Mr. Jones. arrived at, for fear of the conditions being disturbed. They dared not move, and the result was that they did not advance; nor would they advance until there was some change in the law.

Correspondence.

Mr. Anderson. Mr. G. ANDERSON considered the Paper a valuable contribution on an interesting subject, hitherto but imperfectly understood. Since Mr. Patterson, the late Gas Referee, pointed out that the difficulty of removing the sulphur compounds, other than sulphuretted hydrogen, was in consequence of the presence of carbonic acid, it had been easy to comply with the requirements of the law, but there was still the difficulty of doing so without creating a nuisance. That difficulty, however, he believed had arisen, and still continued, from the want of apparatus of adequate capacity. Although his provincial works were not under the law that applied to London, he was much interested in the embarrassment in which the London gas companies were placed. Some years ago, he caused gas to be tested, first with the Referees' test, and subsequently with Mr. Vernon-Harcourt's colour tests, while working with lime in four purifiers. The tests varied from 12 to 16 grains per 100 cubic feet. The washer and scrubber, however, were very effective, and removed a large quantity of carbonic acid and sulphuretted hydrogen. He also made strong liquor, of 14- to 16-oz. strength, and found from experiments that such liquor contained double the quantity of impurities per ounce of strength that weak liquor did. Hence he considered it not only advisable thoroughly to remove those impurities before the gas reached the purifiers, but to do so in a certain manner, namely by producing strong as against weak liquor. As the strong liquor was also more valuable to a chemical manufacturer, he saw no reason for the existing custom of producing weak liquor of only 9- to 10-oz. strength. As to the purifiers, it was a tradition that the lime should be spread on the trays in layers about 3 inches thick, and of such dampness that it would squeeze into a solid mass in the hand. Both of these he considered most inadequate conditions. For many years he had increased the thickness gradually, and for the last eight or ten years he had put in layers of lime 10 to 14 inches thick. Some people thought that such thick layers must give great resistance, but he did not find it so, because he ignored the theory as to dampness, and made the lime as wet as it could be, consistent with its not falling into paste. In such a state the lime existed in nodules from the size of a walnut down-

wards; the whole mass was porous, and it was thick enough to ensure considerable contact of the gas and the lime before the gas escaped from it. On the other hand he advocated purifiers of 0·50 foot area of surface per 1,000 cubic feet of gas passing through in twenty-four hours; if they were larger, the better would be the results. Some London gas engineers had expressed a doubt as to his statements of the quantity of gas he had purified per ton of lime. Let them wash the gas with strong liquor, use large purifiers and damp lime, and he believed their scepticism would vanish. Although it was true that lime apparently fully carbonated gave off no smell, but oxidised after exposure, still it contained some sulphide of calcium, as was found in an analysis of well carbonated lime from the Cork works, of which he was the engineer. The lime had no appreciable smell even if taken in the hand, yet if the wind blew across a heap of it a smell could be detected on the lee side. Indeed, when one of the principal London gas companies applied to be relieved from the Sulphur Impurities clause, he was employed by the Metropolitan Board of Works, and he put a lump of lime nearly a foot cube in the committee-room under the table, close to the committee, and no one knew of its presence till he produced it on the top of the table. His men often had to use picks to remove the lime from the purifiers, which on breaking up was found saturated with impurity. On the other hand where lime was not used so wet, he had seen underdone pieces in layers under 4 inches thick. In making these statements he did not wish to throw discredit on his London brethren. The fact was that the consumption of gas had increased so enormously by the continual cheapening of its price, that gas engineers had never had any rest. It had been gasholders one year, retorts the next, purifiers the next, until they came round to gasholders again; and most of the time, for twenty years, something had required enlarging, while, as the Author stated, excessive stringency had been exercised by the local authorities, who found it a popular cause to attack a gas company.

Mr. Anderson.

While admitting the benefit of large purifiers, the difficulty had been in many cases in old works to obtain room. Under these circumstances it had occurred to him some years ago to design a purifier that would double the quantity of gas purified on a given floor area. He would describe this purifier by comparing it with a house of four storeys, in which each storey represented the thickness of the ordinary purifying depth. He provided an inlet-pipe for the gas, with four branches on it, and a valve on each, one branch leading into each storey. He commenced by opening the valve

Mr. Anderson. into the basement storey at the floor, and the valve on the branch leading into the upper storey, but at the ceiling; thus one stream of gas ascended, the other descended, through the purifying material; both streams met in the centre and passed off, there uniting in one stream again. When, from increase of pressure, or from decrease of temperature, or from other causes, it was known that the material in the lower and upper storeys was fouled, he threw open the similar valves into the second and third storeys; the gas met at the centre and passed off as before. Now there was nothing novel in causing the gas to pass either up or down through purifying material; the only novelty was in causing one-half of it to pass in each direction at the same time. Such a purifier would be from 30 to 40 feet in height, having several floors external to it on which to spread the material when using oxides, with suitable doors in the sides of the purifier through which the purifying material would be passed, and which would also serve for purposes of ventilation. He proposed that such purifiers might be of any convenient size up to 50 feet in the side or in diameter. He did not consider it necessary, however, to have the top lid of similar size, as was the case in the largest purifiers at present. The uses of the lid hitherto had been to get in to the purifiers to charge and discharge them of the purifying material.

When gas was first made, purifiers were vessels about 5 or 6 feet square, and a couple of men could lift the lid. As the purifiers were enlarged, and the lids came to be 10 or 12 feet square, mechanical means were employed for lifting them, and lids now weighed 8 or 10 tons, for they were 30 to 40 feet square. But he apprehended this enlargement of the lid was but following precedent and custom, and was not necessary. He proposed in his deep purifiers to make the lid 10 or 15 feet in diameter, or what should be found necessary to remove spent material, and afford sufficient means of ventilation. Such a purifier 50 feet in diameter and 30 feet deep would hold considerably more than 1000 tons of oxide, and should do as one of a series, while a volume of 200,000,000 feet of gas was being purified. When once in action that quantity of gas would be purified before it required to be changed. He would propose to remove the spent materials much in the same way as a 1000-ton vessel of coal was discharged; but the purifiers could be discharging at each storey as well as through the top at one and the same time, and therefore could be emptied expeditiously. The house round such a purifier should be ventilated so that all effluvia would be cast into the atmosphere at a height of 60 to 70 feet, instead of as now at the level of the ground.

If any one should doubt the feasibility of this arrangement, let him consider that greater changes had been long since made in the construction and dimensions of most apparatus, and rather let him scheme its accomplishment, as the result to be achieved was so desirable, namely, to increase the size of the purifiers without increasing the area of the ground on which they must stand. Mr. Anderson.

With respect to manganese as a purifying agent, when the Great Central Gas Works were started in 1851, chloride of manganese in solution and wet lime were the purifiers. By the chloride all the ammonia and so large a quantity of sulphur were caught that, in the after process by lime, purification was effected at the rate of 60,000 cubic feet of gas per bushel of lime. This was better than anything he had known since; and with a matter of more than 1,000,000 cubic feet of gas per day, one man did all the labour of purification. The Author stated that benefit had been derived by introducing a jet of steam, by which the temperature of the gas was raised. It had occurred to him that the jet of steam helped to damp the lime, and so might have done good in that way. He had noticed that the condensation from steam, passed through a pipe with foul gas, had extracted sulphur from the black deposit.

Mr. GEORGE LIVESEY observed that the methods of purification in common use twenty-five or more years ago were quite as effective for all practical purposes as the most elaborate system now in vogue. He held, in fact, that the attention of engineers and managers of gasworks had, by the claptrap cry of sulphur, sulphuric acid, and sulphates, and he knew not what else, been almost completely withdrawn from the really important matters that should engage their attention. Before Dr. Letheby raised this bugbear, the impurities it was essential to remove were sulphuretted hydrogen and ammonia only, and means were then in existence which were effective for that purpose. Of all impurities sulphuretted hydrogen was the most objectionable; fortunately its removal was easy, and the test for it was ready, simple, and very sensitive or delicate, an inappreciable quantity instantly blackening paper dipped in a solution of acetate of lead. If sulphuretted hydrogen in any quantity was left in coal gas, its presence was at once made known by the obnoxious odour which rapidly pervaded the room where the gas was burnt. He had, in years gone by, discovered the presence of foul gas directly after it was lighted in a sitting-room, and on looking for the cause had found that a valve at the purifiers had, from some accident, been left partially open. It was supposed by some persons that the presence of sulphur in other forms in coal gas was productive of Mr. Livesey.

Mr. Livesey. the same ill effects, but this was not so. If sulphuretted hydrogen was present it was certainly not all burnt into the innoxious sulphurous acid; whereas the "sulphur in other forms" appeared to be entirely consumed into sulphurous acid, and not sulphuric, and as such was imperceptible and not in the least injurious; this, he felt sure, would be admitted not many years hence, when the gas companies having gone into the hands of the public authorities, the sulphur question would be dropped. Holding strongly to these views he did not take so great an interest in sulphur purification as if he felt it of any importance; still he agreed with the Author in the conclusion that it was necessary to remove the sulphuretted hydrogen, as well as the carbonic acid, from the gas before it reached the sulphide-of-lime purifiers. Some years ago Mr. H. P. Stephenson, M. Inst. C.E., had a conversation with Dr. Odling, F.R.S., on this question, with the result that Mr. Stephenson recommended the adoption of a plan similar to that set forth in the Paper, at the Crystal Palace District Gas Works, of which he is the vice-chairman. Nor did he agree with the Author that it was of no consequence how rapidly or suddenly the gas was condensed. He once tried an experiment of this kind at the suggestion of the late Mr. Young, of Birmingham. Having a water condenser, that was a series of gas pipes laid in a large tank of water, he was told that the more complete and rapid the condensation the better; sufficient water was consequently turned into the tank to maintain the normal temperature of the water; the gas was therefore very suddenly cooled, and, as a result, the whole of the mains in the purifying house were within a fortnight completely choked with naphthaline.

He held that the attention and efforts of gas makers should be directed to cheapening and simplifying the process of purification, and the conversion into marketable products of the various impurities. He maintained that, so far as the gas was concerned, its purification was nearly perfect, and that although in a badly-ventilated gas-lighted room a decided oppressiveness was felt, this oppressiveness was not due to the trifling amount of sulphur in the gas, but rather to the carbon in an unconsumed or partly consumed form that pervaded the room. As to the sulphur, the result of the last twenty-five years' work in this direction of chemists and engineers had been to reduce the normal amount of about 33 grains in 100 cubic feet of gas to something like half that quantity. He always had objected to the unfairness of stating it as so many grains in 100 cubic feet, because it not only failed altogether to give an idea of the true proportion, but it grossly

exaggerated the case; 33 grains represented not more than $\frac{1}{700}$ part of the gas by weight, or stated decimally it was 0·00143. Mr. Livesey.

He was sincerely anxious to improve and cheapen the production of gas, but he refused to be led away by a false scent, and had come to the conclusion that, compared with the great questions of economy in construction of plant and general economy in manufacture, it was scarcely worth attention.

Mr. H. E. JONES remarked, in reference to Mr. Livesey's statement, that he claimed to have been the first practically to observe the mischievous effect of sulphuretted hydrogen, the elimination of which, in addition to carbonic acid, together with the regulations of both by the tests and tables described, was essentially the method set forth in the Paper. He was also the first practically to work on such a system; and in proof of this he might state that the purifiers at the Ratcliff Gas Works were being so used in 1877, whereas Mr. H. P. Stephenson in May 1877, before the Committee on the Crystal Palace District Gas Bill for repealing the sulphur clauses, distinctly described the Patterson process as being at that time in use by that Company. Dr. Odling on the same occasion gave evidence for the Crystal Palace Company, but he did not mention any such process. In addition to this, in the autumn of 1877, Mr. Jones informed Mr. Livesey of his discovery and practice, at which time Mr. Livesey did not profess to have any knowledge, through Dr. Odling or Mr. Stephenson, of any similar suggestion. Moreover, the Author did not gather from Mr. Gandon's remarks, that the process of the Crystal Palace Gas Company was identically the same as that laid down in the Paper; but, if so, then it had been adopted since the plan was in operation at the Ratcliff works of the Commercial Gas Company. Mr. Jones.

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16 March, 1880.

WILLIAM HENRY BARLOW, F.R.S., President,
in the Chair.

The discussion upon the Paper No. 1692, on "The Purification of Gas," by Mr. H. E. Jones, occupied the whole evening.
