CHAPTER XI.

METALLURGICAL FURNACE SMOKE.

THE smoke nuisance is produced by Domestic Fires, 25 per cent., Boiler Fires, 30 per cent., and Metallurgical Furnace Fires, 45 per cent., approximately, so the greatest of the offenders are the Furnace Fires, and about 80 per cent. of the smoke made by the Furnace Fires is not necessary.

Little has been done to combat this evil, perhaps because it has seemed too great a problem to deal with.

The Sheffield manufacturers deserve to be congratulated heartily for taking a national lead in preventing some unnecessary smoke from metallurgical furnaces. During the last 20 years they have spent much money in rebuilding furnaces on more modern principles, erecting improved coal-fired furnaces, substituting gas for coal, raising furnace chimneys to a reasonable height, and stoking furnaces on a more scientific, economic, and smokeless system. During the war the writer spent a great deal of his official time in the works advising and assisting the furnacemen to burn the coal without clouds of smoke and thus save coal and increase the output of munitions.

The little help rendered was greatly appreciated by the manufacturers from an economy output and other points of view, as being far better than prosecuting for making smoke which some of them did not know how to prevent.

PUBLIC HEALTH ACT, 1875.

Public Health Act, 1875.—*Section* 91 enacts that (*a*) Any fireplace or furnace in trade premises, which does

not so far as practicable consume the smoke arising from the combustible used therein, and (*b*) Any chimney (except a private dwelling-house) sending out black smoke in such quantity as to be a nuisance, shall be deemed to be a nuisance liable to be dealt with summarily. Under *Section* 92 the local Authorities are required to cause inspection of their district to be made from time to time, with a view to abating nuisances, and to enforce the provisions of any Act in force in their district requiring fireplaces and furnaces to consume their own smoke. If the local authority make default in this, the Local Government Board may under *Section* 106 authorise any police officer acting in the district to take proceedings, and the costs being recoverable from the defaulting authority. *Section* 94 provides for service of notice requiring abatement of the nuisance, and on non-compliance, complaint may be made before a justice (*Section* 95), who may make an order to abate the nuisance, and to prohibit the recurrence of the nuisance, or for all these purposes, and impose a penalty not exceeding £5 (*Section* 96). Further penalties for each day's neglect to obey an order of the court are 10s. and 20s. per day respectively. *Section* 334 provides for the protection of certain processes, and enacts—"Nothing in this Act shall be construed to extend to mines of different descriptions, so as to interfere with, or to obstruct the efficient working of the same, nor to the smelting of ores and minerals, nor to the calcining, puddling and rolling of iron and other metals, nor to the conversion of pig iron into wrought iron, so as to obstruct or interfere with any of such processes respectively."

Prevention as far as Practicable.—A careful reading of these sections will destroy doubts in the minds of the most sceptical, concerning statutory power to enforce the prevention of unnecessary smoke from metallurgical furnaces, and liability of penalties for non-prevention. For 50 years there has been legislation to enforce, as far

as practicable, the prevention of smoke from all sorts of metallurgical furnaces, but the law has not been administered, and its non-administration is responsible for the belief that there is no law to stop furnace smoke.

There has been no reason why the law should for so long have been a dead letter, and to-day with greatly increased population and increased smoke nuisances it is only reasonable and right that the law should be enforced, for its enforcement would benefit all.

Re-heating Furnaces.—About 80 per cent. of the metallurgical furnaces of all sorts and sizes, are for the re-heating of ingots, bars, billets, rods, springs, and all sorts of metals. It is much more difficult to prevent economically smoke in re-heating furnaces than in boilers. In boilers the first consideration is to burn all the gases, prevent the formation of smoke, and generate the maximum amount of steam. But in re-heating furnaces, the first consideration is the re-heating of the steel to the required temperature, for pressing, hammering, rolling, etc., and to burn all the gases when re-heating some classes of steel, would burn and spoil the steel. So temperature must be first, economy second, and smoke third. Then there is an additional difficulty in preventing smoke every few hours when the furnace is recharged with cold steel, for the temperature is reduced below the point of complete combustion and great care is necessary in stoking the furnace to prevent excessive smoke until the normal temperature is reached. Generally the working temperature of re-heating furnaces is high, and if the fires are fed lightly instead of heavily, the formation of large quantities of smoke will be prevented and temperature of the furnace increased. The re-heating will be done in a shorter period of time, with advantage to the workmen, who are generally on piece-work.

Criminally Low Chimneys.—Metallurgical furnace chimneys are, to say the least, criminally low, lower, indeed, than domestic chimneys and not a third the

height of boiler chimneys. With very few exceptions they consist of *iron pipes*, the average height being from 25 to 30 feet. Each pipe serves 1 furnace, and such "chimneys" are quickly erected at comparatively little cost. Manufacturers have been permitted by local authorities to erect them of any height they choose, and some have put up lower chimneys, and in all probability the general height would not have been 25 feet, had it not been considered the minimum height for the necessary natural draught, for there is often little sentiment or sense of justice in industry, which would put cost before comfort and public health. Dense volumes of smoke of long duration, discharged from chimneys at the outrageously low level of 25 feet, fill the streets and houses. The damage is far greater than that caused by either domestic or boiler smoke, and the amazing and appalling fact is that the public have endured it for so long.

Defective Draught.—A large number of low furnace chimneys have been raised to a reasonable height when owned by men of good will, as a result of complaints by aggrieved persons living near the chimneys. Very quickly after the erection of low chimneys, the majority of manufacturers found out the big blunder they had made, for the draught was insufficient. The man who worked the furnaces complained of inability to get the steel hot quickly enough, and demanded more draught to enable them to get a higher furnace temperature made to produce more work in a stated time.

Forced Draught.—The chimney foundations not being sufficiently strong enough, in the majority of cases, to warrant the raising of the chimneys with safety to the necessary and reasonable height for the efficient working of the furnaces, they were nearly all of them compelled to adopt "Forced Draught," which consists of a closed ashpit (by metal plate), the insertion of steam jets producing a pressure in the ashpit blowing up the fire through the grate bars, and greatly increasing the consumption of

coal per square foot of grate bar, thus increasing furnace temperature, and output.

In some instances in addition to jets in the ashpit, a jet has been put over the fire. After charging the furnace with raw coal, if the jet over the fire were put on a minute or so before the jets in the ashpit, then a more complete combustion of the coal resulted. But the great majority of the forced draught furnaces have only jets in the ashpit, with the result of incomplete combustion, and the gases are forced by the ashpit pressure from the chimney.

Draught Control.—It is alleged by furnacemen and others "that fairly low chimneys, with a chimney for each furnace, gives them more control over the draught (which is so essential in heat treatment) than does a tall chimney, for with the latter they have too much draught." Such a statement is the product of fancy, not of fact. There have been for years many metallurgical furnaces served most satisfactorily by tall chimneys, not 30, but 130 feet high, serving from 5 to 20 furnaces and in many cases boilers as well. The draught is controlled completely by the dampers, and the efficiency of the furnaces with tall chimneys is greater than with short chimneys.

If it were possible either by natural, or forced draught, to work metallurgical furnaces smokelessly with chimneys of 30 feet high (which it is not, without exceptionally great care), even then the products of coal combustion, visible or invisible, ought not to be discharged at such a low level, but should be emitted at a level higher than the surrounding buildings, thus reducing the nuisance, whether injurious or offensive to the lowest possible minimum.

Furnace Firemen.—There are furnacemen and firemen. The former are responsible for the re-heating of the steel to the exact temperature required for rolling, forging, etc. Very rarely do the furnacemen fire the furnaces, because

their whole time is occupied in the oversight of the re-heating, drawing when hot, and recharging the furnaces. The firing of the furnaces is done, not by one man specially trained and deputed to do the work as is done in the firing of boilers, but by three, four, and sometimes more men or boys.

The Rollers, Forgemen, etc., work in sets of six, eight, or more, and they have charge of one or two furnaces. Three, four, or more of the set are called upon by the furnacemen to fire the furnace when he requires it to be fired, and they fire it in turn, and sometimes out of turn. Each of the men has his own work to do at rolls, or hammer, and the firing of the furnace is certainly part of his work, but is generally considered as a very insignificant part.

Careless and Costly Firing.—The men who do the firing have frequently to walk from 12 to 20 yards from their work to the furnace. They get through the firing as quickly as possible, to get back to the hammer, and the firing is done in a most careless and culpable fashion, which is most costly in coal to the master. They are not concerned for one moment about burning the coal economically, considering that all they have to do is to "put the coal on the fire." This they do most liberally—putting on about three times as much coal as is required to last 20 or more minutes, choking the fire, reducing the temperature, and shutting the fire-hole door, which is generally solid, and so exclude the air necessary for combustion. Then the forced draught in the ashpit forces the gases up the chimney and the latter, after each firing, emits dense black smoke for 12 or more minutes. But when the furnace is recharged with cold steel, the firing is, if possible, more careless and costly.

It is no unusual thing after recharging the furnace to put not only three but four and five times more coal on the fire than required, for the fireman considers that "after recharging the furnace it requires a heavy fire,"

and so nearly fills the fireplace with raw coal to last, and black smoke is discharged for 20 or more minutes at a low level of 30 feet. When the men are rebuked for such unnecessary and foolish firing, they retort that they know how to work the steel, having done it for 40 years, and if it has to be done in any other way, they should not be held responsible for spoilt steel.

Such is the universal system of firing furnaces to-day, and no one can study it for a moment without unhesitatingly coming to the conclusion that the furnace smoke nuisance is the greatest of all, and that it is caused chiefly by careless and senseless firing, which is responsible for 80 per cent. of unnecessary smoke.

Trained Furnace Firemen.—To prevent the 80 per cent. of unnecessary smoke made by reheating furnaces, save an enormous quantity of coal, increase the output of the furnaces, it is necessary for the manufacturer to have firemen trained practically, on the lines laid down for boiler firemen. Instead of four or more irresponsible persons to fire a furnace, he will have one man to fire and be responsible for the firing of one or more furnaces, with no other work to do. Under such conditions it would be possible to fire the furnaces sensibly, and scientifically burn the coal instead of wasting much of it in smoke. Manufacturers who have put specially trained firemen to their furnaces, have found the change profitable and all furnace owners voluntarily should do likewise or be compelled to do so.

Furnace Smoke Limits.—There is no reason why furnace smoke limits should not be fixed, as is done for boilers, for the whole of the country by the Minister of Health, and the following (with trained firemen) would be reasonable and just sufficient for re-heating furnaces working under normal conditions.

1 Furnace allowed 3 minutes of black smoke in the hour.
2 Furnaces „ 5 „ „ „
3 and more Furnaces allowed 6 minutes of black smoke in the hour.

Some may say that if it is reasonable to allow 6 minutes for 3 furnaces, it is reasonable to allow 12 minutes for 6 furnaces. In practice that is not found necessary, for the heat from the 6 furnaces increases the temperature prevents the formation of smoke, and the 6 minutes allowed need not be exceeded.

Special Heat Treatment of Steel.—Sheffield is famous the world over for the making of High Speed Steel. It can be truthfully said that if Sheffield has equals (which is questionable) there is no superior steel producer, as is proved by the power of Sheffield steel to penetrate the thickest, and get over the highest tariff walls of the world. To produce the special high carbon steel, rods, sheet, very thin sheet, etc., it requires very skilful heat treatment, as evidenced by Sir Robert Hadfield's statement that 5 or 6 excessive degrees of heat will burn and spoil the steel.

The furnaces in which the special heat treatment process is carried on are of the re-heating high temperature type, with low chimneys, forced draught (mostly) and natural draught, but worked at a lower temperature.

Before the furnace is recharged with cold ingots or billets, it is necessary to reduce the temperature of the furnace to prevent cracking of the steel. After recharging, the temperature is raised gradually to the required degree. But there must be a smoky flame in the furnace; or in other words, it is absolutely essential for the steel to be in an envelope of smoke (or reducing atmosphere) to prevent decarbonisation of the steel, and the steel thus enveloped absorbs carbon and produces the super special steel. In this special steel producing process, to prevent the formation of smoke in the furnace would burn and spoil the steel, so it is absolutely necessary to produce large quantities of smoke to get the required results. But it is not absolutely necessary to discharge the volumes of smoke, after they have done their work in the furnace, into the atmosphere at an

abnormally low level, and so smother the whole district with smoke. The valuable smoke should, after it has done its work in the furnace, be utilised by passing it over an auxiliary grate (incandescent) of a waste heat boiler, burning the gases and generating steam to drive machinery, and the products of combustion discharged from the chimney, of a reasonable height, of the waste heat boiler. If the firm does not require steam for driving or any other purpose, then it is incumbent upon them to put down a waste heat furnace instead of a waste heat boiler. The smoke required in the special low-temperature furnace after it has done its work will pass through the attached waste heat furnace, the gases being consumed and the heat utilised in the re-heating of different steels, metals, etc. Only the products of complete combustion will be discharged into the atmosphere.

It is both practicable and profitable to utilise the unconsumed or combustible gases from all sorts and sizes of metallurgical furnaces, and public health demands that it shall be done.

Sheet Mill Furnaces.—There is a large number of furnaces known as *sheet mill, re-heating furnaces*, with low iron chimneys, damper on the top of the iron pipe (muffle), for the most part utilising natural draught, and worked at periods of the re-heating process at a low temperature. They are used for the re-heating of steel slabs, rolled down to thin sheets, and also when a number of the thin sheets are put together and re-heated for the finishing rolling process. When re-heating the thin sheets for the finishing process, the furnace must be filled with smoke to prevent the burning of the sheets, and the smoke can only be consumed after it leaves the furnace.

Many years ago, one enterprising and public spirited firm decided to end the smoke nuisance from their sheet-mill re-heating furnaces. They converted their

furnaces from coal to gas-fired, at an enormous cost, believing that gas-fired furnaces would produce the same quality of sheet steel as coal-fired. They did not inform their customers of the change from coal to gas. But the firm very quickly found out to their utter dismay the great and costly mistake they had made, for the whole of the sheet steel worked in the gas-fired furnaces was returned with the statement that the sheet steel was not of the usual and required quality, and the firm having proved for themselves that the steel was not of the coal-fired quality, was reluctantly compelled to go back to coal-fired furnaces.

Annealing and Hardening Furnaces.—The furnaces used for annealing and hardening various kinds of steel have often low brick chimneys, natural draught, and are also worked at a comparatively low temperature. In most of the furnaces, the steel annealed by heat treatment is exposed to the heat of the furnace, but in other furnaces the steel is not exposed to the direct heat, but protected in metal boxes. In the former furnaces annealers of 40 years experience say they must always have a smoky flame to prevent oxidation and scaling of the steel. But in the latter furnaces where annealing is done in metal boxes, there is considerably less smoke required in the annealing process. Many firms are now annealing various classes of steel in gas-fired furnaces, and they say that the results are satisfactory from all points of view, accuracy of heat-treatment, quality, output and economy, and they are most satisfactory from a public health point of view, for there is no smoke nuisance from them.

If owners of annealing and hardening furnaces refuse to convert their furnaces from coal to gas-fired, then they should be compelled to consume the smoke after it leaves the annealing furnaces.

Cupolas.—Pig iron is melted in the cupola (coke being used, not coal), then tapped into a blower, the blast is

put on for 20 minutes or more, and manganese silica and other impurities are forced from the vessel up the chimney (only moderately high for safety) into the atmosphere, in the form of very dense yellow smoke, of 20 minutes duration and deluging the whole district. To stop the smoke nuisance would stop processes, and large industries employing thousands of men, and which have been carried on for 30 and more years. It is unquestionably a great intermittent nuisance, but one in which the cure would be far worse than enduring it.

Converting Furnaces.—There are furnaces known as converting furnaces, in which a heat treatment process is carried on, whereby bar iron is converted into bar steel. The chimneys are about 35 feet high, conical shaped, very large in diameter at the base, and small at the top. During the process of conversion (lasting days) at periods there is a large amount of dense smoke emitted from the chimneys, which is necessary for the process, and the difficulties of consuming the smoke after it leaves the furnaces are almost insurmountable, owing to the peculiar shape of the furnaces and the chimneys.

Puddling Furnaces.—The process is divided into four stages. In the first stage, the furnace having been charged with pig iron and hammer slag, is made air-tight by closing the doors and during this stage the fire is kept as hot as possible and no smoke should be emitted. The melting of the iron completes the first stage. During the second stage the heat must be maintained to remove the impurities and there should be no smoke. The third stage is to bring on " a boil of the metal " in the furnace. To do this the temperature of the furnace is lowered by closing the damper and filling the furnace with smoke. The result is, the burning of the fuel on the grate with insufficient air causes smoke. But even during this stage of the process with care much smoke can be prevented. It is claimed at this stage an oxidising atmosphere would be detrimental to the finished product. The fourth stage

is a welding heat to form the iron into balls to be worked under the hammer. With care at this stage little smoke should be made.

Armour Plate " Harveyising " Furnaces.—This is known as the " Cementation Process." It converts the face of the plate from low to high carbon steel, increasing it four times. The process takes about four weeks—firing three weeks, and soaking the rest.

There are a group of very large furnaces capable of holding plates of from 20 to 40 tons or more. The chimneys are only about 30 feet high. The furnaces are fired about every four hours, several simultaneously with large quantities of coal (air excluded to prevent injury to plate), and dense volumes of smoke are emitted from the chimneys for over an hour, filling and darkening the whole district and penetrating the houses, even when the doors and windows are shut, making the whole neighbourhood unfit for human habitation. If the process does demand the smoke in furnaces, then it ought to be consumed after leaving the furnaces and not discharged into the atmosphere.

One large enterprising firm has a similar group of furnaces of the same size, using the same process, and obtaining the same satisfactory results from the process. But they make no black smoke for the furnaces are not coal but gas-fired.

The remedy then is the conversion of the coal-fired furnaces into gas-fired furnaces.

Producer Gas-Fired Furnaces.—Hundreds of reheating furnaces in Sheffield have been converted from coal to gas-fired with ideal results of no smoke, saving of fuel, and increased output.

Sir Robert Hadfield says :—" The gas furnace turns out better work, reduces the ' *Cast Outs* ' to a minimum, and speeds up the output, but is actually in many cases considerably reducing the cost of the articles produced. The temperature of gas-heated furnaces can be regulated with

ease, and there are scientific methods for ascertaining the exact heat in the furnaces at any moment."

It was a short-sighted policy to hesitate to spend £100 on a gas furnace, for the amount would be returned in a very short time by the saving in labour and material spent on " cast outs," caused by antiquated and inefficient heat-treatment methods, this elimination of " *cast outs* " means a reduction in costs per unit, but it is not in the elimination of cast outs only that gas furnaces are economical. Gas furnaces take up considerably less room than solid fuel furnaces, and their initial cost is lower, with no fuel to store and stoke, no ashes to remove, and the life of pots in crucible furnaces is considerably increased when gas is used as the heating agent. The proposition of substituting gaseous fuel for solid fuel becomes one which deserves the very serious consideration of every manufacturer.

Gas Producers.—There are a number of special processes for the generation of gas either for direct use as a fuel or for power purposes. To describe in detail these special processes is unnecessary, for they are well known having been in use for many years, and have given excellent results both from a smoke abatement and from an economical point of view.

The following are a few of the systems :—

Siemens and Wilson Gas Producer.—These gas producers are amongst the oldest and the best, and as a proof of the latter statement they have had a remarkable reception, and very many are now in use. The gas may be used directly in its original state as a fuel for various kinds of metallurgical furnaces and boilers, the essential consideration being the proper amount of air supplied to ensure combustion. It can also be used, after all the tarry matter has been taken from it, for driving gas engines.

Dowson Producer Gas.—In this gas there is no tarry matter, it being produced from coke, charcoal, or anthracite coal. It is therefore chiefly used for driving gas engines. It is also used in a great number of cases for heating purposes such as metallurgical furnaces, bakeries, laundries, boilers, etc., but in boilers its substitution for solid fuel has not been found economical, although it is smokeless.

Mond Gas.—In this process gas suitable for either fuel or motive power is produced from bituminous slack, and not from coke or anthracite, which coal would increase the cost of production. The cost of production is further reduced by the recovery of the by-products, the sale of which it is alleged covers the cost of the fuel used, which makes the process a very cheap one as there is only the cost of labour and interest on the first cost of the plant. As far back as 1901 a scheme was on foot to produce Mond gas in large quantities in a central station in Staffordshire and to distribute it through pipes for use in the surrounding districts in metallurgical furnaces, and for the driving of gas engines. Very little has been heard of this scheme since.

Coke Oven Gas, when purified, can be burned under retorts and also beneath boilers in order to raise steam.

Water Gas, which is produced by sending steam through incandescent coke, can be used as a gaseous fuel.

Waste Gases from Blast and other Furnaces.—The combustible gases discharged from the tops of blast furnaces may be used to fire the boilers, or in other ways, and the gas given off in the process of refuse destruction may also be burned under retorts or cells by the admixture of air.

Residues.—In Sheffield years ago it was the custom for all the firms who had their own gas producers to shut them down about every three months to clean out the culverts, etc. There would be in the culverts, or flues through which the gas went from the producers to the melting or other kinds of furnaces, from 3 to 6 inches thick of tarry matter. It was loosened with the pick-axe

and taken out. Either the process was too costly or from some other reason it has been abandoned by some of the big firms, who now at the week end fire the gas or tarry deposits. This is in all probability a cheaper way of getting rid of the residue, but it creates a serious smoke nuisance, for the gas producer chimney pours out for over two hours, without cessation, dense black smoke, which deluges the whole district. Whatever the advantages to the manufacturers of this change, it is a decided disadvantage, and a gross injustice, to those who are compelled to live near such chimneys, and immediate steps should be taken to burn all the combustible matter and reduce the week-end nuisance to a minimum.

Town Gas-Fired Furnaces.—Mr. R. Halkitt, General Manager of the Sheffield Gas Company, says :—" The cleanly, efficient and easily controlled gas furnace is gradually displacing the old-time coke-fired hearth and the more modern coal-fired furnace in Sheffield, for various heat operations, especially where rapidity of working together with uniformity of temperature is required.

" During the war when maximum output was essential, the value of gas as an industrial agent was clearly demonstrated. That leading manufacturers were quick to recognise its possibilities, will be appreciated when it is pointed out that in the last five years the Sheffield Gas Company have supplied and fixed no less than 864 *gas furnaces*. The experience gained will lead them to make an even greater use, in the near future, than in the recent past, of this modern smokeless method of industrial heating, for the no less important work of reconstruction during which period increased production will be no less vital than it was during the war.

" The initial and installation costs of gas apparatus are in almost every case lower than those in respect of solid fuel furnaces. The wear and tear is lower, and the renewal of parts is less expensive with gas furnaces than

with solid fuel furnaces. With a given size of furnace interior the gas heated apparatus requires generally only one-third to one-half of the space required by a furnace heated by solid fuel. No stoking, clinkering, or ash to remove, and the time spent in supervision of the furnace is reduced to a minimum. A shorter time is taken in getting up first heat and the output is double that of a furnace heated by solid fuel. The principal manufacturing silversmiths in Sheffield employ gas furnaces for annealing silver and German silver, moulding and melting German silver, and Britannia metal.

" In the steel trade and cutlery trade gas-fired furnaces are used for forging, hardening, tempering, annealing high-speed steel and carbon steel, for heating spring steel, for punching and coiling, and for heating fish plates for bending and blanks for drop stamping."

The Brayshaw Furnaces.—Low Pressure Normal Gas Oven Furnace " Nor." These furnaces are regularly used for carburising, re-heating, etc., where air under pressure is not available or desirable.

Brayshaw Gas-Heated " Lopress " Recuperative Oven Furnaces.—For annealing, hardening, re-heating, case-hardening and the heat-treatment of steel bars and billets and of non-ferrous metals. It was originally designed to eliminate the scaling and oxidising of work under treatment, and this has been successfully accomplished.

Its handling and adjustment are simple, and a " reducing," " neutral," or " oxidising " atmosphere can be secured at will. The " greasy " flame so essential for annealing work on any considerable scale, may be produced to perfection in this furnace.

Gas is used at ordinary town's pressure with air at 4 to 6 inches water-gauge pressure, only a fan being required, and the burners are so constructed that explosion due to back-firing is impossible.

The air supply is subjected to true recuperative action, as distinguished from mere pre-heating by a cold-air

jacketing arrangement. Burners to consume producer gas can be used.

The gas consumption with these furnaces is low. Compared with natural draught furnaces the length of time required for heating up and the gas consumption are

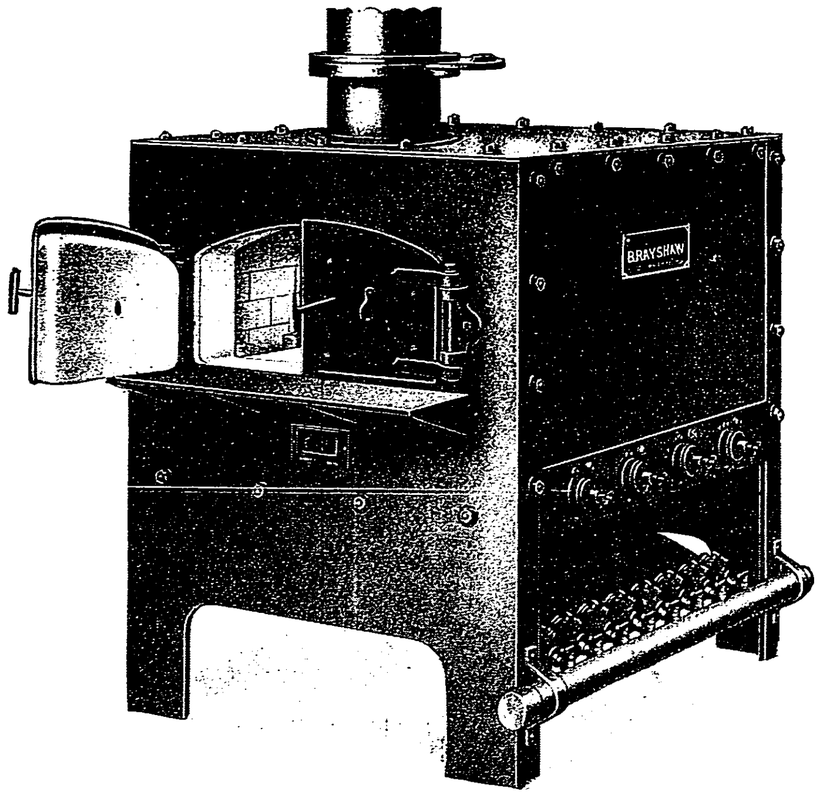

Fig. 29.—Low Pressure Normal Gas Oven Furnace.

greatly reduced, in actual cases as much as 50 per cent. saving being effected.

On all sizes having a door-opening up to 24 inches hinged doors are fitted at one end only, unless specially ordered otherwise. In the larger sizes lifting doors, supported by suitable counter-balance weights, are supplied, and these have inspection holes with shutters.

To facilitate the handling of material, a cast-iron shelf

or rollers are supplied at the bottom level of the door-opening in front of casing. The flue outlets are fitted with sliding dampers and a short length of fluepipe.

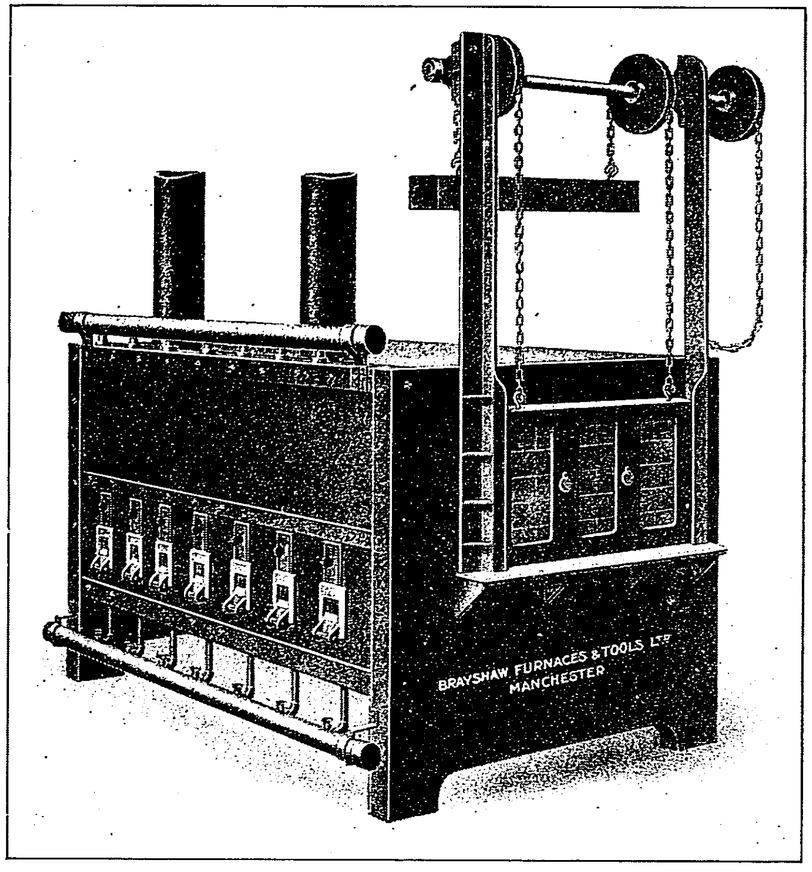

Fig. 30.

Gas-Heated Tilting Crucible Furnace (Lip-Axis Type).—This furnace for melting brass, gunmetal, aluminium, etc., has all the advantages of the Central Axis Tilting Furnace, including the "W.B." Gas Burner. In addition it is so arranged that the pouring point remains constant throughout the whole tilting movement. It has the trunnions fixed on an axis adjacent to the pouring lip of the crucible

and the bottom part of the furnace is raised by chains operated by means of a handwheel geared down to a shaft carrying machine-cut chain wheel.

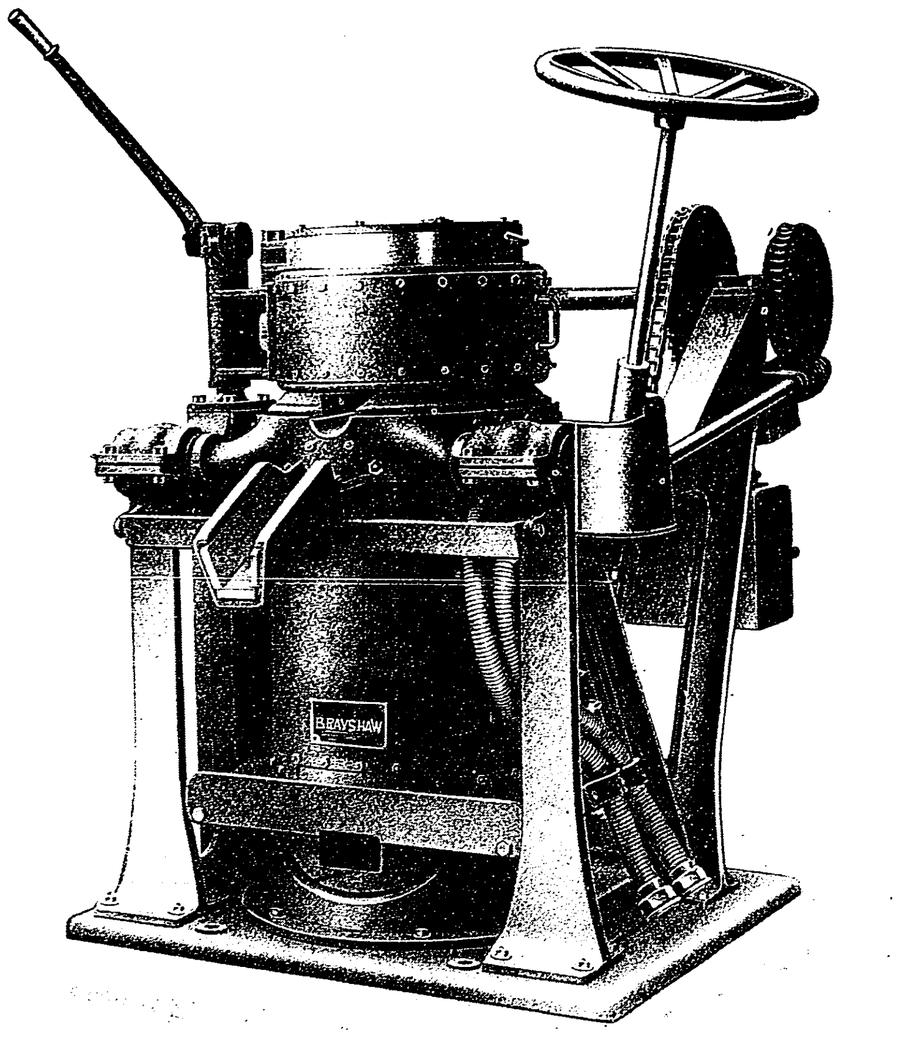

Fig. 31.

The ends of the chains are fastened to the bottom of the furnace body, and the weight of the furnace body is balanced by a suitable counterweight, so that when the

handwheel is turned the furnace is tilted on its axis without the pouring point being shifted, and with the minimum of effort on the part of the operator.

The " Lip Axis " has a pre-heater and cover, which may be swung aside by means of lever-and-cam arrangement when pouring.

An important feature is the arrangement for slagging and cleaning out the bottom of the furnace, and for collecting the metal in the case of crucible breakage. The furnace has a special arrangement of dropped doors in the bottom, through which the spilled metal falls into a suitable receptacle, and can be cleaned out from the bottom without removing the pot.

A supply of air at a pressure of 3-4 lbs. per square inch is required.

Gas-Heated " Porceflam " Pottery Furnace.—This furnace is applicable to all ordinary classes and sizes of pottery up to and including the finest chinaware.

The gas is burned by means of patent " Flamos " Burners, which constitute an entirely new departure in furnace-burner construction and allow the heat to enter the furnace from large mouths instead of from small jets. The consequence is that the velocity of the currents inside the furnace is very much lower than with ordinary burners, and the action is much more gentle. The " Flamos " Burner lends itself to a very good distribution of heat and the inlets and outlets are so arranged that the temperature of the furnace is remarkably uniform throughout. Explosion due to lighting back is impossible.

The burners are accessible and can be replaced with little disturbance to the brickwork of the furnace. When using town gas a supply of air at a pressure of not more than 8 or 10 inches head of water is required, and usually a pressure considerably lower than this is sufficient. There are arrangements for regulating accurately the gas and air so that a high degree of control can be exercised.

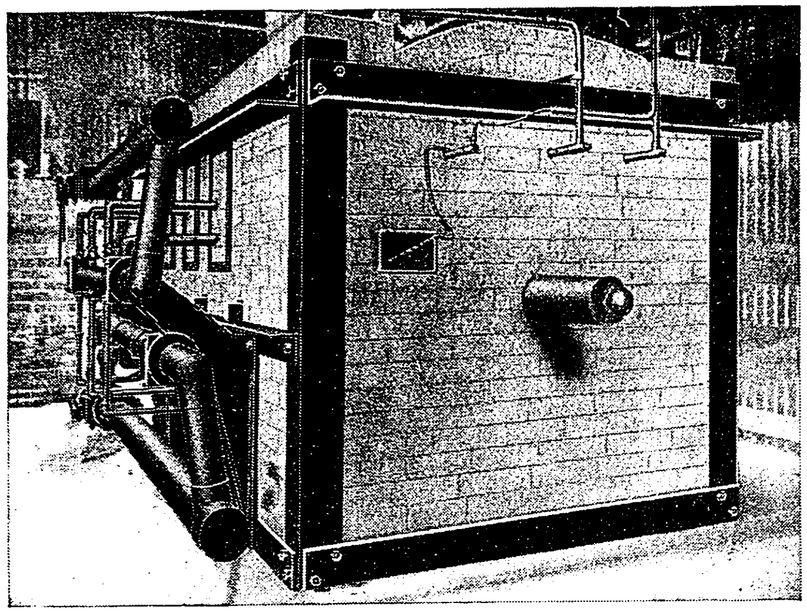

Fig. 32.—Pottery Furnace (Back View).

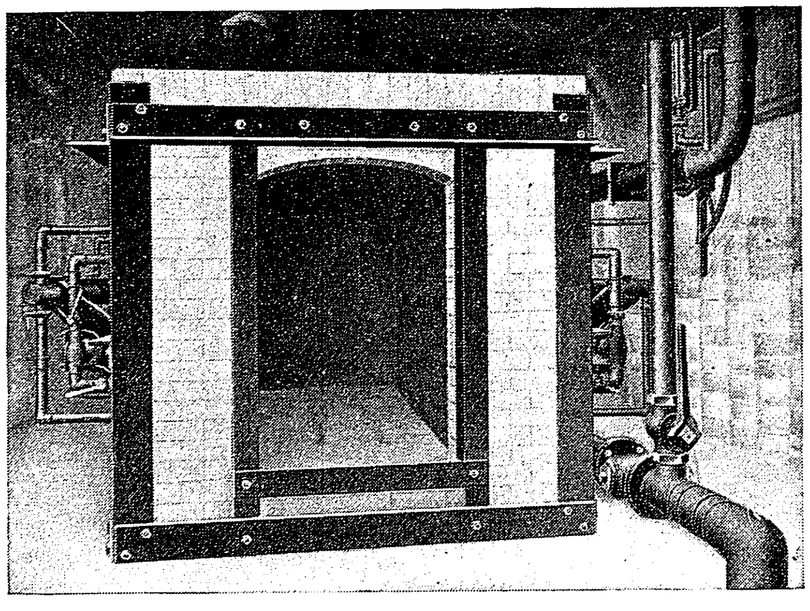

Fig. 33.—Pottery Furnace (Front View).

Oil-Fired Furnaces.—Many re-heating furnaces have been converted from coal to oil-fired. An oil fire requires as careful attention, as with soft coal, to render its combustion smokeless. There need not be any dense smoke from oil-fired re-heating furnaces if the fireman regulates properly the supply of steam and oil to the atomiser.

Coke-Fired Furnaces.—There is a fairly large number of small re-heating furnaces coke-fired. They are smokeless and give greater satisfaction than coal.

Electric Furnaces.—A large number of electric melting furnaces are now in daily use, melting steel and other metals with satisfactory results. The problems connected with the melting of brass in the electric furnace have baffled engineers for many years, but scientific research has now found a way by which this can be done successfully. There is no need to dwell on the manifest advantages of dealing with iron and steel in this way. They are sufficiently obvious and it is evident that by treating brass in a similar manner a great saving of zinc would be effected, a product free from either sulphur or oxygen would be obtained, and much larger charges could be handled with ease. Dr. Gillett and his associates after five years of investigation have designed an electric furnace for melting brass, have tested it, and are satisfied that when its advantages are more widely known the new furnace will supplant the older and more crude methods of working.

Unnecessary Furnace Smoke.—More than sufficient has been said to convince the most biased that four-fifths of the furnace smoke now made is unnecessary, that it can be prevented practically and profitably, and that its prevention would not hinder or obstruct trade, but most materially help it by reduced coal consumption, increased output, and last but not least, it would contribute considerably to making the air more fit for a civilised nation to breathe.

Prosecution for Unnecessary Furnace Smoke.—There have been in Sheffield (and probably other towns) many prosecutions for the emission of unnecessary smoke from boilers and furnaces served by the same chimney, with convictions and heavy penalties, but there has been only one case (as far as the writer knows) in which a firm has been prosecuted *for unnecessary furnace smoke only, emitted from a chimney serving furnaces used for the Special Heat Treatment of Steel.*

This case is of importance to every owner of a metallurgical furnace of any sort or size, for conviction was secured, and an appeal dismissed. Thus it is established that unnecessary furnace smoke, much or little, is a statutory nuisance, and that manufacturers must prevent it or be penalised.

CHAPTER XII.

UTILISATION OF WASTE HEAT FROM METALLURGICAL FURNACES.

Waste Heat Boilers.—Many manufacturers, with the double object in view of securing economy, and a reduction of the metallurgical furnace smoke nuisance, have put down Waste Heat Boilers. The gases having done part of their work in the furnaces are diverted, instead of going direct to the chimney and being discharged, and passed through the waste heat boiler, in their passage generating steam, and are then discharged from the chimney. By this process sufficient steam is generated to drive the whole of some manufacturers' machinery. But the whole of the gases are not consumed, for some pass through the boiler unconsumed into the atmosphere, creating a smoke nuisance and a waste of fuel.

Waste Heat Auxiliary Grate Boilers.—In order to burn the whole of the gases after leaving the furnaces, it is necessary on their entering the waste heat boiler to pass them over an incandescent fire, which consumes them, utilising the whole of their heat value and in this way creating no smoke nuisance.

For years, waste heat auxiliary grate boilers have been on the market, but few comparatively have been put down in spite of their great economical and smoke preventing claims.

Cochran Furnace Smoke Prevention System.—Fig. 34 shows the Cochran system for the utilisation of waste gases, and the prevention of smoke.

The actual boiler shown is 6 feet 6 inches in diameter