	*a* Manchester . .	35 [1]	35 [2]
a Nottingham	31·8 [2]	*a* Leicester . . .	25·4 [2]	..
Derby	No return available	*a* Norwich . . .	34 [1]	and Griffith's figures

Thus taking the six towns marked (*a*) it would be found that

[1] Parry on water-supply. [2] Parliamentary returns for 1887.

the average quantity to be deducted for trade supplies was 30·2 per cent., or 17 per cent. more than the amount to be deducted in the case of London. Moreover, taking the average daily supply for London for the nine years ending 1892 and deducting the trade supply (which did not include unmetered trade) as returned by the eight companies, the average was 19·75 per cent., and not 13 per cent. as in the above Table, making the total daily supply for domestic purposes 24·7 gallons instead of 26·56 gallons as given by Mr. Griffith. Now if 35 per cent. be deducted for metered and unmetered trade supplies, which was the amount for Manchester, the total supply of London for domestic purposes would be found to be 20·05 gallons per head per day. London, therefore, as a whole, could not be looked upon in so bad a light as the above figures would indicate. Again it was not a fair comparison to select seven towns where the consumption of water was low and to contrast them with London taken as a whole, for it must be remembered that London was not altogether under the waste-meter system. If the comparison were made with the district supplied by the New River Company, a very different complexion would be put upon the case. The average daily supply by the New River Company for domestic purposes (deducting metered supplies only) for the nine years ending 1890 was 20·6 gallons per head per day, and deducting an additional 10 per cent. for unmetered trade supplies, the total domestic supply would be found to be 18·5 gallons per head per day. It had been stated by Mr. Griffith that the waste in London was so great that some effort should be made to reduce the quantity of water supplied by no less a volume than 10 gallons per head per day. Of course he referred to the district served by the New River Company as well as to those of the other London companies, and he proceeded to make the astonishing statement that the above volume could actually be saved. This would mean that the New River Company's supply per head per day was to be reduced from 18·5 gallons to 8·5 gallons—a conclusion which was manifestly absurd. Mr. Collins had compiled from the official water examiner's returns the average daily supply per head for the eight London companies for domestic purposes for the nine years ending 1892 which was as follows :— Mr. Collins.

	Gallons.		Gallons.
New River Company . . .	20·6	Southwark and Vauxhall Company	24·4
Lambeth Water Company . .	22·3	East London Company . . .	25·5
Kent Water Company . . .	22·9	Chelsea Water Company . .	28·8
West Middlesex Company . .	24·8	Grand Junction Company . .	31·2

Mr. Collins. The trade supplies, as returned by each company, had been deducted in the case of metered supplies only, which was the usual practice. If now the habits of London and the comparative number of baths and water-closets were considered, it would be seen that the rate of supply of the first three companies could not be called a very wasteful one and the statement that these supplies could be reduced by 10 gallons per head per day was a matter of impossibility. Of course it might be admitted that there was plenty of room for improvement and doubtless a reduction in the volume would in time be effected, but not to the extent of 15 or 16 gallons per head per day. At present about 75 per cent. of the London area was under constant supply and the remaining 25 per cent. was being rapidly dealt with, involving the loss of a great quantity of water during the change. Moreover the comparison of the seven towns with London by Mr. Griffith was otherwise unfair, because the towns selected were not wholly on the water-closet system and there were few baths in proportion to London. In the district served by the New River Company, the number of water-closets averaged about three per house and there was approximately one bath to every four houses. None of the towns above mentioned had anything like this proportion of baths and water-closets, and as most of them were supplied by gravitation, the water being gauged, the quantities quoted must be taken with all reserve. Mr. Griffith had further stated that if the daily supply were reduced by 10 gallons, £100,000 per annum would be saved; half this amount would represent the cost of pumping and filtration and the balance would be saved in the expense of dealing with the sewage. But the London companies had nothing whatever to do with the sewage, and the responsible authorities were strong advocates for the use of an increased amount of water per head per day. He might add that owing to the introduction of the constant supply and the precautions taken to prevent waste, the local authorities in London, finding that a smaller volume of water was going down the drains, had to commence sewer-flushing, so that a part of the water saved was resold at much better prices than those quoted. In the New River Company's district there were frequently twenty or thirty gangs of men employed in street-washing and sewer-flushing with hose-pipes. In some cases they were using open hose, in others not less than a $\frac{3}{4}$-inch jet, and this work was continued both day and night.

With regard to remarks made in reference to the automatic tank, he considered the apparatus to be a source of very serious waste,

and whether metered or unmetered it was very unreliable and could not be depended upon. Moreover the fact of supplying the apparatus through a meter only altered the method of charge, it did not make the contrivance less wasteful. Mr. Collins.

The suggestion that the regulations concerning fittings should be made to apply to the class of water-closet pan to be used was, he thought, a good one. Water-undertakings were doubtless in the hands of builders or property-owners in the matter of the selection of the closet apparatus. It had been actually proved that in the case of nine out of every ten complaints made of inadequate flush to a water-closet, the cause proceeded from the defective shape of the pan, and after the objectionable pan had been replaced by one of approved design, the cause of complaint had been removed. With reference to low-pressure lifts, ornamental fountains and careless garden watering, the meter system would no doubt to a certain extent check waste. A supply by meter to a low-pressure lift or motor did not, he considered, stop the undue consumption, but with a high-pressure service it certainly did so. It might be stated that before the introduction of the waste-water-meter system, as adopted by the New River Company, an endeavour was made to cope with the waste in the following way. A systematic periodical house-to-house inspection was carried out over a certain area; the inspectors notified that great waste had been found, and in due course such waste was reported to have been stopped. It would clearly be seen that in the case of a Company whose supply extended over an area of 36 square miles of thickly inhabited districts, serving a population of about 1,143,000 persons through 157,694 supplies with 1,000 miles of mains, it became almost impossible to provide any adequate check upon the statements so made, and much uncertainty prevailed as to the correctness of the assertions that the large quantities of waste, previously reported, had been stopped. This resulted in the adoption of an ordinary meter to govern a certain isolated district, and after a knowledge had been obtained of the total supply to the district in question, instructions were given for an ordinary house-to-house inspection. Great waste was reported to prevail, and in due course this waste was stopped. The total supply by the meter was then again ascertained, with the result that, though there was found to be a reduction in the volume supplied, the quantity of water saved would not pay for the cost of the men's time in making the necessary inspections. Another inspection was then made with similar results; the meter being thus worked somewhat after the

Mr. Collins. waste-water-meter system. In doing this one man was stationed at the meter to take readings every fifteen minutes after midnight, and another inspector was instructed to shut a service sluice-valve upon this district at similar intervals after midnight, with the result that the waste was at once localized and found to occur in certain individual streets. Instructions were then issued for the inspectors to again examine the streets in question and the waste was found to be due principally to underground leakages, which were very difficult to discover. Now he might state that with the system of stethoscoping upon these individual service sluice-valves commanding the streets, where the quantity of waste water averaged from 300 to 500 gallons per hour, although the valves were carefully manipulated and a sensitive stethoscope was employed, the waste passing through these valves could not be heard with sufficient distinctness to form an accurate idea of the quantity so passing. It might further be mentioned that, although the system of stethoscoping upon the sluice-valve would work satisfactorily in small country towns, it was not applicable to crowded London thoroughfares where the traffic never ceased by day or by night. The experiments made in this way with the ordinary meter were so successful that it was evident that great advantages were likely to be derived from the introduction of the waste-meter system. The ordinary meter employed worked quite as well as the waste-water-meter, but this plan entailed the services of an extra man, who had to be stationed at each meter during the times the valve-inspections were being carried out. Further, the accuracy of the results could not be depended upon like those obtained by the automatic recording-machine, the readings of which could be checked off at the office. One of the direct advantages therefore of the waste-water-meter over an ordinary meter was the saving of one man's time for each night-valve inspection taken, since the meter inspector could work on an average from ten to fifteen meters. Again, the chief advantage of the waste-water-meter system over the periodical house-to-house inspection was that it not only pointed out the individual district where the waste was taking place and saved unnecessary inspection, but it also localized the waste to an individual service, and to a house or houses, and acted as a check upon the district until the waste was sufficient in volume to warrant its localization and suppression. It was also a further check upon the inspector, to show whether he was performing his duties faithfully or not, and it had been found by the adoption of the waste-water-meter system that three men could perform the same quantity of work as twelve men could

without its aid. Moreover the twelve men would miss a large quantity of hidden waste, which this meter would successfully detect and trace to its source. With respect to Mr. E. B. Marten's statement as to waste caused by water-closets, it was clear that the town to which he referred was supplied by gravitation and that he did not know precisely what quantity of water was being wasted. Mr. Collins might state, however, that if good and efficient tested-fittings were used it was found that they would withstand a pressure of 80 lbs. and that they could be kept in proper working order. Passing to Mr. H. W. Pearson's remarks about continuous running of garden-hose at night, he might say that where it was ascertained and could be proved that this practice prevailed, the occupier was threatened with an increased charge, which made the use of the water for the purpose prohibitive; this subject was, however, surrounded with many difficulties. Mr. Pearson also asked if trade-supplies by meter were included in the reduction of waste from 14·9 to from 5 to 8 gallons per head per day; his answer was that trade meter-supplies were deducted in both sets of figures. He was also asked if any difficulty arose in enforcing the repairs of faulty fittings. Certainly great trouble did arise with obstinate consumers, but prosecutions for waste were attended with very great annoyance and inconvenience. Mr. Collins.

An assertion had been made by Mr. Malcolm Paterson to the effect that the question as to the quantity of water required to secure an efficient flush for closets had been definitely settled by the experiments carried out by the Sanitary Institute. That statement could not, he believed, be accepted; he had witnessed the tests in question and he considered that they were most incomplete and unreliable. A series of experiments was, in fact, now being conducted which would entirely upset the conclusions arrived at by the Committee of the Sanitary Institute.

After the Paper had been read the President and Council held the third monthly Reception of the Session.

20 March, 1894.

ALFRED GILES, President,

in the Chair.

The discussion of the Paper on "The Prevention and Detection of Waste of Water" by Mr. E. Collins occupied the evening.

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27 March, 1894.

In accordance with the provisions of the by-laws there was no meeting, this being the Tuesday in Easter week.
