Mr. J. GLAISHER remarked that, although more or less familiar with the rainfall in every part of the country, yet he was best acquainted with that in the district of the Royal Observatory at Greenwich. He would in the first place direct attention to a table showing the annual rainfall at the Royal Observatory for each of the years from 1815 to the end of 1869:—

Year.	Rain.	Year.	Rain.	Year.	Rain.	Year.	Rain.	Year.	Rain.
	Inches.		Inches.		Inches.		Inches.		Inches.
1815	22·5	1826	23·0	1837	21·0	1848	30·2	1859	25·9
1816	30·1	1827	24·9	1838	23·8	1849	23·7	1860	32·0
1817	29·0	1828	31·5	1839	29·6	1850	19·7	1861	20·3
1818	25·7	1829	25·2	1840	18·3	1851	22·7	1862	26·5
1819	31·1	1830	27·2	1841	33·3	1852	34·2	1863	19·8
1820	27·7	1831	30·8	1842	22·6	1853	29·0	1864	16·8
1821	34·5	1832	19·3	1843	24·6	1854	18·7	1865	28·6
1822	27·7	1833	23·0	1844	24·9	1855	21·1	1866	30·1
1823	27·1	1834	19·6	1845	22·4	1856	22·2	1867	28·5
1824	36·3	1835	24·9	1846	25·3	1857	21·4	1868	25·2
1825	24·6	1836	27·1	1847	17·8	1858	17·8	1869	24·0

It would be observed that there was a great difference in the fall of rain at Greenwich between one year and another, and even of consecutive years, and the difference was relatively as great in all other parts of the country. In 1824 the amount registered was 36·3 inches, whilst in 1864 it was only 16·8 inches. The average fall of all the years was 25·3 inches, and at times, for several consecutive years, as from 1819 to 1824, the fall for each year was above the average; and at other times, as from 1854 to 1858, the fall for each year was below the average. Now, no reservoir had been made which would balance the rainfall for more than three years, so that the falls of rain in consecutive wet years could not be impounded under any circumstances; in fact, very heavy falls of rain were of no use, either to millowners or anybody else, as such rain took the shortest course to the sea. Evidently, therefore, the quantity to be dealt with must be less than the average. The safest principle appeared to be to treat with the amount of the water fallen in three consecutive years yielding the least. This amount was found to be nearly the average of all the years reduced by one-sixth. Thus at Greenwich the sum of the falls of rain in the three years ending 1857, viz., 61·4 inches, being smaller than in any other three years in the period, or 20·5 inches on an average of these years, the average, 25·3 inches, reduced by $\frac{1}{6}$th, or 4·2 inches, was 21·1 inches, differing from the observed by 0·6 inch. Taking this as a base, the capacity of storage reservoirs should be for two hundred days. But as water was growing more important and more valuable the need was becoming greater and greater for economising it, in order to supply large towns with continued service. He would refer especially in this respect to the town of Norwich. The late Mr. Brooke had told him that, many years ago, when the quantity drawn was equal to 40 gallons per head per day, the supply was insufficient, and the water was shut off from 8 P.M. to 6 A.M., and the company were obliged to send persons round at night to be in readiness in case of fire. The contrast at present was great indeed. In 1868 the city had a constant service, and the quantity of water used was only 16 gallons or 17 gallons per head, including what was consumed for trade purposes. This was entirely the result of economising.

He would next call attention to another table of each rainfall at Greenwich which had amounted to at least 1 inch per day during the last fifty-five years:—

Year and Date.			Amount of Rainfall.	Year and Date.			Amount of Rainfall.	Year and Date.			Amount of Rainfall.
			In.				In.				In.
1816	June	28	1·32	1831	Sept.	28	1·09	1853	July	14	2·63
1818	May	10	1·34	1832	Mar.	14	1·21	„	July	28	1·11
„	Sept.	26	1·30	„	July	12	1·01	„	Oct.	27	1·05
1819	Sept.	29	1·00	„	Oct.	7	1·47	1854	Aug.	3	1·40
„	May	5	1·10	1833	Aug.	30	1·14	1855	July	11	1·42
1820	Jan.	20	1·13	„	Dec.	23	1·10	„	July	26	1·15
„	May	16	1·10	1834	July	29	1·44	„	Oct.	30	1·06
„	July	31	1·51	1835	May	13	1·00	1856	June	20	1·00
„	Sept.	18	1·38	„	Oct.	25	1·14	1857	Aug.	14	1·12
1821	June	8	1·17	„	Oct.	30	1·00	„	Sept.	8	1·00
1822	April	16	1·11	1837	Jan.	26	1·10	„	Sept.	11	1·16
„	July	5	1·40	„	Aug.	23	1·10	„	Oct.	22	2·57
„	Oct.	19	1·16	1838	Sept.	27	1·10	1858	June	5	1·16
„	Nov.	16	1·12	1839	Nov.	27	1·20	1859	Sept.	26	1·26
1823	Jan.	29	1·07	1841	June	24	1·03	1861	May	11	1·07
„	July	25	1·05	„	Sept.	23	1·03	„	Nov.	13	1·29
„	Oct.	1	1·15	„	Oct.	27	1·03	„	Nov.	22	1·00
„	Oct.	31	1·15	1842	Aug.	10	1·10	1862	April	9	1·10
1824	Feb.	14	1·18	1843	Aug.	23	2·16	„	Aug.	17	1·27
„	May	16	1·25	1844	Oct.	15	1·38	1863	June	19	1·46
„	Aug.	14	1·63	„	Nov.	8	1·03	1865	Jan.	27	1·25
1825	May	13	1·40	1846	Sept.	23	1·18	„	May	23	1·03
„	Sept.	17	1·37	1848	June	12	1·43	„	June	30	1·39
1826	Mar.	7	1·00	1849	May	28	1·15	„	Aug.	23	1·79
„	July	24	1·97	1851	Mar.	15	1·45	„	Oct.	19	1·06
1828	July	22	1·21	„	July	23	1·44	„	Oct.	22	1·11
„	Aug.	8	1·00	1852	June	9	1·36	1866	Jan.	11	1·61
„	Aug.	14	1·21	„	July	25	1·99	„	June	4	1·34
1829	April	9	1·00	„	Aug.	15	1·08	1867	July	26	3·67
1830	June	3	1·38	„	Oct.	4	1·01	1868	Jan.	22	1·21
1831	Feb.	7	2·89	„	Nov.	26	1·00	„	May	29	1·08
„	Sept.	1	1·16	1853	June	13	1·15				

In this period there were eleven years in which the daily rainfall did not amount to 1 inch. The fall exceeded 1 inch, on five days in 1852 and on six days in 1865. Only one instance occurred in which the fall exceeded 3 inches, viz., on July 26th, 1867, when it reached 3·67 inches. The mean monthly fall of rain at Greenwich was least in February and largest in October, whilst at Aberdeen the least was in May and the greatest in November; and in fact the month of least rain proceeded from Greenwich going northwards in March, April, and May successively. The monthly fall of rain at Greenwich and at Aberdeen was—

Month.	Greenwich. Inches.	Aberdeen. Inches.
January	1·85	2·21
February	1·56 (Min.)	1·65
March	1·60	1·90
April	1·74	1.68
May	2·15	1·47 (Min.)
June	1·96	2·02
July	2·60	2·22
August	2·41	2·51
September	2·42	2·31
October	2·80 (Max.)	2·79
November	2·35	2·93 (Max.)
December	1·94	2·45

The distribution of rain at times differed greatly from the average. At Greenwich in the year 1868, in which there was an average fall, there were ten months of deficient rainfall, and the balance was made up by a great excess in the months of January and December.

By taking five-yearly means during the period from 1815 to 1869, he found a generally decreasing rainfall at Greenwich till the year 1859, but since then there had been an increase:—

					Inches.
In the five years ending		1819	the mean annual fall was		27·68
"	"	1824	"	"	30·67
"	"	1829	"	"	25·84
"	"	1834	"	"	23·98
"	"	1839	"	"	25·28
"	"	1844	"	"	24·74
"	"	1849	"	"	23·98
"	"	1854	"	"	24·64
"	"	1859	"	"	21·68
"	"	1864	"	"	23·08
"	"	1869	"	"	27·28

The deficiency to 1859 was therefore in no way attributable to an excess of drainage or clearance of trees, for the amount of drainage within the last few years was greater than at any preceding period.

Respecting evaporation, from all the experiments he had seen, it appeared to amount to from 13 inches to 15 inches per annum; therefore in the three driest years all the available water would be the difference between the mean of those years and from 13 inches to 15 inches, which would leave but little in one of those years to work upon.

Mr. G. J. SYMONS had been an observer of rainfall for many years, but had not specially inquired into the accuracy of the Greenwich register till a short time since, when, at the request of Mr. Dines, who had detected certain inaccuracies, he examined into the correctness of the early portion of the series of observations given in the table produced by Mr. Glaisher. His remarks applied to a period anterior to that at which Mr. Glaisher became connected with the Royal Observatory. Mr. Beardmore had referred to the early portion of that register in terms which were not altogether expressive of confidence.[1] The remarks of Mr. Beardmore referred to the total annual rainfalls, whilst the point which he had examined into was the daily fall. With regard to the table of heavy daily rainfalls at Greenwich, he might remark that the only way in which a list of that sort could be reliable, and useful, was where it was certain that the gauge was visited and emptied every day. Whenever that was done the numbers were comparable amongst themselves and with others. If there was any possibility of the fall of two days having been entered as one, the value of these numerical data was entirely destroyed. Upon the point which he was required to investigate were dependent a series of calculations made by Mr. Glaisher, also by Mr. Dines at Cobham, and by Mr. Chace in America, as to the influence of the moon's age upon rainfall. On examining into these early daily returns, it was found that the number of days on which rain was recorded to have fallen, during the ten years from 1820 to 1830, was about thirty-five per annum less than the average of the whole period. That might be due to something peculiar in the climate of those ten years. He had therefore compared this result with the registers of rainfall at Chiswick, at Cobham, at the Royal Society, and with Howard's register at Tottenham; and they all agreed in indicating a larger number of days of rainfall in those years than were recorded at Greenwich. Again, if a long-continued register like this of fifty-five years was taken, and the total rainfall during a month divided

[1] *Vide* "Manual of Hydrology," p. 282, foot note, 8vo. London, 1862.

by the number of entries, it would give the mean fall of each day on which rain was reported to have fallen. He applied that process to the Greenwich observations for the month of January during the fifty-five years, and the mean daily quantity during that period was about 0·15 inch; but during the period from 1820 to 1830 or 1831 the amount ran up to nearly 0·30 inch; consequently the average fall on each day of entry was nearly twice as great as at any other period. That implied that the small amounts during those periods were not registered separately. This did not show whether the rainfall was systematically taken at longer intervals, for instance, if the rain-gauge was emptied regularly once a week; but by tabulating the entries he found that that was not the case; consequently it was not an alteration in the rule that the rainfall should be measured every day, but negligent observance of it. One further test applicable to this case was the regular measuring of small quantities. Again, referring to the register of rainfall in January, there were on an average four or five days in the month on which a depth of 0·05 inch or less than that quantity was recorded; but from 1820 to 1829 or 1830 he found there was not an average of more than one day or a day and a half. These different investigations all tended to show, that the small quantities were not registered, but that they were allowed to accumulate till they became large ones; and, in fact, they proved what had been previously suspected, that the early records of rainfall at Greenwich were unworthy of confidence. He agreed with Mr. Glaisher as to the shifting of the epoch of minimum monthly fall of rain travelling north from London to Aberdeen; but the case was different in mountainous districts. In the hill districts of Cumberland or Wales, and even in Derbyshire, instead of the maximum rainfalls occurring in July and October, they occurred in December and January.[1]

He thought that a great deal of confusion had arisen with respect to the use of the term evaporation, as applied to the loss of water. A certain amount of rain fell on a gathering ground, and a certain amount was stored: the difference between the two was not necessarily due to evaporation from the surface, but arose to some extent from percolation.

Mr. J. Glaisher said he had every reason to believe, from the records that were left, that every rainfall between 1820 and 1830 was registered at the Royal Observatory at Greenwich. The

[1] *Vide* "Report of the British Association, 1868," p. 435, *et seq.*, 8vo. London 1869

gauge was made by Troughton with the utmost care, and was as accurate in its construction as it was possible to be, and that was more than could be said of other gauges used at that distant date.

Mr. S. C. HOMERSHAM said, in the neighbourhood of the metropolis there were extensive districts, embracing an area exceeding 4,000 square miles, where all the rain that fell was absorbed by the chalk formation. Railway engineers could bear testimony, that large valleys in chalk districts were frequently crossed without there being any necessity for a single culvert. The rain was absorbed by the chalk as fast as it fell, though it might be as much as 3 inches in an hour. Over a water-shed consisting of 200 square miles, distant not 30 miles from London, not a drop of rain that fell appeared on the surface in the shape of springs or streams. The observations of Mr. Glaisher would not apply there because the whole of the water, whether in a wet year or in a dry year, was absorbed and stored under ground in the pores of the chalk. If there was a heavy rain, followed by very hard frost, then a fall of snow, and then a sudden thaw, water might flow off the surface in chalk districts; but such a concurrence of circumstances was very rare. The surface of the ground must be saturated, the water must be frozen, a fall of snow must cover the frozen surface, and sudden thaw take place with rain; then there were floods off those districts he was speaking of, otherwise there was no flow of water off the surface.

The question of the natural storage of subterranean water in the chalk, the lower green sand, the oolite, the red sandstone, and other similar formations, was one of great importance. Those were the formations which gave water of the best quality for domestic purposes, and with which surface water impounded in natural lakes or artificial reservoirs could bear no comparison. It was free from organic matters, and was of an uniform temperature the whole year through, and it could be artificially rendered as soft as any water that could be supplied to a town.

Mr. HAWKSLEY, Vice-President, said, before entering into the particular merits of the Paper and its very general subject-matter, which was far more important than the mere description of the works which had been made for the supply of Paisley with water, he would refer to the statement of Mr. Homersham. The Paper related to the supply of water from gathering grounds, by means of large storage reservoirs. Now the chalk district was not a gathering ground, and no storage reservoirs were ever made in such districts. The consequence was, though the observations of Mr. Homersham were perfectly correct in themselves, yet they had no bearing upon the subject-matter of the Paper. Excellent discussions might be raised upon the means of obtaining water from chalk districts, but that had nothing to do with mountainous water-sheds.

The first thing which presented itself to an Engineer, charged with the duty of obtaining a supply of water for a large community, was to ascertain the quantity of water which could be obtained from any of the gathering grounds in the neighbourhood. That was an important inquiry, and an inquiry about which many mistakes had been made. Formerly it was thought possible that, by means of reservoirs, the average of all the rainfall of a long period of years might be calculated upon for use by the community, with the exception of a small deduction to be made for what had been called 'loss,' but which was in general nothing more than evaporation. Now, in the course of years, it was found, in the first place, that the allowance for evaporation had been considerably too small; and next, that it was impossible to store the floods of a series of wet years, or even, very frequently, of one year only. The endeavour had therefore been made to discover what were the real facts of the case, and what was the law by which Nature dealt with this important subject-matter. It was found, after long experience, and after laying down in curves the results of the observations over long periods—observations which had been afforded by the outlay of millions of money, in some cases successfully, but in the majority of cases more or less unsuccessfully—that in general, but not as an invariable rule, there were situations in which reservoirs could be made that would deal with the available rainfall of three consecutive minimum years, The next thing was to ascertain what was the law of the minimum; and this singular thing came out, which was true within the smallest possible fraction of all long series of rain-gauge observations extending over not less than twenty years,—that if the average of say twenty years was taken, and from that average one-sixth was deducted, the average of three minimum dry years would be obtained, within the fraction of a single inch. That quantity might then be relied on as the probable rainfall. The amount of loss or evaporation had then to be ascertained, according to the particular district. That loss varied in these islands from 10 inches per annum as a minimum to 18 inches as a maximum. The minimum occurred very rarely—indeed only in the case of bare precipitous mountains, consisting of non-absorbent rock, such as slate or granitic rock. From that surface all the rain that fell could be gathered, with the exception of about 10 inches. But the case was very different where the surface was covered with soil and peat, where it became flat moor-land on the summit, and, more so, where the land was cultivated and thrown into the character of a sponge. In general, however, with mountain water-sheds, where the *intermediate condition* existed, the actual ascertained loss amounted to from 13 inches to 15 inches per annum, according to the situation and some local circumstances, and might be taken at a mean of about 14 inches per annum. As a practical illustration, he would take perhaps the most important one that had ever presented itself in this kingdom, the case of Sheffield. In that instance a population of a quarter of a million was entirely dependent upon mountain water-sheds. There were correct records for forty years, from which it was known that, upon the average, the fall of rain had been 39½ inches annually. Deducting one-sixth, there remained about 33 inches; and taking from that 14 inches as the loss from what was called evaporation, there were left 19 inches, which was the actual quantity received into the storage reservoirs on a mean of three dry years. From that again had usually to be deducted, before the water could arrive at the town, a very large amount for the supply to the millers on the stream on which the reservoirs were made. Formerly, the legislature was in the habit of giving too large a proportion; but after longer experience, that had now been fixed at one-third of the available quantity. That, in the case of Sheffield, would have been 6⅓ inches, leaving 12⅔ inches for the use of the town. However, in consequence of the law of the deduction of one-sixth not having been known, and the loss by evaporation having been underrated—only a small deduction being made for loss—the legislature had given the millers 12 inches, thus reversing the proper figures, and leaving only 7 inches for the town. Under those circumstances it could not be wondered at that the town fell periodically short of water. He had been thus precise in dealing with this particular case, because it was typical of a great number of other cases, and because it was owing to mistakes upon this point that three-fourths—nay, five-sixths of all the large towns dependent upon gathering grounds had been left short of water, sometimes for many weeks together; and, at all events, their daily supply had been diminished for two or three months whenever the rainfall was less than the average.

After having ascertained, by a process of that kind, the actual, as distinct from the theoretical, quantity which could be depended upon from the rainfall, the Engineer had next to consider the magnitude of the basins which must be provided for impounding that supply. As was well known, rain fell very irregularly; so that if there were not large storage reservoirs, the floods would rush away at one period of the year, and the town would be left dry, with the exception of the little rills formed by permanent springs at another period. That was the condition in which, forty or fifty years ägo, the towns in the mountainous districts of this kingdom really were. Engineers began with the idea that it was impossible a drought could last in England more than 100 or 120 days, so reservoirs were made capable of holding a supply equal to the requirements of from 100 to 120 days. That plan having failed, the reservoirs were increased in size so as to store a supply for 140 days, and subsequently for 160 days, when the failures, although not so numerous, still occurred in the majority of cases. An inquiry was then instituted to ascertain whether there was any law particularly applicable to the case; and, by dint of perseverance and of an extensive range of observation, it was found that the least proportionate storage was necessary in those parts of the kingdom where there was the greatest rainfall, and that the largest amount of storage was necessary in those parts of the kingdom where the least quantity of rain fell. The reason of this was—that where the greatest quantity of rain fell there was the greatest number of wet days, and where the least quantity fell there was the least number of wet days. Moreover, where the greatest quantity of rain fell, as a rule there was the least evaporation; and where the least quantity fell, as a rule, but not without some exceptions, there was the greatest amount of evaporation. Therefore it became apparent that a rule which was applicable to one part of the kingdom would not be available in another part of the kingdom. It was then discovered that when the rainfall amounted on the average, as at Sheffield, to 40 inches per annum, storage must be provided for more than 180 days' consumption, and then the reservoirs would be just run out at the end of the longest drought. Coming farther south, and taking Leicester by way of example, where the rainfall was somewhat under 30 inches, a supply for 180 days would not last; and it had been found by observation that there was no re-elevation of the surface of the water in these reservoirs for 250 consecutive days. In the east of England, where there was a still less fall of rain, a continuous supply of water to the towns could not be depended upon unless there was 300 days' storage. In places where the rainfalls exceed 40 inches, smaller reservoirs in proportion were required; while in the very driest parts of the kingdom, where the rainfall was only 22 inches, it was necessary to impound a supply for a longer period. The result was, it had been found, according to observation in England, that where the greatest quantity of rain fell a supply must be provided for 150 days; and where the least quantity of rain fell, 300 days' storage was absolutely necessary.

The determination of the quantity of water to be calculated upon as the use and waste of the town was one of the most serious of all the calculations, because that quantity had to be multiplied by 150, 180, 200, or 300 days, as the case might be, and the reservoirs must be made larger exactly in proportion to the quantity of water which it was probable would be consumed in the place, while, of course, there must also be a larger area of catchment ground. Now, the facts upon that question were most extraordinary. The consumption varied in large cities, where there was a constant supply, day and night, and every person drawing as much or as little as he pleased, between 15 gallons per head per diem and 100 gallons per head per diem, including in both cases the supply for manufacturing and sanitary purposes. No more water was wanted in the city where the quantity was 100 gallons per head per diem than in the town which was served with 15 gallons per head per diem. The cause of the difference was simply in the management of the undertaking. In many places the company or the corporation, or whoever might be the parties supplying the water, merely turned the water into the pipes, and left the care of the internal fittings and the mode of their application entirely to the consumer, or to the builder, or to the landord, as the case might be. The result was, as a rule, the worst possible character of fittings, and every cistern supplied with an overflow-pipe; and where there was an overflow-pipe, as a matter of course the ball-cock, which let in the water, was never attended to, because, whether it was right or wrong, nobody on the premises suffered the least inconvenience. The consequence was the ball-cock got out of order; it would not rise to shut off the water, and the water ran down the waste-pipe day and night. The same thing happened with regard to those abominations called soil-pans, and also to water-closets, the handles of which were propped up, under the idea of "doing good to the drains." The result was the water ran away without anybody being sensible of the loss. But when the consequences were considered, it would be at once apparent how important it was that those sources of waste should be suppressed; for, as a rule, every million gallons per day supplied to a city from a gathering ground cost in capital about £120,000, and ought to be capable of supplying 50,000 people. Now, there were places, particularly in Scotland, where the consumption amounted to 50 gallons per head per diem; so that, to supply the same number of people, an outlay would be required of £300,000. And it must be remembered that the taxation for the supply of water must, of course, be in proportion to the outlay. But there were still more important difficulties. It frequently happened that it was not possible to obtain in the neighbourhood of the town a sufficient supply to meet that amount of waste, and hence it had to be brought from a long distance. The area of the gathering ground must also be two or three times as great, and the reservoirs must be two or three times as large, or two or three times as many as would otherwise have been necessary; and altogether the affair became so onerous, that it was not surprising that in general there was great reluctance to encounter the expense, and still greater reluctance to support the taxation which that expense necessitated. All this could be remedied, but it was almost impossible to convince public bodies of this fact. At the present time many places were in great difficulty, by reason of the supposed want of a sufficient quantity of water, but where in reality there was plenty of water to effect every object which the law required, if only this extravagant waste was suppressed. There was still a further evil. In the majority of cases, where a constant supply was not enforced by law, the companies and the corporations, and particularly the local boards, refused to give the constant supply because of the enormity of the waste with which it was frequently attended.

In the metropolis the three millions of inhabitants were receiving more than 30 gallons of water per head per diem—a quantity far more than was necessary—and yet the water was rarely supplied for more than half an hour, and scarcely ever for more than one hour, out of every twenty-four hours. If the necessary care were taken, and improved fittings were applied, there might be a constant service during the whole of the twenty-four hours, and everybody might have all he wanted, although less than 30 gallons per head per diem would be used.

With respect to the tables which had been supplied by Mr. Glaisher, he regarded them as being of the utmost importance. One showed the average rainfall at Greenwich over a period of fifty-five years, and gave a good idea of the great variability of this climate; it also applied relatively to the case of the mountain gathering grounds in the north of England.

In reply to the question why the water taken into the houses should not be supplied by meter, rather than by the present defective system, Mr. Hawksley observed that the reason was a very plain and a very powerful one—the law did not allow it. It had been the policy of the legislature, ever since the formation of companies under legislative authority, to require that houses should be supplied for a payment proportionate to their rentals. It had been endeavoured, a great many times, to induce the legislature to adopt the system of supply by meter with respect to water, as in the case of gas. The legislature had invariably refused; and the reply always made to the application was, that it would not tend to the good and comfort of the people, or to their health, but that on the contrary it would be injurious to the poor if water were sold by measure. Water was allowed to be sold by meter for manufacturing and other non-domestic uses; but with regard to domestic purposes, the legislature was obdurate.

Mr. S. C. HOMERSHAM said there was no rule without an exception. Mr. Hawksley had said positively that the legislature would not allow water for domestic purposes to be sold by meter. Now he had obtained an Act in 1862 to construct works to supply a large district near London. The Act allowed the domestic supply to be by meter, and water had been supplied ever since by meter. The company charged according to rental, and if any person exceeded a certain quantity he was charged 2*s*. per 1,000 gallons in excess.

Mr. J. A. LONGRIDGE stated that he was anxious to get water by meter, and had applied to the Lambeth Water Works Company for this purpose in vain. They did not tell him that it was not allowed to do so by the Act, but they said that they would not. He thought if there was no Act of Parliament against it, and if water companies complained of the great waste of private consumers, there could be no reason why a man who was willing to pay for what he got should not be allowed to do so.

Mr. BEARDMORE expressed his doubt as to the practical success of meters for private houses. He thought they would cause dissatisfaction generally. The charge for supply to the poor would be greatly increased by the rental of the meter, and there would be perpetual quarrels as to damages; but they were used in the East of London and other places for manufacturing purposes.

Mr. HARRISON, Vice-President, observed that when he was a member of the Royal Commission for reporting on the question of the water supply of London, no subject which had come before them was of greater importance than the general want of a good and sufficient water supply for the poor. From the returns of the large towns they found that wherever there was a superabundant supply of water there was large waste. In the case of Glasgow the consumption was 50 gallons per head per day; but in some places where the strictest economy was used the supply was under 20 gallons per head. He felt satisfied that, if strict economy were observed, which could only be effected by strict supervision, 20 gallons per head would be found to be a full and sufficient supply in nearly every case. But it was next to impossible for any private company to exercise that inquisitorial supervision of the supply, which was so necessary, in private houses, to ascertain where the waste took place; and thoroughly efficient supervision could only be exercised by placing the water supply in the hands of the public themselves.

Mr. HAWKSLEY, Vice-President, said, the result of an immense amount of experience in the management of water companies was, that only in one was the water supply managed economically by a public body; while there were an immense number of cases in which they were managed very economically by private companies. At Norwich, where there was a private company, the supply of water was unlimited; yet the consumption did not exceed from 15 to 16 gallons per head per diem. That was only typical. Glasgow was in the hands of a public body, and there the consumption of water was 50 gallons per head per diem; and that was only typical again. Many public bodies were in the same position. The water ran to waste, through water-closets and overflow-pipes, for which there was no use; but public electoral bodies were exactly the people who dared not go into the houses of the electors to stop the waste which a company was able to suppress.

Mr. BEARDMORE said that the rainfall was as variable as the climate of England itself. Where the country was flat the fall was more uniform than where it was hilly, and generally in much less quantity.

There was perhaps no other science so difficult as meteorology whence to generalize from observed facts, and those who had to apply meteorological records to elucidate practical questions of water supply, drainage, and the economy of rivers, should be very cautious in accepting isolated facts. A long series of observations over wide ranges of country was required to develope the law of rainfall in respect to its periodical variations.

It was very doubtful, for instance, what provision should be made for floods, in carrying out engineering works—what was the maximum beyond which it was a waste of labour to provide; and where the line should be drawn between floods which might be controlled and extraordinary *débâcles* which overwhelmed all the works of man, and against which it was useless for the Engineer to contend. It was not safe to assume that the highest flood or the most severe drought in any man's experience would not be exceeded even in this country; and this was still more likely to be the case in India and Australia. Nor could he accede to the deduction of broad generalizations from the Greenwich series of rainfall observations, since there might be instances in the future when the results deduced from selected exceptional periods of the past might be nullified by conditions of which there was no present experience. For instance, in November 1852, there were nine days of constant rain in the Midland and South Eastern districts of England, and this rainfall was considered to be unprecedented. At that time the Great Northern, and some other neighbouring railways, had been but recently opened, and it was found that sufficient provision had not been made for the safe passage of the flood waters. Yet subsequent events proved that the magnitude of that flood might be, indeed had been, greatly exceeded in the districts served by those railways.

Intelligence had just been received that the Chey-Air bridge on the Madras railway had been carried away by a flood. The spans were large, and doubtless every reasonable provision was made; yet the experience of the past had been insufficient, and a time had come when the victorious waters had proved the peril of trusting to deductions from data extending over a limited period.

The time occupied in the fall of rain had an important bearing both on the replenishing of reservoirs and on the regulation of floods. There might be a year of abundant rainfall, yet, from its occurring in occasional heavy storms, and in summer, the water supply might still be deficient.

The years 1857 and 1858 were certainly the driest in modern times, taking into consideration the wide area over which the absence of rain was experienced. On the Continent the deficiency was chiefly felt in 1857, but in England in 1858; and the fall in some places did not reach 60 per cent. of the average. That drought extended over the whole of Central Europe, and was most severe over the area including the sources of the Weser, the Elbe, the Rhine, and the Danube. The foundations of a Roman bridge were laid bare on the latter river, the existence and presumed locality of which were only previously known from the writings of Pliny. And the springs suffered so greatly in Westphalia that they did not recover their full volume till three years after. Similarly the drought of 1868, which did not at the time seriously affect the flow of water in the English rivers, was probably one cause of the want of water in the past summer of 1870.

Seasons had a certain tendency to run in cycles, and one of about eleven years seemed to show more uniform maxima and minima than any other grouping.

The ridge of hills south of Paisley extended from the frith of Clyde opposite Arran to a point about 4 miles south of Glasgow, and these hills were subject to a very heavy rainfall, but this was confined to a limited area, probably not exceeding 2 miles in breadth.

Mr. HAWKSLEY, Vice-President, observed, that the apparatus which had been adopted for rendering the constant supply of water successful, by suppressing the waste, to which otherwise it would be subject, was distinct from the apparatus used for intermittent service. In constant service pressure was applied to the pipes during the whole twenty-four hours, instead of only during a very small portion of that time. Now, if a service pipe in the interior of a house would bear pressure for half an hour, it would bear the same pressure for half a year; but in the case of the constant supply forces came into operation which did not usually operate in the intermittent system, or only to a small extent; for where the supply was intermittent, the draught during the short time the water was on, owing to the majority of the ball-cocks in the houses being open, very much diminished the pressure; and besides that there were few or no shocks. But upon the system of constant supply the pipes were subjected to all the shocks occasioned by the rapid closing of the cocks, whereby the column of water was suddenly arrested when in rapid motion. That brought on a considerable amount of impulsive action which was unknown, or little known, in the case of an intermittent supply; and it was constantly found that the pipes leading into the houses, and distributed through the houses, although perfectly competent to bear the pressure of the intermittent supply, would not bear that of the constant supply when it became introduced in place of the intermittent supply. From this it followed that wherever the constant supply had been introduced, either voluntarily or by the pressure of the legislature, it had been found necessary to adopt rules and regulations for determining the magnitude and thickness of the pipes; also the mode in which the pipes should be united, and the kind of tap and ball-cock and water-closet apparatus to be used in connection with the constant pressure.

The rules and regulations now found to be necessary, and very generally adopted, were reduced to writing.[1] Formerly univer-

[1] The Rules and Regulations recently adopted by the Rochdale Corporation Water Works are as follow:—

"1.—The Corporation will, at their own cost, lay down and maintain all the sally, and still in most cases where the intermittent supply was used, a common plug tap was generally applied. This had the

---

lead or other branches extending from their main pipe to the side of the public highway in which such main pipe is situate; and will, at their own cost, carry the pipe through the frontage wall (if there be one), and six inches beyond, or otherwise equivalently allow fifteen inches in length for the owner's or occupier's plumber to connect his work to.

"2.—The owner or occupier must, at his own expense, lay down and maintain all the pipes and apparatus upon his premises or for his use, and of the strengths and descriptions, and subject to the rules following, that is to say:—

"A.—Such pipes must, unless otherwise agreed, be of lead, and of not less than the following weight, namely:—

inch.	lbs.
$\frac{1}{2}$	7 per yard.
$\frac{5}{8}$	9 "
$\frac{3}{4}$	11 "
1	16 "
$1\frac{1}{4}$	$22\frac{1}{2}$ "

NOTE.—*Detective or warning pipes* may, if desired, be used of lighter weights than the foregoing.

"B.—The drawing (bib) stop and ball cocks must be strong and of hard brass, and the better to secure watertightness, of the kinds from time to time sanctioned and approved by the Committee; and unless and until due notification to the contrary, the drawing cocks must be of the best and most approved kind of those called 'screw down cocks,' and in principle as manufactured by Messrs. Guest and Chrimes, and in courts of houses and other exposed places, must be protected by an iron casing, and be made to open with keys. And the ball taps must also be of the best and most approved kind, and in principle as manufactured by Messrs. Lambert and Sons. Till otherwise notified, no other description of cock must be used without the previous and express permission of the Water Works Committee.

"C.—Every cistern must be absolutely watertight, and be provided with a ball cock, and proper means of access and inspection, *but must not have an overflow or waste pipe;* and if any such should exist, the same must be removed, or be effectually and permanently closed before the water is turned on; but nevertheless, as exceptional instances will occasionally occur in which it will be necessary to provide against the possibility of over-filling, the Corporation will, in such exceptional instances, allow a *detective or warning pipe* to be attached to the cistern, provided that in every such case a written consent must be first obtained from the Manager of the Water Works, stating the fact of such consent, and the position in which the *detective or warning pipe* must be fixed; and in every such case the work must be executed under the immediate superintendence of an officer of the Corporation, and in the manner stated. On no account whatever can the water of the Corporation be allowed to communicate with any cistern or place intended or used for the reception of *rain water.*

"D.—WATER CLOSETS.—Every *pan closet* must be provided with a full and complete apparatus, comprising a ball cock and a service cistern, fitted effect, on rapid closing, of suddenly arresting the column of water in the lead service pipe, and gave rise to two or three

---

with a boot or division, to be carried as high as the top of the cistern, and capable of containing not more than one and a half gallons of water, when filled within three inches of the top, and two proper valves, so arranged as to let down not more than one boot or division full of water at each pull, or be capable of allowing the water to run to waste either by intention or neglect; and must also have a down pipe of lead from the cistern to the basin of not less than 1¼ inch in diameter, and weighing 9 lbs. to the yard run; and a proper basin, scatterer, weighted lever, pan, trap, and other appliances, needful to prevent such water closet from becoming a nuisance, and thereby inducing an undue consumption of water; and the valves must be worked by brass rods instead of by wires or chains. Every *self-acting, or pull-down water closet,* must be of a description approved by the Water Works Committee, and must have either a lead cistern similar to a pan closet, or a double valve cast-iron service box, of a kind approved by the Committee, and fitted with a proper cover to screw on, and internal apparatus in all respects similar to that of the boot of the pan closet above described, and a similar down pipe of lead or cast iron, and must have a proper wide-rim flushing basin and trap, of a kind approved by the Committee. No wire will be allowed to be used in the construction of these water closets.

"NOTE.—No pipe will be suffered, under any pretence whatever, to communicate directly or indirectly with the basin, or trap, or otherwise than with the *cistern* or *service box* of a water closet or soil pan, and the same shall be so constructed and used as to prevent the waste or undue consumption of water, and the return of foul air, and other noisome or impure matter, into the mains or other pipes of the Corporation.

"E.—Every bath must be constructed without an overflow or waste pipe, and must be provided with a well-fitted and perfectly water-tight apparatus, to prevent the water from flowing into and out of the bath at the same time. With the view to prevent damage from accidental overfilling a *detective or warning pipe* will be permitted, subject to the regulations and conditions hereinbefore-mentioned with respect to cisterns.—(See regulation C.)

"F.—No pipe must be laid through, in, or into any *sough, drain, ash pit, manure hole,* or other place, from which, in event of decay or injury to such pipe, the water of the Corporation might be liable to become fouled, or to escape without observation, or without occasioning the necessity of immediate repair. In every case in which any such sough, drain, ash pit, manure hole, or other place as aforesaid, shall be in the unavoidable course of the pipe, such pipe shall be passed through an exterior cast-iron pipe, or box, of sufficient length and strength to afford due protection to the water pipe, and to bring any leakage or waste within the means of easy detection.

"G.—Every pipe and apparatus laid and fixed by, or for the use of the consumer, must be inspected by an officer of the Corporation before it is connected to the works of the Corporation: and, if found not in accordance with the regulations of the Committee, must be forthwith removed or altered.

violent reactions. In time the lead pipe expanded into a sort of aneurism, and ultimately burst by a long slit, exactly as an

---

"H.—Every meter (unless otherwise specially agreed) must be provided with a separate and distinct *inlet* pipe, leading from the main or other pipe of the Corporation—upon which *inlet* pipe no stop cock, except the stop cock (if any) immediately attached to the meter, branch, drawing cock, or other outlet, leading to or connected with the premises for the supply of which such meter is fixed, will be permitted.

"I.—No pipe will be suffered, under any circumstances whatever, to communicate directly with a steam boiler.

"3.—The water supplied must not be allowed to run to waste, either wilfully or by neglect; nor must it be used for any other purpose, or to any greater extent, than shall have been agreed for.

"4.—No pipe must be attached to the works of the Corporation, or to any pipe or apparatus connected therewith; nor must any alteration be made in any existing pipe or apparatus, without due notice being given to, and the consent of the proper officer of the Corporation being first obtained.

"5.—The supply and use of water for the purpose of trade and manufacture must be open to inspection and admeasurement whenever required; and such information must be from time to time afforded, as will be sufficient to enable the Committee to obtain a satisfactory account of the quantity of water actually consumed; and of the pipes, cocks, cisterns, and other apparatus, and conveniences for delivering, receiving, and using such water.

"6.—The Corporation will, if, and when so desired, execute all kinds of plumbers' work connected with the supply of water to their tenants, but are nevertheless desirous that the private business of the consumers of water shall be open to all the plumbers of the town; as, however, it is essential to the protection of the interest of the consumers, as well as of the Corporation, that such work shall be well and soundly executed, and that the Water Works Committee shall possess a full and satisfactory knowledge of the state of the undertaking in all its departments, it is announced that no plumber or other workman will be allowed to do or perform any work connected with the supply of water, till he shall have been admitted, enrolled, and published by the Committee, as 'an authorized water works plumber,' and shall have entered into a written engagement to conform to and comply with the rules and regulations of the Committee in relation to the construction and management of the works and fittings to which such rules and regulations shall from time to time apply; and all responsible master plumbers, on expressing their willingness to comply with such rules and regulations, will be admitted immediately on signing an undertaking to that effect. If at any time afterwards any such plumber shall be found guilty of wilfully breaking or evading the said rules or regulations, either by himself or his workmen, or shall refuse to communicate any information required of him in regard to any work done by him, or his workmen, or under his superintendence, or on his responsibility, his name shall be erased from the list of 'authorized plumbers,' and will be forthwith advertised as having been so struck off.

"7.—No person is to be employed in or about the Water Works, or any pipe or apparatus connected therewith, who has not been admitted 'an authorized plumber;' or whose name shall have been struck off the list as aforesaid.

artery under similar circumstances burst in the human body. Thus the introduction of constant supply led to the flooding of houses, damage of furniture, and destruction of property in many ways. But that had been entirely got over, and a cure established by the introduction of a screw-down cock in lieu of the old plug tap. This closed slowly against the pressure of the water, and prevented recoil. Also, by reason of the looseness of the face, the leather, which was interposed for the purpose of making a perfect valve, did not turn round on its face with the revolution of the screw; and consequently it was not ground or worn away as when the leather turned round with the screw. These valves did not lead to the bursting of the pipes, and were besides perfectly water-tight, which other valves were not; consequently the continuous trickle, which was often observed in other valves, and amounted to a serious quantity, did not occur. Moreover, the leathers could be replaced at about the cost of a penny, and so the cocks would last, with very little expense to the householder, for a considerable number of years. Probably, however, nine-tenths of the whole waste of water arose in the water-closets, and in every case where the constant supply had been attempted without a special apparatus to prevent the enormous waste which otherwise occurred in the water-closets, there had been a failure of the constant service system. In cases where there had not been total failure the leakage had brought up the supply from under 20 gallons per head per diem to 50 gallons or more; and in one town, with which he was well acquainted, the amount of water distributed and wasted through water-closets had amounted to 110 gallons per head per diem. Now an apparatus had been arranged, and was largely in

---

"8.—The Committee will pay a reward of *twenty shillings* to any person who will give such information as shall lead to the conviction of any person who shall fraudulently attach any pipe or pipes to the pipes of the Corporation; or to any pipe, cistern, or apparatus connected therewith; or to or into which the water of the Corporation shall flow or proceed; or who shall fraudulently use or otherwise misappropriate the water of the Corporation, or who shall knowingly permit the same to be fraudulently used or otherwise misappropriated.

"The Committee will also adequately remunerate any person (not being interested therein) who will communicate timely information to their officers, of any leakages or wastes of water, and whether the same be accidentally, negligently, or wilfully occasioned or suffered.

"10.—The Corporation do not permit their officers, servants, workmen, or agents, to solicit or receive any fee or gratuity whatsoever, and desire to be informed with respect to any infraction of this regulation; and also in respect to any act of incivility, or any neglect of attention on the part of such officers, servants, workmen, and agents, or any of them."

use, that had completely removed this difficulty. The vessel might be of any size, and of any material. The water was introduced into the vessel in the usual manner by means of a ball-cock; and the vessel was divided into two parts, one of which held a regulated quantity of water. By a particular contrivance two valves were worked, so that one valve always closed before the other valve opened. When the valve opened from the larger division, the water passed out of it into the smaller division, and was ready to be drawn for the use of the water-closet. On pulling the wire, the valve in the larger division descended, and closed the aperture; and no more water could therefore pass from the larger division into the regulating division. All this was done in an instant; but the wire being now pulled a little farther, the other valve began to open, and a flush of water immediately descended and cleared out the basin, leaving the regulating vessel empty. The down pipe leading to the basin was of considerable size to admit of a powerful flush of water, but the regulating cistern was only refilled when the pull-wire was allowed to return to its original position. The apparatus was not necessarily expensive, and might be made of iron for cottages at a cost of 35*s*. At Norwich, where this apparatus was in general use, the reduction of the expenditure of water had been from 40 gallons per head per diem to 15 gallons per head per diem; and no one had ever found fault with its action.

There was another apparatus suitable for supplying water to manufactories, railways, and numerous large establishments. The water in these cases was formerly supplied by contract; nobody knew the quantity that was taken; and, as a matter of course, owing to the waste pipes and to general negligence, much more water was allowed to run to waste than was paid for. Years ago, however, it became apparent that some means must be contrived for measuring the water. For this purpose numerous meters had been invented. Many of them resembled a small high-pressure steam-engine, and some of them, particularly Kennedy's meter, measured the water with considerable accuracy. But they were exceedingly cumbersome; they produced in many cases considerable shocks; and when they got out of order, often allowed the water to pass by without measurement. One beautiful instrument had been invented by Mr. Siemens, M. Inst. C.E., but that instrument was not strictly a meter, but rather an indicator; for it was made upon the principle of the turbine, and the quantity of water measured was determined by the number of revolutions of a wheel put in motion by the water itself. That meter was very useful

F 2

for many purposes, but it failed more or less with particular descriptions of water, and with particular modes of drawing the water. The meter had apertures through it, which allowed the water to pass, whether the revolution of the wheel was accomplished or not: so long as all went right the meter indicated with tolerable accuracy the quantity of water which passed through it; but if, as happened in many cases, the instrument became furred by deposits from the water, the meter worked slower, and at last stopped. The water, however, did not stop: consequently the meter did not then register the quantity of water which passed through it.

The two meters he had alluded to were called high-pressure meters; they would act under any pressure of water, and they would, with a slight diminution of pressure, convey the water to any place that might be required. But there was another called the low-pressure or Crossley meter—one of singular accuracy, and it had not the defects of which he had spoken. The principle on which it worked was that of the common gas meter reversed. In this meter the measurement was due to the number of revolutions of a partitioned drum. Below the drum was a kind of trough; and the water, entering the meter, was compelled to pour over the edges of the trough. The quantity of water propelled in one revolution was therefore determined by the depth at which the drum revolved in the trough. The adjustment was effected by raising or lowering the trough by means of a small screw; and when the accurate measurement was arrived at, it was soldered down, and became immovable. The meter was then sent from the maker to the water company or consumer, and constantly remained in the same state of adjustment. This meter had the apparent defect—for it was not a real one—of measuring the water only at a low pressure. The water must go through the meter into a cistern, the pressure would therefore be only that due to the elevation of the cistern, instead of the pressure due to the elevation of the reservoir of the water company. That was an advantage to the consumer, as well as to the company; for, in the case of a manufactory, the high pressure on the valves, the pipes, and other apparatus within the premises was so great, and the shocks occasioned by the sudden opening and closing of the valves were so violent, that the wear and tear were excessive. By placing this meter at the top of a manufactory, and leading pipes from it over the premises, those difficulties and inconveniences were avoided; and in the case of a dyer or other large consumer, it remained without much wear or tear for a long term of years; whereas on the other system the occupier of the manufactory had a plumber almost constantly on his premises. There was also a public reason why this should be used in preference to the high-pressure apparatus, because with a high-pressure apparatus the water was let out, say, into a brewer's vat, with great rapidity, and then as suddenly shut off. The consequence was that the shock extended out of the factory, along the whole line of pipe, and was heard in every house in the neighbourhood. If the factory worked at early or late hours, the violent recoil had such a noisy effect that people were prevented sleeping in their beds. It was by means of these few arrangements that nearly the whole of the waste otherwise incident to the constant supply could be suppressed.

There had been much said of late years with regard to the virtues of soft and hard water. For towns in which water was used in large quantities for manufacturing purposes, and particularly where clothing materials were manufactured, or where, as in Lancashire, there was a good deal of dyeing, it was exceedingly desirable that soft water, and especially mountain water, should be introduced. But in other cases where it was not an essential, there could be no question that, in a sanitary point of view, moderately hard water was preferable to perfectly soft water, and the records of the Registrar-General established this fact, although he believed the result was not attributable solely to the kind of water used. However, the broad result proved that there was greater longevity in the places where moderately hard water was used, than where the water was particularly soft. Apart from that, water free from colour was a beverage generally preferred to water which was coloured: but coloured waters were for the most part those very soft waters of which he was speaking; for the soft waters had an extraordinary avidity for colouring matter, which they took up from peat and from heather, and other vegetable organic matters. That tinged the water brown and made it disagreeable to place on the tables of most persons. On the whole, there was no rule whatever by which it could be distinctly said whether hard or soft water ought to be adopted: the occupations of the people and their habits must be regarded, and in those cases in which soft water was wanted to enable them to obtain their livelihood, soft water ought to be introduced, while in other cases there was at least no objection to water of a harder class. There was, too, this important consideration—four-fifths of the land of the earth's surface, and far more of the populated part of the land, yielded hard water. It was therefore nonsense to say that water which Providence had supplied in such superabundance, while the other was only an exceptional water, should not be supplied for the use of man.

With respect to the construction of embankments for impounding water, there was an idea prevalent that they might be made with slopes, dependent on the nature of the material, but independent of the consideration of height. If an embankment 20 feet or 30 feet high would stand at a slope of $1\frac{1}{2}$ to 1, why should not an embankment 200 feet or 300 feet high stand at the same slope? Theoretically it would; and if no other circumstance than the mere question of slope entered into the consideration, there was no doubt the same slope might be adopted in the one case as in the other. But water-works embankments were usually made of necessity across valleys, which sometimes had a rather sharp fall downwards. As the embankment increased in height, so the weight increased: and the weight of the upper part of the embankment was much more considerable than the weight at the foot of the embankment. That, *per se*, would not make any difference: but it usually happened that the site of the embankment was more or less of a treacherous character, and that under the embankment there was some material or other of a compressible kind, or that would yield under a heavy pressure. The result of that was, and particularly if the base of the bank was liable to become wet, that the pressure at the centre compressed that particular stratum, and threw it out at the foot, the centre sank down, and perhaps the embankment was lost. That was provided against by flattening the slope or by adding a step at the lower part, which threw out a considerable amount of weight. That gave the necessary stability, and resisted the tendency to sink of the upper part of the bank.

The magnitude of floods was one of the most important things which the civil engineer had to consider—not only in the construction of water-works, but in the construction of bridges, and many other works. That subject, it was true, was dealt with empirically, but in this respect it was like nine-tenths of the rules which governed the actions, the contrivances, and the schemes of civil engineers. They were founded on long-continued observations, and if those observations were correctly arranged and properly plotted, a curve which represented the law in that particular instance could always be obtained. With regard to floods in this climate, it had been found that those which ran from any district were governed in part by the geological character of the district—for which an allowance could be made; by the more or less precipitate character of the dstrict, for which an allowance could also be made; and further, by the maximum amount of rain which fell in that district. In England the maximum falls of rain of short duration were nearly everywhere the same.

It was well known that from very small areas as much as 1 cubic foot of water per acre would come off in a second; from larger areas $\frac{3}{4}$ of a cubic foot would flow off; and $\frac{1}{2}$ or a $\frac{1}{4}$ of a cubic foot from still wider areas; for the water required a considerable time to descend to the point where the reservoirs were to be made. Now by making a horizontal line, which represented acres, and by plotting up the observed volumes of floods, which there were many opportunities of measuring on a great scale, it was possible to find points amongst which a curve could be drawn; and that curve would give the law which an engineer might safely, and, at all events, reasonably, apply with regard to the quantity of water which would flow over the weirs of reservoirs. This method had led to important determinations, which Mr. Hawksley promised to explain on a future occasion.

November 22 and 29, 1870.

CHARLES B. VIGNOLES, F.R.S., President,
in the Chair.

The discussion upon the Paper No. 1,255, "On the Water Supply of Paisley," by Mr. A. Leslie, occupied both evenings.
