On noxious vapours and town smoke, with suggestions on house warming / by Alfred E. Fletcher ; read before the Society, 25th January, 1888.

On Noxious Vapours and Town Smoke, with Suggestions on House Warming. By Alfred E. Fletcher, F.C.S., F.I.S., H.M. Chief Inspector under the Alkali, &c., Works Regulation Act.

[Read before the Society, 25th January, 1888.]

Yielding in an unwary moment to the seductive invitation of your excellent President, Dr. Russell, I consented to read a paper before you this evening on Noxious Vapours, including Town Smoke, and to touch on a subject that leads naturally from this—namely, House Warming. I will do my best now to fulfil the promise, asking your forbearance beforehand should my lecture partake of the dulness inherent in the subject of which I treat.

I will not take up your time by dwelling on the necessity of our having a sufficient quantity of air to breathe, remarking only that the air should be unmixed with any foreign gas, whether that gas be one that is actively hurtful to our bodies or whether it is to them inert and serves only to dilute the air we inhale. The air, composed of oxygen and nitrogen with a little carbonic acid and a varying quantity of watery vapour, is not a definite compound of these, but a mixture only, and one that can be modified by diminishing or increasing one or other of its ingredients. The same relative proportions of its constituents is, however, steadily maintained, thanks to the many agencies in nature ever working to this end.

The animal breathes the air, and oxygen is absorbed into the blood. There it combines with effete matter, composed chiefly of carbon and nitrogen, forming with them carbonic acid and watery vapour. These are exhaled and mix with the atmosphere, which would soon be thus vitiated but for the corrective action of plants which take up the carbonic acid and under the influence of sun-light decompose it, assimilating the carbon into its structure and returning the oxygen to the atmosphere. And lest this action should locally be impeded and air of irregular composition be found lurking in places, the atmosphere moves in mass from place to

place, and the winds of heaven search out every nook of valley and forest, to the end that by incessant mixture the air should retain its normal condition, its parts being ever mixed in just that proportion which is best fitted for the respiration of man and beast. If, then, nature is so careful to maintain the pristine condition of the air we breathe, let us imitate her care and use every practicable means to avoid its contamination.

Man in all the methods of his activity seems to be ever at war with nature; he subverts her arrangements and attacks her at every step. She in turn resists him and impedes his progress. The settler in a new country commences his operations by cutting down and destroying the branching forest which adorns the hill-side; he thrusts in his ploughshare and breaks up the tangled under-growth. It is true that in time a lovelier prospect may present itself than the primeval one which has been disturbed, nevertheless man's first act seems to be to disturb and to injure. As in the earth so is it in the air, that this part goes on and is ever more extended as man's activity increases.

Man's very act of breathing contaminates the air, and the more he works the more he breathes. He lights a fire to warm himself and cook his food—the injury is accelerated. Population increases, the common war against nature goes on, and no heed is given until she retaliates. The return blow is not, however, always aimed at the original offender; often the innocent suffer for the crimes of others. One man is a chemical manufacturer; he sends into the atmosphere gases for which he has no present use; the injured air moves on, and passing over the ground of a neighbouring farmer wreaks vengeance there by killing his crops.

If, in general, a man's ill deeds affected himself only, and the results of his actions fell wholly on his own head, there would be less complaining and the evil itself would be much curtailed. It is not so, however, and the case before us—that of contamination of the atmosphere—is no exception to the general rule.

What is a noxious vapour? Let us not stay until we are satisfied with an answer to that abstract question; rather let us say some vapours are noxious.

Can all noxious vapours be prevented? I think not wholly. They may be lessened, but not wholly suppressed. The preliminary remarks in this paper have been intended to lead up to this negative reply. Dirt seems to be one of the unavoidable accompaniments of man's work—of his attack on nature in the

pursuit of objects necessary to his existence. But just as a brighter prospect grows up under the cultivator's hand than was seen in the wildness of nature, so the gain of the manufacturer is an ample reward for the dirt and turmoil of his processes.

The material of the white paper from which I read was in colour as brown as is the floor on which I stand, until it was bleached by chlorine, an irritant noxious gas. The dye which colours the garments we wear is the result of manufacturing processes from which noxious vapours abundantly may proceed. The brighter tints of women's dress can boast no different parentage. The metals which we use on every hand are the outcome of smelting processes, the sulphurous fumes from which are noxious in the highest sense. It would, indeed, be difficult to name any article we use whose substance, texture, or colour has not been produced by some manufacturing process, during the conduct of which some noxious gas has been evolved.

You groan! the burden grows too heavy. Is this the price we pay for our vaunted civilisation? Can we not shirk it? No, verily, but we may compromise with the creditor. Let the skill used to elaborate the much-valued result be employed to avoid, as much as is possible, the injury committed. If due diligence is bestowed in this direction there will be but little ground left for complaint. Much, indeed, may be done to diminish, and yet again diminish, the amount of noxious vapour emitted, until the residue is small and comparatively harmless, but utterly suppress them we cannot.

Forgive if I have been so long in reaching this point; its importance is my excuse. If not positively acknowledged, we aim at a mark to which we can never attain; if we admit it, we reach higher and higher, until we are surprised at our own successes.

This principle is admitted in the law of our country—in our Noxious Vapours Act, the so-called Alkali, &c., Works Regulation Act, and in the Rivers Pollution Prevention Act; the admission may be inferred from the existence and phraseology of these Acts, that there are and will be pollutions of air and of water, but it is made incumbent, under heavy penalties, on every citizen to employ the best practicable means for controlling and diminishing them.

This wise position has not, however, been always taken by the legislature. If we trace back the laws which have been passed in

reference to noxious gases, we must go back to very distant times. Five centuries and a-half ago, in the reign of King Edward II., it seems that coal ("sea-coal," as it was called, since it was brought from Newcastle by sea) was already largely employed in or about London, principally, I suppose, in smithies, breweries, and other factories where large fires were needed, not yet in houses, perhaps. It was used in sufficient quantities to cause great offence by the black smoke emitted. So great were the complaints that in the year 1813 the Parliament petitioned the King to forbid the use of sea-coal altogether; and this was done. It was a trenchant measure, and did not recognise the principle I have tried to establish, and, in consequence, it was unsuccessful. How far the edict was obeyed at the time I cannot learn, but certainly the abstinence enjoined was not practised long. Wood, the ordinary fuel of the country, became scarcer as the forests vanished before the increasing population, and coal had to take its place.

Ever since these early days, smoke has held its own against all attempts at suppression. To come down to more recent times, we find that in 1829 a Select Committee of the House of Commons inquired into the effect of the smoke of factory chimneys on the public health; and, in 1843, another Committee considered the "means and expediency of preventing the nuisance of smoke." Since that time three Imperial Acts have been passed—namely, those of 1857, 1861, and 1865—in which black coal-smoke is declared to be a nuisance, and its emission prohibited under penalties. In the Public Health Act for Scotland, 1867, black smoke is condemned as a nuisance, and in the Scotch Smoke Abatement Act, 1857, it is enacted that—"Every furnace be constructed or altered so as to consume or burn the smoke arising from such furnace." The penalties attached are from forty shillings to £5 for the first offence; £10 for the second offence; and for every subsequent offence, the penalty is to be double that of the last, with all costs in addition. This seems severe enough; surely there are no people daring enough to emit black smoke after this. Wait! there is one more line to be quoted:—"This Act is to be enforced by the Local Authority."

And do not the Local Authorities throughout the kingdom enforce it? Yes, certainly; at least, they do in Glasgow. They punish every one who emits black smoke, but they put their own interpretation on the word "emit." "Emit" is held to mean "discharge during three consecutive minutes," but this must not

occur too often, that is to say, "in the aggregate, not more than ten minutes in the hour."

The descriptive word "black" is also, I am told, literally interpreted. To draw down a prosecution the smoke must be quite black. Is not three minutes of uninterrupted densely black smoke a long measure, or an aggregate of ten minutes in the hour? It would, I think, show that no great effort had been made on the part of the proprietor to prevent smoke emission. Moreover, is a space of three minutes, or an aggregate of ten minutes in the hour, allowed for each boiler? If so, in cases where there is a battery of six or more boilers, black smoke may be sent out all day from the chimney-top without giving ground for interference on the part of the police. Let us presume the ten minutes' allowance is for each chimney, not for each boiler.

In London the police inspectors do not consider that their duty is limited to the simple observation of the chimney-top. When offensive smoke is found to issue from it, their engineer visits the factory and ascertains by his own inspection whether any and what means are in use for preventing smoke. If the owner of the furnace is earnestly applying means likely to accomplish the desired end, time for carrying out the plan is given, and much greater leniency is shown than where nothing is being done of a remedial nature. The engineer so employed under the Home Office no doubt is often able, by judicious advice and by affording information, to smooth the path which steam users sometimes find such a difficult one to tread.

There can be no need, however, for continued leniency where the emission of black smoke is permitted. Abundant proof has been given of the possibility, and in most cases the economy, of smoke prevention, and it may be safely asserted that, if a determination were come to on the part of the public and the authorities that the emission of black smoke should cease, the difficulties which have presented themselves would be found to have been imaginary, or, at any rate, such as could be overcome by the application of skill and determination.

To obtain correct information as to the efficiency of the various smoke-preventing appliances which are offered by their various inventors is not easy. One man declares that he is using a certain arrangement with great success. You look at his chimney and are delighted with the continued absence of black smoke. You make inquiry as to the consumption of coal and the duty done by the

boiler, but probably no correct information can be given—they are not in the habit of making such exact observations. Or, again, a friend using a novel apparatus, or some fresh arrangement of his furnace, assures you that not only has he entirely ceased to produce smoke, but he saves 10 per cent. of his coal. This sounds more promising, but on close inquiry you find that your friend's consumption of fuel had previously been most extravagant, and that to save 10 per cent. was a very simple matter, that, indeed, his present system affords no model for you to copy advantageously.

In order to make real advance in this matter, and to afford a fair comparison of the various systems proposed for economical firing with avoidance of smoke, one could wish that as many of them as possible should be worked in competition, one against the other, in the same place, subject to the same conditions, and doing the same work—all being done under strict scientific registration of the results attained.

Such an opportunity is not often to be found, but a proposal has lately been made that at the International Exhibition to be opened shortly in Glasgow such a scheme might be carried out. A battery of nine or ten large boilers is to be employed in raising steam to drive the machinery of the Exhibition; if each of these were fitted with a mechanical stoker, a hollow bridge, a steam blast, or with any one of the many appliances now brought forward, an accurate comparison could be made of their relative efficiency, both as smoke-preventers and as steam-raisers. An assistant-engineer appointed for the purpose would be able to register the amount of water evaporated and the coal consumed, so that a visitor would then receive the precise information needed, and which otherwise it is most difficult to obtain. Such a display of steam-furnace appliances would, I think, form a very marked feature of interest in the forthcoming Exhibition—one that would attract a large number of visitors, not from our own country only, but from all parts of the world. It would also leave behind it a permanent mark, as the report which would be issued would be of extreme value for future reference. Unfortunately, I have to add that this useful project is not to be carried out; the scheme has been discussed by those having the conduct of the Exhibition, and dismissed as impracticable. I cannot but think that they have magnified the difficulties to be encountered, and somewhat lost sight of the many advantages that would have been obtained.

One of the advantages gained by it would have been that of affording an opportunity of showing to any smoke-producer a number of furnace appliances, all of them successful in preventing smoke. The plea of *non possumus* would have been effectively taken away, since it would have been possible to point to a variety of arrangements of furnace appliances, all of which accomplished the desired end, and with an economy of fuel and boiler space.

Another and important class would also have been greatly benefited—namely, the Scotch colliery proprietors. Since most of the Scotch coal is highly bituminous and, when burnt unwisely, is very smoky, it has been rejected by many merchants in favour of Welsh coal, which is less gassy. Loud complaint was made last year when some of the vessels of H.M. Channel Fleet were anchored for awhile in the Forth, because they sent to South Wales for a supply of smokeless coal, instead of using that from the neighbouring collieries. Now, had this competition of smoke-preventing furnaces been encouraged at the Glasgow Exhibition, no doubt it could have been shown that the Scotch gassy coal, if properly treated, can be burnt without producing black smoke.

Some years ago some of the Durham coal-owners carried out a series of furnace tests, for the purpose of proving to the Admiralty and other consumers of smokeless coal, that their coals were also smokeless if burnt in a proper manner; and they showed that the duty got from the coal was greater when smoke was avoided than when it was emitted from the chimney. A similar set of experiments was also conducted at Wigan, at great expense, at the instance of the colliery proprietors there, and with the like result. In both cases the record of the experiments showed that the bituminous coals from those coal-fields could be advantageously burnt without producing smoke, and it was distinctly shown that there was loss of effect when black smoke was permitted to escape. Had this promising scheme been carried out at the forthcoming International Exhibition as proposed, the Scotch coal-owners would have been able to prove the economic value of their coal without going to the expense of special experiments. The fiat has, however, gone forth—the smokeless contest is not to take place.

I have dwelt now as long as my time allows on the nuisance arising from the black smoke which too often issues from factory chimneys. Much more might have been said descriptive of the various means available for its cure, and also of the repeated declarations made by the Legislature that the pollution of the

atmosphere by coal-smoke is an offence against the community and punishable as a crime.

I pass on now to consider the sub-divided but constant pollution carried on by the coal-smoke which issues from the chimneys of our dwelling-houses.

Living as we do in a climate in which for half the year artifical heat is necessary to our comfort it is a matter of primary importance that we should learn how to warm the air of our houses. The method first adopted by the Highland cottar of lighting a fire of peat on the floor of his cabin was one most economical of heat. The heat given out by the fire was all usefully applied to the warming the interior of his dwelling. Unfortunately, with the heat was also smoke, and if the cottar ever wished to close the door of his hut he must make a hole in the roof for its escape. As an ornamental finish an old barrel, with both ends knocked out, was stuck on the roof—an incipient chimney stalk. This did pretty well in calm weather, but a gust of wind entering at the door so whirled about the smoke, mixing it with the air of the room, that it was no longer pleasant for eye or nostril.

Some adventurous spirit, determined in building his abode to advance beyond what his father had done, prolonged the chimney downwards, passing it along, or building it in, the house wall, and, removing the fire from the centre of the floor, placed it against the wall under the chimney prepared for it. What convulsion of society accompanied the taking of this important step in domestic economy we are not told. Probably the first innovators were placed under a ban—were shunned as those who desired to overturn society. They were iconoclasts, dishonouring the traditions of their ancestors. Indeed, this step was so painful that humanity has steadily refused to take another in this matter, and our elaborate fire-places, with their ornamental surroundings, are but the hole in the wall with the uprising chimney devised by this remote ancestor.

Much may be said in praise of the open fire. Who does not love its bright and genial blaze, or would undertake the thankless task of pointing out deficiencies in so cheery a friend? May be, indeed, the fault is ours, we expect too much of the fire, demanding of it that which can better be otherwise supplied.

To make sure that all the smoke should pass quickly up the chimney and not mix with the air of the room, we make an ample opening. This permits the passage not only of the smoke but of

a large stream of air also. The air thus taken from the room and expelled through the chimney must be supplied again; it is therefore drawn in through every crevice, through half-shut door or leaky window. Nor is it possible to avoid this in-draught of cold air, for were it completely prevented the chimney would cease to keep the room free from smoke.

The cure for draughts of cold air should not be sought by listing the door and putting sand bags on the windows, but by providing a quantity of warm air sufficient to supply all the demands the open chimney may make upon it. When the house-doors are shut and many fires are burning a considerable suction is set up by the draught of the chimneys, and if no proper provision is made for the entrance of air, air will enter at improper places, perhaps through cellars, bringing with it a damp unwholesome taint; or, may be, through an untrapped sink or faulty drain pipe; or down an unused chimney, bringing with it the unwholesome smell of soot.

A remedy for all this will be found in providing for the free entrance of air through some proper channel. In my case I have chosen the back or garden side of the house, and about 10 feet from the ground have cut a hole for the admission of a light iron pipe 10 inches diameter; this turns upwards a little towards the sky, and is protected from falling dust by a slight hood. The air passing inwards meets first a large sheet of thin woollen cloth, through which it filters and there deposits the smuts and dust too frequently found in the air of all towns. This cloth should be as large as possible so as to offer as little obstruction to the air as may be. In my case the extent is 24 square feet. From the shallow box containing the filter cloth the air passes on as before through a 10-inch iron pipe to the heating stove, the construction of which I will presently describe (see Plate VI.). There warmed to a temperature of about 150° Fah. it ascends through a short pipe to a grating in the hall. This becomes filled with warm air, and from it the adjoining rooms draw their supply. The warm air ascends by the staircase-well and finds its way into every apartment. The chimneys of the house are all open; the ventilation not only goes on as usual but is much assisted by the constant stream of warm filtered air ever driven in. There is produced an all-pervading sense of comfort. It is no longer necessary to carefully select the one or two places in the sitting-rooms which have the repute of being free from draught—all places are alike. The doors may now be left ajar

without arousing complaint, and the window is no longer accused of causing a draught.

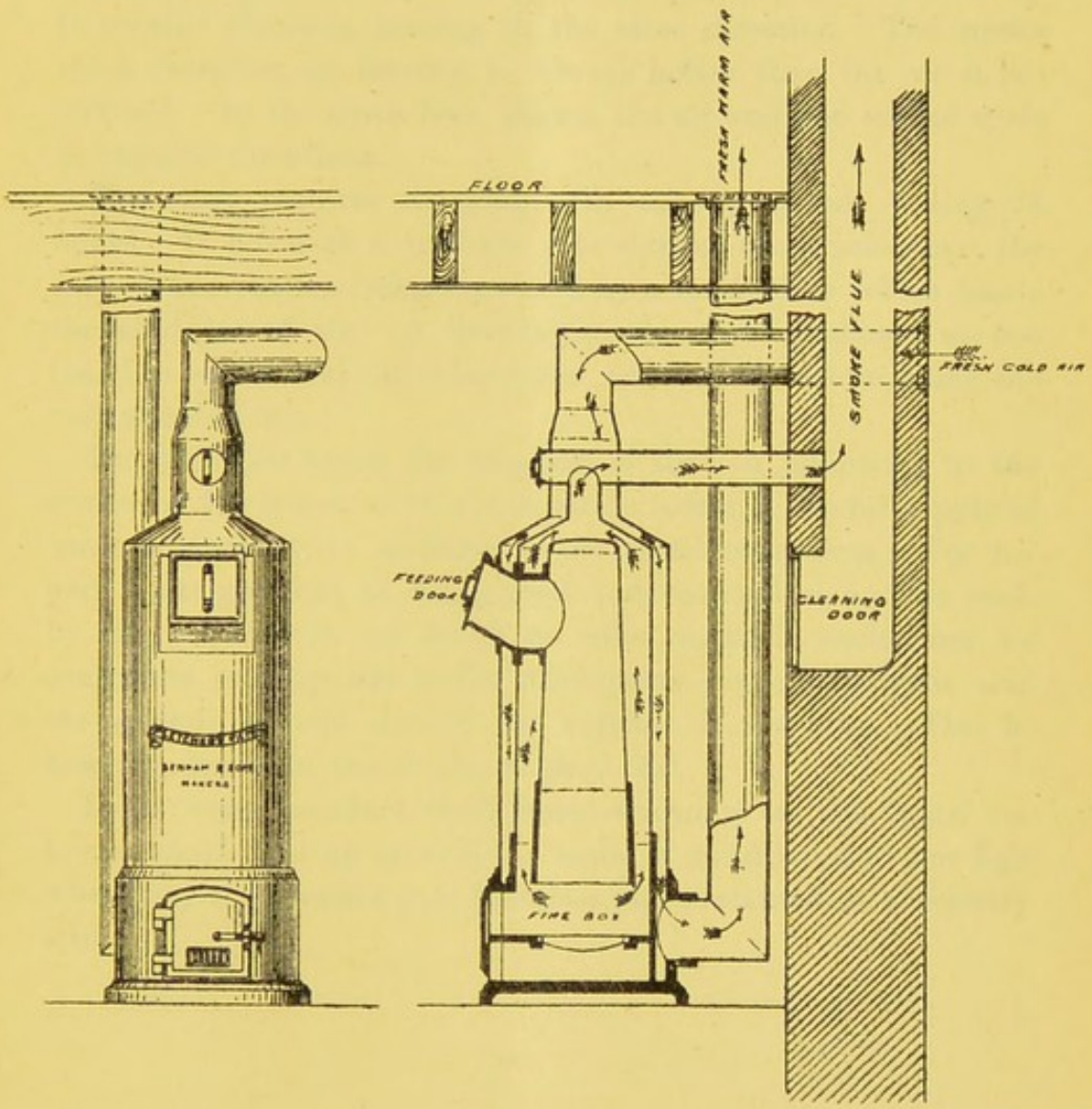
Much might be said as to the moral effect of such an arrangement in that many of the minor discomforts of the house are removed. The effect of supplying a house freely with warmed fresh air is like that of changing the climate, it is as a change of season—a leap from January into May.

Air warmed by a stove is often said to be unpleasantly dry. Yet, how has the air been dried? The heating surfaces do not absorb moisture, nor have they power to destroy it. True, the air is expanded, and therefore the warm air has less moisture per cubic foot than had the cold air. Yet, can this be an evil? The air of our climate is usually too moist, and we gladly avail ourselves of an opportunity of staying in a district where the air is dry. Why then is the alleged dryness of stove-warmed air objected to? To this the following reply may be given. The air around us is laden with dust. This is composed of filaments of cotton, wool, hair, and other matter chiefly either of animal or vegetable origin. These small particles on coming into contact with the heating surfaces are singed or burnt, and made to give out a characteristic smell. It is this burnt smell which is objected to. The air, however, is not burnt, but only the dust with which it was laden; nor is it dried, and if it were that would not be detected by the nose. It is not usual on a dry sunny day for us to say—"How unpleasantly dry the air smells."

If, then, the over-heated or burnt dust is the cause of the offence, the evil may be avoided by removing the dust. This is done by filtering the air through a woollen cloth before it reaches the heating stove, as has been already described. It is found that air so filtered before being warmed does not assume the unpleasant smell referred to in passing the stove. Of course all heating stoves should be so contrived as to have a large moderately heated surface, rather than one small and over hot. In the drawing now shown (Plate VI.) it will be noticed that the heat is, in the first instance, taken up by the products of combustion which are made to surround the stove itself in an annular envelope. Outside this is the air to be warmed which gets its heat thus at second hand, and moderated in degree.

It will be noticed that the air to be warmed enters at the top of the stove, coming first in contact with the smoke as it leaves. Descending now it passes over surfaces progressing warmer until

HOT-AIR STOVE FOR HOUSE WARMING.



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it touches the hottest part, and then ascends to pass into the house. Thus the air leaving the stove is much hotter than the smoke, it being about 200° Fah., while the smoke is about 120° Fah. This is the reverse of the condition usually experienced in air-heating apparatus. There the air and the smoke pass away in parallel channels, moving in the same direction. The smoke must, therefore, on leaving, be always hotter than the air it has warmed. In the stove here shown, the air and the smoke move in opposite directions.

The stove requires charging with coke once only during 24 hours. It burns at a uniform rate during the whole time, the rate of combustion being regulated by a small slide which limits the admission of air. A drawing of this stove is shown as one that has been found convenient and economical, not as being the only suitable one.

The principle urged for adoption is that of admitting to the centre of the house, or to the separate rooms, a liberal supply of warm filtered air, in addition to the usual open fires. For my part I use gas fires as being clean and economical, and we cook by gas, so that in my house no coke smoke is made, and we contribute no impurity to the atmosphere beyond carbonic acid the sulphurous acid due to the sulphur of the coke. This is, however, less than was in the original coal.

If all would conduct their house-warming on this plan our towns would light up as with the smile of sunshine, and our fogs when they come would pass harmless and unstained as a country mist.