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The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

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One More Committee?

It appears to us that for the better prosecution of the war, there is need for the creation of still one more committee. This, superficially, does not have the appearance of adding to our popularity, but there is a serious gap in the organisation of the steel foundry industry, which requires filling. Through lack of foresight on the part of past Governments, the not inconsiderable steel foundry industry of the last war was allowed to shrink during the slump to dangerously small proportions. Just before and during this war there has been a very considerable expansion; moreover, old-established firms are being required to tackle new types of jobs, and some make an immediate success of them, whilst others require more time than can be spared at the present for getting into production. The weights of some castings vary in order to take care of machining allowances by more than 25 per cent. This, *inter alia*, causes much coming and going between foundries inspecting each other's methods. A comparison with the iron foundry organisation reveals exactly where the steel foundry industry is weak. In ironfoundry, research work is carried on by the B.C.I.R.A., which additionally and probably preferentially is undertaking much development work. That is, it makes itself familiar with new jobs, and where difficulties in production arise, it sends its officers to the actual foundries to get things going. Then the Directors of Iron Castings have their own technical advisory committee, and so has the Council of Iron Foundry Associations. Moreover, a committee of the Institute of British Foundrymen has been energetically employed in creating, what eventually turned out to be a group of steel foundries!

The steel foundry is well served for pure research work, through the joint auspices of the British Iron and Steel Federation and the Iron and Steel Institute, supported by the General Steel Castings Association—but there is no development and advisory work in progress such as there is with iron castings, and this is the very committee we suggest should be formed. Moreover, the committee we visualise would not be merely a periodic assembly of half-a-dozen or so of the better known foundry managers, but the reinforcement of such a body by a high grade competent official supported by a staff. The work of this permanent and perhaps somewhat curious committee would include questions of standardisation, of design, and of methods of moulding, composition of metal fuel economy, and technical help in achieving the production of high grade castings. It would advise the Director of Steel Castings and co-operate with the fighting services in the simplification of design. We leave the obvious utility of such an organisation for post-war development to the imagination of the leaders of the steel foundry industry. The American counterpart of the General Steel Castings Association has provided all the necessary pointers. It is obvious, that by the creation of such an organisation as we have outlined, that the industry will gain in status, for it must be borne in mind that employers' associations (except those negotiating with the trade unions) exist for three purposes only. One is to ensure an economic return for their efforts; the second to provide a voice to speak for the industry in matters concerning Governmental orders and other influential bodies, and the third, which we rate as of equal importance, the giving of service to its customers. At the moment, the all-important customer is the Government through its various departments, and we have every reason to believe that the step we propose will be enthusiastically received by the clientele. We sincerely hope that our proposals will be equally well received in steel castings circles.

Book Review

New Methods for Sheet Metal Work, by W. Cookson. Published by The Technical Press, Limited, "Piccancot," Gloucester Road, Kingston Hill, Surrey. Price 7s. 6d.

The reviewer often wonders whether or not an engineer's patternmaker could derive advantage from a study of the methods used by sheet metal workers in setting out their jobs. The main difference, of course, is that metallic sheets can be bent, and wood cannot, yet when one examines the patternmaking for a propeller, consisting, as it does, mainly of sweeps, one sees that there can be a connection. This book appeals to the reviewer as being much more practical than the average treatise on the subject; the illustrations, which are so very important in this type of book, are particularly clear. Added interest is given by the fact that entirely new methods are disclosed.

Contents

Protection Against Industrial Dust*

By KENNETH L. GOODALL, M.Sc., F.Inst.P.†

Industrial dust presents two main hazards to the workers in factory and mine: (1) risks to health, *(2) risks to life and limb through fire and explosion* from certain types of dust. Many factory operations give rise to dust, the chief including crushing, breaking, disintegrating, grinding, abrading, drilling, sawing, turning, mixing, sieving, rumbling, sand- or shot-blasting, and almost any operation involving material which is itself a dust or contains a percentage of dust.

The risks to health from industrial dusts arise from the damage they can cause to the respiratory system, and from the action of certain dusts as general systemic poisons or skin irritants. Thus the inhalation of silica or asbestos dusts, which is cumulative in effect, can cause the incurable lung diseases of silicosis and asbestosis respectively, in which the lung tissue is gradually destroyed, with the result that blood aeration diminishes; the inhalation of animal or vegetable dusts, and of some mineral dusts such as limestone, glass, cement, marble, and emery may affect the respiratory passages and give rise to bronchitis, asthma, or catarrh. The breathing of certain metallic oxide fumes such as zinc oxide, magnesium oxide, manganese dioxide, and copper oxide, can give rise to metal fume fevers, while the inhalation or swallowing of certain toxic dusts such as lead, arsenic, cadmium, or manganese, and their compounds, leads to poisoning. Of these dangers to health the most serious are undoubtedly those due to silica and asbestos dusts and to the poisonous dusts such as lead.

Physical principles are involved at many stages in the estimation and control of dusty conditions in the working atmosphere.

Protection Against Industrial Dust

By a suitable combination of the physical and physical-chemical methods which are described in the Paper, a fair assessment of the amount and nature of the dust clouds being breathed by workers in any particular case can be made. Methods of protection to suit can then be devised. This is the ideal approach to the problem which can only be adopted at present in a limited number of cases on account of the time involved in such surveys. In practice a selective survey of dusty conditions associated with typical processes in an industry offers valuable guidance for more general application of protective measures to generally similar conditions in a whole industry.

In the normal individual the human nose, throat, and lungs in themselves provide a defensive mechanism for arresting fine dust and preventing its reaching the ultimate air sacs in the lungs. The nose traps large particles in the nostrils and finer particles in the maze of passages above the nostrils in which dust is deposited from eddy current action, particle aggregation, and from impingement on the sticky secretion of mucus which lines all the air passages from the nose downwards. The windpipe and air tubes of the lungs are also lined with minute whip-like processes known as cilia, whose function is constantly to sweep upwards to the windpipe for expectoration the mucus and the dust particles it has trapped, the process being aided by the rhythmic contraction of the smaller muscular air tubes. Fine particles which succeed in reaching the air sacs of the lung are attacked and ingested by phagocytic cells, some of which manage to carry the dust back into the air tubes where they can be expelled. The importance of nose breathing in dusty atmospheres, in order that all the natural defences of the respiratory system may be brought into full play, will be appreciated, though individuals differ widely in the power of these defences.

The main methods of protection against industrial dust take a wide variety of forms. The purpose of general ventilation is to dilute with fresh air the dust laden air liable to be breathed, so that the resulting dust concentration is below the toxic or otherwise harmful limit. Such ventilation can take two forms, the extraction system with wall fans removing the contaminated workroom air, which is replaced by warmed fresh air, entering through suitably disposed openings in other parts of the room, or the plenum system in which clean, warmed and possibly humidified air *is blown into the workroom under slight positive* pressure through a ducting system, the air finding its way out *via* doors, windows or other openings. These methods of dealing with dust in workrooms, or a combination of them both, are of strictly limited application and are only successfully applied where the dust concentrations are generally disseminated in the workrooms. Even then, the use of general mechanical ventilation is often a confession of failure to provide what is more effective, namely, adequate localised exhaust ventilation.

Localised Exhaust Ventilation

Localised exhaust ventilation is the commonest and most usually effective way of protecting workers against local dust concentrations. The basic idea is to capture the dust or fume as near as possible to its point of origin by means of concentrated air currents flowing into suitable exhaust hoods, which need to be designed on sound physical principles to suit each individual case. The collected material is sucked away through ducting by a fan and passes to filtration plant. It is found that most industrial dusts can be captured by exhaust hoods designed to produce a linear air speed of from 100 ft. to 500 ft. per min. at the point of origin of the dust.

Ducting resistance is an important item contributing to running costs, and proper application of the laws governing the flow of dust-laden air in pipes will enable resistance to be reduced to a minimum by securing a symmetrical layout of adequate sectioned piping, fed by branch ducts at small angles in the direction of air flow and provided with gradual bends, tapered connections to fans, cleaning panels suitably sited, smooth joints and the like. The type of fan used for dust exhaust systems is the paddle type, receiving the dusty air approximately radially and discharging it tangentially against resistances which may reach as high as 14 in. w.g. In many cases the fans are placed downstream from the air cleaning plant, which is thereby kept under suction, an advantage where filters are, against the best practice, sometimes located in workrooms. The fan itself also thereby handles practically clean air.

The main types of dust collecting apparatus are all based on physical principles and include gravitational and centrifugal settling chambers, inertial separators, viscous type filters, wet scrubber filters, bag filters and electrostatic precipitators.

Considerable use is also made of the wetting of materials to prevent dust creation, but Watson has pointed out that in certain cases this practice may be more dangerous than dry working. In some cases safe material may be substituted for dangerous dusty material, for example in the classic cases of the substitution of steel shot for sand in the operation of sandblasting iron castings, and of alumina for powdered flint in the process of china bedding in the pottery industry.

All dusty processes should, of course, be separated from other processes so as to limit the number of workers exposed to any particular dust risk. By what is called "good housekeeping" a great deal can be done to protect workers from dust; for example by widely spacing dust producing machines, by storing dusty materials not in immediate use outside workrooms, and by keeping plant and workrooms as clean as possible, preferably with the aid of vacuum methods of cleaning. The periodical medical examination of workers now required statutorily in a number of dusty industries is of great value, whilst much may also be achieved by the education of workers in the risks they run, and in their personal responsibility for preventing and suppressing dust clouds. A respirator of good design and with high filtering efficiency for low breathing resistance is useful as a secondary line of defence against dusty conditions.

Fire and Explosion Risks

The extent to which protection is needed against the risk of fire and explosion from many industrial dusts under certain conditions is not generally realised, yet such dust fires and explosions frequently involve serious loss of life and injury to workers, and extensive damage to factory premises and plant. Examples of dust liable to burn or explode under appropriate conditions are pulverised coal, sugar, dextrine, cocoa, various cereal dusts, cork, shoddy and rags, sulphur, wood flour, various resins and dyes and plastics, malt, tea, magnesium and aluminium, to name but a few.

Oxidation of combustible material is a surface phenomenon, and so is most rapid and capable of causing explosion with material in the finely divided state, *i.e.*, with dusts, and particularly when these are in suspension in air as dust clouds. The increase of surface area with decrease in constituent particle size, for a given weight of dust, is striking. Thus Berger, on the basis of certain assumptions, shows that the surface of a cube of aluminium weighing 1 grm. is approximately 3 sq. cm., whereas if the cube is comminuted until the thickness of the resulting lamellæ is 20 μ (coarse stamped powder), the surface increases to 429 sq. cm. If the process is continued until the thickness of the lamellæ is reduced to 0.6 μ (fine stamped powder) the surface of the 1 grm of metal becomes 14,290 sq. cm., while for the finest powder (prepared *industrially in large quantities*) with lamellar thickness 0.3 μ, the surface of a gramme becomes 28,570 sq. cm. The increase in intensity of explosion of dust clouds with decrease in constituent particle size is also of interest in this connection. Gliwitzky obtained the following figures from experimental explosions of three types of commercial aluminium pigment powder in a bomb of 53,000 c.c. capacity, for two powder concentrations.

Particle size μ	Duration of explosion (sec.) for 700 mg. per l.	Explosion pressure (atm.).	
		700 mg. per l	580 mg per l.
1·2	0·06	7·7	7·7
0·6	0·03	8·6	9·2
0·3	0·012	10·6	11·6

The maximum pressure of 11.6 atmospheres for a powder concentration of 580 mg./l is higher than the maximum pressures recorded for the explosion of gas/air mixtures, including the hydrogen/oxygen mixture with which 9.7 atmospheres has been obtained. Pressures up to 18 atmospheres have been recorded for coal dust and flour explosions at certain concentrations and finenesses. Much greater values still have been measured for starch dust. The dangerous potentialities of the finely divided carbonaceous and metallic dusts for fire and explosion are manifest, since factory buildings, unlike mines, are not capable of withstanding such high pressures and rates of pressure rise. For each combustible material there is an upper and a lower limit of concentration and beyond these limits the material will not burn. Within these limits there is also a minimum temperature or "ignition temperature," below which the material will not ignite. Safety measures against dust cloud fires and explosions therefore aim fundamentally at keeping concentrations outside (and in practice usually below) the inflammable concentration limits, and avoiding sources of ignition; and if this should not be successfully achieved and a fire or explosion should result, one should aim at so designing the plant concerned and arranging the manner of working the process that there is a minimum of damage to workers and plant.

Electrostatic Charges

It is of interest, in connection with sources of ignition, to mention that electrostatic charges are known to be formed when powder issues from nozzles, or is blown into a dust cloud, or rubs frictionally against machine surfaces. Belts running over pulleys also accumulate charges. Discharges of such accumulations may ignite dust clouds, and although very little is known about this danger, it needs to be taken into account. Safety measures take the form of keeping the air as humid as possible, or in special cases ionised, using electrically conducting belting or suitably earthed collectors, and of bonding all plant to earth to prevent accumulation of charges. It has also been claimed by Wolf that, where aluminium foil or powder is produced, it can be ignited not only by fire and sparks, but also by the effect of light.

In the case of grinding particularly dangerous dusts, such as magnesium, the only safe practice is to prevent any worker being in the mill room whilst grinding is in progress, to which end the grinding mill door should be so interlocked with the electrical control to the grinding mill motor that, unless the door is shut, the grinding plant cannot be set in motion, and the door cannot be opened until the current has been switched off and the mill has come to rest.

* Extracts from a Paper in the "Journal of Scientific Instruments," March, 1942.

† H.M. Engineering Inspector of Factories

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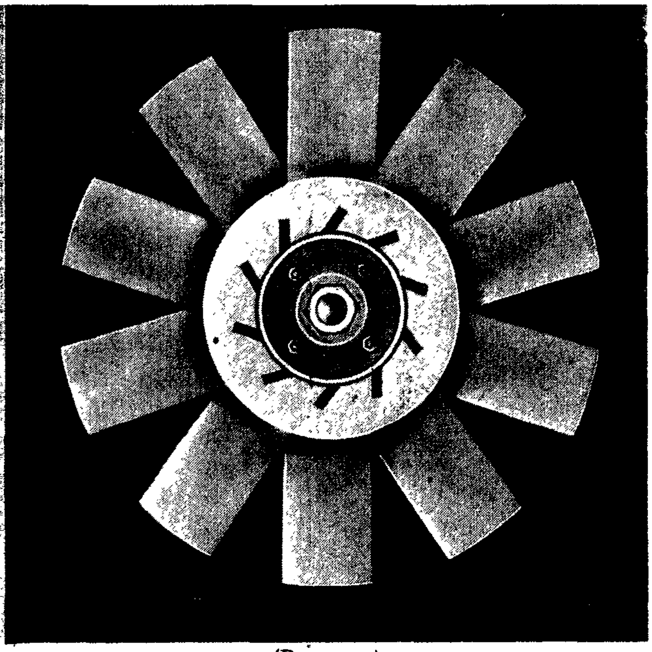

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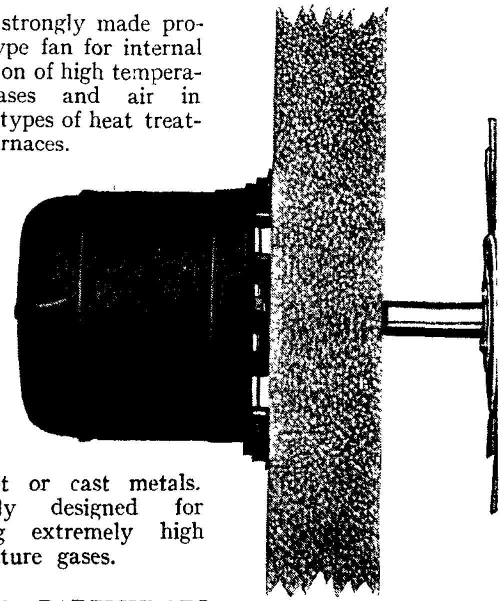

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