"Mr. Bryan Donkin, M. Inst. C.E., has published figures from some tests he carried out with different kinds of fuel in the same boiler, the conditions in all cases being the same; the results are comparable on the basis of the cost of fuel required to evaporate 1000 gallons.

Kind of Fuel.	Cost of Fuel per Ton.	Water Evaporated per Pound of Fuel.	Cost of Fuel per 1000 Gallons Evaporated
	s. d.	lb.	s. d.
A.—Dust Coke	5 0	.. 6 ..	3 8
B.—Dust Welsh coal	10 0	.. 8 ..	5 3
C.—Large Welsh coal	22 0	.. 9 ..	10 11

"Discovering that the Sheffield Gas Company made a considerable quantity of coke dust, which they gave away to builders and others, we entered into a contract for a supply for three years. Having a spare boiler, we had Meldrum's forced draught fitted, and soon discovered that coke dust made a very satisfactory fuel for steam raising. Our second boiler was then fitted, and we are now burning coke dust on the two almost exclusively. From an economical point of view the experiment is very satisfactory, as will be seen from the following figures:—

Average week, coal only, on one boiler.

	£ s. d.
45 tons at 12s. 6d.	28 2 6
Ashes at 2s., seven loads	0 14 0
	£28 16 6

Present consumption on two boilers.

	£ s. d.
Six tons of coal at 9s. 3d.	2 15 6
Coke dust	3 4 0
Two extra stokers	2 12 0
Flues cleaning	0 10 0
Ashes, 12 loads at 2s.	1 4 0
	£10 5 6

"There is no smoke from the chimney stack of the 'Telegraph' office, which is another good point in favour of coke dust as fuel."

In cases when the boilers were slightly under power, it had frequently been found that by applying this system the necessity of providing larger boilers had been avoided, and thus a large outlay for plant had been saved. When the chimney draught was insufficient through faulty construction of flues, or by the addition of extra boilers, it had frequently happened that the evaporation of the boilers had been increased as much as 25 per cent. With forced draught the heat of the waste gases could be utilised to a much fuller extent than with natural draught, and in this direction further economies could be looked for in the near future when methods of utilising the waste heat were elaborated.

The following table, showing three simple cases of increased steaming power through using the same class of fuel, was of interest as corroborating the foregoing statements:—

Place.	Type of Furnace.	Kind of Fuel.	Gallons evaporated per hour.	Water evaporated per lb. of fuel	Increased fuel efficiency.	Increased evaporation.
Blaenavon	Ordinary	Small Welsh	515	8.6		
,,	Meldrum	,, ,,	840	8.75	1.74%	63%
Hartlepool	Ordinary	Durham small	126	7.87		
,,	Meldrum	,, ,,	196	8 83	12%	55%
Martle	Ordinary	Burgy	621	9.75		
,,	Meldrum	,,	844	9.89	1.4%	35%

The great success achieved by this furnace was the best test of its value. Up to the present time, nearly 10,000 have been fitted, representing in steam production well on to two millions horse-power. The system has been adopted by leading firms throughout the world —in the iron and steel, engineering, mining, textile, dyeing, preserving, tanning, and numerous other trades. It had been successfully applied to all kinds of boilers, such as Lancashire, Cornish, marine type, vertical, and various kinds of water-tube.

The whole air-supply was under absolute control, so that the fire could be forced or slackened at will, and this entirely independently of atmospheric conditions. In electric light works, paper mills, breweries, etc., wherever large quantities of steam were often suddenly required, this apparatus was of special value; as had already been shown, the rate of combustion could be increased to much beyond what chimney draught would effect, by simply regulating, with a steam valve, the air supply.

The Meldrum system of forced draught had also been successfully adopted in connection with puddling and heating furnaces; similar advantages followed as with furnaces for steam-raising. The bars could be placed much closer together, thus saving a large percentage of fuel. Common or refuse fuel could be used very advantageously. The labour of clearing the grate was lessened, and as the maximum temperature was practically obtained, the charge could be worked off with greater rapidity, while the greater control of the air supply enabled the operator to readily adjust his flame to the required degree of activity, with a consequent improvement in the quality of the finished product.

In conclusion, he desired to give the result of a recent test of this apparatus, made at the North Sydney Gas Company's works. The furnace was attached to a large Cornish boiler, with a 36" flue. The chimney-stack was a low one, not much over 40 feet in height, and the test was made purposely under the most unfavourable conditions obtainable, the object being to demonstrate the efficiency of the furnace as a smoke consumer. The fuel used was Newcastle and Southern slack of inferior quality. The steam jet was cut off, and the doors and ash-pit thrown open; the fire was heavily charged and roused-up, which had the effect of producing very dense smoke. The doors were then closed, and the apparatus put into operation. The densest smoke was cut off within two minutes; ordinary dense smoke, when the valvular dead-plate was opened, was cut off inside of 30 seconds.

Mr. J. L. Rae said the author had truly stated the subject was one of very great interest indeed, the more

particularly so bearing in mind the action taken by some of the inspectors connected with the Municipal Council of Sydney. First considering the question of the pollution of the atmosphere—while everyone rightly deplored any pollution of the fresh air—the fact remained that the presence of large manufacturies meant pollution of the atmosphere. Smoke was only one of the causes, but without a doubt it could be abated to a certain extent. Not only factory owners, but every householder added his quota to the smoke nuisance, although the larger consumer was most abused, being easily singled out with his high chimney stack and the large volume of smoke that was discernable issuing from it. He could not agree with people who said the production of smoke meant waste. It was a very difficult matter to define smoke, and the subject was a very wide one. He had read of a case in court at Home in 1853, when the judge had decided that a definition of coal was impossible, it therefore followed that the same difficulty appeared in the definition of smoke. The author's reference to the municipal authorities being too weak to enforce their powers to abate the smoke nuisance really meant as far as he could see, that the authorities found the difficulty of establishing a standard for smoke nuisance too great for the time being. He agreed with the author that the trouble experienced with firemen was one of the chief causes of the smoke difficulty, it being very hard to get firemen to work in a proper manner. With a properly constructed furnace and ample height of chimney, a good stoker would be able to fire with a minimum production of smoke production was controllable, but not absolutely preventable.

The author had mentioned a patent taken out by a Mr. C. W. Williams, in 1480, with the object of preventing smoke, but he had failed to find the record of it. He was aware about this time that a Mr. Holdsworth experimented with this object, and was fairly successful. The author's system of furnace had been largely adopted, no doubt, but it seemed to him that it was more suitable for collieries and other works where refuse fuel was obtainable. The coke dust quoted as used as fuel at the Sheffield "Telegraph" no doubt had simply cost them the cartage, but there was a limit to this cheap fuel, as

unless it was near at hand the cost of cartage made it prohibitive. The figures quoted in the paper, certainly, showed a saving in the Meldrum furnace, but it was a pity that the natural draught at the works quoted was not also stated. The question of the building of chimneys and their cost was certainly an item, but what was the cost of the Meldrum furnace per boiler? Information was lacking on that point. If, as the author had given him to understand, the cost of fixing the boiler at the North Sydney Gasworks was about £50, the question naturally arose as to how far that amount would have gone towards increasing the height of the chimney there. The chimney there was not costly, and appeared to him to be 48 ft. high, by about 40 ft. 6 in. base, and of ordinary bricks; he considered £50 would add another 20 ft. in height, and increase the draught an appreciable degree. Would the author give them more data as to the cost of his furnace, and thus enable him to compare the cost of erecting a chimney suitable for any boiler plant, with that of applying the Meldrum furnace.

Mr. Russell Sinclair said that he had not had the opportunity of studying the paper, but in glancing over it the point that appealed most to him was the very large claim made about solving the difficulty dealt with. The claim was hardly borne out in the paper. The tests referred to in the paper were made in England, and not in these States, and as the conditions here were so different, they were without the data they ought to have. The class of coal used and the class of boilers should have been more fully described to enable some criticism to be passed. The Meldrum gave a forced draught, but beyond that they could not lay claim to having completely done away with the smoke nuisance. It did nothing more than increase the draught of the furnace. He contended the money could be spent in putting in a boiler of a larger size, with the same result. The fault with nearly all boilers was that they were not designed for the particular purpose they were required for, and the furnace did not get time to do its share of work, hence the result—smoke. The Meldrum furnace got over the difficulty to a certain extent, but at the same time he did not consider it represented the right lines to work upon for the prevention of smoke.

Mr. J. S. Fitzmaurice said that in all well regulated furnaces as soon as the furnace door was opened to fire up there was a mass of smoke, and he could not see how the author's forced draught would prevent that. Where there were chimney stacks up to 160 feet in height—he failed to see the utility of the Meldrum forced draught. The feature that seemed most prominent in forced draught furnaces was their ability to use coal dust and waste products, not used as fuel in ordinary furnaces. But in some instances he could name, notably electrical machinery—it would not do to use this dust—as it would tend to generate a dust nuisance in place of a smoke nuisance, so coal had to be used, and the best coal. They certainly made smoke at the General Post Office, but it was not the fault of boiler power. The firemen were to blame. A good human stoker was not born. It was necessary to make them.

Mr. James Shirra said that they could write two volumes, one on the subject of smoke prevention, the other on the Meldrum furnace as dealt with in the paper, but it was generally accepted at present that to prevent smoke was an impossibility. He would like to know how the author's furnace differed from other forced draught furnaces in use—it was exposed to cold air as were the others. As far as his experience taught him the true solution of the question of smoke prevention was to use gas.

Mr. Hector Kidd said it was fairly well understood that what was required was the thorough incoroporation of the minimum quantity of air, and the keeping up the temperature of ignition. When visiting the gasworks at North Sydney, as already mentoned by Mr. R. Sinclair, they tested the draught. As regarded the effect of the draught, of course the Meldrum furnace was one of a very large number of the same kind. The advantage gained by the forced draught was the more thorough mixing effected of the products of combustion, the result being, as was claimed, the use of less fuel. He considered it a matter for regret that the representatives from the Town Hill were not present to take part in the discussion of the matter before them. It seemed to him

that it was their duty to come and give them some hints as to how to prevent the smoke nuisance.

Mr. A. M. Howarth said that while casually looking through some books, he had come across a sketch of an invention by Jas. Watt of the first so-called smokeless furnace. Thinking it possibly of interest to the members he reproduced the sketch on the blackboard.

Mr. Meldrum, in reply, said that the discussion on the paper had been a lengthy and exhaustive one. The lateness of the hour prohibited him from dealing individually with the majority of the points raised. He could assure them that he did not feel disposed to take up much more of their time that evening. The paper had been compiled at very short notice, and items singled out by members under other circumstances would have received more elaboration at his hands. He desired to thank them for the kindly way they had received his paper, and the candid criticism pased upon it. Referring to the matter of smoke prevention and economy in combustion, he wished to point out that in his paper his firm had practically reversed the ordinary course of things in furnace construction. In place of having atmospheric pressure under the grate, and something less than that over the fire, they had approximately atmospheric pressure over the fire, and something more than that under the grate. They had less residue of ash, and obtanied greater heat activity, and consequently greater efficiency of boiler power. The whole fact, to his mind, was that the air was distributed more evenly through the fire than it could be with a wide grate, and nothing combustible could fall through. He was of opinion that since the advent of his forced draught in connection with various furnaces in England, the law regarding the smoke prevention nuisance had been sufficiently met. He could produce testimonials from some of the largest coal consumers in the world, showing that the apparatus in question had certainly prevented the formation of smoke. He doubted very much if any smoke at all was generated in the appaartus, it could have no opprtunity of forming unless a very small quantity from the back of the furnace. In the material used, everything of value was consumed, indeed, the maximum amount of heat was obtained from it.