Milroy Lectures

ON

HEALTH HAZARDS IN THE COTTON
INDUSTRY.*

BY

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(Abridged.)

[In some preliminary observations Dr. Dearden quoted figures from the Registrar-General's occupational mortality tables, also mortality figures relating to Blackburn weavers, compiled by Dr. A. Greenwood and published in 1907, and Dr. W. A. Daley, published in 1923, to show the diminution in mortality among cotton operatives over certain periods, the relatively higher incidence of certain diseases (bronchitis and diseases of the circulatory system) among them, and the improvement in the health of the weavers, particularly during the last thirty years. He further quoted some morbidity figures which he had himself compiled from the records of the Card and Blowing-room Operatives' Society, based on more than 10,000 cases of sickness causing absence from work during 1922-24; these showed an excessive sickness incidence from bronchitis, pneumonia and pleurisy, rheumatism, influenza and colds, tonsillitis, and digestive troubles. His conclusion was that the health of all classes of cotton operatives was steadily improving, but that the various branches of the industry still exhibited a definite partiality for particular diseases and ailments.]

ATMOSPHERIC CONDITIONS IN COTTON FACTORIES.

Having arrived at certain conclusions regarding the diseases and ailments to which operatives in the cotton industry are particularly liable, we have to consider the various factors which can be shown to account for the excessive and selective susceptibility. The successive processes to which cotton is submitted in the course of conversion from vegetable down to plain cotton cloth demand certain definite atmospheric conditions. As the processes are operated under control by, and with certain assistance from, the human element, man and machine working together in the same confined space, it would appear essential that these atmospheric conditions should be so arranged as to be equally satisfactory to both the factors concerned. Considerable headway has been made in this direction since the close of the last century, but there are still difficulties to overcome before the ideal relationship is reached. I am satisfied, however, that the proposition is practicable, and I hope in what I have to say fully to support this optimistic statement.

In dealing with the influence exercised by temperature and humidity in cotton manufacturing processes, I propose to treat the subject, in the first place, from the cotton point of view, and afterwards from the human aspect. I will then endeavour to show where the two interests conflict, and what can be done to bring them into line.

THE REQUIREMENTS OF THE PROCESS.

Geographically our cotton towns and their surroundings occupy a dished-out area in the south-east of Lancashire, sheltered by the Pennine chain to the east and north, and by the Derbyshire hills to the south; only the west is open, and in that direction the land extends as a level plain to the sandy shores of the Irish Sea. There is thus ample protection from cold dry winds, and an open door to the temperate, moisture-laden breezes from over the water. The climate of this particular district is temperate, equable, and moist. The high percentage of moisture is due to the cooling influence of the hills on the warmer air of the plain, the relative humidity automatically increasing in proportion to temperature lost. The temperature of Blackburn is ordinarily about 2 degrees less than that of Liverpool, but the humidity averages rather more than

8 per cent. higher. The same conditions which produce a higher humidity percentage bring about an increase of the rainfall, but there is no closer relationship between the two.

Both spinning and weaving processes flourish best where there is little variation in atmospheric conditions, but weaving requires a higher relative humidity.

(a) *Spinning and Associated Processes.*

Under modern conditions the process of spinning requires a high temperature, which must be maintained as nearly as possible at one level throughout the year. This is due to the fact that by means of heat the individual fibres are rendered more pliable, and thus easier to spin, owing to the softening of their waxy content. The wax melts at about 80° F. Actually the temperature of a spinning room should be ruled by the class of "counts" going through at the time, but the effective temperatures range from 70-80° to 85-90° from the coarse to the fine counts. A certain amount of humidity is also required, and must be kept at an even percentage. Dry air makes the fibres brittle, interferes with their twisting properties, and produces a less uniform and weaker yarn. There is a limit, however, to effective moisture. In fine-spinning rooms it is found that a higher relative humidity than 50 per cent. interferes with the drawing out of the roving, though for coarse "counts," spun from cotton of lower quality and shorter staple, a humidity of 60 to 65 per cent. may be regarded as the limit.

In the preliminary processes of opening, scutching, and carding the natural atmosphere as modified by frictional heat is usually sufficient in Lancashire, except during cold weather, when the rooms are heated before beginning work. Card-rooms, where the process of carding, drawing, combing, and roving take place, have an ordinary working temperature of 70° to 75°, though some mills start work at much less than this without detriment, and even in July the temperature rarely exceeds 80°. The doubling of yarn is carried on under similar conditions of high temperature to those which obtain in spinning, and the heat may be very trying in the summer-time. As the practice has now become very general to drive the frames directly by electric motors, an additional source of heat comes into play, and at the same time air movement from running straps and pulleys is diminished. This means a greater call on ventilation. The common practice is to run the threads through water before twisting so that no question of artificial humidification arises. The natural atmosphere, with steam pipes for warming when necessary, and windows to open, meet the requirements for winding, reeling, beaming, and warping.

(b) *Weaving.*

In the early days of weaving cotton cloth by hand loom, high temperature was unobtainable, owing to the segregation of looms and the slow speed at which the process was carried on. Humidity, however, was an important condition, and a damp out-building or half-cellar was considered a good asset to the weaver. The advent of the mechanical loom, with the concentration of large numbers of these machines under one roof, and the increased speed at which they were driven, brought about the first change in the requirements for efficient weaving. A higher temperature in the weaving space was a natural consequence, and this was found to be beneficial by preventing breakages. The humidity percentage was lowered, but, with the aid of evaporation from the workers and the nature of the site usually selected, was found to be sufficient. Next came a demand from Eastern markets for a very cheap type of cotton cloth. To provide this at a profit meant high-speed production, and the loading up of the yarn with foreign material. The friction of the shuttle and reed against the warp at high speeds has a tendency to produce electrical trouble with the warp threads, and therefore an increase of humidity is called for to neutralize electrification and increase the tensile strength of the yarn. The earliest method of increasing the natural humidity was by the use of raw steam, and the factories in which this method was employed were known as "wet" sheds, in contradistinction to factories where artificial humidity was not required, which were known as "dry" sheds. The latter are said to number 61 per cent. of the sheds in

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this country, and there the better quality and more elaborate varieties of cotton cloths are produced.

Lander states that 70° F. is the most suitable temperature for weaving purposes. From numerous shed records I have examined it would appear that this need not be exceeded. In practice, however, high temperatures are the result to a large extent of demands for a high percentage of humidity and the utilization of steam, and this was particularly exemplified in the days when raw steam issuing from unlagged pipes was the sole method of providing this humidity. It is now generally agreed, according to Lander, that an average humidity of 78 per cent. is a reasonable amount for materials commonly woven in humid sheds. The popular view that the efficiency of the process in humid sheds, within certain limits, increases with the temperature or relative humidity is supported by Wyatt (1923), who considers that "under existing regulations the best conditions for productive efficiency in weaving in humid sheds of the type under investigation seem to be obtained with a dry-bulb temperature of 70° to 75° F., and a relative humidity of 80 to 85 per cent." In view of the divergence of opinion among manufacturers it would be the proper course, from the standpoint of weaving efficiency, to establish an experimental shed and make an exhaustive series of tests with a view to ascertaining the most suitable temperatures and humidities for warps of different tensile strengths and with varying percentages of size.

PHYSIOLOGICAL AND PHYSICAL CONSIDERATIONS.

[Dr. Dearden then recapitulated the known facts regarding the generation of body heat, the regulation of body temperature, and the reaction of the regulating mechanism to atmospheric and other external factors. He mentioned the observation of Haldane, who, experimenting with men stripped to the waist, found that the limit of wet-bulb temperature which could be endured in still air was 88° F. when resting and 78° F. when ascending steps; and of Vernon, who pointed out the influence of acclimatization in increasing the endurance. Air movement counteracted both the ill effects of rising atmospheric temperature on convection and the bad influence of humidity on evaporation. He then continued with a description of the kata-thermometer (for short the "kata"), an instrument designed by Professor Leonard Hill primarily for the measurement of its own rate of cooling when its temperature approximates to that of the human body.]

At an early period of his investigations Professor Hill recognized the importance of being able to obtain some definite indication of the extent to which the external atmosphere could carry out its function of removing the excessive heat generated by the living body. He therefore sought out a means of measuring atmospheric cooling power. The theory of the kata-thermometer appears to be that the rate and amount of heat lost from a given surface of a body at the same temperature as the human body should indicate fairly accurately the loss from an equivalent surface of the latter when exposed to the same atmospheric conditions. When the uncovered instrument is used the resulting figure shows the amount of heat dealt with by radiation and convection, and is known as dry kata cooling power; when the bulb is covered with a wet silk stall the calculated figure indicates in addition the heat lost by evaporation, and is known as the wet kata cooling power. The difference between the two results, when both methods are being used, indicates the cooling power exercised by evaporation only. This was followed up by ascertaining what dry and wet kata figures under fixed conditions of heat production correspond to atmospheric conditions yielding the greatest feeling of comfort to the individual. Hill has come to the conclusion that a dry cooling power of 6 and a wet cooling power of 18 may be taken as indicating the most suitable conditions when light work only is carried on. I do not insist that as standards these represent finality, and that they will not be subjected to some modification as the result of larger and more varied experiences; but I do recognize their present utility as standards, and the consequent facility they give for comparison of results; if the upsetting factors are known allowances can be made for them when gauging the atmospheric conditions. The clothing factor, for in-

stance, is exceedingly variable. Hill found that a naked kata at 64.9° atmospheric temperature cooled two and a half times faster in a mild breeze than in still air at 61.3°, but that this rate was reduced to only 85 per cent. increase when the thermometer was covered with a silk stall, and to only 46 per cent. increase when covered with a woollen stall.

[Dr. Dearden also described an American system of assessing atmospheric conditions by the "effective temperature," but while appreciating its suitability to American systems of ventilation, he was not convinced that it could substitute for the kata-thermometer under the conditions which had to be dealt with elsewhere.]

THE MECHANICAL AND HUMAN INTERESTS IN ASSOCIATION.

(a) *Spinning and Associated Processes.*

I have now to show to what extent efforts have been made to reconcile the apparently conflicting interests of the mechanical and the human element, the faults still needing rectification, and the further accommodating measures which must be devised. The Report of the Home Office Committee on Ventilation of Factories and Workshops (1902) shows how much the manufacturing conditions and how little the human needs were studied not many years ago. The small number of mills that were reasonably ventilated and the still fewer mills that had combined ventilating and humidity systems had even then satisfactory temperatures and humidities, but the large number—nearly all spinning fine "counts"—which were not ventilated at all had, without doubt, unnecessarily high temperatures and humidities. Conditions have altered materially, and fine-spinning mills are now excellently provided with mechanical methods for filtering the air and for regulating the supply of air and the temperature and humidity. Dry and wet bulb thermometers are fixed up in the spinning rooms, and thus the indications for any necessary adjustments are provided. It is the custom to take regular readings twice a day, so that there are plenty of systematic records available for inspection and study. It has been my privilege to analyse a ten years' complete record taken at a group of four mills.

[Dr. Dearden here showed charts giving the curves obtained in respect of temperature and humidity in several rooms over a period of one year.]

The graphs as a whole show how closely the temperature and humidity conditions are confined within the limits I have previously given. The afternoon temperatures are higher than the morning ones, and the humidity percentages are kept at a fairly even level throughout both the day and the year. In two rooms the daily variation is between 1 and 2 degrees, and the monthly variation is kept well within the same range in spite of seasonal changes. The other rooms, though also showing equable results over the greater part of the year, appears to have been readily influenced by outside temperature during the summer. Where this occurred it was discovered that the humidifying plant could be regulated from inside the rooms, while, in the rooms in which the temperature remained even, this interference was not possible. Spinners will try to regulate the water sprays in hot weather if they have the opportunity, and each spinner in the room has different views on the subject, though all of them appear to be fond of a high temperature.

The humidity question requires more consideration than appears at first sight. It is true that, for the sake of the cotton, the percentage is kept low, but the fact must not be overlooked that the maintenance of the desired proportion means the provision of a considerable amount of moisture over and above that of the outside air at the high temperature required for successful spinning, and that it is the quantity and not the percentage which concerns the operative. The charts show how exactly the wet-bulb temperature rises and falls with the dry-bulb temperature; in well conducted mills the former is always above 70°, and frequently above 75°.

Air movement receives little encouragement in spinning rooms where fine counts are being dealt with. The conditions are often such that there is no appreciable air

movement a few feet away from the duct openings through which the outside air, driven along one or more tubes running the length of the room, emerges at regular intervals; the air exits are the doorways, of which there are generally two to a room. To ensure no air entering by unauthorized routes a slight plenum is aimed at, and when this is exceeded the swing-doors are pushed outwards, the escape of air relieves the pressure, and the doors coming together again are ready for the next puff. The deficiency in sensible movement at high temperature is reflected in some typical examples of wet kata-thermometer readings taken in August, 1926, which also show that diminution in cooling power follows elevation of wet-bulb temperature when there is no undue interference by air currents:

D.B. temperature.	W.B. temperature.	Wet kata.
94°	78°	9°
89°	76°	10°
88°	76°	10°
89°	74°	10.3°

Standing four feet from a doorway with one of the swing-doors two-thirds open a wet kata cooling power of 10 advanced to 18.8, and the dry kata showed an air velocity of 73 feet a minute.

The clothing of spinning-room operatives is also a consideration. The male workers in the spinning rooms are quite suitably attired for the work in cotton shirt or singlet and cotton trousers or blue overalls, but the females are not always clothed so suitably. The latter may simply take off the outdoor dress and don an overall, and whatever is under the dress, whether little or much, on the worker arriving at the mill, remains under the overall. Where "welfare" is in vogue, however, supervisors have made strides in establishing a more rational dress. Both sexes have bare legs and feet.

The spinner has to put up with high temperature and humidity, and, in fine-spinning mills, with a low air velocity, all the year round. For a short period in summer these conditions, more particularly in coarse-spinning mills, are intensified. He is, however, well acclimatized to this atmospheric state, and unless the temperature is excessive or he indulges in extraordinary muscular effort, he usually keeps his own temperature equilibrium. In the colder months of the year the change to a much lower temperature on leaving work, particularly to the overclothed, explains the special susceptibility to colds and influenza. On the other hand, Dr. E. M. Brockbank of Manchester has noted that cotton operatives under 50 years of age enjoy a somewhat remarkable freedom from the ill effects of high blood pressure, possibly owing to the removal of waste products of metabolism by perspiration.

What are the methods to be adopted to prevent the ill effects I have described? In the first place, the temperature necessary for the particular "counts" being spun should not be exceeded, and in no case should be allowed to rise above 90°. It is generally recognized that sweating should be avoided. That the temperature can be satisfactorily regulated, even in fine-spinning rooms which require the higher range, is amply demonstrated. Mills spinning at the lower counts have a lower range of temperature, and are satisfied with the outside air unaltered. In summer, however, they are more affected by extreme heat and solar radiation than are the exactly regulated fine-spinning rooms, and the temperature may rise to 100°. This necessitates artificial humidity, and where humidifiers are installed these are started when breakages become too frequent. The remedy is an increased air movement, and this type of mill could be most conveniently supplied with propulsion fans and ducts to assist the windows; water vaporizers acting in conjunction would be a distinct advantage.

Every effort should be made to instruct females particularly as to the most suitable attire. With the uniform high temperature in the fine-spinning rooms, bloomers, singlet or blouse, and overall are quite enough to wear, and this applies to other varieties of spinning during the summer months, though a skirt and blouse may

be added in the lower temperature rooms during the colder months.

With regard to the preliminary and subsidiary processes, in none of these is artificial humidity really required in Lancashire, nor, except in the doubling rooms, is the summer temperature excessive. As moderate air currents are not conducive to breakages or bad work, efficient ventilation by extraction fans with or without ducts can be safely utilized. Though some gassing rooms are still objectionably hot and stuffy, the modern variety are so efficiently provided with mechanical ventilation that the workers no longer suffer discomfort.

(b) Weaving.

Dry weaving sheds are not difficult to deal with, but wet sheds provide by no means an easy problem—a problem, by the way, which would not exist if manufacturers would so compound their warp size that artificial humidity would not be required. The cost of softeners and deliquescent in sufficient quantities is held to be prohibitive, and as moisture is not only effective as a softener but reasonably cheap to produce it seems unlikely that it will be superseded. Several sets of regulations have been produced with regard to excessive humidity in weaving sheds, and each set has marked a stage of improvement, each has placed a good "brick" in the protective wall around the worker, but I have formed the strong opinion that the most far-reaching effect is that produced by the compulsory standard of ventilation. The fact that this opinion was formed before the physical theory superseded the old chemical theory of ventilation does not affect my point. Quite a number of appliances for ventilation follow up-to-date precepts, and can deal with air either from inside or from outside the shed as desired.

An undue elevation of temperature invariably brings about adverse conditions affecting the individual. Legge found that weavers are subject to a rise in mouth temperature when the wet-bulb temperature exceeds 75°. Pembrey and Collis found elevation of temperature, quickened pulse and respiration, and lowered blood pressure when the wet-bulb temperature was much over 70°, and, like Legge, they noticed that the mouth temperature in women was consistently higher than in men, and this is ascribed to the greater amount of clothing worn. On the other hand, as the result of over 16,000 observations of body temperature in Indian mills, Maloney is of opinion that it is not possible to say that this begins to be adversely affected at a given wet-bulb temperature. Again, in addition to the chronic strain on the circulation from excessive peripheral blood supply during the eight hours of each working day having a tendency to diminish resistance, there is a susceptibility to chills on leaving work through the humid air at mill temperature having percolated shawls and coats hung up in the shed, as well as the clothes being worn.

The general principles, therefore, regulating the prevention of these ill effects are: reasonable temperature, suitable clothing, clothing kept dry whilst in the mill, and effective air movement.

[Here the lecturer summarized the 1911 Regulations (now approaching the out-of-date stage) in these respects. Whilst these had assisted prevention in many ways, the question of clothing was apparently out of their purview, and what was really wanted to effect a general hygienic practice in dress was a system of instruction by welfare workers or by leaflets. He also summarized Wyatt's report for the Industrial Fatigue Research Board (BRITISH MEDICAL JOURNAL, March 3rd, 1923, p. 389).]

The reports of both Wyatt and Maloney clearly indicate that, apart from other requirements, there should be means available for securing better air movement. In my opinion much could be done in this direction by fixing separate kata cooling standards for wet weaving sheds, though I am not prepared to say that Hill's standard for sedentary work would quite meet the case, but rather that the figures should be varied according to temperature. Something in the nature of 6 dry and 16 wet for temperatures below 70°, and 5 dry and 14 wet when above 70°, might prove reasonable.

DUST.*(a) Sources and Nature of Dust.*

Just as high temperature and humidity constitute the principal menace to the health of the worker in spinning and weaving rooms, so in the preliminary processes of preparing the raw cotton for further manufacture the principal militating factor is the generation of dust. Whilst all processes in cotton manufacture are more or less dusty, those of mixing, opening up, and carding are subject to a specially objectionable variety which renders the workers liable to develop diseases dangerous to life. The amount of dirt contained in the raw cotton, which has to be removed, varies with the quality of the staple. Where bale-breaking is still a hand process the worker has to put up with a considerable quantity, but where the modern mechanical method is in vogue dust is not nearly so much in evidence. Although modern cards are enclosed, there are several points where dust escapes, so that in most card-rooms there is a tendency towards a hazy atmosphere. A considerable amount of noxious dust arises from the brushing of the flats, but the most intense clouds are produced by the stripping of dirt and waste from the carding and doffer cylinders. Up to quite recent times the process of stripping was carried out in the open, but owing to the modern provision of a closely fitting tin cover with an exhaust attachment this evil condition no longer obtains in Lancashire. The newer method of stripping is worked on the lines of the ordinary vacuum cleaner. The clearing of the waste and dirt from the receptacles beneath the cards, openers, and scutchers is also a very dusty proceeding.

The dust arising in cotton manufacture, though mainly "vegetable," contains, in the preliminary processes of preparation, during weaving, and in the manipulation of the finished cloth, a considerable proportion of mineral matter. In breaking up the bales the dusty product consists mainly of short fibres. The opening and scutching processes bring away a considerable quantity of seeds, husks, and sand. Carding produces a dust made up of short and knotted pieces, seeds, broken husks, and, again, much fine sand.

Mill operatives in the carding and blowing departments are particularly liable to bronchitis. Cleaning out the dirt boxes beneath the machines, and, to a lesser degree, leaky brush covers, are in my experience the factors mainly responsible for this susceptibility. The symptoms one notices in strippers at work are undoubtedly those of asthma. There is pronounced dyspnoea, which is distinctly asthmatical in character and of a thoracic type, also a dry irritative cough, and a small but very sticky expectoration. A very noticeable feature of the complaint is the complete disappearance of the symptoms during the week-end at home. In imperfectly ventilated gassing rooms the atmosphere is quite hazy from the charred particles floating about, and the odour of burnt cotton is disagreeably pronounced. The dust is very irritating, and I find that girls suffering from blepharitis or subject to conjunctivitis or catarrhal conditions of the respiratory mucous membrane are markedly affected. Workers in ordinary health, however, soon get acclimatized, though among some I notice a distinct tendency to anaemia and a liability to headache, dizziness, and lassitude—symptoms which in my view are the result of imperfect removal of the unburnt products of the Bunsen gas flame.

(b) Preventive Measures.

In the preliminary breaking up and decompressing of the raw cotton, dust is very successfully prevented from polluting the atmosphere by the unbroken bales being placed directly into the hopper of the bale-breaker in the first instance, and subsequently conveying the cotton to the openers by exhaust ducts. In most Lancashire card-rooms the dust problem is being satisfactorily dealt with, though the coarser varieties of cotton still make considerable trouble. The more free use of humidifiers is effective in bad cases, but operatives do not favour this method, and personally I agree with them. If properly taken in hand, ventilation should do all that is necessary. The methods of cleaning away the dust and fluff deposited on the machines in card and blowing rooms are deserving of

attention. I think vacuum cleaners will in the future be universally adopted for cleaning cotton machinery, because they clean without throwing the dust into the air. Cases of asthma among men emptying dirt boxes can be satisfactorily prevented by the use of a suitable respirator. I have adopted a perforated aluminium and rubber one to cover mouth and nose. A strip of surgeon's lint placed inside this, which can be readily changed as desired, collects an enormous amount of dust. In gassing rooms the dust and fumes can be kept out of the surrounding air space and conducted outside the building by attaching an exhaust duct to each burner or series of burners.

FATIGUE.

In former days the continuous exposure to excessively high temperatures in hermetically sealed spinning rooms, or to the hot and almost saturated air of the wet weaving sheds, must have produced a definite and lasting impairment of constitution. The cotton operative generally is a much healthier individual to-day. Though the general improvement has been mainly due to circumstances explained elsewhere, I cannot ignore the important bearing which the reduction of hours of work must have on the whole subject. Granted the existence of fatigue in a particular industry, such a measure is the most direct and probably the most effective means which can be taken to bring about its reduction. Unfortunately, we have nothing in this country in the way of comparative statistics to show the direct effect of this important reform on the cotton operative.

The Industrial Fatigue Research Board published in 1920 what is apparently meant to be a preliminary treatise on individual differences in output to be found in various processes of the cotton industry and the extent to which production in each process depends upon human as opposed to mechanical efficiency. In mule-spinning and ring-spinning the chief feature was the comparative smallness of the mean variation and the slight differences between maximum and minimum values. Here the part played by the operative is very minor in comparison to that undertaken by the machine, so that there is little opportunity for the manifestation of individual differences in efficiency. In drawing, slubbing, and roving the human factor was more pronounced than in spinning, and less than in weaving. On the whole, the investigations show the extreme difficulty of trying to gauge fatigue in the spinning industry by output.

When temperatures are excessive—that is, over 90° F.—one does come across spinning-room operatives who show definite signs of fatigue, mainly, of course, towards the end of the day's work. It would also appear that mule-spinners suffer to an abnormal extent from varicose veins, varicocele, and flat-foot. In the matter of static fatigue, due to prolonged fixation of certain muscles through having to work in a strained position, the inquiry into bobbin-winding showed that any strained position taken up was only temporary, and that the ill effects were quickly rectified. The lifting and dragging of heavy skips and tins still requires some alteration. Provision should be made for this work to be done in all cases by men or well grown youths, and the most successful practice is to move the skips from point to point on low bogies running on tram-lines. It is also wrong for growing girls to carry even 27-lb. laps from scutchers to cards. They rarely attempt to get into the way of using each shoulder alternately, and are consequently liable to show some degree of lateral curvature of the spine.

The only systematic investigation of any definite value which the Industrial Fatigue Research Board has so far been able to carry out on the incidence and extent of fatigue in the cotton industry is described in the Report on Variation of Efficiency in Cotton Weaving (1923). Efficiency is shown to depend on two factors—namely, the number of loom stoppages and the ability of the operative to attend to them. Yarn breakages are the principal cause of stoppages, and the more numerous these become, through physical defects in the yarn or adverse atmospheric conditions, the greater is the loss in efficiency. The fatigue is measured by an ingenious method [described and illustrated by the lecturer] which takes cognizance of the

human as distinct from the mechanical efficiency, and it is shown that the highest efficiency is manifested on Tuesday mornings, after low efficiency Mondays; then there is a progressive decrease during the remaining mornings of the week. The efficiency is much less during the afternoon spells, and steadily diminishes in the afternoons from Monday to Friday. I think it is reasonable to suggest that this daily decrease is due to cumulative fatigue caused by incomplete recovery from daily fatigue, except on Monday mornings, when the low efficiency is due to the process of getting into the stride. The efficiency peak, in hourly variations, is in evidence from 8.15 to 10.15 a.m., and decreases each subsequent hour, except for the hour immediately after the dinner stoppage, but the drop commences sooner in the afternoon than in the morning.

Twister's Cramp.

In the report of the Chief Inspector of Factories for 1919 Dr. Bridge describes a disability among twisters, loomers, or twisters-in, as they are called, whose work it is to join the ends of a new warp to the warp ends of a woven piece. The overworking of a particular set of muscles produces a permanent condition of the hand which either prevents the worker from continuing his employment or precludes him from earning his former wage. The muscles of the left forearm as well as of the thumb and index finger are involved in a complex series of movements. The subjective symptoms are pain, tenderness, weakness, and loss of power. The principal physical sign is an unusual flattening of the thenar eminence of the palm. Bridge believes the cause to be a central nervous lesion, and in addition a local fibromyositis of the thumb muscles. As a considerable amount of this particular work is now done mechanically the disability should tend to disappear.

LIGHTING.

The modern spinning mill is well provided with window space, but owing to the length of the mule the rooms have to be of a width which in many cases prevents direct light reaching the centre. In weaving sheds, universally of one story, roof lights facing north are invariably adopted, but there is sometimes diminution of light from obstructive buildings. Prismatic glass might be an advantage for cotton factory windows. Artificial illumination is mainly provided by electricity. In the Third Report of the Departmental Committee on Lighting (1922) it is shown that there is a very general inadequacy in cotton factories. Weaving processes were found on the whole to be better lighted than spinning processes. Owing to the universal ignoring of the provision for effective shading of lights, glare is a very pronounced factor in all factory lighting systems.

INFECTIONS.

"Shuttle-kissing."

The practice of "shuttle-kissing" has to do with the threading of the shuttle-eye each time a fresh cop is placed in the shuttle. The weaver places the outside of the shuttle-eye to his lips, and with a strong inspiratory effort draws the thread through. This action may be performed by a four-loom weaver four or five hundred times a day, and although each weaver has his own set of shuttles, they may receive an additional kiss from the tenter, tackler, or overlooker. The diseases likely to be caused by this objectionable practice, according to the replies sent by fifty-eight Lancashire medical officers of health to questions circulated by the county medical officer, are syphilis, phthisis, diphtheria, caries of the teeth, skin diseases, septic throat, scarlet fever, and infective conditions of the mouth; but only five specific instances were given of actual transmission of disease, and even in these cases, though every one was carefully investigated, no justification was found for making the shuttle responsible for causation. Though "shuttle-kissing" may not have brought about all the ill of which it is suspected, there is no doubt that it is potentially dangerous to health. The newspaper campaign of 1911 stimulated invention, and a number of devices for shuttle threading without kissing came on the market. The Northrop loom, which has a mechanical shuttle-threading arrangement, causes no trouble during

weaving, and supports the view that practical methods are available for doing away with the need for this exceedingly bad habit.

Weaver's Cough.

In certain dry sheds the operatives have had an unusual type of cough and dyspnoea. An investigation by Dr. E. L. Collis, on behalf of the Home Office, showed that the warps used in these instances contained less than the ordinary amount of size, and that the usual antiseptic, zinc chloride, had been omitted. The warps had also not gone through the complete process of drying after sizing, and had developed mildew on being placed in the looms. A reversion to "dry taping" for all the warps cured the disease.

Infected Cotton.

In certain outbreaks of small-pox in the cotton districts in recent years it has been suggested that cotton may have conveyed the infection. The theory is that undetected mild cases exist among the negro cotton-pickers, and that, as all the tufts are handled in the picking, some of them may become infected. Two outbreaks certainly present some *prima facie* evidence inculpating the cotton. In one outbreak, in which there were eleven cases in one mill, the cases were distributed among the workers in the different processes, suggesting that the infection travelled with the cotton.

SANITARY ACCOMMODATION.

To the best of my knowledge, every Lancashire cotton district is provided with a good high-pressure public water supply, and practically all are served by well designed drains and sewers. Yet the closet accommodation is of a very insanitary type in quite a large number of factories. The water-closet system is the proper one for cotton factories, and in spinning mills accommodation should be provided for each sex on each floor. The absence of a public sewer is no deterrent in these days of the septic tank and filter bed.

Clean, well ventilated cloak-rooms, with hygienic metal lockers, perforated at the top, bottom, and in front, and capable of being sufficiently heated to dry wet clothing, are a necessity for cotton mills. The present practice of changing clothes behind mule creels is objectionable from the hygienic point of view, and, where the two sexes work together, from the moral aspect as well. All Lancashire cotton towns are fairly well provided with public baths. Workers in the spinning and doubling rooms, who necessarily perspire a great deal, have the greatest need to bathe frequently.

MULE-SPINNER'S CANCER.

In cleaning their machines most operatives get exposed parts of the body soiled with lubricating oil. Mule-spinners and piecers have a specially dirty task when cleaning the headlock gears, and also they are subjected twice each day to a definite impregnation of certain parts of their clothing with this material. The cotton trade was first made aware of the fact that mule-spinners were particularly susceptible to a form of skin cancer by an article in the *BRITISH MEDICAL JOURNAL* (November 18th, 1922) by Southam and Wilson, in which it was stated that out of 141 patients attending the Manchester Infirmary with epithelioma of the scrotum during a period of twenty years, 69 were mule-spinners. In a report published by a Special Committee of the Home Office (1926) [*BRITISH MEDICAL JOURNAL*, April 24th, 1926, p. 746] it was stated that 539 cases had been traced. The region involved was not invariably the scrotum, as first suggested, for 89 cases had other parts affected. Recent mortality figures show 23.3 per cent. in which the affection was elsewhere than at the scrotum. The growth is usually preceded by a warty formation which may exist for several years before becoming cancerous. When the mule is started the oil comes in contact with the spindles and is thrown off as a fine spray for about two minutes, the spinner getting the full benefit of this spray as he moves backwards from the advancing carriage, the result being that a distinct oily patch is to be seen on his trousers at the level of the pubes.

The remedy for this disease lies either in the provision of innocuous oils (not attainable until the actual carcinogenic

factor is known and a method of removal discovered) or in preventing contamination (a practicable solution). I cannot conceive that engineers famous for their conceptions of the most intricate self-acting motions ever adapted to any mechanical contrivance can be nonplussed by a spindle-bearing. Cleanliness must also be urged, and employers should arrange suitable washing facilities. Whatever is done, however, there must be a body of men already infected from whom a stream of fresh cases will be drawn, and that these should receive prompt treatment is an axiom in dealing with epithelioma. The Home Office Committee, with a view to detection of cases, very properly recommends medical examination every four months for all spinners over 30 years of age.

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ACUTE ABDOMINAL EMERGENCIES COMPLICATING PREGNANCY AND THE PUERPERIUM.*

BY

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THOUGH, owing to the lamented death of Mr. J. E. Adams, I have no surgical partner in opening this discussion, I intend to keep to the part I had agreed to take and to speak only from the standpoint of the obstetrician and gynaecologist. My chief object will be to point out to the surgeons how symptoms arising from pregnancy and its complications may make diagnosis and treatment more difficult in abdominal emergencies.

It would seem to be a reasonable supposition that the liability of women to acute mechanical disturbance of the bowel and to the spread of inflammation in the peritoneum would be greater during child-bearing owing to the increase in, and displacement of, the abdominal contents, followed by their rapid diminution after labour, and gradual return to the non-pregnant state.

Diagnosis is clearly the outstanding problem, because it is materially affected by pregnancy, which may introduce additional symptoms, such as vomiting, abdominal pain and distension, and jaundice. These symptoms are also those which are outstanding ones in acute abdominal emergencies. Further, the pregnant uterus becomes an abdominal tumour after the third month, and in its later stages so large that it interferes with the appreciation of abdominal physical signs.

*The introductory paper to a discussion by the Medical Society of London, February 28th, 1927.

Abdominal symptoms may arise either as part of a disorder of metabolism—the toxæmia of pregnancy—or from mechanical effects or abnormalities of the pregnancy or reproductive tract.

Vomiting.

Severe vomiting is not usual in pregnancy, and great caution must always be exercised before accepting pregnancy, *per se*, as the explanation of this symptom unless there is definite evidence to that effect. The vomiting of pregnancy usually begins as soon as the patient knows she is pregnant—that is, about the time of the first missed menstruation—and continues and may become aggravated from then onwards over a period of two or three months. It is usually more severe in primigravidae, but tends to recur in subsequent pregnancies in lessening degree. The vomited material is commonly food recently taken and little altered, but later of bile-stained fluid. Coffee-ground vomit is only seen in long-continued and in definitely toxic cases. Constipation almost always accompanies it, but an action of the bowels is generally obtained by enemata. The abdomen is usually sunken and not distended. Vomiting beginning after the fifth month without evidence of toxic origin is unusual and should suggest an organic cause; still more any vomiting that rapidly progresses towards a faecal type.

The cases, therefore, that particularly require investigation as to some cause other than pregnancy are those in which vomiting arises late in pregnancy (and not as a simple aggravation and persistence of the early morning sickness), in which vomiting has not occurred in previous pregnancies, and when there is no evidence of impairment of the renal and hepatic functions on clinical and biochemical examination. In cases of doubt treatment on the ordinary lines, usually by isolation away from home under capable nurses, should be tried for as long as the patient's condition permits, and if successful will settle the diagnosis. If there is definite evidence of renal or hepatic insufficiency, or if no improvement results from treatment, the pregnancy should be terminated. Early in my career I took over a case from a surgical colleague, an acute clinical observer, because he had discovered no other reason than the pregnancy for continued vomiting. The vomiting differed in type from the ordinary vomiting of pregnancy and there was no albuminuria or jaundice. Shortly after the termination of a seven and a half months' pregnancy an urgent operation was performed for obstruction from a carcinoma of the colon that became obvious very soon after the uterus was emptied. Many similar cases of gastrointestinal disease are recorded in which vomiting was wrongly ascribed to the pregnancy.

JAUNDICE.

Another type of the toxæmia of pregnancy that may cause difficulty in diagnosis is that characterized by jaundice, vomiting, and epigastric pain, suggesting gall stones or cholecystitis. Petersen,¹ in an analysis of 35 cases of gall stones during pregnancy and the puerperium, found jaundice present in 60 per cent. of 25 that occurred during pregnancy, whilst one case only out of 10 arising in the puerperal period had jaundice. Usually, in the toxæmic cases, vomiting is a marked feature and may become coffee-ground in character and albuminuria is usually present. In a case recorded by Banister and Stevens² from Queen Charlotte's Hospital as a "fatal case of acute hæmorrhagic hepatitis following toxæmia of pregnancy" the patient had jaundice with severe epigastric pain and tenderness in the umbilical area and to the right side. The temperature was 100° F. and the pulse rate 100. There was also referred pain in the left shoulder and hæmatemesis, and the authors of this paper considered these last two features as unlike a case of gall stones.

My colleague Mr. Maybury has kindly given me particulars and allowed me to quote a case of his illustrating the difficulty in differentiating gall stones from the toxic hepatitis of pregnancy.

The patient was aged 26 and about two months advanced in her second pregnancy. There was a history of her having had an attack of jaundice of a few days' duration about five years before; it began with pain in the left scapula, which soon passed off but