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# Exhaust Ventilation in Asbestos Textile Works

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**H.M. Engineering Inspector of Factories**

ASBESTOS, a unique mineral and, in some of its forms, very beautiful, is nevertheless an essentially utilitarian material, evidenced by its ever-widening field of service in modern social and industrial life. Capable of being spun into yarn and woven into cloth, or of mixing with cement, rubber, resins and other bodies to form a variety of useful products, it provides the engineering, electrical, building, chemical and other trades with materials of very great utility. These include a wide range of heat insulation products—asbestos fibre, magnesia, and so on, as well as the mattresses into which these materials are packed, asbestos cement sheets for roofing and other building work, brake and clutch linings, electrodes for welding, acid resisting filtering cloth, packings and jointings, and so on.

Unfortunately the dust of asbestos, if inhaled, is highly injurious to the worker in the asbestos factory, and asbestos, except where, as is rarely possible, it can be handled in a sufficiently wet state, or is impregnated with resinous or similar material, gives rise to much dust in very many of the processes necessary for producing the various asbestos products.

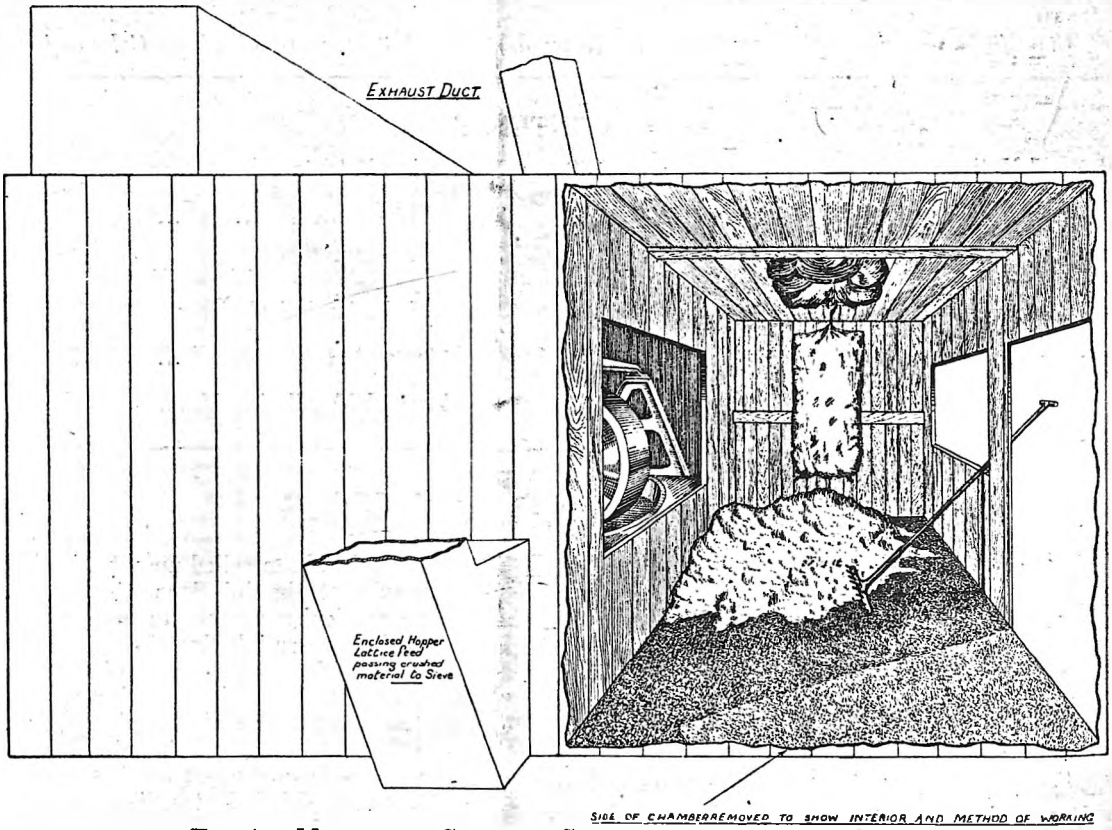


FIG. 1.—MIXING AND CRUSHING CHAMBERS, UNDER EXHAUST.

The fact that this danger existed remained for long unsuspected. Asbestos is a silicate, and contains no free silica. In other words, all the silica present is in the combined form. For many years, as you will all know, dust from the free silica has been recognised as very harmful, being capable, if inhaled, of producing a fibrosis of the lungs known as silicosis. On the other hand, dust from silicates has been regarded as comparatively innocuous, if

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not entirely so. This view is no longer tenable, at least as regards asbestos, which can also produce a specific fibrosis of the lungs, otherwise asbestosis. Those interested in this aspect of the matter will be well repaid by a careful reading of the Paper by my friend Dr. Merewether, of the Home Office, printed in the Journal of Industrial Hygiene for May and June, 1930. Dr. Merewether has made the subject peculiarly his own, and no one, as far as I am aware, can speak of it with more intimate knowledge.

The danger has come to light with a somewhat disconcerting suddenness. Asbestosis is of post-war recognition. In the last year or two, however, those concerned with industrial dust problems, or with Workmen's Compensation, have become familiar enough with the fact that there is such a disease.

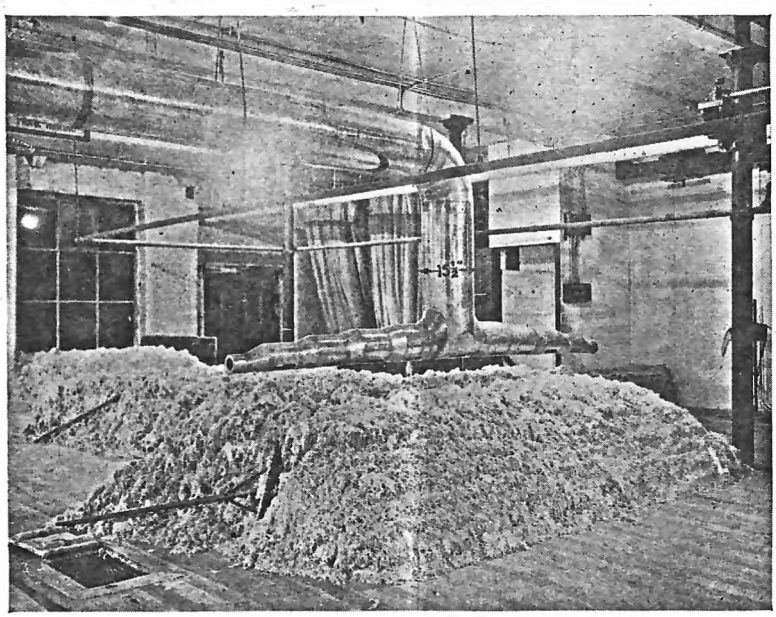

FIG. 2.—EXHAUST FOR BLENDING OF CRUSHED ASBESTOS.

Parliament, by an Act passed so recently as last year, has deemed it necessary to extend the benefits of the Workmen's Compensation Act to those suffering from it and with the object of its more effective control, provision has been made for the medical examination of workers engaged in certain of the more dangerous processes, by experts in chest diseases.

In addition, regulations under the Factory Act must be contemplated, to attack the evil at its source by requiring provision in the factories and workshops of effective means for suppressing and removing the dust created. In this connection, I may, perhaps, briefly refer to the official steps already taken. As you know, the Home Secretary has statutory powers enabling him to make special regulations for any dangerous trade or process carried on in a factory or workshop. Every effort is made to ensure that such regulations are based on a full understanding of the problem, and therefore the parties concerned, employers and employed, are consulted about the draft proposals before they are formally issued. It is very desirable to secure the greatest possible measure of agreement of all parties, and this procedure contributes to that end.

As regards the case before us, the Report* issued by the Home Office, in March, 1930, described the risk and made recommendations for dealing with it. To ventilating engineers, the most interesting feature of that Report is perhaps this that, of the various recommendations made, greatest stress is laid on the importance of applying efficient exhaust ventilation at all dust-producing points. The Report made clear, however, that there were difficulties, particularly on the textile side of the industry, in the way of adopting this measure and that a solution of these difficulties was very necessary and would involve some amount of experimental work. A Conference of Asbestos Textile Manufacturers was therefore called to consider the matter and this led to a Committee being formed, consisting of Trade and Home Office representatives. This Committee considered the processes in the textile factories in detail and came to a series of agreements concerning the steps which should be taken in each process to secure the adequate suppression of dust. Special attention was given, naturally, to the difficulties to which I have just referred, and the Trade representatives, in the search for a solution, made experiments in their factories. A gratifying measure of

*Report on Effects of Asbestos Dust on the Lungs and Dust Suppression in the Asbestos Industry. (Published by H.M. Stationery Office. Price 1s. 3d. net.)

success resulted, and some of the agreements are actually based on the results of these experiments. The way seems therefore clear for the issue of appropriate regulations. The Report of the Committee,* together with the agreements, and a series of illustrations, which I am sure will be of much interest to members of your Institution, was recently published.

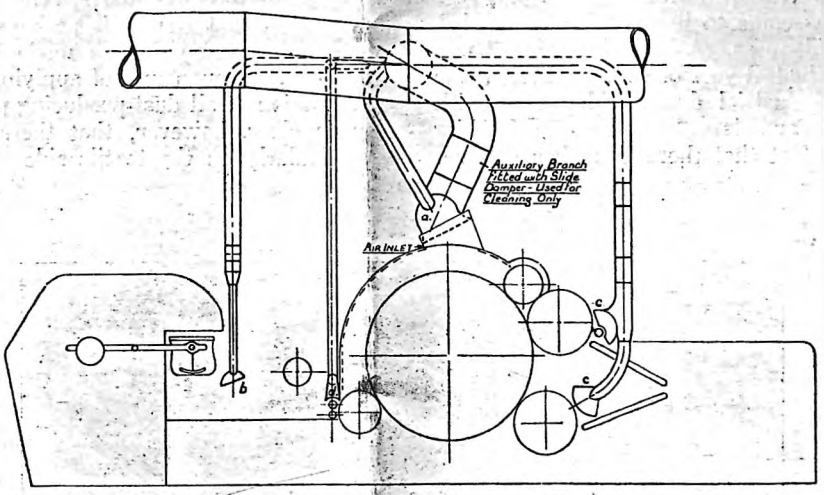


FIG. 3.—EXHAUST FOR CARDING MACHINE.
Applied at: (a) Cylinder head.
(b) Feed Apron.
(c) Fly Combs.
(d) Licker-in.

I have mentioned these somewhat official matters, because they are revelant to my subject, which is "Exhaust Ventilation in Asbestos Textile Works." I shall not attempt, in this short Paper, anything like a full survey of the various stages of manufacture, but I hope that in such partial treatment as may be possible, you will find something of interest.

Effective suppression of dust in the asbestos factory is not possible unless at each point where dust is produced, to such an extent as to present risk, efficient exhaust ventilation is applied. Now, unfortunately for the manufacturer and the workman, as we shall see, dust is produced in amount exceeding the safe limit, not only in processes such as crushing and grinding, in which one naturally expects to find evolution of large quantities of dust, but also in processes like weaving and even in some spinning. Such problems do not arise in other branches of textile manufacture, the reason for the difference being apparently due to the unique character of the mineral fibre which is very brittle and capable of infinite subdivision, there being no ultimate fibre comparable to that of wool, cotton, jute and the like. This subdivision happens whenever the conditions are favourable. The mere handling and cutting of a piece of finished, calendered asbestos cloth will give rise to visible dust, which shows how readily surface particles can be detached and broken up.

The asbestos imported into this country for textile manufacture has usually to be crushed and in all cases opened out, to supply the material in a suitable form for the carding process—the basis of all textile manufacture. The opening out, which is known as "fibreising," transforms the asbestos into

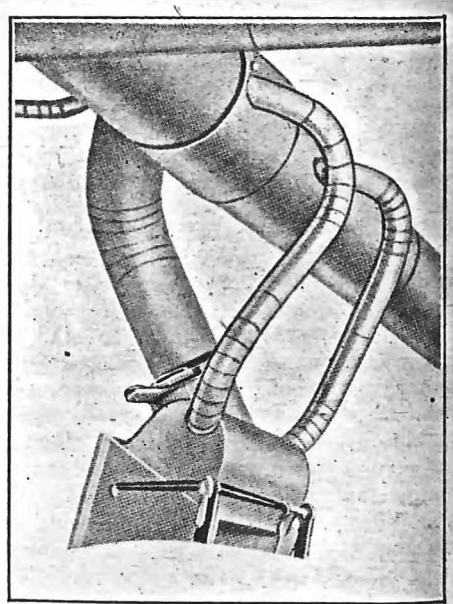

FIG. 4.—COVER HOOD AND EXHAUST CONNECTIONS FOR CYLINDER HEAD OF CARDING MACHINE.

*Report on Conference between Employers and Inspectors Concerning Methods for Suppressing Dust in Asbestos Textile Factories. (Published by H.M. Stationery Office. Price 1s. net.)

a flock-like condition, such as one expects to find in every textile factory at that stage of manufacture.

There is no special difficulty in enclosing the crushers and applying exhaust to control the dust generated in the crushing process. But it is the practice in the trade, both before crushing and after, to blend the material, to produce uniform "fibre" for the later processes. This blending involves emptying out a number of sacks upon the floor and raking the material over to mix it thoroughly. Large piles are formed in this way and much dust is produced. The dust from material spread out in front of the crusher cannot for obvious reasons be effectively controlled by the exhaust at the machine. Much thought has been given to this matter by one firm and a reasonable solution arrived at by the arrangement shown in Fig. 1. The crusher is completely enclosed, except at the large working opening, and powerful exhaust is applied to the enclosure. A large chamber is provided in front of the opening and the blending is done in it, but the men stand outside and use long-handled tools. They are also outside when the sacks are emptied, this being accomplished by means of apparatus, suspended from the roof of the chamber, which can be controlled from outside. As all the air extracted at the crusher passes through the mixing chamber, there is little or no tendency for dust to break out, and in fact the dust produced in sack emptying and mixing is very well controlled by the draught. The men must enter the chamber to shovel the blended material into the pan, so that there is still some little exposure to dust, but the total exposure for the whole process is far less than formerly.

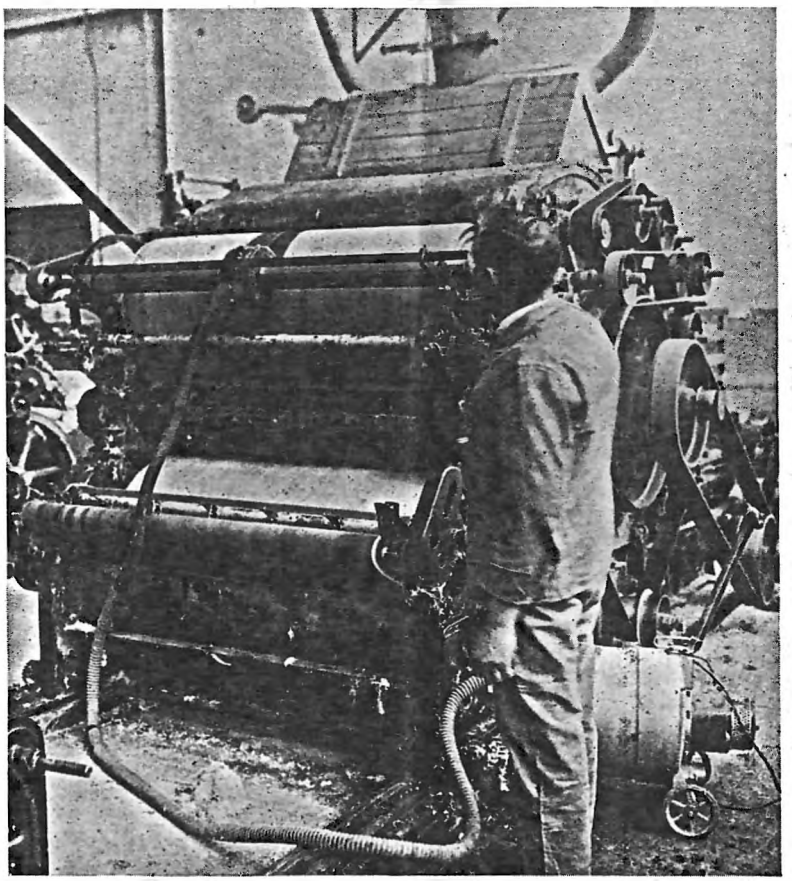

Fig. 5.—Portable Vacuum Plant for Card Cleaning.

The arrangement embodies another interesting feature, the crushed material being passed on to the next process, sieving, through a "trap" within the crusher enclosure. Continuity was achieved in this way by re-alignment of the machinery.

Control of dust produced in the blending of the crushed material is a more difficult matter. Up to the present, the only method I have seen of applying exhaust is that illustrated in Fig. 2. The draught acts directly above the middle of the heap. A full

solution of this problem will, it seems, not be arrived at until the process is accomplished by machinery.

I must pass rapidly over the subsequent opening processes. Opening machines include sieves, willeys, Crighton openers; they should be well enclosed, as they usually are, and kept in first-class condition to prevent leakage at the sides and at other points. The problem of dust control resolves itself in the main into devising methods of extracting the dust generated at feeding and delivery lattices, which is not difficult if the lattices are as fully enclosed as practicable. Bagging lattices, and particularly those of the reversible type, such as are now coming into use at opening plant, are valuable aids to the main dust suppressing method. I might also mention a further small detail in aid of dust suppression. Instead of the leaky sack formerly used for the internal transport of material within the factory, which gave rise to unnecessary dust, some firms are providing sacks of rubberised fabric which are quite dust-tight.

We now come to carding, which is done at machines of the roller and clearer type. The process gives rise to large quantities of dust at several points, and for some years past, and indeed before the risk of asbestosis was realised, exhaust arrangements were fitted to render the conditions less trying, but they were not very effective. Experience has pointed the way to improvements and some carding machines are now fitted with very efficient plant, as indicated in Figs. 3 and 4.

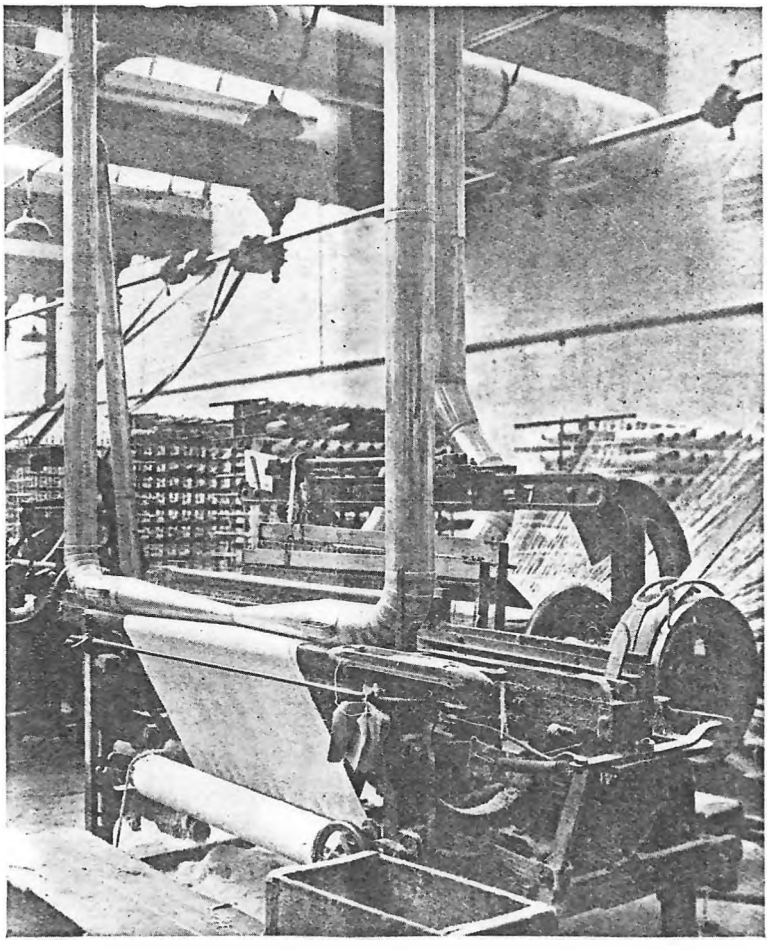

Fig. 6.—Exhaust Ventilation at Cloth Loom. Applied above Warp.

Pyramidal hoods have been discarded for the cover types shown, which are fitted with side branch ducts. Five cover hoods are provided, *viz.*, at the cylinder head, the two doffer combs, the feed apron and the "licker-in," each being specially designed to control the conditions at these points. The hood at the cylinder head shown separately in Fig. 4, is of particular interest. It is placed some 4 inches

above a rectangular opening in the wooden cover of the machine, from which the dust emerges. The wooden "valve," which rests during carding on the cylinder cover, closes the spaces under the hood at the back and sides, while the space at the front permits inflow of the air necessary to maintain the efficiency of the arrangement for removing the dust. The design not only successfully avoids the carrying away of valuable material by the exhaust, but enables the machine to be opened out for cleaning with the minimum of inconvenience. The large central branch duct, it should be observed, is used only while the machine is being cleaned, the damper being shut while carding is in progress. This hood has been developed by Messrs. Turner Bros., Asbestos Co., of Rochdale. The firm have placed at the service of the trade, full particulars of the constructional details and the air volumes removed, and they are given in the Report to which I referred just now.

to remarkable improvement. A revolving brush, fitted with a cover connected to a portable vacuum plant, is carried on a suitable mechanism for cross-traversing the cylinders. The apparatus is shown in Fig. 5. In view of this successful development we can forecast, I think, that the hand-cleaning method will soon become a thing of the past.

Finishing cards are fitted with the so-called condenser by means of which the web of fibre delivered by the doffers is condensed into sliver yarn. The material at the two sides of the condenser is, however, unsuitable for yarn, being delivered somewhat irregularly. It is, therefore, removed by pneumatic exhaust and collected by a machine known as a card waste end machine, so that it can be used over again. The small fan for creating the suction forms part of this machine. The usual type, which is quite small, often gives rise to much dust. The material is blown by the fan upon perforated

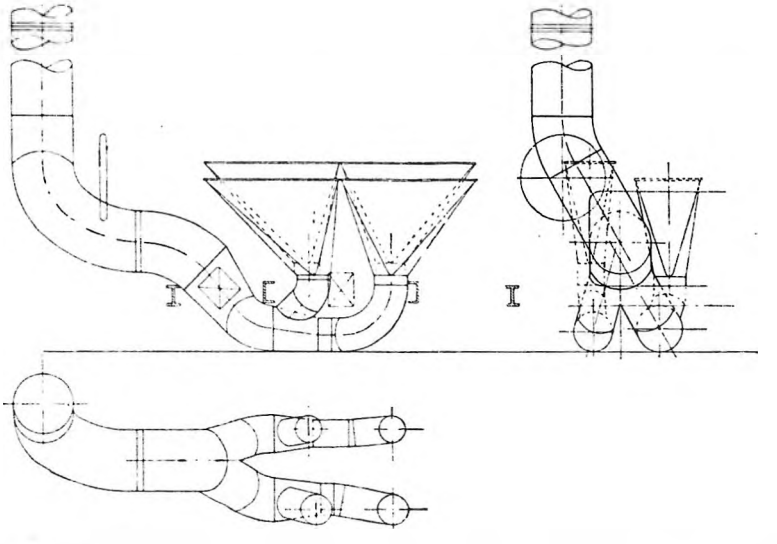

Fig. 7.—Exhaust Ventilation at Cloth Loom.—Applied under Warp.

Card cleaning, by which is meant the cleaning of the large cylinder and the two doffer cylinders, is an incidental operation, but calls for special notice, because it gives rise to terribly dusty conditions. To effect the cleaning the hinged covers are first lifted and the various smaller rollers are taken away. These rollers are cleaned at a separate machine. The three cylinders of the carding machine are cleaned with hand strickles and dust arises in dense clouds. Until recently the only means available for carrying away the dust was the exhaust draught at the cylinder hood. The large central branch duct was added to increase the air volume removed during cleaning, but even with this addition such arrangements could not possibly be satisfactory. The principle of vacuum cleaning has therefore been tried by one firm and has led

cylinders from between which it emerges as a "lap." The air finds its way through the perforations and escapes at the sides. As you can well imagine, the spent air is not free from dust, and moreover, if the delivery of asbestos falls off, as it often does, a veritable cloud of dust is blown out between the cylinders. This machine, like most of the machinery of the asbestos factory, was introduced from the older branches of textile manufacture, in which such a result might possibly not be of very great importance, but in view of the danger from asbestos dust it cannot be tolerated in the asbestos factory. The solution has been found by providing a machine in which the delivery cylinder is under suction and not under pressure.

Spinning, the next important process, is not free from dust, which is produced by the ballooning out

of the yarn from the rapid rotation of the spindles, and also when the yarn breaks. Flyer spinning gives rise to less dusty conditions than ring spinning. While the amount of dust evolved in spinning is not comparable with that produced in carding, it is unfortunately true that a number of cases of fibrosis have occurred among spinners, although in these cases a greatly increased period of exposure to dust, as compared with cases due to work in more dusty processes, was necessary before signs of the disease appeared. The question of precautionary measures for spinning has called for careful consideration, and the tentative conclusion has been reached that exhaust ventilation may not pede the process, and the plant is rendered as efficient as possible by a complete panelling in of the end frames and by panelling at the fronts of the frames from the floor level to the highest point compatible with the working requirements. Up to the present, so far as I know, flyer spinning frames have not been fitted with exhaust arrangements.

The final process to be considered in this short survey is weaving. Dangerous amounts of dust are given off, particularly in dry weaving—the usual method. The evolution results from the forward movement of the slay in the beating up at the cloth beam, the repeated contacts behind the healds of

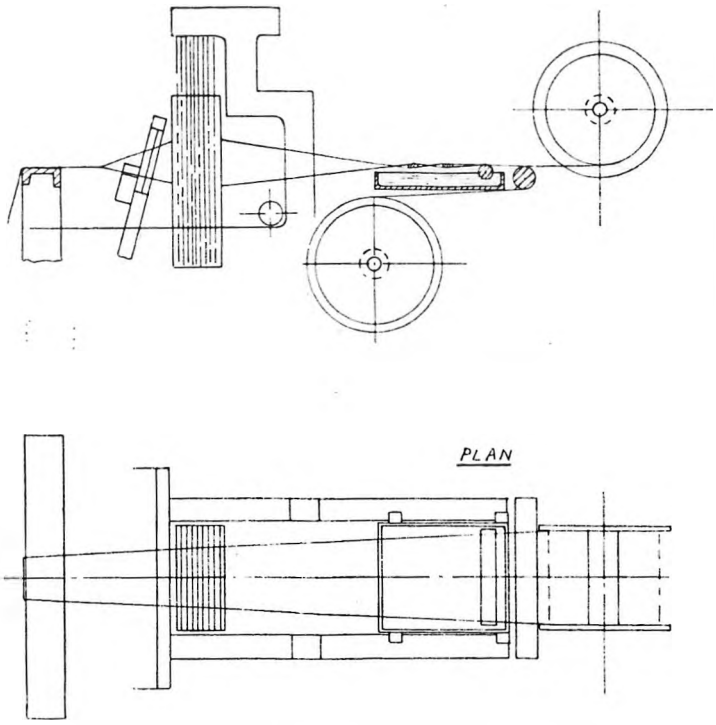


Fig. 8.—Arrangement of Water Tray and Idle Roller for Wet Weaving.

be necessary for flyer spinning if carried on under good general conditions, and where protection is afforded against dust derived for more dusty processes. Flyer spinning has indeed come to be looked upon at the present time as indicating what I may call "dust datum" conditions for the asbestos trade. By this, I mean that if, in any process, the dust exceeds that in flyer spinning, the need for exhaust ventilation may be regarded as established. On this basis, exhaust is necessary for ring spinning frames, and in one factory where this method is in vogue, a very satisfactory plant has been fitted and the dust concentration greatly reduced. The ducts are neatly installed under the creel board above the tin rollers, so as not to im-

the rising and falling warp threads with their neighbours, and the disturbance of dust or fibre on the looms, particularly the parts in motion. A fine dust cloud can always be observed at a dry asbestos loom.

As you might imagine, the fitting of suitable exhaust hoods at looms has presented no little difficulty as room for their accommodation is restricted. The difficulties are, however, being surmounted in some cases as the next illustrations (Figs. 6 and 7) show. Under-warp hoods appear to offer the best solution, provided the air volumes are sufficient. The dust, which otherwise rises above the warp and spreads through the room, is readily sucked downwards through the narrow spaces between the

threads. This arrangement offers rather a striking example of effective exhaust ventilation. When weaving is done wet, exhaust will not be necessary if dust is adequately suppressed. Fig. 8 shows one wet method; a water tray is fitted under the warp behind the healds, and the warp threads are damped by means of the partly immersed idle roller.

The settling of the dust removed from asbestos factories is accomplished in different ways, and the largest settling plants are usually well separated from the work-rooms. Some large firms have adopted textile filtration, while others have combined large settling chambers and cyclones, in series. The latter method presents the advantage of steady efficiency, even though collection of the deposited material is infrequent. Automatic shaking plants have not been installed in connection with bag or other filtering settlers, and some amount of beating is necessary. Wet settling methods are not used to any extent. Some small bag filters and relief balloons are placed in the workrooms, an objectionable feature. All such apparatus should be placed in parts separated from the workrooms, well ventilated to the open.

Some slight reference to the general ventilation and heating of the factories may not be out of place. From the foregoing account, it will be realised that the exhaust ventilation plant in many parts of asbestos factories is on an extensive scale and the air volumes extracted are therefore considerable. While under these circumstances general ventilation is never likely to be unsatisfactory, a very free inflow of air must be maintained to ensure efficient operation of the exhaust plants; also efficient heating is particularly necessary in cold weather, to avoid the risk that, in the attempt to secure comfort, the air supply will be interfered with by the workers and the efficiency of the exhaust reduced. In very many cases plenum ventilation on a large scale has been provided.

In conclusion, I hope you have gathered from this Paper that provision of efficient exhaust ventilation plant in asbestos textile works is a very important matter, and that in a large measure the health—indeed the lives—of the workers are dependent upon it.

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**The illustrations in this Paper are reproduced by permission of the Controller of H.M. Stationery Office from the Report on Conferences Concerning Methods for Suppressing Dust in Asbestos Factories (1931).**

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# The Equipment of Modern Rolling Stock.

**By A. E. Cook, M.J.I.F.**

ROLLING stock engineering covers a wide field, due to so large a variety in the design and system of transport to suit the many conditions for the conveyance of passenger and freight.

In such a limited time it is impossible to describe the many details connected with rolling stock, or at this stage to go closely into technical matters, as to do this each section would require a series of lectures, and, apart from an outline description of body construction, it is proposed to describe principally the undercarriage and general equipment. The subject is one of constant research owing to the rapid strides which are being made in the design and various improvements for additional passenger comfort, etc., both for road and rail vehicles.

## Ventilation.

Ventilation is an important item and a much discussed matter by passengers. The main aim is to change the air without draughts, which would be the case if all the air was changed in a compartment in less than, say, 12 minutes. About 180 cu. ft. of air is allowed per person; an adult at rest gives off about 0.6 of a cu. ft. of carbon dioxide per hour, and the atmosphere is regarded as impure when it contains six parts of carbon dioxide in 10,000.

There are various types of ventilators in use for which many claims are made. Open saloons are often fitted with louvre type vents over the side windows and found to give good results. Fixed side vents, which are sometimes fitted over side windows on motor 'buses with opening between inner and outer roof, are good extractors, which, if properly arranged, prevents the windows from clouding with moisture or what is sometimes called "steaming."

An air-conditioning apparatus was installed on dining cars in the United States with a view to improving the ventilation and atmospheric conditions; the full winter heat capacity of the car was turned on, this being intensified by heat from the kitchen and warm outdoor weather, and when the system was set in operation to counteract these effects the temperature was reduced in twenty minutes from 93° to 70° F. Refrigeration is accomplished by

**Extract from paper read before the Sheffield Section of the Junior Institution of Engineers.**