WORKERS IN COPPER, ZINC, BRASS & TIN.

BY ROBERT M. SIMON, M.D. CANTAB.,

Physician to the General Hospital, Birmingham.

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WHEN your Council did me the honour to invite me to lecture to you on the use of tin, zinc, copper, and brass in manufacturing processes, and the dangers to which those working in these metals were subjected, I very naturally began to consider how I might hope to make the subject interesting to an audience like the present.

It was very easy to understand that those whose business in life it would be to act as Inspectors of factories should wish to know from what points of view these manufacturing processes ought to be regarded, in so far as they might influence the health and well-being of large numbers of working men, and through them the health and physical perfection of the next and succeeding generations. You are probably aware that lead workers, as a class, are not the parents of vigorous children, and that women who work in lead are not unfrequently sterile.

No doubt these facts are due largely to the particular poison to which lead workers are exposed, but in great part also to the general deterioration in health and physique to which all those who are employed in unhealthy trades are liable.

A trade may be unhealthy, or regarded by the Home Office authorities as dangerous, for two reasons: firstly, if the materials employed are, in themselves, poisonous; and, secondly, if the conditions under which non-poisonous materials are employed render them a danger to health.

With regard to zinc, tin, and copper miners, I have little or nothing to say.

I know nothing more than I have read, and have had no opportunity for making personal observations.

My remarks, therefore, will be confined to the use of these metals for manufacturing purposes, and more especially to the employment of zinc and copper in the manufacturing of brass.

Before considering these industries in detail, it will be well to determine, if possible, how the use of the metals affects the body, and becomes dangerous to the lives of the workers.

The great animal functions of the body are the circulation, respiration, digestion, and the nervous processes.

All hard physical labour, which makes a continual and great demand upon the muscular powers, and secondarily upon the heart, has a tendency to induce disease of the heart and blood vessels; but such a result is the outcome of any kind of physical strain, and hardly comes within the scope of a lecture like the present. It is possible that it would be wise to be on the alert that the more laborious portion of the work should not devolve upon those who are least able to stand the strain, and that care should be taken that the young who are in the stage of development, and the middle-aged in whom the natural process of physical degeneration has set in, should be kept away from that part of the work which makes the greatest demand upon the purely muscular powers.

The respiratory functions, however, come under a very different category, and it is impossible to over-estimate the importance of paying attention to the conditions under which these trades are carried on, and the influence that they exert on the respiration, and the tendency that they have to develop disease of the lungs, and the respiratory tract.

In the Out and In-patients Departments of the large Birmingham Hospitals, a very large proportion of the patients is furnished by those who are suffering from chronic chest diseases, induced by working in these metals, and especially by the manufacture of brass; and it might be well, very briefly, to put before you the nature of these diseases, and the manner in which the lungs become affected among those engaged in these trades.

It is common experience that the ease with which one breathes depends largely upon the purity of the inhaled air, and that discomfort at once results from breathing air impregnated with dust or poisonous vapours. Most people living in towns have every-day experience that the mucus at the back of the throat contains dust; but it has only recently been established that the dust can find its way into the tissues of the lungs themselves.

In 1869 Dr. Greenhow, who took much interest in, and wrote about, the trades we are discussing, satisfied himself and the medical profession that the black pigment, with which the lungs of miners are coloured, was derived from soot and smoke; and in 1878 Dr. Arlidge, whose name is so well and honourably known here, demonstrated that dust penetrated into the intimate structure of the lungs of potters and colliers.

Everyone is subjected to the inhalation of a certain amount of dust; but if this becomes constant, or excessive, lung troubles arise.

At first the dust is expelled by coughing, set up by the irritation of the air passages; but, after a time, a moderate inflammation or catarrh is set up in the bronchial tubes.

Unless dust inhalation is checked, this catarrh inevitably becomes chronic, and the lung tissue, in the immediate neighbourhood of the bronchial tubes, also becomes inflamed, and ultimately so seriously damaged, that it loses any useful function it possessed for ærating the blood, and becomes instead a focus of disease.

You are aware that the modern theory of the cause of consumption is, that it is due to a microscopic germ, the tubercle bacillus; but it is an important and hopeful fact, that though the air, and possibly the mucus in the air passages of very many, if not most of us, may contain these bacilli, it needs a deteriorated condition of the constitution, and of the lungs to give them a chance of exerting their sinister powers.

Such opportunity is afforded by the damage to the lung-tissue, which is the result of prolonged dust inhalation, or the irritation of the mucous lining of the bronchial tubes by poisonous vapours. If even consumption be not induced, it is certain that life will be rendered miserable and painful by the development of chronic bronchitis and asthma, with all their attendant sufferings.

I shall discuss more in detail, when dealing with brass work, the digestive troubles associated with it, and allude to some of the diseases of the nervous system induced by copper and zinc, but I have thought it well thus briefly to summarise what are the dangers common to all metal-workers before thoroughly considering the branches of our subject.

BRASS.

The subject of the dangers of brass-casters is one of the greatest interest to those who live in manufacturing towns, such as Birmingham, where large numbers of men are employed in the brass trade. That brass-workers are exposed to unhealthy conditions is fully recognised by the men themselves, as well as by their employers, who speak of the trade as a most unhealthy one.

Brass-workers rarely attain old age, and formerly provident sick societies either altogether refused to enrol them on their lists or accepted them as members at greatly increased rates.

The recognition of working in and making brass as causative of disease is due to Dr. Headlam Greenhow, who, in 1862, read before the Royal Medical and Chirurgical Society a paper on "Brassfounders' Ague." This was based on his experience gained while paying a brief holiday visit to Birmingham in

1858, in connection with his investigation of trades injurious to health.

It is curious that he should have selected for his title the name of a disorder which undoubtedly occurs, but which, as I shall endeavour to show, is only an acute expression of a chronic disease, and one which rarely or never comes within the range of experience of practising physicians.

In the out-patient department of the Birmingham hospitals one meets with an enormous number of brass-workers complaining of various pulmonary and gastric disorders; but in over twelve years' experience among over 50,000 patients, I have never yet been consulted by anyone in the matter of this so-called ague, although questions will very frequently elicit the statement of its occurrence.

The literature of this subject is very scanty, but Greenhow quotes Thackrah's essay on the *Effects of Arts, Trades, and Professions on Health and Longevity*, published about 1830, as well as the writings of a few Frenchmen, who have not, however, materially advanced our knowledge of the disease. Thackrah's observations were clearly inaccurate and imperfect, for he mentions only "ague," which he speaks of as an intermittent fever, attacking brass-workers from once a month to once a year, and leaving them in a state of great debility.

Dr. Hogben, Physician for out-patients at the Queen's Hospital, Birmingham, published a very interesting paper on this subject in the *Birmingham Medical Review* in May, 1887. Dr. Greenhow refers only to ague and bronchial disorders, and very cursorily to nervous troubles, as resulting from brass-casting; but Dr. Hogben mentions also the colic, constipation, and dyspeptic troubles which result from this occupation.

Dr. Greenhow, on the one hand, refers all the symptoms to intoxication by zinc, while Dr. Hogben thinks they should rather be referred to chronic copper poisoning. These two metals are the principal ingredients in the making of brass which needs a brief description.

Copper is put into crucibles, which are plunged into a sunken furnace, and covered in order to exclude the air. When the copper is melted, the crucible is removed, and zinc—about 30 per cent.—and small quantities of lead, tin, and brass dust are mixed with the molten copper, which is hot enough to melt them. When the whole mass is molten, it is poured into moulds called sows; during the pouring the zinc deflagrates, and a dense white smoke is formed, which almost instantaneously fills the atmosphere of the casting shop. This smoke is rapidly converted into snow-white flakes and white powder, consisting of the oxide of zinc, which remains for some time diffused

through the atmosphere of the shop, and, in ill-ventilated casting shops, collects upon the rafters and ceiling in the form of a dense white incrustation. The quantity of these fumes depend—first, upon the amount of zinc employed; secondly, upon the ventilation of the casting shops; thirdly, upon the weather—a dull, foggy day preventing their escape.

The shops in newly-erected factories are only one storey high, and have large sliding panels in the roof to permit free escape of the fumes; but in the older buildings they sometimes have other rooms above them, and free ventilation is impossible. It is a matter of experience that workers in ill-ventilated shops suffer much more from ague and bronchitis than those who work in the better buildings.

The men who do this work are called mixers, and protect themselves, to some extent, by tying handkerchiefs over the nose and mouth to prevent, as far as possible, inhalation of the fumes. From the mixers the work goes to the casters or founders, who re-melt the pigs of cold brass, at a lower temperature than is required for melting copper, and pour it into the sand moulds, which are faced with a fine powder of loam, charcoal, coal, and bean flour. From this powder rises a dense cloud of dust, and from the molten metal a cloud of zinc oxide, though not so much as in the mixing shop. Founders suffer principally from bronchitis, or asthma, as they call it, and ague, though in a lesser degree than the mixers. From the casters the work goes to the warehouse, where it is sorted, and sent to be polished, or dipped and bronzed. By the polishers, emery, fine sand, lime, and rouge are used on rapidly revolving brushes, or wooden wheels, faced with leather. From these considerable dust is given off, and bronchial troubles are caused; but "ague" does not affect the polishers. The dippers work under a shed, open on all sides to the air, and immerse the brass in a weak solution of sulphuric acid; it is then dipped into water, then into a stronger acid solution, again into water, once more into acid, then into a solution of soda; finally, into pure acid, and washed in water.

There are always exhalations of acid, and in warm weather these are especially troublesome. It is noteworthy that, though dippers do not suffer from ague or intestinal troubles, their occupation is considered by masters and workmen alike to be the most unhealthy of all, on account of the great bronchial irritation from the acid fumes.

From the bronzers the work is sent to the lacquerers, who are nearly always females and suffer nothing from their occupation. From them it goes to the dressers to be fitted, and finally to the warehouse. It will appear from this account of the process,

that those who deal with the molten metal are the only ones to suffer from brass ague, while they, as well as those occupied in shops where there is much dust or acid fumes, are liable to bronchitis and asthma. Moreover, all brass-workers except dippers and lacquerers are subject to colic, constipation, and various other disturbances of the gastro-intestinal system.

That Thachrah was in error in speaking of brass ague as an intermittent affection, occurring once a month or once a year, is clearly proved by the following positive observation, which is supported by all brass-workers. Ague never occurs among the regular workers, but always affects those who are new to the work, or who resume work after an absence of even a month or a fortnight.

If a man resumes work, that is melting or casting, after even so brief an interval, he is sure to have an attack of ague, but he will only have one attack, and remain free until after his next holiday. There is most certainly no kind of regular intermission, and according to brass-workers themselves, they only suffer until they are inured to the poison.

The following are the symptoms of this so-called ague: after working a few hours, a man becomes languid, depressed and feels very cold. He is very pale and almost in a state of collapse, his face is covered with a cold perspiration, he shivers, his teeth chatter, and he is restless and anxious. His head aches, there is much nausea and complaint of muscular pains. As a rule he goes or is led home, where he drinks freely of milk and goes to bed. The symptoms continue until he has vomited, either as the result of taking an emetic or independently of it. Vomiting is usually followed by sleep or recovery, with more or less of debility and lassitude on waking.

Drs. Greenhow and Hogben speak of a more or less marked hot stage following the cold, and following the hot stage they mention profuse sweating. The hot stage may be absent, but the sweating, according to these writers, invariably occurs. My own observations, based on enquiry amongst those who have suffered from this ague, have never elicited a statement of these hot and sweating stages. Even direct questions as to their occurrence have always been met with positive negation, though some have spoken of free perspiration in the stage of collapse. How to reconcile these statements I do not know.

The cycle of events, as recorded by Greenhow, is just that of ordinary ague, from which this disease differs, otherwise than in the suggested sequence, *in toto*. The enquiries I have made do not support such a sequence, and certainly not a relationship to malarial ague. The symptoms are just such as would be caused by the ingestion of a quantity of irritant metal, sufficiently large

to cause vomiting, and its attendant depression. Such indeed, is my opinion of the causation of the symptoms, and therefore the name "ague" should not be continued, as being wrongly suggestive and misleading. It will be remembered that it is only when fresh to the work that brass-workers suffer from "ague," but, though they do not suffer from acute metallic poisoning, they do suffer from its chronic effects, and it is extremely probable that, as with arsenic and opium eaters, they may become inured to the use of the metals.

It is not very common for brass-workers to use tooth-brushes, and the accumulating tartar will be found coloured green. If every effort be made to cleanse the teeth, there will yet be generally green discolouration of them.

This has been proved to be due to the presence of copper. White hair is often coloured green among these workmen, and the underclothing is often stained green by the perspiration. The gums may be slightly blackened at the edges, but there is nothing distinctive as in the case of the blue line of lead poisoning; nor, indeed, beyond the green colouring of the hair and teeth, do brass-workers present any unequivocal evidence of their calling.

Ague is not a disorder for which brass-workers consult a medical man; they know how to treat it themselves, and also that it is transitory in its effects; but they come to hospitals in large numbers to be treated for bronchitis. About this there is nothing special. They suffer from it in common with all workers in dusty trades; and, so far as I can learn from the Secretary of the Brass-workers' Organisation, they usually die from chronic bronchitis or fibroid phthisis, unless they succumb to some acute ~~malady~~ malady.

The existence of nervous disorders, especially paralysis agitans, has been said to be common amongst them; but I cannot find that a larger percentage of brass-workers than of the rest of the community suffer from diseases of the nervous system. It is common, however, amongst them to meet with complaints of disturbance of the digestive function. They suffer from dyspepsia, loss of appetite, gastro-intestinal catarrh, nausea, vomiting, metallic taste, thirst, colic, constipation, and diarrhoea. They are often nervous and hypochondriacal, complaining of headache and muscular pains.

There is nothing distinctive about any of these disorders, except the obstinacy with which they resist ordinary methods of treatment, and the readiness with which they yield to the administration of iodide of potassium in combination with the other drugs indicated by the various conditions of ill-health. All the symptoms bear a remarkable resemblance to those

produced by chronic copper poisoning, and in Guy and Ferrier's *Forensic Medicine*, an outbreak of copper poisoning from the use of copper vessels in cooking is recorded, in which the symptoms were almost identical with those here mentioned.

The inmates of a convent suffered severely from obstinate and severe colic, retching, and bilious vomiting, costiveness, and flatulence, burning pain in the pit of the stomach and extremities, and paralytic weakness in the arm. According to Stevenson, it is impossible to distinguish between the symptoms produced by zinc and copper poisoning. These are just such as brass-workers suffer from, and it is, therefore, impossible to say which metal—copper or zinc—is most concerned in the production of these symptoms.

Dr. Greenhow attributes them all to the inhalation of the deflagrating zinc. This forms oxide of zinc, which is only sparingly if at all soluble, and, therefore, is not likely to be freely absorbed into the stomach; but he pays little or no attention to the common and chronic gastric and intestinal troubles to which brass-workers are liable. These affect all those engaged in the various processes by which, either in vapour or in minute particles, copper and zinc—that is, brass, are distributed in the atmosphere.

Dr. Hogben, on the other hand, considers copper alone to be the efficient cause of the symptoms, and advances the following arguments—

1. We have no evidence that the internal administration of zinc ever produces the symptoms of brass-ague. Enormous doses of the oxide have been administered without apparently producing the characteristic febrile reaction of brass-ague.

2. The malady is observed in individuals whose work is other than casting.

3. The malady is not observed in operatives, such as galvanised iron workers, who work with zinc, and are exposed to its fumes.

4. Zinc is rapidly excreted, and does not, like lead, mercury or copper, become fixed in the body, and produce chronic affections.

It seems more probable that, accepting Stevenson's statement of the impossibility of distinguishing between the effects of acute copper or zinc poisoning, the symptoms of ague are due to an admixture of the two metals; whereas, for the chronic complaints, the copper is responsible. How the practice of taking milk during an attack of so-called ague has arisen is not clear; but its wisdom is proved by the fact that in cases of both copper and zinc poisoning milk is one of the best antidotes, since it precipitates both these metals into

insoluble albuminates. It is abundantly evident that brass-workers are especially liable to diseases from the use of the metals employed in its manufacture, but they are not new disorders; they are either proofs of chronic poisoning by zinc or copper, or, as in the so-called ague, are due to intoxication by them.

If more proof were wanting of the unhealthiness of brass-casters, it would be afforded by the fact, that though there are 1,200 brass-casters in Birmingham, there are not more than ten over 60 years of age.

Not long ago I met an old patient who told me, with pride, that he was 58 years of age, and that there were not half-a-dozen brass-casters in the town as old as he.

There is in connection with the Amalgamated Brass-Workers' Association a superannuation fund, from which casters can, at the age of 55, derive benefit, and I think it is an appalling fact, that there are only three men—two in Birmingham, and one in Sheffield—enjoying this benefit.

It is abundantly evident from the above description that there are real dangers to the health of brass-workers, and it is a curious coincidence with the date of this lecture, that during this autumn the whole question has been, and is being, thoroughly discussed by the Home Office, and employers and employed engaged in the brass industry.

I may take this opportunity of stating my obligation to all those concerned in this question.

Her Majesty's Inspectors of Factories in Birmingham, the Secretary of the Brass Workers' Association, Mr. W. J. Davis, masters and men alike, have given me every facility and assistance in making my investigations.

COPPER.

I have had very thorough opportunities of satisfying myself as to the conditions under which copper-workers are placed, and inquiring into the troubles to which they are liable in consequence of their work. On the whole, I am convinced that it is by no means so dangerous an occupation as brass-working, the pouring of the metal is not associated with the same abundant vapours as is brass pouring, and such vapour as arises is mainly due to the presence of a small quantity of spelter in the mixture. The same precautions as advised to brass pourers should be taken; but the need is less, and I have seen a pouring shop with a perfectly clear atmosphere five minutes after the pouring has taken place. A muffler or respirator should be worn during the operation, and, as far as I have seen, this is generally done.

Apart from the pouring, I was struck by the excellent health

of copper-workers ; and as the dust is very heavy, and does not float in the air, but falls down, there are none of those respiratory troubles which, as we have seen, are the bane of brass-workers.

I have found that men had been employed in this work for a lifetime, and that it was not uncommon for men to spend over thirty years in the same employment.

There is one danger to which apparently they would be subjected ; but I have found no evidence of its having arisen, from the accumulation of the heavy copper dust over the tables or boards on which the men were working. It seemed not unreasonable to expect that any want of cleanliness on the part of the workers would entail digestive troubles from the mixing of copper dust with food. As I have stated, no evidence of this is forthcoming.

It will be seen that I am unable to confirm Dr. Arlidge's view of the dangers to copper-workers from the inhalation of copper dust ; nor am I able, though contrary to my own expectation, to assert that men employed in the trade are liable to suffer from colic. According to Blandet, this colic is attended by extreme prostration—by vomiting and purging, and it is very probable that such results would follow if the men were dirty in their work and habits, by the introduction of copper dust by means of food into the stomach. Opinions are much divided on this subject, and it is possible that working in old copper and brass, which are covered with a carbonate of copper, may be responsible for the ill-effects noticed.

According to M. Perron, of Besançon, clockmakers, who have to handle copper freely, suffer from a slow intoxication from it, exhibited by gastric derangements, diarrhœa, oppression, and some feverishness ; but my own experience among copper-workers and other persons, negatives these observations.

TIN.

Working in tin is practically the same as working in tin plates. These are made by immersing thin plates of iron or steel, after they have been scoured by dipping in tanks containing sulphuric or hydrochloric acid, in baths of molten tin. This unites with the iron and coats it completely. The dangers to which those so employed are exposed, arise from the fumes of tin and from the acids used in cleansing the plates. Immersion of the hands in the acid baths whitens and hardens the skin and makes it liable to crack and to excoriations. The acid vapour reaches the eyes, nose, and throat, and irritates and inflames the mucous membranes. The teeth suffer decay, and the gums get red and soft, and acid dyspepsia is generated and toothache

is common. When the tinning of the plates is completed a process called branning follows. It is done by women while the plates are still hot, and developes clouds of dust obnoxious to the lungs.

For the above description I am indebted to Dr. Arlidge's invaluable book on the diseases of occupations, which ought to be in the hands of all interested in the subject matter of this and kindred lectures.

Dr. Arlidge suggests that many of the troubles arising from eating fruits preserved in tin boxes are produced not by the tin but by the lead employed in the soldering. Some of the salts of tin, especially stannic oxide, better known as putty powder, contain lead, and the following interesting and terrible case is a good illustration and a proof of Dr. Arlidge's contention. I was asked at the beginning of the year to see a chemist, in a large neighbouring town, suffering from lead poisoning. He was paralysed in every limb, almost in every muscle. He could not raise his head from the bed, was very anæmic and altogether alarmingly ill. He progressed under treatment with encouraging results, though the issue was hardly ever doubtful, until the nerves governing the movement of the diaphragm became affected. He rapidly developed bronchitis and a low form of pneumonia, and died in twenty-four hours. The way in which he became ill is very curious. Adjoining each other on a shelf were canisters of pepper and of putty powder or stannic oxide. By a mistake, and a not altogether remarkable mistake, the pepper mill was filled from the putty powder canister. As he was fond of pepper, and the supposed pepper was naturally weak, he took a good deal. This went on for some time until he and others of his household developed symptoms of lead poisoning, when the mistake was discovered.

This case has, of course, no bearing on the use of tin in manufacture, except in as much as it increases the probability of lead being responsible for many of the symptoms which have been attributed to the work as a cause.

GALVANISED IRON.

The commercial process of coating iron with zinc, or, as it is commonly called, the process of galvanising, consists of two distinct operations—first, the preparation of the article to be galvanised, and second, the immersion in molten zinc. It must be understood that the first process is necessary from the fact that zinc will not adhere to iron until every particle of oxide or other impurity has been removed from its surface. The cleansing is effected by placing the iron to be coated in a tank, usually of stone, filled with hydrochloric or sulphuric acid

diluted with water. To facilitate the action of the acid the workman moves the iron to and fro in the tank, and removes it when clean into another tank filled with water. The second operation—or the galvanising process proper—consists in heating, in a wrought-iron vessel called a “pot,” some tons of zinc to a temperature sufficiently high to render it fluid, but not so high as to cause it to deflagrate. To prevent oxidisation, as well as to facilitate the mechanical adhesion of the two metals, the surface of the molten zinc is covered with a layer of chloride of ammonium, which, on coming into contact with the molten metal, is converted into chloride of zinc. The baths being ready, the article is removed from the water, allowed to drain, but not to oxidise, and is plunged through the chloride of ammonium into the molten zinc and held there for a few moments; on removing it, it is found to be coated, or galvanised.

There are no diseases known as special to the workmen engaged in this trade, and there is no reason why the process should be injurious to the health of those who work in it. At the same time, there are acid fumes given off from the acid tanks; and the “picklers,” as they are termed, who are engaged moving the iron in the acid, should, during this part of the process, place a cloth over mouth and nose.

Further, the “pot” men, who immerse the iron in the zinc, should be careful not to allow the temperature to be too high, so as to cause the metal to deflagrate when exposed, or the chloride of zinc to burn, as it gives off a pungent and irritating fume at a high temperature.

There are certain general principles which must be observed by all metal workers, such as cleanliness and care in the matter of taking food, but these need not be specially insisted upon, as the need of them is so obvious.

There are, however, some definite rules which ought to be prominently published for the guidance of those engaged in the most noxious of all the trades we have been discussing—the brass trade. These rules or instructions were summarised and brought forward tentatively by H.M. Chief Inspector of Factories, Mr. R. E. Sprague Oram. They were approved by the National Union of Amalgamated Brass-workers, but before they had been adopted they were withdrawn by an order from the Home Office, which had decided to appoint a Special Commission to consider the whole question of Brass-work. They were not withdrawn on account of being inappropriate, but solely for the reason I have given.

It is possible that the Commission may see fit to recommend some alteration, but they are so good that I reproduce them.

1. They shall provide washing conveniences, with a sufficient supply of hot and cold water, soap and towels.

2. They shall provide respirators for all persons when they are employed in pouring metal into moulds.

3. They shall provide suitable means of carrying off all noxious fumes and dust.

4. They shall provide a sufficient supply of milk, or approved sanitary drink.

5. No food shall be eaten in any part of the works where brass mixing or casting is carried on.

6. All rooms, in which brass mixing or casting is carried on, shall be limewashed every six months.

In addition to the rules affecting the health of brass-workers, there is a strong ethical objection to the present system. This has been succinctly and graphically stated to me by a prominent official of the Brass Workers' Union, and I cannot do better than repeat his own remarks :

"When a young caster is first 'put to the tub'—*i.e.*, when he is first entrusted to make his own moulds—he will also have to melt and pour his own metal. Almost invariably the effect upon him will be a kind of exhaustion. His older shop-mates, seeing his condition, will, ten to one, advise him to 'go and have a pint.' He does so, and, for the moment, the beer refreshes and stimulates him. Naturally, when the sulphur renews its deleterious work upon his system, he flies to the same remedy again, and thus, in many cases, a taste is induced which ends in his becoming addicted to alcohol. If milk, or other approved sanitary drink were substituted, the dangerous first pint would be avoided, and there is at least a probability that many of those who fall, would remain sober and respectable members of society."

Rule No. 5, which says that no food shall be eaten in any part of the works where brass-casting or mixing is carried on, is a most important one, and it is quite clear that the rules ought to be enforced and that casters ought to be prevented by law from taking their meals in the casting shops. In a general way a caster gets into the habit of having no regular meal hours as other workmen have, because from the time he begins in the morning until he has poured his last heat he can scarcely take his attention from his work. Some process or other, such as punning sand, making cases, moulding his odd side, mixing and stirring his metal, &c., has always to be taken up in time so as to dovetail with the other parts of the work. As most of the operations are severely laborious, the workman, anxious to get on, despite his being in a grimed and heated condition, is tempted to snatch his mid-day meal how he can.

He will perhaps sit upon the spilling hearth and eat a portion of his dinner; then go on with something that wants doing, and return to it; thus perhaps making the meal spread over a considerable time with many intervals. Food thus exposed will necessarily receive some injurious deposit from the poisonous particles which are always floating about a casting shop while work is going on. A piece of bread, or bread and butter, left uncovered in such a shop during an average working hour, would be found to be coated with a greyish substance consisting mainly of the powdered oxide of zinc, and it must be clear that food in such a condition is highly unfit for human consumption.

Regulations which break the continuity of work and seem to hinder the workman might not be acceptable to him, but still they ought to be insisted upon for health's sake. It ought to be *sine quâ non* that no meals should be taken in the casting shop, and that consequently proper accommodation should be provided elsewhere. Besides the caster himself, there are others to be considered—his assistants, if he has any—who work in the same shop and under the same conditions.

It may be urged that such a requirement would press hardly upon the small tradesmen, such as an out-caster, whose casting shop constitutes the whole of his working premises. But this is the very thing which the larger and more reputable houses complain of, that the small trader undersells them by reason that he is under less expense through having no regard for his workpeople. Sympathy for the struggling tradesman is all very well, but he should not be allowed to make his way by the sacrifice of human lives. If, as is too generally the case, the shops of these small employers are badly constructed and ill-ventilated, then, for the sake of those employed in them and for the general good of the trade and of the community, the sooner they are closed the better.

The unhealthy conditions to which casters are subjected have been of late years greatly augmented, through the practice of giving out scrap materials for the caster to mix his own metal as he goes on with his own work, instead of giving out to him "pig" or ingot metal, which is the custom observed in the best regulated factories at the present time. This scrap material consists of substances such as corroded locomotive tubes filled with verdigris, disused naval appliances, &c., coated with deleterious substances, such as arsenic, &c.. During the mixing process these impurities are given off and impregnate the air of the casting shop, the effect on the workmen being most injurious.

No scrap should be given to the casters; but it should be

properly cleansed, refined, and smelted, and issued to him in the form of ingot.

Rules 1 and 6 need no discussion as to their propriety. There ought to be no difficulty in the way of their being carried out.

Milk is, I believe, the most efficient means at our disposal for neutralising the ill effects of the vapours and dust of a brass casting shop on the digestion, and should I think be supplied, and its use be enforced.

The respirator would to a considerable extent diminish the evil effects of casting on the lungs.

About the necessity of using respirators there can be no question, though a muffler worn over the mouth and nose is a not inefficient substitute. All these regulations are, however, of less importance than Rule 3, which insists that suitable means shall be provided for carrying off all noxious fumes and dust.

It will appear from a general consideration of brass manufacture that the formation of deflagrating zinc cannot be avoided, and that there must always remain a certain risk of pulmonary disorders, bronchitis, asthma and consumption among those so employed, but it is very certain that these evils can be minimised, and it is the duty of the State to issue regulations to effect this; while it will remain for Sanitary Inspectors and Inspectors of Factories to see these regulations carried into practice. If the deflagration of zinc cannot be avoided, it is possible by efficient ventilation to facilitate the escape of the poisonous atmosphere, and it is to efficient ventilation that our attention must be directed. For this reason it is in the highest degree important that casting shops should be lofty, and should have either a movable or sliding roof and large open windows or spaces.

In the old days the casting was often done in the lower storey of a two-storied building. No more certain way to damage the health of the workers could be devised, and it is greatly to the credit of the manufacturers that in the Birmingham district they have in many cases converted a poisonous workshop into a healthy and lofty one by removing the flooring between the two storeys, but even now a good deal of mixing is done in the cellars of small houses.

It seems a hardship to discourage individual enterprise, but the law ought to forbid the possibility of such an arrangement, and it should be the earnest endeavour of every Inspector to prevent the existence of such an abuse, by his knowledge of the evils of the proceedings and by his promptitude in exposing it.